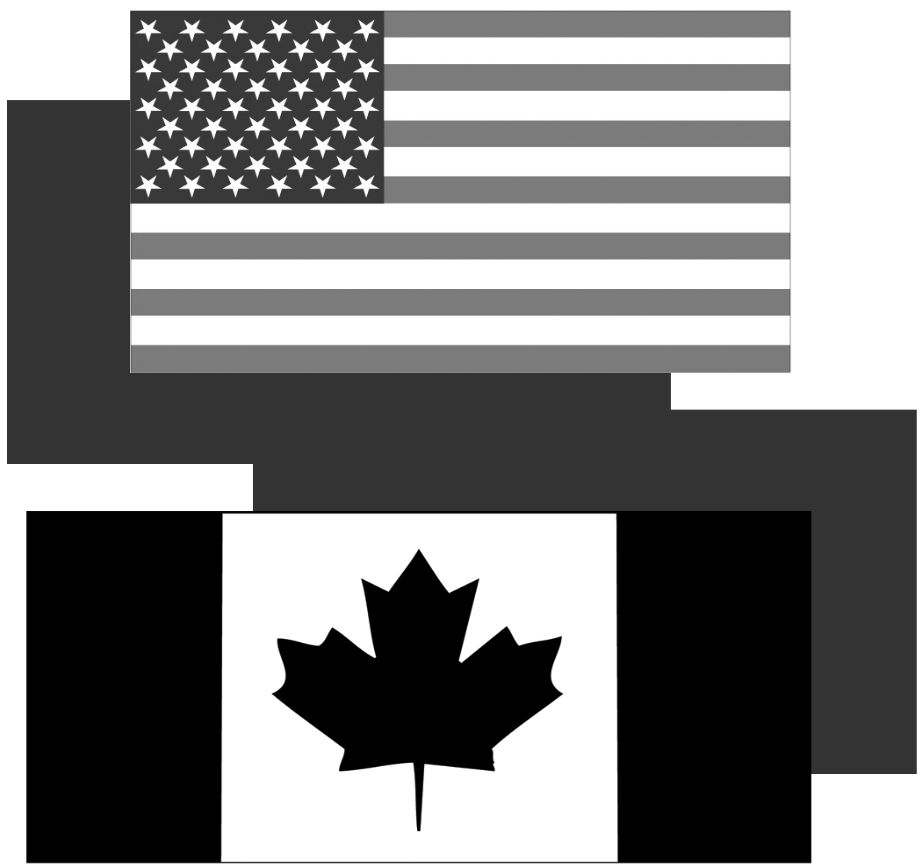
Report of the Technical Subcommittee
of the
Canada-United States Groundfish Committee
51st Annual Meeting of the TSC
May 5-6, 2010
Nanaimo, British Columbia



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	DATES	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
2008	May 6-7	Seattle, WA	Wilkins	Brylinsky
2009	May 5-6	Juneau, AK	Clausen	Clausen
2010	May 5-6	Nanaimo, BC	Stanley	Clausen

Table of Contents

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 May 5-6, 2010 in Nanaimo, British Columbia. The meeting was hosted by DFO Pacific Biological Station and held at the Nanaimo Convention Center. The meeting was chaired by Dave Clausen, AFSC Auke Bay Lab. As is done each year, participants reviewed previous year (2009) research achievements and projected current year (2010) research for each agency.

The TSC again noted the ongoing work of the **Committee of Age Reading Experts** (CARE) (http://care.psmfc.org), a long-standing TSC Working Group that was originally created by TSC in 1982. Shayne MacLellan (DFO), representing CARE, reviewed CARE activities that followed the CARE 2009 workshop. The results of the workshop were summarized during the previous TSC meeting. During the workshop, seven CARE to CARE recommendations were developed. Related to these, CARE subsequently assembled and presented a poster on the mission, history, and accomplishments of CARE at the August 2009 International Otolith Symposium in Monterey, California. CARE has tasked itself with updating the CARE manual and exploring the possibility of a meeting in 2010 to review results of the sablefish otolith exchange study. There were no outstanding TSC to CARE recommendations that required action and no outstanding recommendations from CARE to TSC. Shayne noted that Moss Landing has not sent a representative to the last two CARE meetings. With the retirement of Greg Cailliet and Allen Andrews moving to Hawaii, future MLML representation may be in question.

There was no **Trawl Survey Working Group Report** meeting in 2009; however the committee endorsed a meeting for early 2011. TSC suggested that the format be expanded to include hook-and-line surveys (see TSC to TSC recommendations below). Discussion topics for the meeting would include survey design issues, operational issues, and updates concerning at-sea methods of data acquisition.

Members from most of the agencies contributed to a discussion on developing **methodologies for data poor assessments**. Steve Ralston mentioned that at the NMFS National Stock Assessment Workshop this year, data poor assessments will be a major discussion topic and that a WG will produce a document with recommendations. There was a suggestion that TSC sponsor a workshop on data poor assessment methods or create a WG but the overall committee noted that there already appeared to be lot of activity in this field with numerous conferences and publications including books dedicated to the issue. The TSC did not endorse any specific recommendations on this issue.

Greg Workman noted that the process to formally ratify the hake treaty between the U.S. and Canada has slowed and that each country has submitted "competing" assessments for the last three years. He suggested that the **TSC Hake Working Group** should be re-activated. Following general discussion on the actual role of this WG, the TSC endorsed the idea but noted that given the relatively high profile that this WG would receive, initial discussion should focus on development of a Terms of Reference (see TSC to TSC and TSC to Parent Committee recommendations below).

Other important topics discussed at the meeting included: 1) discussion of the issues of separating cryptic rockfish species; while managers in Canada and the US may be allowed to manage an aggregate grouping of species, the absence of catch data, survey indices, and biological sampling for each species separately, renders stock assessment problematic; and 2) extensive discussion on "no-take" survey technology. The TSC recommended that a workshop be held in late 2010 to discuss non-lethal survey methodologies.

The **52nd Annual Meeting of TSC** is scheduled for May 3-4, 2011 in Astoria, Oregon. We hope to see representation from all the West Coast agencies that deal with groundfish research and management, especially those agencies that were not able to attend the 2009 meeting.

C. Minutes of the Technical Subcommittee

51st Annual Meeting of the Canada-U.S. Groundfish Committee's Technical Subcommittee (TSC)
May 5-6, 2010
Nanaimo Convention Center
101 Gordon Street, Nanaimo, BC V9R 5J8
Chair, Dave Clausen, AFSC
Host, Rick Stanley, DFO

<u>Wednesday, May 5</u>

I. Call to Order – Dave Clausen, Chair, called the meeting to order at 9:20 am, May 5, 2010

II. Appointment of Secretary – Rick Stanley, DFO Pacific Biological Station

III. Introductions - Greetings from Greg Workman, Section Head for DFO's Groundfish Section, Marine Ecosystem, and Aquaculture Section. Stephen Phillips sent his apologies for not attending owing to an illness in the family.

Reports that were made available on line before the meeting, or provided at the meeting, included the 2009 TSC report, and the 2009 reports from SWFSC, ODFW, WDFW, NWFSC, IPHC, DFO, AFSC, ADFG and CARE. The 2010 report will be compiled by Stephen Phillips. ODFW also provided Information Report 2009-04: Length and age at maturity for female yelloweye rockfish (*Sebastes ruberrimus*) and cabezon (*Scorpaenichthys marmoratus*) from Oregon waters based on histological evaluation of maturity.

List of Participants

Cleo Brylinsky	Alaska Department of Fish and Game, Sitka, (Cleo.Brylinsky@alaska.gov)
Troy Buell	Oregon Department of Fish and Wildlife, Newport, (*Troy.v.Buell@state.or.us*)
Dave Clausen	Alaska Fisheries Science Center, NOAA, Auke Bay Lab, Juneau, (*Dave.Clausen@noaa.gov*)
Claude Dykstra	International Pacific Halibut Commission, Seattle, (*Claude@iphc.washington.edu*)
Adam Keizer	Fisheries and Aquaculture Management, Canada DFO, Vancouver, (*Adam.Keizer@dfo-mpo.gc.ca*)
Aimee Keller	Northwest Fisheries Science Center, NOAA, Seattle, (*Aimee.Keller@noaa.gov*)

Shayne MacLellan	Science Branch, Pacific Biological Station, Canada DFO, Nanaimo, (Shayne.Maclellan@dfo-mpo.gc.ca)
Steve Ralston	Southwest Fisheries Science Center, NOAA, Santa Cruz (Steve.Ralston@noaa.gov)
Kate Rutherford	Science Branch, Pacific Biological Station, Canada DFO, Nanaimo, (Kate.Rutherford@dfo-mpo.gc.ca)
Eric Soderlund	International Pacific Halibut Commission, Seattle, (Eric@iphc.washington.edu)
Rick Stanley	Science Branch, Pacific Biological Station, Canada DFO, Nanaimo, (Rick.Stanley@dfo-mpo.gc.ca)
Rob Tadey	Fisheries and Aquaculture Management, Canada DFO, Vancouver, (Rob.Tadey@dfo-mpo.gc.ca)
Theresa Tsou	Washington Dept. of Fish and Wildlife, Olympia, (Tien-shui.tsou@dfw.wa.gov)
Tom Wilderbuer	Alaska Fisheries Science Center, NOAA, Seattle (Tom.Wilderbuer@noaa.gov)
Mark Wilkins	Alaska Fisheries Science Center, NOAA Seattle, (Mark.Wilkins@noaa.gov)
Malcolm Wyeth	Science Branch, Pacific Biological Station, Canada DFO, Nanaimo, (Malcolm.Wyeth@dfo-mpo.gc.ca
Greg Workman	Science Branch, Pacific Biological Station, Canada DFO, Nanaimo, (Greg.Workman@dfo-mpo.gc.ca)
Lynne Yamanaka	Science Branch, Pacific Biological Station, Canada DFO, Nanaimo, (Lynne.Yamanaka@dfo-mpo.gc.ca)

IV. Approval of the 2009 report – The 2009 Report was approved at 9:30 am.

V. Approval of the 2009 agenda – The 2009 Agenda was approved at 9:35 am.

VI. Brief historical reviews of TSC for new participants – Provided by various members.

VII. Working Group Reports

A. Committee of Age Reading Experts (CARE)

Shayne MacLellan reviewed CARE activities that followed the CARE 2009 workshop. The results of the workshop were summarized during the previous TSC meeting. During the workshop, seven CARE to CARE recommendations were developed. Related to these, CARE subsequently assembled and presented a poster on the mission, history, and accomplishments of CARE at the August 2009 International Otolith Symposium in Monterey, California. CARE has tasked itself with updating the CARE manual and exploring the possibility of a meeting in 2010 to review results of the sablefish otolith exchange study. There were no outstanding TSC to CARE recommendations that required action and no outstanding recommendations from CARE to TSC. Shayne noted that Moss Landing has not sent a representative to the last two CARE meetings. With the retirement of Greg Cailliet and Allen Andrews moving to Hawaii, future MLML representation may be in question.

Regarding particular species, Shayne mentioned that she was not hopeful concerning the development of ageing methods for shortspine and longspine thornyheads; historical and ongoing attempts to age these species have showed little promise to date. She also reported that study (AFSC) that included used of a known-age sablefish otoliths indicated a tendency to underage sablefish.

Steve Ralston proposed that an attempt be made to compile a catalogue across agencies of what exists in archives of ageing materials. These materials could be used to develop additional ageing chronologies. This idea was endorsed by TSC (see TSC to CARE recommendations below).

Claude Dykstra noted that the IPHC is now maintaining a clean/dry reference collection in addition to the main collection which is stored in glycerol to facilitate future analyses that might otherwise be corrupted by the glycerol medium. The AFSC has recently switched to glycerol from alcohol owing to lab safety concerns. Shayne noted that older historical DFO sablefish samples (in glycerol) seem to suffer from de-calcification and there is ongoing concern about the status and quality of archived samples. In reply to a query regarding the impact of ocean acidification on otoliths, she said that little had been published. She referred members to a recent paper (Checkley et al. 2009, Nature vol. 324) where, contrary to expectations, study results indicated that larval fish otolith growth was enhanced by elevated CO_2.

B. Trawl Survey Working Group Report

There was no trawl survey WG meeting in 2009; however the committee endorsed a meeting for early 2011. TSC suggested that the format be expanded to include hook-and-line surveys (see TSC to TSC recommendations below). Discussion topics for the meeting would include survey design issues, operational issues, and updates concerning at-sea methods of data acquisition.

C. Yelloweye Rockfish Working Group

TSC originally started the yelloweye rockfish WG to discuss the potential for conducting a coast wide assessment for yelloweye. There has been no action on this issue although all yelloweye rockfish researchers have shared their data and are open to the idea of cooperative work in the future. Since this WG has not been active in the past two years, the TSC recommended that it be de-activated until needed.
The yelloweye rockfish discussion, however, led into an extensive discussion on “no-take” survey technology. Lynne Yamanaka noted that DFO had moved from submarine to ROV technology owing to cost. Troy Buell summarized ODFW’s ongoing work with drop cameras. He suggested that this technique shows promise for indexing sedentary species. ODFW is also experimenting with stereo cameras. Mark Wilkins noted that AFSC is also working with stereo cameras. The research leads are Chris Rooper and Kresimir Williams. They plan to organize a workshop for September 2011 on stereo video technology. Mark also commented that a study

comparing near-bottom trawl, ROV and drop camera performance was completed and should be written up this year. Contacts for this study are Chris Rooper, John Butler, and Kresimir Williams.

Steve Ralston noted that NMFS has funding for further development of no-take monitoring technology. It was his understanding that sometime within next 12 months, Liz Clarke (NWFSC), Mary Yoklavich (SWFSC), and John Butler (SWFSC) were planning a field study comparison of no-take monitoring technologies to include AUV, submersible, and ROV. Steve referred TSC members to the SWFSC report for a summary of work on passive-acoustic techniques.

As noted above, the NWFSC continues to experiment with mounting a camera in a midwater trawl net with the codend open. Theresa Tsou commented that WDFW plans to conduct comparative studies of longline gear with release mechanisms and submersible technology.

Following further discussion on no-take survey technologies, the TSC recommended that a workshop be held to bring together various groups working on these technologies (see TSC to TSC recommendations below).

D. Proposal for Data Poor Assessment Working Group or Workshop

Members from most of the agencies contributed to a discussion on developing methodologies for data poor assessments. Steve Ralston mentioned that at the NMFS National Stock Assessment Workshop this year, data poor assessments will be a major discussion topic and that a WG will produce a document with recommendations. There was a suggestion that TSC sponsor a workshop on data poor assessment methods or create a WG but the overall committee noted that there already appeared to be lot of activity in this field with numerous conferences and publications including books dedicated to the issue. The TSC did not endorse any specific recommendations on this issue.

E. Proposal to re-activate a TSC Hake Working Group

Greg Workman noted that the process to formally ratify the hake treaty between the U.S. and Canada has slowed and that each country has submitted “competing” assessments for the last three years. He suggested that the TSC Hake Working Group should be re-activated. Following general discussion on the actual role of this WG, the TSC endorsed the idea but noted that given the relatively high profile that this WG would receive, initial discussion should focus on development of a Terms of Reference (see TSC to TSC and TSC to Parent Committee recommendations below).

VIII. Other Topics

Representatives were invited to elaborate on select issues from their reports or add any items that were omitted from their reports.

A. Marine Reserves

Troy Buell noted that Oregon plans to have two new MPAs in place in 2011 (Redfish Rock and Otter Rock) and are now collecting reference data in the areas. NGOs are offering substantial research funding to work on marine reserves in Oregon. Steve Ralston commented that it is difficult to obtain funding to provide monitoring of existing MPAs in California. Lynne Yamanaka noted that DFO has begun ROV monitoring in selected MPAs from among the total of 164 however, no "before" studies had been conducted on these locations. Various members noted that "compliance" was suspected to be poor in MPAs.

B. Genetics and stock structure

The TSC discussed the issues of separating cryptic rockfish species. Rick Stanley noted that while managers in Canada and the US may be allowed to manage an aggregate grouping of species, the absence of catch data, survey indices, and biological sampling for each species separately, renders stock assessment problematic. This leaves managers vulnerable to the criticism that quota management is not possible, and, by definition, each of the populations can be considered "threatened or endangered". Furthermore, fisheries that catch each species may find it difficult to attain eco-certification.

Positive identification of blackspotted and rougheye rockfish based on visual characteristics continues to be a problem in both B.C. and Alaska. Aimee Keller noted that NWFSC trawl surveys are attempting to separate blackspotted and rougheye rockfish at-sea while obtaining fin-clips from problematic specimens. Steve Ralston commented that in California they are having difficulties distinguishing between vermilion and sunset rockfish and also separating the two proposed "blue" rockfish species.

Dave Clausen noted that unpublished genetics work by Tony Gharrett (University of Alaska) indicates that Pacific ocean perch probably move less than 100 km and, at most, 400 km during their lifetime. Mark Wilkins noted that walleye pollock and Pacific cod show isolation by distance although the Georgia Basin population may differ from that of the Gulf of Alaska. Claude Dykstra commented that genetics work on Pacific Halibut continues to indicate a panmictic stock. If there were a dividing line it would be Amchitka Pass.

C. Western Groundfish Conference 2010 and 2012 Update

Dave Clausen noted that the abstracts from the 2010 conference will be online soon. There were 165 registrants, many signing up at the last moment including many students. The 2012 conference will be in Washington. The organizing committee has not yet been formed.

IX. Review of Agency Groundfish Research, Assessment and Management

A. Agency Overviews

There were limited additional comments to add to what was included in the Agency reports.

B. Multispecies Studies

1. SWFSC

Steve Ralston noted that John Field (SWFSC) has been appointed to the PMFC's Ecosystem Plan Development Team. He also commented that the long-running midwater trawl YOY rockfish survey was conducted in 2009 on the RV *Miller Freeman* rather than the RV *David Starr Jordan*, which was recently retired. Catches in 2009 were consistent with previous years of colder water. Catches of rockfish were modestly above the long term trend for the first time since 2004. Work continued on the *Collaborative Optically-Assisted Acoustical Survey Technique* (COAST) to study rockfish dispersions and abundances. Lead staff members in COAST are Dave Demer and John Butler.

2. ODFW

Troy Buell noted that ODFW staff are conducting various studies directed at hypoxic zone monitoring, acoustic telemetry; maturity-at-age, and rockfish depth-dependent discard mortality estimates. They are also initiating a study of shrimp trawl impact on macrofauna (Bob Hannah).

3. NWFSC

Aimee Keller commented that the NWFSC is examining the catchability (q) of petrale sole by their survey nets. In particular, they are attempting to estimate the herding of petrale sole by the sweeps and bridles. They also continue to experiment with placing video cameras in the nets while leaving the codend open. They are also now equipping their survey nets to measure fluorescence, light, and oxygen. There was evidence of hypoxia in the more northern area of the survey. Jason Cope, a Research Scientist is examining data-poor assessment techniques.

4. WDFW

The WDFW black rockfish tagging project has been expanded to address more species. The Puget Sound trawl survey changed from a random to a fixed design. In 2008, one bocaccio was observed during an ROV survey in the San Juan area which translated to 4,000 bocaccio specimens after spatial expansion. A publication on Puget Sound rockfish biology was completed. Steve Ralston asked whether there was a genetic basis for separating Puget Sound rockfish species from outside populations. Theresa Tsou responded that there is no direct genetic evidence. The biological review team (BRT) report inferred the separation based on other rockfish species like copper, brown, quillback, yelloweye, and POP

5. DFO

DFO is conducting a pilot test version of the Australian *Ecological Risk Assessment of the Effects of Fishing* (ERAEF). The pilot focuses on 25 selected benthic species captured in the bottom trawl fishery of Hecate Strait. The lead researcher is Kendra Holt.

C. Stock Assessment (general)

Steve Ralston recommended that assessment staff consider the work of Alec MacCall and E.J. Dick (SWFSC-Santa Cruz) on their Depletion Corrected Average Catch (DCAC) and Depletion-Based Stock Reduction Analysis (DBSRA) assessment procedures. They appear to show promise for assessing west coast rockfish and other species for which little more than average catch is available. It has been endorsed by the Pacific Fishery Management Council (PFMC) and used for over 40 species. It provides a relatively rapid method for providing harvest management advice for data poor species with estimates of uncertainty. A manuscript has been prepared and should be available by the end of June. The model will be added to the NMFS assessment toolbox and includes examples.

The SWFSC is also active in investigating an objective basis for adjusting ABCs relative to the uncertainty in the assessments for data-rich stocks. Steve Ralston led an effort by the PFMC's Scientific and Statistical Committee to quantify retrospective, among assessment, variation in biomass estimates, which was ultimately used by the PFMC in buffering ABCs below overfishing limits (OFLs). Washington, Oregon, and DFO all noted they are spending considerable time and effort in improving their reconstruction of groundfish catch histories.

D. By Species

1. Pacific Cod

See agency reports; no additional information reported.

2. Nearshore Rockfish

There was a general discussion on estimating post-capture rockfish mortality. Oregon has a publication on harvesting procedures that could aid individual rockfish recovery but there is no official California or Oregon policy on the handling of rockfish by harvesters. Steve Ralston noted that there is a published document which identifies the mortality rates assumed for estimating of total catch mortality. [Note: subsequent to the meeting Steve informed the rapporteur that this document can be found at http://www.pcouncil.org/wp-content/uploads/chp4_0910.pdf].

