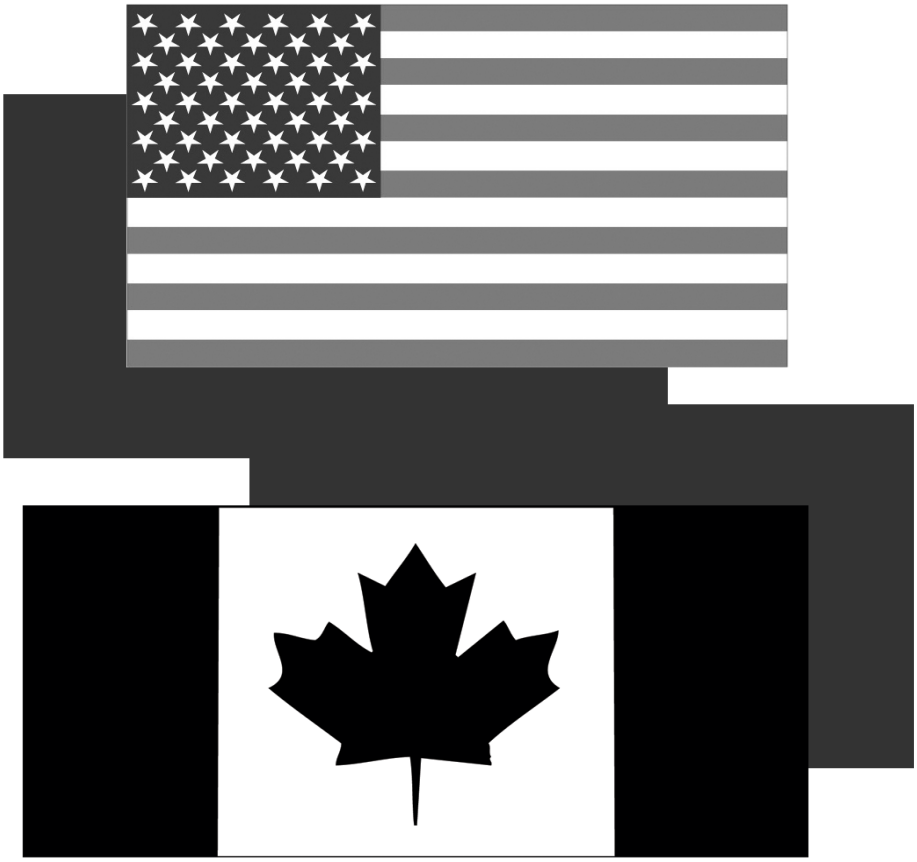
Report of the Technical Subcommittee of the Canada-United States Groundfish Committee

Forty-Eighth Annual Meeting of the TSC
April 24-25, 2007
Southwest Fisheries Science Center
Santa Cruz, California



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

Compiled by the Pacific States Marine Fisheries Commission

History of TSC Meeting Locations, Hosts and Chairpersons

YEAR	DATE	LOCATION	HOST	CHAIR
1984	June 20-22	British Columbia	Westrheim	Rigby
1985	June 25-27	Juneau, AK	Morrison	Westrheim
1986	June 19-19	Ashland, OR	Demory	Westrheim
1987	June 9-11	Seattle, WA	Jagielo	Demory
1988	June 7-9	Carmel, CA	Henry	Demory
1989	June 6-9	Ladysmith, BC	Saunders	Jagielo
1990	June 5-7	Sitka, AK	Bracken	Jagielo
1991	June 4-6	Newport, OR	Barss	Wilkins
1992	May 5-7	Seattle, WA	Jagielo	Wilkins
1993	May 5-7	Point Lobos, CA	Thomas	Saunders
1994	May 3-5	Nanaimo, BC	Saunders	Saunders
1995	May 2-3	Seattle, WA	O'Connell	Bracken
1996	May 7-9	Newport, OR	Barss	O'Connell
1997	May 6-8	Tiburon, CA	Thomas	Barss
1998	May 5-7	Olympia, WA	Jagielo	Barss
1999	May 4-6	Seattle, WA	Methot	Barnes
2000	May 9-10	Nanaimo, BC	Saunders	Barnes
2001	May 8-10	Newport, OR	Schmitt	Schmitt
2002	May 7-8	Point Lobos, CA	Barnes	Methot
2003	May 6-7	Sitka, AK	O'Connell	Jagielo
2004	May 4-5	Coupeville, WA	Wilkins	Jagielo
2005	May 3-4	Parksville, BC	Stanley	Stanley
2006	May 2-3	Otter Rock, OR	Parker	Stanley
2007	April 24-25	Santa Cruz, CA	Field	Brylinsky

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A. Overview and Terms of Reference

During the Conference on Coordination of Fisheries Regulations Between Canada and the United States (April 1959, Vancouver B.C.), the Ad Hoc Committee on Trawl Fishery Regulations recommended that the governments of Canada and the United States establish a continuing group made up of administrative and technical representatives of Oregon, Washington and Canada to review trawl regulations, to exchange information of status of bottom fish stocks, and to continue, enhance and coordinate bottom fish research programs. The Technical Sub-committee (TSC) was then created by the Committee on Trawl Fishery Regulations (now the Canada-U.S. Groundfish Committee) at the trawl committee meeting held in Seattle, Washington, on November 4, 1959. The TSC first met in Portland, Oregon, on January 19-20, 1960. Dr. K.S. Ketchen (Canada) served as Chairman. Member agencies at the time were the Fisheries Research Board of Canada (now the Department of Fisheries and Oceans), Washington Department of Fisheries (now the Washington Department of Fish and Wildlife), Fish Commission of Oregon (now the Oregon Department of Fish and Wildlife), and the California Department of Fish and Game. In 1972, two more agencies became members – the Alaska Department of Fish and Game and the U.S. Bureau of Commercial Fisheries (now the National Marine Fisheries Service).

The TSC has met at least annually since 1960 and submitted a processed report of each meeting to its Parent Committee.

These terms of reference did not apply to Pacific halibut, whose research and management are the responsibility of the International Pacific Halibut Commission:

1. Exchange information on the status of groundfish stocks of mutual concern and 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 aspects of existing or proposed management strategies and their component regulations relevant to conservation of stocks or other scientific aspects of groundfish conservation and management of mutual interest.
4. Transmit approved recommendations and appropriate documentation to appropriate sectors of Canadian and U.S. governments and encourage implementation of the recommendations.

The TSC has exhibited considerable flexibility in reacting to the diverse problems of the dynamic groundfish fishery off western Canada and the United States. It has coordinated coastwide fishery statistics and research projects; created working groups to deal in depth with specific problems; scheduled workshops at which appropriate specialists met to jointly deal with specific problems and exchange data and information; and provided an on-going forum for exchange of data, procedures, and regulations. The TSC has identified problems associated with the utilization and management of groundfish resources of importance to both countries; often well in advance of public or agency awareness. The concerns expressed in 1962 by the TSC over the development of foreign fisheries and recommendations for stock assessments were significant.

TSC-coordinated Canada-U.S. research on Pacific Ocean perch provided the basis for negotiation of bilateral fishing agreements between the United States and Japan and the USSR. Furthermore, the continually updated information provided the basis for quotas imposed in 1977 by Canada and the United States when they both promulgated their 200-mile zones of extended jurisdiction.

B. Executive Summary

The TSC met **April 24-25, 2007** in **Santa Cruz, California.** The meeting was hosted by the National Marine Fisheries Service – Southwest Fisheries Science Center. As is done each year, participants review previous year (2006) research achievements and projected current year (2007) research for each agency.

There continues to be significant informal collaboration between U.S. and Canadian staff in the research and stock assessment of such species as yellowtail, canary, yelloweye rockfish, sablefish, and more extensively, Pacific whiting. Nevertheless, the TSC suggested that assessment and management of these and other groundfish populations that co-exist near national boundaries would benefit from closer collaboration. One means for achieving this would be to include staff from both countries is included at pre-assessment workshops. This would help to ensure that all relevant data are brought to bear on the assessment and also act to stimulate long term collaborative research.

The TSC again noted the ongoing work of the Committee of Age Reading Experts (**CARE**) (http://care.psmfc.org/). TSC appreciates the work of CARE and recognizes that a direct link between the assessment biologist and the ageing lab is the most efficient means of requesting species ageing exchanges. The TSC noted that it will rely on fishery managers and stock assessment authors to interact directly with their ageing lab supervisors to communicate with CARE for ageing exchanges.

The TSC noted the interagency Sablefish Workshop was held at the Alaska Fisheries Science Center (AFSC) in Seattle in February, 2007. The two-day meeting was a success. Agencies gave overviews of their fisheries and research, and Dan Kimura (AFSC) and Delsa Anderl (AFSC) gave a presentation on sablefish ageing. The Sablefish Workshop summary is available from Cleo Brylinsky (ADFG) or by contacting Chris Lunsford (AFSC) at the Auke Bay Lab.

TSC also noted that organization is under way for the **2008 Western Groundfish Conference**. It is scheduled for February 4-8, 2008 at the Santa Cruz Coast Hotel in Santa Cruz, CA.

The Trawl Survey Working Group, created under the auspices of the TSC, met for the fifth consecutive year in February in Seattle. This Working Group has been successful in transferring technology and design features among the various survey groups operating in U.S. and Canadian waters. Mark Wilkins (AFSC) reported that during the 2007 meeting, three groups – DFO, NWFSC and AFSC – spent one day reviewing various survey topics. There exists the potential for a lot of bias when extending the bottom trawl data to untrawlable areas which is an issue for rockfishes of concern.

The GIS Working Group: The second follow-up fall workshop did not get organized as hoped. It was brought forward that since GeoHab will be meeting in Sitka April 29 to May 2, 2008, it may be possible to convene a GIS tools workshop in conjunction with this meeting. Lynne

Yamanaka (DFO) will send an email to the steering committee of the GIS workshop to see if there is any interest in pursuing this.

Field Data Acquisition Workshop Working Group: Mark Wilkins has reserved the Sand Point auditorium for December 4-7, 2007. The topic list will include biosampling, equipment and acquisitions, web based applications (field to headquarters), automated data stream integration into databases and quality control, and overcoming the challenges of very large data bases including video compression. There is interest in looking at other industries for techniques, i.e. police and fire departments.

Workshop on Acoustic Telemetry: The objective of the workshop will be to bring together researchers from California through Alaska to discuss approaches and techniques for conducting acoustic telemetry experiments in the unique environments and species present in the NE Pacific Ocean. Steve Parker, ODFW, has been interested in organizing a workshop to discuss all these issues, however he is moving to New Zealand in June for a year and possibly longer. It is hoped that Steve's replacement on the TSC will continue to pursue putting this workshop together.

The next meeting of the TSC will be held May 6 and 7, 2008 in Juneau, Alaska at the Alaska Fisheries Science Center's Auke Bay Lab. Dave Clausen will host the meeting and Cleo Brylinsky will chair the meeting.

C. Minutes of the Technical Subcommittee

Forty-Eighth Annual Meeting of the TSC
April 24-25, 2007
Fisheries Ecology Division (SWFSC/NMFS/NOAA)
110 Shaffer Road
Santa Cruz, California

Tuesday, April 24

I. Call to Order- Cleo Brylinsky, Chair, called the meeting to order at 8:38am, April 24, 2007

II. Appointment of Secretary- Lynne Yamanaka, DFO

III. Introductions

Cleo Brylinsky	Alaska Department of Fish and Game, Sitka *(cleo.brylinsky@alaska.gov)*
Dave Clausen	Auke Bay Lab, NMFS/NOAA Alaska Fisheries Science Center *(dave.clausen@noaa.gov)*
Claude Dykstra	International Pacific Halibut Commission, Seattle *(claude@iphc.washington.edu)*
John Field	NMFS/NOAA Southwest Fisheries Science Center, Santa Cruz *(john.field@noaa.gov)*
Larry Hufnagle	Acoustics Team, NMFS/NOAA Northwest Fisheries Science Center, Seattle *(lawrence.c.hufnagle@noaa.gov)*
Tom Jagielo	Washington Department of Fish and Wildlife, Olympia *(jagiethj@dfw.wa.gov)*
Kristen Munk	Alaska Department of Fish and Game, Juneau *(Kristen_munk@fishgame.state.us)*[1]
Steve Parker	Oregon Department of Fish and Wildlife, Newport *(steve.parker@oregonstate.edu)*
Stephen Phillips	Pacific States Marine Fisheries Commission, Portland *(Stephen_phillips@psmfc.org)*
Nick Sagalkin	Alaska Department of Fish and Game, Kodiak *(nick_sagalkin@fishgame.state.ak.us)*[1]
Rick Stanley	Science Branch, Pacific Biological Station, Fisheries and Oceans Canada Nanaimo *(stanleyr@pac.dfo-mpo.gc.ca)*
Diana Trager	Fisheries and Aquaculture Branch, Fisheries and Oceans Canada, Vancouver *(tragerd@pac.dfo-mpo.gc.ca)*
Mark Wilkins	NMFS/NOAA Alaska Fisheries Science Center, Seattle *(mark.wilkins@noaa.gov)*
K. Lynne Yamanaka	Science Branch, Pacific Biological Station, Fisheries and Oceans Canada *(yamanakal@pac.dfo-mpo.gc.ca)*

[1 All ADFG email addresses are scheduled to change ~July 2007, the new format is firstname.lastname@Alaska.gov]

Churchill Grimes, Fisheries Ecology Division Director, welcomed the TSC to the Santa Cruz Lab and presented a review of projects.

IV. Approval of 2006 Report

The 2006 Report was approved, and the addition of the title to the spine of the publication was acknowledged as a welcome change in formatting.

V. Approval of the Agenda

A discussion of transboundary species was added to the agenda.

The agenda was approved.

VI. Working Group Reports

A. The Committee of Age Reading Experts (CARE), Kristen Munk

Kristen reviewed the 2006 CARE workshop, and brought forward concerns from CARE on how ageing error affects population models and how agencies will cope with the recruitment, training and retention of age readers. There is a general forecasting of a 50% turnover of age readers through retirement and concern about how that will impact ageing labs. This is of particular concern regarding the more difficult species such as sablefish and slope rockfishes where the learning requires longer training. Kristen explained that there is a three to four month training process for new readers and then they move into a precision/accuracy analysis paired with an experienced reader. This process could take up to a year to bring new readers into production and possibly two years to have these readers proficient in more species. For example, yelloweye in SE Alaska is a difficult species to read. Age readers have a status code associated with their experience; training, novice, journey, expert. At some labs there is currently a problem with the recruitment and retention of age readers.

Rick Stanley asked whether agencies had considered a keypunchable format for age reading analyses that would capture all the nuances of ageing that are now transcribed in writing along with the individual fish age data. Kristen has a readability code that is entered into a database which gives managers a way to rate the confidence that the reader had in that particular age, but a range of possible ages is not entered. Rick wants to incorporate all the information on the ageing sheet into a database. Kristen does enter dependant and independent ages where the former is a resolved age. Tom Jagielo from WDFW captures some metadata about the age sample. No lab appears to make an attempt to capture all the annotations. It was decided that at the 2008 meeting we will discuss ways to capture ageing metadata in a database, on an individual, sample, or species level.

Another concern brought forward from Kristen was the need for some kind of programmer resources. Additionally, Kristen would like to request from TSC a species of interest. Yelloweye rockfish was one priority species requested by Farron Wallace (WDFW) at a meeting of the yelloweye working group in December of 2006.

B. Sablefish Workshop

An interagency workshop on sablefish was held at the AFSC in Seattle in February, 2007. It was well organised by Chris Lunsford and was attended by himself and Dana Hanselman (AFSC, Auke Bay Lab), Rob Kronlund, Malcolm Wyeth (DFO), Sean Cox (Simon Frazer University), Jim Hastie (NWFSC, Montlake), Sherri Dressel, Kyle Hebert, Cleo Brylinsky and Dave Carlile (ADF&G), and Franz Meuter (Sigma Plus Consulting) The two-day meeting was a success, agencies gave overviews of their fisheries and research, and Dan Kimura, and Delsa Anderl gave a presentation on sablefish ageing. Discussion began regarding an idea to pool data from the multitude of tagging and migration studies that each agency has conducted. Clear objectives need to be developed for the tagging data, i.e. what products would result, consideration of confidentiality issues, elements to stock assessment models, etc. No tasks were assigned. The TSC will work with this group and leave it as informal (not a formal TSC working group) to keep the momentum going. Michael Shirripa was absent from this workshop and Cleo will get in touch with him. Larry will follow-up with Michael also. The Sablefish Workshop summary is available from Cleo Brylinsky or by contacting Chris Lunsford at the Auke Bay Lab.

C. Trawl Survey Working Group Report (see report in Attachment 1)

Mark Wilkins reported that three groups, DFO, NWFSC and AFSC, spent one day reviewing various survey topics. There exists the potential for a lot of bias when extending the bottom trawl data to untrawlable areas, an issue for rockfishes of concern. AFSC is investigating a more systematic approach to looking at trawlable and untrawlable areas in the Gulf of Alaska. Preliminary analysis of trawlable and untrawlable was not as biased as expected. Ian Stewart from the NWFSC, presented a wave height and catch rate analysis. A 7 ft wave shows a 50% drop in catch rate. Steve Parker mentioned that the PICES meeting this year will convene a workshop on reconciling acoustics and trawl data. The PICES meeting is to be held in October in Victoria. Rick and Mark will put together a paper for the meeting on TSC efforts/accomplishments, (such as the trawl working group). Dave Somerton (AFSC) has led extensive research into trawl survey and gear performance, Mark Wilkins mentioned that Ken Weinburg is putting together a session at ICES in Helsinki, similar to the PICES meeting, on "Science Underpinning Stock Abundance Survey Practice". Rick received the NMFS keys to invertebrates, a laminated deck book to take to sea, in exchange for a survey planning tool (simulator) developed at DFO. The simulator is used to test the number of tows required within the survey strata to achieve desired precision in abundance estimates, and the effects of annual versus biannual surveys.

D. Field Data Acquisition Workshop Working Group Report

The idea of a workshop was brought to TSC by the IPHC. Mark Wilkins commented that the FISCUS system will be deployed on the research and charter vessels conducting trawl surveys. FISCUS interacts with the shipboard computing system that records oceanographic and positioning data. It receives data from measuring boards and scales on deck and integrates it with the shipboard data. The steering group comprised of persons representing the AFSC (Seattle), NWFSC, DFO, AFSC (Auke Bay), ODFG, and ADFG, organized a three day workshop, intended for late Jan-Feb. Due to budgeting and/or travel issues, this workshop did not happen. Therefore, Mark has reserved the Sand Point auditorium for Dec 4-7, 2007. The topic list is to include biosampling, equipment and acquisitions, web based applications (field to headquarters), automated data stream integration into databases and quality control, and overcoming the challenges of very large data bases including video compression. There is interest in looking at other industries for techniques i.e. police and fire departments. The steering committee is anticipating 3.5 days for this workshop which could possibly include a trade show component as well.

E. GIS Workshop

The second follow-up fall workshop did not get organized as hoped. The idea was brought forward that since GeoHab will be meeting in Sitka Apr 29 to May 2, 2008, it may be possible to convene a GIS tools workshop in conjunction with this meeting. Lynne will send an email to the steering committee of the GIS workshop to see if there is any interest in pursuing this.

F. Acoustic Workshop

Steve Parker commented on the desire for an overall coordination of acoustic telemetry projects on the West coast, however, found it difficult to coordinate activities with the Pacific Ocean Shelf Tracking Project (POST). Coordination of acoustic telemetry projects are currently made on an ad hoc basis. There is a need to discuss surgical techniques, more receivers, and signal recognition for other projects. Steve Parker has been interested in getting a workshop together to discuss all these issues, however he is moving to New Zealand in June for a year and possibly indefinitely. Steve is trying to hire someone to take his place and take over the organization of a workshop. Acoustic tags cost $500 apiece for pressure tags, $1200 for receivers. Claude Dykstra mentioned that IPHC has been conducting research with archival and pit tagging, as well as surgery and techniques. IPHC has been conducting some trials on a reverse concept where the fish is tagged with a "receiver" and fishing vessels emit a signal that is detected by the tagged fish. The tag, once recovered, will have recorded the time and date that the fish came near a vessel. This is a different type of tagging method – STAR-ODDI is the company that produces these tags. They also produce a small, inexpensive, temperature-depth recorder that IPHC uses on their survey sets.

VII. Other Topics

It was decided that the discussion of IJFA funding which supports TSC and other PSMFC managed projects will be removed from the agenda for 2008 as there is no need to continue discussing it every year.

A. Age Validation

An annual species specific workshop is going to be left for discussion directly between personnel in stock assessment and the ageing labs. Work regarding ageing issues and species of interest should be generated by the people using and generating the data, rather than TSC.

B. Marine Reserves

BC has finished the implementation of 164 Rockfish Conservation Areas coastwide. These areas prohibit any fishing that would intercept rockfish.

There are 34 closed areas in the Central California area, and work is proceeding to the north. The MPA working group has wrapped up in Santa Cruz. Many papers have come out of this project. Spatial management methods will be covered in a session on MPAs at the AFS meeting in San Francisco, another session will cover ecosystem modelling. Spatial methods are becoming increasingly important with the use of individual transferable quotas (ITQ) and the spatial resolution of these in the fishery.

C. Genetics and Stock Structure

The IPHC has been developing micro satellite genetic work over the last two years. There is a possible genetic differentiation between the Aleutians and Bering Sea halibut stocks. Bering Sea stocks may be more closely related to Oregon halibut stocks than Aleutian stocks. Additionally, using otolith elemental composition to look for signatures or fingerprints showed 80-90% accuracy in determining location of the young from Kodiak, Bering Sea or other locations.

More work in the development of the genetic sampling hook is being conducted at NWFSC. NMFS has used modified hooks during hook and line surveys in California.

AFSC and the University of Alaska Fairbanks are looking at POP for evidence of "sweepstakes" recruitment based on genetics of young-of-the-year. Tony Gharrett (UAF) is not finding evidence of this so far.

Studies in the Gulf of Alaska have begun to look at the genetics and stock structure of forage fish such as capelin.

Scientists are investigating the idea that there maybe two species of blue rockfish and vermilion rockfish.

D. Western Groundfish Conference Update

The location will be in Santa Cruz, at the Coconut Grove Ballroom. There will be an organized bus trip and evening event at the Monterey Bay Aquarium. The dates are Feb 5-8, 2008. The format will remain with no concurrent or breakout sessions. Alan Longhurst will be the keynote speaker; he will talk about the perceptions of sustainability into the future.

E. International Observer Conference – May in Victoria

Apart from the standard format, this conference will explore whether observer programs are working. DFO has a graduate student looking at long term systematic biases in observer reporting.

F. Transboundary Issues and Yelloweye Working Group

Brian Culver submitted and e-mail messages via Tom Jagielo which was read to the group. In that correspondence it was stated that Brian would like to see yelloweye rockfish considered as a transboundary stock. The recommendation from TSC to the Parent committee is to encourage stock assessment scientists that are working on any species to coordinate with their counterparts in other countries during the development of the stock assessments. An opportunity for this exists with the pre-assessment workshops. TSC would like to encourage the development of the best datasets available for the stock assessments. There is also a transboundary issue with groundfish stocks to the south of the US. [Note: Please see Attachment 2 -- Minutes of Yelloweye Working Group -4/25/2007]

VIII. Review of Agency Groundfish Research, Assessment and Management

A. Agency Overviews

1. ODFG

Hal Weeks has moved onto a position in a lab at Cornell. Recently a long vacant age reader position was filled. ODFW will be hiring a GIS – habitat person soon. There was recently an initiative to multibeam map the whole of the state waters outside of 3 miles at 2m resolution.

2. SWFSC

CalCOFI will host a Symposium on jumbo squid invasions, Nov 26-28, 2007. Poleward range expansions of jumbo squid have been documented in both the southern and northern hemispheres over the past decade, such that in recent years the species has been found as far north as Sitka, AK. A workshop on the application of juvenile rockfish survey data in stock assessments was held in Santa Cruz, and a report was delivered to the Pacific Fishery Management Council.

3. WDFW
Michelle Culver was promoted to head of region 6. Eric Eisenhart has left the Department.

4. NWFSC
The hake survey this year will be conducted with a new acoustic person

5. DFO
Jon Schnute is retiring in June. Andrew Edwards has been hired.

6. ADFG
Tory has retired as Groundfish Project Leader and Cleo is taken her place. Jenny Stahl was hired to replace Cleo. The Groundfish Project needs to fill one more position in Sitka, a Research Analyst II.

7. AFSC
Guy Fleischer was selected to fill the Deputy Director position for the RACE Division when Russ Nelson was selected as RACE Director. Dan Ito was selected as the Deputy Director of the REFM Division. Bob Foy, formerly with the University of Alaska, Fairbanks, was selected as the new Director of RACE Division's Shellfish Program in Kodiak, There is the potential to extend multispecies surveys further north into the Chukchi and Beaufort Seas.

8. AFSC Auke Bay Lab
Although construction of the new lab at Lena Point has been completed, there has been no move into this new facility as yet.

B. Multispecies Studies

Steve Parker has been working with Steve Berkley and students to research the maternal effects on other nearshore rockfish species (yellowtail, widow, chilipepper, and POP primarily). Steve has also been working on gear modifications to reduce the catch of yelloweye rockfish in the jig fishery. They are finding that using a 15 foot leader (between the weight and the hook) dramatically changes the species composition of the catch. This new gear can eliminate the catch of yelloweye rockfish by keeping the hooks off the bottom. There was a 90% reduction of yelloweye rockfish when fishing for halibut, with no effect to the halibut catch.

1. IPHC
During the standard annual IPHC survey personnel will work to tag rockfish at sea for ADFG and WDFW by set to be delivered dockside for sampling. For DFO the IPHC will take a third biologist aboard and sampling of rockfish will be accomplished on board the survey vessel. WDFW expanded the IPHC survey in Washington by adding 25 stations in 2006, and will be keeping 10 of these stations and adding 8 stations to the 2007 survey. Hook size and spacing experiments are to be conducted in area 2B. Didson sonar research monitoring of baited hooks on frames will be conducted in the Sitka area. Experiments minimizing shark (dogfish) bycatch

by using rare earth metals and electromagnetics were discussed. IPHC will continue to develop their ongoing tagging work.

2. NWFSC

Ecosystem studies are covered in the report submitted this year to the TSC.

3. AFSC

It was noted that the report from REFM's Resource and Ecosystem Modeling Program is missing from the draft report, but will be included in the final version. A summary of social science and economics was not included in the report but is available from Mark Wilkins.

4. AFSC Auke Bay Lab

Regarding surface trawling aimed at juvenile rockfish, sablefish and salmon off of SE Alaska; in 2005 just a handful of young-of-the-year rockfish were caught in these studies, whereas thousands were caught in 2006. In 2005 jumbo squid were caught but none in 2006 as the water was much colder.

C. By Species

1. Pacific Cod

a) ADFG

There was less Pacific cod fishing effort and catch in 2006 than in 2005.

2. Nearshore Rockfish

a) ADFG

Dark rockfish were moved out of the FMP and given to the State to manage. This species needs to be formally recognized in the catch database by adding a new species code for Dark Rockfish. Dark rockfish are incidentally caught in the black rockfish directed fishery. More research using ROVs in nearshore habitats will be conducted out of the Homer office in the Central Region. An acoustic study on Black rockfish will continue in the Westward Region (Kodiak).

b) NWFSC

Black (west coast) and Blue (California) rockfish will be assessed this year.

c) DFO

The Department will conduct joint work with IPHC in BC Area 2B and an industry funded (PHMA) survey will be conducted to cover the southern area of the coast in 2007.

d) ODFW

An acoustic project to determine home range and movements of nearshore rockfish species will be conducted this year and also will explore species specific movement over various habitat types.

3. Shelf Rockfish

a) DFO

COSEWIC listing for canary rockfish as threatened. A "recovery potential assessment" including a stock projection and a socio-economic analysis is due in by early spring (2008).

b) ODFW

A selective flatfish trawl to target flatfish and reduce rockfish catch, especially canary rockfish, was deemed the mandatory gear to be used in 2005 and estimated bycatch rates were predicted. The trawl performance was evaluated but had higher canary bycatch rates than projected. More stringent net specifications are required and more outreach to assist fishers with the proper use of the nets.

4. Slope Rockfish

a) AFSC Auke Bay Lab

Reviewers from the Centre for Independent Experts reviewed Alaska rockfish assessments. It was concluded that the advice given by NMFS was conservative. The review recommended that trawl survey data needs to be examined for possible biases caused by the difference in trawlable and untrawlable bottoms and that biological population parameters also need more examination. James Orr is investigating rougheye rockfish to split into two different species. Shortraker rockfish have recently been aged for the first time by the AFSC (average age of 44 yrs, max 116 yrs) and the Center would like to use bomb carbon dating for verification of ages.

b) ODFG

Multiple paternities for POP. Over half of the 75 fish samples, had more than one father. More research will be done investigating whether older females have more mates than younger females. A paper has been submitted.

5. Thornyheads

a) ADFG

A bomb carbon study has verified fish ages by using 1955 through 1968 cohorts, which only verifies part of their total age range.

6. Sablefish

a) NWFSC

Sablefish stock assessment is to be reviewed in May.

b) DFO

Science is continuing to develop and refine management procedures with managers and industry.

c) AFSC Auke Bay Lab

Recently received a sablefish tag return from a fish tagged 33 years ago. It's possible this may be the longest period at liberty for any tagged groundfish.

d) ADFG

In the Bering Sea there is a sablefish pot fishery. Fishermen have switched to pots to protect their fish from killer whale depredation. The Department plans to continue to use a mark-recapture method to estimate the abundance of sablefish in Chatham Strait. Fish are tagged and released on a tagging survey using pot gear.

The commercial fishery is used as the recapture portion of the study. This year an additional estimation of abundance will be determined using the recaptured tagged fish from the Chatham Strait Longline Survey to compare to the result using tags recovered in the fishery.

7. Flatfish

No reports were given regarding flatfish.

8. Lingcod

a) ADFG

The Central region is conducting a lot of research using an ROV to develop a habitat based assessment. In a GIS they are using primarily bathymetry to determine probable habitats. For fishing gears that contact the bottom, such as dingle-bar gear, the Federal Government requires fishers to have a Vessel Monitoring System (VMS) when directed fishing for lingcod in Federal water. This could impact the fishery by keeping some fishers out of Federal water to avoid this requirement since it is not a requirement in State water.

b) DFO

A substantial proportion of the lingcod is going to market live as far south as San Francisco. Lingcod fishery opens in the Strait of Georgia in 2006 between June 15 and September 30.

9. Pacific Whiting

a) NWFSC

This is a survey year for whiting.

b) DFO

A hake biologist was hired this year.

10. Walleye Pollock

a) AFSC

Require charter vessels to use scientific sounders ES60 and collect echo soundings during the bottom trawl tows and in between stations. The acoustic backscatter data collected in-between the stations to will be used to augment the data for pollock.

11. Dogfish

No reports on dogfish. Basking shark stock status question – they are considered severely overfished.

12. Skates

a) AFSC

A field guide to skates is soon to be out in bookstores (Summer 2007). A new leopard skate has been described.

b) NWFSC

Longnose skate assessment to be reviewed this year.

13. Other Species

a) Auke Bay Lab

First stock assessment of giant grenadier will be done this year. Ageing is difficult but not as bad as it was first thought to be. The maximum age is 58.

b) AFSC

Research is being conducted using passive acoustics to locate where Atka mackerel spawn.

D. Other Related Studies – None Brought Forward.

E. Other Items

Diana Trager of DFO presented a report on the Groundfish Integration Pilot Project in B.C. The Pilot 3-year project was started in March 2006. The two key elements are 100% monitoring in the hook and line and trap sectors, and transferable quotas. Monitoring focuses on electronic monitoring rather than observers because of cost. Sensor data verifies fishing activity in time and space. Random viewing of video data is used to check veracity of logbook data for catch (retained and discarded). Developing the criteria for assessing logbook quality has been difficult; the project also requires a complicated real-time information management system. Three hundred boats made 5000 trades in 2006. The directed deep water rockfish fishery has been greatly

reduced with just the shallow water, live rockfish fishery component remaining. Most of the deep water rockfish quota was used within the "halibut" fishery.

The meeting adjourned at 4:30 p.m. on Tuesday April 24, 2007.

Wednesday, April 25, 2007

IX. Progress on 2006 Recommendations

A. From TSC to Itself

Telemetry workshop
Steve Parker commented that there is interest in participating in this workshop. Steve is leaving for New Zealand, so coordinating this workshop will be left to his successor. Steve is to call interested parties to see if there is support in continuing to attempt to convene a workshop for this topic. TSC thanks Steve for his efforts to organize this workshop and TSC will wait to hear from Steve regarding who will take over the organization of this project.

B. TSC to CARE

TSC will rely on fishery managers and stock assessment authors to interact directly with their ageing lab supervisors to communicate with CARE for ageing exchanges. TSC appreciates the work of CARE and recognizes that a direct link between the assessment biologist and the ageing lab is the most efficient means of requesting species ageing exchanges.

X. 2007 Recommendations

A. From TSC to Itself

The TSC notes that there continues to be significant informal collaboration between U.S. and Canadian staff in the research and stock assessment of such species as yellowtail, canary, yelloweye rockfish, sablefish, and more extensively, Pacific whiting. Nevertheless, TSC suggests that assessment and management of these and other groundfish populations that co-exist near national boundaries would benefit from closer collaboration. One means for achieving this would be to ensure that staff from both countries is included at pre-assessment workshops. This would help to ensure that all relevant data are brought to bear on the assessment. It will also act to stimulate long term collaborative research.

Cleo will follow up with members of the sablefish workshop to see where the next steps will be.

Lynne will follow up with the steering committee members of the GIS workshop to see if there is any interest in convening a GIS methods/tools section at the GEOHAB meeting in Sitka in 2008.

XI. Update the supervisors list to include all supervisors, and add a list of all recipients of the supervisor letter.

XII. Schedule and location of the 2008 meeting- Juneau, May 6 and 7. Dave Clausen kindly offered to host the meeting at the Auke Bay Lab.

XIII. Other

Thanks to Stephen Phillips and John Field for hosting this meeting of the TSC.

Best wishes to Steven Parker on his new job in New Zealand.

It was an enhancement to the group having IPHC and Kodiak ADFG in attendance.

Adjourned 10:00 am, April 25, 2007

Attachment 1

Report of the Trawl Survey Working Group to the Forty-Eighth Annual Meeting of the Canada-United States Groundfish Committee April 24-25, 2007

Attendees: Mark Wilkins, Bob Lauth, Aimee Keller, Rick Stanley and Greg Workman

For the past four years, survey personnel from the Alaska Fisheries Science Center (AFSC) and the Northwest Fisheries Science Center (NWFSC) of the U.S. National Marine Fisheries Service, and Canadian Department of Fish and Oceans (DFO) have met in Seattle in mid-February. The working group was initiated under the auspices of the Technical Subcommittee (TSC) of the Canada-U.S. Groundfish Committee and affords survey staff from these agencies the opportunity to compare methods, survey designs, and recent developments in the science behind fishery-independent trawl surveys of groundfish and invertebrate resources in the North Pacific and eastern Bering Sea.

AFSC scientists hosted the 2007 meeting on February 20 at the Sand Point Laboratory. Their scientists presented a summary of work done to improve measurement of survey trawl effort (distance fished and net width) and summarized progress on a project investigating how expanding survey catch rates over untrawlable portions of the survey area may affect stock assessments.

NWFSC scientists reviewed their current West Coast survey sampling scheme, informed the Working Group (WP) about updates to the equipment and software used to record and analyze data, and summarized research on the impact of waves on trawl survey catches.

Canadian scientists reviewed the overall strategy of the suite of surveys they conduct off British Columbia and presented a recent business review of their Queen Charlotte Sound bottom trawl survey. The business review included a summary of a survey simulator which was designed to explore the accuracy of any survey for each species. Using power test criteria, it allows stakeholders, managers and researchers an intuitive perspective on how accurately the surveys will track hypothetical trends in abundance. It also provides a design tool for exploring how alternative survey configurations will affect the tracking ability. Canadian scientists also discussed implications of a legal decision regarding selling fish caught during research charters to help defray the cost of the research programs.

Canadian scientists were provided with a copy of a new field guide to invertebrates. U.S. staff was provided with a copy of the survey simulator at the 2007 TSC meeting. The Working Group plans to meet again in February 2008.

Attachment 2

Yelloweye Rockfish Working Group Meeting
Santa Cruz, California
April 25, 2007

Draft Agenda
Yelloweye Working Group for the TSC
April 25th, 2007 (~1:00-4:00PM)

I. Introductions if necessary
II. Request for note taker
III. Reports on progress of CARE exchange idea for ager error detection (Farron)
IV. Report from Farron/Mark W. on sablefish survey bycatch information
V. Discussion of results of IPHC survey bycatch analysis and trends
    A. Oregon
    B. Washington
    C. B.C.
    D. Alaska
VI. Future work
VII. Schedule next meeting

Attending: Cleo Brylinsky, Lynne Yamanaka, Stephen Phillips, John Devore, Steve Parker, Claude Dykstra, John, Tom Jagielo, Dave Clausen, Mark Wilkins, Rick Stanley, Diana Trager, Kris Munk

Cleo opened the meeting. The agenda (see end of document) was reviewed and approved.

The yelloweye rockfish issue had been discussed at the preceding TSC meeting to some extent. A brief recap of the history of the issue was presented, beginning with a request from the Pacific Fishery Management Council for the TSC to consider the need and propriety for an international stock assessment of the species. In the fall of 2006, the TSC assembled a working group to look into the matter. The working group met initially October 16 in Seattle and again by teleconference on December 5. At those meetings, the group reviewed all sources of data that have and could be used by stock assessment authors and attempted to identify additional data sets that might shed light on the subject. For the most part, the data sets that have been used for assessment represent the extent of the information available.

At today's meeting, the group looked at the potential utility of a scheduled CARE otolith exchange to detect and quantify ager error. The group felt that the exchange was still important.

For the past few years, the IPHC has added supplementary 3-skate rockfish stations to their Standardized Stock Assessment (SSA) survey off the Washington coast to better sample yelloweye. Claude Dykstra handed out maps showing the supplementary stations that were added in 2006 and where they'll be added in 2007.

Lynne Yamanaka presented a summary of her report "International Pacific Halibut Commission (IPHC) Standardized Stock Assessment (SSA) survey Data Analysis for the Canadian Zone 2B" that she prepared for the working group. The analysis shows a decline of approximately 75% between 1995 and 2006. The decline appears to be worse in the southern part of Zone 2B.

Cleo has also looked at the IPHC data from SE Alaska, but less rigorously than was presented by Lynne. With help from Lynne, Cleo will be taking another look at the historic IPHC bycatch information for Southeast Alaska as a way to compare the data over time and to the information from Canada.

One additional source of data had been investigated. Mark Wilkins reported on yelloweye rockfish information from a 1994 extension of the Alaska Fisheries Science Center's sablefish longline survey into Washington and Oregon. The 1994 extension was the one and only time this survey had included waters south of Canada. Fourteen stations were fished between Nitinat Canyon (48°15' N latitude) and Cape Blanco, OR (42°50' N latitude). Yelloweye rockfish were caught at only 9 of the 14 stations. A total of 40 fish were caught, nearly half of them (18) were caught at the station off Willapa Bay. All but 4 fish were caught at the Washington stations (1-6). All fish were measured to the nearest centimeter (FL), though sex was not recorded for these fish. Fish were not weighed and otoliths were not collected. Mark will summarize the data from this survey in a memo to Farron Wallace and provide a copy of it to the working group (see Attachment 2A).

The yelloweye working group members who were present at this meeting felt that there was no reason to continue this group unless there was participation and clear direction from the persons who first initiated this working group. We also would like there to be consensus as to the purpose.

Submitted by Mark Wilkins.

Attachment 2A

Memo on Yelloweye Rockfish Data from 1994 West Coast Extension of AFSC's Domestic Longline Survey.

June 18, 2007 F/AKC1:MEW

MEMORANDUM

TO: Farron Wallace - WDFW
FROM: Mark Wilkins - F/AKC1
SUBJECT: Yelloweye Rockfish Data from 1994 West Coast Extension of AFSC's Domestic Longline Survey

I was unable to locate the electronic database from the 1994 West Coast Extension of the AFSC Longline Survey where we fished at 14 sites off Washington and Oregon. I went back to the data book, however, and dug out the catch (only numbers of fish were recorded, no weights) and length information for yelloweye rockfish from those stations. This memo will serve to document what little information I found from this search.

Fourteen stations were fished during the 1994 extension of the survey (**See Table 1**). Yelloweye were caught at 9 of those. In all, 40 fish were caught and unsexed lengths were collected from all 40. I'm including a table with the station locations, depths, and the catch and length information for yelloweye rockfish. All in all, I don't think there's enough information to give you any major sense of stock condition, especially since this is the only year that this type of work was done in this region. Please let me know if I can provide any additional information that might be in those data books and I'll see whether I can mine it out of the notebook.

Attachment

cc: Yelloweye Rockfish Working Group –
Cleo Brylinsky
Lynn Yamanaka
Stephen Phillips
Tom Jagielo
Claude Dykstra
John Devore

Table 1.-- Catch and length information for yelloweye rockfish from the 1994 Washington/Oregon extension of the NMFS/AFSC domestic longline survey.

Catch Data by Station

Station	Hauls	Date	Start Latitude	Start Longitude	End Latitude	End Longitude	Min Depth (m)	Max Depth (m)	Yelloweye Catch (no)
1 - Nitinat Canyon	27 & 28	10/12/1994	48° 14.8'	125° 40.15'	48° 07.7'	125° 50.73'	173	1157	3
2 - Cape Johnson	1 & 2	9/29/1994	47° 52.9'	125° 13.22'	47° 50.6'	125° 27.54'	284	1013	3
3 - Cape Elizabeth	25 & 26	10/11/1994	47° 35.0'	125° 00.18'	47° 26.2'	125° 05.65'	181	1071	4
4 - Copalis Head	3 & 4	9/30/1994	47° 10.1'	124° 56.58'	47° 18.4'	125° 10.53'	196	1198	2
5 - Willapa Bay	23 & 24	10/10/1994	46° 46.0'	124° 47.91'	46° 37.1'	125° 00.37'	172	1158	18
6 - Columbia River	5 & 6	10/1/1994	46° 17.6'	124° 36.78'	46° 22..5	124° 48.82'	198	1256	6
7 - Tillamook Head	21 & 22	10/9/1994	45° 59.0'	124° 42.11'	46° 02.0'	124° 59.00'	220	1052	0
8 - Nehalem Bay	7 & 8	10/2/1994	45° 43.4'	124° 40.47'	45° 43.8'	124° 55.85'	235	1286	0
9 - Cape Lookout	1 & 20	10/8/1994	45° 17.9'	124° 37.76'	45° 21.8'	124° 53.92'	475	952	0
10 - Cascade Head	9 & 10	10/3/1994	45° 04.3'	124° 42.31'	45° 03.7'	125° 01.04'	295	1235	1
11 - Yaquina Bay	17 & 18	10/7/1994	44° 15.6'	124° 53.17'	44° 23.8'	125° 07.30'	146	1178	0
12 - Siuslaw River	11 & 12	10/4/1994	43° 54.7'	124° 51.28'	43° 59.0'	125° 06.11'	178	1520	2
13 - Cape Arago	15 & 16	10/6/1994	43° 28.0'	124° 38.15'	43° 27.7'	124° 58.36'	240	1038	1
14 - Cape Blanco	12 & 14	10/5/1994	42° 50.3'	124° 45.86'	42° 51.1'	125° 01.62'	183	1325	0

Length Data by Station

Station	Unsexed Lengths (cm)
1 - Nitinat Canyon	38, 39, 46
2 - Cape Johnson	36, 37, 41
3 - Cape Elizabeth	35, 39, 45, 45
4 - Copalis Head	33, 38
5 - Willapa Bay	33, 35, 35, 41, 41, 42, 43, 44, 44, 44, 45, 46, 48, 48, 50, 50, 54, 54
6 - Columbia River	33, 40, 44, 45, 46, 47
7 - Tillamook Head	none
8 - Nehalem Bay	none
9 - Cape Lookout	none
10 - Cascade Head	38
11 - Yaquina Bay	none
12 - Siuslaw River	34, 37
13 - Cape Arago	36
14 - Cape Blanco	none

D. PARENT COMMITTEE MINUTES

Minutes of the 48th Annual Meeting
of the
Canada-U.S. Groundfish Committee
(aka "Parent Committee")

I. Call to Order

Chair Stephen Phillips, PSMFC, represented the U.S. (for Randy Fisher, PSMFC), and Diana Trager, DFO, represented Canada, called the meeting to order at 11:00 Wednesday, April 25, 2007. Also in attendance: Tom Jagielo (WDFW), Mark Wilkins (NMFS, AFSC Seattle), Cleo Brylinsky (ADFG), John Field (SWFSC) and Steve Parker (ODFW).

II. Diana Trager was appointed secretary for the meeting.

III. The agenda, following the format of previous meetings, was approved.

IV. Adoption of May 2006 Parent Committee meeting minutes: The minutes were adopted as presented.

V. Progress on 2006 Recommendations:

1. **Telemetry workshop:** No action. However there still appears to be interest in this workshop. The workshop lead organizer Steve Parker is leaving ODFW for a job in New Zealand, so his successor will need to follow-up on this and contact interested parties to see if there is support in continuing to organize this workshop.

2. **CARE:** The Parent Committee agrees that the TSC should rely on fishery managers and stock assessment authors to interact directly with their ageing lab supervisors to communicate with CARE for ageing exchanges. The Parent Committee appreciates the work of CARE and recognizes that a direct link between the assessment biologist and the ageing lab is the most efficient means of requesting species ageing exchanges.

VI. 2007 Parent Committee Recommendations

1. **Acoustic Telemetry Workshop:** Carry over from 2006. The Parent Committee agrees with TSC that a workshop on acoustic telemetry techniques and analysis for Pacific coastal marine species should be held.

Action: The Parent Committee anticipates that the replacement for Steve Parker at ODFW will follow-up with the planning of a potential telemetry workshop.

2. **Preassessment Collaboration:** The Parent Committee agrees with the TSC that while there continues to be significant informal collaboration between U.S. and Canadian staff in the research and stock assessment of such species as yellowtail, canary, and yelloweye rockfish, sablefish, and more extensively, Pacific whiting, assessment and management of these and other groundfish populations that co-exist near national boundaries would benefit from closer collaboration. One means for achieving this would be to ensure that staff from both agencies are included at pre-assessment workshops. This would help to ensure that all relevant data are brought to bear on the assessment. It will also act to stimulate long term collaborative research.

   Action: The Parent Committee recommends a letter be written to directors of relevant agencies AKFSC, NWFSC, PBS DFO (Nanaimo) to encourage closer collaboration and interchange on stock assessment planning meetings.

VII. Meeting Location

Dave Clausen, Auke Bay Lab, AFSC/NMFS/NOAA, offered to host the 2008 meeting in Juneau, Alaska. The proposed dates are May 6-7, 2008.

VIII. Other Business

a. The Parent Committee thanks John Field for hosting the meeting.

b. The Parent Committee thanks Cleo Brylinsky for chairing this year's meeting, and Lynne Yamanaka for recording minutes.

E. AGENCY REPORTS

Report of the Technical Subcommittee Of the Canada-United States Groundfish Committee

AGENCY REPORTS

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1. ALASKA FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE

2. COMMITTEE OF AGE READING EXPERTS (CARE)

3. INTERNATIONAL PACIFIC HALIBUT COMMISSION (IPHC)

4. NORTHWEST FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE

5. SOUTHWEST FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE

6. STATE OF ALASKA – ALASKA DEPARTMENT OF FISH AND GAME

7. STATE OF OREGON – OREGON DEPARTMENT OF FISH AND WILDLIFE

8. STATE OF WASHINGTON – WASHINGTON DEPARTMENT OF FISH AND GAME

Alaska Fisheries Science Center
of the
National Marine Fisheries Service

2007 Agency Report
to the
Technical Subcommittee
of the
Canada-US Groundfish Committee

April 2007

Compiled by
Mark Wilkins, Tom Wilderbuer, and David Clausen

VIII. REVIEW OF AGENCY GROUNDFISH RESEARCH, ASSESSMENTS, AND MANAGEMENT IN 2006

A. Agency Overview

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, the Fisheries Monitoring and Analysis (FMA) Division, and the Auke Bay Laboratory (ABL). The RACE and REFM Divisions are divided along regional or disciplinary lines into a number of tasks and subtasks. The FMA Division performs the observer monitoring of the groundfish fleets operating in the North Pacific. The ABL conducts research and stock assessments for Gulf of Alaska groundfish. All Divisions work together closely to accomplish the missions of the Alaska Fisheries Science Center. A review of pertinent work by these groups during the past year is presented below. A list of publications pertinent to groundfish and groundfish issues is included in Appendix I. Yearly lists of publications and reports produced by AFSC scientists are also available on the AFSC website at http://www.afsc.noaa.gov/Publications/yearlylists.htm , where you will also find a link to the searchable AFSC Publications Database. Lists or organization charts of groundfish staff of these four units are included as Appendices II - V.

RACE DIVISION

In 2006, the primary activity of the Resource Assessment and Conservation Engineering (RACE) Division continued to be fishery-independent stock assessment surveys of important groundfish species of the northeast Pacific Ocean and Bering Sea. Regularly scheduled bottom trawl surveys in Alaskan waters include an annual survey of the crab and groundfish resources of the eastern Bering Sea shelf and biennial surveys of the Gulf of Alaska (odd years) and the Aleutian Islands and the upper continental slope of the eastern Bering Sea (even years).

Two major bottom trawl surveys of groundfish resources were conducted during the summer of 2006 by RACE Groundfish Assessment Program (GAP) scientists; the annual eastern Bering Sea shelf survey and the Aleutian Islands survey. Funding shortages necessitated cancellation of the Bering Sea upper continental slope survey and a 20% cutback in coverage during Aleutian Islands survey. RACE scientists of the Habitat Research Team (HRT) also continued Groundfish habitat-related research.

RACE scientists of the Habitat Research Team (HRT) continue research on essential habitats of groundfish. In FY06, the focus was on investigating the utility of acoustic backscatter as a habitat predictor. Details on the work of the HRT can be found under D. Other Related Studies.

The Midwater Assessment and Conservation Engineering (MACE) Program conducted winter echo integration-trawl (EIT) surveys of midwater pollock abundance in the Shumagin-Sanak area in February 2006 and around Chirikof-Shelikof Strait in March 2006. The Bogoslof Island area was also surveyed in March 2006. A summer survey of pollock on the eastern Bering Sea shelf was conducted in June and July 2006. A fifth year of information was collected on a summer interaction study between commercial fishing and pollock distribution east of Kodiak in

late August. MACE scientists also continued research on development of salmon excluder devices for pollock fisheries. MACE staff and other RACE survey personnel continued work on the intervessel calibrations between the *Oscar Dyson* and the *Miller Freeman*.

Guy Fleischer was selected to fill the RACE Deputy Director position formerly held by Russ Nelson, who replaced Gary Stauffer as Director.

For more information on overall RACE Division programs, contact Division Director Russ Nelson at (206)526-4170.

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 US 200-mile Exclusive Economic Zone (EEZ) of the northeast Pacific Ocean and Bering Sea. Specifically, REFM's activities are organized under the following Programs: Age and Growth Studies, Socioeconomic Assessments, Resource Ecology and Ecosystem Management, and Status of Stocks and Multispecies Assessment. Scientists at AFSC assist in preparation of stock assessment documents for groundfish in the two management regions of Alaska (Bering Sea/Aleutian Islands and Gulf of Alaska, conduct research to improve the precision of these assessments, and provide management support through membership in regional groundfish management teams.

For more information on overall REFM Division programs, contact Division Director Dr. Pat Livingston at (206)526-4173.

FMA DIVISION

The Fisheries Monitoring and Analysis (FMA) Division is responsible for placement of observers on vessels fishing for groundfish species in the U.S. 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 the regional management council and NMFS, and are used in the stock assessment process. Observers play important roles in providing information that is critical to the U.S. fishing industry.

During 2006, no foreign vessels were allowed to catch or process fish in the U.S. EEZ off the coast of Alaska. The FMA Division trained and deployed 713 observers to 303 vessels and 24 shore plants in Alaska. These observers spent 36,420 days collecting data in 2006. The Division is 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 are provided to the Alaska Regional Office to assist in management decisions regarding the catches of groundfish and prohibited species. Data are also collected regarding the operations of the groundfish fishery.

For more information on overall FMA Division programs, contact Division Director Dr. Bill Karp at (206)526-4194.

AUKE BAY LABORATORY

The Auke Bay Laboratory (ABL), located in Juneau, Alaska, is a division of the NMFS Alaska Fisheries Science Center (AFSC). In 2006, what was formerly called ABL's "Groundfish Assessment Program" changed its name to the "Marine Ecology and Stock Assessment Program" (MESA), a name which more accurately reflects the varied tasks and research of this group. The MESA Program is primarily involved with research and assessment of sablefish and rockfish in Alaska and with the study of fishing effects on the benthic habitat. Presently, the program is staffed by 15 scientists, including 14 permanent employees and 1 term employee. One Program member, Dean Courtney, has transferred to another NMFS position and will be leaving ABL in summer 2007. Also, two new staff members were added to the program: Cara Rodgveller and Doris Alcorn. Four employees in other ABL programs have also been involved with research on groundfish in the past year.

In 2006 field and laboratory research, ABL's MESA Program, in cooperation with the AFSC's RACE Division, conducted the annual NMFS sablefish longline survey in Alaska. Other field and laboratory work by ABL included: 1) continued juvenile sablefish studies, including routine tagging of juveniles and electronic archival tagging of a subset of these fish; 2) a genetics study to determine species identification and stock structure of young-of-the-year rockfish from offshore waters of the Gulf of Alaska and eastern Bering Sea; 3) a tagging study of Pacific sleeper sharks in southeastern Alaska; 4) epipelagic trawling in offshore waters of southeastern Alaska to sample young-of-the-year rockfish and sablefish; and 5) a study of the reproductive biology of giant grenadier.

Ongoing analytic activities involved management of ABL's sablefish tag database, analysis of sablefish logbook and observer data to determine fishery catch rates, and preparation of five status of stocks documents for Alaska groundfish: sablefish, Gulf of Alaska northern rockfish, grenadiers, Bering Sea and Aleutian Islands sharks, and Gulf of Alaska sharks. Other major analytic activities during the past year were: 1) convening a Rockfish Modeling Workshop at ABL 2) participating in a Center for Independent Experts review of stock assessments of Alaskan rockfish 3) an updated analysis of sablefish migration based on tag release and recovery data through 2005.

Construction was finished in late 2006 at Lena Pt., north of Auke Bay, on a new facility that will house the Auke Bay Laboratory. However, because of technical problems, the actual moving of ABL employees to the new facility has been delayed and is now expected to be completed sometime this summer. A small number of ABL employees will remain at the old ABL location, although most of the office and laboratory space there will be leased to other government agencies. The new name of the Auke Bay Laboratory will be the "Auke Bay Laboratories" to reflect its location at more than one campus.

For more information on overall Auke Bay Laboratory programs, contact Laboratory Director Phil Mundy at (907) 789-6001.

B. Multispecies Studies

1. Research

Diel Sampling of Epipelagic Ichthyofauna in Offshore Waters of the Eastern Gulf of Alaska

During the period 11-21 August 2006, the Auke Bay Laboratory (ABL) used the Alaska Department of Fish and Game research vessel Medeia to conduct research directed at diel sampling of epipelagic ichthyofauna in offshore waters of the Eastern Gulf of Alaska. The general objective of this cruise was to evaluate procedures for establishing a trawl indexing survey for young-of-the-year (YOY) rockfish and sablefish and for juvenile salmon in offshore waters of southeastern Alaska. The project was a continuation of similar research conducted in mid-August 2005. Specific objectives included: 1) conduct an experiment to determine if surface trawling at night is more effective than surface trawling in daytime for capturing YOY rockfish, YOY sablefish, and juvenile salmon; 2) determine the spatial distribution of these three taxa at selected stations along transects off the northern region of southeastern Alaska; and 3) collect physical oceanographic data coincident with the trawl hauls and vessel track to investigate the relationship between oceanographic conditions and the distribution/abundance of fish captured in the trawl. Three programs within ABL collaborated on this study: Marine Ecology and Stock Assessment (formerly ABL's Groundfish Program), Marine Salmon Interactions, and Ocean Carrying Capacity.

Day and night surface trawl sampling with a Nordic 264 rope trawl was successfully completed by the Medeia at each of the six planned stations. These stations were located up to 75 km offshore southeastern Alaska along two transects: Icy Point and Cape Edward. Catches totaled nearly 10,000 fish representing 25 species in 35 hauls. Catch in numbers for the target species of the study were as follows: YOY rockfish, 6,283; YOY sablefish, 276; and juvenile salmon, 206. YOY rockfish species identification will be made in the laboratory at a later date. Relatively high catches of YOY rockfish were found in several hauls at stations along both transects. The largest catch of YOY rockfish in a single haul was ~3,700 fish, which appears to be the most YOY rockfish ever taken in a pelagic research haul in Alaska. The large numbers of YOY rockfish encountered in this cruise may be an indication of an abundant year class in this region.

There was a marked difference in the catches between day and night. Day tows yielded much higher catches of the target species. In particular, 6,283 YOY rockfish were caught in the day, vs. only 21 at night. These results indicate that for the Nordic 264 rope trawl in 2006, daytime surface tows were much more effective at sampling these species than were surface tows at night.

The 2006 results were very different than results of ABL's 2005 Medeia surface trawling cruise. This was true despite the fact that both cruises were conducted during almost the same dates in August, and they each sampled the same stations along the Icy Point and Cape Edward transects. In contrast to the large catches of YOY rockfish in 2006, a total of only 11 YOY rockfish were caught in 2005. Also, unusual species not commonly found as far north as Alaska, such as Humboldt squid and Pacific sardines, were caught in 2005 but not in 2006. These differences may be explained by the variable oceanographic conditions encountered in each year's cruise, especially water temperature. Summer 2005 was unusually warm in the eastern Gulf of Alaska,

and average water temperatures near the surface at stations along our transects were 2.4o C. higher than in 2006.

For more information, contact Dave Clausen at (907) 789-6049.

Bering Sea Crab/Groundfish Bottom Trawl Survey – RACE

The annual crab-groundfish demersal trawl survey of the eastern Bering Sea shelf was completed from May 30- July 27, 2006. A total of 405 stations were sampled, covering nearly 500,000 km^2 from inner Bristol Bay to the shelf edge and from Unimak Pass to 62^o N near St. Matthew Island. The chartered vessels FV *Northwest Explorer* and FV *Arcturus* and this also marked the 25^{th} survey of the 'standard' time series of consistent area, gear, and general sampling protocol.

Biomass estimates for major species indicated a decrease from 2005 for walleye pollock, Pacific cod, and yellowfin sole, and increases for northern rock sole, flathead sole, Alaska plaice, Greenland turbot, arrowtooth flounder, Kamchatka flounder and Pacific halibut. Walleye pollock biomass decreased by almost half in 2006, from 5.13 to 2.85 million t. Arrowtooth flounder increased from about 508 to 608 thousand t. Greater ice cover in the eastern Bering Sea during winter lowered bottom water temperatures to the lowest point since 1999. The average bottom temperature for the 2005 survey, 3.47^oC, was the second highest in the time series compared to 1.87°C for 2006, which was among the five coldest. The lower spring bottom temperatures may have resulted in delayed molting and spawning of female red king crab in Bristol Bay. To prevent a closure in the fishery because of a minimum threshold of red king crab females being unfertilized, 30 stations in Bristol Bay had to be resampled at the end of the survey.

There were 22 special projects and collections undertaken during the 2006 survey and all but two of the projects were from programs inside the AFSC (Table 1). The RACE Division projects included studies of: 1) gear performance and monitoring; 2) fish behavior in response to light and vessel noise; 3) fish and crab pathology; 4) summer zooplankton biomass; 5) octopus populations, and 5) additional biological sampling of Bering flounder, eelpouts, and miscellaneous fish species. The Resource Ecology and Fisheries Management Division (REFM) and Auke Bay Laoratory (ABL) special studies projects included: 1) fish stomach scans and collections; 2) a seabird survey; 3) biological sampling of sculpins and forage fish; 4) collections of fish prey for stable isotope analaysis, and 5) tissue collections for a DNA-based identification library. The two projects from outside the agency involved halibut otolith, tag and size collections by the International Pacific Halibut Commission (IPHC), and collection of fish specimens for stable isotope analysis rof fur seal prey by the University of Alaska Fairrbanks (UAF).

Data from the 2006 eastern Bering Sea (EBS) continental shelf groundfish bottom trawl survey were error-checked and edited with a final validated data set uploaded to the survey database by mid-September. Survey results of biomass and abundance were presented to the Plan Team members for walleye pollock, Pacific cod, yellowfin sole, flathead sole, arrowthooth flounder, rock sole, rockfish, halibut, Greenland turbot, Alaska skate, and various other non-commercial species for the production of Stock Assessment and Fishery Evaluations.

For further information, contact Bob Lauth, (206) 526-4121.

Aleutian Islands Biennial Groundfish Bottom Trawl Survey - RACE

The fourth in the series of biennial bottom trawl surveys of Aleutian Islands region (AI) groundfish resources was conducted from June 1 through August 11, 2006. The full series of periodic AI surveys dates back to 1980. Prior to establishing a biennial schedule in 2000, these surveys had been done on a nearly triennial schedule by the RACE Division. Surveys conducted prior to 1991 were cooperative efforts involving U.S. and Japanese vessels and scientists. Since 1991 they have been planned and conducted entirely by the RACE Division of AFSC. The primary objective of the surveys is to provide a standardized time series of data to assess, describe, and monitor the distribution, abundance, and biological condition of Aleutian groundfish and invertebrate stocks. Secondary objectives are to collect environmental data (e.g., surface-to-bottom water temperature profiles, etc.) and to make special collections of biological specimens and data requested by scientists from the AFSC or other cooperating research groups.

The 2006 AI triennial survey area stretched over 900 nmi from the Islands of Four Mountains (170º W long.) to Stalemate Bank (170º E long.), including stations on Petrel Bank. In addition, the region between 165° and 170° W long. along the north side of the archipelago is included as the Southern Bering Sea subarea. Stations range in depth from nearshore to 500 m. Sampling was conducted aboard the chartered commercial trawlers *Sea Storm*, which was under charter for 70 days, and the *Gladiator*, which was chartered for 50 days. Sampling began near the Akutan Pass and progressed westward to Adak during the first 25-day leg. For safety considerations, the westernmost portion of the survey was completed at the beginning of the second leg, leaving the central portion for the final leg when the *Sea Storm* was operating alone. Stations were allocated among 45 depth and geographic strata and were preselected randomly from a grid of potential sites overlaying the survey area. If untrawlable bottom, swift currents, or conflicts with commercial fishing prevented sampling a station, a nearby alternate station was selected. Out of 366 stations assigned to the vessels, 358 were successfully completed, ranging in depth from 32 to 484 m.

Over the total survey area, the most abundant species in 2006 were, in order, Atka mackerel, Pacific ocean perch, northern rockfish, giant grenadier, arrowtooth flounder, walleye pollock, and Pacific cod. Increases in survey-wide estimated biomass since 2004 were observed for Pacific ocean perch by 16% to 667,000 t, northern rockfish by 15% to 218,000 t, and arrowtooth flounder by 94% to 184,000 t. Survey-wide biomass estimates decreased for Atka mackerel by 36% to 741,000 t, giant grenadier by 22% to 193,000 t, pollock by 69% to 113,000 t, and cod by 19% to 93,000 t. Results have been supplied to stock assessment authors for updating assessment reports for the North Pacific Fisheries Management Council.

Biological data and specimens were collected from a wide variety of groundfish and invertebrates. Over 96,000 length observations were recorded from 52 species. Length and individual weight measurements were recorded from almost 10,600 fish from 50 species. Over 7,800 pairs of otoliths were collected from 20 species, including 3 species of sculpin that were sampled for the first time this year.

For further information please contact Mark Wilkins, (206) 526-4104.

Groundfish Systematics Program - RACE

James Orr and Duane Stevenson continue working on the taxonomy and systematics of several families of fishes, most recently skates, snailfishes, rockfishes, sculpins, eelpouts, manefishes, and deep-sea anglerfishes. Both participated in meetings of the American Society of Ichthyologists and Herpetologists in New Orleans and the Charles Henry Gilbert Ichthyological Society in Newport, where they presented papers on skate distribution and systematics. Orr's work with Sharon Hawkins of Auke Bay Laboratory on the recognition, identification, and nomenclature of *Sebastes melanostictus* will be completed with the examination of important Japanese type specimens, which will be examined during an extended stay as a visiting professor to Kyoto in January-March 2007. Stevenson's paper synonymizing the name *Stlegicottus xenogrammus* with *Rastrinus scutiger* is in press and he presented a paper on his work at the annual meeting of the Gilbert Ichthyological Society. His range extension and review of the morphology of *Caristius* in the eastern North Pacific with lead author Dave Csepp of the Auke Bay Lab is in press. Stevenson also had a manuscript published in Copeia in 2006 describing a new species of eelpout, *Lycodes akuugun*, from the Aleutian Islands. This species is currently known from less than 20 specimens, all collected on the RACE Division's Aleutian Islands bottom trawl surveys. Duane is nearing completion of another manuscript detailing a worldwide taxonomic revision of the eelpout genus *Bothrocara* with Eric Anderson and Gento Shinohara. The center of distribution of this genus appears to be the eastern Bering Sea, where 6 of the 8 recognized species have been collected on NMFS bottom trawl surveys. One of these species, the recently described *Bothrocara nyx*, was recently described from the Bering Sea slope and is apparently endemic to that region. Duane has a third manuscript in internal review that describes emerging patterns of species richness and density in the skates of Alaska based on groundfish survey data.

Over the past several months, Orr, Stevenson, and Jerry Hoff have been working with Alaska Sea Grant to finalize the Field Guide to the Sharks, Skates, and Ratfish of Alaska. The guide will be released for sale to the public in summer 2007. It will include anatomical diagrams, dichotomous keys to the adults and egg cases of Alaska's chondrichthyans, color photos, range maps and tooth illustrations. This publication is based primarily on data collected during the AFSC's bottom trawl surveys, as well as the authors' visits to research collections in Japan and Russia. The target audience includes professional fish biologists, fisheries observers, commercial fishermen, students and educators, naturalists, and divers. The primary goal of this publication is to facilitate the effective stewardship of Alaska's chondrichthyan populations by making species-level identification of sharks, skates, and ratfish accessible to professionals and laymen alike. Popular Alaskan fish artist Ray Troll has been commissioned to produce the cover art for the guide.

For further information, contact Dr. James Orr, (206) 526-6318.

Recruitment Processes Program

Scientists of the Recruitment Processes Program conduct a number of studies investigating distribution, abundance, and size structure of larval and juvenile groundfish in the Gulf of Alaska

and Bering Sea. In the Bering Sea, species under investigation include northern rock sole and Greenland halibut; flatfishes, Pacific cod, walleye pollock and capelin are being studied in the Gulf of Alaska.

Bering Sea northern rock sole – A study of distribution, abundance and size structure of northern rock sole (*Lepidopsetta polyxystra*) larvae was conducted on the eastern Bering Sea shelf. Highest abundances of larvae were collected in Unimak Pass and northeast of Unimak Island. Larval abundance and size varied with depth. Highest abundances were at depths of 10-30 m during the day, and larger fish appeared to migrate from below 20 m to 0-10 m at night. There was evidence of multiple spawning locales and larval dispersal pathways that were depth- and area-specific. Dispersal of northern rock sole larvae at depth (>10 m) is probably more affected by factors that modulate geostrophic flow than wind-driven surface currents.

Current work on northern rock sole larvae in the Bering Sea (Stockhausen et al.) uses the Dispersal Model for Early Life History Stages (DisMELS) model to simulate egg and larval dispersal. The DisMELS model utilizes a 3-D oceanographic model based on the Regional Oceanographic Modeling System for the northeast Pacific (NEP ROMS) but also incorporates individual behavior (vertical migration). Goals of this project are to generate quantitative indices of predicted recruitment from 1978 to 2007 as alternatives to OSCURS predictions.

Bering Sea Greenland halibut – A project funded by the North Pacific Research Board has begun that investigates the transport pathways from spawning to potential nursery locations of Greenland halibut eggs and larvae in the eastern Bering Sea. Goals of the project are to assess Greenland halibut (1) spawning locations, (2) egg and larval drift pathways, (3) egg buoyancy, (4) larval and juvenile feeding and growth patterns, and (5) vertical egg distribution. A research cruise was undertaken in May, 2006 to begin assessing horizontal, vertical distribution of larvae, and future cruises are planned for May, 2007 (Pribilof Canyon & Pribilof Island vicinities) and February, 2008 (Bering Canyon vicinity). We are collaborating on this project with Dr. Lorenzo Ciannelli (Oregon State University).

Gulf of Alaska walleye pollock and capelin – A research study was undertaken in 2005 (with partial funding by the North Pacific Research Board) to examine the effects of local hydrography on the distribution and diets of capelin and young-of-the-year walleye pollock in Barnabus trough, Gulf of Alaska. Physical oceanographic sampling indicated a mid-trough front separating two different water masses, with mixed schools of age-0 pollock and capelin where found offshore in cool, high-salinity water, and capelin (mixed with jellyfish) inshore of the front in warmer, low-salinity water. Diet analyses indicated that age-0 pollock consumed primarily euphausiids and large copepods offshore, while capelin consumed mostly small calanoid copepods and larvaceans inshore and offshore. Another cruise is planned for this September on the NOAA Ship *Miller Freeman*.

There have been a number of field and laboratory studies completed on the ecology of walleye pollock in the Gulf of Alaska. In a report by Porter and Bailey (in press), they showed that early hatching larvae are more vulnerable to predation by invertebrate predators than those that take longer to hatch. A paper by Dougherty et al., (accepted) examined growth and hatchdate variability of juvenile walleye pollock caught in the Shumagin Is region, and showed that resident juveniles originate from spawning in Shelikof Strait. A report by Ciannelli et al.,

(in press) examined the locations of pollock spawning in the GOA from the abundance of pollock eggs in the ichthyoplankton. They found that persistent spawning occurs in several nearshore areas, but spawning in offshore regions is variable.

Gulf of Alaska Pacific cod – A study examining the distribution, abundance and feeding of juvenile Pacific cod in nearshore habitats was conducted near Kodiak Island, Alaska (Abookire et al., 2007). Beach seines were used to collect individuals, and associated environmental measurements (depth, water temperature, salinity, sediment grain size, and percent cover by emergent structures) were collected. Density of juvenile Pacific cod was highest in areas of moderate depth (15-20 m) and positively and linearly related to percent cover by sea cucumber mounds and to salinity. Presence of eelgrass and macroalgae had no significant affect on cod distribution. Diets consisted mainly of small calanoid copepods, mysids, and gammarid amphipods and were significantly related to depth and percent mud.

Gulf of Alaska Flatfishes – Several projects have been completed examining ontogenetic changes in the distribution of stages of offshore spawning flatfishes. Distribution shifts of Dover and rex sole were examined in a report by Abookire and Bailey (2007). Dover and rex sole were compared with arrowtooth flounder and Pacific halibut in Bailey et al. and retrospective research into the association between larval fish assemblages and their environment continue (Doyle et al., 2006).

For further information, contact Dr. Jeff Napp, (206) 526-4148.

Fisheries Behavioral Ecology Program — RACE

The Fisheries Behavioral Ecology Program based in Newport, Oregon conducts experimental research designed to understand the role that behavior plays in regulating distribution, abundance growth, and survival of fish species and their interactions with fishing methods and gear. The goal of the Program is to provide the critical information needed to improve survey techniques, to improve predictions of population abundance and survival, and to conserve populations of economically significant marine resource species and their habitats. Research conducted during 2006 continued under long-term research themes related to bycatch stress and basic studies in fish ecology relevant to the performance of fishing gear, definition of essential habitat, and recruitment processes.

Experimental Bycatch Studies - Bycatch studies in AFSC's Fisheries Behavioral Ecology Program fall into two main categories: 1) the fate of fish which are discarded after their arrival on the deck, and 2) the fate of fish which escape trawl gear at depth through cod-end meshes. Laboratory studies have identified key principles which control mortality; integrating analysis of injury, behavior, and plasma constituents with observed mortality. In general, capture and environmental stressors interact to produce physical injury, behavior impairment, and immediate and delayed mortality. High incidence of mortality in smaller fish indicates that the practice of high-grading in fisheries is counter-productive for stocks and should be generally restricted.

Behavioral impairment and mortality in fish escapees and discards from fishing operations may be predicted directly from measurements of reflex actions (Davis & Ottmar,

2006). A major advantage of this technique is that routine long term holding of fish in cages or tagging and recapture are not needed for determination of mortality. Reflex impairment in walleye pollock, sablefish, coho salmon, northern rock sole, and Pacific halibut was significantly related to delayed and total mortality in biphasic relationships described by sigmoid curves. These relationships are termed RAMP (reflex action mortality predictors). RAMP initially increased without concomitant mortality, and then continued to increase as mortality appeared and increased. The essence of the approach is to find ways to stimulate reflex actions consistently in control fish and then measure reflex impairment in stressed fish. Reflex impairment can be observed after capture or escape in either free swimming fish or restrained fish. For free swimming fish, impairment of orientation, position, and startle responses to visual and sound stimuli can be observed and recorded in sea cages or tanks on board ships. For restrained fish, impairment of body flex, operculum closure, mouth closure, gag response, and vestibular-ocular response can be observed. Other reflex responses may also be present in species of interest. Measurement of reflex impairment may be a powerful tool for expanding the scope and replication of fishing experiments in the field and for comparing bycatch mortality among various fishing practices and fisheries. RAMP may also be used in any context in which rapid assessment of fish welfare is needed, e.g., aquaculture, fish transport, stock enhancement, holding for experimentation. The RAMP method is being expanded to crab and other invertebrate bycatch species in future research.

Surveys with underwater vehicles - Underwater vehicles including submersibles, ROVs and towed camera systems are used increasingly to assess the abundance and distribution of demersal fishes, particularly in structurally complex habitats. It is often assumed that visual survey data have less inherent bias than sampling with conventional survey gear. To evaluate potential biases in surveys employing underwater vehicles, the AFSC Fisheries Behavioral Ecology Program conducted an analysis of reactions by demersal marine fishes. Almost all of the 46 fish observed respond to underwater vehicles in some way, depending upon operational variables including vehicle type, speed, light and sound levels. Direct responses were common, and some fishes respond indirectly, by attraction to sediment disturbance and prey species gathered in artificial lights.