3. Shelf Rockfish

Steve Ralston drew TSC's attention to a weight specific fecundity study developed by E.J. Dick (SWFSC). Results of that study have already been incorporated into the stock assessment of four rockfish species. SWFSC work is also continuing work on the passive acoustic studies particularly on bocaccio. SWFSC updated the assessments on widow rockfish, bocaccio, and cowcod as well as worked on assessments of greenspotted and bronzespotted rockfish.

Troy Buell referred participants to the comments in the report regarding recreational gear experiments by Oregon to selectively capture yellowtail while avoiding yelloweye rockfish. Preliminary results appeared promising. ODFW has completed a paper on yelloweye rockfish age at maturity. Cleo Brylinsky reported that ADFG will be doing a submersible dive survey for yelloweye rockfish in Southeast Alaska in late July – early August.

Rick Stanley (DFO) reported that the Federal Minister of the Environment was expected to make a decision this fall (2010) on whether canary rockfish and bocaccio would be listed as "threatened".

4. Slope Rockfish

Dave Clausen noted that OSU graduate student Linsey Arnold presented work at the Western Groundfish Conference indicating a positive relationship between maternal age and offspring quality for Pacific ocean perch. Dave mentioned, however, that similar work for quillback rockfish in Southeast Alaska indicated low correlation between maternal age and size of the oil globule in larvae. Steve Ralston commented that ongoing work by Susan Sogard has not consistently revealed such a relationship among rockfish species.

5. Thornyheads

Dave Clausen mentioned that Kris Munk and the ADFG ageing lab had validated their shortspine thornyhead rockfish ages with C^{14} techniques. Shayne MacLellan noted that the PBS sclerochronology lab, as with other labs, was attempting to age thornyheads but the irregularity in the patterns makes them difficult. There is also significant variation among samples in the readability of the otoliths.

6. Sablefish

Cleo Brylinsky (ADFG) commented that the recreational fishery for sablefish is continuing. The bag limit is 4/day, with a 4 fish possession limits and an 8 fish annual limit. The technical specifics of the "permitted" electric sport reel have been officially defined. She also noted that sablefish taken in ADFG's Chatham Strait longline survey are now being counted toward the quota in this area. Because the survey takes about 10% of the quota, this has made some fishermen unhappy. Dave Clausen added that due to new regulations in the recently amended Magnuson-Stevens Fishery Conservation and Management Act, survey catches in U.S. Federal waters for sablefish and other species also count toward annual fishing quotas.

7. Halibut

IPHC staff commented that tagging and stock studies are continuing. Data continue to indicate one population with considerable movement/migration. Moving further towards the assumption of one management stock has necessitated the development of new procedures for allocation among management areas. This process has been very controversial. Current methods are based on survey abundance which requires strong assumptions on relative catchability among areas. Ageing data indicates that mean length at age is the lowest ever seen and is declining.

The pop-up tagging program is proving informative. In 2009, the IPHC survey deployed Seabird units on each of the 1,200+ stations to collect oceanographic observations. They have an MSc student working on doing spatial interpolation of the O_2 data.

The IPHC is conducting a review of their survey design. In particular, the IPHC is considering expanding further north in the Bering Sea, and extending the survey deeper from 275 to 325 fm. They are also looking at whether bait costs can be reduced by changing bait although this would require a "connection" factor. Chum salmon has been the standard bait in the survey since 1998. The IPHC is considering holding a catchability workshop in 2011.

8. Flatfish

Aimee Keller noted that petrale sole (Washington-California) were assessed in 2009. The biomass is estimated to be depleted to about 11% of unfished biomass. The base model indicates that the spawning biomass has been below 25% of the unfished level continuously since 1953. Petrale sole are considered overfished and catches have been restricted for 2009 and 2010. A rebuilding plan for petrale sole is complete. Petrale sole abundance in the Washington-California survey has been declining.

9. Lingcod

Oregon is conducting a comparison of otoliths and fin rays for ageing lingcod. ADFG is re-examining old yelloweye rockfish submersible footage to estimate lingcod density by habitat type. WDFW is planning to conduct an assessment of Puget Sound lingcod.

10. Pacific hake

The TSC endorsed the re-creation of a TSC Hake Working Group (see TSC to TSC, and TSC to Parent committee recommendations).

11. Walleye Pollock

The AFSC noted that walleye pollock population in the Bering Sea has been decreasing. This had been attributed to five consecutive years of poor recruitment. The Gulf of Alaska population appears to be increasing.

12. Sharks, rays and Skates

DFO noted that an "outside" dogfish (i.e., excluding Strait of Georgia) assessment will be presented at PSARC on May 17. The work is a joint collaboration of DFO staff with Dr. Vince Gallucci of the University of Washington. The basking shark in BC waters is under consideration for being designated as threatened or endangered by the Canadian Minister of the environment.

13. Pacific Mackerel and Sardines

The committee recommended that "Sardines and mackerel" be excluded from further TSC discussion.

14. Other Species

a) Cabezon

The fishery for live cabezon is increasing in northern California. Oregon has published a paper on cabezon biology.

b) Hagfish

ODFW has suspended their limited entry permit system for hagfish reverting to open access management due to funding limitations. There is a harvest guideline of 1.6 million pounds and a pot limit. There is a proposal under consideration in BC to restart a modest hagfish fishery. Commercial interest has also been expressed in SE Alaska. WDFW has initiated research on hagfish.

b) Grenadiers

Dave Clausen noted that there has been recent interest in starting a fishery on giant grenadiers in the Gulf of Alaska**.**

Thursday, May 6

E. Other Related Studies

a) SWFSC

Steve Ralston referred TSC to the SWFSC document for a summary of a number of economic studies on the various groundfish fisheries.

b) AFSC

Mark Wilkins commented that Craig Rose of the AFSC is testing the performance of salmon excluders in trawl nets. The AFSC also continues to benefit from the analysis of the specimens collected in a "benthic bag" which is attached to the bottom trawl gear in AFSC surveys. A number of new species of fish and invertebrates have been obtained with this device.
Mark Wilkins noted that the Northeast Fisheries Science Center (NEFSC) is taking a lead role in ensuring US fishery surveys do not represent a threat to marine mammals. The development of a review and permitting process has been problematic since NOAA is responsible both for issuing the permits and conducting the surveys. NMFS researchers are examining whether pingers on trawl gear would reduce trawl net/marine mammal interaction.

Dave Clausen reported that Pat Malecha of the AFSC's Auke Bay Lab conducted a trawling impact study in 2009 in which a submersible was used to re-examine a study site off Southeast Alaska that had been trawled in 1996. Although the study site was in a trawl closure area and had not been trawled since 1996, trawl damage to the sea floor and to sponges was still apparent after 13 years.

F. Other Items

1. Integrated groundfish management in B.C. - update

Rick Stanley provided a brief update on the Integrated Groundfish Project in BC. It is generally considered to be a success in BC and has been converted from a 'pilot study" to a quasi-permanent status. Some details of the monitoring are provided in a paper by Stanley *et al*. cited in the Canadian report. DFO and the TSC recommended that this topic can be deleted as a "permanent" item on the agenda for future TSC meetings.

2. Marine mammal predation on groundfish

Lynne Yamanaka noted that the preliminary results from an ongoing yelloweye rockfish assessment for the Strait of Georgia indicates that marine mammals may be consuming significant amounts of yelloweye rockfish and thus slowing or possibly even preventing the recovery of this population.

IX. Progress on 2009 Recommendations

A. From TSC to Itself -

1. There is a need for a WDFW person to attend TSC and TSC should ask councils to send a participant. A letter should be sent out by December to directors of agencies, regions, centers, and states. This may promote attendance of TSC meetings. The TSC meeting this year was also lacking someone from Canada DFO management. It was likely hard to travel because this meeting was in Alaska, and the TSC hopes more can make it in future.
   - The TSC chair (Dave Clausen) sent these letters in early 2010.
   - Dr Theresa Tsou of WDFW attended this years meeting
   - DFO management was represented by both Adam Keizer and Rob Tadey.

2. As in recent past years, a summary letter explaining the purpose of the TSC and highlights of the meeting should be sent to agency supervisors and/or division directors.
   - These letters were sent by the TSC chair in summer 2009.

B. TSC to CARE – No recommendations were made.

C. TSC to Parent Committee –

1. The TSC recommends that a letter be sent to the Division Director of the NMFS AFSC Fisheries Monitoring and Analysis Division (FMA, sometimes referred to as the Alaska groundfish observer program) inviting

a representative of this division to attend annual TSC meetings in the future.

- This letter was sent. The invitation was declined.

X. 2010 Recommendations

A. From TSC to Itself

1. As in recent past years, a summary letter explaining the purpose of the TSC and highlights of the meeting should be sent to agency supervisors and/or division directors.

2. The TSC requests that members of the Trawl Survey Working Group coordinate with individuals who conduct hook-and-line surveys to plan and host a 3-day workshop in Seattle in late February 2011. Mark Wilkins and Rick Stanley offered to organize the workshop.

3. The TSC notes the number of projects related to the development of no-take monitoring technologies. It recommends that these initiatives would benefit from a 1-2 day workshop. Theresa Tsou has offered to initiate organization of a workshop on no-take monitoring methods to be held later in 2010.

B. TSC to CARE

Recognizing the value of carbon dating and other potential uses of archived ageing material, TSC recommends that CARE examine the feasibility of preparing an on-line summary of the material that is archived by each of the west coast groundfish research agencies.

C. TSC to Parent Committee

1. The TSC requests that the Parent Committee ask the AFSC to host the 2011 survey workshop in Seattle.

2. In the interim period while the Hake Treaty legislation is pending approval, TSC recommends that the Parent Committee create an interim Hake Working Group under the auspices of the TSC. Greg Workman has offered to initiate discussions with Canadian and US staff on developing the Terms of Reference for this Working Group.

XI. Schedule and Location of 2011 Meeting

Dave Clausen will continue as chair for a third year. The location and date will be Oregon, Tuesday May 3 and Wednesday May 4. ODFW offered to host the meeting. Note: the Astoria location within Oregon was approved subsequent to the meeting.

XII. Other

The Parent Committee and TSC once again thanked Stephen Phillips and the Pacific States Marine Fisheries Commission for providing funding and organizational support to TSC meeting. This includes producing the annual report and maintaining the website. The TSC thanked Dave Clausen for chairing the 2010 meeting and offering to stay on for a third term. They also thanked Rick Stanley and DFO for hosting (with PSMFC assistance) the 2010 meeting. The 2010 meeting was adjourned at 11:45, May 6, 2010.

D. Parent Committee Minutes

Minutes of the 51st Annual Meeting of the Canada-U.S. Groundfish Committee (aka "Parent Committee")

I. Call to Order

Mr. Mark Wilkins, AFSC, represented the United States (for Stephen Phillips, PSMFC) and Adam Keizer represented the Canada (for Tamee Mawani, DFO). The meeting was called to order at 11:45 Wednesday, May 6, 2010.

II. Rapporteur

Rick Stanley was appointed secretary for the meeting.

III. The Agenda

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

IV. The 2009 Parent Committee meeting minutes

The Parent Committee minutes were adopted as presented

V. The 2009 Parent Committee recommendations

There were no Parent Committee recommendations

VI. 2010 Parent Committee Recommendations

a. Parent Committee agrees with the 2010 TSC recommendation to ask the AFSC to host the 2011 survey workshop in Seattle.

b. The Parent Committee agrees with 2010 TSC recommendation that in the interim period while the Hake Treaty legislation is pending approval, that TSC create a Pacific Hake Working Group. They also agree that this process starts with development of the Terms of Reference of this Working Group.

VII. 2011 Meeting Location

a. Parent Committee agrees with the proposed location and schedule for the 2011 TSC and Parent Committee Meeting: Astoria Oregon, Tuesday May 3, and Wednesday May 4, 2011. Troy Buell of ODFW has offered to host the meeting. [Note: the Astoria location within Oregon was approved subsequent to the meeting].

VIII. Other Business

a. The Parent Committee thanks Dave Clausen for chairing the meeting and Rick Stanley for being the recording secretary

b. The Parent Committee thanks PSMFC for its ongoing support for the Annual TSC meetings.

c. The TSC thanked Cleo Brylinsky for her long standing contribution to, and support of, the TSC and congratulated her on her impending retirement.

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 FISHERES SERVICE
2. CANADA, BRITISH COLUMBIA GROUNDFISH FISHERIES
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

2010 Agency Report
to the
Technical Subcommittee
of the
Canada-US Groundfish Committee

April 2010

Compiled by
Mark Wilkins, Tom Wilderbuer, and David Clausen

VIII. REVIEW OF AGENCY GROUNDFISH RESEARCH, ASSESSMENTS, AND MANAGEMENT IN 2009

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 Laboratories (ABL). The RACE and REFM Divisions are divided along regional or disciplinary lines into a number of programs and tasks. The FMA Division performs all aspects of 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 Center divisions are included as Appendices II - V.

RACE DIVISION

The core function of the Resource Assessment and Conservation Engineering (RACE) Division is to conduct quantitative fishery surveys and related ecological and oceanographic research to measure and describe the distribution and abundance of commercially important fish and crab stocks in the eastern Bering Sea, Aleutian Islands, and Gulf of Alaska and to investigate ways to reduce bycatch, bycatch mortality, and the effects of fishing on habitat. The staff is comprised of fishery and oceanography research scientists, geneticists, pathobiologists, technicians, IT Specialists, fishery equipment specialists, administrative support staff, and contract research associates. The status and trend information derived from both regular surveys and associated research are analyzed by Center stock assessment scientists and supplied to fishery management agencies and to the commercial fishing industry. RACE Division Programs include Fisheries Behavioral Ecology, Groundfish Assessment, Midwater Assessment and Conservation Engineering, Recruitment Processes, Shellfish Assessment, and Research Fishing Gear. These Programs operate from three locations in Seattle, WA, Newport, OR, and Kodiak, AK.

In 2009 one of the primary activities of the 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 2009 by RACE Groundfish Assessment Program (GAP) scientists; the annual eastern Bering Sea shelf survey and the biennial survey of the continental shelf and slope in the Gulf of Alaska. In 2010 GAP scientists will again conduct the annual Bering Sea shelf survey and the biennial Aleutian Islands survey of the continental shelf and upper continental slope resources.

RACE scientists of the Habitat Research Team (HRT) continue research on essential habitats of groundfish.

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 2009 and around Chirikof-Shelikof Strait in March 2009. A summer survey of pollock on the eastern Bering Sea shelf was conducted in June and July 2009. Research cruises investigating bycatch issues also continued.

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. This observer data also provides a means for evaluating and developing management strategies by NMFS and the regional management council, 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 2009, the FMA Division trained and deployed 657 observers to 267 vessels and 19 shore plants in Alaska. These observers spent 35,677 days collecting data in 2009. 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.

The FMA Division's existing North Pacific Groundfish Observer Program (Observer Program), has been in place since 1990. It established coverage levels for most vessels and processors based on vessel length and amount of groundfish processed, respectively. Vessels and processors contract directly with NMFS-certified observer provider companies to procure observer services to meet coverage levels in Federal regulation. During the past several years, the North Pacific Fisheries Management Council (Council), NMFS, and the Council's Observer Advisory Committee have been working to develop a new system for observer funding and deployment in the Observer Program. The concept is often called 'observer restructuring.' In general, the program would be 'restructured' (the service delivery model would be changed) such that NMFS would contract directly with observer providers for observer coverage, supported by a broad-based user fee and/or direct Federal funding. Concerns with the existing program arise from the inability of NMFS to determine when and where observers should be deployed, inflexible coverage levels established in regulation, disproportionate cost issues among the various fishing fleets, and the difficulty to respond to evolving data and management needs in individual fisheries. The problem statement and alternatives developed by the Council are as follows:

Problem Statement:
The Observer Program is widely recognized as a successful and essential program for management of the North Pacific groundfish fisheries. However, the Observer Program faces a number of longstanding problems that result primarily from its current structure. The existing program design is driven by coverage levels based on vessel size that, for the most part, have been established in regulation since 1990 and do not include observer requirements for either the <60' groundfish sector or the commercial halibut sector. The quality and utility of observer data suffer because coverage levels and deployment patterns cannot be effectively tailored to respond to current and future management needs and circumstances of individual fisheries. In addition, the existing program does not allow fishery managers to control when and where observers are deployed. This results in potential sources of bias that could jeopardize the statistical reliability of catch and bycatch data. The current program is also one in which many smaller vessels face observer costs that are disproportionately high relative to their gross earnings. Furthermore, the complicated and rigid coverage rules have led to observer availability and coverage compliance problems. The current funding mechanism and program structure do not provide the flexibility to solve many of these problems, nor do they allow the program to effectively respond to evolving and dynamic fisheries management objectives.

Alternatives:

- Alternative 1. Status quo; continue the current service delivery model.
- Alternative 2. GOA-based restructuring alternative. Restructure the program in the GOA, including shoreside processors; and include all halibut and <60' vessels participating in groundfish fisheries in the GOA and BSAI. Vessels in the restructured program would pay an ex-vessel value based fee. Retain current service delivery model for vessels > 60' and shoreside processors in the BSAI.

- Alternative 3. Coverage-based restructuring alternative. Restructure the program for all fisheries and shoreside processors with coverage of less than 100 percent. Vessels in the restructured program would pay an exvessel value based fee. Leave vessels and processors with at least 100 percent coverage under the current service delivery model.
- Alternative 4. Comprehensive restructuring alternative with hybrid fee system. Restructure program for all groundfish and halibut fisheries off Alaska. Vessels and shoreside processors with 100 percent or greater coverage would pay a daily observer fee and vessels and shoreside processors with less than 100 percent coverage would pay an ex-vessel value based fee.
- Alternative 5. Comprehensive restructuring alternative that would assess the same ex-vessel value based fee on all vessels and shoreside processors in the groundfish and halibut fisheries in the GOA and BSAI.

The Council's work on restructuring the Observer Program is a high priority issue and a significant amount of FMA resources are being spent to enable Council decision making. An implementation plan for restructuring the Observer Program was presented to the Council in 2009. Work is now proceeding on an analysis of the alternatives to support Council decision making. The initial analysis will be presented to the Council at its June, 2010 meeting in Sitka.

On another priority issue, the FMA Division is working with the Alaska Region and the fishing industry, in the development of regulations and data collection protocols implementing the Council's action in 2009 which approved Amendment 91 to the groundfish fisheries management plan in the North Pacific. The Council's action recommended placing a hard cap on the number of Chinook salmon that can be caught as bycatch in the Bering Sea pollock fishery. This action will be implemented via Federal rule-making and NMFS is planning for implementation in January of 2011. The proposed rule can be found at: http://www.fakr.noaa.gov/prules/75fr14016.pdf

As drafted, the proposed rule envisions the salmon cap to be distributed to fishing sectors (groups of vessels), after which it will be further allocated by industry to individual fishing vessels with creative incentives to avoid salmon and mechanisms to transfer allocations. The FMA Division is challenged with developing approaches to account for salmon bycatch at the finer scale of individual vessels. Chinook salmon bycatch amounts that reach the established cap could be controversial because they will limit further pollock fishing. The rule also proposes that pollock vessels currently covered 30 percent of the time will shift to 100 percent observer coverage with the implementation of this action.

In 2009, the FMA Division's Observer Program continued to adapt to new observer coverage requirements implemented under Amendment 80 to the groundfish fisheries management plan in the North Pacific. This amendment allowed fishing cooperatives to form among the Bering Sea flatfish catcher-processors and required additional observers (an increase from one to two observers) on each vessel. Amendment 80 vessels have offered the FMA Division and the fishing industry a workable example of video monitoring. Videos are used in a surveillance capacity to monitor fish bins which cannot be directly seen by observers from where they sample. When the observer's line of sight is obstructed, the video cameras along with a live monitor screen at the observer station provide an electronic visual record saved on a computer hard drive which can later be used for enforcement purposes, if needed.

Also in 2009, the FMA Division made significant improvements in the details of data collection and electronic storage for information concerning seabird/fishing activity interactions and seabird species of interest sightings. Sightings information of six species of seabirds, including short-tailed albatross and red-legged kittiwake are now systematically collected by observers. Also, observers are collecting more detailed information about seabird interaction with fishing gear and vessel operations which often results in seabird mortality. This information is now collected by observers at sea using standardized methods and stored in an electronic format which has interactive capabilities with the larger observer sampling database.

For more information on overall FMA Division programs, contact Division Director Martin Loefflad at (206)526-4194 or Deputy Director Pattin Nelson at (206)526-4194.

AUKE BAY LABORATORIES

The Auke Bay Laboratories (ABL), located in Juneau, Alaska, is a division of the NMFS Alaska Fisheries Science Center (AFSC). ABL's Marine Ecology and Stock Assessment Program (MESA) is the primary group at ABL involved with groundfish activities. Major focus of the MESA Program is on 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 16 scientists, including 15 permanent employees and 1 term employee. One personnel change in early 2010 was the retirement of Nancy Maloney, who for many years had responsibility for ABL's Sablefish Tag Program. At present, this position has not been re-filled. Several employees in other ABL programs have also been involved with groundfish-related research in the past year.