A simple conceptual model was developed to evaluate relationships between stimulus intensity, distances from the vehicle where reactions occur, and survey bias. While light level and vehicle speed have been explored experimentally in a few cases, much remains to be learned about how reactions and biases vary among species and age classes, and among different vehicles and operating conditions. It was concluded that surveys need to be conducted using methods that minimize variation in vehicle operation and that vehicle time be devoted specifically to manipulations of operating conditions to evaluate bias quantitatively. FBEP is currently conducting laboratory experiments to evaluate the effects of light on fishery species including rockfishes, sablefish and halibut.

For further information, contact Dr. Allan Stoner, (541) 867-0165.

Age and Growth Program - REFM

The Age and Growth Program of the REFM Division serves as the Alaska Fisheries Science Center's ageing unit for groundfish species. The program currently consists of a biometrician,

age validation researcher, IT/data specialist, and 9 age readers. Ages are usually determined from otoliths, but scales, finrays and vertebrae are sometimes used. The protocols governing age determination at the AFSC have recently been documented by (Kimura and Anderl, 2005), whose paper is now available on the Age and Growth website.

Data provided by the program are used in stock assessment modeling, which contributes to the estimation of the allowable catch of many commercially important groundfish species. These species include walleye pollock, Pacific cod, sablefish, Pacific ocean perch, northern, rougheye, and dusky rockfishes, Atka mackerel, yellowfin sole, rock sole, rex sole, and misc. sole and rockfish species. Increasingly, the program is ageing "minor" species, which either are possible candidates for commercial harvest, or may be important in monitoring the broader ecosystem. Examples of these include the giant grenadier, big and longnose skates, and several sculpin species.

Research in the Age and Growth Program in 2006 has focused on the following areas:

1. Craig Kastelle and Dan Kimura are also completing a manuscript documenting results on C-14 age validation of Pacific ocean perch from the Gulf of Alaska. Although some outliers exist, the bomb carbon method provides strong support of the POP ageing criteria used at the AFSC, and proposes new methods for data analysis. Papers on the application of C-14 to other species will follow.
2. Dan Kimura, Delsa Anderl, and Betty Goetz are completing a manuscript analyzing 17 years of edge type data collected by age readers on 9 different species. These data support the hypothesis of seasonal growth in 7 of these species.
3. Charles Hutchinson and Delsa Anderl are documenting methods being developed for the ageing of giant grenadier (*Albatrossia pectoralis*)." This species is turning out to be difficult to age, and is hoped that we can validate our ageing methods using C-14.
4. Also, Charles Hutchinson and Betty Goetz have been involved in standardizing the ageing of shortraker rockfish, so that ageing can be done on a production, rather than a research basis. Again, ageing of this species is proving difficult and we hope that C-14 can be used to improve our method of ageing and eventually validate ageing criteria for this species.
5. Jon Short recently developed a new online website for direct users of age data from the Age and Growth Program. This database is meant to show the progress of samples as they are processed by age readers. The purposes of this database are to allow users to track their requests, and to make the internal operations of the Age and Growth Program more transparent. The site can be found using the link http://www.afsc.noaa.gov/REFM/Age/ageingrequests.htm. When queried, this database will display three groups of samples:

    a. The first group of samples is "Requests in Queue." These are samples which have been requested, but have not been started by age readers.
    b. The second group of samples is "Currently Ageing." These are samples in the process of being read. It is possible to view the total sample sizes and the sample

size that has been read. Don't forget samples must be tested by a second age reader, and the test results reconciled before samples are released to users.

c. The third group of samples is "Released Collections." These are samples have completed processing and have released to the users. This list includes recently released samples and samples that have been released during the previous calendar year.

For further information contact Dr. Daniel K. Kimura (206) 526-4200.

Resource Ecology and Ecosystem Modeling - REFM

2007 TSC Report – Multispecies Studies

Resource Ecology and Ecosystem Modeling – Multispecies, foodweb, and ecosystem modeling and research are ongoing. Documents, symposia and workshop presentations, and a detailed program overview are available on the Alaska Fisheries Science Center (AFSC) web site at: http://www.afsc.noaa.gov/REFM/REEM/Default.php.

Groundfish Stomach Sample Collection and Analysis - The Resource Ecology and Ecosystem Modeling Task (REEM) continued regular collection of food habits information on key fish predators in the North Pacific. Collection of groundfish stomach samples is primarily through the RACE bottom trawl and echo-integration/trawl surveys. Additional samples that broaden our spatial and seasonal coverage are obtained through the Observer Program and through coordinated studies with other agencies. In 2006, REEM collected samples and data during bottom trawl surveys of the Aleutian Islands and eastern Bering Sea. Stomach samples were also collected during surveys by other agencies and by Observers during fishery operations. In total, 5,984 stomachs were collected from the eastern Bering Sea and 2,074 stomachs were collected from the Gulf of Alaska and Aleutian Islands. Laboratory analysis was conducted on 8,452 fish stomachs from the Bering Sea and 2,601 fish stomachs from the Gulf of Alaska and Aleutian Islands. At-sea analysis was conducted on 780 fish stomachs from the Bering Sea and 1,402 fish stomachs from the Aleutian Islands. The REEM predator-prey database was updated with 50,032 records in 2006. Complete database details can be found at http://www.afsc.noaa.gov/REFM/REEM/data/default.htm.

Predator/Prey Interactions and Fish Ecology - REEM examines patterns in predator-prey data based on predator species, predator size and spatial distribution, and trends in seasonal and interannual predator-prey interactions are analyzed. Such food habits data is a key input into REEM multispecies and ecosystem modeling efforts, which rely on diet composition matrices from these data in order to produce yearly estimates of predation mortality for key species such as walleye pollock. Recent additions to the series of REEM food habits reports for the Gulf of Alaska (http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-164.pdf) and the eastern Bering Sea (http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-158.pdf) are now available. The food habits of over 40 fish species are described in these two reports. The reports indicate that internannual comparisons of the diet composition of major predatory species often show large differences. For example, arrowtooth flounder in the Gulf of Alaska consumed a greater percentage of pollock and osmerids (primarily capelin) in 2001 than

in 1999. Predator/prey data is also used by REEM to estimate the biomass of economically important species consumed by groundfish predators. For example, REEM recently updated the biomass of snow crabs consumed by groundfish predators in the eastern Bering Sea.

Multispecies and Ecosystem Modeling - A database of life history characteristics of Alaska groundfish, as determined by extensive literature review, was made available to the public at http://access.afsc.noaa.gov/reem/LHWeb/index.cfm. These life history parameters will be a key to developing the next generation of multispecies models. Modeling results, including trends of estimated population consumption by key groundfish in the eastern Bering Sea, were also made available to the public. These results are from MSVPA (multispecies virtual population analysis) (http://www.afsc.noaa.gov/refm/reem/models/MSVPA.htm) and the multispecies statistical model (http://www.afsc.noaa.gov/refm/reem/models/MSM.htm).

Assessing interactions between fisheries and marine mammals remains a critical national and international issue, and ecosystem models continue to enter this debate. In making policy decisions based on these models, it is important to evaluate the ecological assumptions underlying each model. For example, how do predators react to changes in prey in the model and in the real ecosystem? Do they forage over separate areas, each selecting from a range of prey choices or do they compete directly in local "hotspots" for individual prey types? The answer may differ by predator, by ecosystem, or especially by local conditions. Current multispecies and ecosystem models tend to make a single assumption on the scale of competition and this may lead to biased results: the "complexity" of predator/prey interactions may be best evaluated by using a wide range of statistically validated models and assumptions for any particular predator/prey interaction.

REEM is collaborating with SSMA and University of Washington (UW) researchers to incorporate trophic interactions within a Management Strategy Evaluation (MSE) for Gulf of Alaska pollock. REEM is providing information on potential changes in pollock mortality under different ecosystem conditions in a streamlined format that allows SSMA and UW scientists to minimize computational complexity within the MSE. This summer, we distilled results of thousands of Gulf of Alaska ecosystem model runs into functional relationships between pollock mortality and predator biomass which considered different levels of pollock biomass and ecosystem-wide primary productivity. Preliminary results show fairly strong relationships between the biomass of a handful of key predators and total pollock mortality; the relationship is especially strong between juvenile pollock mortality and arrowtooth flounder biomass. In general, these results suggest that pollock mortality increases with predator biomass more quickly and to a higher level when pollock biomass is relatively low , and that individual predators affect pollock mortality to a lesser extent when pollock biomass is high. REEM continues to refine this work in collaboration with SSMA and UW to provide a full range of ecosystem interactions for analysis within the Gulf of Alaska pollock MSE.

The AFSC is developing a scientific framework for providing ecosystem-based advice for the management of groundfish fisheries. This framework has three main goals for protecting the ecosystem attributes: 1) maintain predator/prey relationships, 2) maintain energy flow and balance, and 3) maintain diversity. This framework includes using multispecies models (biological and technological interactions) for developing statistically rigorous multispecies forecasts. In particular, we have developed a multispecies virtual population analysis and a

multispecies forecasting model for the eastern Bering Sea. Unfortunately, these models lack statistical assumptions obstructing the inclusion of uncertainty into multispecies model parameter estimation. Therefore, REEM recently developed a simple version of a multispecies statistical model (MSM) to show that it is possible to incorporate MSVPA predation equations into a statistical catch-at-age model. The MSM focuses on two species, walleye Pollock and Pacific cod. A more elaborate version of this model has been set up in the AD model builder platform (ADMB).

The integration of multispecies and ecosystem modeling results into the Stock Assessment and Fishery Evaluation (SAFE) was substantially expanded in 2006, especially in the ecosystem assessment and Bering Sea walleye pollock ecosystem considerations sections. In particular, forage fish biomass trends from bottom trawl surveys for the last 24 years in the Bering Sea were summed using catchability coefficients ('q') calculated from the Bering Sea ecosystem model. The results show two notable features: First, forage fish seemed to show an "ecosystem response" to decreased pollock biomass in the early 1990s, with the decrease in pollock being followed by an increase in shrimp, capelin, and other forage species. This increase may be due to prey release or alternating climate conditions favoring different suites of species: Second, forage fish biomass seems to have dropped abruptly after 1998, and the last 7 years (1999-2006) have shown the lowest biomass of non-pollock forage since the time series began. Another trend of note in the Bering Sea has been the increase in arrowtooth flounder in recent years; analysis of this trend, particularly with respect to its impact on pollock, is ongoing.

Seabird - Fishery Interaction Research - The annual estimates of seabird bycatch have been posted on the AFSC website seabird page. These estimates provide bycatch numbers by certain species groups or species from 1993 through 2004 for all gear types (longline, pot, trawl) in Alaskan waters. Numbers are provided by Fishery Management Region as well. The estimate of seabird bycatch is completed by NMML staff each year and provided to the REEM Program. Two data sources are necessary for these estimates to be completed: those provided by groundfish observers and managed by the Fishery Monitoring and Analysis Division and the fisheries catch database maintained by the Alaska Regional Office's Sustainable Fisheries Division. While data are provided for all gear types, much of the focus has been on longline fisheries. Overall seabird bycatch has dropped in those fisheries from a high of more than 25,000 birds in 1998 to current levels of less than 5,000 birds. This is primarily due to the voluntary adoption of paired streamer lines by the freezer-longliner fleet in 2002 after a Washington Sea Grant study showed that paired streamer lines were the most effective seabird deterrent measure. Paired streamer lines were required for all vessels over 55 ft through regulatory rulemaking completed in February 2004. Prior to the extensive use of paired streamer lines in 2002, the average annual bycatch of seabirds in the combined Alaskan demersal groundfish fleet was 15,888 birds. Since then (2002 -2004) the average has been 4,910, a 70% reduction.

Conducting and coordinating seabird surveys is an important focus for the AFSC's seabird program. Two types of surveys were worked on. The first is the stationary survey format developed by Washington Sea Grant for longline cruises in 2004. This format was expanded to all research and charter cruises conducted by the AFSC for 2006. Staff also coordinated with the NWFSC to implement the surveys on the West Coast charter cruises. These surveys now cover NOAA Fisheries research and charter cruises from southern California, up the

west coast, and throughout Alaskan waters. The second is the strip-census seabird survey. Staff have worked very closely with the USFWS Migratory Bird Division to conduct strip-census seabird surveys on appropriate platforms. This work will add to the extensive survey work completed in the 1970's and early 1980's and will ultimately be made available to researchers through the North Pacific Pelagic Seabird Database (USGS).

Two analyses relevant to the short-tailed albatross biological opinion are nearing completion. A risk assessment of short-tailed albatross interactions with trawl vessels and a threshold analysis for short-tailed albatross incidental takes in the Alaskan groundfish fishery are being conducted by UW scientists. These analyses are under the direction of the AFSC Seabird Program through funds provided by the National Seabird Program.

Ecosystem Considerations - REEM coordinated the annual production of the Ecosystem Considerations section of the Stock Assessment and Fishery Evaluation for the North Pacific Fishery Management Council. It is utilized to advance our understanding of marine ecosystem dynamics and deliver ecological, oceanographic, and climatic indices to stock assessment scientists and managers. The report includes an ecosystem assessment, updated status and trend indices, and ecosystem-based management indices and information for the Bering Sea (BS), Aleutian Islands (AI) and the Gulf of Alaska (GOA) ecosystems. Integration of information regarding ecosystem status and trends and the use of models to predict possible future ecosystem states using an indicator approach constitutes the framework of a BS/AI and GOA ecosystem assessment. Annual updates of historical trend and present status of various ecosystem indicators are performed by internal development and update of indicators and communicating with the diverse scientific community that is involved in climate, protected species, sustainable fisheries, and ecosystem research. The purpose of the third section, Ecosystem-based Management Indices and Information, is to provide either early signals of direct human effects on ecosystem components that might warrant management intervention or to provide evidence of the efficacy of previous management actions. The information in the Ecosystem Considerations report is utilized by the NMFS Alaska Regional Office and the North Pacific Fishery Management Council to evaluate the environmental impacts of various Fishery Management Plan alternatives. A new website has been developed that provides access to the contributions as well as to data time series summarized in the report: http://access.afsc.noaa.gov/reem/ecoweb/Index.cfm.

Major environmental trends last year included the reversion to relatively cold conditions in the Bering Sea during the winter of 2005/2006, which resulted in an extensive cold pool in the summer of 2006. This cold trend, however, was regional in nature and a continued warming trend with reduced ice extent has been documented through much of the Arctic. Temperature conditions in the Gulf of Alaska were the warmest on record in 2005 (information for 2006 was not available). A major conclusion from the analysis of various trends is that no apparent adverse effects of fishing on the ecosystems have been documented to date. Concerns about high bycatches of salmon in the Bering Sea pollock fishery, however remain, and these are being addressed by the Council.

An example of an updated and reanalyzed index is the trophic level of the catch. The trophic level of the catch and the Fishery in Balance (FIB) indices have been monitored in the BS, AI, and GOA ecosystems to determine if fisheries have been "fishing-down" the food web

by removing top-level predators and subsequently targeting lower trophic level prey. The FIB index indicates whether trophic level catch trends are a reflection of deliberate choice or of fishing-down the food web. This index declines only when catches do not increase as expected when moving down the food web (i.e., lower trophic levels are more biologically productive), relative to an initial baseline year. Although there has been a general increase in the amount of catch since the late 1960s in all three areas of Alaska, the trophic level of the catch has been high and relatively stable over the last 25 years. Unlike other regions in which this index has been calculated, such as the Northwest Atlantic, the FIB index and the trophic level of the catch in the EBS, AI, and GOA have been relatively constant and suggest an ecological balance in the catch patterns.

For more information about REEM research, please contact Kerim Aydin at (206)526-4225.

2. Stock Assessment

Status of Stocks and Multispecies Assessment Task - REFM

The Status of Stocks and Multispecies Assessment Task is responsible for providing stock assessments and management advice for groundfish in the North Pacific Ocean and the Bering Sea. 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 by the Task for the Gulf of Alaska and Bering Sea/Aleutian Islands Groundfish Plan teams of the North Pacific Fishery Management Council and for the groundfish management team of the Pacific Fishery Management Council.

Assessment scientists provided analytic assistance on many current fisheries management issues. These included: 1) identification and prioritization of research activities intended to improve groundfish stock assessments; 2) Developing a FMP Amendment to define overfishing for the crab stocks of the Bering Sea, 3) completed Aleutian Islands pollock, rockfish and Atka mackerel cooperative research projects with industry ; 4) convened workshops on recruitment with REFM/ABL/RACE, FOCI and PMEL, a PFMC B_0 workshop (by Martin Dorn Chair of Groundfish Subcommittee of SSC) and a Lowell Wakefield Symposium (organized by Jim Ianelli), 5) initiated a breakout of species in the "other species" category of the FMP for improved management, and 6) various task members participated in numerous national and international committees and workshops on a variety of issues.

Sarah Gaichas, currently a member of the Resource Ecology and Ecosystem Modeling program, completed her Doctoral Dissertation (University of Washington) titled: Development and Application of Ecosystem Models to Support Fishery Sustainability: A case study for the Gulf of Alaska. A summary of her dissertation can be found at:
http://www.afsc.noaa.gov/Quarterly/jas2006/jasfeaturelead.htm

The Fishery Interaction Team (FIT), a part of the Status of Stocks and Multispecies Assessment Task, in the REFM Division, conducts studies to determine whether commercial fishing

operations are capable of impacting the foraging success of Steller sea lions either through disturbance of prey schools or through direct competition for a common prey. The present research focus is on the three major groundfish prey of sea lions: walleye pollock, Pacific cod and Atka mackerel.

FIT investigates the potential effects of commercial fishing on sea lion prey in two ways. First, by conducting field studies to directly examine the impact of fishing on sea lion prey fields and to evaluate the efficacy of trawl exclusion zones. FIT research examines the hypothesis that large-scale commercial fisheries compete with sea lion populations by reducing the availability of prey in relatively localized areas. Since 2000 FIT has been conducting field studies to examine the impact of fishing on sea lion prey fields in all three major Alaska regions: the Gulf of Alaska, Bering Sea and Aleutian Islands.

The second way that FIT investigates the potential effects of commercial fishing on sea lion prey is by studying fish distribution, behavior and life history at spatial scales relevant to sea lion foraging (tens of nautical miles). This scale is much smaller than the spatial scales at which groundfish population dynamics are usually studied and at which stocks are assessed. This information is needed to construct a localized, spatially-explicit model of sea lion prey field dynamics that can be used to predict spatial and temporal shifts in the distribution and abundance of sea lion prey and potential effects of fishing on these prey fields.

FIT researchers collaborate with other AFSC scientists who are studying Steller sea lions and their prey, such as scientists in the Resource Ecology and Ecosystem Modeling program and the National Marine Mammal Lab. For more information on the FIT program, contact Dr. Libby Logerwell or access the following web link: http://www.afsc.noaa.gov/REFM/Stocks/fit/FIT.htm

For further information on the SSMA task group, contact Dr. Anne Hollowed (206) 526-4223.

3. Management

Economics and Social Science Research Program – REFM

The Economics and Social Science Research Program of the REFM Division has been focusing on the following projects during 2006:

- **The Demand for Halibut Sport Fishing Trips in Alaska** - Dan Lew
  For further information, contact Dan.Lew@NOAA.gov
- **Integrating Trip and Haul-Level Groundfish Fishing Data** - Alan Haynie
  For further information, contact Alan.Haynie@noaa.gov
- **Groundfish Market Data Collection and Translation** - Ron Felthoven
  For further information, contact Ron.Felthoven@NOAA.gov
- **Collecting Regional Economic Data for Alaska Fisheries** - Hans Geier and Chang Seung
  For further information, contact Chang.Seung@NOAA.gov
- **Two Phases of an Integrated Economic-Ecosystem Modeling Project Completed** - Chang Seung

For further information, contact Chang.Seung@NOAA.gov

- **Gulf of Alaska Halibut IFQ and Small Remote Fishing Communities** - Dan Lew and Jennifer Sepez
  For further information, contact Jennifer.Sepez@NOAA.gov
- **Through a Cod's Eye: Exploring the Social Context of the BSAI Pacific cod Fishery** - Emilie Springer
  For further information, contact emilie1@u.washington.edu

For further information or if you have questions about the Economic and Social Sciences Research Program, please contact Dr. Ron Felthoven (206)-526-4114.

C. By species, by agency

1. Pacific Cod

a. Research

Larval recruitment – In 2006, the Fisheries Behavioral Ecology Program began a multi-year research program with support from the North Pacific Research Board to develop spatially-explicit models of growth potential for Pacific cod larvae and juveniles in the Bering Sea with respect to climate change. The project was designed to be a true collaborative effort among modelers and laboratory scientists as a means of generating the necessary data and model framework to examine environmental-survival/growth interactions. Research was initiated in 2006 with the first shipment of fertilized eggs from Kodiak to Newport to examine the effects of temperature on developmental rate, energy allocation, growth, and mortality in eggs and larvae. Pacific cod eggs survived and hatched at all the temperatures tested, but hatching success was significantly lower at 0°C relative to temperatures ≥ 2°C. The effects of temperature on egg development are being examined by lipid/fatty acid analysis.

The consequences of eggs hatching early and late to larval growth and survival were further examined by following cohorts of early and late-hatching larvae to 50% mortality, i.e., the 'Point-of-No-Return', the period at which remaining larvae are too weak to feed even if prey were available. In all temperature treatments, early hatching larvae were smaller but had more lipid reserves and survived longer after hatch in the absence of food than late hatching fish. Additional experiments are designed to examine the interactions of food and temp

Currently, the data from Pacific cod larval experiments are being incorporated into models using field data on larval and juvenile distributions, temperature and primary productivity (SeaWiFS/MODIS Aqua data) to examine population-level consequences of changing environmental conditions in the North Pacific. This project component is being conducted in a collaborative effort between AFSC's Fisheries Behavioral Ecology Program and Oregon State University oceanographers, and is anticipated to be finished in 2008.

Juvenile habitat – Studies of habitat associations in age-0 Pacific cod were initiated by the AFSC Fisheries Behavioral Ecology Program in Kodiak during 2006 using seines, trawls and baited cameras. Seines provided physical samples for collections in shallow water whereas the baited cameras were effective in determining relative abundance in a wide range of habitats including deep water, seagrasses and rocky areas. Age-0 fish were abundant in nearshore macrophytes (*Laminaria* and *Zostera*) particularly during the earliest post-settlement stages, and then expanded into open habitats at greater depths with size during the first summer. Laboratory experiments showed that preferences for structurally complex habitats are strongest when potential predators are present.

Age-0 Pacific cod were captured in Kodiak nursery sites and shipped to the Newport laboratory for experiments on potential growth. Following laboratory acclimation, fish were reared under *al libidum* feeding conditions for 2-3 months at four temperatures between 2 and 13^{o}C. Subsequent experiments will test growth at additional temperatures and examine the thermal effects on consumption rate.

For further information, contact Dr. Allan Stoner, (541) 867-0165.

b. Stock Assessment

BERING SEA/ALEUTIANS

The present assessment is a substantial revision of last year's assessment, incorporating an analysis of a combination of model runs with different configurations. The 200`6 EBS shelf bottom trawl survey resulted in a biomass estimate of 518,000 t, down 14% from the 2005 estimate (604,000) and the lowest observed for the 24 year time series. The 2006 Aleutian Islands estimate of 92,500 t was 19% lower than the 2004 estimate.

The following models were evaluated. Model 0 is last year's preferred model, where catchability was fixed (Q = 1.0). Eight alternative models were tested (Models A1, A2, B1, B2, C1, C2, D1, D2) with some features in common including estimation of shelf trawl survey catchability (Q; prior mean = 1.0, CV = 0.3) and separate estimation of Q for the pre-1982 and 1982-and-later trawl surveys. The eight alternative models differed in whether longline surveys were included, the functional form of selectivity, and whether priors were given full (1.0) or partial (0.5) weight. The two selectivity functions were the double-logistic (8 parameters) and the double-normal (4 parameters). The combinations of these eight models form a factorial design.

The following criteria was proposed for selecting the preferred model: 1) reasonable selectivity for a trawl survey (no pronounced "kink" in the shape); 2) data are validated and ready for use (e.g. longline survey data); 3) model converges well and is not strongly dependent on initial values; and 4) the model is not strongly dependent on prior distributions. The model fits were similar regardless of the model configuration. All models converged successfully, but models with partial weights on priors had to be started from the converged parameter from runs with full weight on priors. The senior author's preferred model, B1, was chosen to represent the Bering Sea cod population in 2007. For many years, cod was challenging to assess because age data were limited. In

this year's assessment, three more years of age data were added to total 11 years of age data. This addition provides for an age data set of reasonable duration to support an age-structured assessment. In addition, catchability is estimated and natural mortality is fixed in this year's assessment. A simplified selectivity function with four (double-normal) rather than eight (double-logistic) parameters was successfully applied and improved model performance. The results for Model B1 estimate the 2007 spawning biomass for the BSAI stock at 307,000 t, up about 10% from last year's estimate for 2006 and up about 25% from last year's $F_{40\%}$ projection for 2007. Abundance is projected to continue to decrease during 2007-2009 because recent (2000-2004) recruitments are below average.

The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, and that this stock therefore qualifies for management under Tier 3. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 320,000 t, 0.34 and 0.42, respectively. Pacific cod qualify for management under sub-tier "b" of Tier 3 because projected biomass for 2007 (307,000 t) is about 4% below $B_{40\%}$. Fishing at an instantaneous rate of 0.33 is projected to result in a 2007 catch of 176,000 t, which is the maximum permissible ABC under Amendment 56. The 2007 ABC was set at the maximum permissible value of 176,000 t, 9% below the 2006 ABC of 194,000 t. ABC is projected to continue to decline; the current estimate of the maximum permissible ABC for 2008 is 131,000 t. The recommended OFL was determined from the Tier 3b formula, where fishing at a rate of 0.39 gives a 2007 value of 207,000 t, down 10% from the 2006 OFL of 230,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

The new maturity-at-length schedule implies that Pacific cod mature earlier than the previous schedule. The new schedule is based on microscopic examination of the ovaries which detected developing eggs in small cod that the previous macroscopic methods had missed.

GULF OF ALASKA

The stock assessment was updated as follows:

1) Catch data for 2006 were incorporated.
2) Size composition data from the 2006 commercial fisheries were incorporated.
3) Age composition data from the GOA bottom trawl survey were incorporated.
4) Parameters governing the length-at-age and weight-at-length relationships were re-estimated based on all available data from the NMFS bottom trawl survey time series.

A trawl survey was not conducted in the GOA in 2006. A single model was presented which was similar in structure to the model preferred last year by the Plan Teams and SSC, with Q fixed at 1.0 and M fixed at 0.37. The author noted that he intended to respond to Plan Team requests to explore alternative model structures and the incorporation of longline survey data, but that analysis was precluded by an outside review of the BSAI cod assessment which occurred during the time allotted for assessment preparation

Incorporating the new age data doubled the amount of age information in the model, and allowed the estimation of the length-at-age relationship to be done externally.

The current biomass in this year's assessment places the GOA Pacific cod stock in Tier 3a. Based on the model, the estimated 2007 female spawning biomass for the GOA stock is 126,903 mt, up about 9% from last year's estimate for 2006 and above the *B40%* value of 103,000 mt. These changes are due to the incorporation of additional age information, combined with different estimates of length at age and weight at length, which in turn reduced overall estimated recruitment variability. Less recruitment variability in turn contributes to less variability in stock size, accounting for the slightly more optimistic picture of the stock this year as opposed to last year. Based on the model, the maximum permissible ABC (Tier 3a) for 2007 is 81,200 mt. An ABC of this magnitude would represent an increase 18%, relative to the 2006 ABC. The assessment notes that the 2001-2003 year classes are almost certainly below average, and that biomass is very likely to decrease in coming years as these cohorts work their way through the age structure. The ABC for 2007 is set at 68,859 mt, equal to the actual ABC for 2006, which corresponds to a fishing mortality rate of 0.38. The 2007 OFL under Tier 3a is estimated to be 97,600 mt (86,000 mt for 2008), corresponding to a fishing mortality rate of 0.57. The ABC was apportioned for 2007 and 2008 according to the average of the biomass distribution in the three most recent surveys.

For further information, contact Dr. Grant Thompson at (541) 737-9318.

2. Shelf Rockfish

b. Stock Assessment

GULF OF ALASKA

Pelagic shelf rockfish – ABL – The pelagic shelf rockfish assemblage consists of four species (dusky, dark, yellowtail, and widow rockfish) that inhabit waters on the continental shelf in the Gulf of Alaska (GOA). Dusky rockfish (*Sebastes variabilis*) is by far the most abundant species in the group, and has been the target of an offshore bottom trawl fishery since the late 1980's. Dark rockfish (*S. ciliatus*) share an inshore reef or kelp environment with black rockfish (*S. melanops*), and the two species are often caught together. In 1998, black rockfish in Alaska were placed under state jurisdiction.

In February 2005, the North Pacific Fishery Management Council (NPFMC) initiated a Groundfish Plan amendment to remove dark rockfish from the GOA pelagic shelf assemblage and transfer management to the State of Alaska. The NPFMC GOA Plan Team and the NPFMC Scientific and Statistical Committee (SSC) had endorsed the recommendation of removing dark rockfish in 2004, but action was delayed until the 2005 GOA trawl survey data were available for analysis. In April 2006, Council staff presented the updated information on dark rockfish distribution in a draft environmental assessment (http://www.fakr.noaa.gov/npfmc/analyses/GOA67_406.pdf) to the SSC and Council. The SSC determined there was insufficient information to determine the depth

and distribution of GOA dark rockfish. The Council and SSC recommended another iteration of the analyses which included information on the Bering Sea and Aleutian Islands dark rockfish distribution. An update on available information was provided to the Council in October 2006 and initial review of the updated draft assessment took place at the 2007 February Council meeting. Final action on this amendment should occur at the 2007 April Council meeting.

Rockfish in the GOA have been moved to a biennial stock assessment schedule to coincide with data from the GOA biennial trawl surveys. This means that full assessments are done only in years that the trawl survey occurs. For age-structured assessments in non-survey years (such as 2006), we now run only the projection model with updated catch data. This satisfies recommendations in 2006 from the Groundfish Plan Team and accounts for changes in catch from last year's estimates. Assessments in non-survey years for rockfish species without an age-structured assessment or projection model use information from the previous year's stock assessment to determine this year's estimates. As with the 2005 full stock assessment, the average of exploitable biomass from the three most recent trawl surveys was used to determine the recommended ABC for dark, widow, and yellowtail rockfish, while an age-structured model was used for dusky rockfish. For the pelagic shelf rockfish assemblage, ABC and OFL for dusky rockfish are combined with the ABC and OFL for dark, widow, and yellowtail rockfish. For the 2007 GOA fishery, we recommend the maximum allowable ABC for the pelagic shelf rockfish complex of 5,542 mt. This ABC is similar to last year's ABC of 5,436 mt. The stock is not overfished, nor is it approaching overfishing status.

For more information, contact Chris Lunsford at (907) 789-6008 or Kalei Shotwell at (907) 789-6056.

3. Slope Rockfish

a. Research

BERING SEA, ALEUTIAN ISLANDS AND GULF OF ALASKA

Species Identification of Young-of-the-Year Rockfish and Population Genetic Structure of Pacific Ocean Perch Collected in Offshore Waters of the Gulf of Alaska and Bering Sea – Young-of-the-year (YOY) *Sebastes* rockfish were collected as "bycatch" during Auke Bay Laboratory (ABL) Ocean Carrying Capacity surveys of juvenile salmon in the Gulf of Alaska (GOA) in 1998, 2000–2003, and in the Bering Sea in 2002. The YOY rockfish were caught in rope trawls towed near the surface in offshore waters of both regions. Species identification of more than 2,000 specimens using mitochondrial DNA (mtDNA) analysis by ABL scientists in cooperation with Dr. Tony Gharrett of the University of Alaska Fairbanks (UAF) along with identification of a subset of several hundred specimens using morphological analysis by Dr. Arthur Kendall (retired from AFSC's RACE Division) revealed that the majority of the rockfish were Pacific ocean perch (*S. alutus*; POP). Twelve other species were also identified: black, darkblotched, dusky, northern, redstripe, rougheye, sharpchin, shortraker, widow,

yelloweye, yellowmouth, and yellowtail rockfish. With funding from the North Pacific Research Board, Dr. Gharrett and graduate student Lisa Kamin are examining the population structure of the POP using a suite of microsatellite DNA markers to determine the extent of genetic divergence between year-classes and between geographic locations. We are planning species identification of additional collections of YOY rockfish caught in offshore surface waters of northern SE Alaska in August 2006 and in the Bering Sea in September 2006.

A report focusing on species description at this life history stage using morphological features is under review, and a preliminary report on the genetic identifications is in press. We anticipate a third report that will compare the geographic distribution of species in these collections around the Gulf of Alaska within and between years.

For more information, contact Chris Kondzela at (907) 789-6084.

Rockfish Assemblage Analysis – During the fall of 2007 Chris Rooper completed a retrospective analysis of trawl survey data to identify assemblages of rockfish in the Gulf of Alaska and Aleutian Islands. The analysis used non-traditional method for identifying assemblages by first calculating catch-weighted mean depth, temperature and position (and associated variance) for each rockfish species commonly captured in the trawl survey. These distributions across environmental variables were then used to calculate an overlap index between species pairs based on niche theory. Clustering of the overlap index between species pairs resulted in four distinct assemblages of rockfish species found on the continental shelf and slope of Alaska.

The assemblages were sharply divided along gradients of depth and position and, to a lesser extent, along temperature gradients. The major divisions indicate an assemblage inhabiting mid-depths on the upper slope and shelf and a deeper assemblage distributed with a dividing line at approximately 180 m. In addition to the depth division, another noticeable transition was between species centered in southeastern Alaska and those found in the north Gulf of Alaska and the Aleutian Islands. The distribution of species over environmental gradients was correlated to their frequency of co-occurrence in trawl catches, indicating those species with similar environmental preferences were more likely to be captured together.

The method of defining rockfish assemblages by determining the natural distributions of each species group along environmental gradients and examining the potential overlap among species distributions is different than commonly utilized methods that cluster trawl survey catches or stations with similar catch constituents. However, the method used here provided similar results to other studies and, because it is based on an ecological framework, it may be more robust for prediction and management purposes.

For more information, please contact Chris Rooper, (206) 526-4689.

b. Stock Assessment

BERING SEA, ALEUTIAN ISLANDS AND GULF OF ALASKA

Rockfish Modeling Workshop – A rockfish modeling workshop was convened on May 23–25, 2006 at the Auke Bay Laboratory (ABL) to advance assessment analyses of rockfish in Alaska. The workshop objectives were to review the modeling history of rockfish, evaluate where improvements are needed, and identify key assumptions and sources of uncertainty in current rockfish assessment models. The potential for incorporating ecosystem components in rockfish stock assessments was also discussed in addition to approaches for communicating model results for the annual Stock Assessment and Fishery Evaluation (SAFE) reports. Participants included managers and scientists from ABL, REFM, the NMFS Alaska Regional Office, and the Alaska Department of Fish and Game.

Key life history features among rockfish species and stocks were compared. While age-at-maturity data for Pacific ocean perch (POP), *Sebastes alutus*, appears to be adequate for assessment purposes, data on many other rockfish species were lacking. Natural mortality assumptions/estimates for Alaskan rockfish species were generally consistent with growth and longevity patterns. Estimates of bottom-trawl area-swept survey "catchability" varied considerably among species. Simulation analyses presented at the workshop revealed some evidence that patchy populations that tend to cluster by age/size may result in biased catchability estimates. Further analyses and research on the impact of expanding within stratum area-swept estimates over untrawlable regions are needed. Presentations on the impact of estimating recruitment variability terms showed that this was problematic. The workshop recommended that fixed values for this dispersion term be used.

Evaluations on the rockfish models note that they are fundamentally Bayesian in that prior distributions are assumed and, for measures of uncertainty, posterior distributions are traditionally presented. The workshop concluded that the current SAFE reports could be improved by better documentation on how prior distributions were developed. The group also suggested that the shape and distribution of priors be included in the SAFE documents. For posterior distribution analyses, the Markov Chain Monte Carlo (MCMC) integration is typically used. The group discussed using a basic set of chain diagnostics to check for convergence (i.e., that the posterior distribution is adequately represented). The workshop recommended establishing a standardized approach for MCMC presentation and developing a common set of libraries, perhaps available via an intranet site. The group examined different SAFE reports and developed a standard list of tables and graphs. Regarding the ecosystem considerations section of the SAFE report, the workshop noted that developing models to evaluate environmental covariates may be most useful. For improving rockfish stock assessments, it may be more important to include environmental covariates affecting transport/recruitment rather than predation effects, because rockfish mortality does not appear dominated by predation.

A workshop summary and set of recommendations for future rockfish age-structured models was developed. In the short term, participants suggested 1) adding

tables in SAFE reports that clearly document management activities; 2) carefully evaluating different data sets for quality; 3) developing a system to evaluate model configurations where hypotheses about model assumptions can be easily performed; 4) evaluating the impact of different data sets on model results; 5) describing prior assumptions clearly and including associated posterior distributions; 6) standardizing computer code among rockfish stocks, particularly for generating standardized output and evaluations; and 7) comparing results between areas and models to understand where assumptions and differences may exist. For the longer term: a) collect more maturity samples for a number of species; b) continue research into larval viability of older rockfish mothers; c) explore the utility of environmental covariates in rockfish models; d) consider time-varying parameters; e) where data exist, investigate more spatially explicit model configurations; and f) evaluate the use of alternative likelihood specifications (e.g., robust forms).

For more information, contact Kalei Shotwell at (907)789-6056 Dana Hanselman at 789-6626.

Rockfish CIE Review – A Center for Independent Experts (CIE) Review Panel convened June 19-22, 2006, at the Alaska Fisheries Science Center in Seattle to consider the current harvest strategies and stock assessment methods for Alaskan rockfish stocks. Three reviewers were contracted: Dr. Patrick Cordue, Dr. Cynthia Jones, and Dr. Robert Mohn. The primary motivation for the review was the concern of some stakeholders that rockfish harvest strategies are "too aggressive" and to validate the current methods being used to assess rockfish. ABL and other AFSC staff presented a wide variety of relevant information and conducted exploratory model runs as requested by the reviewers.

The main conclusions of the reviewers were that there are multiple and cumulative layers of conservatism in the current harvest strategy which will conserve rockfish stocks at high levels of biomass. The current assessments are of high quality and at the appropriate spatial scale, given the limited knowledge about stock structure and migration patterns. Suggestions were to improve basic biological knowledge of maturity, migration and stock structure, develop informative prior distributions for key parameters, and consider more uncertainty in projection modeling. The summary document is available on the AFSC website at http://www.afsc.noaa.gov/refm/docs/2006/RF_CIE.pdf.

For more information contact Dana Hanselman at (907) 789-6626.

Another concern raised by the CIE Review panel had to do with the possible source of bias resulting from expanding bottom trawl survey estimates, particularly those for rockfish, obtained in trawlable portions of the survey area over untrawlable portions of the survey area. In response to this concern, the RACE Groundfish Assessment Program assembled a team to focus on methods to identify and distinguish trawlable from untrawlable grounds in the Gulf of Alaska. They initially reviewed existing information gleaned from past trawl surveys to derive estimates of the proportion of untrawlable bottom in each of the survey strata. This spring they conducted a two-week cruise to collect split-beam echosounder data corrected for vessel attitude and motion to assess whether these sorts of data can be useful in the classification of bottom trawlability.

For more information contact Michael Martin at (206) 526-4175.

BERING SEA AND ALEUTIAN ISLANDS

Pacific ocean perch (POP) – Pacific ocean perch assessments are conducted on a two year cycle to coincide with the Aleutian Islands survey cycles. Since the survey was conducted in 2006, a full stock assessment was performed.

The 2006 assessment updated the previous assessment by including the 2006 Aleutian Islands survey results and the 2004 and 2005 Aleutian Islands fishery age compositions. The Aleutian Islands survey resulted in a biomass estimate of 667,300 t, a 15% increase over 2004 and the highest estimate during the time-series. Stock assessment model results indicate that Pacific ocean perch total and spawning biomass were at low levels in the 1970s and increased to the present high and stable levels.

Changes in assessment methodology include estimation of the natural mortality rate *M,* AI trawl survey catchability in the model using prior distributions and the assumption that numbers at age prior to the first year of the model are in equilibrium with an unfished population. In previous assessments, the numbers at age prior to the first year of the model were not assumed to be in equilibrium and reflected variation in recruitment strength for each cohort. In addition, model runs were made to evaluate the utility of dropping the CPUE survey index and to evaluate the utility of modeling time-varying fishery selectivity. These changes were investigated in a series of five models (Models 1-5).

The authors selected Model 3 as the preferred model. This model is similar to that used for POP in the GOA – including model estimates of *M* - but also adds estimation of time varying selectivity. The author provided rationale for including time-varying selectivity based on documented changes over time in catch by area and depth, which could contribute to varying selectivity over time. The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, thereby qualifying Pacific ocean perch for management under Tier 3. The current estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ are 133,000 t, 0.059, and 0.070 respectively. There are reliable estimates of the 2006 spawning biomass (B), $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ and $B > B_{40\%}$ (155,000 t > 133,000 t). Therefore, the POP reference fishing mortality is defined in tier 3a. For this tier, F_{ABC} is constrained to be $\leq F_{40\%}$, and F_{OFL} is constrained to be equal to $F_{35\%}$. The ABC associated with the $F_{40\%}$ level of 0.059 is 21,900 t. This ABC is approximately 7,320 t higher than last year's recommendation of 14,800 t. The change in ABC reflects the increase in $F_{40\%}$ from the 2005 update, which was caused by an estimated M (0.06) higher than the fixed level (0.05) used in previous assessments. The recommended ABC (21,900 t) is a marked increase over last year's ABC. However this increase is consistent with increases in trawl survey biomass. The increases in model- and survey-estimated biomasses suggest a successful re-building trajectory for this population. For the Aleutian Islands, the ABCs are set for each region based on the proportions in combined survey biomass as follows: BS = 4,160 t, Eastern Aleutians (Area 541) = 4,970 t, Central Aleutians (Area

542) = 5,050 t, Western Aleutians (Area 543) = 7,720 t. The OFL fishing mortality rate is computed under Tier 3a as 26,100 t, which is the recommended OFL for the BSAI. The OFL for BSAI is not regionally apportioned. For 2007, the recommended ABC is 21,900 t, and the OFL is 26,100 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

Northern rockfish – Northern rockfish assessments are conducted on a two year cycle to coincide with the Aleutian Islands survey cycles. Since a survey was conducted in 2006, a full stock assessment was performed to determine the 2007 harvest level.

The 2006 Aleutain Islands survey biomass estimate was 218,000 t, a 14% increase over 2004 and the highest point estimate from the survey time series dating back to 1980. The methodology in this year's assessment was the same as in 2004, with updated catch data, survey data, and an addition of substantially more aging data. Despite this, uncertainty about selectivity led to the authors' recommendation to use a model with constrained selectivity (Model 2 in the assessment). The SSC has determined that this stock qualifies for management under Tier 3 due to the availability of reliable estimates for $B_{40\%}$ (52,000 t), $F_{40\%}$ (0.045), and $F_{35\%}$ (0.053). Because the female spawning biomass of 72,800 t is greater than $B_{40\%}$, sub-tier "a" would be applicable, with F_{ABC} = $F_{40\%}$ and F_{OFL} = $F_{35\%}$. Under Tier 3a, the maximum permissible ABC is 8,190 t, which is the 2007 ABC. Under Tier 3a, the 2007 OFL is 9,750 t for the Bering Sea/Aleutian Islands combined. The TAC of the previous year was assumed as the 2007 catch, in order to make projections to 2008. Model projections indicate that this stock is neither overfished nor approaching an overfished condition. The stock assessment model indicates that the northern rockfish stock steadily increased from 129,000 t in 1977 to 211,000 t in 1999, and has remained at that high and stable level the past 7 years.

Shortraker/rougheye rockfish – Since there was an Aleutian Islands survey in 2006, a full update of the stock assessment was performed this year. The 2006 Aleutian Islands survey biomass estimates for shortraker and rougheye rockfish were 12,961 t and 9,505 t, respectively. These estimates are of the same magnitude of other surveys conducted in the Aleutian Islands since 1991. The stock assessment model indicates that the rougheye rockfish resource has slowly declined to less than half of the biomass estimated for 1980, the initial year in the model. Shortraker rockfish are estimated to have been fairly stable over the same period, declining 13% from the 1980 abundance level.

The assessment methodology used is a straightforward update of last year's assessment, adding new catch data and biomass estimates from the 2006 Aleutian Islands survey. The SSC has previously determined that reliable estimates of biomass and natural mortality exist for shortraker and rougheye rockfish, qualifying the species for management under Tier 5. F_{ABC} was set at the maximum permissible level under Tier 5, which is 75% of M. Accepted values for M for these stocks, 0.025 for rougheye rockfish and 0.030 for shortraker rockfish, resulting in F_{ABC} values of 0.019 and 0.023 for rougheye and shortraker, respectively.

In 2001, the Plan Team, SSC, AP, and Council recommended separating shortraker and rougheye rockfish species and setting BSAI area-wide ABCs and TACs for 2002. However, NMFS was unable to implement those recommendations because of the difficulty of species identification, and instead set separate BS and AI TACs for the combined shortraker/rougheye rockfishes category. In 2004, the NMFS Regional Office and Observer Program developed a catch accounting program that separated shortraker and rougheye rockfishes. With this improvement, concerns over management of small OFLs led to recombining regions into a BSAI-wide quota for each species. The author presented comparisons of length compositions, age compositions, and size compositions for the two species between regions, showing several significant differences between regions for rougheye and fewer for shortraker. In previous years, the author has recommended an area split; this year, this recommendation was deferred pending a new model for next year, although he noted several biological factors which might justify such a split.

The biomass estimates for 2007 are 18,900 t for shortraker rockfish and 10,800 t for rougheye rockfish, leading to BSAI OFLs of 564 t for shortraker and 269 t for rougheye, and ABCs of 424 t for shortraker and 202 t for rougheye. It is not possible to determine whether these species are overfished or whether they are approaching an overfished condition because they are managed under Tier 5.

Other rockfish complex – The BSAI "Other Rockfish" are also managed on a two year cycle to coincide with years when an Aleutian Islands survey is conducted. This complex formerly consisted of 28 *Sebastes* and *Sebastolobus* species, but now considers only the 8 species that have been caught at least once during AFSC research surveys or appeared in more than 1% of observed fishery hauls between 1990 and 2001. The assessment is updated for 2006 and includes the 2006 Aleutian Islands and Bering Sea survey biomass, catches in the EBS and AI, updated length frequency data. The authors recommend assigning a separate ABC and OFL to shortspine thornyheads and leaving the remaining 7 rockfish species within the other rockfish complex. This recommendation was based on the fact that shortshine thornyheads are the most abundant and valuable species in the complex and inhabit deeper regions of the shelf and slope than the others.

For 2007, the authors recommend an M=0.03 for SST and an M=0.09 (based on dusky rockfish) for the remaining species. Multiplying these rates by 0.75 and the best estimates of SST and other "other rockfish" biomass yields 2007 and 2008 ABCs of 414 t in the EBS and 585 t in the AI. The OFL was set for the entire BSAI area, which under Tier 5 is calculated by multiplying the best estimates of total biomass for the area by the separate Ms and adding the results, which yields an OFL of 1,330 t

For further information, contact Paul Spencer at (206) 526-4248.

GULF OF ALASKA

Pacific ocean perch – Pacific ocean perch (POP), *Sebastes alutus*, is the dominant fish in the slope rockfish assemblage and has been extensively fished along its North American range since 1940. Since 2005, Gulf of Alaska rockfish have been moved to a biennial stock assessment schedule to coincide with the biennial trawl survey. In even years (such as 2006's assessment for the 2007 fishery) when the survey does not occur and the only new data are catch information, we run only the projection model with updated catch data for single-species age-structured assessments. This satisfies recommendations from the 2006 Groundfish Plan Team and accounts for changes in catch from last year's estimates. New information for this year's projection model was updated 2005 catch at 11,272 mt and the best estimate of the 2006 catch at 13,654 mt. Last year's estimates were 11,356 mt and 11,930 mt for 2005 and 2006, respectively. Substantially more POP were caught in 2006 than expected due to good market conditions. For the 2007 fishery, we recommend the maximum allowable ABC of 14,636 mt from the updated projection. This ABC is similar to last year's ABC of 14,261 mt, but slightly less than last year's projection due to the increased catch in 2006. Female spawning biomass remains above $B_{40\%}$, with projected biomass stable.

For more information contact Dana Hanselman at (907) 789-6626.

Northern rockfish – For northern rockfish, a new model was accepted in 2006 for recommending 2007 ABC. This configuration is very similar to the models used for the Gulf of Alaska (GOA) Pacific ocean perch, dusky rockfish, and rougheye rockfish assessments. This model was reviewed at a rockfish modeling workshop held in Juneau in the spring of 2006 and at a subsequent Center for Independent Experts (CIE) panel. It differs from the other GOA models by using a logistic selectivity curve, rather than smoothed penalty function. The model differs from the previous northern rockfish assessment to conform to other GOA rockfish models by estimating separate selectivities for the survey and fishery, estimating average recruitment with annual deviations instead of a stock-recruitment relationship, and by adding the option to estimate natural mortality with an informed prior distribution. Overall the new model exhibited better fits to the data, and more plausible estimates of key parameters. For the 2007 fishery, we recommended the maximum allowable ABC of 4,940 mt for the Gulf of Alaska. This ABC is down slightly from last year's recommended ABC of 5,090 mt. This stock is not overfished nor approaching an overfished condition; however, projected biomass indicates some decline in the future.

For more information, contact Dana Hanselman at (907) 789-6626.

Rougheye rockfish – In Alaskan waters, adult rougheye rockfish (*Sebastes aleutianus*) inhabit particularly steep, rocky areas in a narrow band along the upper continental slope at depths of 300–500 m. The fish are relatively evenly distributed within this habitat and often co-occur with shortraker rockfish (*Sebastes borealis*) in trawl or longline hauls. Rougheye rockfish have been managed as "bycatch" only species since the creation of the shortraker/rougheye rockfish management subgroup in the Gulf of Alaska (GOA) in 1991. Recent studies on the genetic differences between the

observed types of rougheye rockfish indicate two distinct species. The southern species of rougheye rockfish now proposed as *S. aleutianus* or rougheye rockfish is typically lighter in coloration with spots absent from the spinous dorsal fin and possibly has mottling on the body. The northern species of rougheye rockfish now proposed as *S. melanostictus* or blackspotted rockfish is often darker in body coloration with distinct spots present on the dorsal fin and body. The two species occur in sympatric distribution with rougheye extending farther south along the Pacific Rim and blackspotted extending into the western Aleutian Islands. The overlap is quite extensive; however a potential difference in depth distribution may occur.

In 2005 and 2006, the NMFS sablefish longline survey conducted two-day sampling experiments in the eastern GOA near Yakutat Bay to collect detailed depth information associated with the longline catch of rougheye and blackspotted rockfish. New GPS and sonar technology on board combined with numerous time-depth recorders along the groundline were used to determine accurate depth and GPS coordinates of the groundline as it was fished. Approximately 250 rougheye and blackspotted rockfish were collected across a depth range of 200-400 m with associated photos of 150 fish and observer identification based on the features in a pamphlet distributed by J. Orr of the AFSC RACE Division. Genetic analysis of these samples is in progress. Preliminary discussions with researchers from this experiment suggest that identification of each species was difficult due to the range of coloration and spotting between individuals.

At present, there appears to be difficulty in accurate field identification between the two species. Methods should be developed and tested that would enable rapid and accurate field identification of the two species by observers and scientists so that population estimates and catch accounting can occur. In addition, studies should be undertaken that assess whether the two species have significantly different life history traits (i.e., age of maturity and growth). Until such information and studies occur it will be difficult to undertake distinct population assessments. Ongoing research in this area may determine particular habitat preference that might be useful for separating the species, and phenotypic research may determine a distinct combination of characters for onboard identification.

In 2005, we formalized the use of the generic rockfish model as the primary assessment tool for rougheye rockfish (*Sebastes aleutianus*). Additionally in 2005, Gulf of Alaska rockfish were moved to a biennial stock assessment schedule to coincide with the biennial trawl survey. In even years (such as 2006's assessment for the 2007 fishery) when there is only new catch information, we run only the projection model with updated catch data for single-species age-structured assessments. New information for this year's projection is updated 2005 catch at 301 mt and the best estimate of the 2006 catch at 327 mt. Last year's estimates were 289 mt and 288 mt for 2005 and 2006, respectively. For the 2007 fishery, we recommend a maximum allowable ABC of 988 mt from the updated projection. This ABC is similar to last year's ABC of 983 mt. Female spawning biomass remains above $B_{40\%}$, with projected biomass stable. Several more years of age samples were completed for rougheye by the AFSC REFM Division's Age and Growth Task and will be incorporated into next year's assessment model. As per the North Pacific Fishery Management Council's Science and Statistic Committee comments in December 2005,

we plan to incorporate a sensitivity analysis of the weighting between the longline and trawl survey data and to consider the relative influence of the length and age compositions from both surveys on model fit.

For more information, contact Kalei Shotwell at (907) 789-6056.

Shortraker and other slope rockfish – Shortraker rockfish and "other slope rockfish" are distinct management categories in the Gulf of Alaska (GOA), but their assessments are presented in a combined report because both assessments are based on biomass estimates from trawl surveys, instead of modeling. "Other slope rockfish" are comprised primarily of sharpchin, harlequin, silvergray, and redstripe rockfish, plus a number of minor species. Rockfish in the GOA have been moved to a biennial stock assessment schedule to coincide with data from the GOA biennial trawl surveys. This means that full assessments are done only in years that the trawl survey occurs. Because 2006 was not a survey year, no assessment was done, and ABCs for the 2007 fishing year remained unchanged from those in 2006. Exploitable biomass for shortraker rockfish and "other slope rockfish" was estimated by the average biomass in the three most recent biennial trawl surveys (2001, 2003, and 2005), excluding the estimated biomass in the 1-100 m stratum. The 1-100 m depth stratum was removed from the estimate because most rockfish in this stratum are small juvenile fish, and thus are not considered exploitable. This results in an exploitable biomass of 37,461 mt for shortraker rockfish and 93,552 mt for "other slope rockfish". Applying either an F=0.75M or an $F=F_{40\%}$ rate (depending on the species) to these values of exploitable biomass results in recommended ABCs for the Gulf of Alaska in 2007 of 843 mt for shortraker rockfish and 4,154 mt for "other slope rockfish".

Shortraker rockfish have long been considered one of the most difficult rockfish species to age. In 2005, the AFSC REFM Division's Age and Growth Task developed a new, experimental technique for ageing otoliths of this species. In early 2007, this technique was used for the first time for "production ageing" of a sample of shortraker rockfish from one of the GOA trawl surveys. Although the results are still preliminary, the average age of the samples was quite old (~44 years), and the maximum age was 116 years. If additional samples can be successfully aged, development of an age-structured model for shortraker rockfish may begin in the next couple of years.

For more information contact Dave Clausen at (907) 789-6049.

4. Thornyheads

b. Stock Assessment

GULF OF ALASKA

As no new survey was conducted in the GOA in 2006, the 2005 assessment recommendations were used for the 2007 fishing season. The highlights of the 2005 assessment are presented below.

Although an age structured model has been developed for the thornyheads, the lack of age composition data from GOA trawl surveys, sablefish longline surveys, and improved length sampling from longline and trawl fisheries has prevented its use for determining ABC and TAC for these species. Thornyhead rockfish are commercially valuable species which are presently not targeted in a directed fishery but are caught incidentally as bycatch in directed fisheries for rockfish, flatfish and sablefish. The catch in recent years is well below the TAC and has been declining. The exploitable biomass for determining the harvest level is calculated as the average of the biomass estimates from the 2003 and 2005 trawl surveys, which is 98,158 t.

The ABC was determined using Tier 5 methodology by multiplying the exploitable biomass by M=0.03 and 0.75 giving 2,209 mt**.** The corresponding OFL recommendation results in 2,945 mt. The OFL fishing mortality rate under Tier 5 is set equal to the estimate of *M*, so F_{OFL}=0.03. Area apportionments for thornyhead ABC's in 2006 and 2007 are as follows.

Western	Central	Eastern	Total
513	989	707	2,209

For further information, contact Dr. James Ianelli (206) 526-6510.

5. Sablefish

a. Research

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

2006 Sablefish Longline Survey – The AFSC has conducted an annual longline survey of sablefish and other groundfish in Alaska from 1987-2006. The survey is a joint effort involving two divisions of the AFSC: ABL and RACE. It replicates as closely as practical the Japan-U.S. cooperative longline survey conducted from 1978-94 and also samples gullies not sampled during the cooperative longline survey. In 2006, the twenty-eighth annual longline survey of the upper continental slope of the Gulf of Alaska was conducted, along with a similar survey of the eastern Aleutian Islands. One hundred-forty-eight longline hauls (sets) were completed between June 4, 2006 and September 1, 2006 by the chartered fishing vessel *Alaskan Leader*. Sixteen kilometers of groundline were set each day, containing 7,200 hooks baited with squid.

Sablefish (*Anoplopoma fimbria*) was the most frequently caught species, followed by giant grenadier (*Albatrossia pectoralis*), shortspine thornyhead (*Sebastolobus alascanus*), Pacific cod (*Gadus macrocephalus*), and arrowtooth flounder (*Atheresthes stomias*). A total of 87,032 sablefish were caught during the survey compared to 81,460 in 2005. A total of 3,930 sablefish, 645 shortspine thornyhead, and 39 Greenland turbot (*Reinhardtius hippoglossoides*) were tagged and released during the survey. Electronic temperature-depth tags were surgically implanted in 35 Greenland turbot. Over 121,000 lengths were collected from six different species, and otoliths and specimen data were

collected from 2,320 sablefish. Killer whales (*Orcinus orca*) took fish from the longline at five stations in the Aleutian Islands and western Gulf of Alaska near Dutch Harbor. Sperm whales *(Physeter macrocephalus*) were common near the vessel in the eastern Gulf, west Yakutat, and central Gulf regions and were observed taking fish from the line at eight stations.

Several special projects were conducted during the 2006 longline survey. Corals caught on the line were collected for identification and sample preservation. A seabird occurrence study was conducted for the fifth year, which helps to address where and when certain seabird species occur in Alaska waters. Spiny dogfish were sampled during the west Yakutat and central Gulf legs for biological studies conducted by graduate students from the University of Alaska Fairbanks and the University of Washington. A giant grenadier reproductive biology study was conducted during the Southeast leg, and maturity samples of these fish were taken for histological analysis.

A marine mammal observer was on board during the first two survey legs in the Aleutian Islands and the western Gulf of Alaska to collect photo identification of resident killer whales that were observed depredating on the gear. A second marine mammal observer studied sperm whale depredation in the eastern and central Gulf of Alaska. Photo identification, dive behavior observations, and biopsy samples were collected. Finally, a 2-day experiment was conducted off Yakutat to collect genetic tissues of rougheye rockfish and to investigate depth distribution patterns of the "light" and "dark" color phases of these fish that are now believed to be separate species.

For more information, contact Chris Lunsford at (907) 789-6008.

Auke Bay Laboratory Sablefish Tag Recovery Program – Processing tag recoveries and administration of the reward program continued during 2006. Total sablefish tags recovered for the year so far are 598, which includes 574 tagged as adults and 24 tagged as juveniles. Two sablefish at liberty for 33 years were recovered in 2006. Both were released and recovered in Chatham Strait. A third fish, out for 28 years, was tagged near Prince William Sound in 1978 and recovered in 2006 in the eastern Shumagins.

Recoveries of other species maintained in the Sablefish Tag Database included 11 shortspine thornyheads, 2 Greenland turbot with archival tags, and 1 spiny dogfish with an archival tag. The dogfish, a female, traveled 821 miles from the Yakutat area to southern Vancouver Island in the 325 days it was at liberty. It was actually caught in 2005, but the fisherman kept it in his freezer for a year before returning it 2006.

Total fish tagged and released in 2006 were 4,698, including 3,930 adult sablefish, 645 shortspine thornyheads, and 39 Greenland turbot on the sablefish longline survey, and 84 juvenile sablefish in southeast Alaska.

The Tag Database was the only Oracle database at the Auke Bay Laboratory, and it was becoming increasingly expensive and inefficient to maintain the Oracle platform. To solve this problem, the database was converted from Oracle to Access during 2006.

For more information, contact Nancy Maloney at (907) 789-6060.

Juvenile Sablefish Studies – Juvenile sablefish studies have been conducted by the Auke Bay Laboratory in Alaska since 1984 and were continued in 2006. A total of 18 juvenile sablefish (age 1+) were tagged with spaghetti tags and released during a cruise of the NOAA vessel John N. Cobb at St. John Baptist Bay near Sitka between May 14-20 2006. During the same cruise, an additional 66 juvenile sablefish were implanted with electronic archival tags. Approximately 174 rod hours were recorded. This relatively small bay is the only known location in Alaska where juvenile sablefish have been consistently found on an annual basis.

The electronic archival tags will provide information on juvenile sablefish behavior and habitat during their transition from nearshore rearing areas to the age at which they are intercepted by the fishery. Since 2003, a total of 389 electronic archival tags have been released on juvenile sablefish in St. John Baptist Bay. These tags record the temperature and depth experienced by the fish and are designed for recovery in the commercial fishery when the fish are age 2+ or greater.

For more information, contact Thomas Rutecki at (907) 789-6051.

Sablefish Migration – A paper by Heifetz and Fujioka (1991) used a Markovian movement model to estimate migration between large management areas and into British Columbia (B.C), Canada. Their general conclusion based on model estimates was to support previously reported information that small fish move west and then return as they get larger to spawning locations in the eastern Gulf of Alaska.

Recently, this model was recoded into AD Model Builder, which will be more amenable to the geometric growth of data, be easier to test more complex stock hypotheses, and more accurately account for uncertainty. Preliminary results from this model using updated tag recovery data through 2005 show conclusions similar to Heifetz and Fujioka's study, but lend less support for a strong westerly movement of small fish (e.g. they are just as likely to move east or west). The model is capable of estimating movement rates to B.C., but does not have the required data to estimate rates from B.C. to Alaska.

Future plans are to attempt new movement hypotheses, with more dimensionality, and include smaller scale directional movement (e.g, inshore versus offshore or radial directionality). Eventually, this information may become important in Alaska for spatially-explicit stock assessment and apportionment of quotas.

For more information, contact Dana Hanselman at (907) 789-6626.

b. Stock Assessment

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA
Relative to the 2005 assessment, substantive changes were made in 2006 to the sablefish assessment. The model has been reconfigured as a split-sex model. This was done to account for the differences in growth and maturity of male and female sablefish. The model now estimates spawning biomass as female-only, which is consistent with other Alaskan assessments. Additionally, the model now incorporates Gulf of Alaska trawl survey lengths and biomass estimates for depths 500 meters and less. This appeared to yield more precise estimates of recruitment, due to the trawl survey's ability to catch younger fish than those caught in the longline survey.

The 2006 sablefish assessment showed that sablefish abundance in Alaska increased during the mid-1960's due to strong year classes from the 1960's. Catches peaked at 53,080 mt in 1972, and abundance subsequently dropped during the 1970's due to heavy fishing. The population recovered due to exceptional year classes from the late 1970's; spawning abundance peaked again in 1987. The population then decreased again as these exceptional year classes died off. The sablefish longline survey abundance index increased 8% from 2005 to 2006 and follows a 2.5% decrease from 2004 to 2005. Relative abundance in 2006 is 16% higher than the recent low in 2000. The fishery abundance index decreased 4% from 2004 to 2005 (the 2006 data are not available yet). Spawning biomass is projected to remain stable from 2006 to 2007. Projected 2007 spawning biomass is 38% of unfished biomass. Abundance has increased from a low of 33% of unfished biomass during 1999 to 2000. The 1997 year class is an important part of the total biomass and is projected to account for 13% of 2007 spawning biomass. The 2000 year class likely is above average and should also account for 13% of spawning biomass in 2007.

We recommend a 2007 ABC of 20,100 mt for sablefish in federally managed waters of Alaska, based on an adjusted $F_{40\%}$ strategy. This ABC is slightly lower than the 2005 and 2006 ABCs which were 21,000 mt. Changes in area apportionment for this year are much more modest compared to the large changes seen in last year's assessment. The largest relative change this year occurred in the West Yakutat area due to sizeable increases in both the survey CPUE in 2006 and the fishery CPUE in 2005. The current apportionment is characteristic of most prior years except for 2004. Future work will concentrate on updating biological parameters, including growth and maturity, and considering environmental variables as proxies for recruitment.

For more information, contact Dana Hanselman at (907) 789-6626.

6. Flatfish

a. Research

Habitat Studies – A five year field survey for juvenile flatfishes conducted with a towed camera sled in nursery grounds of Kodiak was completed in 2006. This survey was designed to provide a spatially-explicit analysis of distribution and habitat

association at several spatial scales, from 10's of kilometers to <1 meter, considering a wide range of environmental variables explore (depth, sediments, biogenic structure, etc). The video records are currently under analysis; however, the first statistical evaluations reveal that broad scale distribution is mediated by physical variables such as temperature and depth, while finer-scale local distribution is mediated by biological variables including the presence of emergent structures and biogenic variables such as worm tubes.

Manipulative laboratory and field experiments, conducted in parallel with the field surveys, were designed to examine the potential influence of predator abundance upon habitat value. While predators may remove juvenile fish directly, through predation, their activity may also indirectly influence juvenile flatfish activity, habitat preference and growth. Results of these experiments indicate that age-0 rock sole respond to perceived predation risk over a range of temporal scales. Upon detection of predators, rock sole reduce activity and bury in the sediment. If predation risk is persistent (hours to days), they move to areas of lower perceived risk. Finally, if they are unable to move to habitats of lower risk, growth is inhibited.

Feeding and growth – Examination of the spatial and temporal variation in growth rates of northern rock sole continued in 2006 with monthly sampling at three Kodiak Island nursery sites. Variation in growth rates among sites was similar to 2004, but less than observed in 2005. The rank order of growth rates across sites has been maintained across the three years of study. This work is being extended to examine the potential differences in energetic condition of rock sole among the nursery sites. Preliminary analyses of condition factors indicates that fish at the site with the fastest growth rates also have the highest energy reserves. This suggests even greater differences in recruitment potential among sites than indicated from growth rates alone.

Examination of stomach contents collected during 48 hours of juvenile flatfish sampling in 2004 was completed. The data demonstrated that diets and diel feeding patterns differed among three abundant flatfish species that co-occur in Kodiak Island nursery sites. Northern rock sole, the most abundant flatfish, fed upon benthic infauna such as clam siphons and polychaetes with feeding occurring most rapidly at dusk. English sole also ate benthic infauna, but fed throughout the day. Pacific halibut had peak feeding in the afternoon prior to dusk and fed on the most mobile prey primarily mysids. Differences in diel feeding pattern may be linked to species-specific variation in predation vulnerability associated with their cryptic behavior and depth preferences.

Fishing gear performance – Trawl ground-gear can damage the seafloor by dislodging and/or removing macro-invertebrates that provide habitat for demersal groundfish. The RACE division is developing experimental trawl sweeps that ride several inches above the sediment surface, thus reducing damage to seafloor macro-invertebrates, while minimizing loss of catch. Concurrently, laboratory experiments are being conducted in a 12 m flume in the Newport facility, to examine how distance above the sediment influences the ability of a sweep to initiate herding behavior in flatfish (Pacific halibut, northern rock sole, English sole). Importantly, prior research has demonstrated that flatfish are less likely to initiate herding in the dark. Since ambient light conditions on the seafloor can vary dramatically with depth and turbidity, as well as time of day, experiments are being conducted under both light and dark conditions, to

more realistically quantify how various sweep configurations can be expected to perform under realistic fishing conditions.

For further information, contact Dr. Allan Stoner, (541) 867-0165.

b. Stock assessments

BERING SEA

Yellowfin sole – The 2006 stock assessment incorporates the 2006 catch and survey biomass as well as the age compositions from the 2005 survey and 2005 catch. The 2006 EBS bottom trawl survey resulted in a biomass estimate of 2,113,000 t, a decrease of 25% from the 2005 point estimate. The stock assessment model indicates that the stock has been slowly declining over the past twenty years, although still at a high level, due to recruitment levels which are less than those which built the stock to high levels in the late 1960s and early 1970s. The time-series of survey age compositions indicate that only 3 of the past 11 year classes have been above the long term average. The 2006 catch of 96,930 t represents the largest flatfish fishery in the United States and the average exploitation rate has been 4% the past five years for this stock. This assessment features an estimate of the relationship between survey catchability and annual mean bottom water temperature and also estimates a Ricker form of the spawner recruit relationship within the model. Results indicate that catchability, averaged over 24 years, = 1.13.

Several models were analyzed for this assessment, the models differed by changing whether natural mortality (M) or catchability (Q) were estimated in the model at varying errors on the priors for these parameters. The assessment authors once again considered moving the assessment to Tier 1. The robustness of the Ricker spawner-recruit model was tested by estimating a single spawner-recruit model then using Tier 1 management on simulated stock production from multiple productivity regimes. The productivity regimes were based on observed productivity in the Bering Sea. Though the results indicated that the Tier 1 assessment was robust, the authors still felt that a move to Tier 1 may not be appropriate due to the non-stationarity of the stock-recruitment relationships for Bering Sea yellowfin sole. The Plan Team agreed with the authors and felt that the recovery from low abundance had only occurred once, during a fairly short time period and the spawner-recruit estimate from the most recent regime predicted a B_{MSY} lower than any spawning biomass during the time period.

For these reasons, the Plan Team decided to use Tier 3. Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, thereby qualifying yellowfin sole for management under Tier 3. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 460,000 t, 0.11, and 0.13, respectively. Given that the projected 2007 spawning biomass of 585,000 t exceeds $B_{40\%}$, the Plan Team's ABC and OFL recommendations for 2007 were calculated under sub-tier "a" of Tier 3. The Plan Team recommends setting F_{ABC} at the $F_{40\%}$ (0.11) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2007 ABC of 136,000 t.

The Plan Team's OFL was determined from the Tier 3a formula, where an $F_{35\%}$ value of 0.13 gives a 2007 OFL of 160,000 t.

The SSC, however, determined that reliable estimates of the spawner-recruit relationship do exist for this stock and placed yellowfin sole in the Tier 1 management classification. Therefore, the 2007 ABC for this stock is 225,000 t and the OFL is 240,000 t.

Model projections indicate that this stock is neither overfished nor approaching an overfished condition. This stock is predicted to be fairly stable or decrease slightly in the near future due to below average recruitment in the last 5 years.

Northern rock sole – Changes to the input data for the 2006 assessment include addition of the 2005 fishery age composition, 2005 survey age composition, the 2006 catch biomass and 2006 trawl survey biomass point estimate and standard error. The 2006 bottom trawl survey resulted in a biomass estimate of 2,215,000 t, a 4.5% increase over last year's estimate of 2,119,000 t. The assessment continued the investigation of catchability (q) began in 2002. As in past assessments, a value of 1.4 obtained from a trawl "herding" experiment was used as the mean of a prior distribution on q. The updated value from this assessment gives a q estimate of 1.53. Natural mortality was estimated as a free parameter (with q constrained as stated above) giving the best fit at M = 0.155. The model estimates that the biomass of rock sole has increased the past three years after declining from a peak value observed in 1995. The increase is due to strong recruitment from the 2001 and 2002 year classes which are now entering the observable portion of the population. The model estimates the 2007 biomass of rock sole at 1,582,000 t, an increase of 5% over 2005 and about 13% less than the peak level observed in 1995.

The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 222,000 t, 0.14, and 0.17, respectively. Given that the projected 2007 spawning biomass of 392,000 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2007 could be calculated under sub-tier "a" of Tier 3. The Plan Team recommended setting F_{ABC} at the $F_{40\%}$ (=0.14) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2007 ABC of 121,000 t. OFL was determined from the Tier 3a formula, where an $F_{35\%}$ value of 0.17 gives a 2007 OFL of 144,000 t.

The SSC, however, determined that reliable estimates of the spawner-recruit relationship do exist for this stock and placed northern rock sole in the Tier 1 management classification. Therefore, the 2007 ABC for this stock is 198,000 t and the OFL is 200,000 t.

Flathead sole – The latest assessment updated the previous by incorporating new catch, discard, survey biomass, length composition, and age composition data. The 2006 trawl survey biomass estimate of 645,000 t was about 4% increase over last year's estimate of 629,000 t. Survey biomass has been relatively stable over the past four years compared to the decrease observed from 1998-2000.

The author undertook an examination of the lumping of youngest and oldest age classes in previous assessments, disaggregating these age classes in the current assessment may have led in part to the 35% increase in assessed biomass over last year; the Plan Team felt that this new model was an improvement and recommended its use.

In response to SSC comments, the author examined the distribution of Bering flounder with respect to the fishery. The northerly distribution of the species did not seem to overlap the spatial distribution of the fishery, although mismatch in seasonal timing of the survey versus the fishery means that this is not conclusive. The SSC has determined that reliable estimates of $B_{40\%}$ (145,000 t) $F_{40\%}$, (0.31) and $F_{35\%}$ (0.37) exist for this stock, thereby qualifying the stock for management under Tier 3. Given that the projected 2007 spawning biomass of 274,000 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2007 were calculated under sub-tier "a" of Tier 3. F_{ABC} was set at the $F_{40\%}$ (0.31) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2007 ABC of 79,200 t. The OFL was determined from the Tier 3a formula, where an $F_{35\%}$ value of 0.37 gives a 2007 OFL of 95,300 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

Alaska plaice – The 2006 assessment incorporated the 2006 shelf survey biomass estimate (636,971 t) and the 2006 catch data into the stock assessment model as well as the 2005 survey age composition. The survey biomass estimate was 26% higher in 2006 than in 2005. The stock is estimated to be at a high and stable level with relatively stable recruitment since the 1970s and a low level of harvest which is typically bycatch from other target fisheries. Catchability investigations do not indicate a temperature effect as shown for some of the other shelf flatfish.

Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, therefore qualifying it for management under Tier 3a of the BSAI Groundfish FMP. The updated point estimates are $B_{40\%}$ = 138,000 t, $F_{40\%}$ = 0.61, $F_{35\%}$ = 0.83. These are high values for flatfishes, but these values are the consequence of Alaska plaice maturing before recruiting to the fishery. Given that the projected 2007 spawning biomass of 295,000 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2007 were calculated under sub-tier "a" of Tier 3. Projected harvesting at the $F_{40\%}$ level gives a 2007 ABC of 190,000 t. The OFL was determined from the Tier 3a formula, which gives a 2007 OFL of 241,000 t. Model projections indicate that this species is neither overfished nor approaching an overfished condition. Reference fishing mortality rates are lower than in previous years due to a shift in the model's estimate of fishery selectivity. The sensitivity of the spawning-per-recruit fishing reference point to the change in fishing selectivity is not unexpected, given that the age at 50% maturity is approximately 8.5 and the natural mortality rate (0.25) is relatively high compared to other flatfishes. Because the age at 50% selection in the fishery is 10.4, Alaska plaice has the potential to spawn twice before it recruits to the fishery. Additionally, the high natural mortality of 0.25 indicates that the lifetime spawning/recruit potential is rapidly reducing at the ages of highest fishing selectivity. There continues to be relatively stable recruitment of Alaska plaice from the late 1970s through the present, with an apparently large 2002 year class.

Other flatfish – The "other flatfish" complex currently consists of Dover sole, rex sole, longhead dab, Sakhalin sole, starry flounder, and butter sole in the EBS and Dover sole, rex sole, starry flounder, butter sole, and English sole in the AI. Starry flounder, rex sole, and butter sole comprise the vast majority of the species landed. For example, Starry flounder and rex sole comprised 90% of the "other flatfish" catch in 2005. Because of insufficient information about these species, no model analyses are possible. The latest assessment incorporates 2006 total catch and discard and 2006 trawl survey information. The 2006 EBS bottom trawl survey resulted in biomass estimates of 132,900 t, an increase from the estimate of 107,500 t from the 2005 survey and the highest observed since 1980. The biomass of these species in the Aleutian Islands is 16,400 t from the 2006 survey, the highest observed since 1983.

With the removal of Alaska plaice from this category in 2002, the SSC reclassified "other flatfish" as a Tier 5 species complex with an assumed natural mortality rate of 0.20. Projected harvesting at the 0.75 M level (F_{ABC} =0.15), gives a 2007 ABC of 21,400 t for the "other flatfish" species. The corresponding 2007 OFL (=0.20) is 28,500 t. It is not possible to determine whether the "other flatfish" complex is overfished or approaching an overfished condition because it is Tier 5 and not managed under Tiers 1-3. Insufficient information about these species makes model analysis impossible.

The SSC requested an evaluation of species-specific natural mortality rates for the species in this complex. Therefore species-specific natural mortality rates are used for the species for which they are available. Estimates of M for the GOA were used for Dover sole (a minor component of the complex) and rex sole (a major component of the complex). Starry flounder natural mortality estimates were examined, but not used as they are only available for San Francisco Bay for data collected in the 1950s. There is no indication that these estimates are valid for starry flounder in the Bering Sea at this time. Proportionally more butter sole are caught in the fishery than in the trawl survey. In response to the SSC's concern about this high exploitation rate, the authors note that this species is at the northern extent of its range, is at times captured in large quantities in a few trawl hauls, and thus the CV's are quite large. Therefore, this is probably not an issue of concern.

Greenland turbot – The Bering Sea slope survey gives the primary estimate of Greenland turbot biomass, but was not conducted in 2006 due to funding deficiencies. This year's Greenland turbot assessment model included updated 2003-2006 catch data, recompiled fishery catch-at-length data by gear type for all post-1988 domestic fisheries, and biomass and length composition estimates from the 2006. The EBS shelf survey. Also included were new age data from 1994 and 1998 surveys, from recent research on age and growth of Greenland turbot, and an updated, aggregated longline survey data index for the EBS and Aleutian Islands.

The 2006 EBS shelf trawl survey biomass estimate was down by about 2% from the 2005 estimate. This compares with the average decline over the past 5 years of 3%. The 2006 Aleutian Islands bottom trawl survey estimate was 20,900 t, an increase of 85% from the 2004 survey estimate and is above the 1991-2006 average level of 17,100 t. Model results based on these surveys and data from longline and trawl fisheries result in

an estimate of $B_{40\%}$ equal to 41,800 t (female spawning biomass). The current estimate of the year 2007 female spawning biomass is 60,430 t. While improvements to the assessment modeling have been made, and there appears to be some favorable recruitment patterns in the past several years, fishing mortalities consistent with recent history are recommended for ABCs until another survey can be completed as well as more analyses to evaluate the modeling approach.

The newer implementation of Stock Synthesis 2 was used for modeling. The current implementation of the model retains the key assumption of former models that the slope trawl survey is an absolute index representing 75% of the Greenland turbot stock in US waters. An updated mortality estimate of 0.112 supersedes the 0.18 used in the past. Compared to previous models, selectivity was allowed to change more over time for some surveys and fisheries, resulting in improvements of some residual patterns. The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock. Updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 41,800 t, 0.51, and 0.67, respectively. Projected spawning biomass for 2007 is 60,400 t. Greenland turbot therefore qualify for management under Tier 3a. The maximum permissible value of F_{ABC} under this tier translates into a 2007 ABC of 12,680 t. Because this was the first implementation of the model under SS2, and because of the lack of a slope survey, the author recommended setting the 2007 ABC at a value less than the maximum permissible. Using F_{ABC} = 5-year average catch, results in a 2007 ABC of 2,440 t corresponding to a full selection fishing mortality rate of 0.09. The OFL fishing mortality rate is computed under Tier 3a, $F_{OFL} = F_{35\%} = 0.67$, and translates into a 2007 OFL of 15,600 t.

Arrowtooth flounder – The present assessment continues to utilize catchability as a function of the annual average bottom temperature during the EBS shelf trawl survey and also uses the EBS shelf trawl survey sex ratios as prior information to estimate sex-specific population numbers at age. This year's EBS shelf bottom trawl survey resulted in a biomass estimate of 670,000 t, which is second only to last year's survey as the highest estimate over the time series. The Aleutian Islands trawl survey estimate of 229,000 t was the highest ever estimated in that region. The stock assessment model indicates that the biomass is at its highest level since observations began in 1975 due to episodes of above average recruitment in the 1980s and again in the period 1998 to the present. The stock remains very lightly harvested with fish caught primarily as bycatch in other fisheries. Discarding occurs at a rate exceeding 50%.

Since more female arrowtooth flounder are caught in trawl surveys throughout Alaska compared to males, and because the oldest female fish have been determined to be older than the oldest males, it is hypothesized that there are different natural mortality values for each sex. With the female natural mortality rate fixed at 0.2, male natural mortality was profiled over a range of values to determine which value provided the best fit to all the observable population characteristics and still gave reasonable estimates of male selectivity to the survey trawl. The male natural mortality rate that provided the best fit was 0.33. With the stock assessment model configured in this way, the population biomass was estimated at 1,275,900 t.

The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, thereby qualifying arrowtooth flounder for management under Tier 3. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 340,000 t, 0.24, and 0.30, respectively. Given that the projected 2007 spawning biomass of 824,000 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2007 were calculated under sub-tier "a" of Tier 3. The F_{ABC} was set at the $F_{40\%}$ (0.24) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2006 ABC of 158,000 t. The OFL fishing mortality rate under Tier 3a is $F_{35\%}$ (0.30), which translates to a 2006 OFL of 193,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

The ABC recommendation is for the combined harvest of arrowtooth flounder and Kamchatka flounder, which are difficult to distinguish and had similar biomass trends from the EBS trawl survey since 1991. Ecosystem considerations of predator-prey dynamics of arrowtooth flounder in the Bering Sea indicated that the top prey species of arrowtooth flounders are juvenile pollock. However, juvenile arrowtooth flounder in the Bering Sea are an important prey for adult pollock. The ramification of increases of one of these species, with decreases of the other, has unknown consequences due to this duality of the predator-prey relationship.

For further information, contact Thomas Wilderbuer (206) 526-4224.

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Arrowtooth flounder – Since no survey was conducted in the Gulf of Alaska in 2006, projections were made using the 2006 catch and the population age structure in 2005 to give the 2007 ABCs listed below. The 2005 stock assessment is summarized below.

The 2005 arrowtooth flounder assessment featured new biomass and length composition data from the 2005 NMFS bottom trawl survey and updated catch and fishery length data for 2005. The model also includes survey age composition data from each survey except for 2005 (ages not determined yet). The 2005 estimated age 3+ biomass of 2,109,700 mt is based on abundance estimates derived from an age structured model and indicates that the population is at a historical (past 40 years) high level. Data from halibut trawl surveys in the 1960's, groundfish trawls in the 1970's, and NMFS triennial trawl surveys from 1984 to 2005 were included in the model. Similar to the previous assessment, the model matched the observed higher proportion of females in the larger size intervals of both survey and fishery data by allowing males a higher mortality rate than females.

The ABC estimate was based on Tier 3a calculations due to the fact that the estimated 2005 female spawning biomass (1,095,700 mt) is greater than the $B_{40\%}$ estimate (545,900 mt). Therefore, $F_{OFL}=F_{35\%}=0.168$ and $F_{ABC}= F_{40\%} = 0.142$ resulting in an ABC recommendation of 177,844 t. The overfishing level for arrowtooth flounder is estimated to be 207,700 mt. The Plan Team recommended that ABC be apportioned among

regulatory areas in proportion to biomass distributions in the 2005 trawl survey as follows:

Western	Central	West Yakutat	East Yakutat/SE	Total	
20,154	134,907	15,954	6,830	177,844	**2006**
20,852	**139,582**	**16,507**	**7,067**	**184,008**	**2007**

Gulf of Alaska flatfish – The 2005 assessment recommendations used for 2006 were rolled over to 2007 for shallow water flatfish and were increased slightly for deep water flatfish until a new survey is conducted in 2007.

New data for the 2005 flatfish assessment included the 2005 NMFS bottom trawl survey biomass estimates and the 2005 catch. The 2005 survey biomass estimates were used to calculate ABC's for 2006 for all species except Greenland turbot and deepsea sole, where the mean catch from 1978 to 1995 was used. The survey sampled to 700 m depth while the distribution of these deep water species extends deeper. Dover sole, the main constituent of the deep water group, is now assessed in using an age structured model. These stocks remain lightly harvested relative to their estimated biomass because the annual catch is almost always less than the TAC levels which are typically set less than the ABC.

The flatfish group is subdivided into arrowtooth flounder, deep water flatfish, flathead sole, rex sole and shallow water flatfish. Flathead sole and arrowtooth flounder, and rex sole are presented in separate assessments using age-structured models. The 2006 exploitable biomass for each group (except for those species with age-structured models) is based directly on results from the 2005 NMFS trawl survey. ABC and OFL were calculated by species, with individual species identified as Tier 4, 5, or 6 depending upon the available data. The ABC's for northern and southern rock sole were estimated based on Tier 4 with $F_{ABC}= F_{40\%}$ (Southern rock sole $F_{40\%}$=0.162; Northern rock sole $F_{40\%}$=0.204) and $F_{OFL}=F_{35\%}$ (southern rock sole $F_{35\%}$=0.192; northern rock sole $F_{35\%}$=0.245) while other flatfish ABC's were estimated with F_{ABC}=0.75 M and F_{OFL}=M (Tier 5).

The stock assessment model for Dover sole indicated that age 3+ biomass estimates increased slightly while female spawning biomass estimates continue to remain relatively unchanged. Recruitment may have been high in 2002 and catches remain well below the TAC. The 2006 ABC using $F_{40\%}$ = 0.142 was estimated at 8,842 t, which is 1,842 t more than the 2005 ABC. The 2006 OFL using $F_{35\%}$= 0.184 was estimated at 10,764 t.

Greenland turbot and deep-sea sole ABC's were estimated at Tier 6 with ABC=0.75 OFL (183 t) and OFL=average catch from 1978 to 1995 (244 t). Total flatfish ABC for 2006 was 1,225 mt greater than in 2005. ABC's were apportioned among the regulatory areas by applying the average fraction of the survey biomass in each area in 2005. As in 2005, the ABC was split between the eastern GOA and the WY and EYAK/SEO sub areas.

2007 ABC area apportionment

Flatfish group	Western	Central	WYAK	EYAK/SEO	Total
Deep water	420	4,163	2,677	1,447	8,707
Shallow water	24,720	24,258	628	1,844	51,450

Flathead sole – Until new survey information becomes available in 2007, the 2005 assessment model results projected ahead (using the 2006 catch) are used for 2006 management. The 2005 assessment is summarized below.

New data for the 2005 flathead sole assessment included the 2005 survey biomass estimate and length data, and 2005 catch and fishery length data. Maturity parameters were updated and estimates of reference fishing mortality were estimated from spawner per recruit analysis. The 2006 biomass estimate from the age-structured model was 291,400 t, continuing a stable trend since the mid 1980s.

The projected 2006 female spawning biomass is estimated to be well above the $B_{40\%}$ level therefore flathead sole ABC and OFL are calculated using Tier 3a calculations. Under this definition, $F_{OFL}=F_{35\%}$, and F_{ABC} is less than or equal to $F_{40\%}$. The ABC for 2007 using $F_{40\%} = 0.36$ was estimated at 39,110 mt. The overfishing level using $F_{35\%} = 0.46$, results in 48,658 mt. Area apportionments of flathead sole ABC's for 2007 (using $F_{40\%}$) are based on the fraction of the 2005 survey biomass in each area:

Western	Central	West Yakutat	East Yakutat/SE	Total
10,908	26,054	2,091	57	39,110

For further information, contact Jack Turnock (206) 526-6549 and William Stockhausen (206) 526-4241.

7. Lingcod

a. Research

Habitat Studies – Relatively little is known about the habitat requirements of juvenile lingcod. Initial laboratory experiments in AFSC's Newport facility demonstrated an affinity for structure (rock, shell, or seagrass) over bare sand habitats. An acoustic tagging study conducted in Yaquina Bay, Oregon, corroborated the basic habitat preferences seen in laboratory experiments. Juvenile lingcod showed a high degree of site fidelity, remaining in discreet areas of significant structural complexity, as evidenced by underwater video of benthic habitat. With this information, we can start to identify what constitutes essential fish habitat for juveniles of this important fisheries species.

For further information, contact Dr. Allan Stoner, (541) 867-0165.

8. Walleye pollock

a. Research

Echo Integration-Trawl Surveys

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Winter echo integration-trawl surveys in the vicinity of Shumagin Islands and Sanak Trough, Shelikof Strait, and the shelf break near Chirikof Islands – The MACE Program conducted a winter echo integration-trawl (EIT) survey aboard the NOAA ship *Miller Freeman*, which targeted walleye pollock in the Shumagin Islands, Sanak Trough, and Morzhovoi Bay. The Shumagin Islands portion of the survey was conducted between 15-18 February along parallel transects. Transects were spaced 5-nmi apart within Shumagin Trough, 1-nmi apart east of Renshaw Point, and 2.5-nmi apart elsewhere. The Sanak Trough survey was conducted between 18-19 February along transects spaced 2-nmi apart. Morzhovoi Bay, which was surveyed for the first time, was surveyed on 19 February along transects spaced 2.5-nmi apart

In the Shumagin Islands, the densest pollock aggregations were observed off Renshaw Point, although in significantly less quantities than detected in earlier surveys. Most fish off Renshaw Point exceeded 40 cm FL. Significant quantities of age-1 pollock (8-13 cm FL) were detected in Shumagin Trough. The only other year when juveniles were detected in more than trace amounts was 2001. The unweighted maturity composition for males longer than 40 cm FL was 0% immature, 3% developing, 66% pre-spawning, 30% spawning, and <1% spent. The maturity composition of females longer than 40 cm was 0% immature, 3% developing, 92% pre-spawning, 2% spawning, and 2% spent. The mean gonado-somatic index (GSI: ovary weight/body weight) for mature pre-spawning females was 0.13. Pollock EIT survey abundance estimates in the Shumagin Islands area were 1,788 million pollock weighing 37,000 metric tons, based on catch data from 11 trawl hauls and acoustic data from 390 nmi of survey transects. The area off Renshaw Point accounted for 68% of the adult (>40 cm FL) biomass.

The densest pollock aggregations in Sanak Trough, which consisted of only adult pollock, were located in the northern part of the Trough. The unweighted maturity composition for males longer than 40 cm FL was 0% immature, 2% developing, 19% pre-spawning, 67% spawning, and 11% spent. The maturity composition of females longer than 40 cm FL was 1% immature, 1% developing, 64% pre-spawning, 7% spawning, and 17% spent. The average GSI for pre-spawning females was 0.16. The abundance estimates for Sanak Trough were 120 million pollock weighing 127,000 t, based on catch data from 4 trawl hauls and acoustic data from 108 nmi of survey transects.

The densest aggregations in Morzhovoi Bay were detected in the mouth of the bay. The unweighted maturity composition for males longer than 40 cm FL was 0% immature, 1% developing, 15% pre-spawning, 79% spawning, and 4% spent. Only four females were collected for length and maturity measurements, thus maturity composition

and GSI estimates could not be completed. The abundance estimates for Morzhovoi Bay is 13 million pollock weighing 12,000 t, based on catch data from 2 trawl hauls and acoustic data from 66 nmi of survey transects.

The MACE Program also conducted winter EIT surveys aboard the NOAA ship *Miller Freeman* which targeted walleye pollock along the shelfbreak southeast of Chirikof Island and in the Shelikof Strait area. The survey of the shelf break from southeast of Chirikof Island to near the mouth of Barnabas Trough was conducted during 14-15 March along parallel transects spaced 6-nmi apart. The Shelikof Strait sea valley was surveyed from south of Chirikof Island to north Kuliak Bay on the Alaska Peninsula during 16-27 March along parallel transects spaced 7.5-nmi apart.

Along the Chirikof shelf break, most of the echosign attributed to pollock occurred in midwater layers between 275 and 400 m depth south of the mouth of Barnabas Trough over bottom depths of 300-1,000 m. Pollock size composition in these layers ranged from 45-60 cm with a mode at 49 cm FL. The unweighted maturity composition in the Chirikof Island area for males longer than 40 cm FL was 0% immature, 0% developing, 46% pre-spawning, 54% spawning, and 0% spent. The maturity composition of females longer than 40 cm FL was 0% immature, 2% developing, 98% pre-spawning, 0% spawning, and 0% spent. The high percentage of pre-spawning females indicates that peak spawning had not occurred. The average GSI for pre-spawning females was 0.14. The pollock abundance estimates for the Chirikof Island area were 61 million pollock weighing 69,000 t, based on catch data from 4 trawl hauls and acoustic data from 162-nmi of survey transects.

In the Shelikof Strait area, dense aggregations of mature, pre-spawning pollock were detected along the northern side of the Strait from Cape Unalishagvak to Katmai Bay, although the abundance was lower than in 2005, which in turn was lower than in the mid-to late-1990s. Adult pollock mixed with age-1 (9-16 cm) and age-2 (17-24 cm) were located on the Kodiak Island side of the Strait as well as south of the mouth of the Strait (between Cape Ikolik and Wide Bay) to near the Semidi Islands. Mid-water layers of age-1 and age-2 pollock were detected primarily in the northern portion of the survey area on the Kodiak Island side of the Strait. The unweighted maturity composition for males longer than 40 cm FL was 3% immature, 4% developing, 60% pre-spawning, 34% spawning, and 0% spent. The maturity composition of females longer than 40 cm FL was 3% immature, 4% developing, 91% pre-spawning, 1% spawning, and 0% spent. These results are similar to previous survey results in terms of the relatively low numbers of spawning and spent female fish, which suggests that the survey timing was appropriate. A logistic model provided a reasonable fit to the female maturity-at- length data and predicted that 50% of females were mature at a length of 43 cm. The average GSI for mature pre-spawning females was 0.14. The pollock abundance estimates for Shelikof Strait were 1.2 billion pollock weighing 294,000 t, based on catch data from 23 trawl hauls and acoustic data from 950-nmi of survey transects.

Summer interaction study between commercial fishing and walleye pollock off East Kodiak – Field work for the fifth year of a fishery interaction study was completed between 13 August and 5 September 2006 off the east side of Kodiak Island in

the Gulf of Alaska as a collaborative effort between RACE and REFM scientists from the Alaska Fisheries Science Center. The work is part of a larger program designed to evaluate the effect of commercial fishing activity on the prey availability of walleye pollock (*Theragra chalcogramma*) and other forage fish species to endangered Steller sea lions (*Eumetopias jubatus*).

The principal objective of the experiment was to use standard acoustic survey methods to describe the spatio-temporal variability in pollock abundance and distribution patterns in two troughs over a period of several weeks before and during the commercial pollock fishery. The study area consisted of a site where commercial fishing was allowed (Barnabas Trough), and a comparison site where commercial fishing was prohibited (Chiniak Trough). Repeated survey passes were conducted within each trough before and during the fishery to document if a perturbation occurred in the fish distribution during the fishing period. To characterize the physical environment, oceanographic data were collected using drifters, CTDs, XBTs, and a vessel-mounted thermosalinograph.

Most of the acoustic backscattering was attributed to adult pollock, age-1 pollock, and mixed schools of age-0 pollock and capelin (*Mallotus villosus*). The adults were generally detected as near-bottom schools or as an on-bottom "carpet." As in other years of the study, adult pollock were generally distributed within the northern half of Barnabas Trough and throughout Chiniak Trough. Relatively large, dense aggregations of age-0 pollock/capelin, located in mid-water during daylight, were broadly distributed throughout Chiniak Trough and predominantly in the northern portion of Barnabas Trough. Unlike the deeper dwelling adults, the age-0 pollock/capelin mix often extended over relatively shallow bottom depths of less than 100 m. The presence of relatively large numbers of age-0 pollock during the survey was similar to what was observed in 2004. Daytime trawl catches often caught more age-0 pollock than capelin, although the selectivity of the AWT to these species is unknown and so it is uncertain whether the different catch rates for these two species groups accurately reflects their relative abundance in the water column.

The size composition of adult pollock ranged between modes of 52-62 cm fork length, larger than adult pollock in 2004. The size composition of age-0 pollock had prominent length modes at 6 or 7 cm standard length, and that of age-1 pollock at 20 to 21 cm.

A total of 589 marine mammal sightings of groups or individuals were made during the survey. A rare sighting of a northern right whale was made in the outer region of Barnabas on 1 Sept (~N 56 47.06, W152 26.18).

Two very localized and persistent vertical sound-scattering "columns" were detected in Barnabas during all passes. The source of these columns is unknown. They may be gas bubbles rising from active geological seeps. The locations of these features are: N57 03.03, W152 42.10 and N56 56.95, W152 25.00.

BERING SEA

Winter echo integration-trawl survey in the southeast Aleutian Basin near Bogoslof Island – The MACE Program conducted an EIT survey aboard the NOAA ship *Miller Freeman* between 4 and 9 March 2006, which targeted walleye pollock in the southeastern Aleutian Basin near Bogoslof Island. The survey comprised 35 north-south parallel transects spaced 3-nmi apart, which covered 1,803 nmi^2 of the Central Bering Sea Convention Specific Area.

As in recent years' surveys, pollock were concentrated in two main regions; northeast of Umnak Island off Cape Idak, and just north of Samalga Pass between the Islands of Four Mountains and Umnak Island. Pollock lengths ranged between 38 cm and 71 cm FL. In the Cape Idak-Umnak Island area, pollock were characterized by a dominant mode at 45 cm FL (representing the 2000 year class), while in the Samalga Pass area pollock aggregations had higher proportions of fish larger than 55 cm FL, generating a bimodal distribution with modes at 47 and 60 cm FL. The unweighted maturity composition for males was 0% immature, 1% developing, 60% pre-spawning, 39% spawning, and less than 1% spent. The female maturity composition was 0% immature, 1% developing, 72% pre-spawning, 6% spawning, and 21% spent. A higher percentage of spent females were captured in the Umnak region than in the Samalga region. The average GSI for mature pre-spawning females was 0.17. The pollock abundance estimates for the southeastern Aleutian Basin area were 239 million fish weighing 240,000 t, based on catch data from 13 trawl hauls and acoustic data from about 732-nmi of survey transects. This was the highest abundance in terms of numbers of fish estimated since the 1999 Bogoslof EIT survey. About 58% of the total biomass was in the Umnak Island area, and 42% in the Samalga Pass region.

Summer echo integration-trawl survey on the eastern Bering Sea shelf – The MACE Program conducted an EIT survey of midwater walleye pollock in the eastern Bering Sea shelf between 6 June and 21 July 2006. The survey design consisted of 28 north-south transects spaced 20 nautical miles (nmi) apart over the Bering Sea shelf from Port Moller, Alaska, to the U.S.-Russia border.

Midwater (near surface to 3 m off the seafloor) abundance estimates were 3.4 billion pollock weighing 1.6 million t based on catch data from 104 trawl hauls and acoustic data from 4477 nmi of survey transects. The biomass was about half of what was observed in 2004 (3.3 million t) and most of it was distributed west of St. Matthew Island. Only about 25% of the estimated biomass was east of 170°W and about 8% of this value was found inside the Steller sea lion Conservation Area (SCA). Although a few juveniles were present east of 170°W, most of the pollock in this region ranged between 35-68 cm FL with a mode at 48 cm FL. West of 170°W, where 75% of the estimated biomass was observed, the pollock length composition primarily ranged between 11-67 cm FL with major modes at 13 cm and 44 cm FL and a minor mode at 23 cm FL.

Population-at-age estimates indicated that pollock from the 2000-2002, and 2004 year-classes made up most of the population. Five-year-old pollock (2001 year class)

were estimated to number 695.3 million and weigh 366.4 thousand t, contributing about 20.5% and 23.5% of the total estimated numbers and biomass, respectively. The age-1 pollock estimate of 455.6 million was significantly higher than the estimate in 2004 (15.8 million) and contributed 13.4% of the total estimated population.

Intervessel Comparison – Scientists from the Midwater Assessment and Conservation Engineering (MACE) Program conducted an intercomparison of echo-integration trawl (EIT) survey data between the NOAA ships *Miller Freeman* and *Oscar Dyson* as part of the 2006 EIT survey in the eastern Bering Sea from July 3 to July 13, 2006. The primary goal of this work was to investigate if walleye pollock differentially avoid the two vessels.

Oscar Dyson was designed to meet the ICES specification for underwater radiated noise to minimize vessel avoidance during fish abundance surveys, while *Miller Freeman* is a conventionally built vessel, which exceeds this specification. It is possible that fish will respond to the vessels differently due to the disparate auditory stimuli produced by the vessels. If this is the case, differential vessel avoidance may influence the biomass estimates derived from EIT methods with the two vessels. This is of particular interest for resource management in Alaskan waters as the *Oscar Dyson* is slated to become the primary vessel for pollock EIT surveys, which have historically been conducted aboard *Miller Freeman*.

Both vessels continuously collected acoustic backscatter at 18, 38, 120 and 200 kHz while traveling in close proximity. A two-part study design was developed and implemented by MACE staff, which included a component in which the vessels traveled side by side at a distance of 0.5 nautical miles (nmi). This was designed to allow for concurrent EIT operations without compromising the survey data for use in stock assessment. In addition, a component in which one vessel followed the other at a distance of 1 nmi was implemented in order to investigate the underlying mechanisms for differences in vessel avoidance. Acoustic data collection from both vessels was conducted over a wide range of densities of adult pollock, and conditions typical of acoustic surveys in this area. Paired trawl hauls were also conducted with the vessels separated by 0.5 nmi.

Analysis of these data in collaboration with a visiting scientist from the Institute of Marine Research, Norway began shortly after the cruise and is ongoing. Initial analyses indicate that the acoustic backscatter detected by the two vessels differ in various ways for the four frequencies, but that the differences are due to echosounder differences rather than vessel induced fish behavior. Additionally, analysis of pollock depth distributions from the transects in which the vessels followed each other revealed that when *Oscar Dyson* was leading, the pollock observed by *Miller Freeman* were on average significantly deeper than those observed by *Oscar Dyson*. Because no difference in pollock depth was observed when the *Miller Freeman* was leading, or when the vessels traveled side by side, this change in depth distribution may suggest that pollock dive in response to the passage of *Oscar Dyson*, with the diving occurring primarily after the fish have been detected in the acoustic beam. Further fieldwork comparing the two vessels is planned for the winter and spring of 2007.

For more information, please contact MACE Program Manager, Chris Wilson, (206) 526-6435.

b. Stock assessments

GULF OF ALASKA

The age-structured model developed using AD Model Builder and used for GOA pollock assessments in 1999-2002 is fundamentally unchanged for the 2006 assessment. This year's pollock assessment features the following new data: (1) total catch and age composition from the 2005 fishery; (2) biomass and age composition from the 2006 Shelikof Strait echo integration trawl (EIT) survey; (3) biomass and length composition from the 2006 ADF&G crab/groundfish trawl survey, and (4) age composition from the 2005 NMFS bottom trawl survey.

The model estimate of spawning biomass in 2007 is 160,670 t, which is 29% of unfished spawning biomass and below $B_{40\%}$ (220,000 t), thereby placing Gulf of Alaska pollock in sub-tier "b" of Tier 3. Estimates of stock status in 2007 indicate a 16% decline in spawning biomass from 2006. These results are consistent with survey trend estimates (13% decline in the Shelikof Strait EIT survey, 13% decline in the ADFG trawl survey). The dip in spawning biomass is expected to be short-lived, as projections indicate an increase in spawning biomass after 2007. These results depend critically on the magnitude of the 2004 year class, which appears to be above average, but is still uncertain. The author's 2007 ABC recommendation for pollock in the Gulf of Alaska west of 140° W longitude is (W/C/WYK) is 63,800 t, a decrease of 22% from the 2006 ABC. This recommendation is based on a more conservative alternative to the maximum permissible F_{ABC} introduced in the 2001 SAFE. The OFL in 2007 is 87,220 t. In 2008, the recommended ABC and OFL are 76,960 t and 105,490 t, respectively.

While there were no additions to the pollock stock assessment ecosystem considerations section this year, pertinent information for GOA pollock was presented within the Ecosystem Considerations Section (SAFE Appendix C). A new analysis conducted with the GOA ecosystem model compared estimates of predation mortality and fishing mortality relative to population production in order to determine whether total mortality exceeded production. The results suggested that high predation mortality plus conservative fishing mortality might exceed GOA pollock production at present (Ecosystem SAFE Figure 9), and that this condition may have been in place since the late 1980's or early 1990s (Ecosystem SAFE Figure 7). Although this analysis was considered preliminary by the ecosystem assessment authors, the Plan Team felt that it provided additional support for continued precautionary management of GOA pollock. The Plan Team concurred with the author's choice to use the same model as last year to provide assessment advice. This model fixed trawl survey catchability (q) at 1.0 and estimated other catchabilities. Although the likelihood is higher for models with q closer to 0.8, the change in likelihood is small (less than 1) between models with q fixed at 1.0 or estimated. Fixing q at 1.0 results in a more precautionary estimate of spawning biomass and therefore ABC than other models. Furthermore, identical to last year, the

Plan Team accepted the author's recommendation to reduce ABC from the maximum permissible using the "constant buffer" approach (first accepted in the 2001 GOA pollock assessment). Therefore, the ABC for 2007 based on this precautionary model configuration and adjusted harvest control rule is 62,150 mt (F_{ABC} =0.16) for GOA waters west of 140 degrees W. longitude (Note that this ABC recommendation is already reduced by 1,650 mt to account for the Prince William Sound GHL).

The model results produced an estimated 2007 spawning biomass of 160,670 mt, or 29% of unfished spawning biomass. The $B_{40\%}$ estimate is 220,000 mt. Because model estimated 2007 female spawning biomass is below $B_{40\%}$, Gulf of Alaska pollock are in Tier 3b. The projected 2007 age-3+ biomass estimate is 833,710 mt. Markov Chain Monte Carlo analysis indicated the probability of the stock being below $B_{20\%}$ to be less than 1% in 2006 and subsequent years. The 2006 OFL under Tier 3b is 87,220 mt (F_{OFL} = 0.23). Spawning biomass is projected to increase after 2008 in part because of the estimated above average 2004 year class, which is included in projections.

Southeast Alaska pollock are in Tier 5 and the ABC and OFL recommendations based on natural mortality (0.30) and the biomass from the 2005 survey: This results in a **2007 ABC of 6,157 t** (27,362 t *0.75 M), and a **2007 OFL of 8,209 t** (27,362 t * M)**.** Since no new survey data will be available until the summer of 2007, the 2008 ABC and OFL should be set equal to the 2007 values for the E.Yak/SE area. The assessment was updated to include the most recent data available for area apportionments within each season (Appendix C of the GOA pollock chapter).

For more information contact Dr. Martin Dorn 526-6548.

EASTERN BERING SEA

The Eastern Bering Sea Pollock resource remains at a high and stable level while sustaining average annual harvest levels greater than 1 million tons. The 2006 stock assessment incorporated revised estimates of age composition from the 2006 Echo integration survey (EIT) as well as the 2006 bottom trawl survey estimate and the 2006 fishery information.

The bottom trawl survey biomass estimate from the standard area (strata 1-6) was 2.85 million t, down by 45% from the 2005 estimate of 5.13 million. This survey estimate is about 59% of the average of all BTS estimates since 1982. The 2006 echo-integration trawl (EIT) survey numbers-at-age estimates were also low with a biomass estimate (1.56 million t) nearly as low as the 1991 value (1.45 million t). Projections for 2007 indicate that the stock is close to or slightly below the B_{MSY} level and will continue to drop given the current age structure estimate. The survey data do indicate that the 2005 year class may be near or above average, but this is highly uncertain.

Three alternative models are presented, all of which follow the statistical age-structured approach that has been used for the last several years. All of these models give point estimates of 2007 age 3+ biomass in the range 6,100,000 t to 6,360,000 t (Table 1.16, Models 1 and 2 only). The author recommends Model 2, which differs from last year's

base model (Model 1) by the addition of data from the northwest area of the bottom trawl survey (strata 8 and 9). This increases coverage of the current range of pollock. The current assessment provides estimates of age-3+ biomass that are very close to those provided in last year's assessment. While the 2000 year class appears much stronger than average, most other year classes spawned after 1996 appear weaker than average, with the exception of the 1999 and 2005 year classes, which appear average.

The SSC has determined that reliable estimates of B_{MSY} and the probability density function for F_{MSY} exist for this stock. Therefore, EBS walleye pollock qualify for management under Tier 1. The assessment authors' has concluded that the Tier 1 reference points are reliably estimated given the structure of the model. The updated estimate of B_{MSY} from the present assessment is 2,060,000 t, compared to 2,120,000 t from last year's assessment. The projected spawning biomass for 2007 is 2,170,000 t, placing EBS walleye pollock in sub-tier "a" of Tier 1. As in the last three assessments, the maximum permissible ABC harvest rate was based on the ratio between MSY and the equilibrium age 3+ biomass corresponding to MSY. The harmonic mean of this ratio from the present assessment is 0.243, virtually identical to the value obtained in last year's assessment. This ratio is multiplied by the geometric mean of the projected age 3+ biomass for 2007 to obtain the maximum permissible ABC for 2007, which is 1,510,000 t. This ABC is about 8% higher than the 2007 yield corresponding to an $F_{40\%}$ strategy, which is 1,390,000 t. For the last five years, ABC for this stock has been set at the maximum permissible value. This year, the assessment authors recommend setting ABC at 1,300,000 t, rather than at the maximum permissible value. Several reasons were cited for recommending an ABC less than the maximum permissible value of 1,510,000 t. In 2006, fishing vessels needed to travel farther to catch pollock, lower abundances of pollock than expected were observed for both the bottom trawl survey and the EIT survey, some evidence exists for recently lowered Bering Sea productivity (reduced zooplankton and forage fish abundance as shown in this year's Ecosystem Considerations Chapter), and arrowtooth flounder, which is an important predator of pollock, is increasing. A catch of 1,300,000 t would maintain the spawning exploitation rate at the current level. In contrast, the $F_{40\%}$ ABC recommendation of 1,390,000 t and the maximum permissible value of 1,510,000 t would increase spawning exploitation rate to the highest values since 1980. On the other hand, an ABC of 1,300,000 t does not preserve markedly more spawning biomass compared to the $F_{40\%}$ ABC recommendation of 1,390,000 t. One reason was cited for recommending an ABC equal the maximum permissible value; the 2007 female spawning biomass is near B_{MSY}, which is the target spawning biomass. The Plan Team chose to accept the senior author's recommendation of 1,300,000 t for an ABC less than the maximum permissible value and to maintain the spawning exploitation rate at the current level. However, the North Pacific Management Council set the 2007 ABC at 1,394,000 t with an OFL of 1,640,000 for the eastern Bering Sea portion of the stock.

ALEUTIAN ISLANDS

For many years, the Aleutian Islands pollock stock has lacked an age-structured model and the SSC has determined that the stock qualified for management under Tier 5. Following preliminary exploration of some age-structured models in the 2003

assessment, several models were presented for potential management use in recent years' assessments. However, the SSC concluded that adoption of a model was precluded until such time as additional field research results in greater confidence in the stock structure and spatial distribution of Pollock in the Aleutian Islands. An experimental survey (AICASS) conducted by the senior assessment author provides research to help resolve the ambiguities in pollock stock structure and may also facilitate exploration of alternative management systems based on finer spatial-temporal scales. The Plan Team supports continuation of these studies as well as genetic studies to resolve pollock stock structure. In this year's assessment, two models from last year's assessment are presented. Model 1 uses data only from the portion of the stock to the west of 174°W and Model 2A includes survey data from the entire Aleutian Islands management area. However, the same ambiguities of stock structures and dynamics present in last year's assessment remain. As a result, the Plan Team does not support using the models to estimate Aleutian Islands pollock abundance. A third model (Model 2B) was presented that also estimates natural mortality within Model 2. The senior author's preferred model is Model 2B. The estimate of $M = 0.235$ appears more credible than the value of 0.3 assumed for previous assessments. The posterior distribution of M is relatively narrow, implying that the estimate of M is precise. In addition, ecosystem modeling indicates that pollock natural mortality is less in the Aleutians than in the Bering Sea.

The SSC has determined that the Aleutian pollock stock qualifies for management under Tier 3 and set the 2007 ABC at 44,500 t and the OFL at 54,500 t.

BOGOSLOF

The 2006 hydroacoustic survey of the Bogoslof region resulted in a biomass estimate of 240,000 t, a decrease of about 5% from the 2005 estimate. The SSC has determined that Bogoslof pollock qualified for management under Tier 5. The maximum permissible ABC under Tier 5 is 75% of the product of the natural mortality rate (0.20) and biomass, giving a value of 36,000 t. For several years, the SSC has used a much more conservative approach. The SSC formula uses a biomass-adjusted harvest rate rule (with 2,000,000 t estimate as a reference stock size) and an estimate of F_{ABC} based on growth, natural mortality, and maturation rate. If the formula used by the SSC is applied, the resulting fishing mortality rate is 0.022, giving a 2007 ABC of 5,220 t. The overfishing level under Tier 5 is the product of the natural mortality rate and biomass, giving an OFL of 48,000 t for 2007. As a Tier 5 stock, it is not possible to determine whether Bogoslof pollock is overfished or whether it is approaching an overfished condition. Two age-structured models were presented in this year's assessment. Survey catchability was assumed equal to 1.0 in both models. The two models differed in whether a portion of Donut Hole catches were excluded (Model 1) or included (Model 2). Both models imply that age 5+ biomass peaked in 1983 supported largely by an enormous 1978 year class. The 1978 year class appears to have been more than 5 times larger than any subsequent year class. Following a decline from the 1983 peak, biomass appears to have been fairly stable since about 1992. The authors have made an excellent start on age-structured modeling of this stock and provide some useful insights into the history of the stock; however, adoption of any of the models would be premature. In part, the portion of the catch data from the "Donut Hole" area to include in the model is uncertain. In addition,

whether pollock in the Bogoslof region can be usefully modeled as a closed stock is uncertain as the amount of interchange with pollock in the Bering Sea is unknown.

For further information, contact Dr. James Ianelli, (206) 526-6510.

9. Dogfish

a. Research

NMFS Auke Bay Laboratory and University of Alaska Fairbanks Joint Research on Spiny Dogfish in the Gulf of Alaska – Scientists from the NMFS Auke Bay Laboratory, the University of Alaska School of Fisheries and Ocean Sciences, and the University of Washington School of Aquatic and Fishery Sciences continued a joint study on spiny dogfish (*Squalus acanthias*) in the Gulf of Alaska. Little is known about the life history or ecological role of spiny dogfish in the North Pacific despite the fact that they comprise a relatively large biomass in coastal northeast Pacific waters. One aspect of this research is to collect a time series of life history and ecological information from spiny dogfish in Yakutat Bay where they are commonly encountered as bycatch.

In 2006, a joint special project was completed with the NMFS Alaska Observer Program to collect length and maturity from random incidental catches of spiny dogfish in commercial fisheries for groundfish in the Gulf of Alaska. Length frequency and maturity data are being analyzed and will be summarized in the annual Stock Assessment and Fishery Evaluation (SAFE) report for sharks in the Gulf of Alaska.

For more information, contact Dean Courtney at (907) 789-6006.

10. Skates

a. Research

Skate reproductive ecology – Gerald Hoff successfully defended his Ph.D. entitled "Reproductive Biology of the Alaska Skate *Bathyraja parmifera*, with regard to Nursery Sites, Embryo Development and Predation" on January 26, 2007. Dr. Hoff began his graduate studies in the fall of 2003 at the University of Washington in the School of Aquatic and Fishery Sciences under the direction of Dr. Ted Pietsch. Dr. Hoff has been a Research Fisheries Biologist in the RACE Bering Sea Groundfish Division at the Alaska Fisheries Science Center since 1997.

His research focused on characterization of an Alaska skate nursery site located in the southeastern Bering Sea. The research identified the nursery extent and habitat type, and included seasonal sampling to determine the timing of reproduction and egg deposition; timing of embryo hatching; and mortality sources to young skates. Jerry has six manuscripts in the works that are in various stages of preparation and review:

1. Embryo development of the Aleutian Skate and the Alaska Skate
2. Characterization of a Nursery Site for the Alaska Skate *Bathyraja parmifera*
3. Skate Egg case predation in the Eastern Bering Sea
4. Emerging patterns of species richness and density in the skates (Rajidae) of Alaska
5. Life History Parameters of Eight Skates from the Eastern Bering Sea
6. Characterization of Skate Nurseries in the Eastern Bering Sea

For more information, contact Dr. Jerry Hoff at (206)526-4580.

11. Other Species

a. Research

Electronic Tagging of Pacific Sleeper Shark in Upper Chatham Strait, Southeast Alaska – Scientists from the NMFS Auke Bay Laboratory continued electronic tagging studies of Pacific sleeper sharks (*Somniosus pacificus*) in the Gulf of Alaska. Pacific sleeper sharks are a deepwater shark of the North Pacific Ocean. Little information is available for Pacific sleeper sharks, although they are considered common in boreal and temperate regions of shelf and slope waters of the North Pacific. Pacific sleeper sharks are captured incidentally in commercial longline fisheries for halibut and sablefish in the Gulf of Alaska. Pacific sleeper sharks are not retained in commercial fisheries, but the incidental bycatch provides an opportunity for tagging research. The recovery of temperature, depth, and location from electronic tags will aid in the identification of Pacific sleeper shark habitat utilization and distribution, and identify potential interactions between Pacific sleeper sharks and other species in the Gulf of Alaska.

In 2006, a total of 10 Pacific sleeper sharks were captured in upper Chatham Strait, Southeast Alaska aboard the chartered commercial fishing vessel *Sea View*. Average length was 233 cm for males and 196 cm for females. Electronic satellite pop-up archival tags were attached externally to the first dorsal fin of 4 Pacific sleeper sharks. The tags were programmed to release automatically in June 2007. Archived temperature and depth data along with the location of the tag at the time it reaches the surface will be recovered by satellite.

For more information, contact Dean Courtney at (907) 789-6006.

Atka mackerel reproductive ecology and use of passive acoustics for studying spawning EFH — Bob Lauth has one manuscript in press with Alaska Fisheries Research Bulletin entitled, "Geographic distribution, depth range, and description of Atka mackerel *Pleurogrammus monopterygius* nesting habitat in Alaska", and another in review with US Fishery Bulletin entitled "Reproductive cycle of Atka mackerel (*Pleurogrammus monopterygius*) in Alaska". Together, these 2 manuscripts provide the most extensive examination of Atka mackerel reproductive ecology conducted to date.

Research provided from this study will be very useful to stock assessment biologists and managers for improving the Atka mackerel stock assessment and developing more prudent harvest management strategies.

A new area of interest is the relatively new and rapidly emerging field of passive acoustics. It promises tremendous potential for studying spawning essential fish habitat (EFH). From 7-9 February, Lauth attended a workshop on Underwater Passive Acoustic Monitoring for Remote Regions. The workshop was sponsored by the Alliance for Coastal Technologies (ACT) and was conducted at the Hawaii Institute of Marine Biology. The workshop provided an opportunity to meet other research scientists in the field and learn more about the passive acoustic tools being used. By collaborating with scientists and technology developers, Lauth was able to build a low cost (<$1000) underwater passive acoustic device for listening to fish. He is currently working with the RACE Fisheries Behavioral Ecology Program in Newport, OR and the Alaska SeaLife Center in Seward, AK to record fish sounds both *in situ* and in the laboratory.

For more information, contact Bob Lauth at (206) 526-4121.

b. Stock Assessment

Shark Bycatch in Alaskan Waters – The shark bycatch assessment chapters from 2005 for the Bering Sea/Aleutian Islands (BSAI) and for Gulf of Alaska (GOA) were updated for 2006 and presented to the North Pacific Fishery Management Council's Groundfish Plan Teams in November 2006.

Incidental catch estimates for sharks are now available from the NMFS Alaska Regional Office (AKRO). Incidental catch for sharks was updated with the most recent AKRO estimates, and incidental catch from the years 1997–2005 was established as a baseline for identifying options for setting future sustainable incidental catch limits for sharks in the BSAI and GOA. Bottom trawl survey biomass data were updated for the 2006 Eastern Bering Sea (EBS) shelf and Aleutian Islands. Previous survey data were available from NMFS AFSC bottom trawl surveys in the EBS shelf (1979–2005), EBS slope (historical 1979-1991, and new time series 2002, 2004), and Aleutian Islands (1980–2004). GOA bottom trawl survey biomass data were updated for 2005. Previous trawl survey data were available from NMFS AFSC bottom trawl surveys conducted triennially and biennially in the GOA (1984–2003).

There are currently no directed commercial fisheries for shark species in federally or state managed waters of the BSAI or GOA, and most incidentally captured sharks are not retained. In the BSAI, average incidental catch of Pacific sleeper sharks from 1997–2005 (445 mt) represented 2.5% of the available Pacific sleeper shark biomass from BSAI bottom trawl surveys in 1996–2006 (total of the average biomass from three surveys was 17,647 mt). Historically, BSAI survey catches of Pacific sleeper sharks were rare, and abundance trends from the surveys were unreliable as evidenced by the high uncertainty in the biomass estimates. However, the new EBS slope bottom trawl survey (2002 and 2004) showed a substantial biomass of Pacific sleeper sharks on the EBS slope in 2002

(25,445 mt) but not in 2004 (2,260 mt). The EBS slope survey was not conducted in 2006 because of budget constraints. Spiny dogfish and salmon sharks were rarely encountered in commercial fisheries or bottom trawl surveys in the BSAI. Therefore, spiny dogfish and salmon sharks were not assessed separately in the BSAI.

In the GOA, average bycatch of spiny dogfish from 1997–2005 (422 mt) represented less than 1% of the available spiny dogfish biomass from GOA bottom trawl surveys in 1996–2005 (average biomass of spiny dogfish in the surveys was 47,733 mt). The 2001 survey did not include all areas of the Eastern GOA; hence, it may not be comparable with the other surveys for species such as spiny dogfish which appear to be relatively abundant in the Eastern GOA. Average bycatch of Pacific sleeper sharks from 1997–2005 (313 mt) represented less than 1% of the available Pacific sleeper shark biomass from GOA bottom trawl surveys 1996–2005 (average biomass of Pacific sleeper sharks was 37,459 mt). Average bycatch of salmon sharks from 1997–2005 (63 mt) was relatively small, and GOA bottom trawl survey biomass estimates for salmon sharks were unreliable because salmon sharks were only caught in four hauls from 1996–2005.

For more information, contact Dean Courtney at (907) 789-6006.

Grenadiers in Alaska – In 2006, a comprehensive assessment was done for the first time for grenadiers in Alaska and incorporated as an appendix into the North Pacific Fishery Management Council's (NPFMC) annual Stock Assessment and Fishery Evaluation Report. This assessment was needed because of the possible inclusion of grenadiers in the NPFMC's Groundfish Management Plans and also because of the relatively large numbers of grenadiers that are taken as bycatch in other directed fisheries. Presently, grenadiers are not "specified" in these management plans. Thus, no previous assessments have been done, fishermen are free to catch as many of these fish as they want, and there is no official tracking of catch by management.

Giant grenadier (*Albatrossia pectoralis*) appears to be the only grenadier species to warrant management concern in Alaska at present. Survey information indicates that giant grenadier is the most abundant fish on the continental slope at depths 400-1,000 m in all surveyed areas of Alaska except the eastern Gulf of Alaska. As such, it has a significant role in the slope ecosystem and is an important predator in this habitat. Although there has been little or no directed fishery for giant grenadier in Alaska, substantial numbers are taken as bycatch and discarded in the sablefish and Greenland turbot longline fisheries. Discard mortality is 100%. Estimated annual catches of giant grenadier in Alaska based on observer data have ranged between 11,000 mt and 21,000 mt in the years 1997-2005. By geographic region, these catches averaged 3,154 mt in the eastern Bering Sea (EBS), 2,358 mt in the Aleutian Islands (AI), and 10,903 mt in the Gulf of Alaska (GOA).

In the assessment, data from AFSC bottom trawl and longline surveys were used to compute corresponding biomass estimates of giant grenadier as follows: EBS, 546,453 mt; AI, 1,363,858 mt; and GOA, 486,627 mt. The assessment applied an F=M=0.057 approach to these biomass estimates to compute overfishing levels (OFLs) for giant grenadier in each region, and then multiplied the OFLs by 0.75 to compute the following

ABCs: EBS, 23,361 mt; AI, 58,305 mt, and GOA, 20,889 mt. When these values are compared with the estimated catches of giant grenadiers, it appears that giant grenadiers are not being overfished at this time. However, the reported longevity, slow growth, and deep-sea habitat of this species makes it susceptible to overfishing. Furthermore, a high proportion of the catch is likely female because mostly female giant grenadier live at the depths where the commercial fishery operates. Disproportionate removal of females by the fishery could put stocks of giant grenadier at greater risk. Because of these special concerns for susceptibility of giant grenadier to overharvest, fishery managers should closely monitor future catches to ensure that overfishing does not occur.

In addition to the stock assessment of giant grenadier, a field and laboratory study is currently in progress on the reproductive biology of this species, and experimental ageing has also been done. Observations of female and male sexual maturity taken during the annual AFSC longline survey in 2004-2006 suggest that nearly all the fish caught in the commercial fishery are mature. Preserved ovaries are being sampled in the laboratory to determine fecundity, to collect histological samples for maturity verification, and to investigate whether giant grenadier are determinate or indeterminate spawners. The first experimental ageing of giant grenadier by the AFSC's REFM Division Age and Growth Task was completed in 2006-2007, and based on a sample of 357 fish, maximum age was 58 years. This is nearly the same as the maximum age of 56 years reported in the only other ageing study of giant grenadier that has been done in the NE Pacific.

For more information, contact Dave Clausen at (907) 789-6049.

D. Other Related Studies

POPULATION STRUCTURE OF FORAGE FISH IN ALASKAN WATERS USING GENETIC METHODS

Forage fish are a critical food source for many seabirds, marine mammals, and other fish species in the North Pacific Ocean and Bering Sea. Several species support small local coastal fisheries. A forage fish species category was created in 1998 for the Bering Sea/Aleutian Islands and Gulf of Alaska Fishery Management Plans, but little is known about the population structure of forage fish species in these regions. As a step toward better understanding these important prey species, we have begun to examine population structure using genetic methods. The genetic structure reflects the spatial scale of productivity, which is important in developing management policies. Opportunistic sampling from various research surveys in recent years has provided collections of several forage fish species from the Bering Sea, Gulf of Alaska, and coastal waters of SE Alaska. We have archived tissue samples from eulachon (*Thaleichthys pacificus*), capelin (*Mallotus villosus*), Pacific sandlance (*Ammodytes hexapterus*), surf smelt (*Hypomesus pretiosus*), and Pacific sardine (*Sardinops sagax*).

Preliminary laboratory analysis has focused on capelin. Samples from Bering Sea and southeast Alaska collections are being analyzed for a suite of about 30 microsatellite DNA markers. Initial results suggest strong population genetic structuring at this geographic scale.

For more information, contact Sharon Hawkins at (907) 789-6081.

SEASONAL DISTRIBUTION, HABITAT USE, AND ENERGY DENSITY OF FORAGE FISH IN THE NEARSHORE ECOSYSTEM OF PRINCE WILLIAM SOUND, ALASKA

Nearshore waters of Prince William Sound (PWS) provide habitat for forage fish species that are important in the diet of marine mammals, sea birds, and other fishes. Nearshore fishes were sampled at eight locations in western PWS in April, July, and September 2006. At each location, fish were sampled with a beach seine in three shallow water (<5 m deep) habitats (eelgrass, kelp, bedrock outcrops) and with a small purse seine in two sites outside the effective depth range of the beach seine (6-20 m; mostly steep bedrock walls). A total of 17,788 fish representing 45 species were captured in 71 beach seine hauls, whereas 853 fish representing 8 species were captured in 32 purse seine hauls. Of the total catch of fish by beach seine, 49% were captured in kelp, 44% in eelgrass, and 7% in bedrock outcrops. Total catch by beach seine (all habitat types) increased seasonally (4,653 fish in April, 5,274 fish in July, 7,861 fish in September); this indicates that fish occupy shallow, nearshore waters for at least several months a year. More importantly, species composition changed with season: pink salmon dominated catches in April, saffron cod in July, and capelin in September. Larval or juvenile stages of pink salmon, capelin, saffron cod, and Pacific herring accounted for 87% of the total catch (beach and purse seine). For forage fish, catches of capelin and herring were highest in kelp and eelgrass. Nearshore vegetated areas provide habitat for juvenile capelin and herring, particularly in summer and early fall in western PWS.

In July and September, we collected crescent gunnels (n = 141), saffron cod (n = 175), walleye pollock (n = 124), and Pacific herring (n = 172) from eelgrass, kelp, and bedrock habitats to investigate quality of habitat on Fulton's condition factor, growth (RNA/DNA analysis), and lipid and energy content. In order to maximize the number of observations in each habitat, we used bio-impedance analysis (BIA) to predict dry mass and lipid and energy content. Preliminary analyses (July only) indicate that there was no effect of habitat on length adjusted dry mass of any species. For crescent gunnels, however, Fulton's condition factor depended on habitat ($P = 0.042$); this suggests crescent gunnels take on water weight in bedrock habitats. Habitat type had no effect on Fulton's condition for the other species. Initial examination of BIA calibrations indicates that the relationship relating BIA response to dry mass is species specific.

For more information, contact Scott Johnson at (907) 789-6063.

LARVAL FISH VISION AND ECOLOGY

Lyle Britt is nearing completion of his PhD at the University of Washington School of Fisheries. His thesis research focuses on larval fish vision with particular emphasis on ontogenetic spectral shifts in light sensitivity during different life history stages. Lyle uses specialized techniques at the UW Friday Harbor Laboratory that require fish husbandry, micro-dissention of eyes from fish, and custom photometric laboratory equipment to conduct his experiments. He has collected over 36,000 microspectrophotometry measurements from individual rod and cone cells of more

than 50 marine fish species in the Pacific Northwest. Lyle currently has 2 manuscripts in review that investigate the ontogenetic changes in the eye pigments of larval and juvenile lingcod, and hypothesize how lingcod may use ultra-violet light to gain advantage during their critical larval stage. This shift is quite pronounced for lingcod, which display sensitivity to UV light early in their lives when they feed on epipelagic zooplankton, but later lose this sensitivity when they become piscivorous. Lyle has also been working on other hypotheses about how larvae may use low wavelength and depolarized light for targeting prey fields in the open water. Lyle's unique approach of integrating the field and laboratory studies was a hallmark of his late friend, mentor, and major professor, Dr. Bill McFarland. To commemorate him, Lyle helped pull together a Symposium during the Ecology and Evolutionary Ethology of Fishes conference at Soka University in June 2006. Lyle is currently teaching a course on fish and invertebrate vision and ecology at the Friday Harbor Laboratory.

For more information, contact Lyle Britt at (206) 526-4501.

RACE HABITAT RESEARCH TEAM

Research by the RACE Division Habitat Research Team (HRT) addresses Congressional mandates to describe and identify essential fish habitat (EFH) of federally managed species in Alaska. In practice, systematic trawl survey data are used to designate EFH as those areas supporting the highest relative abundance. This presumes that density data reflect habitat utilization, and the degree to which a habitat is utilized is assumed to be indicative of habitat value. Subsequent characterization of the habitat in these areas requires systematic mapping of the relevant biotic and abiotic variables.

The research themes of the HRT include: (1) the identification of suitable predictor variables for building habitat models, (2) the development of tools for mapping them over large areas, and (3) the investigation of activities with potentially adverse effects on EFH, such as bottom trawling. In FY06, the focus was on investigating the utility of acoustic backscatter as a habitat predictor. Major milestones during this period were the completion of: (1) the multi-mission hydrographic-fisheries experiment ("FISHPAC") in the southeastern Bering Sea; and (2) statistical analyses of the relationship between groundfish distributions and acoustic backscatter from a side scan sonar pilot experiment in Bristol Bay. Steady progress is being made on: (1) the spatial modeling of the relationship between groundfish distributions and acoustic data from a single-beam echosounder; and (2) building a knowledge base on the ecology of benthic invertebrates for habitat research. Processing and preliminary analysis have begun on the large quantity of acoustic and biological data collected during FISHPAC with forthcoming results.

2006 HRT Research Activities

Long-range fisheries sidescan sonar (LRSSS) R&D – The broad scope of the EFH mandate requires an efficient process for identifying and mapping habitat. Although research indicates surficial sediments affect the distribution and abundance of many groundfish species,

direct sampling with benthic grabs and remote sensing with multibeam echosounders are prohibitively expensive over large areas. The development of a Long Range Side Scan Sonar (180 kHz) capable of very broad coverage (1.5 km swath) addresses the need for greater efficiency when mapping and characterizing the seafloor for fisheries and habitat research. Research and development of the LRSSS and its fiber-optic interface has been progressing since 2004. A prototype LRSSS was successfully deployed and data were acquired during the 2006 FISHPAC experiment in the southeastern Bering Sea. In addition to side scan sonar, the LRSSS towfish also carries an independent single beam echosounder, an integrated multibeam echosounder, and a triplet of optical scatter sensors that measures the concentration of chlorophyll-a, dissolved organics and total particulates.

Acoustic backscatter for Essential Fish Habitat characterization (FISHPAC) — The first FISHPAC field experiment was conducted in the southeastern Bering Sea in the summer of 2006 aboard the NOAA ship FAIRWEATHER[1]. The scientific objective of the cruise was to evaluate the utility of acoustic backscatter data for characterizing EFH, while simultaneously comparing the performance of five different sonar systems. The five systems included two hull-mounted multibeam echosounders on FAIRWEATHER (50 kHz, 100 kHz); a high-resolution interferometric side scan sonar (455 kHz), the prototype LRSSS (180 kHz), and a vertical incidence echosounder (38 kHz) mounted on the LRSSS towfish. Multiple passes were made along 720 nm of survey tracklines spanning strong gradients of groundfish abundance that are represented in a time series of fixed-station annual trawl survey catches. Three sampling devices — (1) a Free Fall Cone Penetrometer (FFCPT), (2) a SEABed Observation and Sampling System (SEABOSS), and (3) a Towed Auto-Compensating Optical System (TACOS) — were used at selected stations on the tracklines to groundtruth acoustic backscatter and assemble a mutifaceted understanding of the seafloor. The performance of each acoustical system will be evaluated based on the degree of statistical correlation between normalized backscatter and fish density. The benefits and costs of each system will be compared to identify the most appropriate system for broad-scale mapping of the Bering Sea shelf. Acoustic data are being processed in collaboration with FISHPAC research partners: the University of New Hampshire Center for Coastal and Ocean Mapping and the NOAA Pacific Hydrographic Branch. FFCPT data processing and sediment grain size analysis have been completed. Infauna identification in collaboration with scientists in the AFSC Resource Ecology and Fisheries Management (REFM) division is near completion, as well as the analysis of TACOS and SEABOSS imagery.

Short-term trawling effects and recovery monitoring in the eastern Bering Sea – This ongoing multi-year study is a process-oriented investigation of short-term effects and recovery using a BACI experimental design. The study area is located within the Crab and Halibut Protection Zone 1 closed area in Bristol Bay. During a 35-day cruise in 2001, 6 pairs of predesignated 10-mi long research corridors were sampled before and after a trawling disturbance with commercial gear (NETS 91/140 Aleutian cod combination). Quantitative assessments of epifauna and infauna populations were undertaken before and after trawling. The experimental and control corridors were also surveyed before and after trawling using a Klein 5410 side scan sonar system. The corridors were revisited in 2002 to monitor recovery. Preparations are underway to conduct the final sampling event in Summer 2009.

[1] See http://www.afsc.noaa.gov/RACE/surveys/cruise_archives/cruises2006/2006_FW_FISHPAC.pdf

Evaluating single beam echosounders for synoptic seabed classification – Nearly 8 million digitized echo returns from the seafloor were simultaneously collected at two frequencies (38 and 120 kHz) along a 9,000 nm trackline in the eastern Bering Sea (EBS) during a 1999 hydroacoustic fishery survey on the NOAA ship MILLER FREEMAN. Collaborative research with QTC has resulted in a fully-automated objective classification process involving a new application of the Bayesian Information Criterion (BIC). An optimal classification scheme for the EBS shelf has been identified (14 distinct classes of bottom types for 38 kHz data) and these results have been merged with 23 years of RACE trawl survey data from the EBS shelf (1982-2004). The acoustic data have also been processed with QTC algorithms to produce continuous variables, namely the three principal components. Statistical analyses using GAM methods are being conducted to examine the degree to which acoustic variability (as a proxy for seabed properties) corresponds to the distribution and abundance of groundfish and benthic invertebrates.

Reconnaissance mapping with side scan sonar – A reconnaissance of Bristol Bay seafloor habitats was undertaken in 2002 using a high-resolution 455 kHz side scan sonar (Klein model 5410). The reconnaissance effort was centered on an 800 mi^2 area of central Bristol Bay that has never been surveyed by NOAA hydrographers. A 150 m swath of bathymetric data and imagery was collected along survey lines totaling nearly 600 linear miles. In addition to providing spatial context for the ongoing trawl impact study in Bristol Bay, the survey also intersected 18 RACE Division trawl survey stations and followed 78 mi of seabed previously classified using a *QTC View* single beam acoustic system. Imagery was systematically groundtruthed using an underwater video camera and van Veen grab samples. These survey data are being used to investigate whether broad-scale, remotely-sensed acoustic data measure seabed properties that are important to marine species. Statistical analysis indicates that seabed parameters derived from *QTC SIDEVIEW* processing of side scan backscatter images explain a significant portion of the variability in groundfish and invertebrate distributions. This suggests that inclusion of acoustic variables will improve the quality of quantitative habitat models. A report on these findings is presently undergoing AFSC internal review and will subsequently be submitted for peer-review publication.

Benthic invertebrate ecology knowledge base – Benthic invertebrates constitute the living component of benthic habitat, functioning as predators, prey, competitors, and shelter for managed species. They are indicators of environmental conditions and a driving force behind the distribution of managed species. Recognizing the need for ecological information on benthic invertebrates in the Bering Sea to support habitat and fisheries research, a knowledge base is being compiled, including: (1) a comprehensive guide to the life history and ecology of key epibenthic macro-invertebrates; (2) a database of EBS infauna (mainly polychaetes) from grab samples collected during HRT trawl impact studies and the FISHPAC project.

For further information, contact Dr. Bob McConnaughey, (206) 526-4150.

Research Related to Improving Bottom Trawl Surveys

Availability of Pacific cod and Pollock to Bottom Trawl Survey Gear – Understanding survey trawl catchability can increase certainty in survey trawl biomass estimates. Availability of Pacific cod to a survey trawl is one component to understanding its catchability. In an effort to ascertain the percentage of Pacific cod available to bottom trawl surveys, Dan Nichol examined the proximity of Pacific cod to the seafloor using archival tags and independent pooled data from research trawls and determined that approximately 50% of Pacific cod would be available to the EBS trawl, and 90% would be available to the GAO and AI trawl. The manuscript for this research is currently in internal review at the AFSC.

Abundance surveys are conducted during daytime hours to minimize diel changes in vertical distribution and reduce the variance in our biomass estimates. Current research indicates light intensity at the bottom, even during the daylight hours, can influence pollock vertical distribution. Stan Kotwicki is investigating the effect of light intensity on availability of pollock to the eastern Bering Sea survey trawl. From 2004 to 2006, light intensity measurements were collected synchronically with hydroacoustic pollock measurements. Both data sets were analyzed to determine how light intensity affected the vertical distribution of pollock available to the survey trawl. Knowing the relationship between light levels and the vertical distribution of pollock may help reduce the variability in our survey trawl estimates of abundance.

Correlating trawl catch and acoustic data in the eastern Bering Sea – The charter vessels used for the annual eastern Bering Sea demersal trawl survey have in recent years been equipped with the relatively high-end Simrad ES-60 echosounders, which are capable of collecting acoustic backscatter data of a quality approaching that of scientific echosounders. Because these sounders provide a large amount of inexpensive and continuous backscatter data between trawl stations, it is of interest to determine whether these acoustic data can be used to improve the precision of walleye pollock (*Theragra chalcogramma*) trawl index of abundance estimates by incorporating them with the trawl data. Catch and acoustic backscatter data collected from over 400 stations executed during the 2005 field season were analyzed to estimate the correlation between trawl and acoustic data in various layers above the seafloor. The correlation for pollock was good, and the highest correlation was obtained for the layer between the bottom and the headrope ($R^2 = 0.61$). The pattern of correlation for layers above the headrope was characterized by a monotonic decline with increasing height, indicating a lack of vertical herding response among pollock. There was no correlation ($R^2 = 0.02$) between trawl and acoustic data for Pacific cod (*Gadus macrocephalus*), the only other significant fish source of acoustic backscatter. The discussion is focused on the potential reasons for the discrepancy in the strength of the trawl-acoustic relationship between pollock and cod as well as the factors that may adversely affect the correlation between trawl and acoustic data in general.

Physical and environmental effects on trawl performance – Maintaining a time series as a representative measure of relative abundance for groundfish requires that the performance of the survey trawl is consistent. Various physical and environmental variables can affect trawl performance and add bias or variability to survey data. Ken Weinberg and Stan Kotwicki are investigating performance of the EBS survey trawl using a General Additive Model (GAM). They are analyzing two years of eastern Bering Sea trawl survey haul data to determine what

physical and environmental factors effect trawl performance. Trawl performance measures include door and net spread, net height, and bottom contact.

Working Group for Bottom Trawl Survey Improvements (WGBTSI) - Reducing Error in Area Swept Estimates – In January 2006, the Groundfish Assessment Program (GAP) formed a Working Group for Bottom Trawl Survey Improvements (WGBTSI) to assess the GAP survey methodology in the context of the best available science. The primary goal of the WGBTSI is to critically review GAP bottom trawl surveys and to make recommendations for reducing systematic errors in survey procedures and data analyses. From January to March 2007, the group focused on reviewing the components of the area swept calculation used for estimating catch per unit effort (CPUE). The objective is to find the most unbiased estimator for distance fished and net width by modeling the bias caused by noisy or curved data, and the effect of the changing catching efficiency of the trawl during the retrieval period. Model simulations showed that a cubic spline method for estimation of net width and distance fished introduced the least amount of error. For outlier rejection, the group is investigating the use of a more objective and robust method using sequential rejection. Before implementation into GAP data analyses, the WGBTSI plans to formalize these new techniques by writing a manuscript and submitting it for peer review.

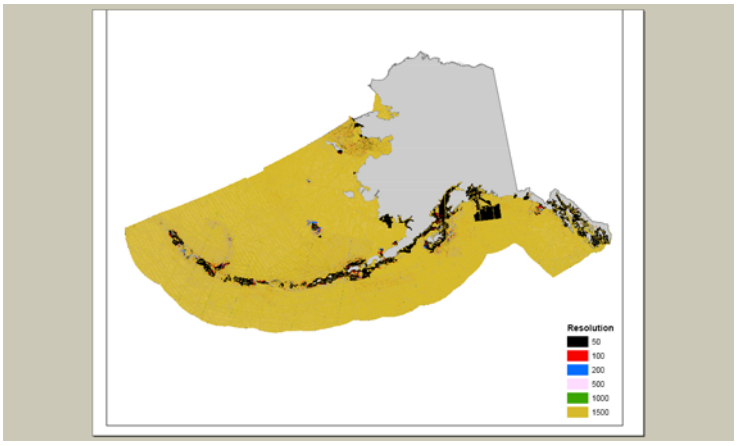
ICES participation – For several years, Ken Weinberg has been a delegate for ICES Study Group on Survey Trawl Standardization and a member of ICES Working Group on Fishing Technology and Fish Behavior. Ken is co-convening an ICES Theme Session on "Science Underpinning Stock Abundance Survey Practice (Q)" in Helsinki this September (see flyer).

E. Other Items

GIS RESOURCES

With reference to new GIS resources, bathymetric data sources, Steve Lewis at the AK Regional Office compiled GEODAS depth soundings to produce a polygon bathymetry layer for Alaska. From the metadata, the polygons were generated from GEODAS depth sounding data, and are supplemented with polygons from the ETOPO2 data set in regions lacking GEODAS data. The ETOPO2 polygons have horizontal resolutions of 1500 meters, and the GEODAS polygon resolutions vary with original sampling density, from 1000 meters down to 50 meters.

There are four regions with each dataset between 800 meg to 2 gig. Metadata for each area can be read by clicking on the XML metadata file in the table of contents in ArcCatalog, and then on the Metadata tab in the window to the right. A power point file describes the overall process of how the shapefiles were created. The figure below shows the resolution of the data. Given the size of this data set, please contact Steve.Lewis@noaa.gov directly for access to these data.



For more information, contact Jan Benson (206) 526-4183.

APPENDIX I - Alaska Fisheries Science Center Groundfish-Related Publications and Documents In Press – January 2006 through April 2007

(AFSC authors in bold text)

Alaska Fisheries Science Center (AFSC) Peer-Reviewed Journal Reports and Technical Memoranda in 2006 (AFSC authors are in bold).

Note: Listings of 2006 Groundfish Stock Assessment Reports and AFSC Processed Reports are accessible by following the links provided below to the appropriate AFSC web page.

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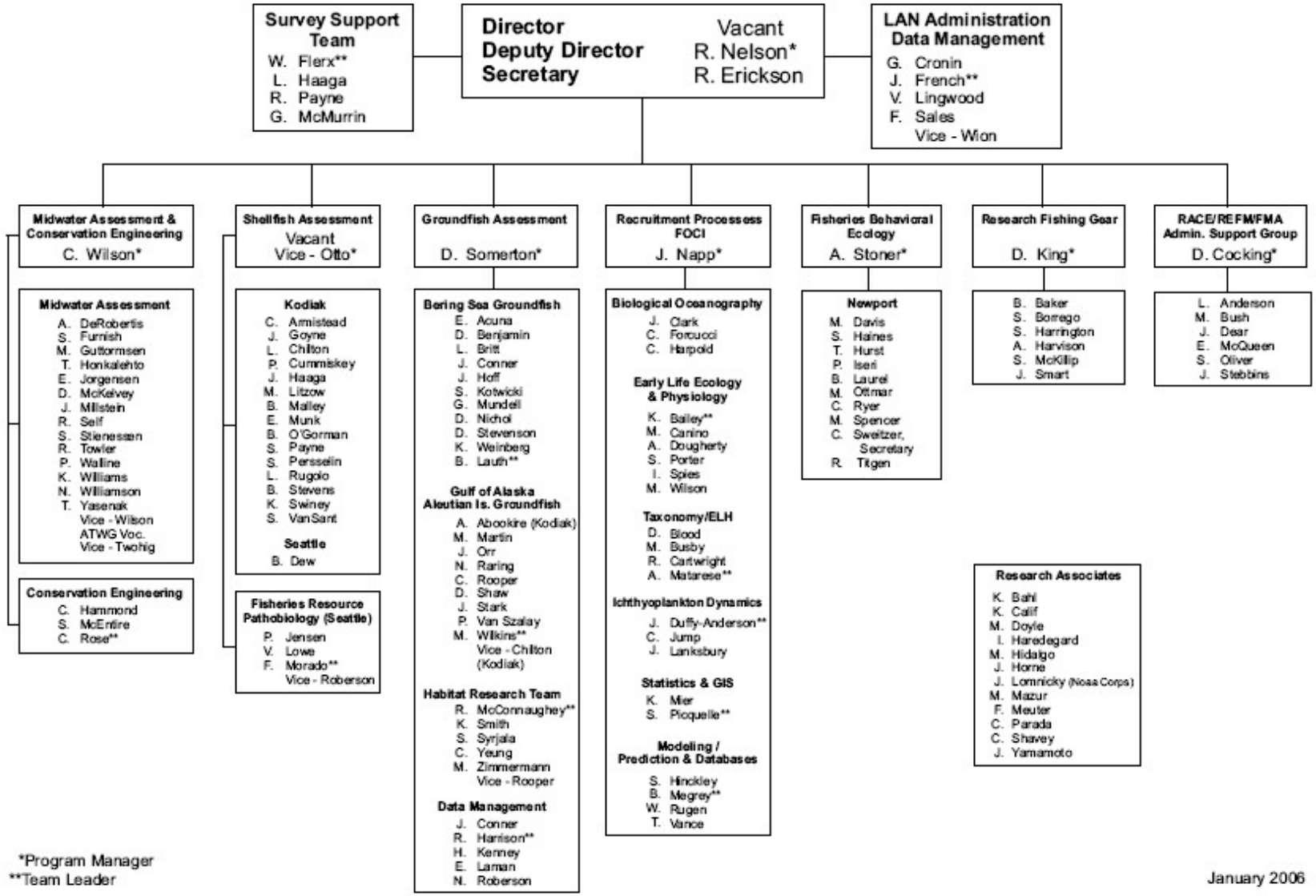
Alaska Fisheries Science Center (AFSC) Groundfish-Related Processed Reports can be listed by year and viewed on the AFSC website at:
http://www.afsc.noaa.gov/Publications/ProcRpts_intro.htm

RESOURCE ASSESSMENT AND CONSERVATION ENGINEERING DIVISION
ORGANIZATION CHART
2006



APPENDIX III.--RESOURCE ECOLOGY AND FISHERIES MANAGEMENT DIVISION

Patricia Livingston -- Director
Loh Lee Low -- Deputy Director

Administrative Support

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Goiney, Bernie

Age Determination Unit

Kimura, Dan -- Supervisor
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Gburski, Chris
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Foy, Dan
Kautzi, Lisa
Shockley, Wes
Short, Jonathan
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Status of Stocks and Multispecies Modeling

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Conners, Liz
Dorn, Martin
Greig, Angie
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Lowe, Sandra
Munro, Peter
Pearce, Julie
Spencer, Paul
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Stockhousen, Buck
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Resource Ecology and Ecosystems Modeling

Aydin, Kerim BActing Supervisor
Buckley, Troy
Derrah, Christopher
Lang, Geoffrey
Yang, Mei-Sun

Socio-Economic Assessment

Felthoven, Ron -- Leader
Haynie, Alan
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Sepez, Jennifer
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ADP

Blaisdell, Mark
Wennberg, Sherrie

Revised April 2005

APPENDIX IV - Auke Bay Laboratory Marine Ecology and Stock Assessment (MESA) Program Staff

Name	Duties
Phil Rigby	Program Manager
Doris Alcorn	Seafloor Ecology, Outreach
Dave Clausen	Rockfish, Grenadiers, Alaska Groundfish
Dave Csepp	Forage Fish, Hydroacoustics
Jeff Fujioka	Sablefish, Rockfish, Stock Assessment, Effects of Fishing
Dana Hanselman	Sablefish, Rockfish, Stock Assessment
Jon Heifetz	Effects of Fishing, Rockfish, Sablefish, Stock Assessment
John Karinen	Gulf of Alaska Groundfish
Mitch Lorenz	Essential Fish Habitat
Chris Lunsford	Rockfish, Sablefish, Stock Assessment, Longline Survey
Nancy Maloney	Sablefish Tag Database, Longline Survey, and Seamounts
Cara Rodgveller	Sablefish, Rockfish, Longline Survey, Grenadiers
Tom Rutecki	Sablefish, Webmaster
Kalei Shotwell	Groundfish Habitat, Rockfish, Stock Assessment
Robert Stone	Seafloor Ecology, Effects of Fishing, Coral and Sponge Life History

Other ABL Staff Working on Groundfish

Scott Johnson	Essential Fish Habitat, Forage Fish
John Thedinga	Essential Fish Habitat, Forage Fish
Christine Kondzela	Rockfish Genetics
Sharon Hawkins	Forage Fish Genetics

CANADA
British Columbia Groundfish Fisheries and Their Investigations in 2005

April 2007

Prepared for the 48th Annual Meeting of the Technical Sub-Committee of the Canada-United States Groundfish Committee
April 24 - 25, 2007
Santa Cruz, California, U.S.A.

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REVIEW OF AGENCY GROUNDFISH RESEARCH, STOCK ASSESSMENT, AND MANAGEMENT

A. Agency overview

Fisheries and Oceans Canada (DFO), Science Branch, operates three principal facilities in the Pacific Region: the Pacific Biological Station (PBS), the Institute of Ocean Sciences (IOS), and the West Vancouver Laboratory (WVL). These facilities are located in Nanaimo, Sidney and West Vancouver, BC, respectively. Dr. Laura Richards is the Regional Director of Science. The Divisions and Sections are as follows:

Division Heads in Science Branch reporting to Dr. Richards are:

Canadian Hydrographic Service	Dr. Denis D'Amour
Ocean Science	Mr. Robin Brown
Salmon & Freshwater Ecosystems	Dr. Brian Riddell
Marine Ecosystems & Aquaculture	Mr. Ted Perry

Section Heads within the Marine Ecosystems & Aquaculture Division (MEAD) are:

Groundfish	Mr. Jeff Fargo
Invertebrates	Mr. Jim Boutillier
Pelagic Fish Research	Mr. Jake Schweigert (acting)
Conservation Biology	Dr. Chris Wood
Applied Technologies	Mr. Ken Cooke (acting)
Fish Health and Parasitology	Dr. Susan Bower
Aquaculture and Environmental Research	Dr. Steve MacDonald

Groundfish research and stock assessments are conducted primarily in the Groundfish Section and groundfish ageing and acoustics work are conducted in the Applied Technologies Section. The Canadian Coast Guard operates DFO research vessels. These vessels include the *W.E. Ricker*, *J.P. Tully, Vector* and *Neocaligus.* A replacement vessel for the *W.E. Ricker* is in the design phase, and if all goes according to plan, is scheduled to arrive in December 2010.

The Pacific Region Headquarters of Fisheries and Oceans Canada are located at 401 Burrard Street (Vancouver BC, V6C 3S4). Management of groundfish resources is the responsibility of the Pacific Region Groundfish Coordinator (Ms. Diana Trager) within the Fisheries Management Branch in Vancouver. Fishery Managers receive assessment advice from MEAD through the Pacific Scientific Advice Review Committee (PSARC). The Chair of PSARC (Mr. Al Cass) advises the Regional Management Committee on stock status and biological consequences of fisheries management actions, and works in consultation with the Canadian Stock Assessment Secretariat (CSAS) in Ottawa. Research documents can be viewed on the CSAS website http://www.pac.dfo-mpo.gc.ca/sci/psarc/ResDocs/res_docs_e.htm.

Trawl, sablefish, rockfish, lingcod, dogfish and halibut fisheries continue to be managed with Individual Vessel Quotas (IVQs). IVQs can be for specific areas or coastwide. Within the general

IVQ context, managers also use a suite of management tactics including time and area specific closures and bycatch limits. Management plans can be viewed on the website at http://www-ops2.pac.dfo-mpo.gc.ca/xnet/content/MPLANS/MPlans.htm.

Managers implemented the "Groundfish Integration Strategy" for the 2006/2007 fishing years. In particular, DFO and the commercial fishery sectors (geartypes) are working towards an integrated fishery plan. Details can be viewed at http://www-comm.pac.dfo-mpo.gc.ca/pages/release/bckgrnd/2006/bg001_e.htm. The plan calls for individual transferable quotas in all commercial groundfish sectors. All vessels require 100% monitoring of their discarded and retained catch.

1. Multispecies or ecosystem models

No update available at the time of report preparation.

2. By species

1. Pacific cod

a) Research program

An age-determination protocol was developed for Pacific cod using fin rays as the ageing structure. Five hundred fish, sampled during an abundance survey for the species in 2003, were aged using this technique. New samples were collected from the west coast of Vancouver Island in 2006. These have been read and the results will be compared between areas.

b) Stock Assessments

No new stock assessments for Pacific cod were conducted in 2006, or are planned for 2007.

2a. Rockfish – offshore

a. Research programs

Currently, DFO's groundfish program of synoptic surveys conducts all field research work for the slope rockfish species. A separate program, headed by Jon Schnute, focuses on the development of models and software tools for the analysis of data pertaining to groundfish and other species. This year we published a paper (Schnute and Haigh 2006) on reference points and management strategies. We also conducted research on estimating mortalities for stocks with limited available age-structure data. Although this publication will be cited in the 2007 TSC report, it is already available at http://icesjms.oxfordjournals.org/ in the March 2007 issue of the *ICES Journal of Marine Sciences* (Schnute and Haigh 2007).

In 2006 we made extensive revisions to our package *PBS Mapping*, available as a library for the statistical language R (Comprehensive R Archive Network, http://cran.r-project.org/). Numerous stock assessments and other reports on Canadian groundfish have used this package for portraying spatial information on maps. In contrast with expensive GIS packages like ArcView, this one is entirely free, as a user-contributed library for the

free language R. We encourage our colleagues elsewhere to check this out, because it can be very effective for portraying detailed and summary spatial information from individual groundfish tows. (See Figure 1 for an example of tow information summarised using grid cells.)

We have also developed a new R package (*PBS Modelling*, Schnute et al. 2006) to facilitate simulations and other analyses relevant to fishery modeling and statistics. The library includes a suite of examples that will be extended in future versions to illustrate applications of our published work. It already includes an example related to the paper on age-structure analysis (Schnute and Haigh 2007) mentioned above. Simple examples also show how to use R for estimating a von Bertalanffy growth curve or a Schnute growth curve. Again, our colleagues can obtain this library at http://cran.r-project.org/.

b. Stock assessment

No stock assessments yielding quotas occurred in 2006. However, Haigh and Starr (2006) published an extensive summary document on redbanded rockfish *Sebastes babcocki* in BC coastal waters. This information was presented for use by multiple clients, including potential writers of COSEWIC stock status reports. Since the report was published, the authors have analysed new information on redbanded rockfish from the IPHC longline survey, but found no statistically significant CPUE trend from 1995 to 2005. Other duties performed by the slope rockfish team included a review of a PSARC paper on buffer zones around glass sponge bioherms in Queen Charlotte Sound (Figure 1). Additionally, we helped Paul Starr in developing PSARC assessments of petrale sole *Eopsetta jordani* and English sole *Parophrys vetulus*.

c. Research activities for 2007

In June, 2007, Jon Schnute will retire as head of this program. He sends his very best wishes to his friends and colleagues on the TSC. He considers it a great privilege to have worked with many remarkable people in Canada, the U.S., and many other countries on problems related to groundfish data analysis and management. He will be replaced by Dr. Andrew Edwards, who holds a Ph.D. in applied mathematics from the University of Leeds and has extensive experience working in applied ecology.

In the context of these changes, research plans are still being developed, but Rowan Haigh anticipates some future collaboration with Jon, who will continue as an Emeritus Scientist, in addition to his work with Andrew. Duties may continue to be influenced by concerns about species at risk. For example, a suggested listing of longspine thornyhead *Sebastolobus altivelis* as "Threatened" by COSEWIC may require work on a so-called "Recovery Potential Assessment".

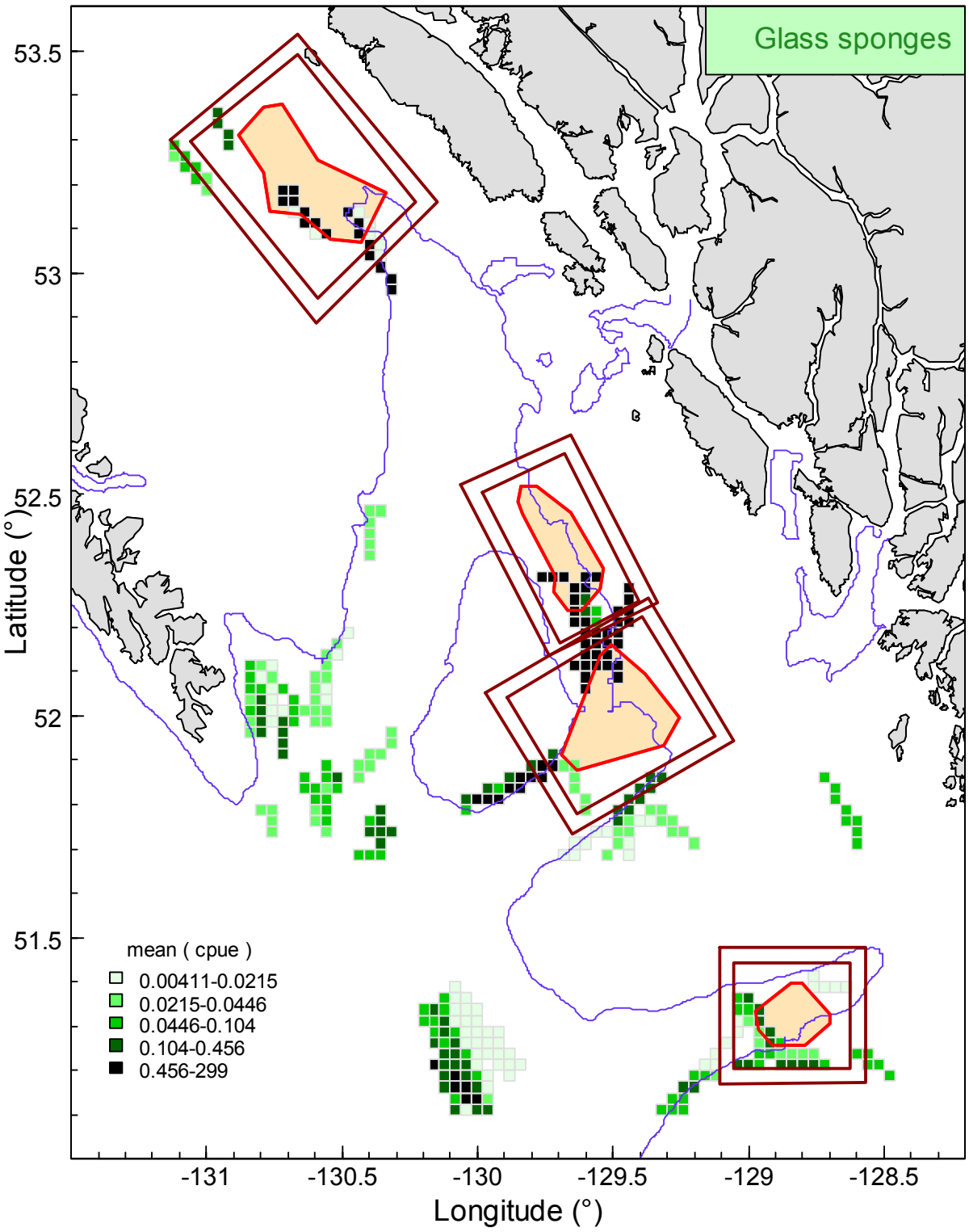

Figure 1. Mean CPUE (kg/h) of glass sponges (code 2I0 in PacHarvTrawl) from trawl tows over the period 1996-2006. The start and end positions of tows capturing glass sponges are used to infer impacted areas, with CPUE prorated over these distances. Grid cells are 0.04° × 0.025°. The isobath is 200 m. Shaded irregular polygons represent current closed areas; rectangles outline the proposed buffers.

2b. Rockfish – shelf

a. Research Programs in 2006

There was no new directed work on any shelf rockfish species in 2006. Staff efforts were directed at the multiple species bottom trawl surveys (see below).

b. Stock assessments in 2006

No stock assessments were conducted on shelf rockfish in 2006.

c. Research activities planned for 2007

Staff will continue to participate in the data collection and the analysis of bottom trawl survey data. They will also author a Recovery Potential Assessment (RPA) for canary rockfish. The Committee on the Status of Endangered Wildlife is considering recommending a Threatened designation for Canary rockfish in B.C. waters. Should this listing be accepted DFO may have to prepare an RPA. There are no other plans for directed research work on shelf rockfish for 2007.

2c. Rockfish – inshore

a. Research programs in 2006

Since 2003, an observer has been deployed on the International Pacific Halibut Commission (IPHC) Area 2B setline survey to collect complete hook-by-hook catch data and conduct biological sampling of non-halibut catch (Yamanaka et al. 2004, 2007, Lochead et at. 2006). This program is funded by the Pacific Halibut Management Association (PHMA). The PHMA also funded a 0.5 PY in the PBS fish ageing lab to assist with the ageing of rockfish.

A longline survey, conducted in 2003 and 2004 in the northern portion of the Strait of Georgia (4B) Statistical Areas (SA) 12 and 13, was moved to survey the southern Strait of Georgia, SAs 14 – 20, 28 and 29 in August and September 2005 (Lochead and Yamanaka 2004, 2006, 2007). Survey locations were selected using a depth stratified (41 – 70 m and 71 – 100 m) random design. No survey was conducted in 2006.

A Phantom HD2 remotely operated vehicle (ROV) was acquired by the Department and used in 2006 to develop visual survey methods for inshore rockfish.

A new longline survey was designed and conducted in the northern portion of BC coastal waters in 2006. Hard bottom areas were identified through bathymetry analyses, inshore rockfish fishing records and fishermen consultations. The hard bottom survey areas were then overlain with a 2 km by 2 km grid (matched with the adjacent trawl survey grid) and survey blocks were stratified by area and depth and chosen at random. Approximately 200 survey sets were conducted in 2006.

b. Stock assessment

No stock assessments were conducted in 2005. National Advisory Process (NAP) and COSEWIC status reports were prepared for yelloweye and quillback rockfishes (Yamanaka et al. 2006a, 2006b). COSEWIC will review the status of these rockfish species in the fall of 2007 and determine whether a listing is warranted.

c. Management actions for 2006

In 2006, the Rockfish Sustainability Team (RST), worked with stakeholders through various advisory processes, publicly held workshops and the Department's consultation website to identify the final Rockfish Conservation Areas (RCAs) to encompass 30% of rockfish habitats within in the Strait of Georgia (area 4B). In 2007, the RCA strategy will be complete with 20% of rockfish habitat closed outside 4B and 30% of rockfish habitat within 4B. RCAs are used as a management tool to protect rockfish. Fishing activities likely to catch rockfish are prohibited
(http://www-comm.pac.dfo-mpo.gc.ca/pages/consultations/fisheriesmgmt/rockfish/default_e.htm)

d. Research activities planned for 2007

Through cooperation with NMFS, Gear trials with the Woods Hole Oceanographic Institute's autonomous underwater vehicle (AUV) and DFO's ROV will be conducted early in 2007 aboard the *CCGS Vector*.

DFO will continue to coordinate and compile the hook-by-hook catch composition and rockfish biological sample collection on the IPHC setline survey. In 2007, the IPHC will take over the duties of the observer using their own technician. A portion of the cost of the third IPHC technician and the additional vessel cost will be borne by the PHMA.

A longline survey is planned for August/September 2007 within the Strait of Georgia Statistical Areas 12 and 13. This survey will be conducted aboard the *CGGS Neocaligus*.

The southern portion of coastal BC (outside of the Strait of Georgia Area 4 B) will be surveyed with longline gear in 2007. This will complete a coastwide survey of hard bottom areas in BC. This survey is funded by the PHMA and is conducted with chartered fishing vessels.

3. Sablefish

a. Stock assessment activities in 2006

Sablefish stock assessment and management in British Columbia was conducted cooperatively in 2006 by Fisheries and Oceans Canada (DFO) and the Canadian Sablefish Association (CSA). This cooperative relationship is formalized as a Joint Project Agreement (JPA) that identifies the respective responsibilities of the two parties and provides a mechanism for joint contributions to fishery management and science activities for sablefish. Government management, enforcement and science staff are in part funded by the CSA through the JPA. The CSA also contributes their expertise related to the commercial fishery and fishing methods, and hires contracted scientific staff to collaborate with DFO staff.

Catch rates from the fall standardized survey have declined by about 38% since 2003. The 2006 stratified random survey has a mean catch rate at about the level observed when it was initiated in 2003. Trap fishery catch rates in 2006 are low at about the level observed during the mid-2000 to mid-2002 period and much lower than those observed in the early 1990s. Shallow-water (<550m) trawl catch rates of sablefish showed distinct peaks in 2001-2004 for Area 3C (southern west coast of Vancouver Island) and in 2002-2004 for Area 3D (northern west coast of Vancouver Island) which have since declined. Catch rates deeper than 550 m in Area 3C have increased as the catch rates in shallower waters declined. The pattern over time in the trawl data is consistent with the expected timing of 1999/2000 year-class fish entering the offshore region, and is also consistent with increases in survey and fishery catch rates. In contrast to the situation in 2001-2002, the shallow water shrimp-trawl survey has shown no significant presence of juvenile sablefish off the west coast of Vancouver Island from 2003 to 2006.

b. Stock assessment activities planned for 2007

No stock assessment for B.C. sablefish is scheduled at this time. A management strategy evaluation for B.C. sablefish was initiated in early 2006. This work is ongoing and will be utilized in the next sablefish stock assessment.

c. Research activities in 2006

The annual research and stock assessment survey program was conducted in the fall of 2006 using two chartered commercial fishing vessels (Wyeth et al. 2006a, b). The traditional fixed locality standardized survey and tagging program was repeated using longline trap gear at offshore and mainland inlet sites. A new stratified random survey introduced as a pilot project in 2003 was continued in 2006. Like the fixed locality survey, the stratified random survey uses trap gear similar to that employed by the directed trap fishery. Sablefish were tagged and released, standardized catch rate data collected, and biological samples were obtained. The long-term intent is to replace the 1990-2006 fixed locality standardized survey and tagging program with the new stratified random survey that simultaneously accomplishes both stock indexing and tag releases.

d. Research activities planned for 2007

Research over the next several years will be focused on completing a management strategy evaluation for sablefish in British Columbia. The first phase of this project in 2006/2007 will require the development of computer software and several stock management scenarios to provide a basis for collaborative discussion with fishery managers and the fishing industry. The first version of this software was implemented and is being used to perform closed-loop simulations to identify a robust harvest rule and to evaluate the requirements for survey and fishery-dependent data programs.

4. Flatfish

a. Stock assessment activities in 2006

Stock assessments were completed for Petrale sole and English sole. Information pertaining to Petrale sole (*Eopsetta jordani)* in British Columbia was reviewed and updated for inclusion in a delay-difference stock assessment model. This model was used to determine the status of this coastwide stock and to provide quantitative advice on levels of catch and the associated risk relative to selected management performance indicators. The reference points were observation-based from the biomass time series. B_{min} was the minimum biomass from the time series (1966-2006). B_{ref} was equivalent to the mean biomass during a period where abundance was stable (1977-84) and from which the stock had recovered in the past.

None of the model runs indicated that the stock would increase in size over the next five years at the current TAC, but the split CPUE series model runs predicted that the stock would stay above the B_{ref} reference point and well above the B_{min} reference point. This was a surprising result which may originate from the use of mean recruitment to drive the predictions. There is some evidence from the model fits that recruitment over the most recent 10 years is about 10% above the mean which may mean that the stock projections are conservative.

Information pertaining to English sole (*Parophrys vetulus)* in British Columbia was also reviewed and updated for inclusion in a delay-difference stock assessment model. This model was used to determine the status of two stocks of English sole: 5CD (Hecate Strait) and 3CD5AB (combined west coast Vancouver Island and Queen Charlotte Sound) and to provide quantitative advice on levels of catch and the associated risk relative to selected management performance indicators for each of these stocks. The biomass reference points used for English sole were the same observations-based reference points that were used for petrale sole.

The 5CD modeling results showed that the effects of fixing or estimating *M* and the age of knife-edge recruitment were relatively minor, with the management advice almost identical across these options. However, the effect of splitting the CPUE data series was important, with the model estimating a drop in catchability in recent years and consequently being more optimistic about stock status. Overall both CPUE analyses indicated that current landings in 5CD will allow the stock to remain above B_{min} and B_{ref} reference points and that there is some potential for an increase in TAC.

The 3CD5AB modeling results were less optimistic, with stronger differences between the CPUE hypotheses. The split CPUE hypothesis indicated that the current TAC will remain above the selected B_{min} and B_{ref} reference points while the single CPUE hypothesis indicates that landings at this level are too high. The credibility of both assessments is dependent on the assumption that the fishery dependent CPUE series are tracking the abundance of these stocks.

b. Stock assessment activities planned for 2007.
No assessments are planned for 2007.

c. Research activities in 2006
Excluding the multispecies groundfish swept area trawl surveys conducted in 2006; no directed research on the flatfish stocks was conducted in 2006 or planned for 2007.

5. Pacific hake

a. Stock Assessment
A new stock assessment had been prepared jointly by Canadian and US scientists. The new stock assessment included additional data for catch, catch-at-age and juvenile pre-recruit abundance in 2005 and a new acoustic survey. As was the case in previous years, the major source of uncertainty was the value of the catchability coefficient (q) for the acoustic survey. As was done in the two previous assessments, two scenarios for the stock size and catch projections were developed based on alternative models (q=1.0 and q=0.69). Both were identified as equally likely, and decision tables were generated for both models.

6. Elasmobranchs

a. Research programs in 2006
A tag/recapture program to examine stock discreteness of big skate, initiated in 2003 was continued in 2006. Approximately 5355 big skate were tagged and released, bringing the total number of skates tagged and released to 16945 fish. As of December 2006, 1125 skates were recaptured (329 were re-released).

b. Stock assessment in 2006.
No assessments were conducted on BC elasmobranchs. COSEWIC status reports on big skate, longnose skate, sandpaper skate, six-gill shark, brown cat shark, and soupfin shark were submitted in April 2006.

c. Management
There are no directed fisheries allowed for sharks (excluding spiny dogfish, *Squalus acanthias*) in BC waters; therefore sharks are bycatch only. There is no immediate concern regarding the bycatch of sharks in BC fisheries, therefore no specific recommendations are made. However, the bycatch should be monitored by species and area in order to ensure that future productivity of BC sharks is not compromised.

Increases in directed catch of skate prompted management to examine options for the 2002/2003 and subsequent fishing years. This resulted in a catch "cap" of 850 t on Hecate Strait (Area 5C/D) big skate in 2002/03, which was continued in 2005/06.Of this the trawl fleet has a quota of 567 t. No quotas are in effect in other areas. In April 2004, a monthly landing limit (coastwide) of 5.7 t was implemented for longline vessels.
Research activities planned for 2007.

The tagging program for big skate will be continued in 2007.

7. Lingcod

a. Research programs in 2006

Lingcod larval survey was conducted in the Strait of Georgia in April 2006. Samples are being enumerated and oceanographic modelling will take place in 2007. Dive surveys for lingcod egg mass and rockfish densities were conducted in February and March by over 85 volunteers at sites throughout the Strait of Georgia.

b. Stock assessment

No assessment was conducted on offshore lingcod stocks in 2006. No assessment was conducted on Strait of Georgia lingcod stocks in 2006.

c. Research activities planned for 2007

An egg mass dive survey in the Strait of Georgia is planned for February.

D. Other related studies

1. Statistics and Sampling

a. Database work in 2006

Principal Statistics and Sampling activities in 2006 included the ongoing population of the groundfish biological database (GFBio). This database now includes about 7,400,000 specimens. Data entry activities continue to concentrate on input of current port sampling and observer biological data and recent research cruises. When time is available, the database is backfilled with research cruise data collected before 1997. This past year involved a considerable effort in the entry of historic rockfish research cruises and the entry of age data. Approximately 50% of the person year dedicated to Groundfish Statistics and Sampling was committed to assisting in data uploads of the trawl observer data and providing catch data summaries. The groundfish trawl fishery continues to be covered by 100% dockside and virtually 100% observer coverage. These observers also provided 367 length/sex/age samples and 202 length samples in 2006. Port samplers provided an additional 139 samples, 84 samples with ageing structures (length/sex/age/weight) and 55 without structures (length/sex/weight). The focus of their sampling efforts was from those fisheries not covered by at-sea observers.

Following significant work through the Commercial Groundfish Industry Advisory Committee (CGIAC) and the Commercial Industry Caucus (CIC), a three year pilot was introduced in the commercial groundfish fisheries in April 2006. The reforms focus on 100% at-sea monitoring and 100% dockside monitoring, individual vessel accountability for all catch, both retained and released, individual vessel quotas and reallocation of these quotas between vessels and fisheries to cover bycatch of non-directed species.

b. Field work in 2006

Staff participated on various bottom trawl surveys including the West Coast Vancouver Island and West Coast Queen Charlotte Island Surveys as well as West Coast Vancouver

Island shrimp trawl survey. This group also included the port sampling activity (1.8 person-years) in the Vancouver and Prince Rupert areas.

Staff authored and presented a Technical Report on the adequacy and cost effectiveness of the Queen Charlotte Sound survey. It was demonstrated that the current configuration of 240 tows every two years is the most cost-effective design. With minor modifications, this design will continue to be used as a template for all the large-scale groundfish trawl surveys on the west coast. The design was tested with a survey simulator that examined how well the survey will track trends in abundance for any species that is caught in these surveys. Staff will also participate in the development of a Draft of a Groundfish Conservation Framework for B.C. groundfishes.

c. Proposed field work for 2006

Port sampling will continue in 2007, as will staff participation in the bottom trawl surveys: Hecate Strait and a Queen Charlotte Sound surveys as well as the shrimp trawl survey in Queen Charlotte Sound and the west coast of Vancouver Island.

d. Proposed catch monitoring research and development in 2007

Staff will continue to participate in implementation of the Electronic monitoring system for the hook and line fisheries.

APPENDIX 1. REVIEW OF CANADIAN GROUNDFISH FISHERIES

1. Commercial fisheries

All catch figures for 2006 are preliminary. Canadian domestic trawl landings of groundfish (excluding halibut) in 2006 were 119,628 t, a decrease of 12% from the 2005 catch. This increase was mainly accounted for by a 64% decrease in landings of arrowtooth flounder and a 7% decrease in landings of Pacific hake. The major species in the trawl landings were Pacific hake (69%), arrowtooth flounder (5%), Pacific ocean perch (4%), yellowtail rockfish (3%), and walleye pollock (3%). Principal areas of trawl production were 5B (25%), 5A (19%), 3C (19%), 4B (16%) and 3D (8%).

Canadian landings of groundfish caught by gear other than trawl in 2006 totalled 6,161 t. Landings by trap and longline gear accounted for 3,924 t, approximately 67% by trap gear and 33% by longline gear. Sablefish accounted for more 93% of the landed amount. Landings of species other than sablefish by longline, handline and troll gear accounted for 2,237 t (73% dogfish, 16% lingcod and 7% rockfish).

2. Recreational fisheries

Each year, Fisheries Management Branch of DFO conducts creel surveys of the recreational angling fishery in the Strait of Georgia. Principal target species are chinook and coho salmon. In 2006 these surveys covered the months of May to September. Provisional estimates of 2006 catches, landings and discards, for this 5-month period were 8,576 fish for lingcod, 31,156 fish for all rockfish species, 508 fish for halibut, 8,296 fish for rock sole, 2,918 fish for starry flounder, 846 fish for dogfish, 11,578 fish for greenlings, and 1,728 fish for cabezon.

Along the west coast of Vancouver Island catch estimates have been generated from creel surveys and fishing lodge reports. Data are available for June to September. Provisional estimates of 2006 catches were 18,624 fish for lingcod, 44,986 fish for all rockfish species, 40,920 fish for halibut, 12 fish for dogfish, 674 fish for rock sole, 197 fish for starry flounder, 376 fish for cabezon, and 468 fish for greenlings.

In Johnstone Strait catch estimates have been generated from creel surveys and fishing lodge reports for July and August. Provisional estimates of 2006 catches were 1,664 fish for lingcod, 5,724 fish for all rockfish species, 3,778 fish for halibut, 1,654 fish for rock sole, 1,256 fish for greenlings, and 9 fish for starry flounder.

3. Joint-venture fisheries

In 2006, 23 Canadian catcher vessels delivered Pacific hake and incidental species to two processing vessels in co-operative fishing arrangements. This fishery took place off the southwest coast of Vancouver Island (Area 3C) and in Queen Charlotte Sound (Areas 5A and 5B). A total of 13,716 t of Pacific hake was processed by the two Russian vessels. The catch breakdown by area

was 35% from area 3C, 19% from area 5A and 46% from area 5B. The quotas and catches are outlined below:

Nation	Species	Quota (t)	Catch (t)
Poland	Hake	15,063	13,716
	Pollock	incidental	23
	Rockfish	incidental	222
	Other	incidental	163

4. Foreign fisheries

There were no national or supplemental fisheries for Pacific hake off southwest Vancouver Island (Area 3C) in 2006.

APPENDIX 2. GROUNDFISH RELATED REPORTS PUBLISHED IN 2006/07.

1. Primary Publications

Andrews, A.H., L.A. Kerr, G.M. Cailliet, T.A. Brown, C.C. Lundstrom, and R.D. Stanley. (in press). Age validation of the canary rockfish (*Sebastes pinniger*) using two independent otolith techniques: lead-radium dating and the bomb radiocarbon chronometer. Marine and Freshwater Research.

Beamish, R.J., G.A. McFarlane and A. Benson. 2006. Longevity overfishing. Prog. in Oceanography 68: 289-302.

Branch, T.A., K. Rutherford and R. Hilborn. 2006. Replacing trip limits with individual transferable quotas: implications for discarding. Marine Policy. 30: 281-292.

Campana, S. E., C. Jones, G.A. McFarlane and S. Myklevoll. 2006. Bomb dating and age validation using the spines of spiny dogfish (Squalus acanthias). Environmental Biology of Fishes. 77: 327-336.

Hwang, S.D., M.H. Song, T.W. Lee, G. A. McFarlane and J. R. King. 2006. Growth of larval Pacific Anchovy, *Engraulis japonicus* in the Yellow Sea as indicated by otolith microstructure analysis. Journal of Fish Biology. 69:1756-1769.

King, J.R. and G.A. McFarlane. 2006. A framework for incorporating climate regime shifts into the management of marine resources. Fisheries Management and Ecology 13: 93-102.

King, J.R. and G.A. McFarlane. (in press). Trends in abundance of spiny dogfish (Squalus acanthias) in the Strait of Georgia, 1980-2005. Am. Fish. Soc. Sym.

Koolman, J., B. Mose, R.D. Stanley, and D. Trager. (in press). The rockfish fisheries in B.C. - Some Lessons Learned in Co-operative Management. Proceedings of the Wakefield Symposium.

McFarlane, G.A. and J.R. King. *2006*. Age and growth of big skate (*Raja binoculata*) and longnose skate (*Raja rhina*) in British Columbia waters. Fish. Res.78(2-3).169-178.

McFarlane, G.A. and J.R. King. (in press). Re-evaluating the age determination of spiny dogfish (Squalus acanthias) using oxytetracycline and fish at liberty up to twenty years. Am. Fish. Soc. Sym.

Schnute, J. T. 2006. Curiosity, recruitment, and chaos: a tribute to Bill Ricker's inquiring mind. Environmental Biology of Fishes, 75: 95–110.

Schnute, J. T., and Haigh, R. 2006. Reference points and management strategies: lessons from quantum mechanics. *ICES Journal of Marine Science*. 63: 4-11.

Shelton, P.A., Sinclair, A.F., Chouinard, G.A., and Mohn, R. 2006. Fishing under low productivity conditions is further delaying recovery of Northwest Atlantic cod (Gadus morhua). Can. J. Fish. Aquat. Sci. 63: 235-238.

Stanley, R. D. and J. Rice. 2006. Fishers' Knowledge? Why not add their scientific skills while you are at it. Pp: 401-420. *In*: Nigel Haggan, Barbara Neis and Ian G. Baird (eds.). UNESCO, 2006, Fishers' Knowledge in Fisheries Science and Management. Coastal Management Sourcebooks 4. UNESCO: Paris, 437 pp.

Wallace, S.S., G.A. McFarlane, S.E. Campana and J.R. King. (in press). Status of spiny dogfish (Squalus acanthias) in Atlantic and Pacific Canada. Am. Fish. Soc. Sym.

2. Other Publications

Beamish, R.J., A. Yatsu, E.P. Dulepova, X. Jin, J.R. King, J.Y. Kim, S. Kim., V.B. Klyashtorin, L.L. Low, G.A. McFarlane, and C.I. Zhang. (in press). Impacts of climate and climate change on the key species in the subarctic Pacific. PICES Working Group 16 Final Report. PICES Scientific Report No.33.

Haggarty, D.R., and J.R. King. 2006. Hook and Line Survey of Lingcod (Ophiodon elongatus) and Rockfish (Sebastes spp.) in Southern Strait of Georgia (Statistical Areas 18 and 19) June 19-29, 2005. Can. Tech. Rep. Fish. Aquat. Sci.: 2623. 42 p.

Lochead, J.L. and Yamanaka, K.L. 2006. Summary report for the inshore rockfish (*Sebastes spp.*) longline survey conducted in Statistical Areas 12 and 13, August 24 – September 10, 2004. Can. Tech. Rep. Fish. Aquat. Sci. 2627: ix + 65 p.

Lochead, J.L. and Yamanaka, K.L. 2007. Summary report for the inshore rockfish (*Sebastes spp.*) longline survey conducted in Statistical Areas 14 to 20, 28 and 29, August 11 – September 6, 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2690: viii + 53 p.

Lochead, J.L., Yamanaka, K.L. and Dykstra, C. 2006. Summary of non-halibut catch from the Standardized Stock Assessment Survey conducted by the International Pacific Halibut Commission in British Columbia from June 1 to August 12, 2004. Can. Tech. Rep. Fish. Aquat. Sci. 2657: ix + 52 p.

Schnute, J.T., Couture-Beil, A., and Haigh, R. 2006. PBS Modelling 1: user's guide. Can. Tech. Rep. Fish. Aquat. Sci. 2674: viii + 114 p.

Haigh, R., and Starr, P. 2006. A review of redbanded rockfish *Sebastes babcocki* along the Pacific coast of Canada: biology, distribution, and abundance trends. Can. Sci. Adv. Sec., Res. Doc. 2006/073, 75 pp.

Martin, J. C., L.C. Lacko and K. L. Yamanaka. 2006. A pilot study using a remotely operated vehicle (ROV) to observe inshore rockfish (*Sebastes spp.*) in the southern Strait of Georgia, March 3 – 11, 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2663: vi + 36 p.

Stanley, R.D., P. Starr, N. Olsen, K. Rutherford, and S.S. Wallace. (in press). COSEWIC status report on canary rockfish *Sebastes pinniger*.

Stanley, R.D., P. Starr, N. Olsen, K. Rutherford, and S. S. Wallace. 2006. Status Report on Canary rockfish (Sebastes pinniger). Can. Sci. Adv. Sec. Res. Doc.: 2005/089.

Starr, P.J., A.R. Kronlund, G.D. Workman, N. Olsen and J. Fargo. 2006. Rock sole (*Lepidopsetta* spp) in British Columbia, Canada: Stock Assessment for 2005 and Advice to Managers for 2006/2007. PSARC Working Paper G2006-03.

Starr, P.J. 2007. Petrale sole (*Eopsetta jordani)* in British Columbia, Canada: Stock Assessment for 2006/07 and Advice to Managers for 2007/08. PSARC Working Paper G2007-01: 120p.

Starr, P.J. 2007. English sole (*Parophrys vetulus)* in British Columbia, Canada: Stock Assessment for 2006/07 and Advice to Managers for 2007/08. PSARC Working Paper G2007-02: 146p.

Surry, A.M., D.R. Haggarty and J.R. King. 2006. Bottom Trawl Survey of Young-of-the-Year Lingcod (Ophiodon elongatus) in the Strait of Georgia, July 26 – August 8, 2005. Can. Data Rep. Fish. Aquat. Sci. 1170. 45 p.

Wallace, S., G. McFarlane and J.R. King. 2006. COSEWIC status report on big skate (Raja binoculata). Committee on the Status of Endangered Wildlife in Canada. Ottawa. 51 p.

Wallace, S., G. McFarlane and J.R. King. 2006. COSEWIC status report on bluntnose sixgill shark (Hexanchus griseus). Committee on the Status of Endangered Wildlife in Canada. Ottawa. 38 p.

Wallace, S., G. McFarlane and J.R. King. 2006. COSEWIC status report on brown cat shark (Apristurus brunneus). Committee on the Status of Endangered Wildlife in Canada. Ottawa. 26 p.

Wallace, S., G. McFarlane and J.R. King. 2006. COSEWIC status report on longnose skate (Raja rhina). Committee on the Status of Endangered Wildlife in Canada. Ottawa. 51 p.

Wallace, S., G. McFarlane and J.R. King. 2006. COSEWIC status report on sandpaper skate (Bathyraja interrupta). Committee on the Status of Endangered Wildlife in Canada. Ottawa. 44 p.

Wallace, S., G. McFarlane and J.R. King. 2006. COSEWIC status report on soupfin shark (Galeorhinus galeus). Committee on the Status of Endangered Wildlife in Canada. Ottawa. 26 p.

Westrheim, S. J. and R. D. Stanley. 2006. Bathymetric distributions of Pacific ocean perch (*Sebastes alutus*) off Birtish Columbia. I. Mean length-at-age versus depth for specimens caught by on-bottom trawl off northwest Queen Charlotte Islands, Hecate Strait, and Queen Charlotte Sound, 1966-78. Can. Man. Rep. Fish. Aquat. Sci. 2764: vi + 78 p.

Westrheim, S. J. and R. D. Stanley. 2006. Bathymetric distributions of Pacific ocean perch (*Sebastes alutus*) off British Columbia. II. Size compositions, by sex, and ex ratios, for specimens caught by off-bottom and on-bottom trawl in Hecate Strait, Queen Charlotte Sound, and off west Vancouver Island, 1969-89. Can. Man. Rep. Fish. Aquat. Sci. 2763: v + 104 p.

Wyeth, M.R, A.R. Kronlund, and M. Elfert. 2006a. Summary of the 2004 British Columbia Sablefish (*Anoplopoma fimbria*) research and assessment survey. Can. Tech. Rep. Fish. Aquat. Sci. 2660. ix + 74p.

Wyeth, M.R, A.R. Kronlund, and M. Elfert. 2006b. Summary of the 2005 British Columbia Sablefish (*Anoplopoma fimbria*) research and assessment survey. Can. Tech. Rep. Fish. Aquat. Sci. *In press.*

Yamanaka, K.L., Lochead, J.K., Cooke K., Lacko, L.C. and Dykstra, C. 2007. Summary of non-halibut catch from the Standardized Stock Assessment Survey conducted by the International Pacific Halibut Commission in British Columbia from May 31 to July 24, 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2689: vii + 55 p.

Yamanaka, K.L., Lacko, L.C., Withler, R., Grandin, C., Lochead, J. K., Martin, J.C., Olsen, N., and Wallace, S.S. 2006a. A review of yelloweye rockfish *Sebastes ruberrimus* along the Pacific coast of Canada: biology, distribution and abundance trends. Can. Sci. Adv. Sec. Res. Doc. 2006/076: 54 p.

Yamanaka, K.L., Lacko, L.C., Miller-Saunders, K., Grandin, C., Lochead, J. K., Martin, J.C., Olsen, N., and Wallace, S.S. 2006b. A review of quillback rockfish *Sebastes maliger* along the Pacific coast of Canada: biology, distribution and abundance trends. Can. Sci. Adv. Sec. Res. Doc. 2006/077: 54 p.

APPENDIX 3. GROUNDFISH STAFF IN 2005

S. Acheson	Groundfish port sampling
W. Andrews	Elasmobranchs
K. Anderson	Groundfish port sampling
E. Choromanski	General stock assessment and biology, flatfish, field technician
K. Cooke	Database technician
J. Fargo	Section Head, stock assessment and biology, flatfish
C. Grandin	Biologist, GIS, programmer, inshore rockfish
R. Haigh	Statistical and exploratory data analysis
V. Hodes	Lingcod and elasmobranchs
G. Jewsbury	Seconded to salmon group
J. King	Lingcod, climate studies
B. Krishka	Biological data control and analysis, thornyhead and slope rockfish
R. Kronlund	Sablefish, analytical programs
L. Lacko	Hook and line database manager, GIS specialist, inshore rockfish
G. A. McFarlane	Groundfish population dynamics and biology, fish/ocean interaction, elasmobranchs
L. MacDougall	Research planning and coordination
W. Mitton	Sablefish
N. Olsen	Biologist/programmer/GIS, Shelf rockfish
K. Rutherford	Biologist/database manager, Shelf rockfish
J. Schnute	(Program Head) Statistical and mathematical modeling, stock assessment
A. Sinclair	Pacific cod assessment and ecosystem research
R. Stanley	Shelf rockfish stock assessment and biology, groundfish statistics.
M. Surry	Lingcod
G. Workman	Port sampling, Pacific Cod, Survey design
M. Wyeth	Sablefish stock assessment and biology
L. Yamanaka	Inshore rockfish stock assessment and biology

Committee of Age-Reading Experts
2006 Committee Report

Prepared for the Forty-eighth Annual Meeting of the Technical Subcommittee of the Canada-USA Groundfish Committee

April 24, 25 2007

Prepared by

Kristen M. Munk

2006-2008 CARE Chairperson
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Age Determination Unit
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CARE 2006 Report to the Technical Subcommittee of the Canada-USA Groundfish Committee

A. CARE Overview

History – The Committee of Age-Reading Experts, CARE, is a subcommittee of the Canada-USA Groundfish Committee's, Technical Subcommittee, charged with the task to develop and apply standardized age determination criteria and techniques, and operating within the Terms of Reference approved by the TSC in 1986 and the CARE Charter developed in 2000 and approved by the CARE in 2004.

1. The most recent biennial CARE Workshop was held April 18-20, 2006 attended by 32 agency members from Oregon, Washington, British Columbia, and Alaska, and 1 participant from California. Please see the summary of this workshop prepared and previously submitted by past chair Patrick McDonald, the 2005 CARE-TSC report dated May 2-3, 2006. The final minutes from these proceedings are completed however failed the first attempt at passage (October 2006) due to lack of meeting e-quorum guidelines, and will be presented again to CARE members at the 2008 biennial workshop.

2. Highlighting and restating a recommendation in 2006 made by CARE to CARE (included in McDonald's May 2-3, 2006 report), is the proposed dropping of precision statistics in the CARE Age Structure Exchange table. This recommendation also proposed use of a data invoice, termed CASE (CARE Age Structure Exchange) invoice, which documents all ages for any exchange. These data will be available to TSC members to use in the manner they choose. The CASE invoice of data will be available via the CARE website and hyperlinked from the CASE table as a pdf file. Raw data may be made available later, however, the web-mechanics of this are not yet resolved.

B. CARE Subcommittee (Working Group) Reports

1. CARE Manual/Glossary Committee-MacLellan, Goetz, Munk

   Manual/Glossary working group members develop suitable and agreed upon age reading sections or definitions for terms suggested by CARE members, which are then approved by CARE members and added to the CARE Manual/Glossary.

   1.1 The term "dark/light boundary" was developed and will be added to the glossary (pending approval at the 2008 CARE workshop).

   1.2 The manual's cover has been replaced with a Steve Wischniowski original composition.

   1.3 Two new sections describing age reading of lingcod fin spines and Dover sole otoliths have been added to Manual.

2. CARE Website – Anderl, Short (webmaster)

The CARE website working group administers to appearance, operation, and access to the site, through the cooperation of the PSMFC website and webmaster. The CARE web page is located at http://www.psmfc.org/care/.

2.1 Website work has included making updates to CARE documents.

2.2 Additional edits and updates are awaiting available time of coordinating members.

3. CARE Charter – Munk, MacLellan, Goetz

The CARE Charter working group developed Charter guidelines, which were then considered, suggestions made, and then approved by CARE members.

3.1 The CARE Charter was previously completed and approved by CARE in 2004.

3.2 The Charter working group—mission completed—disbanded in 2006.

C. CARE Agency Structure Exchanges

Agency structure-exchange organizers provided CARE vice-chair Shayne MacLellan the status and summary of structure exchanges (Table 1).

D. Recent Topics of Interest Raised by Age-Readers

1. Effect of Aging Error on Age Structured Models

1.1 Edge detection due to growth-response differences by latitude: rockfish likely have different timing in the onset of deposition of light and dark zones of an (emergent) annulus relative to latitude (eg, across shared stock boundaries). How is this factor accounted for in determining the marginal increment (edge)? (CARE response needed)

1.2 What are the implications to age structured models for differences between one lab assigning an age of (for example) 6y when it is actually 5+y? (TSC response appreciated)

2. Attrition of Age Readers

2.1 CARE, and its mandate, has been relatively stable due to a high volume of very experienced age readers. Data utilized by the TSC through agency avenues is greatly dependant upon this experience and institutional knowledge. Many of these age readers are close to retirement.

2.2 CARE collectively took a step forward in 2000 by expanding the original Terms of Reference, the CARE Charter, to aid continuity of CARE's mandate especially in response to pending retirements.

2.3 A poll of CARE will soon be taken in 2007 to identify a) the number of full-time age readers (>6mo/y spent aging), b) the number >10y from retirement, c) 5-10y from retirement, d) <5y from retirement.

E. Future CARE Work/Workshop

1. CARE Workshop

   1.1 The next CARE workshop is scheduled to occur April 2008, held at the Pacific Biological Station in Nanaimo, British Columbia, Canada.

2. CARE Website

   2.1 The CARE website serves as a shared access to generally static documents. CARE has some perpetual documents which chronicle age structure exchanges, etc. These require continuity and posting of additional data. These documents have been "secured" through individual maintenance on personal computers (generally the CARE chair and vice chair), which are passed along upon changes in administration. These documents may not always have received or retained all information. CARE will investigate web-placement of these documents with write-protection access by CARE administrators.

F. Recommendations from CARE to TSC

1. 2006-1 CARE to TSC: The biennial CARE meetings have been held traditionally at the Seattle NMFS-AFSC facilities. The Pacific Biological Station (PBS), Nanaimo representatives offered to host the 2008 CARE meeting. Two reasons were given for this proposed departure. First, this invitation coincides with the PBS 100th anniversary (1908-2008). Second, agency travel policies can prohibit age readers from different participating agencies and labs to attend the CARE meeting at the Seattle AFSC facilities. The CARE requests TSC members to support this recommendation and encourage travel funding. This rotation will allow PBS to share in the hosting responsibilities and for greater CARE participation among their personnel. It would also appropriately acknowledge PBS's substantial contributions to the field of fish age and growth.

G. Status of Recommendations from TSC to CARE

None.

Table 1a. An abbreviated list of most recent age structure exchanges and their a) completion status and b) reported precision statistics.

EXCHANGE ID NO.	EXCHANGE YEAR	ORIGINATING AGENCY	COORDINATOR	COOPERATOR(S)	DATE INITIATED	SPECIES	STOCK	STRUCTURE	TECHNIQUE	STATUS
02-001	2002	NMFS-Seattle	D.ANDERL	ADFG-Juneau	12/?/01	Sablefish(known-age)	Gulf of Alaska	otolith	Break and burn	complete
02-002	2002	ODFW	B. MILLER	ODFW, NMFS-AFSC, CDFG, IPHC	1-Feb-02	Dover sole	West Coast	otolith	Break and burn	complete
02-004	2002	ODFW	P. MCDONALD	ODFW,NMFS-AFSC,DFO,ADFG-J	1-Dec-02	sablefish	West Coast	otolith	Break and burn	incomplete
03-001	2003	ODFW	B. MIKUS			Dover sole		otolith	Break and burn	incomplete
03-002	2003	PSMFC	O. RODRIGUEZ	PSMFC-CAP, CDFO	3-Oct-03	Pacific Whiting	West Coast	otolith	Break and burn	complete
03-003	2003	CDFO	S. MacLELLAN	CDFO, PSMFC-CAP	3-Nov-03	Pacific Whiting	West Coast	otolith	Break and burn	complete
03-004	2003	ADFG-Kodiak	J. Brodie	NMFS-AFSC	1-Dec-03	Pacific Cod	Alaska	otolith	Break and burn	in process
04-001	2004	NMFS-AFSC	C. KASTELLE	NMFS-AFSC, ADFG -Juneau	Spring 2002	Pollock	Shelikof st.	otolith	Break and burn	complete
04-002	2004	PSMFC-CAP	P. MCDONALD	PSMFC-CAP, NMFS-AFSC	4-Feb-04	sablefish	West Coast	otolith	Break and burn	complete
04-003	2004	PSMFC-CAP	J. MENKEL	PSMFC-CAP, NMFS-AFSC	4-Mar-04	Darkblotched rockfish	West Coast	otolith	Break and burn	
04-004	2004	ODFW	B. MIKUS	ODFW, PSMFC-CAP, CDFG	4-Mar-04	Dover sole	West Coast	otolith	Break and burn	
04-005	2004	NOAA-CAP	O. Rodriguez	CDFO	5-Aug-04	Hake	West Coast	otolith	Break and burn	complete
04-006	2004	CDFO	O. Rodriguez	NOAA-CAP	20-Aug-04	Hake	West Coast	otolith	Break and burn	complete
04-007	2004	NOAA-CAP	O. Rodriguez	CDFO	17-Nov-04	Hake	West Coast	otolith	Break and burn	complete
05-001	2005	CDFO	O. Rodriguez	NOAA-CAP	17-Mar-05	Hake	West Coast	otolith	Break and burn	complete
05-002	2005	CDFO	O. Rodriguez	NOAA-CAP	13-Nov-05	Hake	West Coast	otolith	Break and burn	complete
05-003	2005	NOAA-CAP	O. Rodriguez	CDFO	11-Nov-05	Hake	West Coast	otolith	Break and burn	complete
05-004	2005	NMFS-NWFSC	S. CONCETTI	NMFS-AFSC	20-Dec-05	Pacific Ocean Perch	West Coast	otolith	Break and burn	complete
06-001	2006	ADFG	K. MUNK	PSMFC,NMFS-AFSC,DFO,ADFG-J	1-Jan-06	Sablefish	Alaska	otolith	Break and burn	complete
06-002	2006	PSMFC	P. MCDONALD	PSMFC,NMFS-AFSC,DFO,ADFG-J	1-Jan-06	Sablefish	West Coast	otolith	Break and burn	complete
06-003	2006	CDFO	S. MacLELLAN	PSMFC,NMFS-AFSC,DFO,ADFG-J	1-Jan-06	Sablefish	West Coast	otolith	Break and burn	complete
06-004	2006	NMFS-AFSC	D. ANDERL	PSMFC,NMFS-AFSC,DFO,ADFG-J	1-Jan-06	Sablefish	Alaska	otolith	Break and burn	complete
06-005	2006	PSMFC	O. RODRIGUEZ	PSMFC, CDFO	16-Jan-06	Hake	West Coast	otolith	Break and burn	complete
06-006	2006	CDFO	S. MacLELLAN	CDFO, PSMFC	1-Aug-06	Hake	West Coast Vancd	otolith	Break and burn	complete

Table 1b. An abbreviated list of age structure exchanges and their a) completion status and b) reported precision statistics.									
EXCHANGE ID NO.	COOPERATOR(S)	DATE INITIATED	SPECIES	STOCK	SAMPLE n=	NO. READERS	% AGREE	AVG % ERR	MEAN CV
02-001	ADFG-Juneau	1-Jan-02	Sablefish(known-age)	Gulf of Alaska	31	1	35.48%	8.36%	0.11829
02-002	ODFW, NMFS-AFSC, CDFG, IPHC	1-Feb-02	Dover sole	West Coast	20	12			0.514
02-004	ODFW,NMFS-AFSC,DFO,ADFG-Junea	1-Dec-02	sablefish	West Coast	30	5			
03-001			Dover sole						
03-002	PSMFC-CAP, CDFO	3-Oct-03	Pacific Whiting	West Coast	99	2	51.52		
03-003	CDFO, PSMFC-CAP	3-Nov-03	Pacific Whiting	West Coast	98	2	47.96		
03-004	NMFS-AFSC	1-Dec-03	Pacific Cod	Alaska	30	2			
04-001	NMFS-AFSC, ADFG -Juneau	Spring 2002	Pollock	Shelikof st.	618	2	14.6		
04-002	PSMFC-CAP, NMFS-AFSC	4-Feb-04	sablefish	West Coast	25	2	52.00%		
04-003	PSMFC-CAP, NMFS-AFSC	4-Mar-04	Darkblotched rockfish	West Coast	50	3			
04-004	ODFW, PSMFC-CAP, CDFG	4-Mar-04	Dover sole	West Coast					
04-005	CDFO	5-Aug-04	Hake	West Coast	50	2	40.00	5.07	7.16
04-006	NOAA-CAP	20-Aug-04	Hake	West Coast	50	2	70.00	2.84	4.01
04-007	CDFO	17-Nov-04	Hake	West Coast	50	2	58.00	3.26	4.60
05-001	NOAA-CAP	17-Mar-05	Hake	West Coast	51	2	84.31		2.05
05-002	NOAA-CAP	13-Nov-05	Hake	West Coast	93	2	79.57	1.42	2.00
05-003	CDFO	11-Nov-05	Hake	West Coast	100	2	84.00	1.39	1.97
05-004	NMFS-AFSC	20-Dec-05	Pacific Ocean Perch	West Coast	100	2	56	6.23%	
06-001	PSMFC,NMFS-AFSC,DFO,ADFG-Junea	1-Jan-06	Sablefish	Alaska	24	4	0	18.33%	0.2462
06-002	PSMFC,NMFS-AFSC,DFO,ADFG-Junea	1-Jan-06	Sablefish	West Coast	25	4			
06-003	PSMFC,NMFS-AFSC,DFO,ADFG-Junea	1-Jan-06	Sablefish	West Coast	20	4	15	17.14%	0.2251
06-004	PSMFC,NMFS-AFSC,DFO,ADFG-Junea	1-Jan-06	Sablefish	Alaska	20	4			
06-005	PSMFC, CDFO	16-Jan-06	Hake	West Coast	100	2	72	2.19%	
06-006	CDFO, PSMFC	1-Aug-06	Hake	West Coast Vancouver Island	100	2	80	1.57%	0.0222

IPHC Research Program:

Review of 2006 Projects and Proposals for 2007

The International Pacific Halibut Commission Staff

January 16, 2007

Introduction

This document reviews research conducted by the IPHC staff in the past year and proposed for the upcoming year. The report is divided into two sections, with the first section reviewing the status of research projects conducted 2006. The second section presents the preliminary staff research proposals for 2007. Information is provided on when each project was initiated, the anticipated completion date, the annual cost, a description of the costs, and the purpose of the project. This report does not include ongoing staff tasks such as data collection and processing that are necessary for the management of the fishery.

Research projects are organized into three funding categories that reflect availability and source of research funds. Limited research requiring direct financial support from the Commission is possible under the basic $3.797 million (as of 2006) government appropriations, although a number of programs can be conducted using only the staff resources that are supported by the appropriations. The three funding categories are:

1) **Funded Research:** Necessary research projects of high priority that can only be conducted with revenues generated by survey fishing in 2007, and/or carry-over from 2006;
2) **Contracts and Grants:** Agreements with other parties to conduct specific research. In this case, contracts and grants are shown for projects where the IPHC staff is the principle investigator; and
3) **Research conducted without direct funding:** Necessary research projects of high priority that can be conducted within the IPHC budget.

Nearly all of the research done by the staff is directed toward one of three continuing objectives of the Commission:

i) Improving the annual stock assessment and quota recommendations;
ii) Developing information on current management issues; and
iii) Adding to knowledge of the biology and life history of halibut.

In each of these areas our routine work program applies the best information and methods available, and our research program aims to improve the information and methods by answering the most important outstanding questions.

SECTION I:
REVIEW OF RESEARCH CONDUCTED IN 2006

Research conducted by the IPHC staff during 2006 continued in three basic areas: life history, fish movements, and general biology. Most of the projects were conducted as part of the normal staff duties, with no additional funding required outside of staff salaries. Funding for projects outside of staff salaries came from supplemental funding, and these projects are outlined below.

Funded Research in 2006

The dockside detection program (Project 413) conducted by IPHC scan samplers continued in 2006, with samplers in eight Alaskan and four B.C. ports. Additionally, IPHC received state and tribal assistance in scanning in nine ports in Washington and Oregon. Through 29 October, over 29 million pounds (46% of total landings) have been scanned. The number of tags recovered in 2006 totals 407 from the 2003 primary experiment and 244 from the 2004 secondary experiment. Additionally, recoveries from a double tag experiment designed to estimate PIT tag shedding rates continue to show a shedding rate of two percent, well within the projected and acceptable range for the experiment. Scan sampler tag detection and fish counts are routinely tested. Results have shown that scan sampler fish counts are quite accurate, approaching 99% agreement, which is crucial to being able to estimate exploitation rates, the goal of the PIT tag project. Scanning success rates in tag seeding tests were found to vary somewhat by sampler but were generally quite high (96-100%), indicating that scan samplers were missing few, if any, tags. In general, results in 2006 are consistent with those from previous years and have offered no additional insights on the low recovery rates in the central/western Gulf and Bering Sea areas. Scanning is currently planned to conclude in 2008.

The Otolith Elemental Fingerprint (OEF) project (#620) has shown that, using age-2 halibut from western Alaska, the chemical composition of otoliths can be used to successfully distinguish and classify individuals within general geographic regions (Bering vs. Kodiak vs. Cook Inlet), with 80-90% accuracy. The spatial model developed over the last two years relies primarily upon oxygen and carbon isotope ratios and secondarily upon trace element data, thus completing the first phase of the project which was simply a proof of concept. During FY 2006 we conducted trace element analysis on otoliths collected from southeast Alaska which will be used to examine temporal stability and variance associated with increasing sample sizes. Stable carbon and oxygen analyses still need to be conducted for these fish; otoliths will be forwarded to Woods Hole Oceanographic Institute by year-end. The second phase of the project will seek to establish appropriate protocols and sampling sites so that a coastwide nursery "otolith element map" can be developed.

Genetics (Project 621) sample analysis continued in 2006 under the supervision of Dr. Lorenz Hauser at the University of Washington's Marine Molecular Biology Laboratory. Two sets of tissue samples were analyzed for variation in nuclear microsatellite diversity: a subset of samples collected during winter charters in 2004 near Queen Charlotte Island, Portlock Bank,

and Pribilof Canyon, and a limited number of samples from a much more extensive collection (~1,900 tissue samples were collected from 20 sites) conducted during the 2005 setline survey.

Analysis of the winter samples has been completed and a formal report presented to the IPHC by Dr. Hauser. The results indicate rather small degrees of genetic divergence among sites which suggests a homogenous population with respect to gene frequencies, but some between-site differences tend to be statistically significant which simultaneously suggests a certain degree of genetic isolation among areas. Additionally, a number of alleles have been encountered which are much more common in females than in males, which is intriguing in two respects. It suggests that we may be able to develop genetic techniques to non-lethally determine sex, but it also means that genetic population analyses need to be conducted in either a sex-specific manner or after exclusion of sex-linked genes. This demands that larger sample-sizes be used for population analysis. Not all of the 2004 winter samples have been analyzed due to time constraints; in 2007 we will endeavor to screen the remaining samples to improve the strength of the population analyses. In addition, we released a charter bid request to re-sample the same winter spawning grounds in winter of 2007. Re-sampling is required because the relative low among-site genetic divergences beg the question: are differences between regions greater than differences due to natural genetic drift? Answering this question is critical to understanding the meaning of the "significance" of between-site differences. In addition, a total of 245 samples collected in 1998-99 at Langara Island (2B) and Portlock (3A) are being analyzed. These should add additional information on temporal drift, although they will do nothing to help us understand potential segregation between the Gulf of Alaska and southeast Bering Sea.

Of the ~1,900 samples collected during the summer of 2005, only 255 have been analyzed to-date. These samples are being analyzed in an attempt to gain further resolution of differences observed during the pilot study completed in 2004 (these results are now available as IPHC Scientific Report #81). During that study we observed greater genetic difference between the eastern Aleutian Islands (Adak) and the southeast Bering Sea (St. Paul Island) than between the southeast Bering Sea and Oregon. This led us to hypothesize that there may be more mixing between the Gulf of Alaska and the southeast Bering Sea shelf than between the Aleutian Islands and other regions. We have begun the analysis of additional summer samples using sites positioned east-to-west from the western Alaska Peninsula into the Aleutians in hopes of detecting potential segregation between Areas 3 and 4. Lab work has been completed, but the quantitative statistical analysis of observed gene frequencies is still under way. It should be noted that even if segregation really does exist along the Aleutians, we may not be able to detect it using summer samples. Reproductive isolation is defined by spawning stock structure, which is established during winter, and a full understanding of potential Aleutian isolation will probably require that at some point we sample the Aleutians in winter.

PAT tags were released in two experiments in 2006: a group of 78 in Areas 2A/2B (Project 646), and 24 in Areas 4A/4D (Project 640). The former was the outcome of discussions at the 2006 Annual Meeting, which sought to provide further information on summer to winter seasonal movements of fish in those areas. These tags are scheduled to pop up during February-March, 2007 at two week intervals. The latter set of releases was also designed to identify seasonal movements and will pop up in mid-February, 2007.

A pilot study on use of internal archival tags in halibut began in 2006 (Project 650). This initial work represents a controlled test of the relative utility of three different models of internal archival tag that can be used on relatively small (60-99 cm) halibut. In August 2006, twenty four halibut ranging from 65-90 cm were captured aboard the F/V Heidi Sue and transported live to the Oregon Coast Aquarium in Newport. The fish were then held for a period of 80 days to allow them to recover from transfer stress, resume normal feeding activity, and heal all visible capture wounds. On October 19 and 20, surgery was conducted to implant internal archival tags into 15 of the study specimens. Five fish were tagged with each of 3 different tag varieties: 1) Lotek LTD 1110, an 11 mm by 32 mm resin-body tag, 2) Lotek LTD 2310, a 16 mm by 76 mm silicon-coated stainless steel tag with a 24 cm external light stalk, 3) Wildlife Computer MK9, a 17 mm by 67 mm resin-body tag with a 19 cm external light stalk. All tag varieties record temperature and depth, and the tags with light stalks are capable of recording ambient light for the purpose of estimating fish location. All fish survived the implantation process, resumed feeding very shortly after surgery, and are showing signs of incision closure. The fish will be held until early 2007 in order to monitor their recovery, after which they will be sacrificed and examined internally to assess any potential reactions to the internal tag, and to determine the feasibility of non-invasive sex determination via veterinary ultrasound.

An experiment (Project 648) was conducted during early June, 2006 to examine the ability of traps to catch halibut but which have minimal bycatch of rockfish. The field effort, which took place around Cape St. James in Area 2B, utilized the newly emerging Didson sonar technology to observe fish behavior around a baited sablefish trap. The purpose of the experiment was to try different trap modifications and determine their effect on the capture rates of halibut and rockfish. The experimental frame was set 37 times, with total observed bottom time at just over 73 hours. Very low catch rates for both halibut and rockfish precluded modifying and testing entrance and escape rings to evaluate trap modifications. We observed one escape of a rockfish which entered via the entrance tunnel, and escaped via an escape ring prior to gear retrieval. One rockfish escaped through an escape ring during gear retrieval. This compares to three rockfish which were captured and did not escape in the acoustical trap. Although we were not able to evaluate trap modifications to change catch rates, the trip was a success in terms of the performance of the Didson and associated gear. Additional funding for the project was provided by Pacific Halibut Management Authority (PHMA).

In 2006, IPHC and Washington Department of Fisheries received funding from Pacific States Marine Fish Commission (PSMFC) to connect a join project with industry (Project 649). The Area 2A summer assessment charter was expanded to included 25 special stations in the Washington survey region to look at rockfish populations. Station locations where selected by WDFW in an effort to better characterize rockfish abundance. Stations were selected with the hope of targeting more rocky bottom than the standard survey stations in the Washington region. Three skates of gear where fished at each station as a precautionary approach due to the exploratory nature of these stations and concerns of over fishing yelloweye rockfish. Activities at each station were identical to those on standard IPHC stations, and all rockfish were tagged for identification and further sampling upon offload. A summary of this project will be submitted to PSMFC by the end of November 2006. Depending on those results, there may be a second season of sampling under this funding opportunity, although station positions may be changed to better characterize rocky bottom type.

In Project 644, Archipelago Marine Research, Ltd. (Victoria, BC) was contracted to investigate the use of video monitoring technology in the groundfish trawl catcher processor fleet operating in the Bering Sea. This pilot study involved field testing a digital video monitoring system consisting of nine closed circuit television cameras, GPS, and on-board data storage. Cameras were installed in key fish handling areas, providing a full view of trawl deck and closer views of the interior factory and discard chutes. Using the series of cameras installed throughout the factory, individually tagged halibut were tracked through the factory sorting process to discard. The tests using video monitoring equipment provided promising results for the use of this technology. The system performed reliably and provided the scientific personnel and vessel crew with a useful real-time monitoring tool. Post-cruise data analysis demonstrated that halibut were readily detectable throughout the factory. However, imagery was not suitable for making detailed assessments of catch composition. We believe that video monitoring offers opportunities to improve observer's abilities to monitor catch on factory trawlers. Further work is needed to evaluate the benefits of video monitoring in terms of the various monitoring issues in the fishery and decide on appropriate specifications for the equipment, how it should be configured, and appropriate methodology for use of video data. In particular, the need for careful consideration for the data issues surrounding the use of this technology was highlighted. The results will be published as an IPHC Technical Report in 2007.

Finally, IPHC hired one intern (Project 618) in 2006. Ms. Jessica Hobden (University of Victoria) worked May-August on a project titled "A one dimensional spatial analysis of Pacific halibut (Hippoglossus stenolepis) on longline gear testing for aggregations based on sex and length", which gave her an opportunity to spend time on a survey vessel collecting data. She presented his results to the staff, and her final report will be included in the 2007 RARA.

2006 Contract Research

NMFS Auke Bay Lab (ABL) has had a sablefish data collection program for several years and IPHC has assisted NMFS with the program. In 2003/2004, the program was reviewed and modified to meet the IPHC confidentiality policy and to encompass all vessels rather than just vessels greater than 60 feet. Under a Statement of Work (SOW), NMFS contracts IPHC to collect and review information on sablefish catches (Project 628) during the IPHC port sampler's logbook interview. Sablefish data are entered by IPHC staff, edited, and an electronic summary provided to the NMFS ABL scientists. Vessels are assigned a unique code in the summarized data to preserve confidentiality. The SOW was renewed for 2006.

IPHC also received a grant from NMFS for the incremental increase in port sampling costs due to the IFQ program (Project 375).

2006 Research Publications

IPHC staff noted in **Bold** type.

Chen, D-G. and **Hare, S.R.** 2006. Neural network and fuzzy logic models for Pacific halibut recruitment analysis. Ecol Modeling, 195: 11-19.

Clark, W.G., and **Hare, S.R.** 2006. Assessment and management of Pacific halibut: data, methods, and policy. Int. Pac. Halibut Comm., Sci. Rep. 82, 81 p.

Clark, W.G., and **Kaimmer, S.M.** 2006. Estimates of commercial longline selectivity for Pacific halibut (*Hippoglossus stenolepis*) from multiple marking experiments. Fish. Bull. 104:465-467.

Foy, R.J., Crapo, C.A., and Kramer, D.E. 2006. Investigating the roles of temperature and exercise in the development of chalkiness in Pacific halibut. Int. Pac. Halibut Comm., Tech. Rep. 50, 24 p.

Hauser, L., Spies, I., and **Loher, T.** 2006. Microsatellite screening in Pacific halibut (*Hippoglossus stenolepis*) and a preliminary examination of population structure based on observed DNA variation. Int. Pac. Halibut Comm., Sci. Rep. 81, 28 p.

Lehodey, P., Alheit, J., Barange, M., Baumgartner, T., Beaugrand, G., Drinkwater, K., Fromentin, J-M., **Hare, S.R.**, Ottersen, G., Perry, R.I., Roy, C., van der Lingen, C.D., and Werner, F. 2006. Climate variability, fish and fisheries. J. Climate 19: 5009-5030. DOI: 10.1175/JCLI3898.1

Loher, T., and Seitz, A. 2006. Seasonal migration and environmental conditions experienced by Pacific halibut (*Hippoglossus stenolepis*), elucidated from Pop-up Archival Transmitting (PAT) tags. Marine Ecology Progress Series, 317:259-271.

Loher, T., and Seitz, A. 2006. Seasonal migration and environmental conditions experienced by Pacific halibut in the Gulf of Alaska, elucidated from Pop-up Archival Transmitting (PAT) tags. Int. Pac. Halibut Comm., Sci. Rep. 82, 40 p.

Sadorus, L. 2005. Pacific Halibut: Flat or fiction? International Pacific Halibut Commission, Seattle, WA.

Sullivan, P.J., Breidt, F.J., Ditton, R.B., Knuth, B.A., **Leaman, B.M.**, O'Connell, V.M., Parsons, G.R., Pollock, K.H., Smith, S.J., and Stokes, S.L. 2006. Review of Recreational Fisheries Survey Methods. National Research Council of the National Academy of Sciences. National Academy Press, Wash. DC. 187p.

Trites, A.W., Miller, A.J., Maschner, H.D.G., Alexander, M.A., Bograd, S.J., Calder, J.A., Capotondi, A., Coyle, K.O., Di Lorenzo, E., Finney, B.P., Gregr, E.J., Grosch, C.E., **Hare, S.R.**, Hunt, G.L., Jahncke, J., Kachel, N.B., Kim, H., Ladd, C., Mantua, N.J., Marzban, C., Maslowski, W., Mendelssohn, R., Neilson, D.J., Okkonen, S.R., Overland, J.E., Reedy-Maschner, K.L., Royer, T.C., Schwing, F.B., Wang, J.X.L., and Winship, A.J. 2006. Bottom-up forcing and the

decline of Steller sea lions in Alaska: Assessing the ocean climate hypothesis. Fisheries Oceanography 15. DOI: 10.1111/j.1365-2419.2006.00408.x

Section II:
Research Proposed for 2007

Projects proposed for 2007 consist of a continuation of several projects currently underway and four new projects. Continuing projects include:

1. Project 413.00 – PIT tag recovery efforts will continue in 2007 with the scan sampling program. Scanning will also continue on the assessment survey vessels. No other changes are planned for port coverage or duration of sampling. Planning for this activity is based on a March 1 – November 15 season.

2. Project 620.00 – Sample analysis will continue in FY2007 in the otolith elemental fingerprinting (OEF) study. Laboratory analysis of accumulated samples will continue during 2007, including those collected in 2005 from southeast Alaska. A survey of potential index sites will begin in 2007.

3. Project 621.00 – The study of the population genetic structure will continue in 2006 in two initiatives. In the first, sample testing and analysis is continuing to be conducted by Dr. Lorenz Hauser (UW Marine Molecular Biology Laboratory). A 2-year post doc approved by the Commissioners at the 2006 Annual Meeting fell through when the UW candidate took a job in the private sector. Additional samples were collected in 2006 on the summer surveys. The FY2007 budget will allow for the completion of the 2004 winter samples and begin work on the 2005 and 2006 summer collections.

4. Project 622.00 – This set of PAT releases occurred in the summer of 2006 from assessment survey vessels in Areas 4A and 4D. Tags are scheduled to pop up in mid-February, 2007, providing additional information on summer to winter movements in the Bering Sea. FY2007 funding is for the satellite transmission fees from the pop-ups.