In 2009 field 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 rockfish acoustic/trawl survey conducted jointly with the AFSC's REFM and RACE Divisions to investigate new survey designs for rockfish; 3) a tagging study of spiny dogfish near Yakutat, Alaska; 4) experiments during the NMFS longline survey to test methods for quantifying sperm whale depredation rates on the catch; 5) a study that used a manned submersible to examine the recovery of sponges and sea whips from effects of bottom trawling 13 years before; and 6) a large-scale, epipelagic trawl survey of the eastern Bering Sea shelf conducted by ABL's Ocean Carrying Capacity Prgram that provides data on abundance of age-0 walleye pollock..

Ongoing analytic activities in 2009 involved management of ABL's sablefish tag database, analysis of sablefish logbook and observer data to determine fishery catch rates, and preparation of eight detailed status of stocks documents for Alaska groundfish: Alaska sablefish; Gulf of Alaska Pacific ocean perch, northern rockfish, pelagic shelf rockfish, rougheye and blackspotted rockfish, shortraker rockfish and "other slope rockfish", and sharks, and Bering Sea/Aleutian Islands sharks. Also, a new longline survey database was nearly completed and a website created to provide the public with on-line access to survey catches and abundance indices.

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

B. Multispecies Studies

1. Research

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 2009 continued under long-term research themes related to recruitment processes, basic studies in fish ecology relevant to the definition of growth, recruitment, and essential habitat.

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

Groundfish Assessment Program – RACE
Eastern Bering Sea Bottom Trawl Survey of Groundfish and Invertebrate Resources -
RACE Division groundfish biologists from Seattle and Kodiak conducted the annual EBS shelf bottom trawl survey, continuing the annual survey series which began in 1971. The survey covers the eastern Bering Sea shelf between 20 and 200 m from Bristol Bay north to 62° N latitude. The primary objective of the survey is to collect data and specimens needed to estimate distribution, abundance, and biological condition of commercially and ecologically important groundfish and crab species for the North Pacific Fishery Management Council. Secondary objectives include investigations into aspects of fish and invertebrate life history (trophic relationships, reproductive biology, groundfish systematics, etc) and improvements to survey methodology.

The survey was conducted aboard two chartered trawlers, F/V *Arcturus* and F/V *Aldebaran*, which have been used to conduct this survey since 1993. Stations were sampled with the standardized RACE 83-112 eastern trawl, which has been used since 1982. Stations are laid out systematically on a 20 nmi square grid with higher density stations in the vicinity of the Pribilof Islands and St. Matthew Island to better assess local blue king crab populations. Trawls are fished for 30 minutes at each station. The catches are brought aboard and sorted, counted, and weighed by species. Individual size measurements (length, carapace width, etc), age structures, and other biological data and specimens are collected from samples of important species in each catch.

The vessels successfully sampled 376 stations and repeated sampling at 32 of the Bristol Bay stations to resample crab populations there. Walleye pollock were the most abundant roundfish species with a mean CPUE of 46.05 kg/ha. Pollock were most abundant in depths between 81 and 171 m. Yellowfin sole and northern rock sole were the most abundant flatfish species with mean CPUEs of 35.10 and 31.05 kg/ha, respectively. These flatfish were most abundant in the shallower strata along the Alaska Peninsula and the northern part of Bristol Bay. Pacific cod was caught at most of the stations, being most abundant in the middle survey depths. Other groundfish species observed in significant numbers included Pacific halibut, Alaska plaice, flathead sole, Bering flounder, arrowtooth flounder, and Kamchatka flounder. Colder than normal bottom temperatures were observed, averaging 1.2°C over the survey area (8-year mean = 2.4°C). These temperatures may have played a part delaying molting and spawning of red king crab, leading to the need to resample the Bristol Bay stations. By the time the stations were resampled, water temperatures had risen from 1.5 to 4.5°C and more gravid females were found.

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

Biennial Bottom Trawl Survey of Gulf of Alaska Groundfish and Invertebrate Resources – The eleventh in a series of comprehensive bottom trawl surveys of groundfish resources in the Gulf of Alaska (GOA) region was conducted from May 18 through July 31, 2009. Since 1999 this survey has been conducted biennially; earlier surveys were conducted triennially between 1984 and 1999. The standard biennial GOA survey area, established in 1999, stretches from the U.S.-Canada border at Dixon Entrance (54° 30' N latitude) to the Islands of the Four Mountains at the base of the Aleutian Islands (170° W longitude) including depths from approximately 15 to 1,000 m. The entire standard area was surveyed in 2009. Commercially and ecologically valuable species of flatfish, roundfish, rockfish, and invertebrates inhabit the area. In many areas rocky bottom conditions provide abundant substrate for many species of bryozoans, hydroids, sponges and corals. These invertebrate communities, in turn, provide essential habitat for juveniles and adults of many groundfish species. The major survey objective is to continue the time series begun in 1984 to monitor trends in distribution, abundance, and population biology of important groundfish species and to describe and measure various biological and environmental parameters. Secondary objectives include investigations into aspects of fish and invertebrate life history (trophic relationships, reproductive biology, groundfish systematics, etc) and improvements to survey methodology.

The survey was conducted aboard three chartered commercial trawlers, the *Pacific Explorer*, the *Vesteraalen*, and the *Sea Storm*, during a 75 day period. A random-stratified sampling scheme is employed to allocate stations among 59 strata defined by area, depth, and general terrain (shelf vs slope vs gully). Stations were sampled with 15-minute tows using standardized RACE Poly Nor'Eastern four-seam bottom trawls rigged with roller gear. Catches were brought aboard and sorted, counted, and weighed by species. Individual size measurements (length, carapace width, etc), age structures, and other biological data and specimens are collected from samples of important species in each catch.

Successful sampling hauls were made at 823 of the planned 825 stations or at nearby alternate sites, ranging in depth from 21 to 984 m. Not surprisingly, arrowtooth flounder was the most abundant species found in the survey. Pacific ocean perch, walleye pollock, Pacific cod, and giant grenadier followed in descending order of abundance. Environmental conditions in 2009 were similar to those seen in 2007, but the patterns seen in these two years were much different that those from prior surveys. West of about 140° W longitude, water temperature cooled rapidly between the surface and about 50 m, below which warmer water was usually observed. The very warm near-surface temperatures that were observed in 2003 and 2005 were largely absent in 2007 and 2009, although surface waters in the western portion of the survey area were generally warmer in 2009 than in 2007. In all years prior to 2007, water temperatures at depths greater than 400 m have generally been cooler than 4 ºC. Since 2007, water warmer than 4 ºC has extended to almost 600 m throughout most of the survey area.

For further information contact Mark Wilkins (206)526-4104, Mark.Wilkins@noaa.gov.

Age and Growth Program - REFM

[Section not updated for 2010]

For further information contact Dr. Thomas Helser, (206) 526-4200.

Resource Ecology and Ecosystem Modeling - REFM

Multispecies, foodweb, and ecosystem modeling and research are ongoing. Documents, symposia and workshop presentations, and a detailed program overview are available on the 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 (REEM) Program continued regular collection of food habits information on key fish predators in the North Pacific. Emphasis is being placed on collecting stomachs during seasons and in regions where historic sampling has been less comprehensive, and on collecting tissue samples for stable isotope analysis that provides trophic information integrated over months of feeding. Emphasis is also being directed toward collection of stomachs with corresponding information about the zooplankton and benthic prey field. 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 2009, REEM collected samples and data during bottom trawl and/or midwater surveys of the Gulf of Alaska (GOA) and eastern Bering Sea (EBS). Stomach samples were also collected during surveys by other agencies and by Observers during fishery operations. In total, 9,018 stomach and tissue samples were collected from the EBS and 7,423 were collected from the GOA regions. Laboratory analysis was conducted on 3,927 fish stomachs from the Bering Sea, 1,332 fish stomachs from the GOA, and 29 fish stomachs from the AI. At-sea analysis was conducted on 2,014 fish stomachs from the GOA. The REEM predator-prey database was updated with 15,229 records in 2008.

Predator/Prey Interactions and Fish Ecology

Accessibility and visualization of the predator-prey data through the web has cleared significant hurdles and is now more readily available. Complete database details can be found at http://www.afsc.noaa.gov/REFM/REEM/data/default.htm.

The predator fish species for which we have available stomach contents data can be found at http://access.afsc.noaa.gov/REEM/WebDietData/Table1.php. Diet composition tables have been compiled for many predators and can be accessed, along with sampling location maps at http://access.afsc.noaa.gov/REEM/WebDietData/DietTableIntro.php.

The geographic distribution and relative consumption of major prey types for Pacific cod, walleye pollock, and arrowtooth flounder sampled during summer resource surveys can be found at http://www.afsc.noaa.gov/REFM/REEM/map/DietMap.php. REEM also compiles life history information for many species of fish in Alaskan waters, and this information can be located at http://access.afsc.noaa.gov/reem/lhweb/index.cfm.
A two-year project funded by the North Pacific Research Board, investigating the age, growth, maturity, reproductive biology, and diet of five sculpin species has been completed. These five species, *Myoxocephalus jaok* (plain sculpin), *M. polyacanthocephalus* (great sculpin), *M. verrucosus* (warty sculpin), *Hemilepidotus jordani* (yellow Irish lord) and *Hemitripterus bolini* (bigmouth sculpin) contribute approximately 95% of the sculpin biomass within the Bering Sea/Aleutian Islands (BSAI) region. Sculpin biomass estimates for the BSAI region have exceeded 200,000 mt. Although sculpins are most common along the eastern Bering Sea continental shelf, unique assemblages appear to be present within the shelf and slope areas of the eastern Bering Sea and the Aleutian Islands. Because of their abundance, sculpins are an ecologically important component in the eastern Bering Sea with some species feeding heavily on commercially caught Tanner and snow crabs and juveniles of walleye pollock.

Potential distributional shifts in overlap between arrowtooth flounder and walleye pollock in the Bering Sea were investigated. This work identified physical and biological habitat characteristics that are correlated with arrowtooth flounder biomass trends sampled at individual trawl stations, and found that small-scale regions within the eastern Bering Sea shelf have contributed unequally to the overall rapid increase in abundance of arrowtooth flounder. Hierarchical k-medoids clustering of arrowtooth catch-per-unit-effort revealed four distinct spatial groups showing stable, increasing, and variable trends. Catch rates in high-density areas near the shelf break have remained stable since the early 1990s while catch rates have increased to the northwest and east. Annual changes in range expansion and contraction are negatively correlated with the extent of the cold pool over the Bering Sea shelf. Age-1 and -2 pollock comprise the majority of arrowtooth diets in all areas, but higher rates of non-empty stomachs in the northwest region indicate that predatory impacts on pollock may be higher there. This analysis provides information about the potential for arrowtooth flounder to further increase their distribution and abundance in the Bering Sea and helps to predict future responses to climate and fisheries management actions.

Comparisons of zooplankton catch data and pollock diet data were initiated. Few zooplankton sampling stations have been identified, that include zooplankton community composition data, to compare to pollock diet composition data, within a reasonably narrow temporal and spatial window. Another source of zooplankton abundance information results from frequency differencing of hydroacoustic data through a MACE, BSIERP project. This technique provides estimates of euphausiid backscatter from Hydroacoustic Surveys back to 2004. During these years, prior to 2009, pollock stomachs were collected only from 14 trawl stations in the northern Bering Sea during the 2004 survey. Cursory examination of this data indicates no relationship between local euphausiid backscatter density nor local pollock density. Average stomach fullness as a percentage of individual pollock body weight appears to be related more to the variation in copepod consumption than euphausiid consumption as indicated by the average amount of each prey type eaten per fish (g-prey / fish). However, all evidence suggests the overall abundance of euphausiids in the Bering Sea in 2004 was extremely low. Stomach samples of walleye pollock were collected during the 2009 Hydroacoustic Survey so much more data will become available in 2010.

Seabird - Fishery Interaction Research

The Seabird Coordinated Studies group activities included updating important information. The seabird presentations for the Observer 3-week training and 4-day briefing sessions were upgraded. This was coordinated closely with the Observer Training Center in Anchorage. In addition, FMA database changes were implemented to capture what was “ad hoc” information on seabirds recorded by Observers. This encompasses bird mortalities from third wires or trawl warps, bird storms, sightings of short-tailed albatross, and other seabird events at sea that go beyond the normal sampling routine. In a separate project, the production of a NOAA Technical Memorandum that reports seabird bycatch from 1993 through 2006 was initiated.

On June 22, 2009, a working session was convened at the AFSC to provide guidance on estimating the bycatch of rare-event species such as seabirds and marine mammals. Participants included representatives from the UW, NWFSC, PIFSC, SWFSC, and NEFSC in addition to staff from the Alaska Regional Office and the AFSC. The day’s focus was to advise the AFSC on how to provide annual estimates of bird and mammal bycatch. Discussions were held noting mandated reporting requirements, strengths and weaknesses of the data, and general needs of a suite of end-users. Having an estimation procedure that is well documented and repeatable was noted as a priority. Generally, the AFSC plans to work with the Alaska Region’s Catch Accounting System to support the annual production of seabird bycatch estimates while also looking into longer-term comparative modeling exercises to evaluate the effectiveness of this ratio-estimator based approach.

The Alaska Fisheries Science Center also hosted the first strategic planning workshop for the NMFS National Seabird Program on September 9-11. The purpose of the workshop was to assess the current state of the program and to consider how the program can best address emerging issues related to seabird conservation, within U.S. waters and on the high seas. NMFS shares responsibility for the conservation of seabirds with the U.S. Fish and Wildlife Service through its role managing fisheries - one of the greatest known threats to seabird populations worldwide.

With funding from the National Cooperative Research Program and the Bycatch Reduction Engineering Program, we conducted a pilot study on seabird interactions with paravanes in August. A paravane is a device that trawl operators use to obtain signals from net monitoring equipment. The paravane receives acoustic signals as it is deployed at 5 or more fathoms deep via a boom alongside the vessel (Fig. REEMBird1). Because seabirds attend vessels to take advantage of fish discharge they may come into contact with this gear. This study is the first work in the North Pacific on seabird paravane interactions.

Project goals were to: (1) learn about the basic usage of paravane gear, (2) obtain baseline information on seabird interactions with the paravane gear, and (3) attempt to develop and deploy at least 3 different types of mitigation measures. Industry partners included the North Pacific Fisheries Foundation and Cascade Fishing, Inc., owners of the fishing trawler *Seafisher*.

This study was needed due to a potential for interactions between paravanes and the endangered short-tailed albatross (*Phobastria albatrus*).

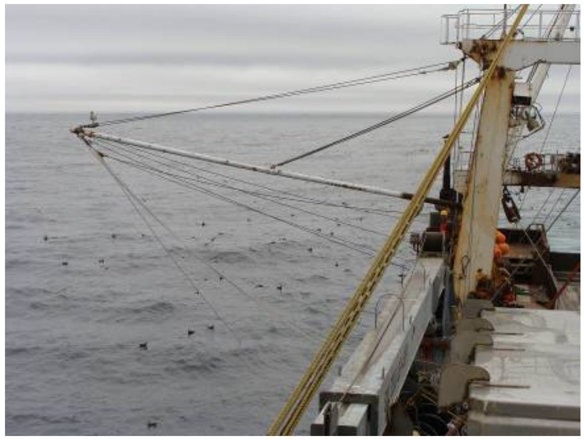

Figure REEMBird1. Field biologist Jeff Pesta conducting a seabird/paravane interaction session. The paravane cable runs down into the water from near the end of the boom (and back to the vessel under the boom). All other lines control the boom or are used to deploy and retrieve the block used to deploy the paravane. Very few interactions were recorded with these lines. Note the gull perched on the boom.

A biologist experienced with seabird mitigation was deployed to the trawler *Seafisher* for one trip, August 8 through 16. During this period we were able to achieve all the stated goals of the pilot project. There were 20 observation sessions of seabird/paravane interactions (without mitigation measures), which will provide baseline interaction rates for comparisons to rates while mitigation measures were deployed. The crew and biologist coordinated together to try 6 different types of mitigation measures (Fig. REEMBird 2). The biologist was able to conduct another 20 observation periods of these measures. There were no seabird mortalities or injuries associated with the paravane during this trip. Interaction rates varied from 0 to 138 per 15-minute observation session. Nearly all interactions were by Northern Fulmars (*Fulmaris glacialis*) and were of the paravane cable itself rather than the various lines supporting or controlling the paravane boom.

Figure REEMBird 2. Crew members working on one of their ideas for a seabird mitigation measure before deploying the paravane. Collaboration between officers, crew, and the field biologist resulted in 6 different measures being developed and deployed.

The AFSC Seabird Coordinated Studies Group, in partnership with fisheries observers, the Fisheries Monitoring and Analysis Division, and the non-profit group Oikonos, has for several years been involved with salvaging bycatch birds from Alaskan Groundfish fisheries, sending them to a necropsy lab, and then having the stomach contents analyzed for plastics (Fig. REEMBird 3) and food habits (Fig. REEMBird 4). Preliminary examination of 30 albatross (19 Laysan and 11 Black-footed) and 43 Northern fulmars has been accomplished to date. Much more natural prey has been found in the stomachs than was expected for bycaught birds. In addition, food items introduced by the fishery also appear to be readily identifiable. This will allow for important information to be gained on the natural feeding strategy of these birds in the region. The Bering Sea albatross samples will provide information from an oceanic region not previously represented. Most comprehensive North Pacific albatross diet studies, utilizing stomach samples, are based on samples collected during the breeding season from the Hawaiian Archipelago or from bycaught birds taken in the North Pacific Transition Zone. Examination of the northern fulmar samples also revealed more natural prey than anticipated. Northern fulmars make up the majority of bycaught birds in the Bering Sea region. The large sample size of birds returned by observers should ultimately allow for a detailed study of potential regional and seasonal variations in the natural diet of this species.

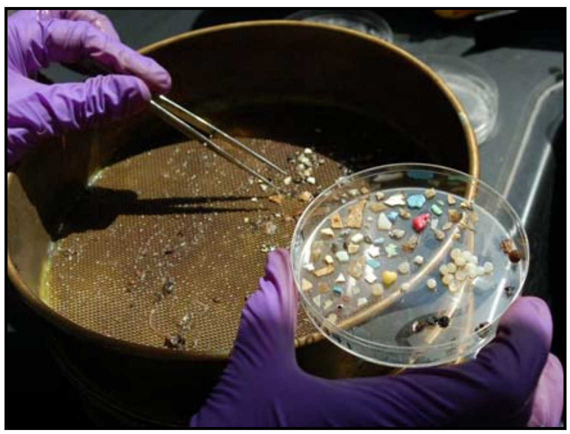

Figure REEMBird 3. Sorting out all of the plastic fragments ingested by a Northern Fulmar.

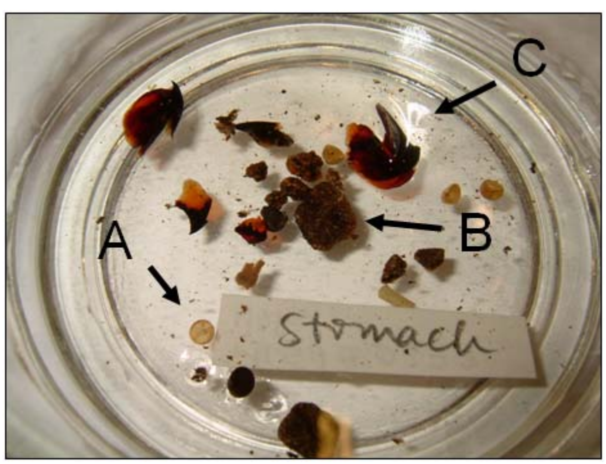

Figure REEMBird 4. Stomach contents from a Northern Fulmar (A) Plastic Fragments, (B) rocks, and (C) squid beaks.

Multispecies and Ecosystem Modeling

REEM modelers have attended weekly meetings with the Bering Sea Integrated Research Program (BSIERP) vertical modelers to continue development of the Forage and Euphausiid Abundance in Space and Time (FEAST) model. FEAST is a multispecies bioenergetics model for forage and predatory fish species linked to NPZ (Nutrient-Phytoplankton-Zooplakton) and ROMS (Regional Ocean Modeling System) models for the Northeast Pacific and Bering Sea at a 10km resolution. This 3D model of the Bering Sea will model the coupling between physics, plankton, forage fish, and predatory fish. FEAST models nine fish species (walleye pollock, Pacific cod, arrowtooth flounder, salmon, capelin, herring, eulachon, sandlance and myctophids) which have a two way interaction with the seven zooplankton groups in the NPZ model (small/large microzooplankton, small/large copepods, euphausiids, jellyfish, and benthic infauna). Additionally, temperature and advection from the ROMS model are used in the bioenergetics and movement components. The operating hypothesis in FEAST is that forage fish and macrozooplankton (e.g. euphausiids) are tightly coupled in a two-way interaction, and the dynamics of this interaction under different climate scenarios is a strong structuring element for the ecosystem as a whole. FEAST itself will ultimately be incorporated into economic and spatial fishery predictions, as well as into management strategy evaluations which are also part of BSIERP. Progress to date includes a fully coupled 1-dimensional version (depth over time) producing expected growth rates and consumption for fish lengths 10cm+ for 1999. The 3D version of FEAST is fully coupled and ready for initial preliminary runs which will focus on refining movement parameters. Milestones in early 2010 include one year runs for 1999 (a cold year) and 2004 (a warm year).

Several workshops and symposia were organized, convened and attended to coordinate the development of the FEAST model, to coordinate the integration of regional ecosystem models, and to promote the integration of ecosystem models with a variety of management interests. REEM modelers hosted a workshop of the North Pacific Research Board's BSIERP Vertical Integrated Modeling Project in Seattle, June 1-3 2009. Results of this FEAST development workshop were presented at the annual meeting of the Resource Modeling Association and at the third international Global Ecosystems (GLOBEC) meeting in late June. Results of the 1D model were presented and discussed during another workshop hosted by the BSIERP Fish Group in Seattle, August 11-13 2009. The workshop focused on preliminary results of the fish-related field projects, introduction to models and discussion of model outputs between modelers and field researchers. Updated results of the 1D and 3D models were presented and discussed again at the annual BSIERP PI meeting in mid-October. REEM personnel participated, on behalf of multiple project members from the AFSC, in a workshop meeting of the GLOBEC Pan-regional-synthesis program in Boulder, CO. The work focused on comparing ecosystem structure and function of the Gulf of Alaska, the Northern California Current, George's Bank, and the Antarctic Ocean. REEM personnel also attended and co-organized a symposium at the International Marine Conservation Congress, a meeting sponsored by the Society for Conservation Biology's Marine Section in Washington, D.C., 19-24 May 2009. The purpose of this international meeting was to bring conservation and fishery scientists, managers, policy-makers, and the public together to "put conservation science into practice" with respect to ecosystem-based management and global climate change, in particular to jointly address fishery and biodiversity conservation objectives. REEM personnel co-organized the symposium "Conservation in Working Seascapes: Bridging the Gap Between Fishery Management and

Biodiversity Conservation." The symposium was very well attended and generated considerable discussion among the audience, the invited speakers, and the organizers. A co-authored review/summary publication is currently in preparation as a result of this symposium.

The second NMFS National Ecosystem Modeling Workshop (NEMoW II) was held August 25-27, 2009 at the Chesapeake Bay Foundation's Merrill Center in Annapolis, MD. NEMoW II continued work started at the first NEMoW in Santa Cruz, CA in 2007 to develop a regular ecosystem modeling (EM) workshop analogous to the National Stock Assessment Workshops and National Economist Meetings. In this context, EM includes a wide range of biophysical, multispecies and ecosystem modeling methods. Where NEMoW classified major ecosystem model types and began a list of "best practices" for using the models, NEMoW II focused on sources of uncertainty in EM and how to provide management advice that appropriately expresses, but is not hampered by uncertainty. REEM personnel served on the steering committee and made a presentation reviewing the venues that each NMFS Science Center is using to present and review EM. REEM personnel also made a presentation reviewing single species and EM comparisons across NMFS Science Centers.

Data and information gaps for modeling were identified across NMFS Science Centers and prioritized to address major sources of EM uncertainty. Common types of uncertainty were identified as well as approaches for addressing that uncertainty. Establishing and refining our list of best practices to address EM uncertainty should be continually re-evaluated. This workshop provided a strong basis for identifying those best-practices. A key conclusion from the workshop was that we need to better engage our stakeholders in terms of communicating, interacting and discussing ecosystem model rationales, uses, applications, and benefits. The four preliminary major recommendations are suggestions to: 1) establish distinct EM review panels, 2) identify and note sources of EM uncertainty as a must for EM use, 3) bolster the value of strategic advice, and 4) bolster Ecosystem Modeling Capacity.

Ecosystem Considerations

The Ecosystems Considerations chapter in the Stock Assessment and Fisheries Evaluation is updated annually by REEM personnel to provide information on relevant ecosystem components to the North Pacific Fishery Management Council for consideration in management decisions. The chapter is composed of three parts, the first of which is an integrated ecosystem assessment, time series of ecosystem indicators that measure components of the ecosystem, and management indices that reflect the impact of humans on the marine ecosystem. The last two parts are composed of individual contributions from a broad range of scientists. Contributions were updated, and two new contributions were added. One provides measurements of the potential area disturbed by trawl fishing gear in the eastern Bering Sea from 1990-2008. This analysis showed that the maximum total area of seafloor potentially disturbed by trawls varied around 120,000 km^2 in the 1990s and decreased in the late 1990s to approximately 90,000 km^2. The area disturbed remained relatively stable in the 2000s with a slight increase in the 2007-2008. The second new contribution describes the spatial distribution of groundfish in the eastern Bering Sea from 1982-2008. The contributors demonstrated that both the latitudinal and depth distribution of the demersal community on the eastern Bering Sea shelf have shown clear directional trends over the last three decades, indicating significant distributional shifts to the north and into shallower waters. Although the average distribution shifted slightly south after the very warm years of 2004/05, there was little evidence that recent cold temperatures in 2006-2008 have led to a commensurate reversal of the long-term northward shifts. Highlights from the draft were presented to the joint North Pacific Fishery Management Council plan teams in mid-September.

This year, status and trends of eastern Bering Sea (EBS) and Gulf of Alaska (GOA) feeding guilds were analyzed by incorporating current stock assessment and survey results within the framework of existing food web models. EBS biomass trends were summed stock assessment model estimates or scaled survey data, where available, for each species within the guild. If neither time series were available, the species was assumed to have a constant biomass equal to the mid-1990s estimated levels. The GOA ecosystem model was forced by stock assessment model estimates where available for each species within the guild, and fit to survey time series, catch data, groundfish diet data, and the mid-1990's mass balance for all other species. Current EBS status (2004-2009) mean biomass, catch, and exploitation rates have been within +/- one standard deviation of 1977-2009 levels for all guilds except pelagic foragers (biomass below mean, exploitation rate above mean) and structural epifauna (biomass above mean). Apex predators and pelagic foragers had decreasing trends in biomass, catch, and exploitation rates, while benthic foragers had increasing catch and exploitation rate trends. The apex predator trends were driven largely by a decrease in Pacific cod biomass and catch. The pelagic foragers guild was dominated by walleye pollock (77% of guild biomass in 2009), whose decrease with general declines in other forage species has brought the biomass of this group to overall low levels. Exploitation rate was over one standard deviation above the mean from 2004-2007, however the decreased catches in 2008 and 2009 have decreased the pelagic foragers exploitation rate back towards its long-term mean. Increasing trends in benthic forager catch and exploitation rate reflect increased Allowable Biological Catches (ABCs) for flatfish species allowable under the 2 million metric ton OY cap with decreased pollock ABCs. Current GOA mean biomass was more than one standard deviation above 1977-2009 mean levels for apex predators and benthic foragers, and the biomass trend is increasing for benthic foragers. The apex predator guild was driven by the stock assessment-estimated high biomass of arrowtooth flounder, and to a lesser extent in Pacific halibut and Pacific cod, while the benthic forager guild was driven by a stock assessment-estimated increase in flathead sole and survey trends for increasing skates and flatfish. In contrast, pelagic foragers recent mean biomass is nearly one standard deviation below the long term mean, driven by the stock assessment estimated decline in pollock. Catch for pelagic foragers remains within one standard deviation of the long term mean, while exploitation rates have trended down. GOA shrimp are above long term mean biomass, due to a long term trend which agrees with trawl survey results.

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

Recruitment Processes – RACE Division

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.

- We are completing our third field year for the Bering Sea Integrated Ecosystem Research Program (IERP) and analyzing data from Years 1 & 2 with colleagues from UAF. Results are helping to address specific questions about the target species (walleye pollock, cod, and arrowtooth flounder). J. Napp serves on the Science Advisory Board for BSIERP. We are also finishing a revised work plan for GOA lower trophic level investigations for the GoA IERP slated to start in 2011.
- Comparative analyses of marine ecosystems - Dr. Kevin Bailey co-organized an international workshop on predatory-prey interactions16-18 March 2010. The goal is to examine existing and new methods for scaling up from local observations, shifting processes as scale changes, and complexity and organizational structure in predator-prey interactions. (http://bioweb.coas.oregonstate.edu/~ciannellilab/cameo/). B. Megrey is a PI for two CAMEO projects, one to construct an end to end model (physics to dynamic fishing fleets) that will simulate low frequency oscillations in the population dynamics of small pelagic fish (anchovies and sardines). The modeling builds on an HPCC proposal to get access to NOAA high performance computing resources to construct and test the model. The other project is an international workshop to use surplus production models to compare and contrast nine different marine ecosystems.
- Chukchi Sea Ecosystem - Ichthyoplankton samples from the second RUSALCA cruise are undergoing analysis and we are preparing for an NOAA/MMS-supported cruise to the Chukchi this summer. In August we will work with PMEL and NMML to deploy biophysical moorings that will examine temporal variability in plankton in the area off Wainright, Alaska near oil/gas lease sites where we will also have passive acoustic devices to detect marine mammal vocalizations. Hydrography, nutrients and plankton samples will also be collected.

Bering Sea

Northern rock sole - Age-0 nursery areas were located along the north side of the Alaska Peninsula as part of a multi-species juvenile flatfish beam trawl survey conducted in September 2008. Mean length was higher in warm, nearshore areas than in cold, offshore areas, suggesting temperature dependent growth and/or shoreward movement with development. Nursery areas north of Unimak Island are significantly closer to shore and warmer than identified nursery areas to the north in the EBS. Reference: Cooper, D. W., Duffy-Anderson, J.T., Stockhausen, W., Stabeno, P., and Jump, C. Northern rock sole (*Lepidopsetta polyxystra*) connectivity between spawning and settling areas along the Alaska Peninsula in relation to currents and hydrography. American Fisheries Society Larval Fish Conference. Portland, OR, July 2009.

Greenland halibut - Early life stages were examined based on historical field data from the EBS and adjacent water along the eastern Aleutian Islands. Results indicate that pre-flexion larvae to newly-settled juveniles have a long pelagic duration and are subject to extended drift pathways. Hatching may occur in deep water, below 530 m, and larvae rise in the water column as they grow. Post-flexion larvae are mostly found around the Pribilof Islands over the middle shelf (50-100 m isobaths) in July, and settling occurs during late summer on the middle shelf near St. Matthew Island. However, given that age-1 individuals were primarily found on the outer shelf, it appears that they halibut actively move to deeper water with age (or size). Reference: Sohn, D., Ciannelli, L., Duffy-Anderson, J.T. In review. Distribution of Greenland halibut eggs, larvae, and juveniles over the Eastern Bering Sea shelf (1990-2007). *Fish. Oceanogr*.

Other Flatfishes - A study was conducted to investigate the early life ecology of Alaska plaice in the EBS. Patterns of abundance and distribution of eggs, larvae and pelagic juveniles over the southeastern Bering Sea shelf were examined to better understand factors controlling transport and recruitment. Eggs were present throughout the water column, though densities of preflexion stage larvae were concentrated at depths 10-20 m. Spawning occurs primarily east of Port Moller in April and May, and eggs and larvae appear to drift to the north and northeast. Connectivity between spawning areas and nursery habitats is likely influenced by wind forcing, so climate-mediated changes to dispersal trajectory or timing is expected to have impacts on recruitment in this species, though entrainment in consistent, directional currents may modify these effects. Reference: Duffy-Anderson, J.T., Doyle, M., Mier, K.L., Stabeno, P., and Wilderbuer, T. In press. Early life ecology of Alaska plaice (*Pleuronectes quadrituberculatus*) in the eastern Bering Sea: distribution, transport pathways, and effects of hydrography. *J. Sea Research.*

Walleye pollock - Retrospective collections were used to examine associations between the early life stages and their environment (Smart et al., in prep. a). Highest abundances of eggs and yolk sac larvae were found at low temperatures and relatively high turbulence levels, whereas pre-flexion and post-flexion larvae and juveniles are most abundant at times of warm temperatures and low wind-driven turbulence. These findings indicate the importance of changing temperature and storm regimes on the growth and survival over the southern Bering Sea shelf.

Another study identified changes in abundance, distribution, and phenology of early life stages under alternate warm and cold climate states (Smart et al., in prep. b). Warm conditions (small cold pool, high sea surface temperature, few storms) favor high abundances of late stages (advanced larvae and juveniles) over early stages (eggs and non-feeding larvae). We also found expansions and contractions of distribution over the shelf for several stages, depending on conditions, along with shifts in the time of occurrence or highest abundance. Changes in distribution and phenology can be attributed to delayed spawning, growth, and increased mortality of late stages under cold conditions relative to warm. References: Smart, T.I., J.T. Duffy-Anderson, E. Farley, J. Horne (in prep. a). Environmental variability and the early life stages of walleye pollock (*Theragra chalcogramma*) in the eastern Bering Sea. Smart, T.I., J.T. Duffy-Anderson, C. Wilson, and E. Farley (in prep. b). Alternate climate states and the early life stages of walleye pollock (*Theragra chalcogramma*) in the eastern Bering Sea.

Pacific cod - Surveys to determine the horizontal and vertical distribution of larvae over the EBS shelf were conducted throughout the spawning season in 2008-09 (partially funded by NPRB). Combined with retrospective data analysis, we identified general trends in distribution and dispersal. Based on egg and yolk sac larval distribution, spawning occurs along the Alaska Peninsula and Unimak Pass and near the Pribilof Islands. Larvae are found primarily in Unimak Pass, followed by the Pribilof Islands and the middle shelf domain. Preflexion and flexion larvae typically are found in the upper water column (< 20 m), suggesting high potential for wind-driven transport of larvae from spawning grounds. However, flexion and postflexion larvae have been collected only north of Unimak Island and the Pribilof Islands, suggesting strong retention of larvae near spawning grounds, which may also serve as nursery grounds. Reference: Vertical distribution of larval walleye pollock (*Theragra chalcogramma*), Pacific cod (*Gadus macrocephalus*), and *Atheresthes* spp. in the eastern Bering Sea. BEST-BSIERP Principal Investigators Meeting, October, 2009.

Gulf of Alaska

Walleye pollock and capelin - A project was undertaken to investigate the processes affecting the productivity of these important forage fishes in the GoA. Objectives were to investigate key physical processes by comparing the distribution of fish and prey with oceanographic properties, and to examine the potential for interspecific competition by comparing measures of foraging success. Results support the linkage between oceanography, prey, fish diet and fish distribution. Age-0 pollock were distributed in cool, high-salinity waters offshore of a mid-trough front, coincident with the distribution of the bulk of their preferred prey, euphausiids. In contrast to pollock, capelin were distributed throughout the trough, as was the distribution of their dominant prey, copepods. Although capelin and pollock had different distributional patterns and diets in 2005, in a previous year's survey they were both found inshore of the mid-trough front foraging on euphausiids, suggesting a potential for competition. Sympatric capelin often had reduced foraging success compared to allopatric capelin. Age-0 pollock were the superior competitor of the two species and that the exclusion of capelin from foraging on euphausiids can have negative consequences for growth and potentially survival. Reference: Logerwell, E., Duffy-Anderson, J.T. and Wilson, M.T. In press. The physical and biological processes resulting in habitat partitioning by two potential competitors, juvenile pollock and capelin, in the Gulf of Alaska. *Fish. Oceanogr.*

Capelin - We studied spatial and temporal patterns of vertical distributions of larvae and related observed patterns to biological and physical environmental parameters. Transport of yolksac larvae is likely heavily influenced by winds, and the importance of wind driven transport likely decreases with ontogenetic development. Vertical migration patterns varied on a small spatial scale, over time, and with published reports for other capelin stocks, which highlights the complexities of larval vertical migration behavior. Reference: Cooper, D.W., Duffy-Anderson, J.T., Lanksbury, J.A., Mier, K.L., and Stabeno, P. Vertical distribution of capelin larvae (*Mallotus villosus*) in the Gulf of Alaska: influence of ontogeny and abiotic factors. American Fisheries Society Larval Fish Conference. Kiel, Germany, August 2008.

Multi-species Approaches: Bering Sea and Gulf of Alaska

- One study focused on a 20+ year time-series of larval fish abundance in the northwest GoA. Links between species larval abundance and the physical environment were explored using Generalized Additive Modeling. Results demonstrate species-specific associations between larval abundance and environmental variables, and were reflective of similarities in life history characteristics. The study showed there is good potential for identifying levels of resilience or vulnerability of individual species early life history patterns to fluctuating oceanographic conditions. Reference: Doyle, M.J., S.J. Picquelle, K.L. Mier, M. Spillane and N.A. Bond (2009). Larval fish abundance and physical forcing in the Gulf of Alaska, 1981–2003. *Prog. Oceanogr., 80*, 163–187.

- A project examined the influence of shelf-edge mesoscale eddies on ichthyoplankton species composition and diversity. Evidence for larval fish entrainment in these eddies was examined using data from: a cruise in 2005 that sampled three eastern GoA mesoscale eddies, and sampling that compared shelf to slope ichthyoplankton assemblages in the northern GoA (2002 – 2004). Hierarchical cluster analysis of oceanographic data showed that stations grouped according to location within an eddy. Species hierarchical cluster analysis revealed a latitudinal turnover in species composition, and an abundant species group. Species richness was correlated with distance from eddy center and assemblages within eddies were significantly different from surrounding basin and shelf waters. These results suggest that mesoscale eddies propagating along the continental shelf-break influence larval assemblages over the shelf and slope, which has implications for the timing and extent of distribution in the GoA. Reference: Atwood, E., Duffy-Anderson, J.T., Horne, J., and Ladd, C. In review. Influence of mesoscale eddies on ichthyoplankton assemblages in the Gulf of Alaska. *Fish. Oceanogr*.
- A project in progress examines shifts in ichthyoplankton community composition in the EBS in response to environmental variability. Non-metric multidimensional scaling is being used to quantify variability and reduce multi-species abundance data to major modes of species composition. These principle axes are used as the response variable for modeling differences in assemblage structure in space and time and as a function of environmental covariates. Using a generalized additive model, we will describe spatial patterns of variability, test for differences in assemblage structure over time, and identify covariates responsible for the largest fraction of variability in assemblage structure. We hypothesize that observed community level changes in ichthyoplankton composition over time reflect species-specific responses to climate change. Reference: Siddon, E., Duffy-Anderson, J.T., and Mueter, F. Community-level response of ichthyoplankton to environmental variability in the eastern Bering Sea. Western Groundfish Conference. April, 2010. Juneau, AK.

Examining Genetic Stock Structure in NE Pacific Groundfish

Walleye pollock - A survey of amplified fragment length polymorphism (AFLP) was conducted to assess the extent of selective mortality during early larval stages. Comparing a cold year (1995) and a warm year (1993) we investigated changes in allele frequencies at 361 loci from two temporal samples collected from a single cohort in the EBS. Levels of genetic differentiation were relatively high, especially in 1995. Permutation tests indicated 24 loci with differentiation higher than expected by chance in 1993, and 125 loci in 1995. The study demonstrated the value of using genetic markers potentially influenced by natural selection (as opposed to neutral genetic markers) for identifying the extent of spatial and temporal variation in natural populations. Reference: Hauser, L., Bailey, K.M., Canino, M.F., Jimenez-Hidalgo, I. 2009. Adaptation to a changing world: molecular evidence for selective mortality in walleye pollock. North Pacific Research Board Final Report 610.

Pacific cod - A study of microsatellite DNA variation across the geographic range of cod in North America found a clear genetic isolation-by-distance pattern for coastal populations.

Notable exceptions to this pattern were cod from the Georgia Basin (Puget Sound and the Strait of Georgia). Further screening of mitochondrial DNA variation revealed that the Georgia Basin group represented a distinct evolutionary lineage. The distinctness of this group from coastal cod, and to some degree between Puget Sound and the Strait of Georgia, provides the first evidence for estuarine stocks in this species. This may be of particular relevance for conservation and management of the transboundary Strait of Georgia population, one of four stocks recognized for management in Canada. References: Cunningham, K.M., Canino, M.F., Spies, I.B., Hauser, L. 2009. Genetic isolation by distance and localized fjord population structure in Pacific cod (*Gadus macrocephalus*): limited effective dispersal in the northeastern Pacific Ocean. *Canadian Journal of Fisheries and Aquatic Sciences*, **66**, 153–166. Canino, M.F., Spies, I.B., Cunningham, K.M., Hauser, L., Grant, W.S. in review. Multiple ice-age refugia in Pacific cod, *Gadus macrocephalus*. Molecular Ecology.

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

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, provide technical support for the evaluation of potential impacts of proposed fishery management measures, and conduct fishery interaction studies with a focus on Steller sea lion prey species.

During the past year, stock assessment documents were prepared by the Task and submitted for review to the Gulf of Alaska and Bering Sea/Aleutian Islands Groundfish Plan Teams of the North 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) continued refinement and review of Bering Sea crab stock assessments, 3) research activities associated with the impacts of climate change, 4) research activities associated with the incorporation of ecosystem variables in stock assessments, 5) significant contribution and development of the analysis for the Chinook salmon bycatch Environmental Impact Statement, 6) development of the Arctic Fishery Management Plan, 7) non-target species fishery management, 8) development of the Northern Bering Sea Research Plan, and 8) various task members participated in numerous national and international committees and workshops on a variety of issues.