5. Project 636.00 – The gonad staging/histology project will continue in 2007 with analysis of the 2004 samples and microscopy work. No additional sampling is scheduled. Work was set aside in 2006 as the researcher took a new position on the staff, which carried additional responsibilities.

6. Project 646.00 – This set of PAT releases occurred in the summer of 2006 from assessment survey vessels in Areas 2A and 2B. Tags are scheduled to pop up in February-March, 2007, at 2-week intervals. These are expected to provide additional information on summer to winter movements within Areas 2A, 2B, and 2C. FY2007 funding is for the satellite transmission fees from the pop-ups.

7. Staff will also continue with other long-standing projects in 2007. These include the collaborative work on contaminants with ADEC (#642.00), participation by IPHC staff

on the NMFS trawl surveys (#604.00), data collections with water column profilers on the assessment surveys (#610.00), and the undergraduate internship program (#618). The otolith marginal increment analysis (#626.00) is expected to be completed in 2007. Finally, the investigation of sleeper shark population structure and development of an aging technique (#630.00) will focus on lab work and genetic testing of samples.

Four new projects are proposed for 2007 and briefly described below:

1. Project 621.11 – In the second part of our genetics studies, winter charters will be conducted in three (and possibly four) areas to obtain additional tissue samples to address questions concerning the geographic separations observed in the 2005 winter samples, i.e., were the separations really generated by geographic differences, or by temporal variability in gene frequencies.

2. Project 641.11 – This is a follow-up to the hook size/spacing work conducted in 2005, which took place in Area 3A. The results were actually confounded by the extremely high catch rates of halibut. It is likely that hook size or spacing effects were masked by the very high availability of halibut. It was our original intention that the Area 3A fishing would be contrasted with a Phase 2 experiment in an area of lower halibut density, which is planned for 2007 in Area 2B. Conducting this experiment in Canada would have the added element of dogfish competition for hooks.

3. Project 651.00 – Recent research suggests that certain types of magnet or rare earth metals in proximity to baited hooks might help reduce the catch of unwanted sharks. We propose examining whether dogfish are similarly affected, initially in a controlled tank environment.

4. Project 652.00 – Past derivation of setline selectivity has been from tag studies, and this project would involve actual underwater observations of halibut capture using the Didson sonar technology.

Projects conducted under contract to other agencies or through research grants will be continued in 2007. IPHC port sampling activities in Alaska will continue being augmented by a grant from NMFS (Project 375.00), and IPHC port samplers in Alaska will collect sablefish logbook data for the NMFS Auke Bay lab (Project 628.00).

We are also awaiting word on several grants which would enable several other projects. This includes: 1) a grant from PSMFC for a second year of additional survey stations off Washington; 2) funding from the State of Oregon for a similar set of additional stations off Oregon; 3) funding by ODFW for the purchase of a water column profiler dedicated for use on the Oregon portion of the Area 2A summer assessment survey; and 4) funding by NPRB for a study of electronic monitoring on halibut vessels off Alaska.

Funded Research

Project 413.00: PIT tagging study: Fourth year of tag recovery and scanning

Start Date: 2003
Anticipated ending: 2008
Personnel: J. Forsberg, C. Blood, G. Williams, B. Clark, A. Ranta, scan samplers

Scanning for PIT tags will continue in 2007. IPHC will hire samplers for Alaskan ports, while contracting with AMR for the Canadian ports and continuing to seek state and tribal assistance in Area 2A. Sampler duties include scanning commercial deliveries for PIT tags, and conducting regular tests of detection and piece (fish) counts to measure accuracy of sample data. Project costs are expected to be about the same as last year. Modest increases are expected in (a) salaries (cola), (b) our contract with AMR for sampling BC, and (c) retrofitting of the scanning equipment with improved hardware.

Project 416.00: PIT tagging study: Double tagging experiment

Start Date: 2003
Anticipated ending: 2008
Personnel: J. Forsberg, G. Williams

During September 2003 in Area 2B, 2,661 halibut were tagged with external wire spaghetti tags on the dark side of the head, and internal PIT tags. The purpose of the study is to examine the retention and durability of internal PIT tags in situ. When a halibut with this type of wire tag is turned in to IPHC personnel, the head is scanned to check for presence and operation of the internal PIT tag. A total of 586 fish have been recovered through the end of the 2006 commercial IQ season, including 157 during 2006. Proposed project costs in 2007 are for the rewards paid to the tag finders.

Project 604.00: NMFS trawl survey: At-sea data collection and IPHC data base management

Start Date: 1996
Anticipated ending: Continuing
Personnel: L. Sadorus, A. Ranta, B. Clark

A series of NMFS trawl survey data on halibut, parallel to our setline data, is extremely valuable to IPHC as a second fishery-independent data source for stock assessment. Trawl data are particularly useful because they include large numbers of juveniles (ages 3-7 yr) that do not appear in large numbers in the setline survey. Otoliths have been collected on the NMFS surveys since 1996 and provide relevant age information. These data are incorporated into a copy of the NMFS haul data, expanded to estimates of relative abundance and age/size composition by IPHC area (NMFS calculates estimates by INPFC area), and stored in a database at IPHC. Project cost is comprised of personnel and travel. In 2007, the staff is planning on placing two staff on the NMFS survey vessels.

Project 610.11: Water column profiler project (annual survey project)

Start date: 2000
Anticipated ending: Continuing
Personnel: L. Sadorus, S. Hare, P. Stabeno (NMFS PMEL)

The IPHC maintains one of the most extensive sampling platforms in the north Pacific. This platform offers enormous potential for collection of valuable oceanographic data. In particular, understanding the dynamics of the structure of the mixed layer depth – a major GLOBEC goal - requires *in situ* vertical profiling. Use of this platform for oceanographic data collection capabilities not only would benefit the scientific community at large, but demonstration of sampling feasibility may also create other funding opportunities for collaborative research. In 2001 and 2002, the IPHC successfully deployed a SeaBird SBE-19 water column profiler from a commercial fishing vessel participating in the annual stock assessment survey. The profiler has been used on selected survey trips each season since. Project cost is directed towards annual maintenance of the one profiler owned by IPHC.

Project 618.00: Undergraduate Internship

Start Date: 2002
Anticipated duration: Continuing
Personnel: L. Sadorus, T. Loher, other staff support as needed

One undergraduate will be selected through the intern/co-op programs at regional universities and colleges to do a combination of office and at-sea work based out of the Commission offices during the summer months. The program includes various pre-determined office tasks as well as being assigned a research project then designing and executing said project. A final report and presentation are given at the conclusion of the employment term.

Project 620.00: Analysis of spatial recruitment dynamics in Pacific halibut using otolith elemental fingerprints (OEF): Phase 2

Start Date: 2002
Anticipated Ending: Continuing
Personnel: T. Loher, S. Wischniowski, temporary staff

Results to-date using age-2 halibut from western Alaska suggest that otolith elemental signatures can be used to successfully distinguish and classify individuals within general geographic regions (Bering vs. Kodiak vs. Cook Inlet), with 80-90% accuracy. The addition of oxygen and carbon isotope ratios to the existing trace element data improved the model considerably. Work in FY 2007 will be comprised of site identification, and numerical analysis of age-1 (southeast Alaska) samples in order to examine issues of temporal stability in OEFs over time. In order to obtain ecologically meaningful results from this project, we will conduct coast-wide sampling of nursery habitats in a single summer to collect same-age fish (presumably age-1) with which to generate a coast-wide "OEF map". We do not know whether all fish need to be collected within a brief window (weeks) or can be collected over a broader period (months). The answer depends upon whether drift at a site over short periods (within season) is substantial relative to regional differences. Second, we don't know whether the signature identified in an area is unique to that

area only in the year of capture, or will persist over time. For example, will Bering juveniles from a number of consecutive cohorts all demonstrate the same oxygen isotope signature, or is the signature year-specific? If the former, then a single OEF-map might characterize numerous cohorts. If not, it will be useful only for the cohort used to generate it. Second, we propose to begin the process of site establishment, as originally approved in our FY 2004 budget. We need to establish index sites in order to conduct coast-wide nursery sampling. The IPHC has no real experience with early juvenile work, so we have no established sites. Potential sites in BC and Yakutat will be assessed using a chartered vessel in 2007.

Project 621.00: Genetic population structure of Pacific halibut assessed via nuclear microsatellite diversity – lab work by UW

Start: 2002
Anticipated Ending: 2007
Personnel: T. Loher, L. Hauser (UW-MMBL), other staff as needed

Results from a preliminary population analysis of the summer 2002 samples suggested potential reproductive isolation in the Aleutians. Tissue samples were collected in winter 2004 to address the question of whether or not the Bering Sea is reproductively isolated from the Gulf. The analyses of these by Dr. Lorenz Hauser (UW - Marine Molecular Biology Laboratory) are nearing completion. His lab is also continuing with the testing and analysis of the summer samples from 2005 and 2006, and would also begin testing of samples from the following project.

Project 621.11: Genetic population structure of Pacific halibut assessed via nuclear microsatellite diversity – collection of additional winter samples

Start: 2007
Anticipated Ending: 2007
Personnel: T. Loher, L. Hauser (UW-MMBL), other staff as needed

A second winter survey is proposed based on the analysis of the 2004 winter samples, which suggested relative separation between the Bering and Gulf, relative to relatedness between Kodiak and Cape St. James. However, all separations were characterized by relatively low F_{st} values. Importantly, the F_{st} values are low enough that additional sampling is warranted. At issue is whether the separations observed in 2005 were really generated by geographic differences, or by temporal variability in gene frequencies. Do the gene frequencies drift so much that samples taken in a different year will generate different results? In order to answer that question we need to re-sample the same sites.

Project 622.11: PAT tagging: summer 2006 releases (Areas 4A and 4D)

Start: 2006
Anticipated Ending: 2008
Personnel: T. Loher

Electronic pop-up, satellite-transmitting archival tags (PATs) can record ambient temperature, depth, and light level (used to estimate longitude under certain conditions) while attached to fish. The tags are programmed to release from the fish on a pre-determined date, float to the surface, and emit a satellite signal that indicates the tag location and downloads all of the environmental data to the satellite. The result is a record of the fish's final location, along with important environmental and behavioral data throughout the fish's time at liberty.

During the 2006 summer setline survey, 24 PATs were deployed in the Bering Sea off the summer assessment survey, 12 in Area 4A and 12 in Area 4D. These tags were programmed to release from the fish and report their location and data during mid-February 2007. Costs for 2007 are for possible invoice for satellite transmission fees (these could be delayed into 2008) and potential reward costs. This set of releases was conducted with a grant from the North Pacific Research Board, with additional funding provided by APICDA and CBSFA.

Project 636.00: Analysis of gonad staging on IPHC setline surveys

Start: 2004
Anticipated Ending: 2007
Personnel: T. Geernaert, B. Leaman (other staff as needed)

The IPHC Stock Assessment surveys assess maturity of halibut based on visual criteria established in the early 1990's and modified in 1995. These survey data combined with the age data are important components in the stock assessment model. Four maturity stages are presently assigned to female halibut; immature (F1), maturing (F2), spawning (F3) and resting (F4). Once a female halibut has spawned, the gonad transitions to a resting phase, back to maturing, and then to spawning again. Our criteria for classification also assume that the immature (F1) stage is only seen with immature fish but we are seeing anomalies during the survey that could question this assumption. Mature females are seen as small as legal size (82 cm) but, area-wide, there have been several large 100+ cm females whose gonadal characteristics classify them as immature (never spawned). The SSA survey data also suggest that fish in the southern latitudes (Area 2B) mature earlier and possibly spawn earlier that fish in the northern latitudes (Area 3A and west). The timing and duration of these events are not clearly understood. We would like to re-evaluate our classification criteria and examine the stages and gonadal tissue development more closely.

In 2003 preliminary histological work on the female gonads was initiated. We developed a sampling design and collection protocols for the 2004 surveys. In 2004, during winter and summer surveys, female gonads from three different regions, in each stage of development, were collected. Three different histological subsamples have been prepared and we are presently standardizing the sample sites on the gonad for the final slide preparation. We have collected nearly 240 gonad pairs and will be analyzing multiple sites from each sample in 2007.

Project 640.00: PAT tagging: summer 2005 releases (Areas 2B, 2C, and 3B)

Start Date: 2005
Anticipated ending: 2007
Personnel: T. Loher, sea samplers

This study is intended to investigate the preliminary observation that adult (presumably female) halibut tagged in the Gulf of Alaska at southeasterly and southwesterly locations (Areas 2B, 2C, and 3B) may have shorter residence times on their summer feeding grounds than fish found in Area 3A. In particular, Gulf PSAT data from 2002 suggest that southerly fish may begin their fall migration as early as September, as evidenced by an increase in depths visited, which may indicate movement away from their summer feeding locations to the shelf-break. We have no information regarding timing of the spring return-migration from the shelf-break back to shallower coastal waters.

In 2005, 26 fish in Areas 2B, 2C and 3B were tagged during the summer setline survey. Focusing primarily upon the eastern Gulf, 18 tags deployed at three general locations (lower Queen Charlotte Sound, northern Queen Charlottes, and western Baranof-Chichagof Islands). Four fish were tagged at each of two locations in Area 3B (Semidi and Sanak Islands). Tags are programmed to pop-up during the last week of May, 2006. Project costs for 2007 consist of the satellite time for transmission relay and potential tag rewards.

Project 641.11: Hook spacing and size impacts on length selectivity and CPUE

Start: 2005
Anticipated ending: 2008
Personnel: B. Leaman, S. Kaimmer, R. Webster, Survey team

The adoption of IQ management for halibut and sablefish, together with coincident seasons for these species, has resulted in an increased amount of mixed-target or combination fishing for both halibut and sablefish in Alaska. The optimum gear for the two species is quite different, with sablefish gear using smaller 13/0 or 14/0 hooks and short 36-48" spacing, while optimum gear for halibut may be larger 16/0 hooks with 15-18' spacing. IPHC assessments make corrections for hook spacing relative to the IPHC standard 1800-ft 100-hook skate. However, the adjustment is based on a relationship developed in the 1970s from spacing experiments using J-hooks. No adjustment of CPUE for hook size is made. There is concern that smaller hooks may affect size selectivity, hence CPUE. This study will address potential differences in CPUE and size selectivity of selected combinations of hook size and spacing in the commercial fishery relative to the configuration of the standard IPHC survey skate.

Phase 1 of the study took place in the waters around Kodiak, AK, and experienced extremely high catch rates of halibut. It is likely that significant hook size or spacing effects are masked by the very high availability of halibut. It was our original intention that the Kodiak fishing would be contrasted with a Phase 2 experiment in an area of lower halibut density. Conducting this experiment in Canada would have the added element of dogfish competition for hooks.

Project 642.00: Assessment of mercury and contaminants in Pacific halibut
Start Date: 2002
Anticipated ending: Continuing
Personnel: C. Dykstra, Alaska Department of Environmental Conservation (ADEC)

For the last few years, health officials and media have raised the profile of pollutant contamination in fish (methyl mercury, PCB's, pesticides). Since 2002, the IPHC has been working collaboratively with the Alaska Department of Environmental Conservation (ADEC) to collect halibut tissue samples to be analyzed for heavy metal and organic pollutant loading. The principal results from the 2002 collection led the Alaska Division of Public Health in 2003 to conclude that the concentrations of heavy metals in Alaskan Pacific halibut are not a public health concern. In 2004, the first results regarding organic pollutants (PCB's, pesticides) were released demonstrating that halibut had the lowest concentrations of the five species (including salmon and sablefish) examined. Since 2002 the IPHC has submitted 572 samples for testing by ADEC. The mean level of total mercury for these samples has been 0.352 ppm (for comparison the FDA limit of concern for methyl mercury is 1.000 ppm, the EPA and the CFIA level of concern is 0.500 ppm) ranging from non-detectable to 1.947 ppm. The IPHC and ADEC are continuing to qualify the data with physical parameters (age, size, and weight) and additional analyses will be done on the samples. ADEC and EPA planned on going ahead with this study regardless of IPHC input. Our involvement in the project has allowed us to provide input on study design, sampling protocols in the field, etc., which will make the resultant information much more robust.

Sampling continued in 2006 with a targeted collection of 60 samples (30 from fish weighing between 20 – 40 lbs. and 30 from fish weighing between 40 – 100 lbs.) from each of four regions (Sitka, Prince William Sound, Area 4A Edge, and St. Paul) during the setline survey. Results will be published as they become available. ADEC has expressed interest in further assessments of contaminant occurrence in halibut in 2007.

Project 646.11: PAT tagging: summer 2006 releases (Area 2A)
Project 646.12: PAT tagging: summer 2006 releases (Area 2B)
Start Date: 2006
Anticipated ending: 2008
Personnel: T. Loher, C. Blood, B. Clark

The purpose of this study is to identify summer-to-winter seasonal movements of halibut in Areas 2A and 2B. In 2006, 18 and 54 PAT tags were released from the Area 2A and 2B summer assessment surveys, respectively. The tags are scheduled to pop-up in February-March, 2007, at two week intervals. Costs for 2007 are for possible invoice for satellite transmission fees (these could be delayed into 2008) and potential reward costs.

Project 650.00: Archival tagging – pilot studies

Start Date: 2006
Anticipated ending: Continuing
Personnel: T. Loher

This study represents a controlled test of the relative utility of three different models of internal archival tag that can be used on relatively small (60-99 cm) halibut. The 24 halibut being held at the Oregon Coast Aquarium in Newport were successfully tagged with one of three types of archival tags. The fish will be held until early 2007 in order to monitor their recovery and rate of incision closure. They will then be sacrificed and examined internally to assess any potential reactions to the internal tag, and to determine the feasibility of non-invasive sex determination via veterinary ultrasound. Having perfected the surgical techniques and determined the best tag configuration, deployment of internal archival tags on wild fish could begin as early as the 2008 setline survey.

Project 651.00: Effects of magnets and rare metals on the catch rates of spiny dogfish

Start Date: 2007
Anticipated ending: Continuing
Personnel: S. Kaimmer

Unwanted or prohibited bycatch in longline catches is a problem in both our research and the commercial fishing for halibut. Recent research suggests that certain types of magnet or rare earth metals in proximity to baited hooks might help reduce the catch of unwanted sharks. This likely also includes dogfish (Squalus acanthias). In 2006, a New Jersey company, Shark Defense, won the Smart Gear award for a demonstration where magnets reduced shark catch on floating longlines. They have gone on to demonstrate similar results with rare earth metals. We are proposing a pilot study to investigate in vitro fish responses to these magnets or metals. This initial study will look at responses of captive dogfish to baited hooks in the presence and absence of these magnets or rare earth metals. This project will use structured observations of dogfish feeding behavior to determine effects of either the magnets or the 'mystery metal'. This will be done at a fish holding facility, possibly the UW lab in Friday Harbor, or the NMFS lab in Manchester.

Project 652.00: Verification of setline selectivity using Didson sonar

Start Date: 2007
Anticipated ending: Continuing
Personnel: S. Kaimmer, B. Clark

The purpose of the study is to verify, by direct observation, the halibut hooking success curve for halibut on setlines. This curve has been estimated from tag release/recovery data and from a small set of direct observation data collected with an underwater video camera in shallow waters. This project would generate a larger set of observations and operate in more appropriate depths.

The study would use leased DIDSON (dual frequency identification sonar) sonar, and a gear frame which was constructed in 2006 for the Didson trap experiment. Although we expect the DIDSON to detect many more hooking attacks than previous methods, this study will be the first real test of this approach, and as such is exploratory in nature. It is possible that additional data will need to be collected in future work in order to precisely estimate hooking success for the full range of 5-cm length classes.

Project 653.00: Species identification of amphipods frequenting Pacific halibut

Start Date: 2006
Anticipated ending: Continuing
Personnel: B. Leaman, E. Soderlund

The project intends to document the occurrence and virulence of attacks by predatory amphipods on halibut caught on IPHC surveys and, by inference, the commercial fishery. The commercial industry suffers annual losses of product due to amphipod predation and must adjust its fishing locations and practices in response to predation. Harvester discussions indicate that predation sites are both known and ephemeral, and the virulence may vary interannually at a given site. The specific identity of the amphipods has not been established and it is probable that more than one species is involved. Harvesters are interested in both documentation of predation areas for avoidance, as well as gaining an understanding of the dynamics of the species at given sites, i.e., are there cycles of abundance that respond to other factors. Data were collected on all stations during the 2004, 2005, and 2006 stock assessment surveys as part of standard protocol, recording incidence of sand flea predation, and the extent and virulence of the predation. The 2006 was the last year of data collection for this stage of the project. No additional analytical work on this project was completed in 2006, due to other commitments of the principal investigator.

Other 2007 Research – Contracts and Grants

Project 375.00: Alaska port sampling

Start Date: 2002
Anticipated ending: Continuing
Granting agency: NMFS
Personnel: H. Gilroy, M. Larsen, L. Hutton

The commercial fishery port sampling program hires samplers to collect otoliths, halibut lengths, fishing logbook information and landed weight data. The U.S. program includes staffing eight Alaskan ports and Bellingham, Washington. The samplers act as the liaison between the fishing industry and the Commission staff in Seattle. The Commission is responsible for the overall assessment and management of the halibut fishery and the data collected are necessary for stock assessment. The U.S. Government adopted the Individual Fishing Quota (IFQ) allocation program in 1995. This grant provides funds to the IPHC for the incremental cost to the Commission sampling program due to the IFQ program. The grant is generated from the NMFS IFQ Fee Collection Program.

Project 628.00: Alaska catcher vessel logbook and sablefish data collection

Start Date: 1999
Anticipated ending: Continuing
Granting agency: NMFS
Personnel: L. Hutton, H. Gilroy, A. Taheri, port samplers

IPHC and NMFS Auke Bay Lab (ABL) have a sablefish data collection program. The program was reviewed and modified in 2003/2004 to meet the IPHC confidentiality policy and to encompass all vessels rather than just vessels greater than 60 feet. Under a Statement of Work, NMFS contracted IPHC staff to interview the IFQ fishers to review and collect the sablefish information in addition to the halibut information. Data are entered by IPHC staff with an electronic summary provided to the NMFS ABL scientists. In the summarized data, the vessels are assigned a unique code to preserve confidentiality.

Pending Grants for Other 2007 Projects

We are awaiting approval on several grants which would enable several other projects. This includes: 1) a grant from PSMFC for a second year of additional survey stations off Washington; 2) funding from ODFW for a similar set of additional stations off Oregon; 3) funding by NPRB for a study of electronic monitoring on halibut vessels off Alaska; and 4) funding from the State of Oregon for the purchase of a water column profiler for dedicated use on the Oregon portion of the Area 2A assessment survey.

Research Conducted Without Direct Funding

1. The 2007 stock assessment

Personnel: B. Clark, S. Hare

The annual stock assessment process comprises a large amount of work including preparation of IPHC data, estimation of bycatch by length in other fisheries, model development and validation, model fitting, examination of residuals, comparison of alternative model specifications, sensitivity tests, evaluation of harvest strategy, incidental analyses, and reporting.

2. Development of IPHC harvest policy

Personnel: S. Hare, B. Clark

Staff quota recommendations are calculated by applying a judiciously chosen harvest rate to an estimate of present exploitable biomass. The constant harvest rate policy was developed on the basis of its performance over a long time horizon and with the explicit goal of avoiding reaching the minimum stock sizes seen in the 1930s and 1970s. In 2003, the staff proposed a conditional

constant catch policy under which total removals would be capped at a chosen ceiling level at high biomass levels, while a constant harvest rate policy would continue to be employed at low and intermediate stock levels. The Commission did not adopt the proposed policy at the 2004 annual meeting, and a staff/industry workshop on harvest policy alternatives in September 2004 showed general satisfaction with the present policy, as mediated in practice by the judgment exercised by the Director in developing staff recommendations and by the Commission in finally setting catch limits. In 2004, an explicit lower limit on spawning biomass and a threshold below which the harvest rate will be reduced—were added to the constant harvest rate policy. As a result the target constant harvest rate for the core IPHC areas (2B, 2C, and 3A) was lowered to 22.5% from 25%. The staff will continue to evaluate the constant harvest rate policy. In particular, we will recalculate the optimum harvest rate itself in light of our present understanding of stock dynamics and new information on commercial length-specific selectivity coming from the PIT tag experiment.

3. Development of a robust management procedure

Personnel: B. Clark, S. Hare, B. Leaman

Staff catch limit recommendations are derived from the annual stock assessment by applying a constant harvest rate to the estimates of exploitable biomass, in the belief that the assessment model is correctly specified and the estimates are accurate. In fact there are a number of structural uncertainties about the model, and the assessment itself has become highly complicated, so it is vulnerable to any small error in data compilation or programming. The aim of this project is to develop a procedure for deriving catch limit recommendations that would achieve the desired harvest policy, potentially relying on much simpler calculations and at the same time be effective across a range of uncertainties about stock, fishery and management behavior. Such procedures have been developed for other fisheries and it is appropriate to investigate their application to halibut management.

4. Estimation of halibut abundance from mark-recapture data

Personnel: R. Webster, B. Clark, B. Leaman

The IPHC has conducted many tagging programs since the 1920s. IPHC has also conducted at least five reviews of these programs, again with differing objectives. However, many of these reviews did not account for the issues of non-reporting or differential reporting of tags by areas, fishing effort effects on recovery probabilities, the relationship of initial tag releases and the density of fish in given areas, and the effect of seasonal migratory patterns on the analysis of recoveries were not always considered. A changed paradigm for the area-specific impacts of juvenile bycatch, questions concerning the effects of changing seasonal distribution of fishing effort, potential halibut distribution changes with climatic shifts, and the utility of juvenile surveys in specific areas have all prompted concerns about halibut movements.

The staff marked the catch of three skates at each survey station coastwide in 2003 and in Areas 2B and 3A in 2004. Preliminary analysis of the 2004 recoveries showed good agreement with the stock assessment in Areas 2B and 2C, but farther west the mark-recapture estimates were

much higher than the assessment estimates. Recoveries in 2005 followed a similar pattern. The 2006 recoveries will be added to the analysis this year.

5. Seabird occurrence project

Cost: Staff salaries
Start Date: 2002
Anticipated ending: Continuing
Personnel: T. Geernaert, Washington State Sea Grant

During the 2004 stock assessment surveys, sea samplers counted the number of seabirds in the vicinity of the vessels following gear retrieval. This is the third year the seabird occurrence data were collected on IPHC surveys. Sampling after the haul addresses the question of where and when certain seabird species occur. Ultimately, these data might be used to identify appropriate seabird deterrent requirements in certain geographic locations, especially for the halibut fleet. IPHC has developed a database to store seabird occurrence data from the IPHC stock assessment surveys, as well as the NMFS and ADF&G sablefish surveys. The data are currently being analyzed. IPHC, in coordination with Washington Sea Grant, will be writing a joint paper on the results for the 2002-2004 data. The collection project is ongoing.

6. Seabird data repository (Project 643)

Start Date: 2005
Anticipated ending: Continuing
Personnel: T. Geernaert

This project encompasses the storage by IPHC of various types of seabird data collected on agency surveys, including the seabird occurrence project conducted on the assessment surveys. Although IPHC has been collecting these data on its assessment survey since 2002, other agencies are just beginning the same procedure. IPHC's head-start with these types of data led other programs to seek the efficiencies provided by IPHC in data management for optimal use by analysts and managers. A grant from Washington Sea Grant funded this activity in previous years.

7. Estimates of bycatch on the setline surveys

Start Date: 2003
Anticipated ending: Continuing
Personnel: C. Dykstra, Survey Team, and DFO personnel

Area 2B

Rockfish bycatch in the halibut fishery can be a constraint in conducting halibut fishing in some areas. In 2006, IPHC worked with DFO to allow a third biologist on IPHC survey vessels to sample rockfish. The program was funded by industry (Pacific Halibut Management Authority). Data collected included hook by hook occupancy information, otoliths, maturities, and lengths

for rockfish and sablefish. This is the fourth year of the extensive bycatch sampling program in Canada, and continued collaboration is anticipated.

Area 2A

Since 2002, the IPHC has worked cooperatively with both the Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW) to collect rockfish bycatch data. All rockfish caught on operations in 2A are tagged with an external Floy tag and the tag number is recorded with the set (and recently the skate number) information. At the offload, a state biologist meets the vessel and samples the rockfish (length, weight, maturity, genetic sample, and otolith). The IPHC then provides each agency with the effort information collected as part of the normal survey data collection.

In 2006, IPHC and Washington Department of Fisheries received funding from PSMFC to connect a joint project with industry. The Area 2A IPHC charter was expanded to included 25 special stations in the Washington survey region to look at rockfish populations. Station locations where selected by WDFW in an effort to better characterize rockfish abundance. Stations were selected with the hope of targeting more rocky bottom than the standard survey stations in the Washington region. Three skates of gear where fished at each station as a precautionary approach due to the exploratory nature of these stations and concerns of over fishing yelloweye rockfish. Activities at each station were identical to those on standard IPHC stations, and rockfish were handled as described above. A summary of this project will be submitted to PSMFC by the end of November 2006. Depending on those results, there may be a second season of sampling under this funding opportunity, although station positions may be changed to better characterize rocky bottom type.

8. Sleeper shark investigations (Project 630)

Start Date: 2003
Anticipated ending: Continuing
Personnel: S. Wischniowski, G. Williams

Ageing Study

The Pacific sleeper shark (Somniosus pacificus) age determination program commenced in 2005. Selected samples were cleaned of extraneous meat and connective tissues and sliced into 5mm thin-sections. It soon became evident that difficulties in the pre-staining preparation phase were going to be encountered. Pacific sleeper sharks lack a great deal of calcification to their vertebra, this structure can best be described as a “cartilagic garden hose”. The entire vertebra is almost completely composed of cartilage, and lacks any hardened surfaces including the centra (structure typically utilized to age sharks). These centra can best be described as thin membranes similar to the tympanic membrane of the inner ear in mammals. As fragile as this structure is, it more than likely does not function as the site of articulation as in most vertebrates. It is surmised that these centra might function as a means of regulating and controlling spinal fluid pressure within the vertebra. Specimen “A” (our first test sample) was recorded to have ~ 75 ml of spinal fluid in-between its two centra. It is possible the animal might gain structural support by retaining a turgid environment within its vertebra.

Further difficulties were encountered when the centra was removed and dried. Water loss resulted in a large amount of shrinkage and cracking which prevented further manipulation of this structure. Current experiments are ongoing to determine which methodology works best to retain hydration of the structure prior to staining. Both EtOH and glycerin (without thymol) are currently being investigated.

Genetics Study

The objective of the second component of this research into Pacific sleeper sharks is to determine if these sharks come from a homogenetic population. The population dynamics of sleeper sharks within the northeast Pacific is not well documented. Preliminary tagging studies have indicated that at least some sleeper sharks display a resident behaviour, and likely have relatively small home ranges. To test this assumption tissue samples were collected from live sharks by way of biopsy darting during the 2004 Stock Assessment Survey. A simple test of homogeneity will compare samples collected from regions of high occurrence to peripheral regions of lesser occurrence. All tissue samples for this project have been collected, and no further are need for this experiment. This portion of the research proposal will specifically target the analysis aspect of the study.

Mitochondrial DNA polymorphisms will be used as the initial genetic marker system to investigate population differentiation among the three sampling locations. We will initially attempt amplification using primers located within the proline tRNA and 12S rRNA regions of the mitochondria. These primers have been used to examine population genetic structure across a similar geographic range in blacktip sharks and yielded sufficient information to differentiate among nurseries of this species. Statistical analysis will be by way of X^2 and AMOVA probabilities of haplotype homogeneity across sampling sites. The lab portion of this experiment will commence in the fall of 2007.

9. Review of port sampling, 1994 to present

Start Date: 2002 (Deferred in 2004)
Anticipated ending: 2007
Personnel: L. Hutton, T. Kong

Report on the changes that have occurred in the commercial catch sampling and port sampling program from 1994 to the present. For example, the report will review the changes made to the program due to the implementation of the IFQ fishery in Alaska, the changes in the method of logbook data collection in the U.S., as well as changes in the Canadian program. This is an update of Technical Report 32.

10. Electronic reporting project for commercial landings in Alaska

Start Date: 2002
Anticipated ending: Continuing
Personnel: H. Gilroy, L. Hutton, T. Kong, A. Tesfatsion, H. Tran

IPHC, ADF&G, and NMFS staffs have worked with contractors initially hired by Pacific States Marine Fisheries Commission (PSMFC) to implement a cooperative interagency electronic

fishery reporting system for commercial landing records in Alaska. The project included designing a web based Interagency Electronic Reporting System (IERS) with the repository database in the State Office Building in Juneau. In May 2006, IERS was optional for statewide groundfish landings and IFQ/CDQ halibut and sablefish. Since the program is operational 24/7 the agencies are working with an outside company to provide help desk support during non-business hours. For halibut, the system reduces duplicative reporting resulting from the current requirements of completing ADF&G fish tickets and NMFS RAM quota share reports. The application (eLandings) records data elements required by regulations, prints fish tickets, and connects with the NMFS quota share database. The appropriate data from IERS is being sent to the agencies for their internal databases. The application allows processors to import or export data into their own databases so double entry is not necessary. The project is ongoing and industry personnel and agency staff have provided feedback on the operation so the application will continuously be modified to add additional features. In 2007, additional fisheries will be added including statewide shellfish.

Northwest Fisheries Science Center

National Marine Fisheries Service

2007 Agency Report to the Technical Subcommittee

of the Canada-U.S. Groundfish Committee

April 2007

Review of Agency Groundfish Research, Assessments, and Management

A. Agency Overview

The Northwest Fisheries Science Center (NWFSC) provides scientific and technical support to the National Marine Fisheries Service (NMFS) for management and conservation of the Northwest region's marine and anadromous resources. The Center conducts research in cooperation with other federal and state agencies and academic institutions. Five divisions, Conservation Biology, Environmental Conservation, Fish Ecology, Resource Enhancement and Utilization Technologies, and Fishery Resource Analysis and Monitoring, conduct applied research to resolve problems that threaten marine resources or that deter their use. The Center's main facility and laboratories are located in Seattle. Other Center research facilities are located in Pasco, Big Beef Creek, Mukilteo, and Manchester, Washington; Newport, Hammond, and Clatskanie, Oregon; and Kodiak, Alaska.

The Fishery Resource Analysis and Monitoring Division (FRAMD) is the source focus for most of the research reported by the NWFSC to the Technical Subcommittee of the Canada-US Groundfish Committee. The FRAMD works in partnership with state and federal resource agencies, universities, and the groundfish industry to achieve a coordinated groundfish program for the West Coast.

FRAMD consists of a multi-disciplinary team with expertise in fishery biology and ecology, stock assessment, economics, mathematical modeling, statistics, computer science, and field sampling techniques. Members of this program are stationed at the NWFSC facilities in Seattle and in Newport, Oregon, with some Observer Program staff located in California. Together, they work to develop and provide scientific information necessary for managing West Coast marine fisheries and strive to provide useful and reliable stock assessment data with which fishery managers can set ecologically safe and economically valuable harvest levels. FRAM researchers develop models for managing multi-species fisheries; design programs to provide information on the extent and characteristics of bycatch in commercial fisheries, as they look at methods to reduce fisheries bycatch; characterize essential habitats for key groundfish species; investigate the design, feasibility, function, and value of marine protected areas; and employ advanced technologies for new assessments.

During 2006, FRAMD continued to: implement a West Coast observer program; build a survey program that will conduct West Coast groundfish acoustic and trawl surveys previously conducted by the AFSC; develop new technologies for surveying fish populations, particularly in untrawlable areas; and expand its stock assessment, economics, and ecosystem research. Significant progress continues in all programs.

For more information on FRAMD and groundfish investigations, contact the Division Director, Dr. M. Elizabeth Clarke at Elizabeth.Clarke@noaa.gov, (206) 860-3381.

Other Divisions at the NWFSC are:

The Conservation Biology Division is responsible for characterizing the major components of biodiversity in living marine resources, using the latest genetic and quantitative methods. It also has responsibility for identifying factors that pose risks to these components and the mechanisms that limit natural productivity. The Division's multi-disciplinary approach draws on expertise in the fields of population genetics, population dynamics, and ecology.

The Environmental Conservation Division (ECD) conducts nationwide research on the effects of chemical pollution and harmful algal blooms on habitat quality and fisheries resources. ECD is also a leader in NMFS' National Marine Mammal Health and Stranding Response Program's bio-monitoring and quality assurances projects.

The Fish Ecology Division's role is to understand the complex ecological linkages among important marine and anadromous fishery resources in the Pacific Northwest and their habitats. The Division particularly places emphasis on investigating the myriad biotic and abiotic factors that control growth, distribution, and survival of important species and on the processes driving population fluctuations.

The Resource Enhancement and Utilization Technologies Division draws together multi-disciplinary groups to address existing and developing challenges of captive rearing of salmon and other marine fish, improved hatchery practices, smolt quality, disease control, and developing technologies for full utilization of bycatch and fish processing waste.

For more information on Northwest Fisheries Science Center programs, contact the Center Director, Dr. Usha Varanasi at Usha.Varanasi@noaa.gov, (206) 860-3200.

B. Multi-species Studies

2. Stock Assessment

a) SS2 Stock Assessment Model Development

Stock Synthesis 2 (SS2) is an assessment model in the class termed integrated analysis. SS2 is built with a population sub-model operating by forward simulation. SS2 has an observation sub-model to estimate expected values for various types of data, and a statistical sub-model to characterize the data's goodness of fit and to obtain best-fitting parameters with associated variance. It includes a rich feature set including age- and size-based population dynamics and the ability to specify observational phenomena, such as ageing imprecision. Model parameters can vary randomly or across time blocks or can be specified as functions of environmental data. SS2 includes routines to estimate MSY and exploitation levels that correspond to various standard fishery management targets. A user-selected harvest policy is used to conduct a forecast in the final phase of running the model. The model is coded in ADMB (Dave Fournier, Otter Research Ltd.). SS2 is now included in the NOAA Fisheries Assessment Toolbox (http://nft.nefsc.noaa.gov/) incorporating a graphical user interface developed by Alan Seaver (NEFSC).

In 2005, SS2 was used to assess the status of about 20 groundfish stocks off the U.S. West Coast. At a workshop in November 2005, its general capabilities were compared to CASAL, Multifan-CL, and SCALA. There were subsequent exploratory applications of SS2 for Pacific tuna assessments. In January 2006, SS2 was introduced to CSIRO scientists in SE Australia and have been applied to six assessments to date. In the same year, SS2 was applied by AFSC scientists to the Pacific cod stock off Alaska. In August 2006, a workshop was held to review the model usage in 2005 and to plan enhancements for 2007. Finally, in 2007, SS2 was updated to version 2.00, which incorporated several enhancements including algorithms to define movement between assessment sub-areas and enhanced controls over processes for growth, selectivity, and recruitment.

For more information, please contact Dr. Richard Methot at Richard.Methot@noaa.gov

b) Stock Assessment Improvement Workshops

Between August and November 2006, FRAMD organized (or co-organized) three workshops intended to better prepare analysts for groundfish stock assessments to be conducted during 2007. These workshops included one focusing on general data and modeling issues, one on the use of pre-recruit survey data, and one on use of FRAMD's bottom trawl survey data.

1) Data-modeling workshop

The West Coast Groundfish Data/Modeling Workshop was held August 8-10, 2006 at the NOAA Western Regional Center in Seattle, Washington. The workshop was held to review available data sources for West Coast groundfish stock assessments and address a number of topics relating to the treatment of data in assessments and other modeling issues, including a review of the features and functionality of the SS2 modeling platform. Over 40 workshop participants included stock assessment scientists from NOAA Fisheries and State agencies, data managers, fishing industry representatives as well as members of the public. Workshop presentations and discussion addressed the following topics:

- Methods employed to construct age and length compositions during the 2005 assessments.
- Issues relating to historic age reading data, including the electronic archival of descriptive meta-data, and logistical protocols for the transfer of age structures and the communication of age determinations between agencies.
- General Linear Mixed Model (GLMM) theory, its application to survey data, in particular, the west coast groundfish bottom trawl surveys, including a preliminary analysis for canary rockfish.
- The Scientific and Statistical Committee's Terms of Reference for Stock Assessments and Stock Assessment Review (STAR) panels, as well as

issues discussed during the Groundfish Stock Assessment Review Workshop in January, 2006.

- Issues relating to the specification of sample sizes for compositional data in assessments, approaches for "tuning" input sizes based on model outputs;

- A review of some of the new features in Stock Synthesis 2 (SS2) and discussion of further additions that would be useful for 2007 assessments.

- A new tool for quickly summarizing the results of a Stock Synthesis 2 (SS2) model run. Using the free software "R" (www.r-project.org), five SS2 output files are condensed into a short list of statistics and a number of plots with one function call. This enables quick and easy evaluation of all aspects of a model run during exploratory development. Authors can contact Ian at: Ian.Stewart@noaa.gov, for a copy of the software or assistance in using it.

- An overview of approaches used to define stock structure and management units for West Coast groundfish, including use of genetics, demographic patterns, and management/assessment units. Results from age-structured simulations evaluating the effects of the spatial distribution of fishing effort on stock size and yield. Preliminary work to identify stock structure using commonly collected data (catch per unit effort; CPUE) and simple clustering techniques.

- A summary of the model parameter priors used in 2005 assessments, along with presentations on the use of prediction intervals for natural mortality (M) and a method for calculating priors for the Beverton-Holt stock-recruitment steepness parameter.

2) Pre-recruit survey workshop

In 1983 the Southwest Fisheries Science Center (SWFSC) initiated a mid-water trawl survey to collect data on, among other things, the abundance and distribution of young-of-the-year (pre-recruit) groundfish, including especially rockfishes of the genus *Sebastes*. Through 2003 this survey was narrowly focused in an area off the coast of central California from lat. 36º30'–38º20' N. In 2001 a new pre-recruit survey conducted cooperatively by the NWFSC and the Pacific Whiting Conservation Cooperative (PWCC) was initiated, with the primary intent of monitoring young-of-the-year Pacific whiting abundance. The initial coverage of this survey ranged from lat. 35º00' N (just south of Morro Bay CA) to lat. 45º00' N (just north of Newport OR). Beginning in 2004, the geographic extent of both surveys was expanded, so that by 2005, the combined area of both surveys covered the entire U. S. west coast, from the Canadian to Mexican borders (lat. 33 º00'– 48 º00' N).

A workshop focusing on the integration of data from these two pre-recruit surveys in west coast groundfish stock assessments was held September 13-15, 2006 at the SWFSC facility in Santa Cruz, CA. The workshop was jointly organized by the SWFSC and the NWFSC and was attended by over 20 people, including individuals involved in conducting both pre-recruit surveys, stock assessment scientists, and the public. Twelve scheduled presentations were organized into three sessions:

Session 1. Developing a Coast-wide Survey of Groundfish Pre-Recruit Abundance
Session 2: Incorporating Pre-Recruit Indices in Stock Assessments
Session 3: Case Studies

Throughout the course of the workshop's discussions, several findings and suggestions for future surveys, research, and/or applications were broadly supported by participants. With respect to whether survey data collected by the SWFSC and NWFSC-PWCC surveys can be combined into coast-wide indices of pre-recruit abundance for Pacific whiting and rockfish, areas of general agreement included the following:

- For species that are distributed exclusively or predominantly north of Point Conception, data from the 2001-06 combined surveys provide acceptable spatial coverage for creating a coast-wide index. The combined spatial coverage during 2004-06 is reasonable for all species, including those with substantial catches taken south of Point Conception. However, the spatial coverage of the SWFSC survey during the 1983-2000 period is largely inadequate to index pre-recruit abundance for most species, particularly where coast-wide assessment areas are used in population modeling. The core SWFSC survey area appears to represent the preponderance of the distribution of a few species reasonably well (e.g., chilipepper), but may also prove useful in region-specific modeling for other stocks that have a more coast-wide distribution (e.g., widow rockfish).

- Comparison of methods and patterns in catch rates currently indicate that the SWFSC and PWCC/NWFSC surveys are sufficiently similar that data from the two surveys can be combined to form a single pre-recruit index over the area covered. However, detailed and more rigorous statistical comparisons of paired trawl observations should continue, and the two surveys should continue to be executed with substantial spatial overlap.

- Existing data from (time-separated) replicate tows in the SWFSC data should be analyzed to assess the potential magnitude of variance and bias effects associated with varying numbers of replicate tows.

- Alternative General Linear Model (GLM) formulations should be explored for developing pre-recruit abundance indices. In particular, the potential benefits of replacing sampling stations with broader latitudinal and depth zones and introducing interaction terms, should be examined. Additionally, mixed-model (GLMM) forms should also be explored, for example, by treating calendar day as a random effect.

- As more data become available and the development of regional ROMS (Regional Ocean Model System) or other oceanographic models progresses, their outputs may help in identifying the manner in which meso-scale ocean variability affects the abundance and distribution of young-of-the-year groundfish. A better understanding of these relationships may facilitate improvements in pre-recruit survey design or interpretation of results.

With respect to the modeling non-linearity in early life history processes, and specifically whether a power transformation should be used, areas of participant agreement included:

- Substantial density-dependent compensatory mortality can occur following measurement of pre-recruit abundance at the ontogenetic stage sampled by the surveys (e.g., 100-d). If compensation is substantial, then non-linearity will be introduced in the relationship between "pre-recruit" and "recruit" abundance.

- When non-linear transformation of an index is considered, the transformation should be conducted internally within the stock assessment model as an explicit part of the estimation procedure.

- The new SS2 option which allows specification of an expectation of density-independent pre-recruit abundance may remove the need for transformation. Comparative work to evaluate this issue should be performed, with a good candidate being southern widow rockfish.

- It is important to evaluate the degree to which non-linear transformation of pre-recruit survey indices is confounded with tuning to the model's RMSE. Transformation and variance inflation should be conducted jointly.

Aside from their use in short-term forecasts of impending recruitment, pre-recruit surveys have the potential to provide significant insights into ecosystem dynamics, including:

- monitoring of epipelagic micronekton species diversity
- sensitivity of sampled taxa to high-frequency environmental variation

- monitoring of "small" forage species for use in trophic models
- potential for early detection of regime shifts (e.g., indicator species)
- providing information that may be useful in retrospective studies
- sampling is consistent with the ocean observing system (OOS) framework.

3) Bottom trawl survey workshop

The NWFSC Bottom Trawl Survey Workshop was held October 31 – November 2, 2006 at the NOAA Western Regional Center in Seattle, Washington. The goal of the bottom trawl survey workshop was to provide stock assessment authors with guidance regarding the incorporation of data from the NWFSC West Coast groundfish bottom trawl survey into stock assessments, particularly those that will be conducted in 2007. The roughly 20 participants included stock assessment scientists, trawl survey personnel, fishing industry representatives as well as members of the public.

The NWFSC bottom trawl survey was initiated in 1998, covering depths from 100-700 fathoms. The survey was expanded in 2003 to include depths ranging from 30-100 fathoms. While data from the 100-700 fathom range have been included in prior assessments, data from the expanded coverage of shallower depths have not.

Primary workshop objectives and areas of general agreement are summarized below:

Objective 1. Review survey protocols and data collected by the NMFS West Coast groundfish bottom trawl surveys: AFSC & NWFSC triennial shelf surveys (1977-2004), NWFSC slope survey (1998-2002), and NWFSC "expanded" shelf-slope survey (2003-2006).

Participants generally agreed that substantial differences exist between the triennial shelf and NWFSC shelf-slope "expanded" survey protocols and gear (Table 1.). Some of these differences such as towing speed and duration, size and type of the nets and footropes, and selection of tow locations, may contribute to changes in catchability and selectivity. It is difficult to disentangle the effects of the various changes in protocol and gear on catchability and selectivity. However, it appears the effects differ among species.

Objective 2. Evaluate methods for including AFSC and NWFSC survey time series in "full" stock assessments.

Workshop participants generally agreed that the triennial and NWFSC Shelf-slope "expanded" surveys are different time series and should be

included separately in assessments, based on the analyses presented for canary rockfish, English sole, darkblotched rockfish and arrowtooth flounder. This conclusion was based on the fundamental differences in survey protocols and performance. Stock assessment authors may explore alternative use or combinations of the surveys. Alternative options for including the NWFSC "expanded" survey are outlined below.

Two principal options were discussed for using the NWFSC "expanded" survey data in assessments for species which primarily occur on the slope (e.g. darkblotched rockfish). The first option is to continue using the NMFS conducted slope survey time series (>100 fm) as in previous assessments, and add data from the recently sampled shelf depths (<100 fm) of the NWFSC "expanded" survey as a new and separate time series. Although this approach may represent a viable interim method for including the new data, as it preserves a longer continuous slope time series, participants generally thought this method is not a long term solution. As the length of the "expanded" survey time series increases, information and statistical power may be lost by separating data from the "expanded" survey into two concurrent time series Also, since the NWFSC survey was not extended to the Mexican border until 2003, a slope time series from 1998 to 2006 would reflect very different geographic coverage. In order to maintain geographic consistency over this time period, data from the Conception INPFC area would need to be excluded from the derivation of a survey index.

The second suggested option for species occurring primarily on the slope, involves including two separate time periods for the NWFSC survey, based on the change in depth coverage (i.e. NWFSC slope (1998-2002) and NWFSC "expanded" slope/shelf (2003-06). Participants noted that if authors are going to include the "expanded slope survey" as new time series, they will need to make sure that the selectivities make sense relative to the first NMFS slope survey.

Three options were explored to include the NMFS triennial shelf survey and the NWFSC "expanded" shelf-slope survey into assessments for species primarily occurring in shelf depths. The first option, agreed by participants as the "default method", includes using both surveys as separate time series with different catchabilities (q) and selectivities. Participants also discussed options for combining the surveys into one time series. If authors choose to combine the surveys they should explore setting "q" and selectivity the same, as well as estimating different "q"s and equal selectivities. Three case studies, including modeling and data analysis for canary and darkblotched rockfishes and arrowtooth flounder, were used to explore various aspects of this question.

Objective 3. Evaluate whether recent data from NWFSC "expanded" shelf-slope survey should be included in update assessments. If they are to be included, should they be treated as a new time series or included as an extension to the time series previously used assessment models?

English sole is scheduled as an "update" assessment in the 2007 assessment cycle. The NWFSC "expanded" survey data will not be included in the update assessment model. Based on the analyses reviewed during the workshop, there was no compelling reason to combine the surveys into one time series. Additionally, there is enough complexity associated with including the NWFSC "expanded" shelf-slope survey data as an expansion of the triennial survey, that the assessment would no longer be considered an "update" as defined by the SSC's Terms of Reference for Stock Assessments and STAR Panels. Fishery catch, age / length data will be included in the update and the analyses produced for this workshop will be included as an appendix in the assessment document.

Workshop participants discussed the inclusion of the NWFSC "expanded" shelf-slope data in other assessments scheduled as updates. Although not all the authors for update assessments attended the meeting, and therefore participants did not see the raw data for other species, it was generally concluded the other update assessments (e.g. widow rockfish) should use the same approach as recommended for the English sole update assessment (i.e. don't use new survey data unless doing a full assessment).

Objective 4. Compare biomass and variance estimates generated using a design-based swept-area approach and model-based (Generalized Linear Mixed Models) approach.

Results from analyses of the NWFC slope survey using generalized linear mixed models (GLMM) for canary rockfish, English sole (northern and southern regions, and arrowtooth flounder were presented. In general, the results suggest that GLMM-based estimators are more robust when catches are comprised of many zero hauls, positive catch rate distributions are skewed (infrequent, very large hauls), and when the assumption of the variance-mean relationship is non-normal. Based on the historical performance of GLMMs and these workshop case studies, participants agreed that the GLMM is the preferred method for developing biomass estimates from survey data for most species.

In order to comport with the SSC's Terms of Reference for Stock Assessments and STAR panels, the English sole assessment (and other

updates if applicable) should use the design-based estimates for triennial shelf surveys as done in prior full assessments.

Additional Notes
Until the expanded NWFSC survey series contains more observations and has been examined rigorously in assessments, authors should explore a range of possibilities through the use of alternate runs and sensitivity analyses. For stocks that are near a critical level, sensitivity tests, including model likelihoods, point estimates and their uncertainties, and posterior distributions are particularly important. The impact of the choice of data preparation method (GLMM or design-based) should also be presented for review.

Limited case-study analysis revealed a significant degradation in model fit when the triennial and shelf/slope surveys (design-based estimates example) were forced into a single series with a common q and selectivity. This type of analysis should be repeated for other stocks and with the GLMM-based estimates. More analysis should also be conducted to identify the best point estimate for characterizing survey biomass trends among candidates such as the arithmetic mean, the geometric mean, and the mode.

Complete summaries of these workshops are available upon request.

For more information, please contact Stacey Miller at Stacey.Miller@noaa.gov

C. By Species, by Agency

The PFMC currently operates under a biennial schedule for the development of stock assessments and management guidance. For all groundfish species except Pacific hake, stock assessments are scheduled for review only during odd-numbered years. A schedule of for Stock Assessment Review (STAR) panels for 2007 full assessments for species other than Pacific hake is shown in Table 1.

Table 1. 2007 Review Schedule for Full Groundfish Assessments

STAR PANEL	STOCK	AUTHOR(S)	STAR PANEL DATES	STAR PANEL LOCATION
1	Longnose skate Sablefish	Vladlena Gertseva Michael Schirripa	May 7-11	Hatfield Marine Science Center Barry Fisher Bldg., Room 101, 2032 SE Oregon State University Drive, Newport, OR 97365
2	Black rockfish (N&S) Blue rockfish (Calif)	David Sampson & Farron Wallace Meish Key	May 21-25	Pacific States Marine Fisheries Commission 205 SE Spokane Street, Portland, OR 97202
3	Bocaccio Chilipepper rockfish	Alec MacCall & Steve Ralston John Field	June 25-29	Southwest Fisheries Science Center 110 Shaffer Road Santa Cruz, CA 95060
4	Darkblotched rockfish	Owen Hamel	July 16-20	NOAA Western Regional Center Bldg 9. Conference Room, 7600 Sand Point Way NE, Seattle, WA 98115
5	Canary rockfish Arrowtooth flounder	Ian Stewart Isaac Kaplan & Tom Helser	July 30-Aug. 3	NOAA Western Regional Center Bldg 9. Conference Room, 7600 Sand Point Way NE, Seattle, WA 98115

1. Shelf Rockfish

West Coast

b) Stock Assessments

No shelf rockfish assessments were conducted during 2006. A full assessment of canary rockfish and an update of the 2006 yelloweye rockfish assessment will be conducted in 2007.

For more information on the canary rockfish assessment, contact Dr. Ian Stewart at Ian.Stewart@noaa.gov

For more information on the yelloweye rockfish assessment, contact John Wallace at John.Wallace@noaa.gov

2. Slope Rockfish

b) Stock assessment

No slope rockfish assessments were conducted during 2006. A full assessment of darkblotched rockfish and an update of the 2005 Pacific ocean perch assessment will be conducted in 2007. For more information on either of these assessments, contact Dr. Owen Hamel at Owen.Hamel@noaa.gov.

3. Thornyheads

b) Stock Assessment

No thornyhead assessments were conducted during 2006, and none are scheduled for 2007.

4. Sablefish

b) Stock Assessment

A sablefish assessment was not conducted during 2006, however a full assessment will be conducted in 2007. For more information, please contact Dr. Michael Schirripa at Michael.Schirripa@noaa.gov

5. Flatfish

b) Stock Assessment

No assessments for flatfish were conducted during 2006. An update of the 2005 English sole assessment and a full assessment for arrowtooth flounder will be conducted 2007. For more information on the English sole assessment, please contact Dr. Ian Stewart at Ian.Stewart@noaa.gov. For more information on the arrowtooth flounder assessment, please contact Dr. Thomas Helser at Thomas.Helser@noaa.gov.

6. Pacific Hake

b) Stock Assessment

The status of Pacific hake was assessed in early 2006 and 2007. In both years, the assessments and reviews were conducted with representation from the U.S. and Canada. The coastal stock of Pacific hake is currently the most abundant groundfish population in the California Current system. Smaller populations of hake occur in the major inlets of the north Pacific Ocean, including the Strait of Georgia, Puget Sound, and the Gulf of California. However, the coastal stock is distinguished from the inshore populations by larger body size, seasonal migratory behavior, and a pattern of low median recruitment punctuated by extremely large year classes. The population is modeled as a single stock,

but the United States and Canadian fishing fleets are treated separately in order to capture some of the spatial variability in Pacific hake distribution.

Fishery landings from 1966 to 2006 have averaged 162 thousand mt, with a low of 90 thousand mt in 1980 and a peak harvest of 360 thousand mt in 2006 (Figure 1). Recent landings have been above the long term average, at approximately 360 thousand mt in 2005 and 2006. Catches in both of these years were predominately comprised by the large 1999 year class.

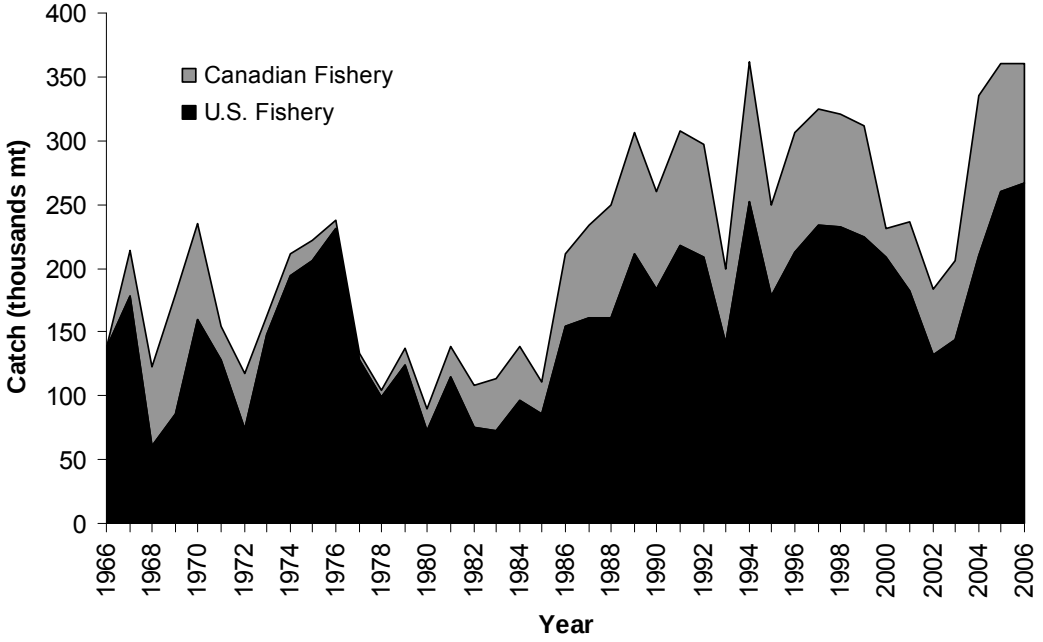

Figure 1. Pacific hake landings (1000s mt) by nation, 1966-2006.

The acoustic survey catchability coefficient (q) has been, and continues to be, one of the major sources of uncertainty in the model. As in the previous year's assessment, two models were developed to bracket the range of uncertainty in the acoustic survey q. The base model, with steepness fixed at h=0.75 and q=1.0, represents the lower endpoint of the range, while the upper endpoint of the range is represented by an alternative model which includes a prior on q (effective q=0.7). This assessment uses the same version of SS2 (Ver 1.23E) as the 2006 assessment, and incorporates a new coast-wide recruitment index that draws upon data from the expanded SWFSC Santa Cruz and PWCC/NMFS mid-water trawl surveys.

Unexploited equilibrium Pacific hake spawning biomass (B_{zero}) was estimated to be 3.57 million mt using the base model, and 4.15 million mt using the alternative model. Recent spawning biomass levels and depletion relative to B_{zero} are presented in Table 2. Stock projections under the PFMC's 40-10 harvest rule are presented in Table 3.

Table 2. Recent trend in Pacific hake spawning biomass and depletion level from the base and alternative SS2 models.

	Base Model				*Alternative Model*			
Year	Spawning biomass millions mt	~ 95% Interval	Relative Depletion	~ 95% Interval	Spawning biomass millions mt	~ 95% Interval	Relative Depletion	~ 95% Interval
1998	1.088	0.952 - 1.224	30.4%	-	1.299	1.113 - 1.486	31.3%	-
1999	0.986	0.850 - 1.122	27.6%	-	1.203	1.013 - 1.394	29.0%	-
2000	0.916	0.774 - 1.057	25.6%	-	1.149	0.946 - 1.351	27.7%	-
2001	1.111	0.925 - 1.297	31.1%	-	1.424	1.147 - 1.701	34.3%	-
2002	1.587	1.298 - 1.875	44.4%	-	2.058	1.624 - 2.491	49.6%	-
2003	1.807	1.460 - 2.154	50.6%	-	2.360	1.839 - 2.880	56.9%	-
2004	1.738	1.384 - 2.093	48.6%	-	2.295	1.764 - 2.827	55.3%	-
2005	1.496	1.156 - 1.837	41.9%		2.024	1.514 - 2.533	48.8%	
2006	1.295	0.954 - 1.637	36.2%	28.9% - 43.5%	1.806	1.299 - 2.314	43.6%	34.9% - 52.1%
2007	1.146	0.790 - 1.502	32.1%	24.3% - 39.7%	1.651	1.126 - 2.175	39.8%	30.7% - 48.8%

Table 3. Four-year projections of potential Pacific hake landings, spawning biomass and depletion for the base and alternative models under the 40:10 rule.

		Spawning biomass millions mt			Depletion percent unfished biomass		
Year	Expected coastwide catch (mt)	Mean	5%	95%	Mean	5%	95%
Base model, h=0.75, q=1.0							
2007	575,090	1.146	0.790	1.502	32.1%	24.3%	39.8%
2008	377,360	0.876	0.617	1.136	24.5%	19.5%	29.5%
2009	232,040	0.690	0.472	0.909	19.3%	15.0%	23.6%
2010	191,600	0.657	0.334	0.979	18.4%	10.2%	26.6%
Alt. model, h=0.75, q prior							
2007	878,670	1.651	1.126	2.175	39.8%	30.8%	48.8%
2008	560,070	1.215	0.844	1.585	29.3%	23.6%	35.0%
2009	334,990	0.921	0.629	1.214	22.2%	17.6%	26.8%
2010	258,650	0.842	0.439	1.244	20.3%	11.7%	28.9%

The 2007 assessment for Pacific hake is available online at ftp://ftp.pcouncil.org/pub/Hake07. The 2006 assessment is available online at: http://www.pcouncil.org/groundfish/gfsafe0406/2006_hake_assessment_FINAL_ENTIRE.pdf . For more information, please contact Dr. Thomas Helser at Thomas.Helser@noaa.gov

6. Other species

b) Stock Assessment

An assessment of longnose skate will be conducted during 2007. For more information, please contact Dr. Vlada Gertsena at Vladlena.Gertseva@noaa.gov

D. Other Related Studies

1. The PaCOOS, West Coast Habitat Data Portal

The PaCOOS Marine Habitat Data Portal was conceived in 2005 as a Local Data Access Center (LDAC) of the Integrated Ocean Observing System (IOOS). Funding for its development was provided by the NOAA IOOS Program through the FRAM Division of the Northwest Fisheries Science Center. The database and GIS system had its origin the data collected together for the West Coast Essential Fish Habitat Environmental Impact Statement, which was completed in 2005/2006. Maintained jointly by FRAM and COAS' Seafloor Mapping Laboratory and in collaboration with PSMFC, the portal provides access to data (search, connection, and download), a visualization environment, and integrated navigation tools. Currently, this portal houses geological and geophysical data including benthic habitat maps, fisheries survey datasets, and ocean climatologies. Data access, which includes data searching and metadata harvesting, is provided through IOOS Data Management and Communications (DMAC) compliant pathways such as OPeNDAP, OGC WMS, and ESRI ArcIMS map services. The portal's centerpiece is its unique map viewer environment (http://nwioos.coas.oregonstate.edu/), an online application that provides a map interface to data holdings with custom tools for data downloads and queries. There is a growing user base that includes local, state, and federal agencies within the California Current Large Marine Ecosystem.

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2. West Coast Bycatch Reduction Research: Fish Behavior During Interactions with Bottom Trawls

Since 2004, the NWFSC has collaborated with the Oregon Department of Fish and Wildlife (ODFW) on a bycatch reduction research project to obtain baseline information on the behavior of demersal fishes when overtaken by a bottom trawl. *In situ* information of this nature is critical to the future development of species-selective trawls and bycatch reduction devices for West Coast groundfish fisheries. In this project, a conventional low-light video was used in conjunction with a DIDSON ultrasonic imaging sonar (Dual-frequency IDentification SONar) to document and categorize fish behavior in response to interaction with a selective flatfish bottom trawl. A complementary project seeks to build a catalog of enzyme activities as an indicator of species-specific, burst-swimming abilities for many groundfish species.

The summer of 2006 marked the second field season for this research project. This project represents the first successful application of a DIDSON sonar in bottom-tending mobile fishing gear, which produced dual observations of fish-trawl interaction vis-à-vis video and DIDSON imaging A novel set of mounting frames provided a stable platform for sonically imaging all areas in front and in the mouth of the trawl (e.g., footrope, headrope, wings, and footropes mud cloud form). DIDSON imaging of Pacific halibut, lingcod, Pacific hake, skates, and flatfish will help inform the second phase of the project, namely assessing the methods to reduce bycatch. Information was gathered on trawl performance, in the form of observational data on the speed and direction of fish movement, herding behavior, wing interactions, and footrope and headrope effects. The 2006 field season focused on deploying the DIDSON sonar system to obtain

information on diel differences in response to contact with the trawl foot rope in the absence of artificial light. Data from the 2006 cruises are currently being analyzed.

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3. NOAA NMFS Advanced Sampling Technology Working Group (ASTWG) workshop on essential offshore habitat for demersal fish

FRAMD hosted a workshop in August 2006 to identify the most effective and promising approaches and technologies for identifying, mapping, and monitoring essential offshore habitat for demersal fish species.

The workshop co-organizers and steering committee included: Waldo Wakefield[1], Dave Demer[2], Chris Gledhill[3], Vince Guida[4], Bill Michaels[5], Frank Parrish[6], Dave Somerton[7]

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The primary objectives of the workshop were

- To provide a forum for the fisheries science centers to exchange information and ideas on using technology and mapping seafloor habitats.
- To identify the most promising approaches and technologies for identifying, mapping, and monitoring essential habitat for demersal fish.
- To develop draft recommendations to the Advanced Sampling Technology Working Group (ASTWG) for research themes that could be included in a future ASTWG RFP.

The workshop was divided into 8 session topics:

1. Review of the current programs and needs at each NMFS Science Center for Essential Fish Habitat (EFH) information.
2. What are the measurable biotic and abiotic environmental parameters that determine the abundance of offshore demersal fishes?
3. Fundamentals of acoustic remote sensing of seafloor types.
4. Methods for acoustic remote sensing of seafloor types and for extracting ecologically meaningful variables.
5. Methods for validating seafloor classifications derived from acoustics data.
6. Other remote sensing technologies for mapping and monitoring habitat for demersal fish (focus on environmental parameters associated with the water column).
7. Methods for validating essential offshore habitat classifications and their importance in the distribution of demersal fish species.
8. Group discussion to identify the most effective and promising approaches and technologies for identifying, mapping, and monitoring essential habitat for demersal fish species.

Approximately 40 individuals representing NMFS Headquarters, five fisheries science centers, two NMFS regional offices, and seven other academic institutions and agencies participated in the workshop. Representatives from the fisheries science centers along with their academic and agency colleagues were given an overview of each NMFS science center's research activities and needs in relation to mapping offshore habitats and current use of technologies. In addition, a representative from the NMFS Office of Science and Technology provided headquarter's perspective on the workshop topic. The workshop helped to identify those limits in technology, approach, and knowledge-base that present roadblocks to completing habitat mapping work.

The complete results of the workshop will be summarized in a NOAA NMFS Technical Memorandum. Funding for this workshop was provided by the NOAA NMFS Office of Science and Technology through the Advanced Sampling Technology Working Group, and the participating NMFS Science Centers and Regional Offices. Julia Clemons (FRAMD) provided additional logistics support and served as the workshop's rapporteur.

For more information, contact Dr. Waldo Wakefield at Waldo.Wakefield@noaa.gov, (541 867-0542)

4. Cooperative Ageing Unit

Cooperative Ageing Project (CAP) provides direct support for U.S. West Coast groundfish stock assessments by providing ages derived primarily from otoliths. In preparation for assessments to be conducted during 2007, CAP aged the following species: canary rockfish, Pacific ocean perch, darkblotched rockfish, Pacific hake, sablefish, arrowtooth flounder, and English sole.

For more information, please contact Dr. Jim Hastie at Jim.Hastie@noaa.gov

5. Cooperative Resource Surveys

a. West Coast Slope and Shelf Groundfish Survey

The NWFSC conducted its ninth annual bottom trawl resource survey for groundfish off the coasts of Washington, Oregon, and California. The objective of the 2006 survey was to provide information on the distribution and relative abundance of demersal species within this region at depths from 30 to 700 fathoms. Other biological information necessary to assess the status of groundfish stocks (e.g. length, weight, sex and age structures) was collected throughout the survey period.

The NWFSC chartered commercial fishing vessels to conduct independent, replicate surveys using standardized trawl gear. Fishing vessels *Ms. Julie, Excalibur, Noah's Ark* and *Raven* were contracted to survey the area from Cape Flattery, WA to the Mexican border in Southern California, beginning in the later part of May and continuing through the third week of October. Each vessel was chartered for eight weeks with the *Ms Julie* and *Noah's Ark* surveying the coast during the initial pass from May to July. The *Excalibur,* and *Raven* operating in tandem, surveyed the coast during the second pass from mid-August to late October. The survey followed a stratified random sampling scheme with 15-minute tows at randomly selected depths. The depth strata were: shallow (30-100 fms), middle (100-300 fms), and deep (300-700 fms). The sample design consisted of 688 sampling locations, with 258 on the shelf (30-100 fms) and 430 on the slope (100-700 fms). Each of the four vessels occupied a different subset of 172 cell sites.

In 2006, we also continued to utilize the FSCS data collection system with updated software applications, and wireless networking. Established NOAA national bottom trawl protocols were used throughout the survey. As in prior years, a series of special research projects were undertaken in cooperation with other NOAA groups and various Universities.

Additional data were collected during the trawl survey for collaborative research projects with several NMFS/academic colleagues: 1) Maternal effects on larval quality in rockfishes - Southwest Fisheries Science Center; 2) Establishing a DNA sequence database for the marine fish fauna of California- Scripps Institution of Oceanography; 3) Life history of the white-spotted ratfish, *Hydrolagus colliei* - Moss Landing Marine Laboratories; 4) Feeding ecology of the roughtail skate, *Bathyraja trachura* - Moss Landing Marine Laboratories; 5) Collection of all unusual or unidentifiable skates, sharks, or chimaeras - Moss Landing Marine Laboratories; 6) Collection of biological data and specimens of the deepsea skates, *Bathyraja abyssicola*, and broad skates, *Amblyraja badia* - Moss Landing Marine Laboratories; 7) Food habits studies of jumbo squid, *Dosidicus gigas*, in the California Current - Southwest Fisheries Science Center; 8) Geographic variation in *Lycodes diapterus*, and the status of the subspecies *Lycodes diapterus beringi*; - Alaska Fisheries Science Center; 9) Local and regional patterns of dispersal and exchange in coastal fishes as determined with otolith microchemistry - Oregon Institute of Marine Biology.

Several other research initiatives were begun by the Survey Team including: 1) the effects of the parasitic copepod *Phrixocephalus cincinnatus* on flatfish growth, reproduction, and population dynamics; 2) use of stable isotopes and feeding habits to examine the feeding ecology of young-of-the-year rockfish (genus *Sebastes*); 3) comparison of volumetric vs. whole haul methods for deriving catch weights; 4) collection of samples from spiny dogfish to aid stock assessment and demographic analysis; 5) collection of *Sebastolobus alascanus* (shortspine thorynhead) displaying fin erosion; 6) fin clip collection for various shelf rockfish species; 7) rockfish fecundity observations for selected species; 8) collection of stomachs for selected species; 9) identification and density-estimation of seabirds along the U.S. West Coast; 10) collection and identification of cold water corals

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b) Development of Survey Techniques for Use in Untrawlable Habitats

The Northwest Fisheries Science Center (NWFSC), in collaboration with researchers at Woods Hole Oceanographic Institution (WHOI), is using the SeaBED AUV to overcome the difficulty of monitoring fish populations in rocky areas. Rocky, untrawlable areas are a challenge to survey, yet important habitat for a variety of commercially important fish stocks including rockfish.

Traditional fish monitoring techniques, such as trawl surveys and ship borne acoustics, are of limited applicability in these areas due to the rugged nature of the terrain. Thus, to enhance our ability to adequately assess fishery species that use these habitats alternate technologies must be identified and evaluated for augmenting current fishery-independent assessment techniques. Hover-capable AUVs offer a unique tool that is appropriate for work in these types of habitat. In addition, AUVs allow other simultaneous shipboard data collections that will greatly enhance the data available for integrated ecosystem assessments.

The Seabed AUV (Figure 2) is a multi-hull, hover capable vehicle, which unlike traditional torpedo shaped AUVs, is capable of working extremely close to the seafloor while maintaining very precise altitude (3m +/- 0.05m) and navigation (O(1m)) control. Its small footprint coupled with its 2000m depth rating makes it an ideal platform for conducting surveys off the continental shelf on ships ranging from standard NOAA oceanographic vessels to smaller fishing vessels of opportunity.

Figure 2. The Seabed – a hover capable AUV developed by HAnu Singh at WHOI

The suite of sensors onboard the AUV include 12 bit 1.2 Megapixel high dynamic range camera and associated strobe, a 230kHz Delta-T multibeam imaging system, a 1.2 MHz RDI Acoustic Doppler Current Profiler, fluorometers, a pumped CTD, and methane sensor. Typical mission durations for the current vehicle allow it to run with its suite of sensors for 6-8 hours covering distances of up to 10-15 km on a single dive.

The sensors, the AUV, and its associated systems are all vertically integrated. Thus the imagery can be easily color corrected, merged with the navigation and attitude data, photo-mosaicked and then analyzed for species counts, sizes and distributions with easy to use, web accessible GUIs. Example mosaics of photos taken using the downward-looking camera during the 2006 cruise are shown in Figure 3.

Enhancements of the Seabed AUV are being developed to improve our ability to identify rockfish. These will include addition of higher resolution cameras and testing of sideward-looking as well as downward-looking camera configurations in Spring 2007 in collaboration with DFO Canada.

For more information, contact Dr. Elizabeth Clarke at Elizabeth.Clarke@noaa.gov

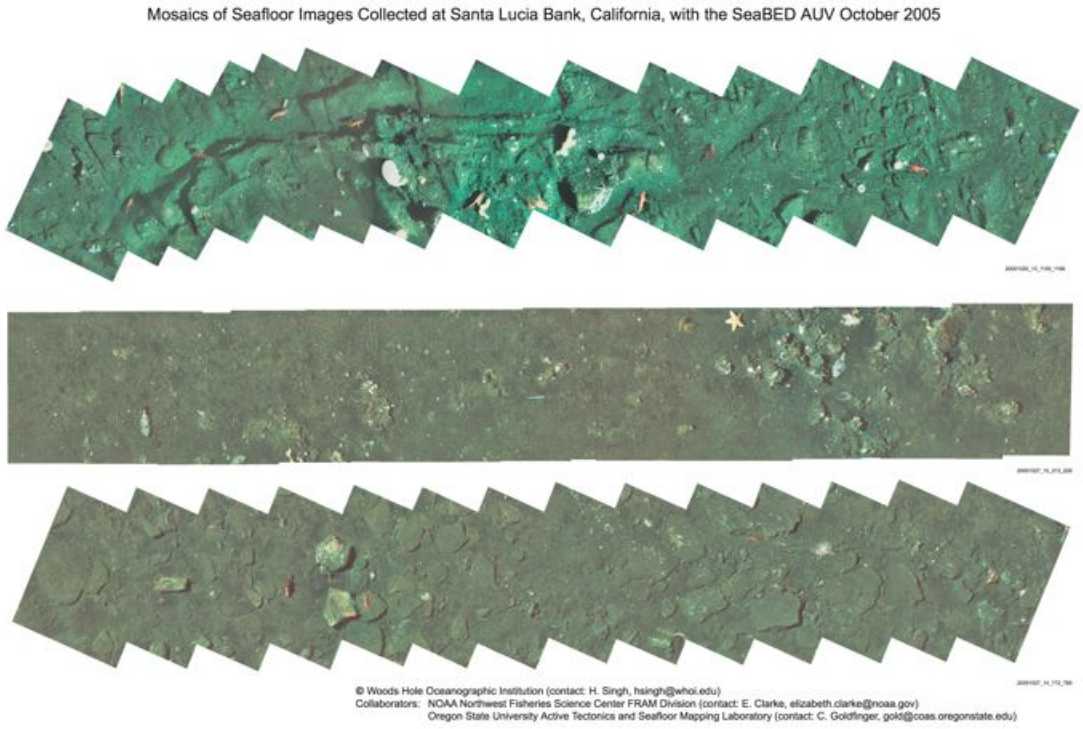

Figure 3. Photomosaics of some of the images collected with the AUV in a rocky untrawlable habitat.

c) Southern California Hook-and-Line Survey

In early Fall 2006, FRAMD personnel conducted the third hook and line survey for shelf rockfish in the Southern California Bight (SCB). This project is a cooperative effort with Pacific States Marine Fisheries Commission (PSMFC) aimed at developing an annual time series of catch rate data and other biological information for structure-associated species of rockfish (Genus *Sebastes*) such as bocaccio (*S. paucispinis*) and vermilion rockfish (*S. miniatus*) within the SCB.

The F/V Aggressor (Newport Beach, CA) and F/V Mirage (Port Hueneme, CA) were chartered for 11 days each, and nine biologists participated during the course of the survey. The two vessels sampled a total of 94 sites ranging from Point Arguello in the north to 60 Mile Bank in the south. Approximately 2200 lengths, weights, fin clips, and otolith pairs were taken representing 33 different species of fish.

Several ancillary projects were also conducted during the course of the survey. This includes the deployment of non-lethal genetic tagging hooks developed by FRAM personnel. These hooks remove a small piece of tissue from a fish's mouth during a strike without bringing the animal to the surface, limiting mortality associated with barotrauma stress. Genetic microsatellite analysis uniquely "tags" each fish which can

then be "recaptured" during subsequent deployments of the tagging hooks. 473 of these hooks were used during the 2006 survey. An underwater video system was deployed at seven sites to gather imagery of the seafloor for future analyses correlating catch rates of key species with specific habitat types. Other projects included the collection of 98 rockfish tissue samples for a histological study aimed at estimating burst swimming speed and the preservation of several rockfish and flatfish specimens for a genetic voucher program conducted by the University of Washington.

For more information, contact John Harms at John.Harms@noaa.gov

d) Joint U.S.-Canada Acoustic Survey

In August, 2006, a joint US/Canadian acoustic survey was performed and backscatter data collected over a large area of Queen Charlotte Sound. During the survey, data were collected on 18-, 38-, 70-, 120-, and 200-kHz EK60 echo sounders simultaneously aboard the CCGS Tully. Concurrent with the Tully, the CCGS Ricker fished representative fish schools for stock assessment using mid-water trawling.

Also on the joint US/Canadian survey, the Canadian BioNess (a multi-net variable depth plankton and CTD sampler) were used in conjunction with the NWFSC Digital Video Plankton Recorder (DVPR). The use of both plankton nets and the DVPR will give a complete picture of the plankton community, including gelantinous zooplankton not identifiable from net tows. The goal of this work is to identify plankton that affect acoustic backscatter during hake surveys. The DVPR is shown in Figure 4.

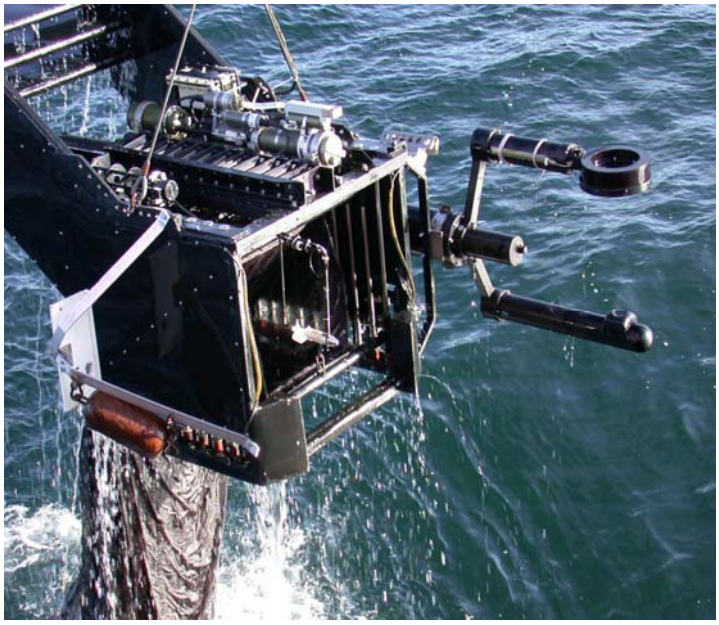

Figure 4. NWFSC Digital Video Plankton Recorder

6. NOAA Program: Fisheries And The Environment (FATE)

Incorporating environmental forecasts into stock assessments and stock assessment decision tables

Significant progress has been made through the Fisheries And The Environment (FATE) program in identifying leading indicators of environmental processes that affect stock recruitment, growth, and survival. However, comparatively little work has focused on evaluating the use of these indicators within the current stock assessment framework. We have been addressing this gap through the use of a fisheries data simulator (FSIM Goodyear 2004, 2005) to produce data sets of populations with known biological properties and explicit environmental influences. By simulating population and fisheries dynamics from predetermined parameters, the ability of the SS2 Assessment Program (Methot 2005a and 2005b) to accurately estimate these parameter values can be evaluated. Results from this work have contributed to improvements in the SS2 model in terms of modeling environmental influences on fish populations. This work has also been used (at the PFMC's Bzero/Bmsy workshop, December 2006) to address issues relating to the estimation of unexploited spawning biomass, which is a critical parameter in applying the Council's harvest policy and in determining whether a stock is considered overfished. Current work addresses the use of ocean environmental variables (known or forecasted) to characterize the possible future condition of fish populations. This type of forecasting is becoming increasingly important to fishery managers and industry.

For more information, contact Dr. Michael Schirrpa at Michael.Schirripa@noaa.gov

7. Ecosystem Studies

a) Impact of fishing on marine community structure.

Using food web models, we are examining a range of marine communities, varying in species richness, productivity, and fishing intensity, to determine how fishing has affected community structure and some basic ecosystem parameters. Our initial work suggests that incompatibilities exist between managing for sustainable fisheries and managing for the health of coast ecosystems—two of NMFS' mission goals. We are developing indices of "ecologically sustainable yield" based, not on single-species fish population dynamics, but on systemic dynamics and NMFS ecosystem goals.

For more information Dr. Phil Levin at (206) 860-3473, Phil.Levin@noaa.gov

b) Groundfish bioenergetics.

Bioenergetics models have proven to be an excellent tool in estimating the energetic demands of fishes and, thereby, better understanding the amount of prey required by fish populations. Bioenergetics models are also useful for explaining fish growth trajectories as they relate to prey quality, temperature, fish size, and species- and sex-specific differences. We developed bioenergetics models for *Sebastes* species to examine various issues such as per capita prey demand of different species, the influence of temperature anomalies (e.g., PDO shifts, El Niño) on fish growth and reproductive potential, and

habitat-specific prey allocation across different life history stages of rockfish (i.e., Do adult and juvenile rockfish share common habitats and common prey, and if so, do the predatory demands of one age group constrain the success of the other?).

For more information, Dr. Chris Harvey at (206) 860-3228, Chris.Harvey@noaa.gov.

c) Fish movement and MPA design.

Rational design of networks of MPAs requires an understanding of the relationship between the spatial extent of a reserve, home ranges of fish, and the distribution of resources. As a result, understanding movement patterns of fishes is of central importance to measuring MPA effectiveness. There are two potentially conflicting objectives of MPAs: (1) to conserve a breeding stock adult, movement out of MPAs should be minimal, but (2) to augment local fisheries, some flux outside the MPAs to harvested areas is desirable. However, very little is known about the short-term movement of most economically and ecologically important temperate fish species. Here, we propose (1) to determine the degree to which habitat structure and food resources affect movement by rockfishes, and (2) to apply these data to models that can ascertain effectiveness of existing MPAs and develop guidelines for designing future MPAs. Our approach involves first documenting the movement of rockfishes on rocky reefs using sonic telemetry. We will then use the information gathered during the empirical phase of our project to model MPA effectiveness as a function of fish motility and habitat-structure food availability.

For more information, contact Dr. Phil Levin at (206) 860-3473, Phil.Levin@noaa.gov

d) Development of a spatially explicit ecosystem model to examine effects of fisheries management alternatives in the Northern California Current

Decision analysis is intimately associated with the analysis of uncertainty: Given uncertainty about future behavior of a system, what policies are most robust over the full suite of alternative future conditions? Classic fisheries science, which relies on single-species population models, has been criticized by some as inadequate for fisheries decision analysis because it considers one possible effect of fisheries policy (i.e., fishing affects abundance and age structure which, in turn, affects yield). In contrast, ecosystem-based management recognizes a broader suite of system responses, and it explicitly recognizes that fish stocks respond to underlying yet unpredictable ecosystem dynamics (e.g., irreducible uncertainties) and that fishing itself can induce ecosystem changes. Thus, decision analysis frameworks ideally explore responses of populations to fishing under alternative scenarios of ecosystem forcing and fishing-mediated ecosystem change.

Do we presently have the tools to predict all elements of marine ecosystems? Absolutely not, and it is unlikely that such a case will ever arise. Do we presently have the tools to identify potential ecosystem responses and behaviors? Fortunately, we have considerable and expanding expertise. Our knowledge of food web processes in marine ecosystems continues to grow, building a strong conceptual framework of the types of food web relationships that are common, rare, and, most importantly, dangerous in the context of fisheries management. What is presently lacking, however, is an integrated modeling

framework that can be used to 1) synthesize this information; 2) analyze possible ecosystem responses; and 3) identify key processes that govern ecosystem condition.

We are developing such a modeling framework for the Northern California Current Ecosystem (NCCE). Our approach explicitly estimates the ecosystem and population-level consequences of various fisheries management alternatives in the face of a varying environment. ATLANTIS, a modeling approach developed by CSIRO scientists in Australia, achieves the crucial goal of integrating physical, chemical, ecological, and fisheries dynamics in a three-dimensional, spatially explicit domain. In ATLANTIS, marine ecosystem dynamics are represented by spatially-explicit sub-models that simulate hydrographic processes (light- and temperature-driven fluxes of water and nutrients), biogeochemical factors driving primary production, and food web relations among functional groups. The ATLANTIS model represents key exploited species at the level of detail necessary to evaluate the direct effects of fishing. The model is thus ideally suited for ecosystem-based decision analysis.

The overarching goal of this project is to develop a model that allows users to examine the effects of large-scale management efforts against a backdrop of environmental variability resulting from climate events, seasonal changes, oceanographic dynamics, food web interactions, and fisheries. To achieve this goal, we are (1) collating data for the processes and functional groups included in the model; (2) defining the spatial structure of the NCCE; and (3) simulating behavior of the NCCE under alternate fisheries management policies and environmental regimes.

For more information, contact Dr. Phil Levin at (206) 860-3473, Phil.Levin@noaa.gov

8. Economic Data Collection and Analysis

a) Commercial Fishing Economic Cost-Earnings Data

Development and implementation of the Oregon limited-entry groundfish trawl fleet survey was completed during 2006. Innovative data collection techniques were used to obtain an extremely high response rate of 77%. Also in 2006, collection of cost-earnings data was initiated in Washington and California for the trawl and fixed gear fleets, and in Oregon for the fixed gear fleet. Some data analysis was begun in 2006 and will continue in 2007.

For more information, contact Dr. Carl Lian at Carl.Lian@noaa.gov

b) Survey of the Economic Value of Sport Fishing

An economic valuation survey was developed and implemented during several 2-month waves of recreational angling in Oregon and Washington during 2006. An original and innovative survey format was used to elicit the effect of regulations on angler valuations and participation rates. Extensive testing of the survey instrument and outside reviews were conducted to improve the quality for responses for use in future research.

For more information, contact Dr. Todd Lee at Todd.Lee@noaa.gov

c) Economic Survey of West Coast Charter Fishing Vessels

The economic survey of West Coast recreational Charter Boat operators has been developed over the past year and is currently being fielded in Oregon and Washington. The survey is designed to determine the state of the industry and to determine the regional economic impacts of the sector on the respective coastal communities. This survey will compliment the survey of the commercial fishing vessels which is also currently being fielded and the processor survey which has been developed and is under review of industry representatives. Upon completion we will be able to build a comprehensive regional economic model of the West Coast that incorporates commercial, recreational, and processors.

Financial enterprise budgets have been developed for a limited number of the commercial fishing fleet. It is intended that all commercial, recreational, and processors sectors will eventually have an enterprise budget which can be used by managers and industry participants alike for planning and analysis.

A research program has also initiated to investigate how coastal communities interface with marine resources. In Phase 1, which is already underway, a Social Accounting Matrix (SAM) will be developed for selected communities. This phase will utilize federal, state, and local secondary data sources and some limited "ground truthing". Presently, Westport, Washington and Newport, Oregon have been selected for inclusion in this project, and one or two communities in California may also be included.

Phase 2 will involve surveying businesses and households in Westport, Newport, and potentially other communities. These interviews will be used to improve the data obtained from the secondary data sources and examine important issues such as location of expenditures by businesses and households, household income from marine related endeavors, extent of income from non-labor sources, and some more sociological questions about people's preferences and values for the marine resources. Phase 3 will focus on estimating visitor usage and visitor expenditure profiles. Completion of these two phases will rely upon future availability of funding.

For more information, contact Dr. Phillip Watson at Phillip.Watson@noaa.gov

9. Observer Data Collection and Analysis

The FRAM division's At-Sea Hake and West Coast Groundfish Observer Programs continued collecting fishery-dependent data during 2006 on groundfish fleets along the entire west coast.

a) At-Sea Hake Observer Program

The At-Sea Hake Observer Program deployed two observers on each of fifteen at-sea Pacific hake processing vessels during the 2006 season, exceeding 1,200 observer days at sea. Due to low limits on some bycatch species in this fishery, observer data is crucial to its successful management and efficient vessel operations in each vessel's observer

sampling area is key to robust observer sampling. Over recent seasons, program staff has taken an active role in engaging each vessel's crew during pre-cruise meetings to outline observer duties, expectations and identify solutions to meet both the needs of the vessel and observer program. The program has always sampled close to 100% of the hauls in the fishery. Through vessel cooperation and the hard work of the observers, the average rate at which each haul is sampled has increased from roughly 30% to just over 50% during recent seasons.

b) West Coast Groundfish Observer Program

During 2006, the West Coast Groundfish Observer Program deployed observers on the bottom trawl and various fixed-gear fleets along the entire U.S. West Coast, exceeding 2,500 observer days at sea on over 300 vessels. The program also continued investigating the utilization of electronic monitoring technology to monitor the shore-based Pacific hake fleet. The program currently conducts observation aboard vessels ranging in size from skiffs to large trawlers, which fish in depths ranging from less than 20 fm to more than 500 fm. As the program encounters unique data collection circumstances, due to the range of vessel sizes, targets, and areas fished, the program stresses observer data quality and safety. During 2006, the program expanded automated data checks and built upon current realistic, 'live' safety drills.

c) Data and analytical reports

Summaries of data collected on observed trips are routinely published on the NWFSC web site. Three new fleet-specific reports were completed during the Fall and Winter of 2006. FRAMD also prepares an evaluation of total annual fishing mortality. The most recent report is for the year 2005. All reports can be obtained at: http://www.nwfsc.noaa.gov/research/divisions/fram/observer/datareport/index.cfm.

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NMFS Southwest Fisheries Science Center

Agency Report to the Technical Subcommittee

of the Canada-U.S. Groundfish Committee

April 2007

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A. AGENCY OVERVIEW

The Southwest Fisheries Science Center (SWFSC) conducts fisheries and marine mammal research at three laboratories in California. Activities are primarily in support of the Pacific Fishery Management Council, the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), as well as a number of international fisheries commissions and conventions. The deputy director of the SWFSC is Dr. Norman Bartoo, and the Science Director is Dr. William Fox. All three SWFSC laboratories have supported the essential needs of the NMFS and the PFMC for groundfish, including as active members of the PFMC's Scientific and Statistical Committee (SSC) and other management teams and advisory bodies.

The Center is headquartered in La Jolla, which hosts three divisions that conduct research on a wide range of Pacific and Antarctic fish, marine mammals, sea turtles, and marine habitats; the Antarctic Ecosystem Research Division (led by Dr. Rennie Holt) , the Protected Resources Division (led by Dr. Stephen Reilly), and the Fisheries Resources Division (led by Dr. Roger Hewitt). The Fisheries Resources Division (FRD) conducts research on groundfish, large pelagic fishes (tunas, billfish and sharks), and small coastal pelagic fishes (anchovy, sardine and mackerel), and is the primary source of groundfish-related research in the La Jolla Laboratory. The La Jolla laboratory is also the primary source of federal support for the California Cooperative Oceanic Fisheries Investigations (CalCOFI) surveys that have taken place along most of the California coast since 1951. Researchers at the La Jolla lab have primary responsibility for ichthyoplankton collections, studies of species abundance and distribution (including responses to climate variability), systematics, and the application of early life history information to stock assessments.

The Fisheries Ecology Division (FED), located in Santa Cruz and directed by Dr. Churchill Grimes, comprises two research branches. The Fisheries Branch (led by Dr. Peter Adams) conducts research (and stock assessments) in salmon population analysis, economics, groundfish, and fishery oceanography. The Ecology branch (led by Dr. Susan Sogard) conducts research on the early life history of fishes, salmon ocean and estuarine ecology, habitat ecology, and molecular ecology of fishes. Specific objectives of FED groundfish programs include (1) collecting and developing information useful in assessing and managing groundfish stocks; (2) conducting stock assessments, and improving upon stock assessment methods, to provide a basis for harvest management decisions for the PFMC; (3) characterizing and mapping biotic and abiotic components of groundfish habitats, including structure-forming invertebrates; (4) disseminating information, research findings and advice to the fishery management and scientific communities; and (5) provide professional services (many of which fall in the above categories) at all levels, including inter-agency, state, national and international working groups.

The Environmental Research Division (ERD), directed by Dr. Franklin Schwing, is located at the Pacific Fisheries Environmental Laboratory (PFEL) in Pacific Grove. The ERD is a primary source of environmental information to fisheries researchers and managers along the west coast, and provides science-based analyses, products, and information on environmental variability to meet the agency's research and management needs. The objectives of ERD are to (1) provide appropriate science-based environmental analyses, products, and knowledge to the SWFSC and

its fishery scientists and managers; (2) enhance the stewardship of marine populations in the California Current ecosystem, and other relevant marine ecosystems, by understanding and describing environmental variability, the processes driving this variability, and its effects on the production of living marine resources, ecosystem structure, and ecosystem function; and (3) provide science-based environmental data and products for fisheries research and management, to a diverse customer base of researchers, decision-makers, and the public. ERD also contributes oceanographic expertise to the groundfish programs within the SWFSC, including planning surveys and sampling strategies, conducting analyses of oceanographic data, and cooperating in the development and testing of environmental and biological indices that can be useful in preparing stock assessments.

B. MULTISPECIES STUDIES

1. Research

Ichthyoplankton Surveys
The FRD, in collaboration with state and academic partners, supports and maintains the CalCOFI ichthyoplankton time series, which extends from 1951 to the present and has been used to study distribution and abundance changes of many fish species in relation to climate and ecosystem change in the California Current region. Since 2002 CalCOFI stations off central California, last routinely sampled in 1984, have been re-occupied during the winter and spring cruises in order to provide improved geographic coverage during the principal reproductive season for Pacific sardine and many of the groundfish species whose spawning distributions extend well north of Point Conception. Over the 55+ years of the CalCOFI time series substantial advances have been made in ichthyoplankton identifications and many currently identifiable species were identified only to the level of genus or above in earlier years.

To increase the consistency of identifications through the time series a project is now underway to systematically work back through the archived CalCOFI ichthyoplankton samples to bring all identifications up to current standards. To date identification updates have been completed from 1972-present. Unfortunately, larvae of most of the rockfish species cannot be reliably identified to species using standard visual techniques. However, because one side of each bongo net sample collected during the Cowcod Conservation Area (CCA) surveys was preserved in ethanol, those larvae can be identified using molecular techniques. Currently, about 25% of the "unidentified rockfish" larvae collected during the CCA surveys have been identified, representing 22 species dominated by squarespot and swordspine rockfishes. The results of this work will greatly enhance the number of species identified in such surveys and assist in the validation of pigment/morphology-based identifications.

Juvenile Surveys
Since 1983 the FED has conducted an annual survey of the distribution and abundance of pelagic juvenile rockfishes, with the goal of providing data for forecasting future recruitment to rockfish and other species, and to otherwise monitor the physical and biological environment. A number of west coast groundfish stock assessments have historically used this pelagic juvenile index to estimate impending recruitment. In 2004 the geographic coverage of the SWC pelagic juvenile

rockfish mid-water trawl survey was expanded substantially, with the addition of new sample lines off of southern and northern California, from San Clemente Island to Point Delgada. As in 2005, pelagic juvenile rockfish catches in the core part of the survey area were at very low levels in 2006, and appeared to be linked to anomalous environmental conditions that included above average sea surface temperatures and delayed upwelling south of Cape Mendocino. The near absence of fish in the core survey area in 2006 seemed to be associated with a redistribution of fish to the north and the south.

At the recommendation of their Scientific and Statistical Committee (SSC), the Pacific Fishery Management Council (PFMC) requested that a workshop be held in order to more formally consider whether data from the SWC survey and a recently initiated NWC survey operated jointly with the Pacific Whiting Conservation Cooperative could be integrated into a single coastwide index, and to evaluate whether or how such data should be used in stock assessments. This workshop was held September 13-15, 2006 in Santa Cruz, CA, and was cosponsored by the Southwest and Northwest Fishery Science Centers. Some general conclusions from the workshop were; 1) for species that are distributed exclusively or predominantly north of Point Conception, data from the 2001-06 combined surveys provide acceptable spatial coverage for creating a coast-wide index, and the combined spatial coverage during 2004-06 is reasonable for all species; 2) The spatial coverage of the SWFSC survey during the 1983-2000 period is largely inadequate to index pre-recruit abundance for most species, particularly where coastwide assessment areas are used in population modeling; and 3) Comparison of methods and patterns in catch rates from the two surveys indicate that they are sufficiently similar that data from the two surveys can be combined to form a single pre-recruit index over the area covered. Additional general conclusions and recommendations, as well as summaries of the presentations from the symposium, are available in a report provided to the PFMC that will be available online in the near future (or contact Steve Ralston, SWFSC or Jim Hastie, NWFSC).

The Early Life History Team is continuing studies of essential fish habitat for newly settled rockfish in Monterey Bay. Using methods of trapping, otter trawling, drop camera surveys, scuba diving censuses and ROV censuses, we are examining a range of habitat types and depths from 20 to 100m. Extremely poor recruitment in 2005 and 2006 has limited our attempts to use video methods of censuses. However, trawling and trapping methods have revealed clear spatial patterns in settlement, with higher densities of YOY rockfish in southern Monterey Bay compared to northern Monterey Bay, and higher densities in deeper regions compared to shallower regions. Low relief mud/sand substrates appear to have nursery value for newly settled rockfishes of several species, with later migration to the high relief rocky substrates typically recognized as adult habitat.

Adult Surveys

The Advanced Survey Technology (AST) and In-Situ Survey groups in FRD have continued efforts to combine acoustic and optical sampling to survey rockfish and evaluate their biotic and abiotic requirements for habitat. The combined methods can provide estimates of biomass and dispersion by species, throughout the Southern California Bight, with realistic sampling effort (Fig. 1). The ultimate goal of these efforts is to provide data for improving rockfish stock assessments.

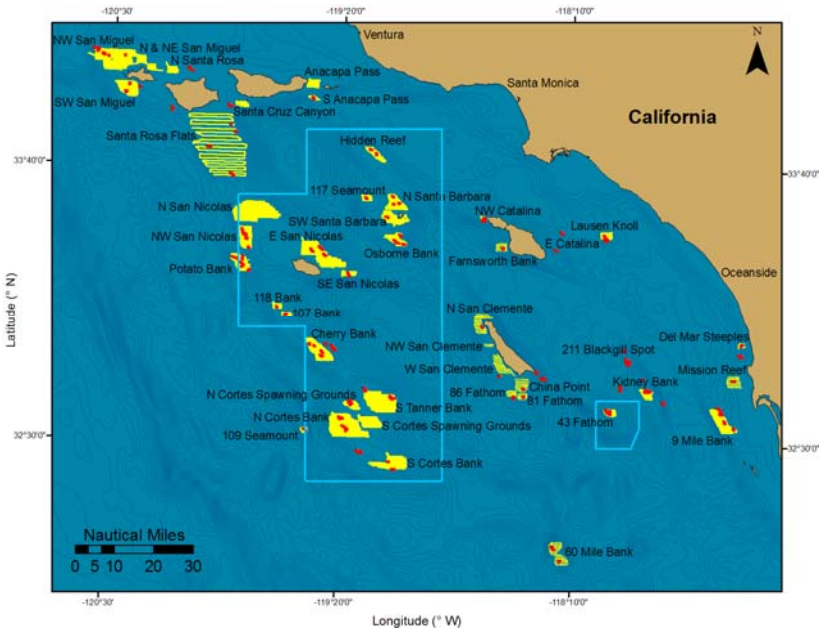

Figure 1. Sites for the 2004-2005 acoustic and optical surveys of rockfish. Multi-frequency echosounder surveys (yellow lines) were conducted from NOAA Ship *David Starr Jordan* and CPFV *Outer Limits*. Still and video cameras, and laser measuring sensors were mounted on a remotely operated vehicle, and deployed (red lines) from *Outer Limits*. Sites where only optical surveys were conducted were surveyed in spring 2006 to examine deep rockfish habitats. Indicated with light blue lines are the boundaries of the Cowcod Conservation Area.

The past year has been dedicated mainly to data analysis and combining the findings of the acoustic and optical surveys. For acoustic data, scattering statistics and frequency-dependence of sound scatter (e.g. Conti *et al*., 2007) were used to resolve fish near the seafloor, identify rockfish, and estimate their number densities. For example, highest rockfish densities were estimated at Potato Bank, NW of San Nicolas Island (~1.4 fish m^{-2}, ~$64x10^6$ total fish), and 57-Fathom Reef, W of San Clemente Island (~1.3 fish m^{-2}, ~$4.2x10^6$ total fish). The rockfish densities in each survey area were apportioned to species based on proportions of species estimated from video recorded with a camera mounted on a ROV. Preliminary estimates ranged from 0.42 million cowcod (*Sebastes levis*), to 6.1 million bocaccio (*Sebastes paucispinis*), to 167.2 million squarespot (*Sebastes hopkinsi*), and the dispersions of each species have also been mapped. The preliminary abundance estimates were made assuming means of the optically-measured lengths, and refinements are to be made using the measured length probability density functions. Another area for refinement is the estimation of the total sampling and measurement error.

Additional optical surveys were conducted during April and May 2006 with the aid of partners in the sportfishing industry to fill in missing data at sites of greater depths. The goals were to examine the species compositions at the maximum depth for rockfish, and to confirm depth ranges for key species (e.g. *Sebastes levis*). A manuscript detailing the depth and substrate associations of rockfish in the Southern California Bight has been produced and will be submitted for publication in May 2007 (Pinkard *et al.*, in prep). Rockfish were found to have species-specific depth and habitat preferences, which varied little by site locations. Species

compositions varied by latitude, with the clearest shifts near the northern boundary of Point Conception (e.g. *Sebastes mystinus* found at northern sites). The majority of rockfish species were associated most commonly with low relief reef, but there was a variety of other substrates where rockfish were found (Fig. 2). Optical methods were proven to provide large amounts of information, specifically species compositions and fish lengths, which were used to make abundance estimates from acoustically-derived estimates of rockfish densities.

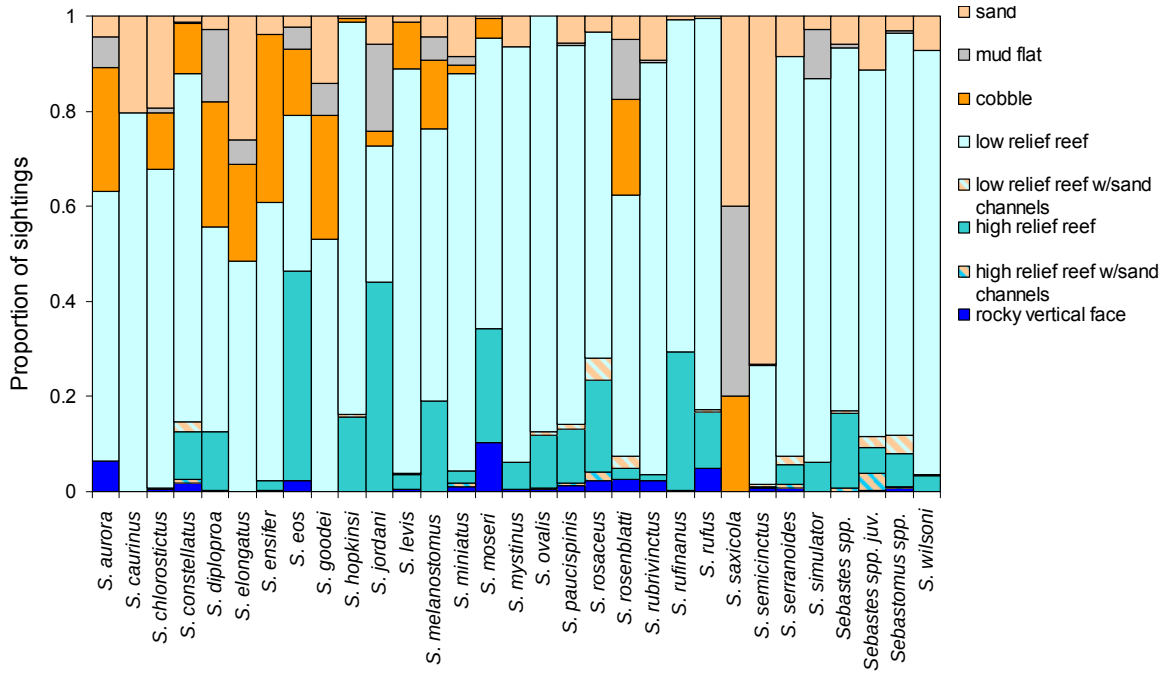

Figure 2. Proportion of individual rockfish species sighted in eight substrate types. Only species sighted during ≥ 5 dives and at total numbers ≥ 50 were included in the analysis.

Over the past year, the Collaborative Optically-assisted Acoustic Survey Technique (COAST) was presented to several audiences for evaluation as a stock assessment tool. The COAST and preliminary results of a pilot survey were first presented to the SWFSC Director Bill Fox; then to Bob Fletcher (President of the Sportfishing Association of California; SCA), and other fishers who are involved in the SCA; and then to a group of stock assessment biologists from SWFSC. Overall, feedback has been positive, and suggestions for improvement have been taken into account. In response to encouragement from fellow scientists and NOAA leaders, the AST and In-Situ Survey groups are currently planning additional COAST surveys of rockfish, and plan to support stock assessment efforts with the results.

2. Stock Assessment Support

Both the FRD and the FED regularly produce stock assessments of groundfish for the PFMC, and support stock assessment science through the maintenance of data systems and the development of new analytical techniques. The FED works closely with the California Department of Fish and Game (CDFG) to coordinate port sampling efforts and to maintain the

CALCOM database, which serves as the source of the data provided to PacFIN by the State of California. The system provides port sampling biologists with Internet access to the database, so that data are entered directly in real time.

Through our liaison with CDFG, the FED also recently acquired a massive amount of historical California landings data on microfiche and original paper, which are currently being digitized through the NESDIS Climate Data Modernization Program. Monthly summaries of landings by block have been processed from 1931 to 1968, and are currently being checked for errors and quality control. Considerably more effort will be necessary to keypunch landing receipt information, but funding is currently dedicated to continue developing this time series into the future.

C. BY SPECIES, BY AGENCY

2. Nearshore Rockfish

Research
The Early Life History Team continues to conduct research to evaluate sources of variability in the fitness characteristics of individual larval rockfish, such as the initial size of larvae at parturition, bioenergetic condition as indexed by oil reserves, initial swimming capabilities, growth rates and mortality. Maternal age appears to play an important role in larval success (growth and survival) for some species but not others. Age also appears to influence the timing of parturition, suggesting that older mothers fertilize their eggs earlier than younger mothers. The strength of some of these maternal effects appears to be related to seasonal patterns of parturition timing. We are currently expanding these studies to additional species common in deeper habitats. This issue is widely recognized by researchers and assessment scientists as important in evaluating the productivity and sustainability of West Coast groundfish fisheries, and insights gained from ongoing research will be incorporated into scientific assessments and management advice as it becomes available. In addition to research examining maternal effects, we have completed experiments testing for multiple paternity in kelp rockfish, with the finding that multiple paternity appears to be common.

Assessment
In 2007, FED biologists are assisting in the development of a blue rockfish (*Sebastes mystinus*) stock assessment being led by the California Department of Fish and Game.

3. Shelf Rockfish

Research
A study is underway to estimate the spawning biomass of bocaccio (*Sebastes paucispinis*) in the southern California Bight (SCB) using data collected during standard winter CalCOFI surveys and during enhanced ichthyoplankton sampling surveys conducted in the Cowcod Conservation Area (orange polygon in Fig. 3, below). Bocaccio is an overfished rockfish that, based on conventional assessment methodologies, is estimated to be heavily depleted (11% of B0 in 2005). FED staff had previously shown that a credible biomass estimate of shortbelly rockfish

(*S. jordani*) was possible based on estimation of total larval production (Ralston *et al*. 2003). For bocaccio, larval abundance data were summarized from the historical CalCOFI data set to reveal seasonality of spawning and the typical distribution of larvae in the SCB. Standard and enhanced ichthyoplankton sampling conducted during 2002 and 2003 were used to generate independent estimates of spawning biomass in those two years through the analysis of larval catch curves. Larval production was then linked to spawner biomass based on information obtained from adult fish recently collected in Ensenada, Mexico (i.e., maturity and fecundity data). The average larval production estimate of spawning biomass during 2002-03 was 10,900 mt, or about 43% higher than that from the 2005 stock assessment.

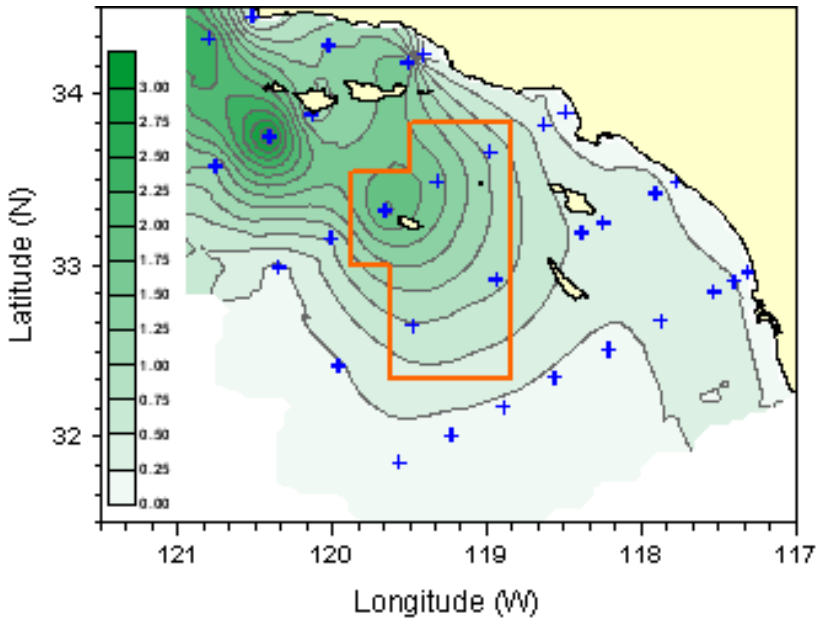

Figure 3: Historical distribution of bocaccio larval abundance (# ≅ 10 m^{-2}) from the CalCOFI database. Shown are contours of the estimated station effects from a Δ-lognormal GLM, with blue "+" symbols indicating actual station locations. The Cowcod Conservation Area is delimited by the orange polygon.

Assessments

In the 2007 stock assessment cycle, the FED is conducting full assessments of bocaccio and chilipepper rockfish, and updates on existing assessments of widow rockfish and cowcod. Bocaccio, chilipepper and the cowcod update will be conducted in the latest version of stock synthesis 2 (SS2), and these models are currently in development. Although the cowcod assessment is being pursued as an update, there is ongoing additional exploration focusing on evaluating location-specific depletion based on spatially explicit catch rate time series from recreational fisheries.

Although not in the current assessment cycle, the FED has also been evaluating catch and life history data for the bronzespotted rockfish (*Sebastes gilli*), a large, relatively rare species that occur mainly in Southern California waters in deep rocky habitats similar to those for cowcod (*S. levis*). Port sampling data and expanded catch histories suggest that while the hook and line fishery has traditionally accounted for most landings, the gillnet fishery grew in the early 80s and accounted for most of the mortality during the period of most rapid decline in the late 1980s and early 1990s. Following this period of high catches, landings plummeted while overall shelf rockfish landings remained relatively high. A preliminary CPUE index based on cowcod effort

indicates that the resource may have collapsed in the mid-1980s, and the population could be significantly depleted. Preliminary investigation of the life history of bronzespotted suggest a high vulnerability to fishing. From 119 otoliths compiled from various agency and academic collections, we observed a maximum age of 89 years, with 8 fish older than 55 years, which was the age of the oldest cowcod observed in 260 aged fish for that assessment. The estimated growth rate (K) is among the lowest observed for *Sebastes*, at approximately 0.03.

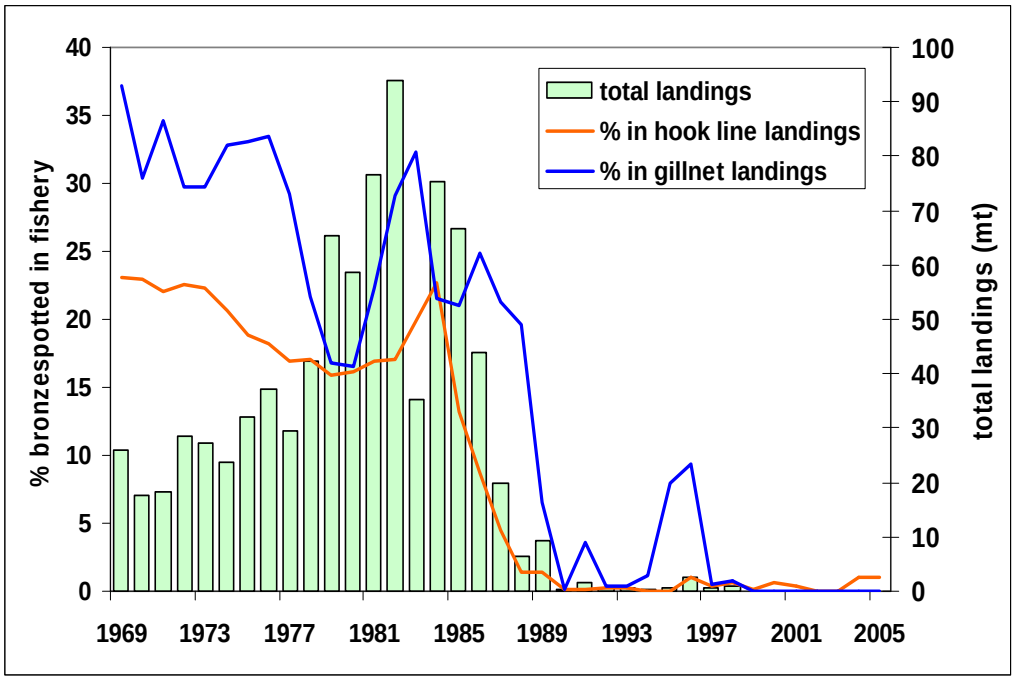

Figure 4. Commercial landings of bronzespotted rockfish in the Southern California Bight. Although sampling data only exists from 1982 onward (previous years were extrapolated), these data show that landings declined severely in the late 1980s, while overall catches of shelf rockfish (including the minor shelf category in which bronzespotted are managed) remained high, and have remained at very low levels since then (average less than 1 ton/year from 1990-1999).

D. OTHER RELATED STUDIES

1. Molecular Genetics

Researchers in the genetics program at the Fisheries Ecology Division have developed a suite microsatellite markers of multilocus nuclear genotypes developed for some 30 rockfish (*Sebastes*) species commonly found in the marine waters off of Central California (Pearse *et al.* 2007). These methods have been demonstrated to accurately assign nearly all individuals to the species level, and were developed primarily to provide a simple and cost effective approach to identify early life history stages, archived, or forensic samples of *Sebastes* species. The method to be applied uses six microsatellite loci selected from an initial 53 screened loci, using a reference data set comprised of 762 individual fish that amplified at two or more loci, for which a 93.3% success rate in species assignments was achieved in the assignment of unknown fish

sampled from outside the basic dataset using fish tissue. Funding was recently secured to apply these methods to identify juvenile rockfish to the species level from trawl surveys in which samples were damaged, as well as to identify rockfish prey remains to the species level in the diets of jumbo squid (*Dosidicus gigas*) and seabirds.

Researchers in the FRD have developed many genetic markers for groundfish, are working to determine stock structure and dispersal distances, and are helping with the design of MPA networks. The laboratory also houses a collection of over 20,000 groundfish tissue samples, which includes virtually all extant rockfish species and DNA extracted from museum specimens. These samples have enabled the completion of a comprehensive and robust phylogenetic hypothesis for the genus (Hyde and Vetter 2007, Fig. 4). This work allowed: (1) major revisions to previous subgeneric classifications based on morphology; (2) assignment of approximate timing of speciation events; (3) evaluation of patterns of species evolution; and (4) the discovery of two "cryptic" species of vermilion rockfish (*Sebastes miniatus*).

In response to the finding of two possible cryptic species, the geographic and bathymetric range of the two putative species of vermilion rockfish were examined (Hyde *et al*. in prep). Additional genetic markers were applied to test for reproductive isolation. The results strongly support the presence of two species, separated primarily by depth of occurrence (Fig. 6). One species occurs from Neah Bay, WA to Punta Baja, Mexico and is found primarily shallower than 100m. The second species is found from Monterey, CA to Punta Colnett, Mexico but is most abundant within the Southern California Bight, deeper than 100m. These results indicate that current depth closures in California are likely overly protecting the species found at depths >100m while placing increased effort upon the shallow, nearshore species. Following the previous study, we initiated a study of genetic connectivity between populations of the shallow, nearshore (<100 m depth) vermilion rockfish species (Hyde and Vetter in prep). A high-degree of genetic heterogeneity was observed among sample locations. Analyses supported a moderate genetic break across Point Conception with weaker breaks observed across Cape Blanco and possibly Cape Mendocino. There was a strong relationship between increasing genetic and geographic distance. The slope of this relationship was used to calculate larval dispersal values. The results suggest limited larval dispersal for vermilion rockfish, similar in magnitude to dispersal values obtained from previous studies on brown, copper, and grass rockfish.

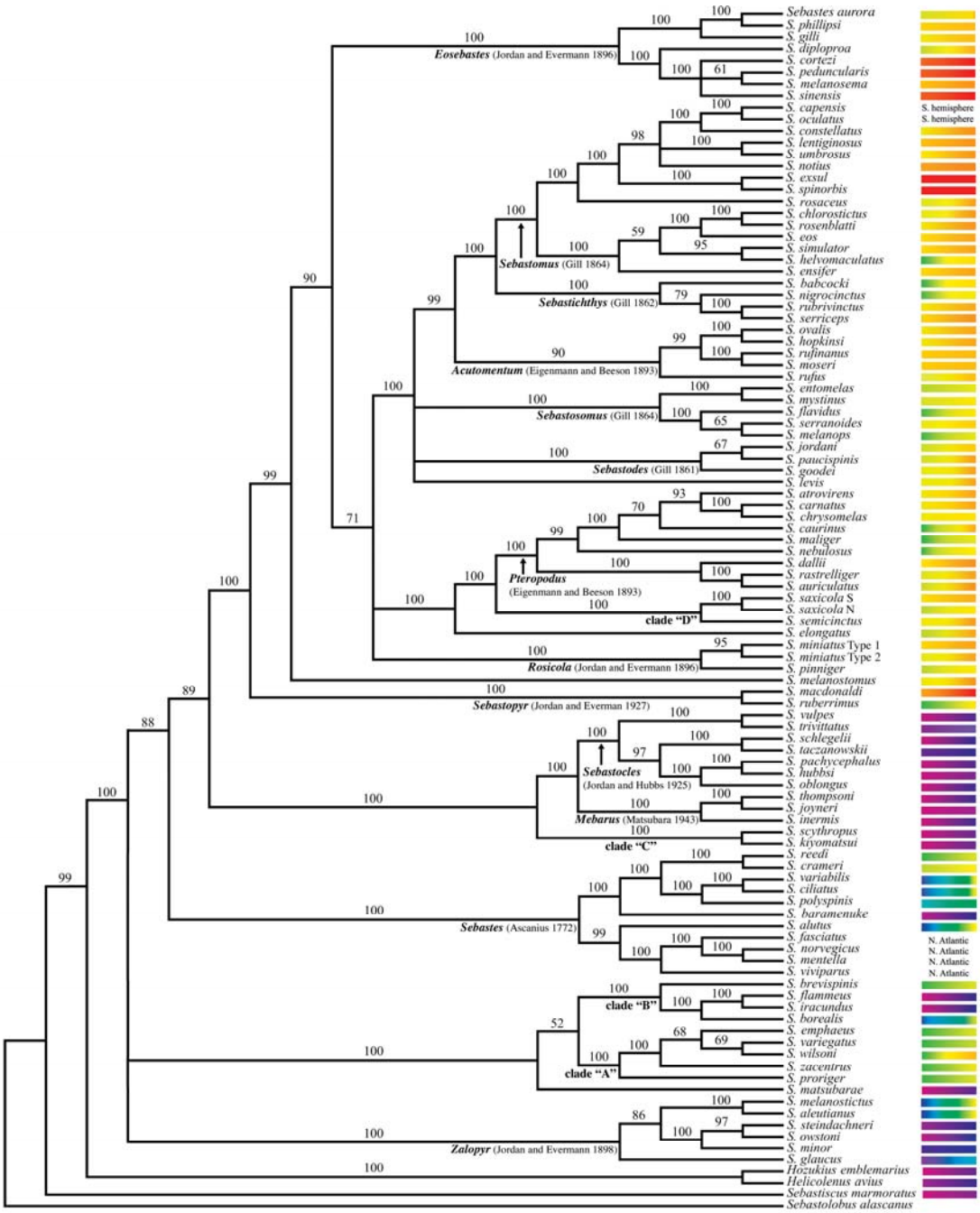

Figure 5. Consensus tree with maximum posterior probability generated from Bayesian posterior analysis using MrBayes v3.1. Numbers above nodes indicate Bayesian posterior probabilities >50%. Color spectrums next to species names indicate common range in reference to Figure 5. Revised sub-generic names are listed below nodes.

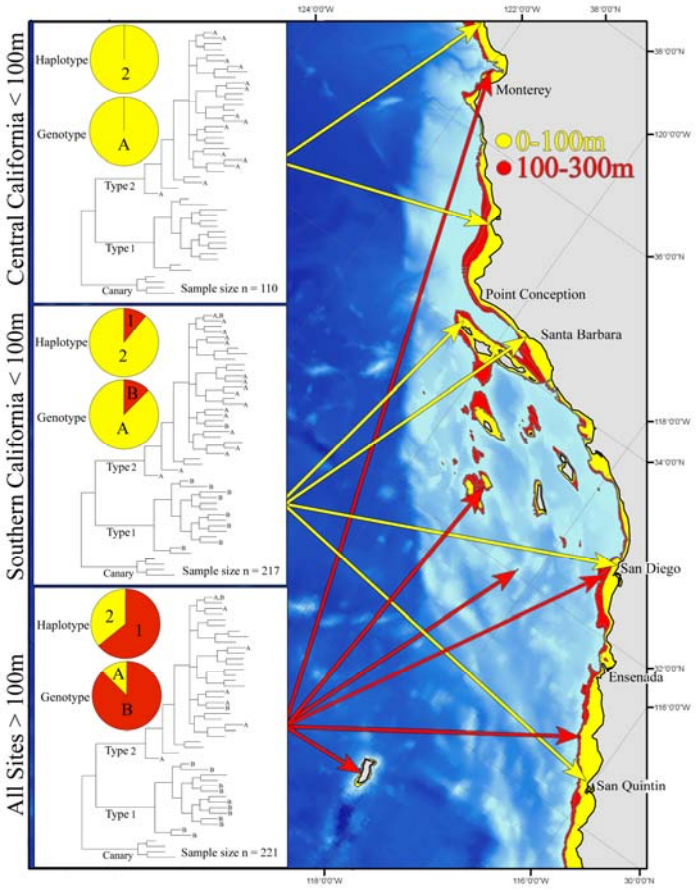

Figure 6. Map showing sampling locations for vermilion rockfish used in this study. Bathymetry is color coded with yellow (0-100m) and red (100-300m). Arrows indicate sampling sites and are color coded by collection depth to match the colored depth contours. Haplotypic (i.e., Type 1, Type 2) and genotypic assignment (i.e., Group A, Group B) for each sample group are presented as pie charts. The consensus Bayesian posterior tree of all haplotypes is presented for each sample group, and haplotypes present in each group are indicated with an A or B, corresponding to genotypic assignment of individuals at that haplotype.

2. Integration of Marine Protected Areas and Fisheries Science

The Santa Cruz Laboratory and the National Marine Protected Areas Science Institute have continued their support of the Science Integration of Marine Protected Areas and Fishery Management Working Group through 2006, and. In order to better understand how fisheries impact ecosystem function with MPAs and how MPAs impact fisheries objectives, the MPA Center Science Institute has been working with a group of fisheries and conservation biologists, sociologists, and economists to develop scientific information that can be integrated with conventional fisheries management strategies. The group was been divided into teams that include fisheries (MPA/ecosystem), connectivity, and natural heritage. Final products from the first phase of this effort are currently being delivered as reports and manuscripts (an example of one such product is below), and a second phase is anticipated which would focus on furthering several or all of the following topics: an MPA-based approach for data poor fisheries management (which would involve using a control rule that used uses fish density within MPAs as an index of unfished abundance); the implications of maternal age effects for MPA-based fisheries management; MPAs as a means of achieving evolutionarily stable harvest strategies; putting MPA/Fisheries science to work: the institutional dimension; assessing indicator performance in three different ecosystems; dynamic pool models and multispecies yield per recruit for multispecies fisheries; and consideration of benthic/pelagic linkages.

One product from these efforts is a simulation study conducted by Steve Ralston and Michael O'Farrell to evaluate the impact of spatial variation in fishing effort on sustainable yield. The purpose of the analysis was to determine what the effect of spatially variable fishing was on long-term yield, by comparing equilibrium yields under spatially heterogeneous fishing to the yields in the homogeneous case. Heterogeneity was modeled by perturbing fishing mortality rates in three areas, which included a reduced impact area, a standard impact area, and an elevated impact area. Fishing rates were perturbed to varying degrees among the areas, i.e., no perturbation (homogeneous fishing), ∀33% (minor), ∀67% (moderate), and ∀100% (extreme). This could be described as the "Goldilocks" design, with low mortality in the reduced impact area, high mortality in the elevated impact area, and standard mortality in the moderate impact zone. Moreover, compensation was modeled in three different ways: (1) larval pool density-dependence, (2) spawner density-dependence, and (3) post-settlement density dependence. Results showed that for the first two compensation scenarios, spatial variation in fishing mortality does not have a major impact on sustainable yield unless perturbations are extreme. Interestingly, simulated yields under the post-settlement compensation scenario indicated that extreme spatial variation in fishing (e.g., marine reserves) could produce yields in excess of the spatially homogeneous case.

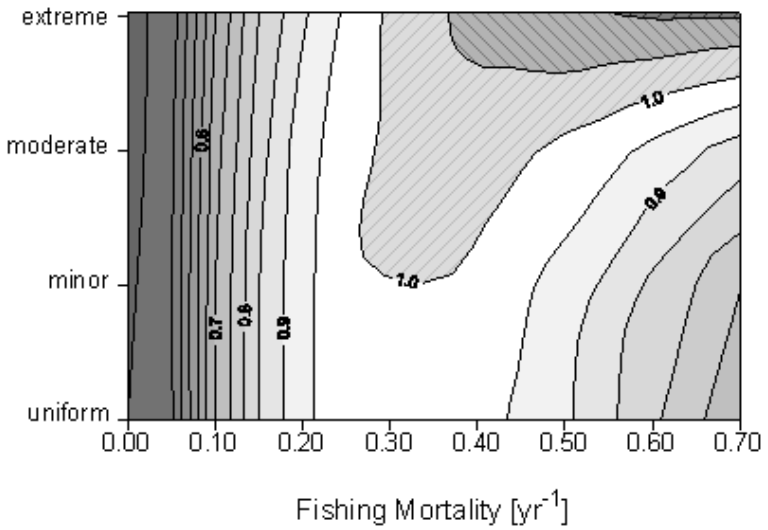

Figure 7: Contour plot of equilibrium yield relative to the homogeneous fishing mortality case for post-settlement compensation. The x-axis indicates the fishing mortality rate within the moderate impact area. The y-axis indicates the degree of perturbation of fishing mortality in the reduced and elevated impact areas. The extreme perturbation results in no fishing in the low impact zone and double the fishing mortality rate in the high impact area.

3. Connectivity of *Sebastes* Populations in California

Christine Peterson, a postdoctoral fellow with Steve Ralston at the FED, has been working on two distinct lines of research loosely related to establishing the extent of demographic and genetic connectivity among populations of winter-spawning *Sebastes* in the California Current.

The first study is an evaluation of genetic isolation by distance of pelagic juvenile widow (*S. entomelas*), black (*S. melanops*), and blue (*S.* mystinus) rockfish sampled during the annual SWFSC/PWCC coastwide midwater trawl survey. Using microsatellite DNA obtained from YOY rockfish collected during 2004-05 from Morro Bay, CA to Newport, OR, she has shown low levels of isolation by distance (e.g., F_{st} # 0.01 over distances of 900 km with no increasing trend), indicating significant genetic connectivity. This research has been conducted in close collaboration with investigators in the genetics laboratory at Santa Cruz. Her other research has been in collaboration with Ralston and Chris Edwards (Ocean Sciences, UCSC), who has a well-developed nested ROMS model of the US west coast. In this study Peterson has developed Lagrangian statistics to describe the fate of "floats" released in the ocean off central California. In particular, she has developed algorithms to estimate retention, dispersion, and connectivity based on outputs of the ROMS model from 2002. Clear patterns have emerged with respect to the advective characteristics of (1) the winter versus summer seasons, (2) the release depth of floats, and (3) the distance offshore of float release. In addition, it has been possible to estimate the ending latitudinal distribution of floats, given starting positions (Fig. 8). This analysis may prove quite useful in establishing the spatial connectivity of regions along the coast and in designing "networks" marine reserves.

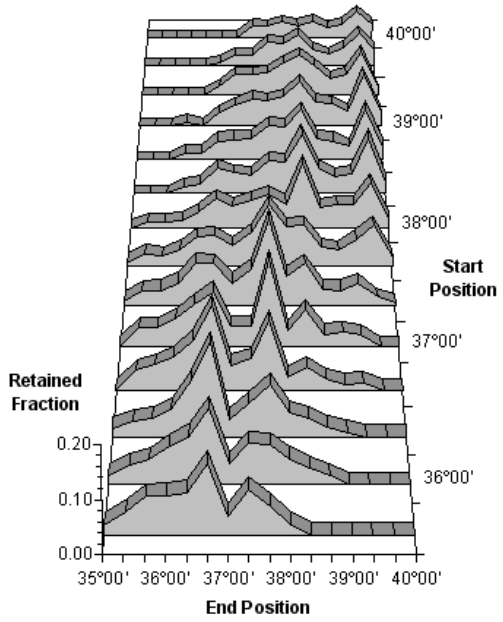

Figure 8: Spatial distribution of passive floats after 5 weeks at liberty during the ROMS reconstruction of the winter season of 2002, given initial release location. Obvious areas of increased retention (36º40'N) and dispersion (37º00'N) are evident.

4. SWFSC/Santa Cruz Lab Groundfish Habitat Ecology Program

The FED has an ongoing research program to implement legislative mandates with respect to Essential Fish Habitat (EFH) and Stock Assessment Improvement for West coast groundfish. This program uses a range of tools, including research submersibles, laser line scan system, and multibeam and side scan sonar. In addition to the Cowcod Conservation Area surveys and the

gear intercalibration research described in the Assessments section for shelf rockfish, other ongoing projects include: 1) an evaluation of patterns in groundfish distribution and abundance and seafloor habitats at a range of spatial scales, being conducted in collaboration with USGS (Anderson and Yoklavich, in press.); 2) characterizing benthic invertebrates that form habitat on deep banks off southern and central California, with special reference to deep sea coral communities (Tissot et al. 2006); 3) an evaluation of the potential for laser line scan (LLS) systems to serve as a bridge between high resolution, limited coverage video survey tools (e.g., remotely-operated vehicle (ROV), occupied submersible, towed sled) and lower resolution, higher coverage acoustic technologies (e.g., multibeam and sidescan sonar) (Amend et al. in press).

5. Economic Studies

The FED's Economics Team is developing a model of fishery dynamics using 1981-2005 vessel- and trip-specific data for all West coast commercial fisheries (including groundfish). This model is intended to: (1) analyze patterns of fishing behavior across space and time, (2) identify biological, economic, regulatory and environmental factors underlying these behavioral changes, and (3) evaluate the cumulative effects of these changes on fishing communities. The project is currently focused on the relationship between fishery behavior and port-level fishery infrastructure. Related efforts include the development of a Bayesian approach to estimating technical efficiency in the limited entry groundfish trawl fleet, in which an analysis is currently focused on the effects of the 2003 trawl vessel buyback program on technical efficiency in that fishery.

The Economics Team is also working in collaboration with the Environmental Research Division on an analysis of the economic effects of the Rockfish Conservation Areas on the groundfish trawl fleet. The ERD has expanded it's mapping of groundfish trawling to cover all of California's offshore waters out to 700 fathoms. Data consists of start and end locations of all tows from trawl logbooks from 1977 to 2005 linked to landings receipts for weight of market species. This year maps were created of the distribution and density of species from the trawl fishery for years before and during rockfish conservation area closures. Files of the 25 different RCA boundaries from 2002 to 2005 were created to overlay these maps. These data are being analyzed to quantify changes in fishing location and effort of the limited entry trawl fleet resulting from the RCA closures, including the spatial distribution of trawling by vessels from each port. This project will include analysis of (a) adaptations made by West coast groundfish trawlers in terms of movement between fisheries, and (b) adaptations by California groundfish trawlers in terms of spatial redistribution of effort and changes in fishing strategies.

6. Predator and ecosystem studies

Jumbo squid (*Dosidicus gigas*) are a large, rapidly growing subtropical cephalopod that have been occasional visitors to the California Current over the last century, however there is evidence that their abundance and distribution has increased between 2002 and 2006. In response to concerns over predation by jumbo squid on commercially important species, 428 stomach samples collected between 2005 and 2006 at various locations and seasons along the U.S. West Coast. Prey were identified using hard parts, primarily squid beaks and otoliths, and prey sizes

were estimated where possible (Field et al. in review). While jumbo squid forage primarily on small midwater and forage fishes, they also prey heavily on adult groundfish such as Pacific hake (*Merluccius productus*), shortbelly rockfish (*Sebastes jordani*), other rockfish, and several species of small flatfish and other groundfish. Pacific hake were the most frequently occurring prey, and were consumed from sizes ranging from less than 3 to over 40 cm. As their ability to prey on larger items suggests potential impacts on ecosystems, their role has also been evaluated in food web models of the California Current. A similar range expansion has been ongoing in the southern hemisphere in Central Chile, where declines in the Chilean hake stock have been partially attributed to predation by jumbo squid.

GROUNDFISH PUBLICATIONS OF THE SWFSC, 2006 - PRESENT

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STATE OF ALASKA
GROUNDFISH FISHERIES

ASSOCIATED INVESTIGATIONS IN 2006

Prepared for the Forty Eighth Annual Meeting of the Technical Subcommittee of the Canada-United States Groundfish Committee

April 24-25, 2007

With new contributions from:
Cleo Brylinsky, William Dunne, Kenneth J. Goldman, Mike Jaenicke, Scott Meyer, Kristen Munk, Nick Sagalkin, Gail Smith, Charlie Trowbridge, Mike Byerly, Dan Urban

April 2007

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION of COMMERCIAL FISHERIES & DIVISION of SPORT FISH
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E. AGENCY REPORTS – STATE OF ALASKA

STATE OF ALASKA GROUNDFISH FISHERIES AND ASSOCIATED INVESTIGATIONS IN 2006

AGENDA ITEM VII: REVIEW OF AGENCY GROUNDFISH RESEARCH, STOCK ASSESSMENT, AND MANAGEMENT

A. Agency Overview

1. Description of the State of Alaska commercial groundfish fishery program:

The Alaska Department of Fish and Game (ADF&G) has jurisdiction over all commercial 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 (GOA) Groundfish Fishery Management Plan (FMP) gives the State of Alaska limited management authority for demersal shelf rockfish in federal waters east of 140^{o} W. longitude. North Pacific Fisheries Management Council (NPFMC) action in 1997 removed black and blue rockfish from the Gulf of Alaska FMP thus the state manages these species in both state and federal waters (of the GOA). The state also manages the lingcod resource in both state and federal waters of Alaska. Other groundfish fisheries in Alaskan waters are managed by the federal government, or in conjunction with federal management of the adjacent Exclusive Economic Zone (EEZ). The information related in this report is from the state-managed groundfish fisheries only.

The State of Alaska is divided into three maritime regions for marine commercial fisheries management. The Southeast Region extends from the Exclusive Economic Zone (Equi-distant line) boundary in Dixon Entrance north and westward to 144^{o} W. longitude and includes all of Yakutat Bay (Appendix II). The Central Region includes the inside and outside Districts of Prince William Sound (PWS), Cook Inlet including the North Gulf District off Kenai Peninsula, and Bristol Bay. The Westward Region includes all territorial waters of the Gulf of Alaska south and west of Cape Douglas and includes North Pacific Ocean waters adjacent to Kodiak, and the Aleutian Islands as well as all U.S. territorial waters of the Bering, Beaufort, and Chukchi Seas.

a. Southeast Region

The **Southeast Region** Commercial Fisheries Groundfish Project is based in Sitka with the groundfish project leader, assistant project leader and a full-time fisheries technician located there. One full-time biologist and one full-time fisheries technician for this project are based in Douglas. Seasonal technicians and port samplers are employed in Petersburg, Ketchikan and Sitka. The project also received biometrics assistance from the regional office in Douglas.

The Southeast Region's groundfish project has responsibility for research and management of all commercial groundfish resources in the territorial waters of the Eastern Gulf of Alaska as well as demersal shelf rockfish, black and blue rockfishes and

lingcod in the EEZ. The project cooperates with the federal government for management of the waters of the adjacent EEZ. The project leader participates as a member of the North Pacific Fisheries Management Council's Gulf of Alaska Groundfish Plan Team and produces the annual stock assessment for demersal shelf rockfish for consideration by the North Pacific Fishery Management Council.

Project activities center around fisheries monitoring, resource assessment, and in-season management of the groundfish resources. In-season management decisions are based on data collected from the fisheries and resource assessment surveys. Primary tasks include fish ticket collection, editing, and data entry for both state and federal-managed fisheries; dockside sampling of sablefish, lingcod, Pacific cod, and rockfish landings; and skipper interview and logbook collection and data entry. Three resource assessment surveys were conducted during 2006. Funding for the Southeast Groundfish project comes from NOAA Grants NA06NMF4370212, NA04NMF4070165, and NA04NMF4370176.

b. Central Region

Central Region groundfish staff is headquartered in Homer and is comprised of a regional groundfish management biologist, a regional shellfish/groundfish research project leader, a groundfish sampling coordinator, a groundfish fish ticket entry position, three marine research biologists, and one seasonal commercial catch sampler. An area management biologist and a seasonal commercial catch sampler are also located in Cordova and regional support comes from Anchorage. The research project leader also functions as a member of the North Pacific Fishery Management Council's Gulf of Alaska Groundfish Plan Team. The R/V *Pandalus*, home ported in Homer, and the R/V *Solstice*, home ported in Cordova, conduct a variety of groundfish-related activities in Central Region waters.

Groundfish responsibilities include research and management of groundfish species harvested in territorial waters of Central Region. Within Central Region, groundfish species of primary interest include sablefish, rockfish, pollock, Pacific cod, lingcod, flatfishes, sharks, and skates. Stock assessment data are collected through port sampling, and through ADF&G trawl, longline, jig, scuba, and remotely operated vehicle (ROV) surveys. Commercial harvest data (fish tickets) are processed in Homer for state and federal fisheries landings in Central Region ports.

c. Westward Region

The **Westward Region** Groundfish management and research staff is located in Kodiak and Dutch Harbor. Kodiak staff is comprised of a regional groundfish management biologist, an area groundfish management biologist, an assistant area groundfish management biologist, a groundfish research project leader, a groundfish research project assistant biologist, a groundfish dockside sampling coordinator, a seasonal age-determination unit biologist, two seasonal fish ticket processing technicians, and a seasonal dockside sampler. A full-time assistant area groundfish management biologist, a seasonal fish ticket processing technician, and a seasonal dockside sampler are located in the Dutch Harbor office. Seasonal dockside sampling also occurs in Chignik, Sand Point, King Cove, and Adak. The R/V *Resolution*, R/V *K-Hi-C*, and R/V *Instar* are home

ported in Kodiak and conduct a variety of groundfish related activities in the waters around Kodiak, the south side of the Alaska Peninsula, and in the eastern Aleutian Islands.

Major groundfish activities include: fish ticket editing and entry for approximately 11,000 tickets from both state and federal fisheries, analysis of data collected on an annual multi-species trawl survey encompassing the waters adjacent to the Kodiak archipelago, Alaska Peninsula and Eastern Aleutians, management of black rockfish, state-waters Pacific cod, lingcod, and Aleutian Island state-waters sablefish fisheries, conducting dockside interview and biological data collections from commercial groundfish landings, and a number of research projects. In addition, the Westward Region has a member on the North Pacific Fisheries Management Council's Bering Sea/Aleutian Island Groundfish Plan Team (Ivan Vining) and the Gulf of Alaska Groundfish Plan Team (Nick Sagalkin).

d. Headquarters

The **Alaska Fisheries Information Network (AKFIN)** project began in 1997 in response to the 1996 Magnuson-Stevens Act. The Alaska Department of Fish and Game (ADF&G) entered into a contract with the Pacific States Marine Fisheries Commission to expand data collection and management duties previously carried out under PACFIN. The purpose of the AKFIN program is to collect and make available the fishery catch information from Alaska's marine fisheries. This includes the major federal and state groundfish fisheries as well as the Bering Sea and Aleutian Island crab fisheries. The AKFIN project provides accurate and timely fishery data that has been essential for management, pursuant to the biological conservation, economic and social, and research and management objectives of the fishery management plans for groundfish and crab resources.

The Alaska Fisheries Information Network also:

1. Provides a forum for agencies to develop coordinated relational data/information systems encompassing State of Alaska and Federal fisheries data for use by fishery managers, associated agencies and the public.
2. Provides data management consultation and technical advice to participating agencies upon request.
3. Promotes the efficiency, effectiveness and timeliness of data acquisition and delivery with a minimum of duplication.
4. Maintains the AKFIN Support Center which conducts such projects set forth in the AKFIN work plan to insure that all available data are accessible to fishery managers, the North Pacific Fishery Management Council and its Plan Development Teams and Scientific and Statistical Committee, and each participating agency to meet respective fisheries management responsibilities.
5. Facilitates and supports a comprehensive and coordinated program to collect, record, store, and make available social and economic data relating to fisheries and fishing communities.

6. Provides support for the acquisition, maintenance, and analysis of fishery dependent data (including but not limited to GIS-based fishing locations, otolith-based age determination, and port sampling) for inclusion in agency databases as appropriate.

The foundation of the state's AKFIN project is an extensive port sampling system for collection and editing of fish ticket data from virtually all of the major ports of landing from Ketchikan to Adak and the Pribilof Islands, with major emphasis on Sitka, Homer, Kodiak, and Dutch Harbor. The port sampling program includes collection of harvest data, such as catch and effort, and also the collection of biological data on the fish and crab species landed, and age determination based on samples of age structures collected from landed catches. ADF&G personnel continued to collect, review, edit and amend, data capture, and archive all ADF&G fish tickets submitted to local offices. These fish tickets include those required as well as tickets voluntarily submitted by EEZ operators.

The state's AKFIN program is supported by a strong commitment to development and maintenance of a computer database system designed for efficient storage and retrieval of the catch and production data on a wide area network. It supports the enhancement of the fish ticket information collection effort including; regional fishery monitoring and data management, GIS database development and fishery data analysis, catch and production database development and access, the Age Determination Unit laboratory, database management and administration, Bering sea crab data collection and reporting, various fishery economic projects, and fisheries information services.

Local ADF&G personnel in ten locations throughout the state of Alaska (Craig, Ketchikan, Petersburg, Sitka, Juneau, Seward, Homer, Cordova, Kodiak, and Dutch Harbor) maintain close contact with fishers, processors and enforcement to maintain a high quality of accuracy in the submitted fish ticket records. Following processing, the data is electronically transferred to Headquarters. The research analyst working with this project works as part of a team to maintain a master statewide groundfish fish ticket database. Data feeds to Headquarters are merged to this master database. Data is routinely reviewed for accuracy with corrections applied as required. Within the confines of confidentiality agreements, raw data is distributed to the National Marine Fishery Service (both NMFS-ARO and NMFS-AFSC), the North Pacific Fishery Management Council (NPFMC), the Commercial Fisheries Entry Commission (CFEC), the Pacific States Fisheries Information Network (PACFIN) and the AKFIN Support Center on a regularly scheduled basis. Summary groundfish catch information is also provided back to regional ADF&G offices as well as to the State of Alaska Board of Fisheries, NMFS, NPFMC and the AKFIN Support Center (Contact Lee Hulbert).

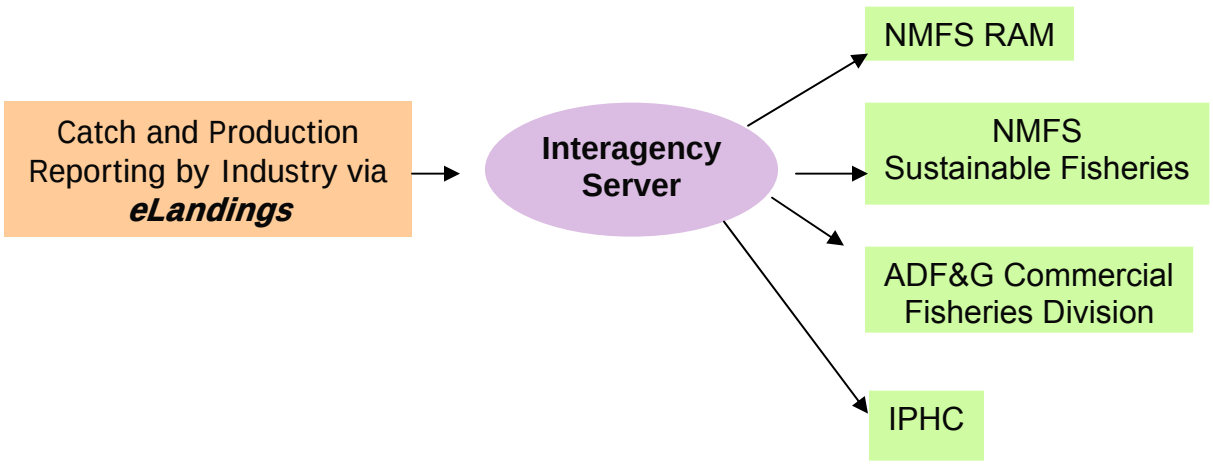
Electronic Fish Ticket System (contact Gail Smith)
The Alaska Department of Fish and Game maintains a commercial harvest database, based on landing report receipts – fish tickets. These data are comprehensive for all commercial salmon, herring, shellfish, and groundfish from 1969 to present. Data is stored in an Oracle relational database and available to regional staff via the State of Alaska wide-area network.