Highlighted accomplishments in the above areas include: 1) development of age-structured stock assessment models for Bering Sea/Aleutian Islands (BSAI) blackspotted and rougheye rockfish and BSAI Alaska skates, 2) development of an analytical framework to forecast the impact of climate change on fish and shellfish. This method was applied in a case study for BSAI northern rock sole, 3) development of stock projection software to conduct Management Strategy

Evaluations for Gulf of Alaska walleye pollock, 4) development of a statistical model of factors influencing the timing and distribution of winter catch of walleye pollock in the eastern Bering Sea, and 5) designing and conducting a nearshore survey of fish habitat in Bristol Bay.
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 species of Steller 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/default.php

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

3. Management

Economics and Social Science Research Program – REFM
Not updated for current year.
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

Juvenile Pacific Cod Nursery and Habitat Study – Kodiak Laboratory and FBE Newport
In 2008, researchers from the Kodiak Laboratory and the Fisheries Behavioral Ecology Program continued studies examining the habitat associations in juvenile Pacific cod in nursery areas around Kodiak Island. One aspect of these studies was to assess the diets of juvenile gadids in the nursery areas in order to quantify their degree of dietary overlap and the extent of cannibalism on younger conspecifics. Juvenile cod (age 1+ Pacific and saffron cod) were collected by hook and line and beach seining at two nursery sites around Kodiak Island, AK during the summer months in 2007 and 2008. To date, a total of 354 juvenile cod (n=260 saffron cod, 17.1-39.0 cm TL; n=94 Pacific cod, 17.4-36.0 cm TL) have been collected. Preliminary results revealed the gadids consumed primarily benthic invertebrates and displayed a high degree of dietary overlap in 2008 (driven mainly by the importance of mysids and amphipods in the diets). Other common prey items included annelids (polychaeta spp.), crangonid shrimps, hermit crabs (Paguridae spp.), and fish (Pacific sand lance, *Ammodytes hexapterus*, Stichaeidae spp., and Cottidae spp.). Pacific cod had a higher rate of piscivory than saffron cod (2007- Pacific cod 16%; saffron cod 3%; 2008- Pacific cod (27%); saffron cod (23%)) although there was no evidence of inter-cohort cannibalism found in 2007 and 2008. A high degree of dietary overlap suggests competition for food resources may occur if food supplies become limited within the nursery areas. However, the diets of the two cod species varied noticeably outside the importance of mysids and amphipods which suggest these species are able to exploit different niches which may reduce competition. Furthermore, differences in the relative importance of secondary prey items (i.e. fish and decapods- Pacific cod *versus* isopods-saffron cod) may reflect small scale differences in habitat use by the juvenile gadids within the nursery areas. Inter-cohort cannibalism does not appear to be a factor affecting cod survival in these areas. However, the abundance of age 0+ cod can fluctuate greatly on a yearly basis within the nursery areas and it is possible that cannibalism is density dependent and is an important function when densities are high. In 2009, an additional 65 juvenile cod samples were collected within and adjacent to the nursery areas. The third year of sampling will allow for the continued assessment of the temporal variations in the food habits of these species.

Juvenile Pacific Cod Movement, Habitat, and Overwintering Study - Kodiak Laboratory
In 2010, researchers from the Kodiak Laboratory will undertake a project examining the seasonal habitat use and over wintering habits of juvenile Pacific cod within nearshore nursery areas of Kodiak Island. Previous investigations conducted by Kodiak Laboratory and Fisheries Behavioral Ecology Program scientists have described the nursery requirements and habitat use of age-0 and age-1+ juvenile Pacific cod during the summer and early fall. The 2010 project is an extension of this work and will focus on examining the habitat use patterns of older juvenile age classes (age 2+) still residing in the nursery areas. The project will test the hypotheses that older juvenile Pacific cod will preferentially utilize bare substrate habitats, show strong site fidelity prior to the winter season, and that their winter migratory behavior will be variable among individuals. Acoustic telemetry and a drop camera system will be used to define the seasonal

habitat use and monitor the overwintering habits of juvenile Pacific cod. Active telemetry will be conducted to acquire habitat patch use of individual cod during the summer and fall. Additionally, a continued passive gate telemetry system will be utilized to measure the movement of individual cod outside the nursery habitat into the winter. The combination of acoustic telemetry (both active and passive) and drop camera techniques will allow us to effectively determine the habitat use patterns of older age classes of juvenile Pacific cod. Results of this project will contribute significant knowledge about seasonal habitat use patterns by juvenile Pacific cod. This knowledge will allow us in the future to examine the interaction of older and younger juvenile Pacific cod as well as to understand how habitat use changes throughout the life cycle of this species. Ultimately it is hoped this project will assist researchers in obtaining a more comprehensive understanding of EFH for juvenile Pacific cod which is needed for effective management and conservation of this species.

For more information, please contact Brian Knoth, (907) 481-1731.

Growth and Condition During Early Life History – RACE FBE Newport
In 2009, the FBEP conducted a series of studies to examine and best quantify growth and condition of Pacific cod during their early life history. The research focused on two separate developmental periods: 1) pelagic larvae (Days 0-30) and 2) settled juveniles (days 180-270). Larval studies were partially supported by NPRB-BSIERP funding and the Auke Bay Laboratory, and focused on critical periods (yolk absorption, flexion) using combined approaches of behavior, starvation trials and RNA/DNA analyses. The goals were to 1) determine whether critical periods exist in the first 30 days of development and 2) groundtruth techniques in the lab so they can be applied to field sampled larvae. Similar approaches were also used for juvenile studies with support from HEPR funding. Using both lab-reared and field-sampled fish, the FBEP groundtruthed modified Fulton's K approaches to determine the degree to which condition is driven by habitat (e.g., inshore vs offshore) or temporal patterns e.g., seasonal and annual variance. Ultimately, the goal will be to determine if patterns in growth and condition of age-0 juvenile cod can be linked with subsequent year class survival and adult recruitment.

In another project, analysis of data from experiments measuring growth rates of fish from three consecutive cohorts (2006-2008) across a range of temperatures indicated temporal instability in the thermal reaction norm for growth. The cold winter and spring of 2007 resulted in the recruitment to Kodiak Island nursery areas of a cohort which grew faster than the other cohorts at low temperatures (2-5°C) but had poor growth and survival at higher temperatures (>12°C). Analysis of vertebral count variation in archived samples of fish from the three cohorts revealed significant differences among the cohorts in mean vertebral counts. The higher mean vertebral counts observed in 2007 are consistent with the phenomenon known in fishes as "Jordan's Rule", or the common observation that low temperature exposure during the egg and early larval stages leads to the development of higher numbers of vertebrae (and sometimes other repeated structural elements, eg. fin rays). Although the mechanism responsible for the observed variation in growth patterns among cohorts could not be unequivocally identified, correlated variation in vertebral counts suggests that a persistent response to environmental history (epigenetic effect) is responsible.

Thermal Effects on Ecology – RACE FBE Newport

Previous experimental work on the effects of temperature on habitat use and behavior of juvenile Pacific cod were supplemented with measures of maximum swimming speeds as a function of temperature. As observed in other fishes, maximum swim speed increased with body size and temperature (2°-9°C). However, analysis of data on routine swim speeds in small groups differed markedly from similar observations made for juvenile walleye pollock. Whereas routine swim speeds in walleye pollock increased at low temperatures (Hurst 2007), swim speeds of Pacific cod decreased at low temperatures. In a separate experiment, we observed that juvenile cod used eelgrass habitat more frequently at high temperatures (9°) than low temperatures (2°) consistent with the observed movement from inshore waters in the fall. These observations on the effects of temperature on the behavior and habitat use are important to understanding the mechanistic links between environmental variability and community dynamics in marine systems.

In a separate experiment, we analyzed the effects of temperature and growth rate on elemental incorporation in to the otoliths of larval Pacific cod. Otolith concentrations of Li, Mg, Ca, Mn, Zn, Sr, and Ba were measured using laser ablation-inductively coupled plasma mass spectrometry. The effects of temperature, somatic growth rate, and otolith precipitation rate on otolith partition coefficients (D_{Me}) varied among elements. D_{Mg} showed no relationship with temperature whereas D_{Sr} and D_{Ba} decreased with increasing temperature. It is possible that, for larval Pacific cod, kinetic effects are more important in the incorporation of Sr and Ba whereas metabolic effects may play a larger role in the incorporation of Mg. There was no evidence for an effect of somatic growth rate or otolith precipitation rate on D_{Me} for any of the elements, which indicates that individual growth variation is unlikely to lead to misinterpretation of field-collected data. Understanding variable relationships among otolith elemental signatures, environmental conditions, and fish physiology can improve the accuracy of interpretations of field data, particularly in marine systems where spatial variation in element concentrations are typically lower than freshwater environments.

b. Stock Assessment

BERING SEA/ALEUTIANS

Relative to last year's stock assessment, the following changes were made to the input data.

1) Catch data for 1991-2008 were updated, and preliminary catch data for 2009 were incorporated.
2) Commercial fishery size composition data for 2008 were updated, and preliminary size composition data from the 2009 commercial fisheries were incorporated.
3) Size composition data from the 2009 EBS shelf bottom trawl survey were incorporated.
4) The numeric abundance estimate from the 2009 EBS shelf bottom trawl survey was incorporated (the 2009 estimate of 717 million fish was up about 50% from the 2008 estimate).
5) Age composition data from the 2008 EBS shelf bottom trawl survey were incorporated into some of the models.
6) Age composition data from the 2008 January-May longline fishery were incorporated into some of the models.

7) Mean length at age data from the 1994-2008 EBS shelf bottom trawl surveys were incorporated into some of the models.
8) Mean length at age data from the 2008 January-May longline fishery were incorporated into some of the models.
9) The variances in the ageing error matrix were updated in all of the models that use age data, and possible biases in age data were corrected for in some of the models that use age data.
10) Seasonal catch per unit effort (CPUE) data for the trawl, longline, and pot fisheries from 2008 were updated, and preliminary catch rates for the trawl, longline, and pot fisheries from 2009 were incorporated.
11) The Pacific cod catch rate from the 2008 International Pacific Halibut Commission (IPHC) longline survey was incorporated.
12) Pacific cod size composition data from the 2009 IPHC longline survey were incorporated.

The assessment of the BSAI Pacific cod stock has gone through a series of changes in the last few years. A major change took place in 2005 when the model was migrated to the Stock Synthesis 2 program. Difficulties encountered in the 2006 assessment resulted in a thorough review of various assessment models in April 2007 during a public workshop. Many suggestions for changes and refinements of the analytical approaches were made. Refinements continued in the 2007, 2008, and 2009 assessment cycles based on suggestions from the plan teams, SSC, and the public.

The accuracy of age readings for this stock has been a continuing concern in this assessment. The chief symptom of the problem is the lack of agreement between the first few well-defined modes of the survey length compositions and the mean lengths at ages 1-2-3 based on age readings. At the September 2009 team meeting Tom Helser, NMFS Alaska Fisheries Science Center, presented some age reading data and analysis that, while not conclusive, suggested greater uncertainty about the age readings. The team minutes from September recommended attempting bias correction within the assessment as a short-term remedy. The minutes also recommended attempting to estimate a growth schedule for each cohort rather than a single schedule.

Three groups of models were presented at the November meeting. The first group (Models A1, A2, and A3) fitted the chosen 2008 model to different data sets. The features of these models, which had evolved over the course of the last two assessment cycles, are: fixed natural mortality rate M=0.34, double normal selectivity functions with freely estimated parameters except for some fisheries that are required to be asymptotic, selectivity parameters estimated for blocks of years where appropriate, trawl survey catchability estimated, mean and standard deviation of length at age estimated internally. Model A1 was fitted using all available age composition data, Model A2 using only length composition data, and Model A3 using all available age data except readings from the 2008 January-May longline fishery. These were the first readings of otoliths from the commercial fishery (all other age data are from the trawl survey), and they showed a highly anomalous abundance of one age group.

The second group of models (Model B1 and its variants) used all available age data and implemented several recommendations while maintaining almost all features of the base model

A1. First, a bias term of 0.4 years at all ages was added to the internal ageing error matrix. This value was found in trials to improve the likelihood most. Second, cohort-specific growth was estimated. This required using external estimates of mean length at age estimated from the biased age readings, with the bias accounted for by the ageing error matrix. Third, the product of survey catchability and selectivity averaged over the 60-81 cm length range was required to equal 0.47, based on archival tag data on vertical distribution. This feature has the effect of pegging the abundance estimates to the trawl survey results, at least for this length group. Fourth, no selectivity deviations were estimated for the last two surveys, so those schedules used the expected values. Fifth, the standard deviation of length at age was estimated externally to avoid the somewhat perverse internal estimates located by the minimizer.

Model D1 was the same as Model B1 except that it does not estimate selectivity at maximum age or length as a parameter of the double normal selectivity; instead this value is determined by the right-side mean and variance parameters. In Model E1 this value is required to be the same for all fleets. In Model G1 no survey selectivity deviations are estimated, so a single survey selectivity is estimated and applied in all years. All of these variants were requested of the author by various reviewers.

The last group of models (Models B2, D2, E2 and G2) were fitted to length composition data only. In addition there was a length-based model named F2 proposed by members of the public in 2007, 2008, and 2009 that differed from Models A2 and B2 in a number of ways. It made trawl survey selectivity asymptotic and estimated natural mortality internally (M=0.48).

All of the models fitted the data adequately. The authors' recommended model was B1, chosen because it achieved the best fit among all the models that made use of the age data and implemented the recommended changes. A majority of the Plan team also preferred Model B1, and for the same reasons. A minority, concerned about the age data and skeptical of the bias correction applied in Model B1 (and even in Model B2 for the purpose of fitting mean length at age), favored Model A2.

The estimate of 2010 spawning biomass from Model B1 is 345,000 t, projected to rise to 370,000 t in 2011, while $B_{40\%}$ is 411,000 t. The 2009 catch was well below OFL. The stock is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

The 2008 year class, which has been observed only once, appears to be extremely large, although this estimate is accompanied by a large confidence interval. The 2006 year class, which appeared exceptionally strong in the 2007 survey, still appears to be above average. However, the 2006 year class follows a string of five consecutive sub-par year classes spawned from 2001-2005.

According to criteria set by the SSC, this stock qualifies for management under Tier 3, where reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for the stock. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 411,000 t, 0.29, and 0.35, respectively. Pacific cod specifically qualifies for management under sub-tier "b" of Tier 3 because the projected biomass for 2010 is below $B_{40\%}$. Fishing at the adjusted Tier 3b rate of 0.24 is projected to result in a 2010 catch of 174,000 t, which is the maximum permissible ABC under Amendment 56.

The Plan Team recommends setting the 2010 ABC at 174,000 t, which is the maximum permissible. ABC is projected to increase to 214,000 t in 2011. The corresponding OFL levels under Tier 3b (F_{OFL}=0.29) are 205,000 t and 251,000, respectively.

GULF OF ALASKA

Relative to the 2008 stock assessment, the following input values were updated for 2009.

1) Catch data for 1991-2008 were updated, and preliminary catch data for 2009 were incorporated.
2) Commercial fishery size composition data for 2008 were updated, and preliminary size composition data from the 2009 commercial fisheries were incorporated.
3) Age composition and mean-length-at-age data from the 2007 bottom trawl survey were incorporated into some models.
4) Age composition data from the 2008 January-May longline fishery were incorporated into some of the models.
5) Mean length at age data from the 2008 January-May longline fishery were incorporated into some of the models.
6) Size composition data from the 2009 bottom trawl survey were incorporated.
7) The numeric abundance estimate from the 2009 EBS bottom trawl survey was incorporated (the 2009 estimate of 574 million fish was up about 199% from the 2007 estimate).
8) The variances in the ageing error matrix were updated in all of the models that use age data, and possible biases in age data were corrected for in some of the models that use age data.
9) Seasonal catch per unit effort (CPUE) data for the trawl, longline, and pot fisheries from 2008 were updated, and preliminary catch rates for the trawl, longline, and pot fisheries from 2009 were incorporated.

Ten models were included in the GOA Pacific cod assessment which addresses many of the comments and requests from the Plan Teams, SSC, and the public. The models were divided into three groups. The first group contained four models, each of which used the analytical model accepted for GOA Pacific cod in 2008 but differed in the data applied to the model. Each of the four models in this group drastically down-weighted the age composition data, and in one case removed it entirely. A second group contained three models that included the age composition data and included features such as cohort-specific growth and attempted to correct for potential bias in age readings. A final group of models contained a set of three models which omitted age composition data but were otherwise identical to the models in the second group.

The authors' criteria for selecting the final model considered: 1) the inclusion of age composition data (which has been consistently been requested by the Plan Team and SSC); 2) the response to requests such as the correction of age reading bias and cohort-specific growth; and 3) the best statistical fit to the data. Based on these criteria, the model with the best statistical fit from the second group (model "B1") was chosen as the preferred model. This model included mean length at age values as input data to the model, and estimates the standard deviation of length at age for the maximum and minimum ages outside the model (the modeling software only allows a linear relationship between the maximum and minimum ages). The model provided several improvements to the 2008 model, notably in the improvement of the fit to the survey abundance.

The authors' procedure to correct for the perceived age reading bias was to use a constant bias (across ages) that gave the best model fit; thus, the age reading bias was estimated within the model. It was unclear that the age reading bias was truly constant across ages, or if this bias could have been reasonably estimated within the model. By simultaneously estimating this bias with all other model parameters, it may have been that the age bias matrix affected related parameters in complex ways. Thus, any improvement in model fit may result not simply from correcting an age reading bias, but also from other features of the model fit that are difficult to interpret. A more straightforward method of estimating age reading bias would be to obtain age readings of known age fish. The assessment would benefit from continued research on age validation and on age-determination errors and potential biases. All of the GOA models presented used age information in some manner, either in the age composition data or in the length at age data. Thus, although there may be concerns about the quality of the age readings, a model that is truly free of age readings is not presently available. The Plan Team was concerned about the ad-hoc procedure used to account for age reading bias but accepted it as a reasonable short-term measure until data becomes available to estimate the bias more reliably (i.e., outside the model).

Model B1 results produced an estimated 2010 spawning biomass of 117,600 t, or 40% of the unfished spawning biomass. The $B_{40\%}$ estimate was 116,600 t. The estimated stock biomass increased relative to the 2008 assessment, due in part to a large biomass estimate in the 2009 GOA trawl survey. Spawning biomass is projected to increase dramatically in subsequent years due to a number of young year classes in the population.

Pacific cod are not overfished nor are they approaching an overfished condition. Catches remain well below levels where overfishing would be a concern. The Plan Team accepted the author's preferred model and therefore recommended Tier 3 for this stock. The model estimate of 2010 spawning biomass exceeds $B_{40\%}$, thus Gulf of Alaska Pacific cod are in Tier 3a, which is a change from the 2008 assessment when Pacific cod were classified in Tier 3b. The projected 2010 age-0+ biomass estimate is 738,300 t. The probability of the stock being below $B_{20\%}$ was estimated to be less than 1% in 2010 and subsequent years. Using the author's recommendation to use the maximum permissible F value from Tier 3a, the ABC for 2010 is 79,100 t (F_{ABC} =0.49). The 2010 OFL under Tier 3a is 94,100 t (F_{OFL} = 0.60).

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

2. Nearshore Rockfish

a. Research

GULF OF ALASKA

Dark Rockfish Mortality Study – Kodiak Laboratory
Accurate natural mortality estimates derived from life history parameters of unexploited fish populations are difficult to obtain, especially for species from the genus *Sebastes*. The objective of this research was to provide growth and natural mortality estimates of an unexploited

population of dark rockfish (*Sebastes ciliatus)* from the western Gulf of Alaska. Based on information obtained from Alaska Department of Fish and Game fish tickets and historical knowledge of the fishing effort in the study area, the dark rockfish population was unexploited at the time of the study. A total of 242 males and 553 females with sizes ranging from 160 to 490 mm FL were caught in August 2001 and July 2002 using commercial jig fishing gear. Maximum observed age was 75 years for males and 61 years for females. The von Bertalanffy growth parameter estimates were: L_∞ = 401 mm, k = 0.297, t_0 = 2.19 for males and L_∞ = 435 mm, k = 0.195, t_0 = 0.84 for females. The annual instantaneous rate of natural mortality rate (M) was estimated to be 0.062 for males and 0.073 for females.

For further information contact Elizabeth Chilton (907) 481-1725.

3. Shelf Rockfish

b. Research

GULF OF ALASKA

Dusky Rockfish Maturity Study – Kodiak Laboratory

Dusky rockfish (*Sebastes variabilis*) has recently been resurrected as a distinct species in the genus *Sebastes*. Reproductive biology and growth were examined for this redescribed species in the central Gulf of Alaska. Prior to this research study, estimates of the size and age at 50% maturity for this species were based on visual observations of gonad maturity taken from a limited sample collection. In order to improve these estimates for the stock assessment and fishery evaluation report, this study determined the maturity stage of female dusky rockfish at the histological level from samples collected over a two year period. Dusky rockfish age and length at 50% maturity are 9.2 years and 365 mm fork length, respectively, which are lower than previously reported. Fertilized ova and eyed embryos were observed in April while evidence of post-parturition was not observed until May. The gonadosomatic index decreased with the onset of post-parturition in May. Von Bertalanffy growth parameters of female dusky rockfish estimated from the maturity samples were L_∞=449 mm, k=0.219, and t_0=0.855 and significantly different than the growth parameters derived from Gulf of Alaska fishery-independent survey data of L_∞=480 mm, k=0.211, and t_0=1.106 (X^2=158.8, df =3, P<0.001).