The three resource management agencies tasked with commercial fisheries management in Alaska are the Alaska Department of Fish and Game (ADF&G), the International Pacific Halibut Commission (IPHC), and the National Marine Fisheries Service-Alaska Region (NMFS-AK). Since 2001, these agencies have been working to develop consolidated landing, production, and IFQ reporting from a sole source. This collaborative effort, the Interagency Electronic Reporting System (IERS), was developed with funding provided through the Pacific States Marine Fisheries Commission. The web-based reporting component of this system is ***eLandings***. An additional application was developed, designed to be installed on local computers for the at-sea, catcher processor fleet.

AKFIN funded ADF&G personnel participate in the IERS project on the development, implementation, and maintenance levels. The IERS provides processors with a web-based online electronic catch and production reporting program. The IERS features include electronic landing and production reports, real time quota monitoring, immediate data validation, and printable (.pdf) fish ticket reports. To date, IERS is being used in the Western Gulf and Bering Sea crab fisheries and groundfish – statewide. Our goal is to move to statewide implementation of electronic reporting in all shellfish fisheries by August of 2007. Staged implementation allows a small staff to successfully manage this ambitious project. Salmon and herring will be addressed, beginning in 2008.

The web-based application provides the seafood industry with the ability to submit landing reports (fish tickets), IFQ fisher/processor quota harvest, and processor production information from a single location. The information submitted via the web application, ***eLandings***, is stored in a single repository database. The ADF&G, the IPHC, and the NMFS-AK copy data submitted by industry to their individual data systems.

DATA FLOW MODEL



This new commercial harvest reporting provides several benefits for fisheries management agencies and industry, when compared to paper-based systems. The most

obvious benefit is a sole-source reporting site for landing and production data. Fisheries managers, individual processing facilities, and the parent company will have the ability to obtain landing report catch and production information immediately. Additional benefits include:

- Significant reduction of redundant reporting to management agencies.
- Immediate data validation when the landing, IFQ, or production report is submitted.
- Real time harvest data availability to management agencies.
- Staged reporting to accommodate the work flow of industry.
- Application function to allow processors to import or export the catch and production information they submit, facilitating one time data entry for processors.

The *eLandings* applications were deployed initially with the Rationalized Crab fisheries of the Bering Sea and Aleutian Islands, August 2005. The implementation for statewide groundfish began on May 15, 2006. To date, the IERS system has recorded approximately 1,000 crab landings and 10,000 groundfish landings. 24/7 user support is being contracted to GCI, an Alaska based telecommunications company.

Local ADF&G personnel in six locations throughout the state of Alaska (Petersburg, Sitka, Juneau, Homer, Kodiak and Dutch Harbor) maintain close contact with groundfish fishers, processors and state/federal enforcement to maintain a high quality of accuracy in the submitted fish ticket records. The Interagency Electronic Reporting System – *eLandings* applications, with immediate data validation and business rules, should continue to improve data quality and allow personnel to function at a higher level.

Landing and production data are submitted to a central database, housed in Juneau, validated and reviewed, and pulled to the individual agency databases. Landing data is available to agency personnel within seconds of submission of the report. Printable documentation of the landing report and the Individual Fishery Quota debit are created within the applications. Signed fish tickets will continue to be submitted to local offices of ADF&G for additional review and comparison to other data collection documents. These documents include vessel/fisher logbooks, agency observer datasets, and dockside interviews with skippers.

Within the confines of confidentiality agreements, raw data is distributed to the State of Alaska Commercial Fisheries Entry Commission (CFEC) daily and to the National Marine Fishery Service NMFS-ARO and AKFIN Support Center on a monthly schedule. The CFEC merges the ADF&G fish ticket data with fisher permit and vessel permit data. This dataset is then provided to the AKFIN Support Center, which distributes the data to the professional staff of the North Pacific Fishery Management Council (NPFMC) and summarized data to the Pacific States Fisheries Information Network (PACFIN). Summary groundfish catch information is also posted on the ADF&G Commercial Fisheries website: http://www.cf.adfg.state.ak.us/geninfo/finfish/grndfish/grndhome.php. Summarized data is provided to the State of Alaska Board of Fisheries, the North Pacific Fisheries Management Council, and to the State of Alaska legislature as requested.

e. Gene Conservation Laboratory

In the past, the ADF&G Gene Conservation Laboratory collected genetic information on black rockfish, light and dark dusky rockfish, and pollock (a list of *Sebastes* tissue samples stored at ADF&G's Gene Conservation Laboratory can be found in Appendix III).

f. Age Determination Unit

The ADFG's centralized statewide age reading program at the Age Determination Unit (ADU) in Juneau continued to provide age data to ADFG regional managers in 2006. Age structures from approximately 8,323 groundfish, representing 14 species, were received through statewide commercial and survey harvest sampling efforts and 7034 age data were released back to managers. Additional age data were produced through training and precision testing. A total of 12,135 otoliths were measured. The majority (63%) of funding for this project is through the Alaska Fisheries Information Network (federal), approximately 17% from the Fisheries Management Plan Early Jurisdiction (Project 15; federal), and 20% is general funding (state). Five people were employed for approximately 39 work months to age groundfish age structures or conduct associated work (sample preparation, data entry, archiving, otolith measurements, and project work). Only one employee was full-time and funded year round. Other individuals were seasonal, employed for 2-11 months duration.

Quality of age data is routinely assessed through second-reading of at least 15% of the sample, either by the initial-reader or by a reader with equal or greater experience. Species-specific control limits are imposed and further guide release of age data; transgression of control limits direct reviewing of some or the entire sample.

In 2006, the ADU was in production status for all species received except gadids (questions regarding contemporary aging practices of gadids remain). Due to substantial increases in sampling of sablefish and the need for these data in age structured models, all age readers are being developed primarily and immediately for aging sablefish otoliths (and less so other rockfish species). This tends to depress production of age data in the short term due to reading difficulties. Sablefish otolith growth patterns are complex, and improvement in data quality generally occurs after at least several months of experience, as opposed to weeks for rockfish. Effort continues toward increasing objective information (age structure measurements) to strengthen foundation of pattern interpretation for all species.

The ADU initiated a pilot project aimed at validating the age of walleye pollock using direct measure of annual increases in otolith weight. ADU staff beach-seined age-0 pollock and are presently culturing these animals at the Auke Bay Laboratory in Juneau. Minimum informative results are not expected for at least four years.

The ADU Oracle database, AegIS, (Age Information System), was used for simple importing and exporting of data throughout 2006. In late 2006, AegIS completed Phase 2 of a 3 phase redevelopment. AegIS now incorporates biological measurements such as

fish and age structure dimensions. Programming work was conducted by 2 non-ADU personnel and funding sources.
Limited refinements to the ADU website (http://tagotoweb.adfg.state.ak.us/ADU/) were made.
(Contact Kristen Munk)

2. Description of the State of Alaska recreational groundfish fishery program (Sport Fish Division)

ADF&G has jurisdiction over all recreational groundfish fisheries within the internal waters of the state, in coastal waters out to three miles offshore, and throughout the EEZ. The Alaska Board of Fisheries extended existing state regulations governing the sport fishery for all marine species into the waters of the EEZ off Alaska in 1998. This was done under provisions of the Magnuson-Stevens Fishery Conservation and Management Act, which stipulate that states may regulate fisheries that are not regulated under a federal fishery management plan or other applicable federal regulations.

Most management and research efforts are directed at halibut, rockfish, and lingcod, the primary species targeted by the recreational fishery. Statewide data collection programs include an annual mail survey to estimate overall harvest (in number) of halibut, rockfish, lingcod, and sharks, and a mandatory logbook to assess harvest of the same species in the charterboat fishery. The Assistant to the Commissioner (Douglas Vincent-Lang), located in Anchorage, took the statewide lead in federal-state jurisdictional management issues.

Regional programs with varying objectives address estimation of recreational fishery statistics including harvest and release magnitude and biological characteristics such as species, age, size, and sex composition. Research is funded through the Federal Aid in Sport Fish Restoration program and through a NOAA grant administered by NMFS. There are essentially two maritime regions for marine sport fishery management in Alaska. The Southeast Region extends from the Exclusive Economic Zone (Equi-distant line) boundary in Dixon Entrance north and westward to Cape Suckling, at approximately 144^{o} W. longitude. The Southcentral Region includes state and federal waters from Cape Suckling to Cape Newenham, including Prince William Sound (PWS), Cook Inlet, Kodiak, the Alaska Peninsula, the Aleutian Islands, and Bristol Bay.

a. Southeast Region Sport Fish

Regional staff in Douglas coordinates a data collection program for halibut and groundfish in conjunction with a regionwide Chinook salmon harvest studies project. The project leader is Mike Jaenicke while assistant project biologists were also located in Ketchikan (Kathleen Wendt), Juneau (Diana Tersteeg), and Sitka (Heather Riggs). The project biometrician (Steve Fleischman) is located in Anchorage. A total of 21 technicians work at the major ports in the Southeast region, where they interview both anglers and charter operators and then collect data from sport harvests of halibut and groundfish while also collecting data on sport harvests of salmon. Data collected on groundfish are limited to species composition, length and weight of rockfish species, length of halibut and lingcod, and sex of lingcod; no otoliths or other age structures are

collected. Data are provided to the Alaska Board of Fisheries, other ADF&G staff, the public, and a variety of other agencies such as the NPFMC and the IPHC.

Area management biologists in Yakutat, Haines, Sitka, Juneau, Petersburg, Klawock, and Ketchikan are responsible for groundfish management in those local areas. In general, sport fisheries for groundfish are not actively managed inseason.

b. Southcentral Region Sport Fish

The **Southcentral Region** groundfish staff consists of the area management biologists and assistants for the following areas: (1) PWS and the North Gulf areas, (2) Lower Cook Inlet, and (3) Kodiak, Alaska Peninsula, and the Aleutian Islands. In addition, a region-wide harvest assessment project was based in the Homer office, consisting of a project leader, field supervisor, and six technicians. The research project biometrician was located in Anchorage. Ongoing assessment of sport harvest and fishery characteristics at major ports throughout the region is the primary activity. Data are collected from harvested halibut, rockfishes, lingcod, and sharks, and anglers and charter boat operators are interviewed for fishery performance information. All age reading is done in Homer, and the staff are active participants in the Committee of Age Reading Experts (CARE). Seasonal technicians collected data from the sport harvest at seven major ports in the region, and two of them read all rockfish and lingcod age structures. Halibut otoliths were collected from the harvest and will be forwarded to the International Pacific Halibut Commission for age reading.

Southcentral region staff is responsible for management of groundfish fisheries in state and federal waters. For all species, the lack of stock assessment information has precluded development of abundance-based fishery objectives. As a result, management is based on building a regulatory framework specifying bag and possession limits, seasons, and methods and means that provides for sustained yield over the long term. Inseason management action has generally been unnecessary, but increasing harvests of some species will eventually necessitate development of a well-defined harvest strategy.

Typical duties also include providing sport halibut harvest statistics to the International Pacific Halibut Commission (IPHC) and NPFMC, assisting in development and analysis of the statewide charter logbook program and statewide harvest survey, working with Alaska Board of Fisheries, advisory committees, and local fishing groups to develop local area management plans (LAMPs), drafting and reviewing proposals for recreational groundfish regulations, and dissemination of information to the public.

B. By Species

1. Pacific cod

Catch rate and biological information is gathered from fish ticket records, port sampling programs, a tagging program, and during stock assessment surveys for other species. A mandatory logbook program was initiated in 1997 for the state waters of Southeast Alaska. Commercial landings in Southeast, Central Region and the Westward Region are sampled for length, weight, age, sex, and stage of maturity.

a. Research

The **Westward Region** has continued the cod-tagging program that was initiated in 1997 in the Central and Western Gulf of Alaska. Approximately 800 fish were tagged in 2006, bringing the total number of tags released to 13,980. By year's end, 792 tags had been recovered, 528 of them with useable recovery location information. Results to date show that while the vast majority of Pacific cod are recovered within 15 km of their tagging location, much longer recapture distances are possible. Several fish were recaptured more than 500 km from their tagging location. The relatively small number of long distance recaptures show movement of cod is occurring from the Shumagin Islands into the Bering Sea, the Alaska Peninsula to Kodiak waters, and several fish tagged in Kodiak waters were recovered in Southeast Alaska. Work has begun to integrate the Westward Region Pacific cod tagging results with those of the National Marine Fisheries Service.

b. Stock Assessment

No stock assessment programs were active for Pacific cod during 2006.

c. Management

Regulations adopted by the Alaska Board of Fisheries during November 1993 established a guideline harvest range (GHR) of 340 to 567 mt for Pacific cod in the internal waters of **Southeast Alaska**. The GHR was based on average historic harvest levels rather than on a biomass-based ABC estimate. Pacific cod along the outer coast are managed in conjunction with the Total Allowable Catch (TAC) levels set by the federal government for the adjacent EEZ.

In 1996, the Alaska Board of Fisheries adopted Pacific cod Management Plans for fisheries in five groundfish areas, **Prince William Sound**, **Cook Inlet**, **Kodiak**, **Chignik** and **South Alaska Peninsula**. The plans did not restrict participation to vessels qualified under the federal moratorium program. Included within the plans were season, gear and harvest specifications. Fishing seasons begin seven days after the close of the initial federal season in all areas except Cook Inlet, which begins 24 hours after the closure and Chignik, which has a regulatory opening date of March 1. The BOF restricted the state waters fisheries to pot or jig gear in an effort to minimize halibut bycatch and avoid the need to require onboard observers in the fishery. The guideline harvest levels (GHL) are allocated by gear type. The annual GHLs are based on the estimate of allowable biological catch (ABC) of Pacific cod as established by the NPFMC. Current GHLs are set at 25% of the Western Gulf ABC to be reserved for the South Alaska Peninsula Area;

25% of the Central Gulf ABC to be apportioned between the Kodiak, Chignik and Cook Inlet Areas; and 25% of the Eastern Gulf ABC for the Prince William Sound Area. Action by the BOF in 2004 reduced the GHL in Prince William Sound to 10% of the Eastern Gulf ABC with a provision to increase subsequent GHLs to 25% if the GHL is achieved in a year.

Additional regulations include a 58' vessel size limit in the Chignik and South Alaska Peninsula Areas and allocations between gear types in all five areas. The fishery management plans also provided for removal of restrictions on exclusive area registrations, vessel size and gear limits after October 31 to increase late season production to promote achievement of the GHL.

Efforts have increased to collect biological data through port sampling. In addition, observers are used on day trips to document catches and at-sea discards in the nearshore pot fisheries.

There is no bag, possession, or size limit for Pacific cod in the recreational fisheries in Alaska, and the season is open year-round. Recreational harvest of Pacific cod is estimated through the Statewide Harvest Survey (SWHS). Limited information is collected through the Sport Fish Division's Southcentral Region port sampling program. Specifically, numbers of cod kept and released by stat area is recorded by ADF&G groundfish stat area for each vessel-trip interview. No size or age data are collected. No information is collected in the Southeast Region creel survey program on the Pacific cod sport fishery.

d. Fisheries

Most of the Pacific cod harvested in Southeast Alaska are taken by longline gear in the Northern Southeast Inside (NSEI) area during the winter months. Pots have been the dominant gear in both the Cook Inlet and Prince William Sound areas. Overall Pacific cod harvest from the Cook Inlet and PWS areas during the parallel season has declined in recent years. In the Westward Region, trawl gear takes over 60% of the harvest, with the remainder split between longline, jig, and pot gear. Prior to 1993 much of the cod taken in Southeast was utilized as bait in fisheries for other species. Pacific cod harvested since that time is roughly 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 totaled 164 mt in the Southeast state-managed fishery during 2006, down 23% from the 2005 catch. The 2006 GHLs for the state-managed Pacific cod seasons in the Cook Inlet and Prince William Sound Areas of the **Central** Region were set at 1,420 mt and 413 mt, respectively. Due to the low number of vessels making landings from the PWS Area in 2006 harvest figures are confidential while harvest from the Cook Inlet Area state-managed Pacific cod fishery totaled 670 mt. Harvest from the 2006 state managed fishery in the Kodiak Area totaled 2,877 mt, while 1,560 mt of cod were harvested in the Chignik Area, and the South Alaska Peninsula Area harvest totaled 5,312 mt. The Kodiak and South Alaska Peninsula Areas obtained their maximum GHL 'step up' provisions for 2000 and all subsequent years. The Kodiak Area will receive 12.5% of the Central Gulf ABC and the South

Alaska Peninsula will receive 25% of the Western Gulf ABC in all future years. The Chignik Area achieved its maximum GHL 'step' up in 2003. The Chignik Area will receive 8.75% of the Central Gulf ABC in 2004 and all future years. Action by the Alaska Board of Fisheries during 2004 increased the Pacific cod allocation in the Cook Inlet Area from 3% to 3.75% of the Central Gulf ABC, the maximum allowed under regulation.

Estimates of the 2006 recreational harvest of Pacific cod are not yet available from the statewide harvest survey, but the 2005 estimates were 13,019 fish in Southeast and 14,931 fish in Southcentral Alaska. The average estimated annual harvest for the most recent five-year period (2001-2005) was 6,722 fish in Southeast Alaska and 11,401 fish in Southcentral Alaska. There are no estimates of average weight in the sport harvest in either region.

2. Rockfishes

Rockfishes are managed under three assemblages: demersal shelf (DSR), pelagic shelf (PSR), and slope rockfish. Demersal Shelf Rockfish include the following species: yelloweye, quillback, china, copper, rosethorn, canary, and tiger. Pelagic shelf rockfish (PSR) include black, blue, dusky, dark, yellowtail, and widow. Black and blue rockfish were removed from the PSR assemblage in the federal fisheries management plan (FMP) and placed totally under state management in 1998. The North Pacific Fisheries Management Council (NPFMC) is in the final stage of determining whether or not to remove darks also from the PSR assemblage in the FMP and turn the management of them over to the State. The final determination will be made at the March meeting of the NPFMC. Slope rockfish contain all other *Sebastes* and *Sebastolobus* species.

a. Research

In the **Southeast Region** port sampling and the mandatory logbook program for all fisheries continued, however in 2006 no port sampling of rockfish occurred in Southeast. 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. In 2006, the directed fishery for demersal shelf rockfish (DSR) did not open in the Southeast Outside District (SEO) because the estimated bycatch mortality in the commercial halibut fishery combined with the estimated DSR harvest in the charter and sport fish fisheries was believed to leave insufficient TAC to support a commercial fishery. The directed fishery for DSR opened in internal waters but landings were minimal and no port sampling of those landings was possible. The Southeast Groundfish Project has made an agreement with the IPHC so that during the summer of 2007 age structures will be obtained as well as biological data from the bycatch of rockfish captured on the IPHC annual longline survey.

Rockfish habitat mapping projects continue in the Southeast Region. The objective of this project is to continue a bottom-mapping project of the Eastern Gulf of Alaska to provide detail on habitat characterization in this important fishing ground. To date

ADF&G has mapped approximately 2100 km^2 of seafloor. This represents over 7% of the total habitat inside the 100-fm contour along the outer coast of Southeast. More importantly, over 980 km^2 of rocky habitat has been mapped, approximately 32% of what is estimated to occur. The goals of this project are to: Produce a GIS compatible sun-illuminated multibeam mosaic of these areas complete with bathymetric contour mosaics and a geological habitat interpretation of the mosaics. Quantification of rockfish habitat based on the geological interpretation of multibeam data is subcontracted to Moss Landing Marine Laboratories. While work continued during 2006 at Moss Landing to finish the interpretation of data collected in 2005, there were no new data sets collected in 2006.

Skipper interviews and port sampling of commercial rockfish deliveries in **Central Region** during 2006 occurred in Homer, Seward, Whittier, Anchorage and Cordova. Efforts during the first half of the year were directed at the sampling of rockfish delivered as bycatch in other groundfish fisheries, primarily slope and demersal shelf species. During the last half of the year, sampling focused primarily on the directed jig fishery that targets pelagic rockfish. Additional sampling occurred during the Cook Inlet and PWS trawl and sablefish longline surveys. Sample data collected included date and location of harvest, species, length, weight, sex, and gonad condition. Otoliths were collected from most sampled fish. Homer office staff determined ages of pelagic and demersal rockfish otoliths. Otoliths from all other rockfish species were sent to the Age Determination Unit (Contact Willy Dunne).

In 2003, **Central Region** staff completed a three-year project to evaluate sampling approaches for estimating black rockfish (*Sebastes melanops*) abundance in specific nearshore habitats of southcentral Alaska along the northern Gulf of Alaska. Two sampling approaches were evaluated; transect sampling (strip and distance sampling) and mark-recapture. In addition, black rockfish habitat use patterns were investigated. In summary, within preferred habitats, strip transect methods may be superior to distance sampling methods for estimating black rockfish density using scuba. However, transect methods can be problematic due to the attraction of black rockfish to divers. A separate responsive movement experiment was conducted to evaluate the extent of the effect. Results indicated a significant positive attraction effect, but also indicated that a timed count method may be a standardized method to quantitative index black rockfish abundance. The implementation of this method on a management area scale would be cost prohibitive, however. Mark-recapture was not a successful method to estimate the local abundance of black rockfish in the time frame employed during this study. However, recapture success may be improved with amended sampling techniques such as increased effort into recapturing marked fish visually using scuba or a greater time lapse between tagging and recapture efforts. It is possible that mark-recapture estimates may only be applicable to small areas. Wave energy and substrate type were highly significant predictors of black rockfish occurrence and this information is deemed essential to increase the efficiency of any field assessment survey.

Another project that assessed the likelihood of using mechanical jigging CPUE and hydroacoustic counts as an index of relative abundance for black rockfish was completed

in 2006. This joint project between regions II and IV compared the two likely indices to under water scuba observations. Results indicated that there was not a significant relationship between CPUE and black rockfish abundance as determined from scuba observations, but that there was slight agreement between hydroacoustic counts and scuba observations. More analysis and field research is needed to further assess the robustness of using hydroacoustic counts to index black rockfish abundance.

A project which involved a series of three separate grants was completed in 2006. This project involved 1) the procurement of a remotely operated vehicle (ROV), 2) the completion of an investigative survey to estimate the density of lingcod (*Ophiodon elongates*) using ROV transects and the estimation of maturity parameters, 3) the development of a marine habitat GIS for Central Region, and 4) the estimation of lingcod and other demersal fish abundances, including yelloweye rockfish (*Sebastes ruberrimus*), for a defined study area using a habitat-based ROV assessment approach. A Deep Ocean Engineering, Phantom HD2+2 ROV was purchased along with other electronic systems to conduct transect surveys. Female lingcod maturity was estimated from historical maturity data and collected field samples. Estimated size at 50% maturity was slightly higher than that from southeastern Alaska and indicated that the minimum size regulation presently adopted for Central Region is appropriate. A marine habitat GIS was developed comprising over 600 data sets of single beam, multibeam, and in-fill bathymetry data. A map of probable rocky reef habitats was produced from the GIS. Two ROV surveys were completed. Results from the first survey, showed significant habitat preferences of lingcod for several habitat features (substrate type, vertical relief, crevice size, and crevice density). Variance in encounter rate indicated that precise estimates of lingcod and yelloweye rockfish density and abundance are probable. In the second survey, estimates of lingcod and yelloweye rockfish abundances were obtained for the Chiswell Ridge area located long the northern Gulf coast of Kenai Peninsula. Estimates were restively precise (22% CV for lingcod, and 18% CV for yelloweye rockfish) and showed that the sampling approach was viable for assessing these populations (Contact Mike Byerly or Ken Goldman).

The **Westward Region** continued its port sampling of the commercial rockfish and Pacific cod harvests in 2006. Rockfish sampling consisted mainly of black rockfish with opportunistic sampling of duskys, darks, and other miscellaneous *Sebastes* species. Skippers were interviewed for information on effort, location, and bycatch. Length, weight, gonadal maturity, and otolith samples were collected (contact Kally Spalinger). Staff from the Kodiak office have completed aging black rockfish otoliths through the 2006 season while a number of Pacific cod ototlihs remain to be read.

The Westward Region also continued several studies on Western Gulf of Alaska black rockfish. Monthly gonad collections of dark rockfish continued throughout the year in an effort to determine reproductive seasonality and size of maturity. Analysis of 225 black and dark rockfish stomachs was completed in 2006 by the University of Alaska-Fairbanks-Institute of Marine Science. In addition, a sonic tagging project was begun in October 2006. An array of 16 moored receivers was

put in position on the east side of Spruce Island, just north of the city of Kodiak. Fifteen fish have had the tags surgically implanted and all fish continue to be picked up by the receivers. (Contact Carrie Worton or Dan Urban).

The **Division of Sport Fish—Southeast Region** continued to collect catch and harvest data from rockfish as part of a marine harvest onsite survey program with rockfish harvests tabulated back to 1978 in some selected ports. Rockfish objectives included estimation of 1) species composition, 2) weight and length composition, and 3) the geographic distribution of harvest by the fleets by port. Primary species harvested in Southeast Alaska included yelloweye, black, and quillback rockfish. Approximately 4,713 rockfish were sampled at Ketchikan, Craig, Klawock, Wrangell, Petersburg, Juneau, Sitka, Gustavus, Elfin Cove, and Yakutat in 2006 (Contact Mike Jaenicke).

The **Division of Sport Fish—Southcentral Region** continued collection of harvest and fishery information on rockfish as part of the harvest assessment program. Rockfish objectives included estimation of 1) species composition, 2) age, sex, and length composition, and 3) the geographic distribution of harvest by the fleets by port. Approximately 2,640 rockfish were sampled at Seward, Valdez, Whittier, Kodiak, and Homer in 2006 (Contact Scott Meyer).

b. Stock Assessment

The **Southeast Region** uses line-transect methods, conducted from the submersible "Delta", to collect density estimates of yelloweye rockfish. Biomass is the product of density, average weight, and area of rock habitat. No line transect surveys were conducted in 2006.

In the **Southeast Region,** no black rockfish surveys were conducted in 2006.

In the **Westward Region,** hydroacoustic equipment was deployed in a preliminary effort at stock assessment of black rockfish. Surveyed areas included the Shumagin Islands and Kodiak Island (contact Dan Urban).

c. Management

Management of DSR is based upon a combination of guideline harvest ranges, seasons, 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. Directed fishing quotas are set for the 4 outside water management areas (SEO) individually and are based on the poundage remaining after assigning a 2% harvest rate to the adult yelloweye biomass estimate and estimating bycatch (reported and nonreported) mortality. Directed fishery quotas for the two internal water management areas are set at 25 mt annually. Regulations adopted in 1994 include trip limits (within any 5 day period) of 6,000 pounds per vessel in all areas except for EYKT where the trip limit is 12,000 pounds, and added a requirement that logbook pages must be submitted with fish tickets

for each fishing trip. At the Board of Fish meeting in early 2006, the season for the directed fishery of DSR in SEO was changed to occur in the winter only from January 5th until the day before the start of the commercial halibut IFQ season, or until the annual harvest limit is reached whichever occurs first. At this meeting, the total allowable catch for DSR was allocated 84% to the commercial sector and 16% to the sport sector.

The 2006 TAC for DSR in SEO was 410 mt which resulted in an allocation of 344 mt to commercial fisheries and 66 mt to sport fisheries. A significant portion of the total commercial harvest is taken as bycatch mortality during the halibut fishery. In 2006, an alternate method to the one used in past years was implemented to try to be more precise in our estimation of bycatch of DSR in the halibut fishery. This new method recognizes the significance of depth as a component of the bycatch rate. Using the new method, the estimate of DSR that was anticipated to be caught as bycatch by the halibut fleet in outside waters in 2006 ranged from 122-337 mt (95%CI) with the point estimate at 230 mt. The estimate using the old method would have been 354 mt. Full retention of DSR has been in regulation in state waters since 2002 and in Federal water since 2005. Landed catch of DSR in the halibut fishery in 2006 was 196 mt which was close to the estimation provided using the new method.

The commercial fishery for DSR in the management areas in SEO (EYKT, CSEO, NSEO, and SSEO) did not open in 2006. Management will put off opening any part of the directed fishery in outside waters for one more year to track the actual bycatch landed in the halibut fishery as it compares with the new estimation technique. Prior to 2005, sport fish catch data was not available for DSR and had not been considered in estimating total mortality. Sportfish harvest estimates have been used in 2005 and 2006 to add to our knowledge of what we determine to be the total harvest of DSR in other fisheries. The sportfish estimate for 2006 was 85 mt. (Contact Cleo Brylinsky).

Management of black rockfish is based upon a combination of guideline harvest limits and gear restrictions. The state has management authority for black rockfish in both state and federal waters of Southeast Alaska. Directed fishery guideline harvest limits are set by management area, and range from 11.3 mt in IBS to 57 mt in SSEO, totaling 136 mt. A series of open and closed areas was also created so managers could better understand the effect a directed fishery has on black rockfish stocks. Halibut and groundfish fishermen are required to retain and report all black rockfish caught. The directed fishery for black rockfish had very little participation in 2006, with 4.5 mt landed in directed and bycatch fisheries combined.

Shortspine thornyhead, shortraker rockfish, rougheye rockfish and redbanded rockfish may be taken as bycatch only (no directed fishing). A total of 127 mt of slope rockfish were landed in NSEI and SSEI during 2006.

Rockfish in **Central Region's** Cook Inlet and PWS Areas are managed under their respective Rockfish Management Plans. Plan elements include a fishery GHL of 68 mt for each area and 5-day trip limits of 0.5 mt in the Cook Inlet District, 1.8 mt in the North Gulf District, and 1.4 mt in PWS. Rockfish regulations underwent significant change

beginning in 1996 when the Alaska Board of Fisheries formalized the GHL into a 68 mt harvest cap for all rockfish species in Cook Inlet and PWS and a 5% rockfish bycatch limit for jig gear during the state waters Pacific cod season. In 1998, the board adopted a directed rockfish season opening date of July 1 for the Cook Inlet Area and restricted legal gear to jigs, primarily because the fishery typically targets pelagic rockfish species. At the spring 2000 meeting, the board closed directed rockfish fishing in the PWS area and established a bycatch-only fishery with mandatory full retention of all incidentally harvested rockfish. In November 2004, the board also adopted a full retention requirement for rockfish in the Cook Inlet Area and restricted the directed harvest to pelagic shelf rockfish. Rockfish bycatch levels were also set at 20% during sablefish and 10% during other directed fisheries. Proceeds from rockfish landed in excess of allowable bycatch levels are surrendered to the State of Alaska. (Contact Charlie Trowbridge)

The **Westward Region** has attempted to conservatively manage black rockfish since 1997, when management control was relinquished to the State of Alaska. Area guideline harvest levels were set at 75% of the average production from 1978-1995 and sections were created to further distribute effort and thereby lessen the potential for localized depletion. Since 1997, section GHLs have been reduced in some areas that have received large amounts of effort.

In the Kodiak Area, vessels may not possess or land more than 5,000 pounds of black rockfish in a 5-day period. Additionally, vessel operators are required to register for a single groundfish fishery at a time. A registration requirement also exists for the Chingik Area; that area was also designated as super-exclusive for the black rockfish fishery beginning in 2003.

In 2006, 57 mt of black rockfish were harvested from six sections in the Kodiak Area. Effort and harvest decreased in 2006 compared to 2005. Guideline harvest levels were attained in four sections. The 2006 black rockfish harvest in the Chignik Area remains confidential because of minimum participation. Less than 3 mt were harvested in the South Alaska Peninsula Area. The staff of the Westward region is currently seeking an economically feasible and statistically valid means to conduct stock assessments on the rockfish resources of the region. A voluntary logbook program was initiated in 2000 in the hope of obtaining CPUE estimates as well as more detailed harvest locations; the logbook program was made mandatory in 2005. (Contact: Nick Sagalkin).

Statewide, the majority of sport-caught rockfish are taken incidental to recreational fisheries for halibut or while trolling for salmon. In Southeast Alaska, there has never been a size limit set for rockfish harvested in the sport fishery, although there has been a progression of bag and possession limits during the last 20 years.

Prior to 1988, there were no bag or possession limits on rockfish in Southeast Alaska's sport fishery. In 1988, a bag and possession limit of 8 rockfish was applied to the waters near Sitka (Sitka Sound, Salisbury Sound, and Peril Strait). The remaining waters of Southeast Alaska had no bag or possession limit on rockfish species for 1988. During

1989 to 1993, for the majority of the marine waters of Southeast Alaska (except Yakutat) the bag and possession limit was 5 rockfish per day and 10 in possession, of which only 2 per day, 4 in possession could be yelloweye; however, for the Sitka area (Sitka Sound, Salisbury Sound, and Peril Strait) and the Ketchikan area (Behm Canal, Clarence Strait, Tongass Narrows, Nichols Passage, George Inlet, Carroll Inlet, Thorne Arm, Revillagigedo Channel) the bag and possession limit was three rockfish, of which only one could be a yelloweye.

Prior to 1994, the Yakutat area did not have any bag or possession limits on rockfish caught in the sport fisheries.

Since 1994, the rockfish sport fish regulations for Southeast Alaska (including Yakutat) have been split into "pelagic" and "other" (other being non-pelagic), with a region wide bag and possession limit of pelagic rockfish of five per day, 10 in possession and a bag and possession limit of "other" rockfish of five per day, 10 in possession of which only two per day, four in possession could be yelloweye. However, the Sitka area (Sitka Sound, Salisbury Sound, and Peril Strait) and the Ketchikan area (Behm Canal, Clarence Strait, Tongass Narrows, Nichols Passage, George Inlet, Carroll Inlet, Thorne Arm, Revillagigedo Channel) the bag and possession limit was three rockfish, other than pelagic rockfish, of which only one could be a yelloweye.

For the 2006 season, the entire Southeast Alaska region's sport bag and possession limit for pelagic rockfish remained at five fish per day, 10 in possession, however, the non-pelagic rockfish regulations were set as follows: 1) The resident and nonresident bag limit was three non-pelagic rockfish only one of which can be a yelloweye; all non-pelagic rockfish caught must be retained until the bag limit is reached. 2) The nonresident annual limit was three yelloweye rockfish and 3) Charter operators and crewmembers could not retain rockfish while clients are on board the vessel (Contact Charlie Swanton).

In most of the fisheries in **Southcentral Alaska**, bag limits in most areas have been designed to discourage targeting of rockfish yet allow for retention of incidental harvest. Bag limits in Prince William Sound, the North Gulf, and Cook Inlet are five rockfish daily, with no more than one or two being non-pelagic (DSR and slope) rockfish. The Alaska Board of Fisheries has allowed a 10-rockfish bag limit in the Kodiak and Alaska Peninsula areas because of lower levels of effort and predominance of pelagic species in the catch.

Given the lack of quantitative stock assessment information for much of Alaska, sport fish managers have established conservative harvest strategies for recreational rockfish fisheries. Recreational seasons and bag and possession limits for rockfish in Alaska are among the most restrictive on the West Coast.

d. Fisheries

Reported harvest of rockfishes – from directed commercial fisheries for rockfish in **Southeast** – totaled 3.5 mt in 2006, all of which was black rockfish and came from the directed black rockfish fishery. There was no directed DSR fishery in 2006. The total

amount of rockfish taken as bycatch in 2006 was 404 mt. A large portion (64%) was DSR bycatch made in conjunction with the IFQ halibut fishery. All rockfish harvested in state-managed fisheries in Southeast is taken by hook-and-line gear either in directed fisheries or incidental to fisheries for other species.

The 2006 **Cook Inlet Area** directed rockfish fishery opened July 1 and closed December 31 with a total harvest of 5.8 mt, primarily pelagic rockfish. Total rockfish harvest including bycatch to longline, pot and trawl fisheries was 12.7 mt. Total rockfish harvest for the PWS Area rockfish bycatch-only fishery was 34.6 mt. This included a 5.1 mt incidental catch of slope rockfish from the walleye pollock trawl fishery and a 29.5 mt incidental harvest of demersal and slope rockfish from the sablefish and halibut longline fisheries.

Estimates of **sport harvest** are obtained by three methods – the Statewide Harvest Survey (SWHS), charter vessel logbooks, and, in major ports, creel survey dockside sampling. Harvest
reporting areas for these programs are different than commercial reporting areas making direct comparisons difficult. Additionally, species-specific data is available only from creel surveys.

The SWHS reports harvest for the general category of "rockfish", and the charter vessel logbook records rockfish harvest in two categories: "non-pelagic" and "pelagic". DSR are part of the "non-pelagic" category. Recreational rockfish harvest is typically estimated in numbers of fish. Estimates of the 2006 harvest are not yet available from the statewide harvest survey, but the 2005 estimates were 89,990 fish in Southeast and 93,743 fish in Southcentral Alaska. These were historic highs for each region. The average estimated annual harvest for the most recent five-year period (2001-2005) was 68,075 rockfish (all species) in Southeast Alaska and 75,820 fish in Southcentral Alaska.

Creel survey data for Sitka indicates that 9,009 individual yelloweye (approximately 36 mt) were retained by anglers in an area roughly equivalent to the CSEO in 2006. This is a 43% decrease in the harvest (by number of fish) of yelloweye in Sitka compared to the 2005 season, and is only 2% above the 2001 yelloweye creel harvest estimate of 8,854 fish. Projections based on creel and SWHS data for SWHS Area B (Prince of Wales Island) indicates that 4,200 yelloweye (approximately 16 mt) were retained in 2006 in the SSEO area of Prince of Wales Island. These numbers do not include harvest of other species of DSR although yelloweye compromise the majority of the sport harvested DSR by biomass harvested in CSEO (~90%) and SSEO (~80%), based on the 2006 projections

3. Sablefish

a. Research

In 2006, sablefish longline surveys were conducted for both the NSEI and SSEI areas. These surveys are designed to measure trends in relative abundance and biological characteristics of the sablefish population. Biological data collected in these surveys

include length, weight, sex and maturity stage. Otoliths are collected and sent to the ADF&G age determination unit in Juneau for age reading. The cost of these surveys is offset by the sale of the fish landed. This year, a biologist from Moss Landing Marine Laboratory was on board one vessel in the SSEI area for the purpose of collecting biological information on skates. Vertebrae and reproductive tracts were collected from three species, predominantly longnose skate (*Raja rhina*); others sampled were (*Bathyraja interrupta*) and (*B. aleutica*). Two specimens of the whiteblotched skate (*B. maculata*) were also encountered on this survey; this is believed to represent an approximate range extension of 1400 km for this species.

In the NSEI survey, the 2006 overall CPUE (kg/hook) was 1.09, down from 2005 (1.29) but up from 2004 (0.96). Thornyhead rockfish dominated the bycatch in all areas except the northern-most statistical area where skates were the dominant bycatch.

The ongoing mandatory logbook program in the sablefish fisheries provides catch and effort data by date, location, and set. In the SSEI sablefish fishery, overall CPUE (adjusted for hook spacing) decreased very slightly in 2006 to 0.23 round kg/hook compared to 0.24 round kg/hook in 2005. In the NSEI fishery, the overall CPUE adjusted for hook spacing expressed in round kg/hook for vessels was 0.33, up slightly from 2005.

In 2006, ADF&G continued a mark/recapture study in NSEI, tagging and releasing 5,325 sablefish. Pot gear was used to capture the fish in June – 1.5 months prior to the start of the fishery which commenced on August 15, 2006. Fish were caught with pot gear to minimize the apparent "hook shyness" pattern of tag returns observed in 1997, 1998 and 1999 when longline gear was use to catch fish for tagging.

Within **Central Region,** ADF&G initiated a limited mark-recapture study in 1999 within PWS using the biennial bottom trawl survey as the capture vehicle. Tagging was continued in the 2003 PWS bottom trawl survey. Fewer than 10 tagged fish have been recovered to date (Contact Ken Goldman).

Skipper interviews and port sampling occurred in Whittier, Cordova and Seward for the PWS Area fishery and in Seward and Homer for the Cook Inlet Area fishery. Data obtained included date and location of harvest, length, weight, sex, and gonad condition. Otoliths were removed and sent to the Age Determination Unit (Contact Willy Dunne).

b. Stock Assessment

In **Southeast**, the department is using mark-recapture methods with tags and fin clips to estimate abundance and exploitation rates for sablefish in the NSEI Subdistrict. Sablefish are captured with pot gear in mid-summer, marked with a tag and a fin clip then released. Tags are recovered from the fishery and fish are counted at the processing plants and observed for fin-clips. Based on Chapman's modification of the Petersen estimator, there were an estimated 1,948,450 sablefish in NSEI at the time of the 2005 fishery (Chapman 1948). The 90% confidence interval for the 2005 sablefish abundance estimate was 1,831,518-079,876 sablefish. Decrementing this estimate to account for natural

mortality, and adding a percent of age-4 recruits equal to that of 2005, the lower 90% confidence interval forecast for 2006 was 1,772,443 sablefish and 13,330,466 pounds of sablefish. In addition to the mark-recapture work, an annual longline survey is conducted in NSEI to provide biological data as well as relative abundance information (Contact Sherri Dressel). In SSEI only, an annual longline survey is conducted to provide biological data as well as relative abundance information.

A longline survey, using ADF&G vessels, has been conducted in **Prince William Sound** annually since 1996. Mean CPUE between 1996 and 2002 ranged from 0.08 to 0.17 sablefish/hook, with an overall mean CPUE of 0.12 (all years combined). Longline survey effort was extended into the North Gulf District in 1999, 2000 and 2002. The 2005 and 2006 PWS survey covered all of PWS, and data will be analyzed during the winter of 2007 to determine the veracity of the data for setting harvest limits on the PWS fishery. Survey costs are partially offset by the sale of fishes caught in the survey, however, Central Region staff is considering a switch to a pre-fishery pot survey that would use tag and recapture methods to set harvest limits, which would not sell the fishes caught (Contact Ken Goldman).

c. Management

There are three separate internal water areas in Alaska which have state-managed sablefish fisheries. The Northern Southeast Inside Subdistrict (NSEI), the Southern Southeast Inside Subdistrict (SSEI), and the Prince William Sound District each have separate seasons and guideline harvest ranges.

In the **Southeast Region,** both the SSEI and NSEI sablefish fisheries have been managed under a license limitation program since 1984. In 1994, the BOF adopted regulations implementing an equal share quota system where the annual guideline harvest level was divided equally between permit holders and the season was extended to allow for a more orderly fishery. In 1997, the BOF adopted this equal share system as a permanent management measure for both the NSEI and SSEI sablefish fisheries.

Due to declines in fishery CPUE and preliminary results from our mark-recapture work, ADF&G reduced the NSEI quota 35% in 1999 to 1,415 mt where it remained through 2000. Beginning in 2001, a biomass estimate was available and the NSEI area total allowable catch (TAC) set using an $F_{40\%}$ applied to the lower 90% confidence limit of the estimate of biomass. The TAC is then decremented by estimating mortality in other fisheries before the directed fishery quota is set. The quota was decreased in 2001 to 990 mt and to 909 mt for 2002 and 2003. In 2004, the quota was increased to 1,018 mt. The 2005 directed fishery quota was 931 mt with 106 permit holders (longline). In 2006, the 2005 quota was used rather than basing the quota on the recommendation put forward by the biometrician. There were 105 permit holders eligible to fish in NSEI in 2006.

The SSEI quota was set at 316 mt in 2000, and has remained the same thru 2006. From 2000 to 2005, there were 28 permit holders (4 pot gear, 24 longline) legally permitted to fish in this fishery. In 2006, the Commercial Fisheries Entry Commission (CFEC) allowed four permits back into the fishery bringing the total permits to 32 for 2006.

During the January 2006 Alaska Board of Fisheries (BOF) meeting, the BOF made only one change in regulations affecting the NSEI and SSEI sablefish fisheries. While permit holders are still allowed to carry-over up to 5% of their annual equal quota share as an overage or underage, the BOF removed the allowance for transfers of quota share among permit holders. The provision for the allowance of fishing outside the regular season remains but no off season fishing trips were conducted in 2006 due to staff constraints.

Sablefish fisheries in outer coastal state waters (0-3 miles) have been managed in conjunction with the federal-managed fishery in the EEZ. There is no open-access sablefish fishery in the Southeast Outside District as there are limited areas that are deep enough to support sablefish populations inside state waters. In some areas of the Gulf, the state opens the fishery concurrent with the EEZ opening. These fisheries, which occur in the North Gulf District of Cook Inlet and the Aleutian Island District, are open access in state waters, as the state cannot legally implement IFQ management at this time. The quotas are based on historic catch averages and closed once these have been reached.

The GHL for the North Gulf District is set using an historic baseline harvest level adjusted annually by the same relative reduction to the TAC in the Central Gulf Area. The 2006 fishery GHL was 34.5 mt. In 2004 the BOF adopted sablefish fishery-specific registration and logbook requirements and a 48-hours trip limit of 1.3 mt. For PWS, a limited entry program that included gear restrictions and established vessel size classes was adopted in 1996. Additionally, a commissioner's permit, which stipulates logbook and catch reporting requirements, must be obtained prior to participation in the fishery. The fishery GHL is set at 110 mt, which is the midpoint of the harvest range set by a habitat-based estimate. Fishery management continued to develop through access limitation and then into a quota share system wherein permit holders are allocated shares of the harvest guideline. Shares are equal within each of four vessel size classes, but differ between size classes. Central Region staff annually conducts dockside interviews and sample landings in the ports of Cordova, Whittier, and Seward.

There are no bag, possession, or size limits for sablefish in the recreational fisheries in Alaska. Sablefish harvest is not explicitly estimated by the SWHS and no information is collected in the creel surveys and port sampling of the recreational fisheries in Southcentral or Southeast Alaska. Sablefish are caught incidentally to other species and the total harvest is believed to be quite small.

d. Fisheries

In the **Southeast Region,** the 2006 NSEI sablefish fishery opened August 15 and closed November 15. The 105 permit holders landed a total of 922 mt of sablefish. The fishery is managed by equal quota share; each permit holder was allowed 8.9 mt. The 2006 SSEI sablefish fishery opened June 1 and closed November 15. Thirty permit holders landed a total of 283 mt of sablefish, each with an equal quota share of 9.8 mt. In SSEI, 28 permits were designated to be fished with longline gear and the remaining four fished with pot gear. Two of the longline permits did not fish in 2006. (Contact Cleo Brylinsky)

In the **Central Region,** the 2006 open access sablefish fishery in the Cook Inlet North Gulf District opened at noon July 15 and closed at 3 PM on July 21. Sixteen vessels harvested 40.2 mt. In the Prince William Sound area, a "shared quota" system was adopted by the Board of Fish and instituted during the 2003 season. Season dates for 2006 were originally March 15 - May 15 and August 1 - 21. However, because of reduced effort due to orca depredation of an unknown extent during the spring season, summer season dates were expanded to July 25 - August 25 by emergency order. The shared quota system allocates half of the 110 mt GHL equally among all registered participants with the balance of the GHL allocated between each vessel size class based on historic harvest within each class resulting in the following percentages: Classes A and B (90 and 60 feet maximum length = 18.53%; Class C (50 feet maximum length) vessels = 70.33% and Class D (35 feet maximum length) vessels = 11.14%. All sablefish landed in excess of an individual's quota are sold and the proceeds go to the State of Alaska. The 2006 PWS harvest totaled 84.1 mt. Skipper interviews and biological sampling were conducted in-season which gathered effort and location information as well as age, length, weight, sex and gonad condition data (Contact Charlie Trowbridge).

Within the **Westward Region**, only the Aleutian Islands have sufficient habitat to support mature sablefish populations of sufficient magnitude to permit commercial fishing. All other sections within the region are closed by regulation to avoid the potential for localized depletion from the small amounts of habitat within the jurisdiction of the state. Bycatch from the areas closed to directed fishing is limited to 1%. The 2006 Aleutian Island fishery opened on May 15, 2006. Additional requirements for the fishery include registration and logbook requirements. The GHL was set at 290 mt for the state managed fishery. The preliminary harvest from the 2006 Aleutian Islands sablefish fishery was 80 mt. The season remained open until the November 15 closure date.

4. Flatfish

a. Research

There was no research on flatfish during 2006.

b. Stock Assessment

There are no stock assessments for flatfish.

c. Management

Trawl fisheries for flatfish are allowed in three small areas in the internal waters of **Southeast Alaska** under 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 fished and other requirements. Trawl gear is limited to beam trawls, and mandatory logbooks are required, observers can be required, and there is a 20,000 weekly trip limit.

There are no bag, possession, or size limits for flatfish (excluding Pacific halibut) in the recreational fisheries in Alaska. Harvest of flatfish besides Pacific halibut are not explicitly estimated by the SWHS and no information is collected in the creel surveys and

port sampling of the recreational fisheries in Southcentral or Southeast Alaska. Flatfish are occasionally taken incidentally to other species and in small shore fisheries, but the recreational harvest is believed to be very small.

d. Fisheries

There has been almost no effort in the **Southeast** fishery for the past five years, with no harvest reported for the 2005-2006 season. The Southeast flatfish trawl areas are also the sites of a shrimp beam trawl fishery. Most of the Southeast harvest is starry flounder. NMFS manages the flatfish fishery and harvest in the state waters of **Westward Region**.

5. Pollock

State-managed pollock is limited to the Central Region

a. Research

Pollock continue to be a dominant species in the **Central Region** ecosystem. Due to uncertainty about the appropriate harvest level for the PWS pollock fishery, assessment in 2006 included commercial fishery catch sampling and a bottom trawl survey of the summer (post-spawning) population. Skipper interviews and port sampling of **Central Region** commercial pollock deliveries during 2006 occurred in Kodiak. Additional sampling occurred during the Cook Inlet and PWS trawl and sablefish longline surveys. Sample data collected included date and location of harvest, species, length, weight, sex, and gonad condition. Otoliths were collected from most sampled fish. Homer office staff determined ages of pollock otoliths (Contact Willy Dunne).

In 1996, interactions between pollock, herring, and juvenile salmon were also examined as part of Sound Ecosystem Assessment (SEA) funded by the *EXXON Valdez* Oil Spill Restoration.

In Pollock, we are testing for spatial patterns of genetic variation in six population samples from three regions: North America - Gulf of Alaska; North America - Bering Sea; Asia - East Kamchatka. We tested for annual stability of the genetic signal in replicate samples from three of the North American populations. These studies, begun in 1998 and 1999, continued into 2000. A manuscript documenting the findings is under internal review. Allozyme and mtDNA markers provide concordant estimates of spatial and temporal genetic variation. These data show significant genetic variation between North American and Asian pollock as well as evidence that spawning aggregations in the Gulf of Alaska, such as Prince William Sound, are genetically distinct and may merit management as distinct stocks. These data also provide evidence of inter-annual genetic variation in two of three North American populations. Gene diversity values show this inter-annual variation is of similar magnitude to the spatial variation among North American populations, suggesting the rate and direction of gene flow among some spawning aggregations is highly variable (Contact Lisa Seeb).

b. Stock Assessment

Hydroacoustic surveys, with sample collection by mid-water trawl, were conducted in PWS in the winters of 1995, 1997, 1998, 2000, 2001, and 2002 by the Prince William Sound Science Center in cooperation with ADF&G. Biomass estimates of prespawning pollock aggregations have been relatively stable, except for 1998, with a slight decline indicated in more recent years. The department also conducts a biennial bottom trawl survey during the summer in PWS, and develops a pollock biomass estimate used to establish the harvest guideline for the winter commercial fishery. This approach is justified, despite the belief that a significant portion of the spawning population targeted by the winter fishery immigrated from federal waters, because the summer population is not assessed by the NMFS summer survey. Survey biomass estimates from the biennial bottom trawl survey have declined in recent years, and the fishery harvest level has been reduced accordingly (Contact Ken Goldman).

c. Management

Prince William Sound pollock fishery regulations include a commissioner's permit and a registration deadline of January 13. The permit stipulates logbooks, catch reporting, and accommodation of a department observer upon request. Vessels are required to check in and check out of the area and fishery as well as contact the department daily to report catch, effort, and fishing location. In 2001, new regulations were adopted dividing the PWS Inside District into three sections (Port Bainbridge, Knight Island, and Hinchinbrook) and limiting harvest to a maximum of 60% of the GHL from any section (Contact Bob Berceli).

d. Fisheries

The 2006 fishery opened on January 20 with a GHL of 1,651 mt. Catch and effort remained low until late February when aggregations of pollock in the Hinchinbrook section increased resulting in achievement of the 40% harvest level for that section. The section closed by emergency order on March 3. Subsequently, fishing improved in the Knight Island and Bainbridge sections, which closed on March 10 due to concerns over increased bycatch. Total pollock harvest for all sections combined was 1,582 mt. As in past years, fishery bycatch was dominated by squid (14.4 mt), rockfish (5.1 mt), and sharks (1.6 mt).

6. Sharks

a. Research

In the **Central Region,** Spiny dogfish and Pacific sleeper sharks have been tagged annually since 1997 as part of the PWS longline survey for sablefish, and since 2000 during bottom trawl surveys in Cook Inlet and PWS. Through 2003, over 400 each of spiny dogfish and Pacific sleeper sharks have been tagged. To date, 10 tagged sleeper sharks have been recovered from PWS; maximum time-at-large was 1,259 days and most sharks moved less than 20 km between tagging and recapture locations. No spiny dogfish have been recovered. In 2003, 340 spiny dogfish were sacrificed and the posterior dorsal spine removed for age determination. In addition, 10-15 sleeper sharks have been sacrificed annually during 2000 to 2003 for parasite and contaminant analysis.

In 2005, muscle tissue samples from 49 spiny dogfish caught in the PWS longline survey were sent to Alaska Department of Environmental Conservation for analysis of mercury levels. Results were received in 2006 and incorporated into DEC's Fish Monitoring Program. Total mercury concentrations ranged from 0.1 to 1.3 ppm with a mean concentration of 0.8 ppm. (Contact Ken Goldman)

In recent years, a small **recreational** fishery targeting salmon sharks has developed in the Gulf of Alaska and Prince William Sound. Little information is available to assess the status or structures of targeted stocks. The Division of Sport Fish initiated a modest cooperative tagging program with a few charterboat operators in 1998 and continues to collect biological data on all sharks harvested in the sport fishery through the port-sampling program.

b. Stock Assessment

Among **Central** Region assessment projects, sharks are caught in trawl surveys and the PWS longline survey. Catch per unit effort for Pacific sleeper shark ranged from 1.1 fish/set in 1996 to 4.3 fish/set in 1999. Spiny dogfish CPUE has ranged from 0.9 to 9.2 fish/set except for a dramatic increase to 51.3 fish per set in 1998. The high catch rates of spiny dogfish in 1998 appear to have been an anomaly (Contact Ted Otis).

The **Division of Sport Fish-Southcentral Region** collected harvest and fishery information on sharks through the groundfish harvest assessment program although no specific research objectives were identified. Shark harvest is still at a relatively low level, but it is hoped that size and age composition of the harvest of some species can be estimated using multiple years of data. In 2006, 80 salmon sharks and 6 spiny dogfish were sampled for length, sex, and age structures from the sport harvest throughout the region. Interviews also provided estimates of the numbers of salmon sharks and spiny dogfish kept and released by ADF&G statistical area (Contact Scott Meyer).

c. Management

The Alaska Board of Fisheries prohibited all directed commercial fisheries for sharks in 1998. In 2000, the BOF increased the bycatch allowance in **Southeast Region** for dogfish taken while longlining for other species to 35% round weight of the target species and also allowed full retention of dogfish bycatch in the salmon setnet fishery in Yakutat. This action was an effort to minimize waste of dogfish in these two fisheries and to encourage sale of bycatch. In **Central Region**, bycatch is set by regulation at 20% of the round weight of the directed species on board. However in 2004, the BOF amended regulations to provide for a directed fishery for spiny dogfish in the Cook Inlet area under terms of a permit issued by the commissioner.

Recreational fishing for sharks is allowed under the statewide Sport Shark Fishery Management Plan adopted by the BOF in 1998. The plan recognizes the lack of stock assessment information, the potential for rapid growth of the fishery, and the potential for over harvest, and sets a statewide daily bag limit of one shark and a season limit of two sharks of any species. Recreational demand for spiny dogfish remains low and they are widely considered a nuisance species. There is, however, a small directed charter boat

fishery for salmon sharks in Southcentral Alaska, primarily at Seward and in Prince William Sound. Pacific sleeper sharks are occasionally caught but rarely retained.

In 2000, the BOF prohibited the practice of "finning", requiring that all shark retained must be sold or utilized and have fins, head, and tail attached at the time of landing. "Utilize" means use of the flesh of the shark for human consumption, for reduction to meal for production of food for animals or fish, for bait, or for scientific, display, or educational purposes.

d. Fisheries

Directed fishing for spiny dogfish is allowed only in the Cook Inlet area under terms of a permit issued by the commissioner. Due to the low numbers of vessels participating in 2006, harvest figures remain confidential.

Estimates of **recreational shark harvest** in 2006 are not yet available from the Statewide Harvest Survey, but in 2005 an estimated 576 sharks of all species were harvested in Southeast Alaska and 1,007 were harvested in Southcentral Alaska. Confidence in these estimates is low. The statewide charter logbook program also requires reporting of the number of salmon sharks kept and released in the charter fishery. Charter anglers account for the vast majority of the recreational salmon shark harvest. In 2005, charter operators reported harvesting 47 salmon sharks in Southeast Alaska and 185 salmon sharks in Southcentral Alaska.

7. Lingcod

a. Research

Over the past eleven years in the **Southeast Region,** 8,896 lingcod have been tagged and 376 fish recovered. Opportunistic tagging of 110 young lingcod in Sitka Sound occurred during 2006. Length, sex and tagging location are recorded for all tagged fish (Contact Cleo Brylinsky).

In the **Central Region**, skipper interviews and port sampling were conducted in Cordova, Whittier, Seward and Homer. Data obtained included date and location of harvest, length, weight, sex and age. Gonad condition was generally not determined as nearly all fish delivered were already gutted (Contact Willy Dunne). A project to estimate the density of lingcod (*Ophiodon elongates*) using ROV transects and the estimation of maturity parameters was completed in 2006. Goals of the research were the development of a marine habitat GIS for Central Region, and the estimation of lingcod and other demersal fish abundances, including yelloweye rockfish (*Sebastes ruberrimus*), for a defined study area using a habitat-based ROV assessment approach.

The **Division of Sport Fish-Southeast Region** continued to collect catch, harvest, and biological data from lingcod as part of a marine harvest survey program with lingcod harvests tabulated back to 1987 in some selected ports. Data collected in the program include statistics on effort, catch, and harvest of lingcod taken by Southeast Alaska sport

anglers. Ports sampled in 2005 included Juneau, Sitka, Craig/Klawock, Wrangell, Petersburg, Gustavus, Elfin Cove, Yakutat, and Ketchikan. Length and sex data were collected from 1,644 lingcod in 2005, primarily from the ports of Sitka, Ketchikan, Craig, Gustavus, Elfin Cove, and Yakutat (Contact Mike Jaenicke).

The **Division of Sport Fish-Southcentral Region** continued collection of harvest and fishery information on lingcod through the groundfish harvest assessment program. Lingcod objectives include estimation of 1) the age, sex, and length composition of lingcod harvests by ports and 2) the geographic distribution of harvest by each fleet. A total of 674 lingcod were sampled from sport harvest at Seward, Valdez, Whittier, Kodiak, and Homer in 2005. These ports accounted for the majority of recreational lingcod harvest in Southcentral Alaska (Contact Scott Meyer).

b. Stock Assessment

The **Southeast Region** is not currently able to reliably estimate lingcod biomass or abundance. Lacking abundance estimates, and given the complex life history and behavior of lingcod, impacts to lingcod populations from fishing are difficult to assess. Analysis of catch per unit effort data (CPUE), in terms of fish per hook-hour for 1988-1998, showed that CPUE had declined between 21 to 62% in areas where a directed fishery and increased recreational catch had developed. Consequently, the quota for lingcod was reduced in all areas in 1999. Commercial logbook data for the period 2002-2006 shows a constant increasing trend in SSEOC and a constant decreasing trend in NSEO. All other areas are holding level or trending down slightly.

The Sport Fish Division, Southcentral Region, is continuing efforts toward a lingcod stock assessment. Initial work focused on compiling data from sport and commercial fisheries, mining existing survey data from other agencies, estimating natural mortality from age data, and estimating length-weight and growth parameters. Some of the next steps include standardization and comparison of CPUE indices and compilation of spatial data.

c. Management

Management of lingcod in **Southeast Alaska** is based upon a combination of guideline harvest ranges, season and gear restrictions. The state has management authority for lingcod in both state and federal waters. Regulations include a winter closure for all users except longliners between December 1 and May 15 to protect nest-guarding males. Guideline harvest limits were greatly reduced in 2000 in all areas and allocations made between directed commercial fishery, sport fishery, longline fisheries, and salmon troll fisheries. This was the first time sport catch was included in a quota allocation. The 27" minimum commercial size limit remains in effect and fishermen must keep their lingcod with the head on, and proof of gender to facilitate biological sampling of the commercial catch. Vessel registration and trip limits are allowed when needed to stay within allocations. The directed fishery is limited to jig or dinglebar troll gear. In 2003, the Board of Fish established a super-exclusive directed fishery for lingcod in the IBS Subdistrict.

Regulations for the **Central Region** lingcod fishery include open season dates of July 1 to December 31 and 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. In 1997, the BOF adopted a jig only gear requirement for the directed lingcod fishery in the Cook Inlet Area. Beginning in 1997, the department set commercial lingcod fishery GHLs for the Central Region at 50% of the average harvest for the period 1987 to 1996. However, GHLs were increased to 75% of this average in 2001 for PWS and in 2003 in Cook Inlet.

In **Southeast Alaska**, the sport fishery for lingcod prior to 2000 had a open season of May 1 to November 30, and a regionwide bag and possession limit of two per day, four in possession, with no size limits. Area-specific exceptions to this included: 1) The Pinnacles area near Sitka has been closed to sport fishing year-round for all groundfish since 1997, and 2) the nonresident sport anglers bag and possession limit for the Sitka Sound LAMP area was one per day, two in possession during 1997-2000.

Beginning in 2000, the open season has been set at May 16 to November 30. Sport harvests of lingcod in Southeast Alaska as of the year 2000 have been incorporated into a region wide lingcod management plan, which reduced GHLs for all fisheries (combined) in seven management areas, and allocated a portion of the GHL for each area to the sport fishery. Since 2000, harvest limits reductions, size limits, and mid-season closures have been implemented by emergency order in various management areas to ensure sport harvests do not exceed allocations.

In 2006, lingcod bag limits were reduced from two to one fish per day regionwide for all anglers, slot limits were imposed for guided and nonresident anglers in all management areas except Southern Southeast Inside near Ketchikan, and the season was closed in northern Southeast management areas (NSI, CSO, and NSO) from June 16 through August 15. In addition, in all management areas in Southeast Alaska (except the Yakutat area) there were the following restrictions: a nonresident annual limit of two lingcod with harvest record required, and captain and crew on charter vessels with clients could not harvest any fish species (Contact Charlie Swanton).

Conservative harvest strategies have been established for recreational lingcod fisheries in **Southcentral Alaska** in light of the lack of quantitative stock assessment information. Resurrection Bay is closed to lingcod fishing year-round to rebuild the population, although no formal rebuilding plan is in place. The season is closed regionwide from January 1 through June 30 to protect spawning and nest guarding lingcod. Daily bag limits are two fish in all areas except the North Gulf, where the daily bag limit is one fish. All areas except Kodiak have a minimum size limit of 35 inches to protect spawning females (Contact Scott Meyer).

d. Fisheries

Lingcod are the target of a "dinglebar" troll fishery in **Southeast Alaska**. Dinglebar troll gear is power troll gear modified to fish for groundfish. Additionally lingcod are landed

as significant bycatch in the DSR longline fishery (35% limit), as bycatch in the halibut fishery (5% limit), and as bycatch in the salmon troll fishery. The directed fishery landed 107 mt of lingcod in 2006 and an additional 66 mt was landed as bycatch in other fisheries. The halibut longline fishery accounted for roughly 76% of lingcod bycatch in the Southeast Region and the salmon troll fishery accounted for 24%.

Central Region lingcod harvests have primarily occurred in the North Gulf District of Cook Inlet and the Outside District of PWS. In 2006, the Cook Inlet GHL was 24 mt and the PWS GHL was 11 mt. Lingcod harvests in 2006 totaled 26.1 mt in Cook Inlet and 12.7 mt in PWS. The majority of both the Cook Inlet Area and the PWS Area lingcod harvest was from longline and pot bycatch to other (primarily halibut and Pacific cod) fisheries. Directed jig fishing accounted for 20.2% of the Cook Inlet harvest and 16.5% of the PWS harvest. Limited directed effort occurred for lingcod in the **Westward Region** during 2006. Incidental harvest in other fisheries totaled 23 mt for the year. The majority of the harvest occurred in the Kodiak Area with a minor amount occurring in the Chignik Area.

Recreational lingcod harvest is estimated in numbers of fish. Estimates of the 2006 harvest are not yet available from the statewide mail survey, but in 2005 an estimated 22,087 lingcod were harvested in Southeast Alaska while 15,434 lingcod were taken in Southcentral Alaska. The average estimated annual harvest for the most recent five-year period (2001-2005) was 14,966 fish in Southeast Alaska and 12,429 fish in Southcentral Alaska.

8. Other species

In 1997, the BOF established a new policy that would strictly limit the development of fisheries for other groundfish species in Southeast. Fishermen are required to apply for a "permit for miscellaneous groundfish" for all fisheries that do not already have specific regulations and permits do not have to be issued if there are management and conservation concerns. At this time, that includes all species except sablefish, rockfish, lingcod, flatfish, and Pacific cod. Most other groundfish species taken in state waters are taken as bycatch in fisheries for other groundfish and halibut. The State also has a regulation that requires that the bycatch rate of groundfish be set annually for each fishery by emergency order unless otherwise specified in regulation.

A commissioner's permit is required before a directed fishery may be prosecuted for skates. This permit may restrict depth, dates, area, and gear, establish minimum size limits, and require logbooks and/or observers, or any other condition determined by the commissioner to be necessary for conservation and management purposes. In 2006, interest continued for a skate fishery in the Cook Inlet and Kodiak Areas. In the Cook Inlet Area, no skate fishing permits were issued in 2006 due to the closure of directed skate fishing in adjacent federal waters. In the Kodiak Area, 22 vessels obtained commissioner's permits and prosecuted target fisheries for skates in state-waters; several additional vessels participated exclusively in federal waters. When NMFS made skates bycatch only in the Central Gulf, ADFG placed skates on bycatch only in the Kodiak and South Alaska Peninsula Areas. The majority of these vessels targeted the

big skate, *Raja binoculata,* and Longnose skate, *Raja rhina.* The 2006 harvest from state waters was 220 mt. In addition to the permit requirements listed above, vessel operators were required to notify ADF&G of deliveries. This was done to ensure that ample opportunity occurred to collect biological data from the landed catch. Dockside samplers performed species identification and obtained sexed lengths from the catch. In addition, vertebrae were collected for age analysis. A commissioner's permit is also required before any trawl fishery besides the existing beam trawl fishery for flatfish may be prosecuted in the Southeast District.

As part of a cooperative research study, tissue samples were collected from approximately 40 longnose skates in Prince William Sound for contaminant analysis.

Work on a "Developing Fisheries" policy, intended to reduce the potential for a fishery to escalate beyond management control, has halted at present.

The recreational halibut fishery is the focus of a statewide research and management effort. Data on the recreational fishery and harvest are collected through port sampling effort in Southcentral Alaska and creel surveys and port sampling in Southeast Alaska. These data are provided annually to the International Pacific Halibut Commission for use in an annual stock assessment, and to the North Pacific Fishery Management Council. T he Council has used the information in the design and analysis of regulations governing the sport charter fishery.

The BOF took action in 2000 prohibiting the development of a live fish fishery for groundfish in the Southeast District.

C. Other Related Studies

Staff in the Central Region has implemented a multi-year study to explore the utility of a remotely operated vehicle (ROV) as a stock assessment tool for a variety of groundfish resources. Initial efforts are focusing on identification of suitable rockfish and lingcod habitat along the northern Gulf of Alaska, and comparing ROV study results with habitat available in a GIS format from NOAA. The ROV is also being used to perform field experiments to test two assumptions of strip transect sampling for yelloweye rockfish, *Sebastes ruberrimus*, and lingcod, *Ophiodon elongatus*, with a remotely operated vehicle (ROV), that, 1) animals do not move in response to the observer (ROV in this case) prior to detection, and 2) 100% of animals are detected within the strip width (Contact Mike Byerly).

The Department of Fish and Game manages state groundfish fisheries 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 at any time for justifiable conservation reasons. The department also cooperates with NMFS in regulating fisheries in the offshore waters.

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, Douglas, Sitka, 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.

In 1997, at the Southeast Groundfish meeting, the Board of Fisheries adopted a regulation that requires all groundfish fishermen to complete mandatory logbook pages while fishing. These logbook pages must be submitted as part of their landing record and attached to their fish ticket at delivery. The Board also requires that fishermen obtain a conditional use permit when fishing for any species for which specific regulatory language is not in effect. This will allow ADF&G to deny permits for some species and allow exploratory or controlled fishing for others.

1. Dixon Entrance Area

Total removals from the Dixon Entrance area (Alaska statistical areas 325431, 315431, 325401, and 315401) have risen in the last two years. The table below lists the catch by species group from 1988 through 2006 rounded to the nearest mt.

Year	# Permits	# Landings	DSR	Other Rock	Sablefish	Other	Total
1988	20	25	3	3	82	3	91
1989	8	7	1	1	20	0	22
1990	16	17	3	5	182	1	191
1991	24	21	6	12	150	2	170
1992	19	19	3	5	150	1	159
1993	27	26	6	14	232	1	253
1994	27	26	1	20	216	2	239
1995	21	18	0	20	137	0	157
1996	16	14	1	12	83	0	96
1997	37	30	1	18	103	0	122
1998	26	23	1	8	95	0	104
1999	23	24	0	7	71	0	78
2000	27	22	0	14	49	0	63
2001	23	29	1	14	86	0	101
2002	30	46	1	11	106	0	118
2003	29	44	8	12	89	2	111
2004	23	33	5	9	114	2	130
2005	23	34	Tr	9	138	Tr	148
2006	35	42	1	12	167	1	181

2. Marine Reserves

In September of 1997, the ADF&G submitted proposals to both the BOF and the NPFMC requesting that they implement a small no-take marine reserve in **Southeast**. The purpose of these proposals was to permanently close a 3.2 sq. mile area off Cape Edgecumbe to all bottomfish and halibut fishing (including commercial, sport, charter, bycatch and subsistence) and anchoring to prevent over-fishing and to create a groundfish refuge. Two large volcanic pinnacles that have a diversity and density of fishes not seen in surrounding areas dominate the Edgecumbe Pinnacles Marine Reserve. The pinnacles rise abruptly from the seafloor and sit at the mouth of Sitka Sound where ocean currents and tidal rips create massive water flows over this habitat. These two pinnacles provide a very unique habitat of rock boulders, encrusted with *Metridium*, bryazoans and other fragile invertebrate communities, which attracts and shelters an extremely high density of juvenile rockfishes. The area is used seasonally by lingcod for spawning, nest-guarding, and post-nesting feeding. Yelloweye rockfish and pelagic rockfish species as well as large numbers of prowfish and Puget Sound rockfish also densely inhabit the pinnacles. This closure protects the fragile nature of this rare habitat, and prevents the harvest or bycatch of these species during critical portions of their life history. In February 1998, the BOF approved of the reserve and the NPFMC approved of the reserve at their June 1998 meeting. The NPFMC recommended to the BOF that they consider closure of the area to salmon trolling which would make the area a complete-no take zone. In February 2000 the BOF rejected closing the area to salmon trolling. The area is an important "turn-around" area for commercial trollers and the BOF did not believe there was sufficient conservation benefit to warrant closing the area to salmon fishing.

In 2004, a short movie of the Edgecumbe Pinnacles Marine Reserve was created because of increased public interest in our work, and to give others an opportunity to learn about, and view the pinnacles from below the waters surface. This movie is available in either VHS or DVD format for schools or non-profit organizations through the Sitka office of the Alaska Department of Fish and Game.

3. User Pay/ Test Fish Programs

The State of Alaska Department of Fish and Game receives receipt authority from the state legislature that allows us to conduct stock assessment surveys by recovering costs through sale of fish taken during the surveys. Receipt authority varies by region. In **Southeast Alaska,** we have several projects that are funded through test fish funds (total allocation approximately 400k), notably the sablefish longline assessments, the king crab survey, and the herring fishery and dive surveys. Also in 1995, the Southeast Region was given a separate receipt authority for $250,000 to conduct sea urchin research using test fish funds. In the case of sea urchins, the industry placed bids on the right to harvest and market sea urchins. The low bidder was responsible for paying for the department's expenses in research and management of this fishery and was limited to a 12% profit after state expenses were paid.

4. GIS

The ADF&G Division of Commercial Fisheries Headquarters Office is using ArcGIS 9.2 for general map production, project planning and spatial analysis. Basemaps are maintained in ArcGIS format. Statistical area charts are currently being updated using ArcGIS 9.0 and the NAD83 datum. All data and maps requests are made in NAD83 (the State of Alaska standard) or

will be converted into NAD83, if possible. Final output and all metadata will be in NAD83. Users in other divisional and area offices use ArcGIS 8, ArcView 3.x, and Mapinfo 8.5 for their GIS work. The Headquarters Office has reduced its GIS staff to one cartographer.

Hardcopy and digital groundfish and shellfish statistical area charts are available. Digital are available in Abode PDF and can be viewed or downloaded at http://www.cf.adfg.state.ak.us/geninfo/statmaps/charts.htm or in ArcGIS format at http://maps.cf.adfg.state.ak.us. The ADF&G Commercial Fisheries GIS Maps and Data Server will be home for all publicly available GIS maps developed by the division in the future. The server will also feature online maps using ArcIMS (Internet Map Server) software (contact Evelyn Russell).

5. Logbooks

In 1997, logbooks became mandatory for all state-managed commercial fisheries in Southeast Alaska. Logbooks for rockfish and lingcod had been mandatory for a number of years. All usable longline and jig logbook data through 2006 has been entered.

Number of commercial fishery logbooks collected by fishery, target species, and year.

SE	Longline				Jig/dinglebar			
Year	DSR	Pacific cod	Slope Rock	Sablefish (includes pot gear)	Lingcod	Black rockfish	DSR	PSR
1986	21	1						
1987	25							
1988	20							
1989	19							
1990	50	1	2					
1991	232	8	1					
1992	259	7						
1993	190	8						
1994	197	9	3		108			
1995	140	13			215			
1996	261	8			252	31	6	
1997	204	98	4	466	177	64	8	1
1998	177	135	15	552	153	70	3	4
1999	165	223	9	405	89	21	1	1
2000	153	97	4	421	153	30		
2001	128	48	2	332	44	2	2	
2002	143	27	5	276	53	31	4	0
2003	115	53	closed	298	54	37	2	closed
2004	96	55	closed	229	40	23	3	closed
2005	14	53	closed	240	52	23	1	closed
2006	4	42	Closed	242	106	9	0	closed

Since 1998, marine recreational charter operators have been required to log port of landing, effort and harvest, and ADF&G statistical area for every charter trip made. Several changes were made to the 2006 logbook, the most important of which is that operators were required to report numbers of halibut kept and released (for the first time since 2001), report the fishing license number of all licensed anglers, and report all catch statistics by individual angler. Other data collected for each vessel trip included port of landing, location(s) fished, effort for salmon and bottomfish, and harvest and/or release (in numbers) of Chinook, coho, sockeye, pink, and chum salmon, pelagic rockfish, yelloweye rockfish, other rockfish, lingcod, and salmon sharks. The Sport Fish Division is cleaning up the logbook database and evaluating the accuracy of logbook entries by comparing the data to observed data and surveying individual anglers.

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Web Pages

ADF&G Home Page: http://www.adfg.state.ak.us/

Commercial Fishery Division Home Page: http://www.cf.adfg.state.ak.us/

News Releases: http://www.adfg.state.ak.us/news/dept_news.php

Sport Fish Division Home Page:
http://www.sf.adfg.state.ak.us/statewide/sf_home.cfm

Sport Fish Division Southcentral Region Halibut and Groundfish Program:
http://www.sf.adfg.state.ak.us/region2/groundfish/gfhome.cfm

Age Determination Unit Home Page: http://tagotoweb.adfg.state.ak.us/ADU/default.asp

Region 1 Groundfish Home Page:
http://www.cf.adfg.state.ak.us/region1/finfish/grndfish/grndhom1.php

Region II Groundfish Home Page:
http://www.cf.adfg.state.ak.us/region1/finfish/grndfish/grndhom2.php

ADF&G Groundfish Overview Page:
http://www.cf.adfg.state.ak.us/geninfo/finfish/grndfish/grndhome.php.

Commercial Fisheries Entry Commission: http://www.cfec.state.ak.us/

State of Alaska home page: http://www.state.ak.us/

Gene Conservation Laboratory Home Page:
http://www.cf.adfg.state.ak.us/geninfo/research/genetics/genetics.php

Adobe PDF versions of groundfish charts can be viewed or downloaded at
http://www.cf.adfg.state.ak.us/geninfo/statmaps/charts.php

ArcView- and MapInfo-compatible charts can be downloaded from the ADF&G CF GIS Maps and Data Server at http://maps.cf.adfg.state.ak.us/. This server will be the home for all publicly available GIS maps developed by the division. In the future this server will also feature online maps using ESRI's ArcIMS (Internet Map Server) software (Contact Evelyn Russell).

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Spalinger, K. 2006. Bottom trawl survey of crab and groundfish: Kodiak, Chignik, South Alaska Peninsula, and Eastern Aleutians management districts, 2005 Alaska Department of Fish and Game, Division of Commercial Fisheries, Fisheries Management Report No.06-43, Kodiak.

APPENDIX I

ALASKA DEPARTMENT OF FISH AND GAME
PERMANENT FULL-TIME GROUNDFISH STAFF DURING 2006.

COMMERCIAL FISHERIES DIVISION

HEADQUARTERS, P.O. Box 25526, Juneau, Alaska 99802-5526

Fish Ticket Programmer/Analyst Phil Witt (907) 465-4753	GIS Programmer/Analyst Evelyn Russell (907) 465-6147	Fish Ticket Research/Analyst Gail Smith (907) 465-6157
AKFIN Program Coordinator Lee Hulbert (907) 465-6109	Age Determination Unit Kristen Munk Box 25526 Juneau, AK 99802 (907) 465-3054	

SOUTHEASTERN REGION

Groundfish Project Leader Cleo Brylinsky 304 Lake St. Rm. 103 Sitka, AK 99835 (907) 747-2683	Fishery Biologist Jennifer Stahl Box 240020 Douglas, AK 99824-0020 (907) 465-4071	Survey and Port Sampling Coordinator Mike Vaughn 304 Lake St. Rm. 103 Sitka, AK 99835 (907) 747-6688
Project Biometrician Sherri Dressel Box 240020 Douglas, AK 99824-0020 (907) 465-4216	Fishery Technician IV Deidra Holum Box 240020 Douglas, AK 99824-0020 (907) 465-4218	Fishery Technician IV Kamala Carroll 304 Lake St. Rm. 103 Sitka, AK 99835 (907) 747-6688

CENTRAL REGION

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Fish Ticket Entry Technician Morris Lambdin 3298 Douglas Place, Homer, AK 99603-7942 (907) 235-8191	Fishery Biologist Mike Byerly 3298 Douglas Place Homer, AK 99603-7942 (907) 235-8191	PWS Management Biologist Robert Berceli PO Box 669 Cordova, AK 99574-0669 (907) 424-3212

WESTWARD REGION

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Groundfish Sampling Coordinator Kally Spalinger 211 Mission Road Kodiak, AK 99615 (907) 486-1840	Assistant Area Management Biologist Lynn Mattess 211 Mission Road Kodiak, AK 99615 (907) 486-1840	Assistant Area Management Biologist Barbi Failor-Rounds P.O. Box 920587 Dutch Harbor, AK 99692 (907) 581-1239
Assistant Groundfish Research Biologist Carrie Worton 211 Mission Rd. Kodiak, AK 99615-6399 (907) 486-1871		

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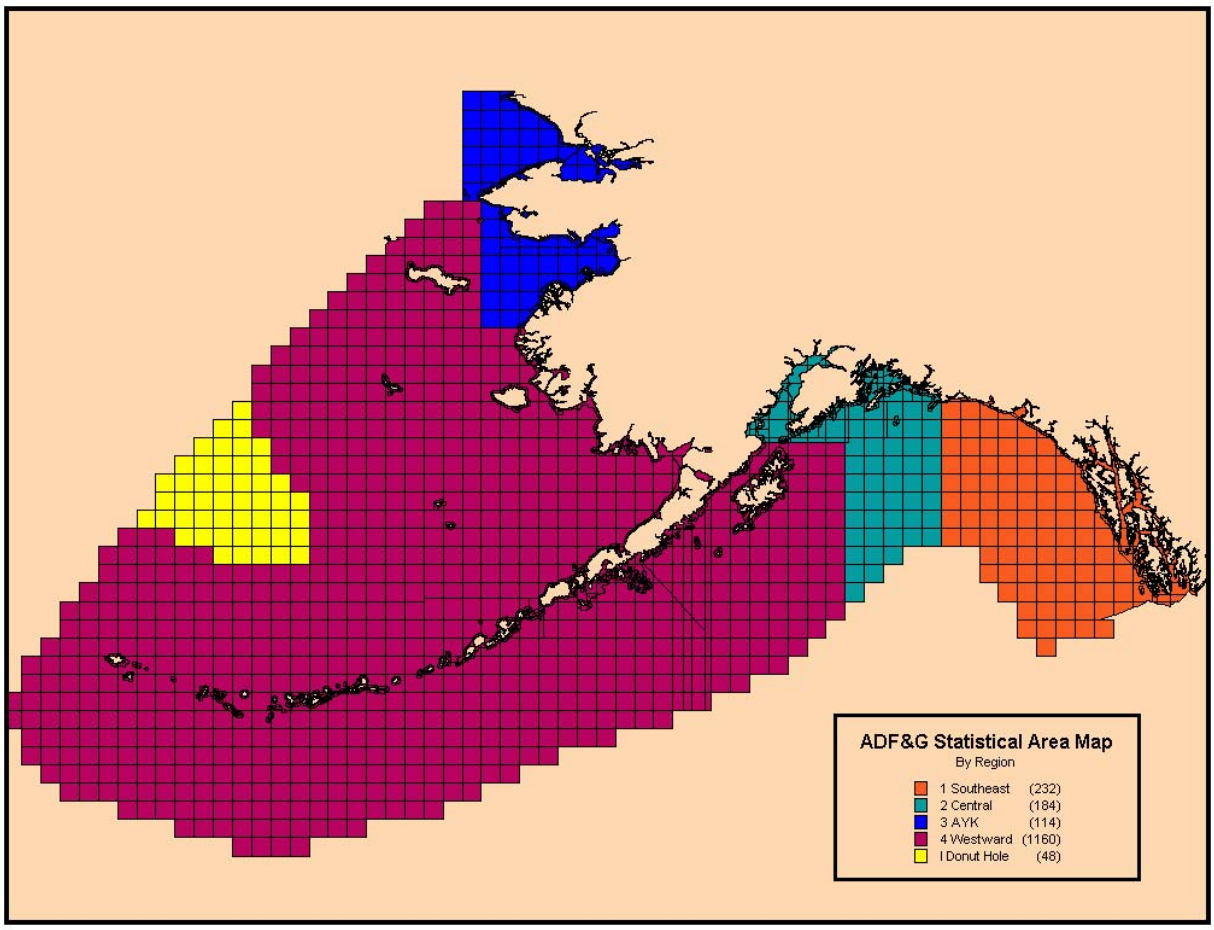
SOUTHEAST REGION

Mike Jaenicke, Project Leader Marine Harvest Studies Division of Sport Fish 802 3rd Street (Douglas, AK) PO Box 110024 Juneau, AK 99811-0024 (907) 465-4301	Charlie Swanton Regional Management Coordinator Division of Sport Fish 802 3rd Street (Douglas, AK) PO Box 110024 Juneau, AK 99811-0024 (907) 465-4297	

SOUTHCENTRAL REGION

Scott Meyer Groundfish Research and Lower Cook Inlet Management Biologist	Matthew Miller PWS and North Gulf Management Biologist Division of Sport Fish	Len Schwarz Kodiak, Alaska Peninsula, and Aleutian Islands Management Biologist

Division of Sport Fish 3298 Douglas Place Homer, Alaska 99603-8027 (907) 235-8191 scott_meyer@fishgame.state.ak.us	333 Raspberry Road Anchorage, AK 99518-1599	Division of Sport Fish 211 Mission Road Kodiak, AK 99615-6399
Steve Fleischman Biometrician Division of Sport Fish-RTS 333 Raspberry Road Anchorage, AK 99518-1599		



Appendix II

Map Depicting State of Alaska Management Regions.

Appendix III

Tissue samples of Sebastes species collected for genetic analyses and stored at Alaska Department Fish and Game, Gene Conservation Laboratory, Anchorage. Species, sampling location and collection ID, year collected, sample size, and tissue type are given.

Species	Silly Name - Location	Year	Size	Tissue Type
Yelloweye Rockfish *S. ruberrimus*	YERFLAM98 - Flamingo, British Columbia.	1998	46	fin clips; larvae
	YERTASU98 - Tasu, British Columbia.	1998	50	fin clips
	YERTOPK98 - Topknot, British Columbia.	1998	49	fin clips
	YERTRI98 - Triangle, British Columbia.	1998	63	fin clips; larvae
	YERSE298 - Sitka	1998	49	fin clips
	YRSE99 - Stat areas 355601, 365701	1999	100	fin clips
	YERYAK99 - Fairweather grounds	1999	100	fin clips
	YEPW91 – Prince William Sound; Gravina, Danger, Herring	1991	27	muscle, liver, eye
	YERGA98 – Prince William Sound, Knight Is./Naked Islands area	1998	100	fin clips
	YERPWS100 - Whittier	2000	97	fin clips
	YERPWS200 - Whittier	2000	50	fin clips
	YERRES99 – Resurrection Bay	1999	100	fin clips
	YERKACH99 - Kachemak Bay	1999	58	fin clips
	YERKOD99 – Kodiak Island	1999	115	fin clips
Black Rockfish *S. melanops*	BRORE99 – Pacific Northwest; Oregon	1999	50	muscle, liver, heart
	BRWASH98 - 47°08' / 124°37'; Washington	1998	20	fin clips
	BRSIT98 - Sitka	1998	50	fin clips
	BRSIT99T - Sitka Sound	1999	200	fin clips
	BRSIT99 – Sitka	1999	83	fin clips
	BRPWS100 - Valdez	2000	13	fin clips
	BRPWS200 - Whittier	2000	16	fin clips

BRRESB97 - Resurrection Bay	1997	82	muscle,liver,heart,eye,fin
BRRESB98 – Resurrection, North Fox Island	1998	24	fin clips
BRKOD96 - Kodiak Island	1996	2	muscle, liver, heart, eye
BRKOD197 - Ugak Bay	1997	100	muscle,liver,heart,eye,fin
BRKOD398 - Westside Kodiak Island	1998	114	fin clips
BRKOD198 - Eastside Kodiak Island	1998	100	fin clips
BRKOD298 - Southwest side Kodiak Island	1998	86	fin clips
BRSAND98 - Carpa Island near Sand Point	1998	40	fin clips
BRSAND99 - Castle Rock near Sand Point	1999	60	fin clips
BRKOD00 - Chignik	2000	100	fin clips
BRBERS99- Akutan	1999	100	fin clips
BRDUTS00 - Dutch Harbor	2000	6	fin clips
BRYAKU03- Yakutat	2003	130	fin clips

OREGON'S GROUNDFISH FISHERIES AND INVESTIGATIONS IN 2006

OREGON DEPARTMENT OF FISH AND WILDLIFE

2007 AGENCY REPORT
Prepared for the April 24-25, 2007 Meeting
of the Technical Sub-Committee of the Canada-United States
Groundfish Committee

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Oregon Department of Fish and Wildlife
Marine Resources Program
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April 2007

A. AGENCY OVERVIEW - MARINE RESOURCES PROGRAM

MRP Program Manager	Dr. Patricia M. Burke
Resource Assessment and Analysis	Dave Fox
Management and Monitoring	Maggie Sommer
Data Services	Bill Herber

The Marine Resources Program (MRP) is within the Oregon Department of Fish and Wildlife (ODFW) and has jurisdiction over fish, wildlife, and habitat issues coast-wide. MRP is headquartered at Newport in the Hatfield Marine Science Center, with field stations at the coastal ports of Astoria, Tillamook, Charleston, Gold Beach, Brookings, and Corvallis. It is tasked with the responsibility for assessment, management, and sustainability of Oregon's marine habitat, biological resources and fisheries. In addition to direct responsibilities in state waters (from shore to three miles seaward), MRP provides technical support and policy recommendations to state, federal, regional, and international decision-makers who develop management strategies that affect Oregon fish and shellfish stocks, fisheries, and coastal communities. Staffing consists of approximately 50 permanent and more than 70 seasonal or temporary positions. The program budget is approximately $5 million yearly, with about 50% of funding from federal sources and the remainder from various state sources.

B. MULTISPECIES STUDIES

1. Sport Fisheries Project:

Sampling of the ocean boat sport fishery by MRP's Ocean Recreational Boat Survey (ORBS) continued in 2006. Starting in November 2005 major ports were sampled year round. We continue to estimate catch during unsampled periods in minor ports. The estimates are based on the relationship of effort and catch in minor ports relative to major ports observed during summer-fall periods when all ports are sampled.

Black rockfish remains the dominant species caught in the ocean boat fishery. Lingcod, several other rockfish species (blue rockfish, china rockfish and other nearshore species), cabezon and greenling are also commonly landed. Oregon's fishery for Pacific halibut continues to be very popular, high profile fishery requiring International Pacific Halibut Commission (IPHC), federal, and state technical and management consideration and management.

The ORBS program continued species composition and biological sampling of groundfish species at Oregon coastal ports during 2006. As in prior years, black rockfish and blue rockfish otoliths were gathered, in addition to lingcod fin rays, for ageing studies. Age structure sampling was expanded in 2005 to include many additional nearshore species. ORBS continued collecting of length and weight data from all groundfish species.

From April through October, a portion of sport charter vessels were sampled at sea for species composition, discard rates and sizes, location, depth and catch per angler (CPUE) using ride-along samplers.

Starting in 2003, the harvest of several groundfish species was monitored inseason for catch limit tracking purposes. Inseason action was taken in 2006 to prohibit retention of cabezon and vermillion rockfish. The shore fishery remained open. As in recent years the retention of canary rockfish and yelloweye rockfish were prohibited year round.

Other ODFW management activities included participation in the U.S. West Coast Recreational Fish International Network (RecFIN) process, data analysis and conducting public hearings to discuss changes to the management of Pacific halibut and groundfish fisheries.

Starting July 2005, sampling of the shore and estuary fishery was discontinued due to a lack of funding. Black rockfish make up the largest component of the estuary boat groundfish and surfperch made up the majority of shore-based catch by weight. Salmon dominate estuary boat landings by weight. Pacific herring made up the majority of both shore-based and estuary boat landings by number of fish.

Landings in the sport and commercial halibut fisheries were monitored weekly for tracking the status of catch limits. The majority of sport caught halibut continue to be landed in the central coast sub-area (Newport). In 2006, the directed sport fishery off the central coast (Cape Falcon to Humbug Mt) was open for 36 days, which is less than in 2005 but a considerable increase from the beginning of the decade when allocation was half the 2005 level. The commercial directed fishery was open for three 10-hour periods, one period less than in 2005.

Contact: Don Bodenmiller (541) 867-0300 ext. 223, Don.G.Bodenmiller@state.or.us

2. Maturity Studies

We continued research begun several years ago to gather female maturity data from a variety of species for which such data is unavailable, outdated or only available for areas far from Oregon. This work continued in 2005, with a focus on nearshore rockfish, and poorly known slope rockfish species (aurora, POP, redbanded). We continue to collect samples for histology and have enough data for two papers in progress. The first is aurora, redbanded and yellowmouth rockfishes. The second is China, quillback, and copper rockfishes.

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3. Maternal effects

The overall goal of this project is to improve the management of west coast groundfish stocks by determining which species exhibit age related increases in larval quality, as we believe these are the species most likely to require management measures, that explicitly protect older age classes. The objectives are to analyze larval and maternal samples from several species to generate estimates of age-specific fecundity, maturation schedules, time of spawning, and larval oil globule volume. Results will be analyzed by general life history type, which should allow us to infer the likelihood of observing similar maternal age effects in other species of rockfish.

We have collected 1185 individuals from 8 species for this project to date. Species include (yellowtail, widow, chilipepper, darkblotched, Pacific ocean perch, and others). For each female, reproductively mature fish, we have collected otoliths, total length, a gonad tissue sample, or if larvae were present, a sample of larvae for determination of larval stage, oil droplet volume and yolk volume. To accomplish this, we have taken digital photographs through a dissecting microscope of approximately 30 larvae from each female. The scaled photographs are used to measure larval characteristics using image analysis software. Of the samples collected for this process, measurements have been made on more than 3000 individual larvae. Once all measurements are made, data analysis will be completed as described in the research proposal. Most of the fish in the collection have been aged already, and we will analyze the data for age-related temporal patterns in parturition.

Contact: Steve Parker (steve.parker@oregonstate.edu)

4. Discard mortality of recompressed rockfishes using acoustic telemetry

Determining the long-term survival of discarded fish is problematic, especially when a major factor in their physiological status is due to barotrauma. We used acoustic telemetry to monitor the vertical and horizontal movement patterns of rockfishes captured by hook and line and released using recompression techniques. We tagged 12 yelloweye rockfish *Sebastes ruberrimus*, 5 canary rockfish *S. pinniger*, 6 black rockfish *S. melanops*, 2 copper rockfish *S. caurinus*, 2 quillback rockfish *S. maliger*, 1 China rockfish *S. nebulosus*, and 1 vermillion rockfish *S. miniatus.* Depths ranged from 40–65 m. Inadequate data were recovered for the China and quillback rockfish. Using vertical movements as indicators of viability with time, we concluded that more than 50% of the tagged individuals for each species survived longer than 21 days, and many showed evidence of survival after several months. These results are encouraging in that mortality rates have been assumed to be near 100% and fishers have been releasing prohibited species by venting or recompressing fish with various methods. This study also indicates that recovery may be possible and studying movement patterns of tagged individuals may be possible.

Contact: Steve Parker (steve.parker@oregonstate.edu), Polly Rankin

5. Effects of catastrophic decompression on rockfish physiology and survival in the laboratory

Overfished species of rockfish (Sebastes spp.) from the Northeast Pacific experience high bycatch mortality due to barotrauma, which is induced from the rapid change in pressure during capture. As a result of barotrauma, "catch and release" techniques are often not effective for overfished species. Field experiments by the Oregon Department of Fish and Wildlife show that it may be possible for rockfish to recover from barotrauma if quickly recompressed prior to release. However, no work has followed the physiological recovery of rockfish after recompression or determined if it is possible for rockfish to survive such a severe physiological stress. We induced barotrauma in adult black rockfish from a simulated depth of 35 m with subsequent recompression. Following recompression, rockfish were slowly acclimated to surface pressure and transported to 2.4 m diameter tanks for recovery. Two control and two

treatment fish were sampled for blood and tissue (eye, gill, heart ventricle, head kidney, liver, rete mirable, and gonad) at days 3, 15, and 31 post-recompression to evaluate the cellular-level response during recovery. This experiment was replicated 4 times, for a total of eight treatment and eight control fish sampled at each time point. No mortality from barotrauma occurred during the duration of the experiments. Results showed that damage due to barotrauma at the macroscopic level consisted only of swimbladder damage, at the histological level only rete mirabile damage was present, and at the enzymatic level, no differences between treatment and control fish could be detected due to extremely high variability. During the 1 month recovery period, swimbladder damage appeared to decrease while rete mirabile damage appeared to increase. These results indicate that although survival is attainable, long-term damage to the ability to regulate buoyancy may occur.

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6. Evaluating fish behavior during capture with a selective flatfish trawl

The selective flatfish trawl became required fishing gear for all U.S. groundfish trawling shoreward of the Rockfish Conservation Area on January 1, 2005. Work in 2006 with the selective flatfish trawl focused on using an imaging sonar to study fish behavior inside and ahead of the trawl to try and understand the factors that result in either capture or escapement. This is a cooperative project with NMFS, Northwest Science Center, and will continue into 2007. To date, we have successfully attached a DIDSON sonar to a bottom trawl, imaging fish in front of the footrope and out along the wings. Specifically, we are trying to understand how different species react to and possibly escape the selective flatfish trawl. Halibut may go over the tops of the wings instead of herding. Others may rise over the headrope or go under the footrope. More work in deeper water and more encounters with various species are needed. We will also try several new views, looking down and backwards toward the footrope and possible from the footrope up towards the cutback headrope of the selective flatfish trawl. An evaluation of the effectiveness of the selective flatfish trawl fishery based on observer data is scheduled for 2007.

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7. Barotrauma in rockfishes

We continued to work with three pressurized aquaria that can hold up to 6 rockfish each and simulate depths of up to 30 m. Work examining barotrauma and discard mortality is hampered by difficulties in capturing numbers of target rockfish species, and if captured, transporting them to lab facilities with low mortality.

We continued work with a "cage-cam" in 2006 using a low-light underwater video camera to observe recompression and release at depth of 9 species of rockfish captured at depths up to 60m. This research has now been published in the North American Journal of Fishery Management. A related project examined the ability of surface-released rockfish to submerge independently and combined these data with information from the prior study to evaluate submergence as a proxy for discard survival. This research showed that most released rockfish submerge quickly and those that fail to submerge are very likely injured from barotrauma. For

some rockfish species, submergence success was determined to be a reasonable proxy for discard survival, but for others submergence success likely over-estimated discard survival.

Contact: Bob Hannah at 541-867-4741; bob.w.hannah@state.or.us

8. Developmental Fisheries Project

The ODFW Developmental Fisheries Program was created in 1993 to allow for controlled development of new species and fisheries. Each year, the Developmental Fishery Board recommends to the Oregon Fish and Wildlife Commission a list of food fish species that are considered to be developmental and a harvest program that includes a limited entry system. The Developmental Fishery Board is made up of members from a broad range of fishing interests (harvesters, processors, and state agencies).

In 2006, a total of 58 permits were issued for all species; 17 permits for finfish species; considerably less than the number of permits issued in 2005. The main reason for the reduction in permits issued was the removal of sardines and several species of bay clams from the developmental species list. Other finfish species for which we issued permits were hagfish (8) and anchovy/herring (9). Several shellfish species are also of interest to fishers such as box crab, Oregon hair, scarlet king, and grooved tanner crabs, spot prawns, coonstriped and sidestripe shrimp, and Giant octopus.

From 1999 to 2005 the Oregon sardine fishery was managed under the Developmental Fishery Program which limits the number of harvest permits. In 1999 and 2000, 15 permits were allowed and all were issued. In 2001, five additional permits were added (for a total of 20) to encourage an increase in processing capabilities. In 2004 ODFW began discussions with the Developmental Fisheries Board and the sardine industry to move Pacific sardine into a limited entry program. By December 2005 the Oregon Fish and Wildlife Commission established a limited entry program with 20 available permits. Then in April and August of 2006, the Commission adopted rules establishing renewal requirements and amended existing rules that established eligibility requirements for limited entry sardine permits. The amended eligibility rules added 6 new permits and the 2006 fishery operated under the new limited entry system with 26 permits issued by the Department.

In 2004, members of the bay clam dive fishery requested bay clams be moved off the developmental species list and placed into its own limited entry system. Throughout 2004 and most of 2005 the Developmental Fisheries Board held six public meetings to discuss limited entry proposals. In November of 2005 bay clams (cockle clams, butter, gaper, native littleneck and softshell clams) were removed from the developmental fisheries species list and a limited entry system was created with ten permits available coast wide and five permits for the south coast of Oregon.

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9. Marine Finfish Ageing Unit:

In 2006, Josie Thompson was hired as the lead for ODFW's aging project. In 2006, she completed production aging of commercial and recreationally caught black rockfish for the upcoming stock

assessment and is working on a research project investigating the use of an image analysis system for indirect age validation for 3 groundfish species. This project is growing and will have a discrete research component to it in the future.

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10. Angling Selectivity Studies

We studied how increasing the height of angled baits above the bottom using long leaders (3.0 and 4.6 m) inserted between the lowermost bait and the terminal weight (long leader gear) altered the species and size composition of the catch off the Oregon coast. Specifically, we examined if long leader gear would reduce the bycatch of demersal rockfishes, particularly yelloweye rockfish (*Sebastes ruberrimus*). Long leader gear was easily handled by fishers and reduced catch rates of large (>29 cm) yelloweye rockfish by 100% ($P < 0.10$) in nearshore (shoreward of the 73 m isobath) fishing and 79% ($P < 0.05$) in offshore fishing in comparison to the control gear. Long leader gear reduced catch rates of large canary rockfish (*Sebastes pinniger*) by 86% ($P < 0.01$) in nearshore and 31% ($P < 0.10$) in offshore areas. The catch of quillback rockfish (*S. maliger*, -100%, $P< 0.05$) was eliminated with long leader gear. Long leader gear reduced or eliminated the bycatch of many small rockfish, including rosethorn rockfish (*S. helvomaculatus*) and greenstriped rockfish (*S. elongatus*). With the exception of lingcod (*Ophiodon elongatus*, -70% in offshore fishing, $P < 0.01$), target species catch rates were not significantly reduced (Pacific halibut, *Hippoglossus stenolepis*, +15%; black rockfish, *Sebastes melanops*, -19%, $P > 0.10$; yellowtail rockfish, *S. flavidus*, +7%). Replicate drifts over the same habitat, with and without the control gear, showed that gear interactions were not the cause of reductions in yelloweye rockfish bycatch. A comparison of catch rates and bycatch reduction in different tests showed that bycatch reduction for canary rockfish with long leader gear may be density-dependent, with the greatest reductions in areas of low abundance.

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11. Nearshore Habitat Mapping

In September 2006, we conducted a pilot ROV fish survey at Orford Reef off southern Oregon to determine a) if we could successfully run an ROV survey in this highly complex, rocky reef environment, and b) to collect preliminary information on fish densities at Orford Reef. We also examined differences in our methods of substrate interpretation at a fine scale (ROV video observations) and coarse scale (sidescan sonar data). In general, the ROV survey was successful; ocean conditions allowed for ROV surveys on 4 out of 6 planned days, and only one survey site was inaccessible due to the presence of bull kelp beds. Our survey sites were located primarily on the outer areas of the reef. Accessing the interior reef area with the ROV was difficult due to heavy wave motion, bull kelp beds, and many emergent rocks. To survey the interior portion of the reef we would need to survey in spring and in very calm seas. Fish observations included ten rockfish species and nine other fish species. Blue rockfish and kelp greenling were most abundant. Disparities in habitat characterization between video review and sidescan sonar methods were noted. Disparities included; minimal ground-truthing of sidescan sonar data, differences in how some substrate features were classified in the two systems, limitations of video field of view for estimating size categories of substrate features (e.g., large vs. small boulder), sidescan habitats were interpreted several years prior without the now available

multibeam bathymetry data. Quantitative analyses of spatial resolution for habitat measures and fish-habitat associations are planned.

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C. BY SPECIES

1. Black rockfish PIT tagging

Oregon's primary recreational groundfish fishery targets the nearshore species, black rockfish (*Sebastes melanops*). Previous assessments relied on the relative CPUE trends derived from recreational fishery sampling programs. These data are not robust to problems of sampling bias or changes in fishing distribution, and can result in errors in the trend of relative population abundance. The need to independently estimate exploitation rates for black rockfish off Oregon prompted us to investigate the use of passive integrated transponder (PIT) tags for a mark-recapture program. Because PIT tags are invisible to anglers, there is no tag non-reporting problem, and tag detection rates can be estimated directly. We tagged 2,550 fish in 2002, 3,000 fish in 2003, 3,013 in 2004, and 2,882 in 2005 with PIT tags (12mm x 2mm) during 20 days of fishing each year near Newport, Oregon. In 2006, we tagged an additional 2,989 black rockfish. Tagging in 2007 will be increased to 3500 fish to increase sample sizes. Tags were injected in the hypaxial musculature below the gill arches, determined to be the best site by a previous PIT tag retention study. At tagging, categorical barotrauma symptoms were noted and fish with significant barotrauma symptoms were recompressed by immediate submersion in a cage and release at depth. During the fishing seasons (May – October), carcasses of almost all black rockfish landed by charter vessels in Newport and Depoe Bay were counted by samplers and electronically scanned for tags. We currently obtain approximately 50 tags per cohort per year. We have had good recoveries each year and exploitation rates are within expected assessment values of approximately 5%. We have begun the sixth year of tagging and will likely continue the project for the next several years. Troy Buell has been developing the multiple cohort brownie model to use with our tagging data. Some evidence of non-mixing in the first year at liberty makes a more straight-forward model fit poorly. We are also investigating model fit issues associated with variation in size selectivity of the tagging in some years. Currently the model estimates exploitation rate well and precisely, but survival estimates are poor due to mixing problems. The data available through 2006 will be used to groundtruth the model output for the 2007 stock assessment.

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2. Evidence for multiple paternity in Pacific ocean perch

The need to rebuild Pacific ocean perch (Sebastes alutus) poulations on the west coast of the US has precipitated a need to better understand the life history characteristics of this rockfish species. One such characteristic is mating behavior, which has the potential to influence effective population size and offspring phenotypes. We documented and examined the frequency of polyandry in Pacific ocean perch collected off the Oregon coast using five microsatellite loci. We found that 47 of 66 (71.2%) females examined had broods sired by multiple males. The mean number of sires per brood was 1.92 (SD = 0.76) and ranged from 1 -

4. Due to skewed paternal contributions in many broods, the effective number of sires per brood was 1.67. Polyandrous females had a significantly older average age then monogamous females (14.7 and 11.9 years respectively; P = 0.007 and the number of sires was correlated with maternal age). This maternal age effect could influence genetic diversity of the population. Our results suggest that polyandrous behavior among female Pacific ocean perch helps to maintain genetic diversity within the population and should be considered in the conservation and management of this species.

Contact: Steve Parker (steve.parker@oregonstate.edu)

3. Pacific hake

The Shoreside Hake Observation Program (SHOP) was established in 1992 to provide information for evaluating bycatch in the directed Pacific hake (*Merluccius productus*) fishery, and for evaluating conservation measures adopted to limit the catch of salmon, other groundfish and prohibited species. The 2006 coastwide optimum yield (OY) was set at the 2005 level, resulting in a U.S.OY of 269,069 mt. Although the allowable harvest level that resulted from the stock assessment was much higher than that adopted, the adopted OY was set due to bycatch concerns for widow rockfish and canary rockfish, and due to uncertainty in the extremely high total biomass projection from the stock assessment.

The tribal fishery was allocated 13% of the U.S. OY (35,000 mt). An estimated 2,000 mt was identified for research and bycatch in other fisheries. Commercial fisheries received the remaining 86.3% (232,069 mt) of the U.S. OY. Long standing sector allocations were used to divide the commercial OY into allocations for the shoreside, 42% (97,469 mt); catcher/processors, 34% (78,903 mt); and catcher vessels delivering to motherships, 24% (55,696 mt).

The directed season for mothership and catcher/processor at-sea processing (north of 42^{o} N) began on the 15th of May 2006. The directed shoreside hake fishery began on April 1, 2006 off California (south of 42^{o} N), and on June 15, 2006 off Oregon and Washington (north of 42^{o} N). To avoid pre-empting more northerly segments of the fishery, the California component of the hake fishery is limited to 5% of the total shoreside allocation until the northern component of the shoreside fishery begins. No landings were made in California after June 15th.

The tribal fishery harvested 35,441 mt (101.3%) of their set-aside. The shoreside directed fishery closed on August 2nd at 6:00 p.m. and harvested 97,296 mt (99.8% of the allocated amount). The catcher/processor fishery remained open until November 3 at 4:00 pm and harvested 78,864 mt (99.95%). The mothership fishery closed September 29 at 9:00 p.m. and harvested 55,355 mt (99.4%).

Continuation of high salmon bycatch rates and the potential for increasing darkblotched rockfish as vessels fished deeper to avoid salmon framed the concerns for the start of the 2006 fishery. Other than two weeks of high salmon bycatch during the California shoreside fishery, salmon bycatch remained low. By late May total darkblotched rockfish and widow rockfish bycatch were high and threatened the opening of the northern (Oregon and Washington) shoreside fishery. A brief voluntary cessation of the at-sea fisheries allowed the coastwide hake fishery to

get beyond the period of higher rockfish bycatch and the remainder of the season continued without any additional bycatch concerns. Total impacts (coastwide; all sectors) of overfished rockfish species are as follows: canary rockfish catch was 3.12 mt; darkblotched rockfish, 13.25 mt, Pacific Ocean perch, 3.65 mt; widow rockfish, 191.29; and yelloweye rockfish, 0.09.

In the shoreside fishery, samplers measured 7,315 Pacific hake for length-frequency information, and collected 1,659 Pacific hake otolith samples, along with length and weight information. Yellowtail rockfish otoliths and length-frequency information are provided to Sandra Rosenfeld at the Department of Fisheries Marine Fish & Shellfish Division in Olympia, Washington for future stock assessments on this species. Biological samples of Pacific mackerel are provided to the California Department of Fish and Game for their stock assessment work on this species. Biological samples of widow rockfish are sent to Don Pearson of the National Marine Fisheries Service in Santa Cruz, California. Sablefish, jack and pacific mackerel, darkblotched rockfish, bocaccio rockfish, and canary rockfish have been retained at ODFW and are available for future assessment efforts. *Past* shoreside hake observation reports are available on the internet at www.dfw.state.or.us/mrp/hake.

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4. Pacific Sardine

Pacific sardines (Sardinops sagax) are managed under the Pacific Fishery Management Council's Coastal Pelagic Species Fishery Management Plan (CPS FMP). Under the FMP, the biomass of sardines is estimated each year and a coast-wide harvest guideline is established. In 2002, the Council adopted an interim allocation system for the 2003-2005 seasons. Discussions to design a new allocation system began in 2004 and in June 2005 the Council approved a new long-term allocation formula for Pacific sardine. The new allocation framework, which releases allocations of fish coast wide by date rather than area, was implemented for the 2006 Pacific sardine fishery under Amendment 11 to the Coastal Pelagic Species Fishery Management Plan. The 2006 harvest guideline (HG) for Pacific sardines was established at 118,936 metric tons (mt) and on January 1st 41,627 mt (35% of the HG) was allocated coast wide. On July 1st 70,049 mt was reallocated coast wide (40% or 47,574 mt of the HG plus 22,475 mt from the initial allocation); and on September 15th 60,000 mt was reallocated coast wide (the remaining 25% or 29,734 mt of the HG plus 30,266 mt from initial allocations).

In 2006, landings for sardine dropped slightly but were the second highest harvest since the current sardine fishery began in 1999. Eighteen vessels landed 78.5 million pounds (35,648 mt); a 21 % decrease from 2005. Most of the sardine catch was by seine gear (99 %), and most fish were landed into Astoria and processed as bait for a Japanese longline fishery. Incidental landings of Pacific mackerel accounted for approximately 0.1.8 % of the catch which is more than twice the amount caught the previous year. ODFW staff made fourteen observed trips. In 2007 National Marine Fisheries Service declared the Pacific Northwest Fishery (PNW) as a category three fishery which will allow the West Coast Observer Program to deploy observers on PNW sardine vessels as needed. From logbook data, bycatch consisted of sharks and 181 salmon. Salmon averaged 0.24 per trip and 56 % were released alive. Market samples were collected for length, weight, maturity, and age data. The average length and weight for all samples was 194 mm (standard length) and 117 gm. The size of sardines off Oregon in 2006

were slightly larger (length and weight) than in 2005 due to an influx of older fish. Although three and four year old fish dominated landing samples of the PNW, the continued abundance of smaller, younger fish caused problems for harvesters and processors. Most of the established markets are geared toward the larger sized fish but developing market opportunities for canned and net penned tuna may utilize the smaller fish.

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D. PUBLICATIONS

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Projects planned for year 2007:

1. **Barotrauma in rockfishes**: We plan to continue the telemetry work described above with black rockfish and other species, but our focus will shift to investigating ingested acoustic tags as a method of gathering telemetry information. Lab studies examining gastric tag retention times and field camera studies to investigate the feasibility of using ingested tags for specific species are underway. We are expecting some problems due to regurgitation and so are working on modified shapes to aid in tag retention.

We also hope to participate in a collaboration with Michael Davis of NMFS Alaska Fisheries Science Center and Richard Brill of the Virginia Institute of Marine Science in a study of the effect of capture on the visual acuity of black rockfish and Pacific halibut.

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2. **Recreational fishery selectivity**: We hope to finish up our studies examining fishery selectivity and terminal gear, by completing small-scale studies investigating the effects of hook size and bait size on the species and size composition of recreational catches.

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3. **Selective Flatfish Trawl Evaluation**: We plan to conduct an analysis of the effectiveness of the introduction of the selective flatfish trawl into the U.S. west coast bottom trawl fishery based on observer data. Work on fish behavior in front of trawls utilizing scanning, imaging sonar (DIDSON) with the NWFSC will continue also.

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Washington Contribution to the 2007 Meeting of the Technical Sub-Committee (TSC) of the Canada-US Groundfish Committee

Compiled by:

Thomas Jagielo
Senior Research Scientist

Washington Department of Fish and Wildlife

April 24th - 25th, 2007

Santa Cruz, California

Review of Agency Groundfish Research, Assessment, and Management

A. Puget Sound Area Activities

2. Puget Sound Groundfish Monitoring, Research, and Assessment

(Contributed by Wayne Palsson, Marine Fish Science Unit (425) 379-2313, palsswap@dfw.wa.gov)

Staff of the Puget Sound Marine Fish Science Unit includes Wayne Palsson, Robert Pacunski, Tony Parra, Jim Beam, and Ocean Eveningsong. Their tasks are primarily supported by supplemental funds from the Washington State Legislature for the recovery of Puget Sound bottomfish populations. Most of the work of the staff is associated with the Puget Sound Assessment and Monitoring Program (PSAMP) and is tasked by the Puget Sound Action Team. The main activities of the unit include the assessment of bottomfish populations in Puget Sound and the evaluation of bottomfish in marine reserves. This year, additional grants and contracts were received for special studies regarding marine fish habitat modifications and marine reserves in Puget Sound.

A major effort was undertaken this year to develop a conservation plan for rockfishes in Puget Sound.

Evaluation of Rockfish Populations in Puget Sound – Staff continued reviewing the biology, ecology, fisheries, stressors, and status of rockfishes in Puget Sound. The Washington Department of Fish and Wildlife manages the 27 species that have been recorded in Puget Sound and manages the various commercial and recreational non-tribal fisheries that have either targeted rockfishes or have caught them incidentally to other targeted species. Rockfishes and other groundfish are managed for non-tribal users under the auspices of the Puget Sound Groundfish Management Plan and are co-managed with the Treaty Tribes of Washington. The technical review is to be a companion to the Conservation Plan for rockfishes in Puget Sound mandated by the Puget Sound Groundfish Management We summarize current knowledge of Puget Sound rockfish biology (life history, habitat usage, and ecosystem linkage) and provide an overview of their exploitation history and population status in 2006.
Because of a lack of complete catch and demographic information, formal stock assessments with retrospective and predictive models could not be conducted. The status of rockfish populations in Puget Sound were evaluated in terms of their vulnerability to extinction and, where appropriate, populations will be evaluated for their fishery potential and biological reference points. To achieve this, information on fishery landings trends, species composition trends, and yield per recruit for nine rockfish species from Puget Sound were evaluated for long-term trends.

The patterns of stocks status were generally similar between North and South among the 17 species of rockfish that were examined. Six populations (19%) of the 32 populations present in either North or South Sound were in Healthy Status. Twelve populations (38%) were in Precautionary status. Only one population in North Sound was in Vulnerable status, and seven populations (22%)

were in Depleted status. Six populations (34%) were in Unknown status with five of these in North Sound.

The pattern of stock condition is related to the frequency of the species in the catch with more common species being in poorest condition and those smaller and deeper species that are seldom caught being in the healthiest conditions. Copper and quillback rockfishes have been the two most important species in the recreational fishery, and both were in depleted or vulnerable status in both North and South Puget Sound. Yelloweye and canary rockfishes are also depleted but were always uncommon in Puget Sound catches but have been overfished in coastal waters. Five species in North Sound and six species in South Sound were in precautionary status, and these species such as black, yellowtail, and bocaccio have been secondary species of importance in recreational and commercial fisheries. Black rockfish in the western portion of the Strait of Juan de Fuca are a special exception to the overall precautionary status, perhaps because this area is fed directly by spillover from coastal areas. Populations of brown rockfish in South Sound are another exception: This population is healthy but generally not present in the recreational catches. Other healthy populations include the deepwater redstripe, greenstriped, and shortspine thornyheads, all species that appear to be uncommon or rare in inspected catches. The status of six populations was unknown with most of these in North Sound. These species are rare in catches and include tiger, China, Blue, brown, and splitnose rockfishes in North Sound and tiger rockfish in South Sound. Several species are generally not detected in South Sound including China and blue rockfishes in South Sound. Vermilion rockfish appear to be invading Puget Sound from coastal waters but their status is Precautionary until more assessment information is developed.

The results of this review are being integrated in the Conservation Plan for Rockfishes in Puget Sound. The current status and fishery patterns strongly suggest more extreme conservation measures will be required to stabilize rockfish populations and to promote their recovery.

Puget Sound Marine Habitat Studies – Wayne Palsson and Robert Pacunski continue to collaborate with Professors Don Gunderson of the University of Washington and Gary Greene of Moss Landing Marine Labs. A Washington Sea Grant study is being conducted to examine the distribution of marine fishes in relation to the distribution of different sea floor habitats in the San Juan Archipelago. The San Juan Channel was mapped with a high-resolution multi-beam echosounder that collected detailed bathymetric and back-scatter information (Figure 1). This mulitbeam bathymetry and bottom type information provided the survey frame for the Sea Grant study. During the 2004 field season, we used a Phantom 2+2HD ROV to survey the diversity of rocky, coarse, and fine sediment habitats in San Juan Channel. We found strong community associations with each substrate type. As expected, rockfish and lingcod were almost exclusively associated with rocky habitats. During the second year of study in 2005, we conducted 87 ROV transects in San Juan Channel and focused exclusively on rocky habitats to tease apart exactly how rockfish and lingcod are associated with different rocky habitat features. As in 2004, we were successful in deploying the ROV with a depressor weight and conducting transects as deep as 500 feet and in current speeds of 1.5 knots. Data are being analyzed and written up for peer-reviewed publications.

A Remarkable Settlement of Young-of-the-Year Rockfishes in Puget Sound and the Strait of Juan de Fuca in 2006 (Contributed by: LeClair, Buckley, Palsson, Pacunski, Parra, Eveningsong, Beam, McCallum) – During 2006, we investigated a remarkable settlement of

post-larval rockfishes in the inland marine waters of Washington. Quantitative scuba transects were conducted to determine how young-of-the-year rockfishes used nearshore habitats and how this use changed with time and growth. Two major patterns of recruitment were observed. In Puget Sound, high densities of copper and quillback rockfishes were observed in nearshore vegetated habitat including attached floating and submerged kelp. Lower densities were observed in eelgrass during the early summer. These post-settlement fish initially measured between 20 mm and 40 mm in length, increasing to near 80 mm by early fall when their habitat associations changed. Genetic identification using microsatellite loci was used to confirm the species composition of sampled juveniles.

The other pattern in rockfish settlement was observed in the Strait of Juan de Fuca where unusually large schools of rockfishes were observed in September at both the eastern and western ends of the strait. The species composition of these schools was different and more varied than those observed in Puget Sound.

Low Dissolved Oxygen Conditions at Sund Rocks Marine Reserve – Hood Canal is a fjord connected to Puget Sound in the north and extending 100 km to the south. The steep sides of the canal extend to depths of 180 m in the north and range to depths of over 125 m for most of the water body. Hood Canal is one of the water bodies identified in the Pew Ocean Commission report as a hypoxic dead zone. Dissolved oxygen (DO) concentrations of less than 2 mg/l have been observed for decades in deep and shallow waters in the southern portion of the canal, and these low concentrations have been attributed to naturally poor circulation resulting from low estuarine flow and bottom water replacement. In recent years, low DO concentrations have become chronic, extending into nearshore waters and possibly becoming worse due to eutrophication (J. Newton, Hood Canal Dissolved Oxygen Program). Mass mortality events of fishes and invertebrates (Fish Kills) in 1926 and 1963 likely have resulted from poor water quality.

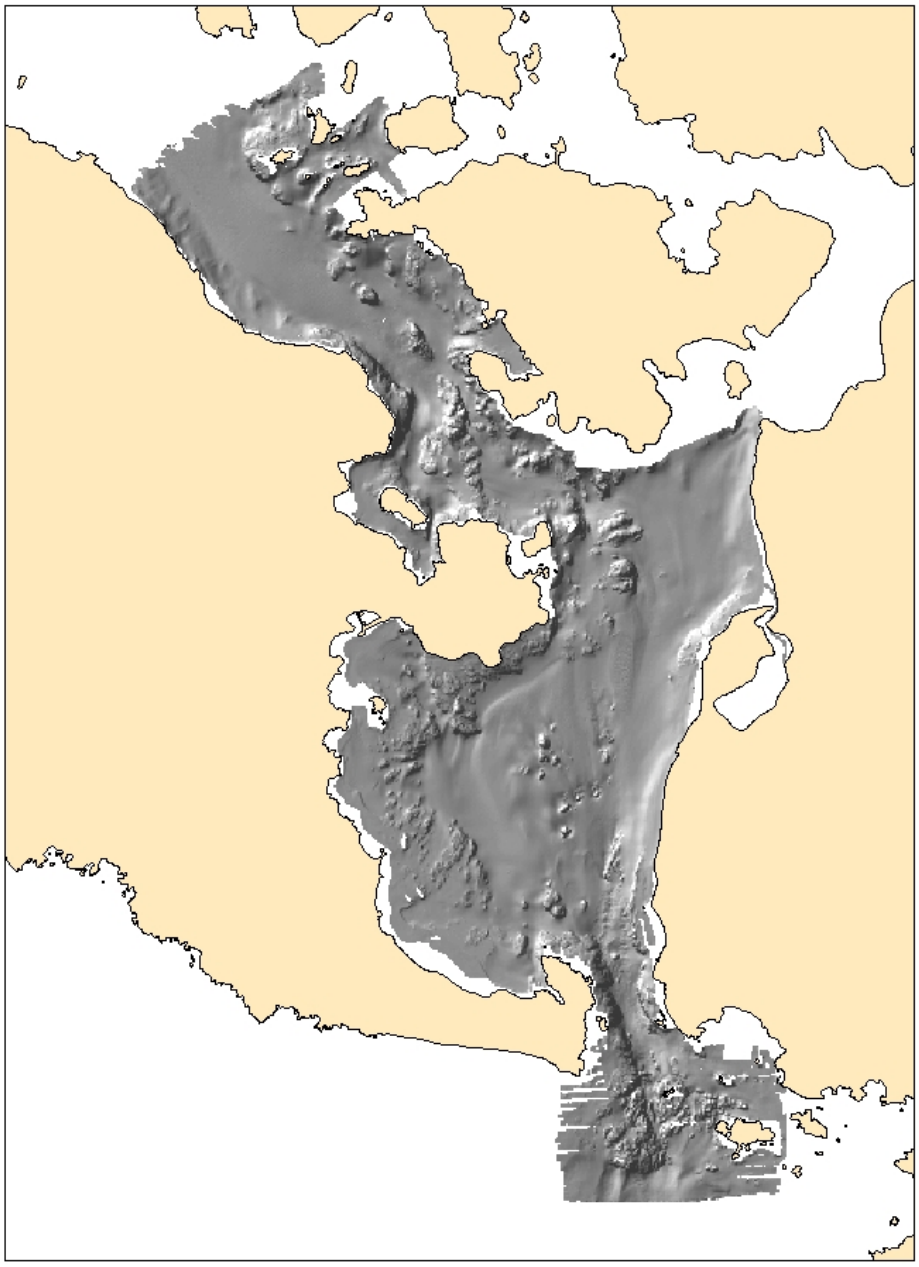


Figure 1. Hillshaded bathymetry of San Juan Channel.

Beginning in 2001, WDFW began surveying marine fishes with respect to depth at the Sund Rocks Reserve. As chronic and episodic hypoxia events developed beginning in 2002, the marine reserve study changed into one on the effects of hypoxia on marine fishes. The goal of this study is to examine the water quality thresholds that initiate avoidance behavior and the conditions that lead to fish kills. Two discrete and prominent rocky habitats located north and south of Sund Rocks Conservation Area were surveyed independently. A team of three divers conducted the visual surveys. One diver swam the 9 m isobath and oriented the two recording divers along the longitudinal axis of each survey area. The two divers swam along predetermined depth zones and identified, counted, and measured key fish species along the rocky outcropping. The divers swam close together to coordinate their observations and not double count fishes. Total length measurements to the nearest 10 cm were made with the aid of a graduated plastic rod. Beginning in Fall 2005, WDFW divers also collected data on temperature, salinity, and oxygen concentrations with a probe on the same days of their scuba surveys.

Dive surveys at both the North and South Sund Rocks sites in November 2001 found that copper rockfish were distributed evenly from a depth of 5 m to a depth of 20 m and were generally not present in depths of less than 5 m. Monthly monitoring by WDOE revealed that DO concentrations were at least 3 mg/l in waters shallower than 20 m. In October 2002, we found rockfish were almost exclusively concentrated in depths of less than 7 m during a period when DO concentrations were greater than 4 mg/l in shallow water and less than 2 mg/l at greater depths. Rockfish were distributed evenly to 20 m in depth again by November 2002 when rains restored circulation and DO concentrations were once again greater than 4 mg/l in the nearshore zone.

During the 2002, 2004, and 2005 low DO events, dead fish were not observed at Sund Rocks. However, during 2003 and 2006 major fish kills were observed along the western edge of southern Hood Canal and at Sund Rocks. These events had marked differences in the biomass of fishes killed. In 2003, the greatest biomass of dead fish were copper rockfish while in 2006 the greatest biomass was lingcod with very few rockfish. We estimated that one third of the copper rockfish at the site died due to hypoxia in 2003 and one third of the lingcod died in 2006. These field observations revealed that copper rockfish are hypoxia intolerant and cannot tolerate DO concentrations below 1 mg/l. The observed avoidance behavior is triggered when DO concentrations range between 2 and 3 mg/l. The widespread occurrence of poor water quality in southern Hood Canal has many ramifications for sustainable fisheries pursued by tribal and recreational fishers and for the location and design of marine reserves in the area. Further work is planned for determining the causes of worsening water quality and the impact on marine resources.

Second Tacoma Narrows Bridge Mitigation Study – In March 2003, the Washington Department of Transportation (WSDOT) and the Washington Department of Fish and Wildlife (WDFW) established a contract to fulfill part of the terms of the mitigation agreement for the construction of a second bridge at Tacoma Narrows, connecting Tacoma with the Kitsap Peninsula across Puget Sound. The contract establishes that staff from WDFW will conduct sampling at the bridge site to determine the impacts of the disruptive activities associated with

the construction of the bridge upon marine fish communities at the bridge site. Primary areas of interest include the two caisson and pier sites, the proposed anchor sites, and the rip-rap fields that will be placed at the footings of the existing and new tower piers. As part of the mitigation, a new artificial habitat was created at Toliva Shoal in spring 2005 that tested the effectiveness of adding small, quarried rock on or near existing artificial habitat composed of large boulders and concrete deployed for attracting adult rockfish (Figure 2).

Monitoring at the bridge site included conducting scuba transects in the shallow waters (<100 ft) at planned anchor sites and conducting towed video transects at planned anchor, rip-rap, and bridge tower locations. Pre-construction surveys revealed that most rockfish and lingcod were distributed along old bridge rubble and natural hardpan habitats on the eastern side of the Narrows. Now that the towers have been erected and the anchors removed, after-construction comparisons will be made from transects conducted during early 2006.

Pre-construction scuba transects at Toliva Shoal, found that most rockfish and lingcod were sparsely distributed on previously deployed, large-rock artificial habitats composed of concrete and quarried boulders. Initial surveys after deployment of small, quarried rock found sub-adult rockfish sparsely distributed on newly created habitat in greater numbers than on comparable transects that were not affected by new construction. Extensive surveys will continue for the next two years to determine the effectiveness of creating a small rock habitat for rockfishes on top of or away from an existing artificial habitat composed of large rocks targeting adult rockfish and lingcod. During 2006, a massive recruitment of young rockfish were observed in the nearshore vegetated habitats of central and southern Puget Sound. However, there were no young-of-the year observed at the artificial habitats at Toliva Shoal upon initial recruitment but a few were observed later in Fall 2006. Hundreds of YOYs were observed at inshore habitats near Toliva Shoal suggesting that offshore habitats are not as important as nearshore habitats for the recruitment of settling rockfish. We did observe higher numbers of sub-adult rockfish after reef construction suggesting these offshore habitats may support a post-recruitment settlement.

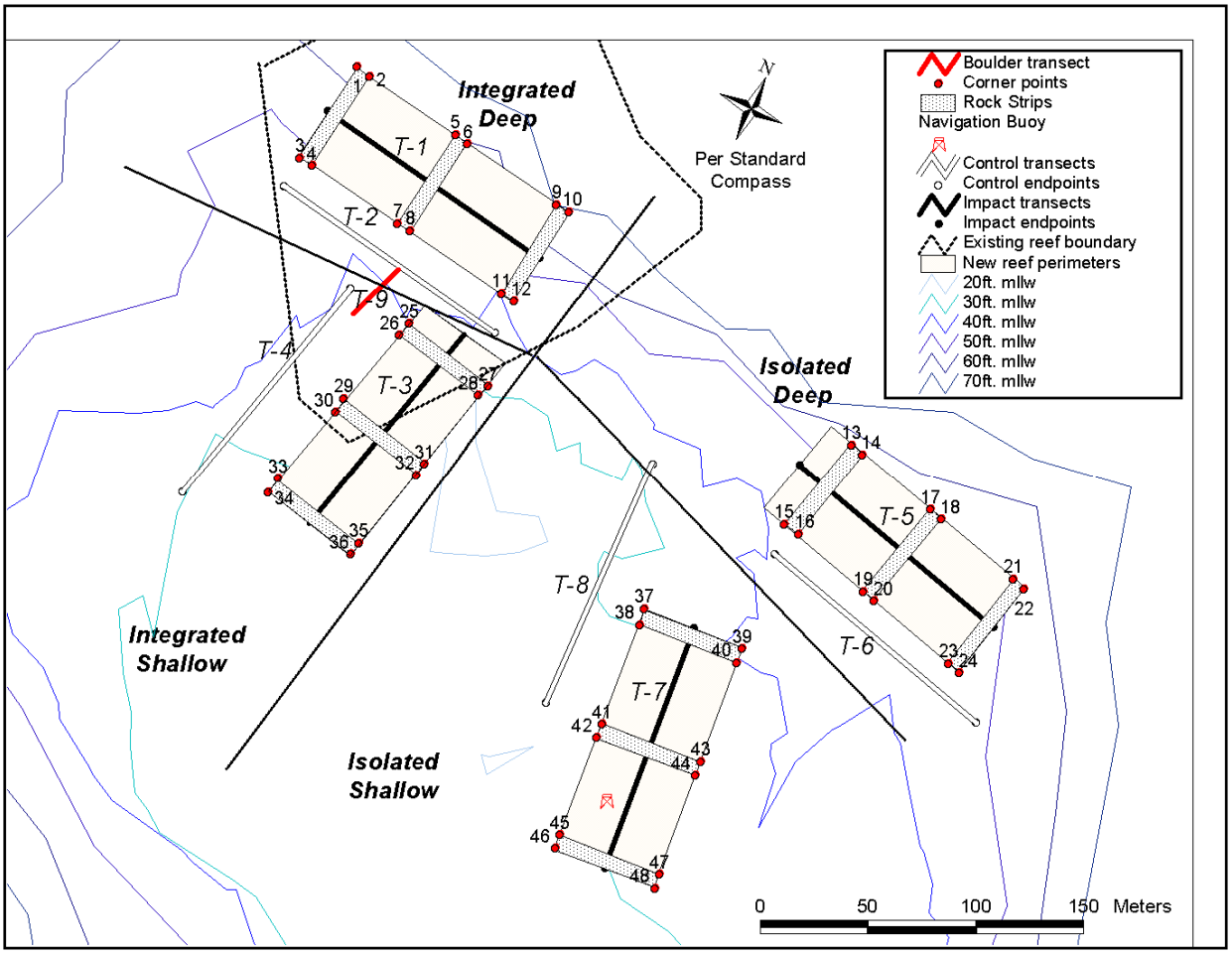


Figure 2. Deployed quarry rock for juvenile rockfishes at Toliva Shoal.

Bottom Trawl Surveys of Puget Sound – Since 1987, WDFW has conducted bottom trawl surveys in Puget Sound that have become invaluable as a fisheries-independent indicator of population abundance for fishes living on unconsolidated habitats. The trawl surveys have been conducted at irregular intervals since 1987 but more recently have focused extra effort in individual sub-basins to improve regions specific confidence intervals. The goals and objectives of the current surveys are to estimate the abundance and describe the distribution of recreational and commercial groundfish and macro-invertebrate species, collect biological information from key species, and evaluate the relationship of abundance and distribution of key species to oceanographic features. During 2006, we surveyed the U.S. Strait of Georgia and the San Juan Archipelago as well as processed information collected from the 2005 survey of Puget Sound. The chartered *F.V. Chasina* is as the sampling vessel which tows a 400 mesh Eastern net fitted with a 3 cm codend liner. Stations are selected with a stratified random approach based upon four depth zones for each of the subregions. The area sampled at each station is measured with differential GPS and known net width openings. The catch from each trawl was identified, weighed, and enumerated, and the weights and numbers of each species are divided by the area sampled to estimate species densities. Abundance is estimated by averaging station densities within each stratum and multiplying these by the stratum area. A total of 40 to 50 trawl stations were occupied in each sub-basin.

3. Herring Stock Assessment (Contact: Kurt Stick (360) 466-4345 ext. 243)

Annual herring spawning biomass is estimated for known herring populations in Washington waters using spawn deposition and/or acoustic-trawl surveys. The Washington Department of Fish and Wildlife (WDFW) recognizes nineteen different herring stocks in Puget Sound and two coastal stocks, based primarily on timing and location of spawning activity. WDFW Region 4 staff based in the Mill Creek and La Conner offices attempts to conduct spawn deposition and/or acoustic-trawl surveys of all herring populations in Washington annually. Stock assessment activities for the 2007 spawning season are in progress.

The herring spawning biomass estimate for all Puget Sound stocks combined in 2006 is 17,765 tons (see table and figure below). The cumulative total is slightly higher than the 2001 and 2002 estimates and considerably higher than the 2003-2005 estimates. The Puget Sound total reflects a general increase in the combined biomass of south/central Puget Sound (including Hood Canal) stocks since the early 1990's.

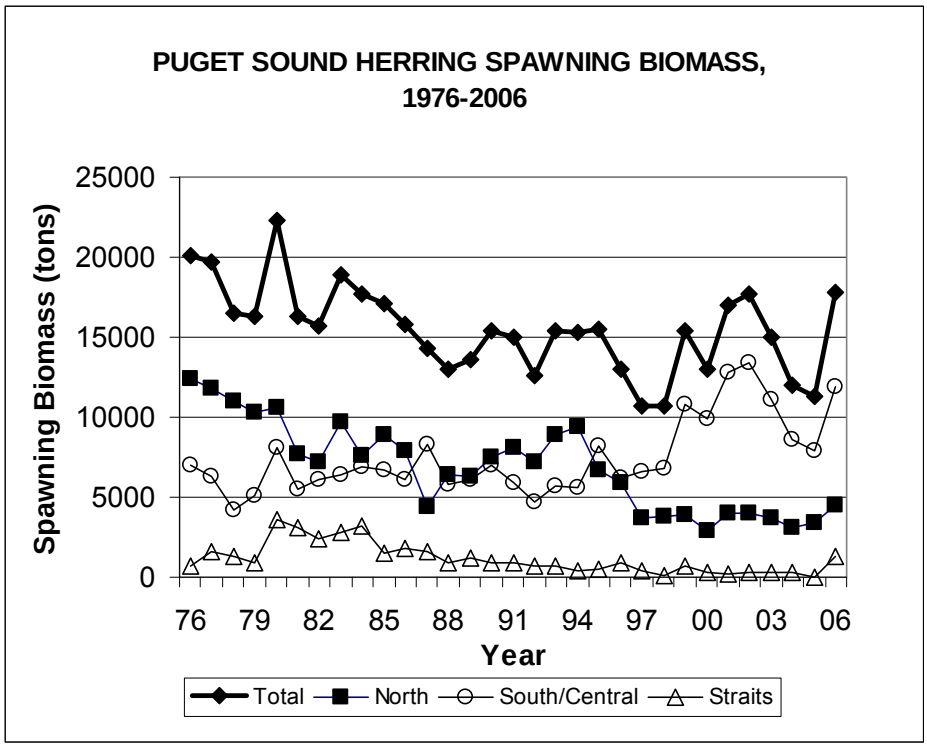
Cumulative biomass of North Puget Sound stocks has remained at a low level of abundance, primarily due to the continued critical status of the Cherry Point herring stock. The Cherry Point stock increased slightly in 2006 to 2,216 tons, continuing an observed annual increase since a low of 808 tons in 2000. The Cherry Point stock ranged from 3,100 to nearly 15,000 tons between 1973 and 1995.

The Discovery Bay herring stock is the primary component of the Strait of Juan de Fuca region. The estimated spawning biomass in 2006 of 1,325 tons for this stock was the highest observed since 1987.

No spawning activity was observed in 2006 for coastal stocks (Willapa Bay and Grays Harbor). In general, herring spawning biomass for these areas is relatively small compared to Puget Sound.

HERRING SPAWNING BIOMASS ESTIMATES (SHORT TONS) BY STOCK AND REGION, 1997-2006.
(blanks indicate no surveys done that year)

	YEAR									
	2006	**2005**	**2004**	**2003**	**2002**	**2001**	**2000**	**1999**	**1998**	**1997**
Squaxin Pass	755	436	828	2201	3150	1597	371	474	68	149
Wollochet Bay	27	67	52	152	106	133	142			
Quartermaster Harbor	987	756	727	930	416	1320	743	1257	947	1402
Port Orchard-Port Madison	2112	1958	700	1085	878	2007	1756	2006	489	360
South Hood Canal	244	210	176	207	166	187	140	516	101	226
Quilcene Bay	2530	1125	2342	916	2585	2091	2426	2464	1152	465
Port Gamble	774	1372	1257	1064	1812	1779	2459	1664	971	1419
Kilisut Harbor	54	170	184	448	774	612	107	802	311	307
Port Susan	321	157	429	450	775	587	785	545	2084	828
Holmes Harbor	1297	498	673	678	573	275	281	175	464	530
Skagit Bay	2826	1169	1245	2983	2215	2170	646	905	209	893
South-Central Puget Sound Total	11927	7918	8613	11114	13450	12758	9856	10808	6796	6579
Fidalgo Bay	323	231	339	569	865	944	737	1005	844	929
Samish/Portage Bay	412	218	351	299	496	470	196	555	643	509
Int. San Juan Is.	285	41	67	72	158	219	128	197		30
N.W. San Juan Is.	0	0	0	13	131	62	90		107	79
Semiahmoo Bay	1277	870	629	1087	1012	1098	926	868	919	621
Cherry Point	2216	2010	1734	1611	1330	1241	808	1266	1322	1574
North Puget Sound Total	4513	3370	3120	3651	3992	4034	2885	3891	3835	3742
Discovery Bay	1325	33	252	207	148	137	159	307	0	199
Dungeness/Sequim Bay	0	0	22	44	131	93	138	352	112	158
Strait of Juan de Fuca Total	1325	33	274	251	279	230	297	659	112	357
Puget Sound Total	17765	11321	12007	15016	17721	17022	13038	15358	10743	10678
Grays Harbor	0*	15	33	129	87	77	166	297	77	
Willapa Bay	0*	145	0*	398	389	150	345	397	57	144
*partial survey coverage										
Coast Total	0	160	33	527	476	227	511	694	134	144



4. Puget Sound Ambient Monitoring Program (PSAMP) (*Contact: Sandie O'Neill (360) 902-2843)*

The Washington Department of Fish and Wildlife continues to be a key component of the Puget Sound Ambient Monitoring Program Project (PSAMP), a multi-agency effort to assess the health of Puget Sound. To assess how the health of the Sound is affected by chemical contamination of it's fish, the PSAMP Fish Component monitors "legacy" pollutants like PCBs and DDTs that persist in the ecosystem despite restrictions in their use, PAHs, which are compounds associated with petroleum and with combustion, heavy metals, and emerging toxics like PBDEs that are used as flame retardants.

5. Puget Sound Marine Fish Research (Contact: Larry LeClair, Marine Fish Science, 360 902-2767, leclalll@dfw.wa.gov)

Trans-generational Marking of Viviparous Marine Fish in Puget Sound, Washington – Investigators at the Washington Department of Fish and Wildlife continued experimenting with the use of elemental strontium as a means to mark the otoliths of viviparous marine fish larvae prior to birth. Laboratory trials with captive perch and rockfish have shown that a single intramuscular injection of strontium into gestating adults is sufficient to produce a lifelong strontium mark in the otoliths of larvae prior to parturition, thus providing a potential method for directly estimating retention and dispersion rates from local populations.

Field trials are now underway at Point Heyer, Washington with brown rockfish (*Sebastes auriculatus*). To date, 139 gestating females have been injected and released *in situ*, and more than 300 injection cohort juveniles have been recovered. A single marked otolith has thus far been found among the 150 juveniles assayed to date. The upcoming year will focus on juvenile recoveries from the last injection cohort and the completion of strontium assays. Preliminary results will appear in a 2007 Sea Grant publication on the biology, assessment, and management of north Pacific rockfishes.

Use of Microsatellite DNA and Pedigree Analysis to Test For Self-recruitment in an Isolated Population of Brown Rockfish in Puget Sound, Washington – This collaborative study between the Washington Department of Fish and Wildlife and the University of Washington is aimed at using genetic markers to identify progeny of resident adult brown rockfish among juveniles sampled at an isolated reef near Point Heyer, Washington. Non-lethal in situ sampling using tissue clipped from the dorsal lobe of the caudal fin are being used to genotype individuals at 12 microsatellite loci. To date, 137 adults, estimated to be about one third of the total adult population, have been sampled and genotyped. Genotypes from 118 juveniles have been obtained. Preliminary results using a maximum likelihood estimation approach indicate self-recruitment to be about 15%; however, low genetic variability and higher than expected genotyping error has lead to some ambiguity in assigning parent-offspring-sib relationships. Additional marker loci with greater allelic richness and reduced genotyping error were developed in 2006 and will be used to assay existing and future collections from Point Heyer and adjacent areas. Results are expected to be directly applicable to the design and placement of MPA's in Puget Sound and elsewhere. The upcoming year will focus on collecting oceanographic data during the larval release season to develop a model for larval dispersal distance and trajectory from Point Heyer. Field sampling and genotyping of adult and juvenile

brown rockfish will continue. Preliminary results will appear in a 2007 Sea Grant publication on the biology, assessment, and management of north Pacific rockfishes.

Allozyme and Microsatellite DNA Analysis of Lingcod From Puget Sound, Washington, and Adjoining Waters – Allozymes and microsatellite DNA were used to examine genetic connectivity among lingcod populations in Puget Sound and between Puget Sound and the outer coast. No significant differences in allele frequencies were detected, though multidimensional ordination suggested minor differences between Puget Sound and the outer coast. Results of the study appeared in the Transactions of the American Fisheries Society, 2006, 135:1631-1643.

Efficacy of PIT tags to monitor movements of juvenile rockfish in Puget Sound. – Passive integrated transponder (PIT) tags are being evaluated for efficacy of in situ monitoring of early life history stage rockfish. Underwater injection and detection techniques are being developed and studies are underway with captive juveniles at local aquariums to determine the lowest fish length limits, tag retention, and survival.

B. Coastal Area Activities

1. Coastal Groundfish Management (Contact Michele Culver, (360) 249-1211 or Brian Culver, (360) 249-1205)

Council Activities – The Department contributes technical support for coastal groundfish management issues via participation on the Groundfish Management Team (GMT), the Scientific and Statistical Committee (SSC), and the Habitat Steering Group (HSG) of the Pacific Fishery Management Council (PFMC). The Department is also represented on the Scientific and Statistical Committee and Groundfish Plan Teams of the North Pacific Fishery Management Council. Landings and fishery management descriptions for PFMC-managed groundfish are summarized annually by the GMT in the Stock Assessment and Fishery Evaluation (SAFE) document.

2. Coastal Groundfish Monitoring, Research, and Assessment

Black Rockfish Tagging Study *Contact: Farron Wallace (360) 249-1207* – In 1998, WDFW began a multi-year mark-recapture survey near Westport Washington, the principal location of recreational landings of black rockfish along the Washington coast. The survey design involves annual releases of coded wire tagged (CWT) fish and recovery of tagged carcasses from the recreational fishery, both of which are currently on going. From 1998 to 2001, WDFW's R/V Corliss was used to capture, tag and release 2,622, 3,478, 2,779 and 3,200 black rockfish annually. Since 2002, commercial charter vessels have been used, including F/V Hula Girl, F/V Slammer and F/V Tequila Too. A total of 4,089 black rockfish were caught, tagged and released in 2002, 6,744 in 2003, 5,981 in 2004, 3,940 in 2005 and 6289 in 2006. In 2004, passive integrated transponder (PIT) tags were used to reduce the labor needed to read and match recovered tags. In 2005, all tagged fish released were tagged with both CWTs and PIT tags, which will allow estimation of PIT tag loss rates (since CWT loss rates are already known). Tag

detection experiments in 2006 indicated that detection of PIT tags during high volume recovery where fish are in the detectors range for less than a second was less than 60%. CWT tag detection was over 95%. Due to this, PIT tags have been excluded from tag releases in 2007.

Fish are released on pinnacles distributed throughout the area fished by the Westport charter fishing fleet. Each CWT tagged fish had two tags placed in the opercular musculature; one on each side of each fish's head. The tags were marked to allow for identification of specific individuals upon subsequent recapture. No tag shedding or tag related mortality was observed during holding experiments during 1998, 1999 and 2003.

On an annual basis, roughly 40% of the total Westport recreational black rockfish catch is sampled for CWT tags by passing fish carcasses through a metal detector tube (Northwest Marine Technologies R8000).

Cooperative Rockfish Sampling Survey (Yuk Wing Cheng[1], Claude Dykstra[2], Tien-Shui Tsou[1], Bruce Leaman[2] and Brian Culver[1]; [1]Washington Department of Fish and Wildlife, [2] International Pacific Halibut Commission) – Twenty-seven and twenty-five survey stations targeting halibut and rockfish, especially yelloweye rockfish, were surveyed with longline fishing gear between June and July 2006. The existing halibut stations have been surveyed annually by the International Pacific Halibut Commission (IPHC) since 1998. The twenty-five new rockfish stations were selected based on historical rockfish catch from the IPHC survey stations, the Pacific Coast Groundfish EFH Mapper program, and spot prawn logbook trawling data. We found that the Groundfish EFH Mapper data might not provide a reliable spatial description of rocky areas, or that there was no relationship between rocky habitat and yelloweye abundance. With the addition of yelloweye survey station results, the CV of the 2006 yelloweye abundance index was 38% lower compared with the use of halibut survey station results alone.

Based on the 2006 survey, the estimated Pearson's product-moment correlation between yelloweye and halibut catches from yelloweye survey stations was 0.37 ($P=0.07$). The estimated Pearson's product-moment correlation between yelloweye and halibut catches from halibut survey stations was 0.96 ($P<0.001$).

Halibut surveys stations 1061, 1068, 1069, 1072, 1076, 1078, 1081-1084, had yelloweye catches during 2002-2006 surveys. Thus, these 10 stations are recommended for use in developing a yelloweye abundance index in the future. Yelloweye survey stations 1501-1511, 1513 –1515 should be surveyed in the future if funding is available. If additional survey effort is available, adaptive systematic stratified sampling can be conducted around station 1082, in order to lower the uncertainty of the developed yelloweye abundance indices.