For further information please contact Elizabeth Chilton (907) 481-1725.

Maternal Age Effects on Larval Viability - Southeast Alaska Rockfish

Rockfish larvae contain an oil globule during embryonic development and at parturition that contains energy for growth and metabolic needs during development and the critical stage when larvae are first learning to feed. The size of this oil globule has been shown to be related to growth and survival of some rockfish larvae based on collections off Oregon and California. The oil globule size, and therefore the survival rate, was also related to the age of the mother in black rockfish (Berkeley et al. 2004). If older rockfish mothers have more fit offspring than younger mothers, stock assessments should be modified to reflect this difference in recruitment.

Quillback rockfish larvae were sampled in 2006-2008 in southeast Alaska for analyses of effects of maternal age on maturation timing and larval quality. A paper describing the results is currently in preparation. The major findings are that maternal age is not related to oil globule size; however, it is related to maturation timing, with older mothers spawning earlier in the spring. Additionally, broods from twenty-five pregnant quillback rockfish were analyzed for multiple paternity, and many were found to have larvae from multiple fathers. Multiple paternity was not related to the age of the female, but may be related to the size. These projects are completed and the data are currently being analyzed and organized into manuscripts.

For more information, contact Cara Rodgveller at (907) 789-6052, Cara.Rodgveller@noaa.gov.

b. Stock Assessment

GULF OF ALASKA

Pelagic shelf rockfish – ABL

The pelagic shelf rockfish assemblage in the Gulf of Alaska is comprised of three species: dusky rockfish (*Sebastes variabilis*), yellowtail rockfish (*S. flavidus*), and widow rockfish (*S. entomelas*). This assemblage is one of three management groups for *Sebastes* in the Gulf which were implemented in 1988 by the North Pacific Fishery Management Council (NPFMC). Until 1998, black rockfish (*S. melanops*) and blue rockfish (*S. mystinus*) were also included in the assemblage. However, in April 1998, a NPFMC Gulf of Alaska Fishery Management Plan amendment went into effect that removed these two species from the federal management plan and transferred their jurisdiction to the state of Alaska. In 2010, dark rockfish (*S. ciliatus*) was also removed from Federal management (including the associated contribution to OFLs and ABCs under the respective assemblages in both regions) and full management authority was turned over to the State. Partial justification for this is that dark rockfish share an inshore reef or kelp environment with black rockfish and the two species are often caught together, suggesting that darks should be managed with black rockfish and other inshore species rather than within the pelagic shelf assemblage.

Gulf-wide, dusky rockfish are the most abundant species in the assemblage, whereas yellowtail and widow rockfish make up a very small proportion of the biomass in Alaska waters. Dusky rockfish have one of the most northerly distributions of all rockfish species in the Pacific. They range from southern British Columbia north to the Bering Sea and west to Hokkaido Is., Japan, but appear to be abundant only in the Gulf of Alaska (GOA).

Rockfish in the GOA have been moved to a biennial stock assessment schedule to coincide with data from the AFSC biennial trawl surveys in this region. In 2009, a trawl survey was conducted in the GOA, and a full assessment was done for pelagic shelf rockfish. We continue to recommend using the average of exploitable biomass from the three most recent trawl surveys to determine the recommended ABC for widow and yellowtail rockfish. For dusky rockfish, the age-structured model used previously was updated with the most recent data and altered slightly by splitting fishery catch into two time periods (1977-1990 and 1991-2009) and reducing the model weight on the earlier time period. Implementing this change resulted in an improved model fit to fishery catch.

For the pelagic shelf rockfish assemblage, ABC and OFL for dusky rockfish are combined with the ABC and OFL for widow and yellowtail rockfish. For the 2010 GOA fishery, we recommend a maximum allowable ABC for the pelagic shelf rockfish of 5,059 mt. This ABC is similar but slightly lower than last year's ABC of 5,231 mt. The stock is not overfished, nor is it approaching overfishing status.

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

4. Slope Rockfish

a. Research

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

GULF OF ALASKA

Rockfish Reproductive Study – Kodiak Laboratory
RACE groundfish scientists initiated a multi-species rockfish reproductive study in the Gulf of Alaska with the objective of providing more accurate life history parameters to be utilized in stock assessment models. There is a need for more detailed assessment of the reproductive biology of most commercially important rockfish species including: Pacific ocean perch, northern rockfish, the rougheye rockfish complex (rougheye and blackspotted rockfish), shortraker rockfish and other members of the slope complex. Scientists from the Kodiak Laboratory have been working with NMFS North Pacific groundfish observers stationed at the fish processors in Kodiak to obtain rockfish samples. This collection request began in February 2009 and will continue until the end of 2011 but it is anticipated that most samples will be obtained during the Rockfish Pilot Program in the months of May through November. In addition, on-going sampling requests have been submitted to the Alaska Department of Fish and Game large and small mesh surveys occurring in September and October, MACE acoustic surveys occurring in February and March, and the RACE Gulf of Alaska survey occurring during the summer months of 2009. Additional funds were obtained from the National Cooperative Research Program to fund a charter during November 2009, December 2009, and January 2010. During this charter Pacific ocean perch, rougheye, blackspotted, shortraker, northern and dusky rockfish samples were collected. It is anticipated that this research will not only enable scientists to derive reproductive parameter estimates needed for stock assessment but to examine these parameters over a number years to assess variability and causes of variability in these parameters. During the upcoming year studies on the reproductive biology of Pacific ocean perch and rougheye rockfish will be completed. During 2011 it is anticipated studies on the reproductive biology of blackspotted and shortraker rockfish will be completed.

For further information please contact Dr. Christina Conrath (907) 481-1732.

Experimental Trawl/Acoustic Survey for Rockfish
Scientists from ABL, REFM and RACE divisions of the Alaska Fisheries Science Center have been collaborating on a joint North Pacific Research Board grant to investigate new rockfish survey designs. The project objective was to evaluate an experimental survey design (TAPAS, Trawl Acoustic Presence Absence Survey) to reduce the variability in estimated biomass for Pacific ocean perch (POP). The design is a variant of adaptive sampling and uses acoustic information to distinguish strata of different densities. In addition to planned trawl stations, additional trawl tows are conducted in high density fish areas identified during the cruise. The rationale of the design is to reduce sampling variability by allocating more sampling effort in the areas of higher fish density. Reducing the uncertainty of biomass estimates for rockfish with patchy distributions has been identified as an assessment and management priority.

First, we analyzed historical acoustic data from NMFS trawl surveys to identify a threshold to define high density rockfish patches. We then used these results to conduct simulation studies to determine when the TAPAS design was most efficient. These simulations were used to design a field application of the design.

From August 2-13, 2009, we chartered the F/V *Sea Storm* to field test our sampling design ideas. Fifty-nine tows were completed (40 background and 19 patch tows). In practical terms, the design and sampling algorithm worked well in the field. However, the results of the field study showed little gains in precision over simple random sampling (assuming the same total sample size). Bootstrap results indicate that the published estimator for the biomass variance for TAPAS may be biased. Increases in precision for TAPAS were hindered by a weak relationship between the localized acoustic signals and CPUE, and relatively low variance in the background stations. Patches also were sometimes ephemeral, and when returning to tow a station, the hydroacoustic signal had diminished. Further analysis will evaluate the performance of the survey design with respect to the variance of biomass estimates under alternative definitions of patch areas. The patch definition for rockfish may benefit from utilizing acoustic variance in addition to the mean to differentiate from other species.

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Catch Efficiency of Longlines for Shortraker and Rougheye Rockfish in Alaska
Demersal rockfish of the family *Sebastes* can be difficult to assess with bottom trawl gear because they may inhabit untrawlable rocky habitats. In contrast, longline gear can often be successfully fished in these areas; however, many factors can affect longline catch rates besides fish density. In field studies conducted in 1994 and 1997 at 19 sites off Southeast Alaska, comparative data were collected on longline catch rates of shortraker (*Sebastes borealis*) and rougheye rockfish (*Sebastes aleutianus*) and on fish densities calculated from observations from a manned submersible. The purpose of these studies was to estimate the catchability coefficient of these two species on longline gear. On separate occasions, rockfish behavior in the presence of longline gear was observed from the submersible. Understanding the behavior of these rockfish in the presence of longline gear will guide the application of their catch rates in stock assessments. Although the data were collected more than 10 years ago, analysis of these data was just initiated this year, and a manuscript is being prepared.

Densities of shortraker rockfish based on observations from the submersible varied from 0 to 6,813 fish per square kilometer (mean of all sites = 2,709, S.D. = 3,095, n = 19). Densities of rougheye rockfish varied from 0 to 11,102 fish per square km (mean of all sites = 5,170, S.D. among sites = 5,416, n = 19). For shortraker rockfish, the linear regression of density and catch rate was not significant (F-ratio = 0.562, r = 0.423, p-value = 0.464). Rougheye rockfish catch rate was also not related to density at an α of 0.05, but was at an α of 0.1 (F-ratio = 3.085, r = 0.626, p-value = 0.097). The non-significance could be due to sample sizes, clumped distributions, or rockfish behavior on longline gear.

On dives where rockfish were observed during a longline set, the number of free-swimming fish increased throughout a set at a quicker rate than fish were caught. Shortraker and rougheye rockfish were attracted to the longline but many were not being caught even when baited hooks were available. We may have detected this trend because we did not observe the longline for a long enough period, or because rockfish are out-competed by other bait predators. Despite not knowing the cause of the reluctance of shortraker and rougheye rockfish to bite a baited hook, this behavior may affect the relationship between longline CPUE and density. We continue to analyze these data and interpret the appropriateness of longline gear as an index of abundance for shortraker and rougheye rockfish.

For more information, contact Cara Rodgveller at (907) 789-6052.

b. Stock Assessment

BERING SEA AND ALEUTIAN ISLANDS

Pacific Ocean Perch (POP)

Beginning in 2005, Pacific ocean perch assessments are conducted on a two year cycle to coincide with planned Aleutian Islands surveys. There has not been a new survey since 2006. Catch data were updated and the projection model was run using results from the 2008 assessment model as the starting point.

Age 3+ biomass for 2010 is up slightly from 2009. According to last year's assessment, spawning biomass has trended slightly downward since 2002. Spawning biomass is projected to be 133,000 t in 2010 and decline slightly to 131,000 t in 2011.

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 123,000 t, 0.057, and 0.068 respectively. There are reliable estimates of the 2010 spawning biomass (B), $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$; and $B > B_{40\%}$ (133,000 t > 123,000 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 2010 and 2011 ABCs associated with the $F_{40\%}$ level of 0.057 are 18,860 t and 18,680 t, respectively, which are the Plan Team's recommended values. The 2010 and 2011 OFLs under Tier 3a are 22,400 t and 22,200 t, respectively.

ABCs are set regionally based on the proportions in combined survey biomass. For 2010, this procedure apportions the ABC as follows: BS = 3,830 t, Eastern Aleutians (Area 541) = 4,220 t, Central Aleutians (Area 542) = 4,270 t, Western Aleutians (Area 543) = 6,540 t. For 2011, the same procedure apportions the ABC as follows: BS = 3,790 t, Eastern Aleutians (Area 541) = 4,180 t, Central Aleutians (Area 542) = 4,230 t, Western Aleutians (Area 543) = 6,480 t. The OFL is not regionally apportioned.

Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

Northern rockfish

Beginning in 2005, northern rockfish assessments are being conducted on a two year cycle to coincide with planned Aleutian Islands surveys. There has not been a new survey since 2006. Catch data were updated and the projection model was run using results from the 2008 assessment model as the starting point.

Age 3+ biomass has been on an upward trend since 2002. According to last year's assessment, spawning biomass has been increasing slowly since 1977. Spawning biomass is projected to be 69,300 t in 2010.

The SSC has determined that this stock qualifies for management under Tier 3 due to the availability of reliable estimates for B40% (55,300 t), F40% (0.043), and F35% (0.051). Because the female spawning biomass of 69,300 t is greater than B40%, sub-tier "a" is applicable, with maximum permissible FABC =F40% and FOFL =F35%. Under Tier 3a, the maximum permissible ABC is 7,240 t, which is the recommendation for the 2010 ABC. Under Tier 3a, the 2010 OFL is 8,640 t for the Bering Sea/Aleutian Islands combined. A combined ABC and OFL are again set for the Bering Sea and Aleutian Islands in 2010. As the catch has routinely been lower than the ABC, a catch of 4,500 t was assumed as the 2010 catch, in order to make projections to 2011. The recommended ABC and OFL for 2011 are 7,290 t and 8,700 t, respectively.

Model projections indicate that this stock is neither overfished nor approaching an overfished condition. Estimation of the probability that the stock will fall below *B20%* within 3-5 years will be addressed in the next full assessment.

Shortraker/rougheye rockfish

The shortraker rockfish assessment was separated from the blackspotted and rougheye rockfish complex in 2008. Prior to 2008, shortraker and rougheye rockfish were assessed with a two-species surplus production model that accounted for potential covariance in catch estimates. The 2008 assessment applied a single-species surplus production model to BSAI shortraker rockfish.

Beginning in 2005, rockfish assessments are being conducted on a two year cycle to coincide with planned Aleutian Islands surveys. However, there has not been a new survey since 2006. Since shortraker rockfish are in Tier 5 and there has been no new survey biomass estimate, the results are the same as in 2008.

Shortraker rockfish survey biomass is 17,200 t, which is the same as the 2008 assessment. In last year's assessment, total biomass was estimated to have trended slowly downward since 1984.

The SSC has previously determined that reliable estimates only of biomass and natural mortality exist for shortraker rockfish, qualifying the species for management under Tier 5. The Tier 5 biomass estimate is based on the surplus production model. At the present time, the Plan Team and SSC recommend that Tier 5 management is retained for these stocks. ABC is therefore set at the maximum permissible level (F_{ABC}) under Tier 5, which is 75% of *M*. The accepted value of *M* for these stocks is 0.030 for shortraker rockfish, resulting in an FABC value of 0.023.

The biomass estimate for 2010 is 17,200 t for shortraker rockfish, leading to a BSAI OFL of 516 t and an ABC of 387 t. 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.

Blackspotted/rougheye rockfish complex
Fish previously referred to as rougheye rockfish are now recognized as consisting of two species, the rougheye rockfish (*Sebatses aleutianus*) and blackspotted rockfish (*Sebastes melanostictus*). The blackspotted and rougheye complex assessment was separated from shortraker rockfish and assessed with an age-structured model in 2008.

Beginning in 2005, rockfish assessments are being conducted on a two year cycle to coincide with planned Aleutian Islands surveys. There has not been a new survey since 2006. Catch data were updated and the projection model was run using results from the 2008 assessment model as the starting point.

Total biomass for 2010 was estimated at a value of 21,200 t, up slightly from 2009. In last year's assessment, spawning biomass was estimated to have trended slowly upward since 1998, but was projected to decline slightly after 2009. Projected spawning biomass for 2010 (AI only) is 6,570 t.

The Plan Team and SSC recommended that this stock qualifies for management under Tier 3 due to the availability of reliable estimates for $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$. Because the female spawning biomass of 6,570 t is less than $B_{40\%}$, (6,720 t, AI only), sub-tier "b" would be applicable, with an adjusted $F_{40\%}$=maxF_{ABC} =0.039 and an adjusted F35% = F_{OFL} = 0.047. Under Tier 3b, the maximum permissible ABC is 547 t (EBS and AI combined), which is the recommended 2010 ABC. Under Tier 3b, the 2010 OFL is 669 t for the Bering Sea/Aleutian Islands combined. The Plan Team continues to recommend setting a combined BSAI OFL and ABC. Since the catch has routinely been lower than the ABC, the catch of the previous year was assumed as the 2010 catch, in order to make projections to 2011. The recommended ABC and OFL for 2011 are 531 t and 650, respectively (both values are BSAI-wide). Model projections indicate that this stock complex is neither overfished nor approaching an overfished condition.

The assessment authors also responded to an SSC request to consider the implications of adopting area-specific ABCs for this stock complex. The age-structured assessment model for blackspotted/rougheye was first accepted by the BSAI Plan Team in 2008. At that time, the ABCs which would result from a single BSAI model as well as an AI-only model were presented, as well as information on stock structure and a comparison of potential area-specific ABCs to recent area-specific catches. More progress has been made on the issue of stock structure in 2009, including: 1) a symposium at the February, 2009 SSC meeting on genetic techniques pertaining to stock structure; 2) the formation of an SSC-Plan Team working group charged with developing guidelines for determining stock structure; and 3) the presentation of the report of the working group at the September, 2009 Plan Team meeting. The working group report identified various types of data to be considered when evaluating stock structure. The current status is that the template outlined in the working group report will be applied to BSAI blackspotted/rougheye and presented to the Plan Team in September, 2010.

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. The BSAI "other rockfish" assessment considers the eight 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 2008 Eastern Bering Sea Slope survey data are included in this year's assessment. Catches in 2008 have been revised and the 2009 catch has been included. Separate estimates of natural mortality (M) and biomass for shortspine thornyheads (SST; M=0.03), the most common species in the other rockfish complex, and the remaining species (M=0.09 based on dusky rockfish) in the complex were used.

Since there has not been a new Aleutian Islands survey since 2006, the assessment results are the same as in 2009. Trends in spawning biomass are unknown. Stock biomass, as measured by trawl surveys of the EBS slope is the same as in 2008.

The recommended approach for setting FABC is using the maximum allowable catch under Tier 5 ($F_{ABC} = 0.75 \times M$). Multiplying these rates with the best estimates of SST and other "other rockfish" biomass yields 2008 ABCs of 481 t in the EBS and 554 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 natural mortality values and adding the results, which yields an OFL of 1,380 t for 2010 and 2011.

As a Tier 5 complex, it is not possible to determine whether "other rockfish" are overfished or approaching an overfished condition.

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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 AFSC trawl survey that occurs in this region. In even years (such as 2008's assessment for the 2009 fishery) when there is only new catch information, we run only the projection model with updated catch data for single-species, age-structured assessments. In odd years (like 2009), we run a full assessment with all new survey and fishery data accumulated since the last full assessment. A new analysis was conducted in the full assessment this year in which changes in fishery patterns were examined. Overall, the analysis showed that the fishery has changed over time, moving to shallower depths and areas closer to port. The fishery is now being prosecuted over a longer period of time since the implementation of the GOA Rockfish Pilot Project. We made changes to fishery selectivity and estimated three time blocks based on changes from large factory trawlers to smaller catcher boats. For the 2010 fishery, we recommended the maximum allowable ABC of 17,584 t from the revised model. This ABC is a 16% increase from last year's ABC of 15,111 t. This increase was attributed to a lower catchability parameter, not the change in recommended fishing mortality from 0.06 to 0.12. The change in the recommended fishing mortality rate is due to different fishery selectivity. While fishing will be taking place at a higher rate for a section of the population, fishing mortality is much lower in the older years of the population due to the dome-shaped nature of the current selectivity curve. The stock is not overfished, nor is it approaching overfishing status.

For more information contact Dana Hanselman at (907) 789-6054, Dana.Hanselman@noaa.gov.

Northern Rockfish
Northern rockfish is the second most abundant slope rockfish in the Gulf of Alaska. Since 2005, Gulf of Alaska rockfish have been moved to a biennial stock assessment schedule to coincide with the biennial AFSC trawl survey that occurs in this region. In even years (such as 2008's assessment for the 2009 fishery) when there is only new catch information, we run only the projection model with updated catch data for single-species, age-structured assessments. In odd years (like 2009), we run a full assessment with all new survey and fishery data accumulated since the last full assessment. The main change for the 2009 assessment model was a consistent method of assigning year-specific likelihood weights. Because of sparse biological sampling for northern rockfish, the new method combined both the number of hauls and the number of samples. For 2010, we recommended an ABC of 5,100 t, the maximum allowable ABC. This ABC is 17% higher than the 2009 ABC. Northern rockfish is not subjected to overfishing, is not currently overfished, and is not approaching a condition of overfishing.

For more information, contact Jon Heifetz at (907) 789-6054, Jon.Heifetz@noaa.gov.

Rougheye and Blackspotted Rockfish
A separable age-structured model is the primary assessment tool for Gulf of Alaska rougheye and blackspotted rockfish. This consists of an assessment model, which uses survey and fishery data to generate a historical time series of population estimates, and a projection model which uses results from the assessment model to predict future population estimates and recommended harvest levels. For Gulf of Alaska rockfish in alternate (even) years we present an executive summary to recommend harvest levels for the next (odd) year.

Orr and Hawkins (2008) formally verified the presence of two species, rougheye rockfish (*Sebastes aleutianus*) and blackspotted rockfish (*S. melanostictus*), in what was once considered a single variable species with light and dark color morphs. Hereafter we refer to these two species together as the rougheye rockfish complex. A new at-sea field identification pamphlet was prepared and will be tested with genetic samples in the 2009 NMFS groundfish trawl survey to determine whether rapid and accurate identification of the two species can occur. When observers and survey biologists can reliably identify both species, we can begin to develop a rationale for mixed species assessments and the potential implications for overfishing a weaker stock. We are also beginning to examine whether differences in life history characteristics (e.g., age and growth) exist for the two species. When combined with accurate species-specific catch and survey data, such information will help determine whether one species is a weaker stock and has a potential for overfishing.

The 2009 assessment methodology was very similar to the 2007 model. Results from a previous sensitivity analysis were incorporated to improve model stability. For the 2010 fishery, we recommended the maximum allowable ABC of 1,302 t. This is a 1.4 % increase from last year's ABC of 1,284 t. Recent recruitments are steady and near the median of the recruitment time series. This is evident in the ages for both fishery and survey with more young fish over time. Female spawning biomass is well above target levels, with projected spawning biomass stable. The stock is not overfished, nor is it approaching overfishing status.

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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 AFSC biennial trawl surveys in the GOA. Because these surveys occur in odd years, one was conducted in 2009, and therefore a full assessment was completed in fall 2009 for shortraker rockfish and "other slope rockfish". As in previous assessments since 1994, an average of the Gulf-wide biomass from the three most recent trawl surveys (presently the 2005, 2007, and 2009 surveys) was used to determine current exploitable biomass. This results in an exploitable biomass of 40,626 mt for shortraker rockfish and 76,867 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 2010 and 2011 of 914 mt for shortraker rockfish and 3,749 mt for "other slope rockfish". Compared with ABCs in 2008 and 2009, this is a slight increase for shortraker rockfish, but a 13% decrease for "other slope rockfish". Much of this decrease for "other slope rockfish" is attributable to the low biomass for silvergray rockfish in the 2009 trawl survey. Neither shortraker rockfish nor "other slope rockfish" is considered overfished in the Gulf of Alaska, and neither is approaching overfishing status. Gulfwide catch of shortraker rockfish was 598 mt in 2008, and estimated catch in 2009 was 535 mt. Gulfwide catch of "other slope rockfish" in 2008 was 809 mt, and estimated catch in 2009 was 846 mt.

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. However, a 2008 validation study (based on carbon 14 levels in the otoliths) of the shortraker ageing method was not successful. Thus, alternative validation techniques will be necessary to verify the ageing methodology. Because of the lack of direct validation for the ageing method, and the consequent uncertainty about the ages, production ageing for shortraker rockfish has now been put on hold. Although we hope to move to an age-structured assessment for shortraker rockfish at some time in the future, better validation of the shortraker rockfish ageing methodology is needed before we do so.

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1. Thornyheads

b. Stock Assessment

GULF OF ALASKA

Thornyheads continue to be on a biennial stock assessment schedule to coincide with the timing of the NMFS trawl survey data. New assessment information includes updated biomass and length compositions from the 2009 NMFS trawl survey data, total catch weight for 2007, 2008 and partial 2009 data and length composition from the 2007 and 2008 longline fisheries. Additionally, Relative Population Numbers (RPN's) and weight and size composition from the AFSC 2008 and 2009 longline surveys were included.

Estimates of spawning biomass are not available for thornyheads since they are assessed under Tier 5. Thornyhead biomass from the 2009 GOA trawl survey showed a decline of 9% relative to the 2007 survey results. However, most of this decrease was observed in the central GOA with a decrease of 24%. Biomass increased by 54% and 10% in the Western and Eastern Gulf areas, respectively.

Thornyhead rockfish are in Tier 5 and will likely remain there until such time as satisfactory age data can be generated and an age structured model can be developed. Age assessment is currently hampered by insufficient age data for this species; two recent studies showed widely variable maximum ages of 115 and 150 years, highlighting the difficulty in ageing thornyheads. It is possible that production ageing could occur, but only for individuals younger than 10 years of age. An average natural mortality (M) of 0.03 is used in this assessment as it is currently considered the best estimate based on the age data available.

The 2010 ABC recommendation from the current assessment (where F_{ABC} =0.0225) is 1,770 t and the OFL (F_{OFL} =0.03) is 2,360 t. Information is insufficient to determine stock status relative to overfished criteria. Catch levels for this remain below the TAC and below levels where overfishing would be a concern.

For shortspine thornyhead (and a number of other species), it is critically important to the assessment that the GOA trawl surveys continue and that they extend to 500m in order to cover the range of primary habitat for this (and other) species.

An examination of the trophic relationships of shortspine thornyheads suggests that the direct effects of fishing on the population are likely to be the major ecosystem factors to monitor for this species, because fishing is the dominant source of mortality for shortspine thornyheads in the Gulf of Alaska, and there are currently no major fisheries affecting their primary prey. However, if fisheries on the major prey of thornyheads—shrimp and to a lesser extent deepwater crabs—were to be re-established in the Gulf of Alaska, any potential indirect effects on thornyheads should be considered.

For further information contact Sandra Lowe at (206) 526-4230.

6. Sablefish

a. Research

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

2009 Sablefish Longline Survey
The AFSC has conducted an annual longline survey of sablefish and other groundfish in Alaska from 1987 to 2009. The survey is a joint effort involving the AFSC's Auke Bay Laboratories and Resource Assessment and Conservation Engineering (RACE) Division. It replicates as closely as practical the Japan-U.S. cooperative longline survey conducted from 1978 to 1994 and also samples gullies not sampled during the cooperative longline survey. In 2009, the thirty-first annual longline survey of the upper continental slope of the Gulf of Alaska and eastern Aleutian Islands was conducted. One hundred-fifty-two longline hauls (sets) were completed during May 30 - August 26, 2009 by the chartered fishing vessel *Ocean Prowler*. 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*), arrowtooth flounder (*Atheresthes stomias*), and Pacific cod (*Gadus macrocephalus*). A total of 74,444 sablefish were caught during the survey. Sablefish, shortspine thornyhead, Greenland turbot (*Reinhardtius hippoglossoides*), spiny dogfish shark (*Squalus acanthias*), and lingcod (*Ophiodon elongates*) were tagged and released during the survey. Length-weight data and otoliths were collected from 1,860 sablefish. Killer whales *(Orcinus orca)* took fish from the longline at ten stations in the Bering Sea region and two stations in the western Gulf of Alaska, and one station in the central Gulf of Alaska. This was the highest killer whale depredation ever observed in the Bering Sea and severely affected catches in this region. Sperm whales *(Physeter macrocephalus)* were often present during haul back and were observed depredating on the longline at five stations in the eastern Gulf and five stations in the central Gulf of Alaska. These numbers represent a high incidence of sperm whale interactions in the central Gulf but the number observed in the eastern Gulf was much lower than that experienced in 2008.

Several special projects were conducted during the 2009 longline survey. Lingcod were tagged with archival temperature/depth tags in the West Yakutat and central Gulf of Alaska regions. Photographs of sperm whales observed during the survey were taken for contribution to the

Southeast Alaska Sperm Whale Avoidance Project (SEASWAP) sperm whale catalog. A NOAA Hollings Scholar intern conducted a hooking injury project for sablefish. During this project, tagged sablefish were examined for prior hooking injuries and injury location and severity were recorded. This information, along with data from a previous tagging study, will be used to help understand mortality that occurs as a result of hooking injury.
A 2-day experiment was conducted near Yakutat July 21-22 to test new methods for quantifying sperm whale depredation rates. Acoustic recorders were deployed during fishing operations to passively collect the acoustic recording of sperm whale sounds during gear retrieval. Sperm whales use echolocation signals for navigation and detecting objects underwater. A "creak" is a rapid series of clicks in short succession which may indicate that a whale is homing in on a prey item. Enumerating the number of "creaks" that occur during hauling operations may provide a quantitative means of evaluating sperm whale depredation.

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New Longline Survey Database, Website, Video, and At-Sea Data Collection
The Alaska Fisheries Science Center conducts annual longline surveys to estimate the relative abundance of major groundfish species, especially sablefish, on the continental slope of the eastern Bering Sea, Aleutian Islands, and the Gulf of Alaska. An SQL server database was developed over several years and is near completion. A website was created to provide survey catches and population indices to the public. This website it s now live and data can be accessed at http://www.afsc.noaa.gov/ABL/MESA/mesa_sfs_lsd.htm. A short video describing the longline survey was created this year for use as an outreach tool on the AFSC website, NOAA Tube, and on informational video monitors located in the vestibule of the Auke Bay Laboratories facility at Lena Point. This video can be viewed at http://www.afsc.noaa.gov/ABL/MESA/mesa_sfs_ls.php.

Ruggedized hand-held computers ("Polycorders") have been used for many years on the longline survey for on-deck collection of data. However, because these computers are breaking and are no longer manufactured or serviced, we recently purchased new hand-held computers (Juniper "Allegro") for data collection on the longline survey. They are currently (spring 2010) being programmed and tested so that they can be used during this field season.

For more information, contact Cara Rodgveller at (907) 789-6052 or cara.rodgveller@noaa.gov.

Auke Bay Laboratory Sablefish Tag Recovery Program
The ABL MESA Program continued the processing of sablefish tag recoveries and administration of the tag reward program and Sablefish Tag Database during 2009. Total sablefish tag recoveries for the year should exceed 600 when all are received. One fish at liberty for 30.9 years was recovered in 2009; it was released off Cape Suckling and recovered near Chichagof Island. Two other fish were out just over 30 years: one was released and recovered off Icy Bay and the second was released off Portlock Bank, Alaska and recovered off the Queen Charlotte Islands, Canada. Twenty-three sablefish tagged with archival tags as juveniles were recovered in 2009. Data from these electronic archival tags, which will provide information on the depth and temperature experienced by the fish, are still being analyzed.

Tags from shortspine thornyheads, Greenland turbot, Pacific sleeper sharks, lingcod, and spiny dogfish are also maintained in the Sablefish Tag Database. Eleven thornyheads and five turbot were recovered in 2009, as well as four spiny dogfish that had been tagged with special pop-off archival tags.

Releases in 2009 totaled 3,388 adult sablefish (including 14 released with archival tags), 783 shortspine thornyheads, 70 Greenland turbot (including 42 with archival tags), 29 lingcod (all archival), and 312 juvenile sablefish (including 75 archival).

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Juvenile Sablefish Studies

Juvenile sablefish studies have been conducted by the Auke Bay Laboratories in Alaska since 1984 and were continued in 2009. A total of 237 juvenile sablefish (age 1+) were tagged with spaghetti tags and released during a cruise to St. John Baptist Bay near Sitka between August 28th-September 2nd. During the cruise, 75 juvenile sablefish were also implanted with electronic archival tags. Approximately 164 rod hours with sport gear were recorded to catch the fish that were tagged during the cruise. Total catch-per-unit-effort (CPUE) equaled 2.00 sablefish per rod hour fished. This was the highest CPUE since 2005, but still considerably lower than catch rates in the 1990s. 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 601 electronic archival tags have been released in 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. We received three archival tag returns from the 2008 fishery, and several more have also been received from the 2009 fishery. In June 2010, we are attempting a new project in which we will explore for and tag juvenile sablefish west of Kodiak Island to aid in determining movement patterns of western Gulf of Alaska juveniles. The St. John Baptist Bay juvenile sablefish tagging cruise will be conducted again in 2010 from August 16-22.

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b. Stock Assessment

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

Relative to the 2008 assessment, we made no substantive changes to the 2009 assessment. We added relative abundance and length data from the 2009 longline survey, relative abundance and length data from the 2008 longline and trawl fisheries, and age data from the 2008 longline survey and longline fishery were added to the assessment model. A NMFS Gulf of Alaska trawl survey was conducted in 2009, and its biomass estimate and associated lengths were added. We

also included responses to a March 2009 Center for Independent Experts review panel of sablefish assessment in Alaska.
The fishery abundance index was up 5% from 2007 to 2008 (the 2009 data are not available yet). The survey abundance index increased 2% from 2008 to 2009 following a 16% decrease from 2006 to 2008. Relative abundance in 2009 is level with 2000, and is near the all-time low for the domestic longline survey. The Gulf of Alaska 2009 trawl survey estimate fell 2% from 2007, and is at its lowest since 1999. Spawning biomass is projected to be lower from 2010 to 2013, and then stabilize.

Sablefish are currently below biomass targets. We recommended the maximum permissible yield for 2010 from an adjusted $F_{40\%}$ strategy, which equals an ABC of 15,230 t. This maximum permissible yield for 2010 is a 5% decrease from the 2009 ABC of 16,080 t. This decrease is supported by three low years in the domestic longline survey abundance estimate and two subsequent low trawl survey abundance estimates. There is also little evidence of any large incoming recruitment classes. Spawning biomass is projected to decline through 2013, and then is expected to increase assuming average recruitment is achieved. Because of the lack of recent strong year classes, the maximum permissible ABC is projected to be 13,658 t in 2011 and 12,592 in 2012.

Projected 2010 spawning biomass is 35% of unfished spawning biomass. Spawning biomass has increased from a low of 30% of unfished biomass in 2001 to a projected 35% in 2010. The 1997 year class has been an important contributor to the population but has been reduced and should comprise only 12% of the spawning biomass. The 2000 year class appears to be larger than the 1997 year class, and is now 92% mature and should comprise 23% of the spawning biomass in 2010.

Center for Independent Experts (CIE) Review of Alaska Sablefish Assessment
A 3-day workshop was held by the authors of the Alaska sablefish assessment to consider recent suggestions made during a 2009 Center for Independent Experts review of the assessment and an industry-sponsored review. Prior to the workshop, all available relevant information pertaining to the sablefish population was synthesized in order to consider alternative modeling approaches. The workshop participants were provided with high resolution data from available scientific surveys as well as age and length information from observed fishing vessels aggregated by time and management area. Simulated datasets that captured the general characteristics of fishery data were also provided in a high-resolution format so that detailed spatial models could be considered.

Stock assessment experts outside of the Auke Bay Laboratories participated in the workshop, as well as scientists from within the lab. Two primary products are expected from the workshop. The first is a report describing the key findings and recommendations for further development of research and modeling of sablefish. The second product, yet to be developed, will be a set of potential models to go forward with in 2010 or 2011 for the sablefish assessment.

Key recommendations developed during the workshop were: (1) Develop generalized linear models for the longline survey and fishery abundance indices to statistically incorporate factors such as whale depredation, spatial effects, and hyperstability; (2) Consider spatially explicit modeling of the population, particularly to incorporate effects of differing fishery selectivity patterns in different regions; and (3) Update the sablefish movement model to include growth to different size classes and explicit choice of temporal comparisons.

For more information, contact Dana Hanselman at (907) 789-6054 dana.hanselman@noaa.gov.

7. Flatfish

a. Research

Habitat Studies – FBE Newport OR
Field studies around Kodiak have examined how biogenic seafloor structure influences the distribution of juvenile flatfish, particularly age-0 yr northern rock sole *Lepidopsetta polyxystra*. Juvenile aggregate in shallow coastal waters (<50m), where they associate with seafloor characterized by sparse to dense coverage of ampharetid polychaete worm tubes. The presence/absence and coverage of these structure forming polychaetes can vary dramatically between years. During the summers 2008 and 2009, the ampharetid polychaete worm *Sabellides sibirica* was more common than during the preceding 7 years, forming a 'turf' that extended from 21m to more than 30m; a 1 km wide habitat feature fringing the shoreline. Age-0 flatfish density increased with depth, being highest at the edge of the worm turf, where the worms were patchy, and lowest in the dense turf. Dietary studies reveal that juvenile flatfish actively forage upon the polychaetes that form this habitat. In addition, benthic community analysis demonstrates that the benthic infauna and epifauna associated with the turf are both more numerous and more diverse than inshore areas without the turf. Fish from trawl samples are currently being worked up to determine whether fish associated with the worm turf habitat differ in size or condition from those captured away from the worm turf. Lastly, we are experimenting with other measures of fish condition and growth, including lipid analysis and RNA/DNA ratios, to determine if these metrics can help elucidate the role that this biogenic habitat plays in the nursery function of Kodiak coastal embayments.

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

Juvenile Flatfish (Rock Sole and Pacific Halibut) – Kodiak Laboratory and FBE Newport
Researchers from the Fisheries Behavioral Ecology Program and the Kodiak Laboratory have been investigating the processes affecting juvenile flatfish distribution, growth and survival within nursery areas around Kodiak Island, AK. Juvenile flatfish typically utilize nearshore, shallow coastal waters in Alaska as nursery areas. Field studies around Kodiak Island, AK reveal that biogenic seafloor structures constitute a critical component of essential fish habitat for juvenile flatfish in these areas and that juvenile flatfish abundance is highly correlated with abundance of ampharetid polychaete *Pseudosabellides sibirica* worm tubes. In some years, concentrated aggregations of *P. sibirica* form a dense lawn covering large sections of the seafloor in the bays around Kodiak. Juvenile flatfish, most notably northern rock sole *Lepidopsetta polyxystra*, aggregate along the shallow (inner) edge of this habitat where tube density is low to moderate and patchy. From 2007 to 2009, researchers conducted a series of integrated field and laboratory studies to examine the ecological processes controlling this fish-

habitat relationship. One hypothesis that was tested was that juvenile flatfish aggregate in areas with worm tubes to feed either directly upon the worms or upon associated fauna. During the summer months of 2008 and 2009, > 1,000 age 0 rock sole were collected in two bays around Kodiak Island with differing densities of worm tubes. Differences in the diet composition, feeding activity, and general body condition of fish between and within the bays were examined. Additionally, benthic sampling was conducted to assess the differences in prey availability between the habitats. Substantial differences in the diet composition of juvenile rock sole between the worm tube habitat and areas devoid of worms were detected. Generally polychaetes were the most important prey in the diets of rock sole collected along the edge of the worm habitat; whereas, cumaceans and/or harpacticoid copepods were the predominant prey consumed in shallow waters devoid of worms. Ampharetid polychaetes were nearly absent in the diets of fish collected in shallow waters but they occurred in the majority of the stomachs collected in the worm habitat. In general, both feeding activity and invertebrate biomass were greater in the worm habitat compared to shallower waters. The preliminary results suggest that areas of low to moderate worm tube coverage may provide enhanced feeding opportunities for juvenile rock sole both directly as an additional food source and indirectly by supporting a higher biomass of prey. It appears that foraging behavior is an important factor influencing the distribution of juvenile flatfish relative to polychaete worm habitat in coastal nurseries of Alaska.

For further information please contact Brian Knoth (907) 481-1731.

b. Stock assessments

BERING SEA

Yellowfin sole

The current assessment model was modified in 2008 to accommodate the sex-specific aspects of the population dynamics of yellowfin sole. The model now allows for the input of sex-specific estimates of fishery and survey age composition and weight-at-age and provides sex-specific estimates of population numbers, fishing mortality, selectivity, fishery and survey age composition and allows for the estimation of sex-specific natural mortality and catchability. The model retains the utility to fit combined sex data inputs.

The 2009 stock assessment incorporates the 2009 catch and survey biomass, the age compositions from the 2008 survey and 2008 catch and an update of weight-at-age estimates using biological data through 2008. The 2009 EBS bottom trawl survey resulted in a biomass estimate of 1,740,000 t, a decrease of 17% from the 2008 point estimate. Part of this decline is believed to be the effect of colder water temperature on survey catchability rather than actual changes in abundance. The stock assessment model indicates that the stock has been slowly declining over the past twenty years, although still at a fairly 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 5 of the past 20 year classes have been at or above the long term average. The 2009 catch of 107,528 t represents the largest flatfish fishery in the United States and the five-year average exploitation rate has been 4% 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 25 years, = 1.12.

Several models were analyzed for this assessment. The models differed by changing whether natural mortality (*M*) or catchability (*Q*), or both, were estimated as free parameters in the model to determine the uncertainty of these key parameters and their effect on the model estimates. The SSC determined in 2006 that the reliability of the spawner recruit relationship estimated in the yellowfin sole assessment warranted moving this stock to Tier 1 management. In the yellowfin sole stock assessment model, a Ricker form of the stock-recruit relationship was fit to the estimates of female spawning biomass and recruitment and estimates of F_{MSY} and B_{MSY} were calculated, assuming that the fit to the stock-recruitment data points represent the long-term productivity of the stock. Results from these Tier 1 calculations for yellowfin sole indicate that the harmonic mean of the F_{MSY} estimate is very close to the geometric mean value of the F_{MSY} estimate due to the low variability in the parameter estimates. This result indicates that the estimates of F_{MSY} are obtained with very little uncertainty. To better understand how uncertainty in certain parameter estimates affects the Tier 1 harvest policy calculations for yellowfin sole, the following analysis was undertaken. Selectivity, catchability, natural mortality and recruitment variability (R sigma) were selected as important parameters whose uncertainty may directly affect the pdf of the estimate of F_{MSY}. Twelve different model configurations were chosen to illustrate the effect of a range of uncertainly in these individual parameter estimates (0.4 and 0.9 for M and 0.8, 1.0, 1.2 and 1.4 for R sigma) and how they affect the estimate of the harmonic mean of F_{MSY}.

Results indicated that increases in recruitment variability would have the largest effect on the pdf of the estimate of $F_{MSY,}$ whereas the uncertainty in the other parameters did not.

The Tier 1 recommendations for this stock are as follows: The estimate of B_{MSY} from the present assessment is 333,000 t. The 1978-2004 spawner recruit data were used as the basis to determine the Tier 1 harvest recommendation. This provided an $F_{ABC} = F_{harmonic}$ mean $F_{msy} = 0.12$. The $F_{OFL} = F_{MSY} = 0.13$ The product of the harmonic mean of F_{MSY} and the geometric mean of the projected 2010 biomass estimate produced the recommended ABC of 219,400 t and OFL of 233,600 t.

Model projections indicate that this stock is neither overfished nor approaching an overfished condition. Although the stock is presently above $B_{40\%}$ and B_{MSY} , it is predicted to slowly decrease in the near future due to below average recruitment from the last 5 years.

Northern rock sole

The assessment model was modified last year to accommodate the sex-specific aspects of the population dynamics northern rock sole. The model now allows for the input of sex-specific estimates of fishery and survey age composition and weight-at-age and provides sex-specific estimates of population numbers, fishing mortality, selectivity, fishery and survey age composition and allows for the estimation of sex-specific natural mortality and catchability. The model retains the utility to fit combined sex data inputs.

Changes to the input data for the 2009 assessment include a new maturity schedule from a recent published analysis of a histological examination of northern rock sole ovaries collected from the Bering Sea. Other new inputs include: addition of the 2008 fishery age composition, 2008 survey age composition, the 2009 catch biomass and 2009 trawl survey biomass point estimate and standard error. The 2009 bottom trawl survey resulted in a biomass estimate of 1,769,000 t, only 75% of the 2009 point estimate of 2,031,000 t. Part of this decline is believed to be the effect of colder water temperature on survey catchability rather than actual changes in abundance. 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 1.5. Natural mortality was estimated as a free parameter (with q constrained as stated above) giving the best fit for both sexes at about M = 0.15. The model estimates that the biomass of rock sole has increased the past five years after declining from an earlier peak value observed in 1997. The increase is due to strong recruitment from the 2001, 2002 and 2003 year classes which are now contributing to the population biomass. The stock assessment model estimates the 2010 biomass of rock sole at 1,769,000 t, a small increase over 2007 and about 2% more than the previous peak level observed in 1997.

The SSC determined in 2006 that the reliability of the spawner recruit relationship estimated in the northern rock sole assessment warranted moving this stock to Tier 1 management. In the northern rock sole stock assessment model, a Ricker form of the stock-recruit relationship was fit to the estimates of female spawning biomass and recruitment and estimates of F_{MSY} and B_{MSY} were calculated, assuming that the fit to the stock-recruitment data points represent the long-term productivity of the stock. Results from these Tier 1 calculations indicate that the harmonic mean of the F_{MSY} estimate is very close to the geometric mean value of the F_{MSY} estimate due to the low variability in the parameter estimates. This result indicates that the estimates of F_{MSY} are obtained with very little uncertainty. To better understand how uncertainty in certain parameter estimates affects the Tier 1 harvest policy calculations for northern rock sole, the following analysis was undertaken. Selectivity, catchability, natural mortality and recruitment variability (R sigma) were selected as important parameters whose uncertainty may directly affect the pdf of the estimate of F_{MSY}. Twelve different model configurations were chosen to illustrate the effect of a range of uncertainly in these individual parameter estimates (0.4 and 0.9 for M and 0.8, 1.0, 1.2 and 1.4 for R sigma) and how they affect the estimate of the harmonic mean of F_{MSY}.

Results indicated that increases in recruitment variability would have the largest effect on the pdf of the estimate of $F_{MSY,}$ whereas the uncertainty in the other parameters had little effect.

Since northern rock sole qualify as a Tier 1 stock, the 2009 assessment was calculated using Tier 1 methodology. Using the 1978-2002 spawner-recruit data set for the Tier 1 harvest recommendation, the Tier 1 2010 ABC harvest recommendation is 239,900 t (F_{ABC} = 0.153) and a 2010 OFL of 243,400 t ($F_{OFL} = F_{MSY}$ = 0.155). The northern rock sole harvest is from a stable fishery that lightly exploits the stock because it is constrained by prohibited species catch limits and the BSAI optimum yield limit. Model projections indicate that this stock is neither overfished nor approaching an overfished condition. Usually the fishery only takes a small portion of the northern rock sole ABC, but there will be more room in cap this year because the pollock ABC is lower.

Flathead sole

The latest assessment updated the previous by incorporating new catch, discard, survey biomass, length composition, and age composition data. The 2009 fishery length composition, and age compositions from the 2006 and 2007 fisheries, based on observer data, were new to the assessment in 2009. Mean bottom temperatures were also updated. The 2009 trawl survey biomass estimate of 418,800 t was only 77% of the 2008 estimate of 545,500 t. As with yellowfin sole and northern rock sole, the decrease in survey biomass is believed to be correlated with colder bottom water temperatures during the survey in 2009.

The 2009 stock assessment model estimates that the age 3+ biomass decreased from 798,000 t in 2008 to 775,500 t in 2009, a 3% decrease. Similarly, the model estimate of female spawning biomass has declined 1% from 246,000 t in 2008 to 241,500 t in 2009. This is a stock which has been in a slow decline since 1994 when a peak total biomass level of 998,200 t was estimated. The decline has been the result of below average recruitment in over the past decade, although above average recruitment has been observed in recent years.

The SSC has determined that that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, thereby qualifying flathead sole for management under Tier 3. The current values of these reference points are $B_{40\%}$=137,000 t, $F_{40\%}$=0.28, and $F_{35\%}$=0.34. Because projected spawning biomass for 2010 (233,000 t) is above $B_{40\%}$, flathead sole is in sub-tier "a" of Tier 3. The ABCs for 2010 and 2011 are set at the maximum permissible values under Tier 3a, which are 69,200 t and 68,100 t, respectively. The 2010 and 2011 OFLs under Tier 3a are 81,800 t and 72,500 t, respectively.

Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

Alaska plaice

New for the 2009 stock assessment of Alaska plaice was the debut of a two-gender stock assessment model to explicitly model males and females, which exhibit dimorphic growth. The 2009 assessment incorporated the 2009 shelf survey biomass estimate (529,700 t) and the 2009 catch data into the stock assessment model as well as the 2008 survey age composition. The survey biomass estimate was 4% higher in 2009 than in 2008, stable compared to the highly variable survey biomass estimates observed in recent years). The stock is estimated to be at a high and stable level (well above $B_{40\%}$) with relatively stable recruitment since the 1970s combined with recent good recruitment 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 3 of the BSAI Groundfish FMP. The updated point estimates are $B_{40\%}$ = 204,800 t, $F_{40\%}$ = 0.58, and $F_{35\%}$ = 0.77. 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 2010 spawning biomass of 487,500 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2010 were calculated under sub-tier "a" of Tier 3. Projected harvesting at

the $F_{40\%}$ level gives a 2010 ABC of 224,000 t. The OFL was determined from the Tier 3a formula, which gives a 2010 OFL of 278,000 t.
The total estimated biomass of Alaska plaice is at a high level and is increasing. Model projections indicate that this species is neither overfished nor approaching an overfished condition. There is not a targeted fishery for this species as there is presently no market. The total exploitation rate is quite low for Alaska plaice as it is caught only as bycatch and is mostly discarded.

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 2009. Because of insufficient information about these species, no model analyses are possible. The latest assessment incorporates 2009 total catch and discard and 2009 trawl survey information. The 2009 EBS bottom trawl survey resulted in biomass estimates of 103,600 t, about the same as the 2008 estimate. The biomass of these species in the Aleutian Islands is 16,400 t from the 2006 survey, the highest observed since surveys began in 1983.

Due to the amount of information available, "other flatfish" are classified as a Tier 5 species complex with natural mortality rates as described below. Projected harvesting at the 0.75 M level, gives a 2010 ABC of 17,300 t for the "other flatfish" species. The corresponding 2010 OFL is 23,000 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.

Species-specific natural mortality rates are used to calculate ABC for the species in this complex, where they are available. Estimates of M for the GOA were used for Dover sole (0.085) and rex sole (0.17). All other species were assigned an M of 0.20. Starry flounder natural mortality estimates were examined (male M = 0.45, female M = 0.30), but are available only from the west coast stock assessment and may not be valid for Bering Sea starry flounder, so they are not being used 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 the disproportionate amount of butter sole caught in the fishery relative to the survey, 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.

Greenland turbot
This year's Greenland turbot assessment model included updated 2008 and 2009 catch data, EBS shelf survey 2009 biomass and length composition estimates, and aggregated longline survey data index for the EBS and Aleutian Islands regions through 2008. The 2009 EBS shelf trawl survey biomass estimate of 11,000 t was down by about 19% from the 2008 estimate and estimates from the last three years average about 68% of the long-term mean value from this survey. The 2008 EBS slope trawl survey biomass estimate was 17,900 t compared to the next

most recent (2004) estimate of 36,600 t. Most of this difference was attributed to the lack of Greenland turbot found in the 400-600 m depth strata compared to the other years.

In contrast to last year when Stock Synthesis 2 was used, this year the updated Stock Synthesis 3 (SS3) was used for modeling the Greenland turbot population.

The projected 2010 female spawning biomass is 40,000 t. Compared to the 2009 spawning biomass of 44,900 t this represents a decrease, consistent with the general decline prevalent since the mid 1970s. Recruitment appears to have improved somewhat in recent years, particularly the 2008 year class.

The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock. Greenland turbot therefore qualifies for management under Tier 3.

There was discussion about the large differences in model-estimated time series of Age 1+ biomass between the previous and current year's assessments, which used SS2 and SS3 respectively. These differences, along with variation in fishery- and sex-specific selectivities, contributed to uncertainties in interpreting the results of the model. Because of these uncertainties and the inability to differentiate the influence of factors such as the varying sex specific selectivities and the use of the SS3 (vs. SS2) model itself, the team discussed the merits of using the ABC results of the current model vs. using results from last year's model and rolling over the ABC from last year or using the projected 2010 ABC from last year's assessment.

There was also some discussion about the merits of using results of the current model or going with a Tier 5 designation. The Team decided to accept the current model results and recommend the maximum permissible ABC from this year's model, abandoning the stair-step approach recommended last year.

Accordingly, updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 24,300 t, 0.26, and 0.32, respectively. Projected spawning biomass for 2010 is 40,000 t, placing Greenland turbot in sub-tier "a" of Tier 3. The maximum permissible value of F_{ABC} under this tier translates into a maximum permissible ABC of 6,120 t for 2010 and 5,370 t for 2011. In keeping with past management, the ABC was apportioned on the basis of 69% EBS and 31% AI. The OFLs for 2010 and 2011 under the Tier 3a formula are 7,460 t and 6,860 t, respectively.

To address lack-of-fit issues, the newest version of the SS software was used and attempts were made to improve fits to all data. However, shifts in Greenland turbot sex-ratios within surveys and between fisheries made fitting the data very difficult. The slope survey is critical because it covers the habitat range of Greenland turbot and, unlike the longline survey, the results are not potentially compromised by killer whale depredation. In the event that the slope trawl survey is cancelled, future ABCs would likely be reduced because of increased uncertainty. Because a significant component of the population occurs in the Aleutian Islands, regular surveys of that region would also be beneficial.

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. All shelf, slope and Aleutian Islands trawl surveys biomass and size compositions are included into the assessment model. This year's EBS shelf bottom trawl survey resulted in a biomass estimate of 453,560 t, a 22% decrease from the 2008 survey. The 2008 slope survey biomass estimate was 96,200 t, by far the highest biomass ever reported on the slope. The 2006 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 0.35. With the stock assessment model configured in this way, the population biomass was estimated at 1,086,200 t.

The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, arrowtooth flounder was assessed for management under Tier 3. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 296,800 t, 0.24, and 0.29, respectively. Given that the projected 2010 spawning biomass of 807,100 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2010 were calculated under sub-tier "a" of Tier 3. The recommended 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 2010 ABC of 156,000 t. The OFL fishing mortality rate under Tier 3a is $F_{35\%}$ (0.29), which translates to a 2010 OFL of 191,000 t.
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.

GULF OF ALASKA

Arrowtooth flounder
The 2009 survey biomass and length data, catch for 2008 and 2009, 2007 and 2008 fishery length data were added to the model. The estimated age 3+ biomass from the model increased

by an order of magnitude since 1961 and peaked at about 2.2 million t in 2006. Since then the stock has stabilized. Female spawning biomass in 2009 was estimated at 1,252,550 t, a 4% decline from the projected biomass from the 2007 assessment. The results of the 2009 GOA survey indicate that arrowtooth flounder are still the highest biomass groundfish species and remain lightly harvested.

Survey abundance estimates were low in the 1960's and 1970's, increasing from about 146,000 t in the early 1970's to about 2,822,830 t in 2003. Survey biomass declined to 1,899,778 t in 2005 and in 2009 declined to 1,772,029 t from the 2007 estimate of 1,939,055 t.

Arrowtooth flounder has been determined to fall under Tier 3a. The 2010 ABC using *F40%*=0.183 is 215,882 t, which is 5,630 t less than the 2009 ABC. The 2010 OFL using *F35%* (0.219) is 254,271 t. The 2011 ABC and OFL were projected by setting 2010 catches equivalent to the average 5 year F (0.0206).

The recommended ABC for arrowtooth flounder in 2010 is equivalent to the maximum permissible ABC. The stock is not overfished nor approaching an overfished condition. Catch levels for this stock remain below the TAC and below levels where overfishing would be a concern.

Area apportionments of arrowtooth flounder ABCs for 2010 and 2011 are based on the fraction of the 2009 survey biomass in each area. The new ABC recommendation for 2010 is slightly lower than that recommended for 2009 using last year's full assessment model (269,237 t). The ABC is apportioned in proportion to the survey biomass results, by area.

Gulf of Alaska flatfish

The shallow water flatfish complex is made up of northern rock sole, southern rock sole, yellowfin sole, butter sole, starry flounder, English sole, sand sole, Alaska plaice and other minor species. New data for the shallow water flatfish complex from the 2009 assessment included final total catch from 2008, current catch for 2009 and the 2009 NMFS bottom-trawl survey biomass estimates.

Stock status for shallow water flatfish is based on the NMFS bottom trawl survey (triennial from 1984 to 1999 and biennial from 1999 to 2009). Survey abundance estimates for the shallow-water complex were lower in 2009 compared to 2007; decreasing by 37,630 t. By species, abundance estimates increased between 2007 and 2009 for southern rock sole and English sole, while all other species in the complex (northern rock sole, yellowfin sole, butter sole, starry flounder, sand sole and Alaska plaice) showed decreases in abundance.

Northern and southern rock sole are managed in Tier 4 while other shallow water flatfish are in Tier 5, since maturity data are not available. The F_{ABC} and F_{OFL} values for southern rock sole were estimated as:
$F_{40\%}$=0.162 and $F_{35\%}$ = 0.192, respectively. For northern rock sole the values are: $F_{40\%}$=0.204 and $F_{35\%}$ =0.245. Other flatfish ABCs were estimated with F_{ABC}=0.75 M and F_{OFL}=M.

The ABC and OFL for 2010 and 2011 shallow-water flatfish are lower than the 2008 and 2009. The GOA Plan Team agrees with authors recommended ABC for the shallow water flatfish complex which was equivalent to maximum permissible ABC. Information is insufficient to determine stock status relative to overfished criteria. Catch levels for this complex remain below the TAC and below levels where overfishing would be a concern.

Flatfish consume a variety of benthic organisms. Fish prey make up a large part of the diet of rock sole adults and possibly sand sole (although the sample size was small for sand sole). Other flatfishes consume mostly polychaetes, crustaceans and mollusks. Area apportionments of shallow water flatfish ABC's (using F40% = FABC) for 2010 and 2011 are based on the fraction of the 2009 survey biomass in each area.

The deep water flatfish complex is comprised of Dover sole, Greenland turbot, and deep sea sole. Catch and trawl survey biomass data for Greenland turbot and deepsea sole are updated for 2009. For Dover sole, the assessment model presented in 2007 is updated with 2008 and 2009 fishery catch and size compositions, 2009 trawl survey biomass, and 1987 and 2007 trawl survey age compositions. Six alternative model configurations exploring selectivity parameterizations are presented, but none outperform the base model.

An age-structured model is used to determine stock status for Dover sole. Dover sole female spawning biomass was relatively flat until 1991 and then declined until 2006. Spawning biomass has been unchanged since 2006. Dover Sole are in Tier 3a while both Greenland turbot and deepsea sole are in Tier 6. The Tier 6 calculation (based on average catch from 1978-1995) for the remaining species in the deep water flatfish complex ABC is 183 t and the OFL is 244 t. These values apply for 2010 and 2011 ABC and OFLs.

For the Dover sole Tier 3a assessment the 2010 ABC using $F_{40\%}$=0.119 is 6,007 and 6,142 t for 2011. The 2010 OFL using $F_{35\%}$=0.149 is 7,436 t and 7,603 t for the 2011 OFL. The recommended 2010 and 2011 ABC's and OFL's for the deep water flatfish complex are equivalent to the maximum permissible ABC. The stock assessment author noted that the 2008 catch of deepsea sole (8 t) exceeded the average catch of deepsea sole for 1978-1995 (6 t). The Plan Team discussed whether biomass data were reliable for application of Tier 5 assessment methods to deepsea sole and Greenland turbot, and requested that the authors include survey CV and M estimates for all species in the complex in the next assessment.

Information is insufficient to determine stock status relative to overfished criteria. Catch levels for this complex remain below the TAC and below levels where overfishing would be a concern.

Area apportionments of deep water flatfish (*excluding Dover sole*) are based on proportions of historical catch. Area apportionments of Dover sole (using *F40%*) are based on the fraction of the 2009 survey biomass in each area.

Flathead sole

Survey biomass decreased from 280,290 t in 2007 to 225,377 t in 2009 (20% decline). Projected female spawning biomass is estimated at 110,387 t for 2010. Two models were presented for this assessment. The base model was an age-structured model that was unchanged from 2007. A new model was presented that estimated selectivity between sexes. The fishery catch and length compositions for 2008 and 2009 were incorporated in the models. The 2007 fishery catch and length compositions were updated. The 2009 GOA groundfish survey biomass estimate and length composition data were added to the model. Survey biomass estimates and length compositions were recalculated for all survey years.

The Plan Team encouraged the author to continue investigating approaches to model selectivity, but recommended using the authors' base model. The Plan Team disagreed with the authors' choice to use the different scaling of male selectivity relative to females. The mechanisms for the resulting differences between the sex-specific survey and fishery selectivities were unclear. The Plan Team also encouraged the author to investigate length based selectivity and examine age data from the fishery. Flathead sole are determined to be in Tier 3a based on the age-structured model. The Team's preferred model gives a 2010 ABC using $F_{40\%}$ (0.406) of 47,422 t which is 958 t higher than the 2009 ABC. The 2010 OFL using $F_{35\%}$ (0.530) is 59,295 t.
The stock is not overfished nor approaching an overfished condition. Catch levels for this stock remain below the TAC and below levels where overfishing would be a concern.

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

10. Walleye pollock

a. Research

Echo Integration-Trawl Surveys

GULF OF ALASKA

Winter echo integration-trawl surveys in the vicinity of Shumagin Islands and Sanak Trough, along the shelf breaks from Sanak Island to Unalaska Island and southeast of Chirikof Island, in the Shelikof Strait area, and Marmot Bay

The MACE Program conducted a winter echo integration-trawl (EIT) survey aboard the NOAA ship *Oscar Dyson*, targeting walleye pollock in the Shumagin Islands, Sanak Trough, and along the shelf break from Sanak Island to Unalaska Island. The Shumagin Islands portion of the survey was conducted 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 18-19 February along transects spaced 2-nmi apart. The shelfbreak was surveyed 19-20 February using a combination of zigzag and 6-nmi apart parallel transects.

In the Shumagin Islands, the densest walleye pollock aggregations were located in Shumagin Trough and off Renshaw Point, although the Renshaw Point quantities were significantly less than detected in earlier surveys. Age-1 (9-15 cm FL) walleye pollock were the dominant age group by numbers in Shumagin Trough and in the mouth of Stepovak Bay. Elsewhere, age-2 (17-24 cm FL), and, to a lesser extent, age-3 fish (25-32 cm FL), were numerically dominant.

The unweighted maturity composition for males longer than 40 cm FL was 0% immature, 33% developing, 48% pre-spawning, 16% spawning, and 2% spent. The maturity composition of females longer than 40 cm was 0% immature, 50% developing, 48% pre-spawning, 1% spawning, and 1% spent. The mean gonado-somatic index (GSI: ovary weight/body weight) for mature pre-spawning females was 0.09. The pollock EIT survey abundance estimate in the Shumagin Islands area was 2.4 billion pollock weighing 63,300 metric tons, based on catch data from 7 trawl hauls and acoustic data from 326 nmi of survey transects.

The densest pollock aggregations in Sanak Trough, which consisted of only adult pollock, were located in the western part of the Trough close to the seafloor and on the shelf to the west of the Trough in dense, on-bottom schools. The unweighted maturity composition for males longer than 40 cm FL was 0% immature, 15% developing, 51% pre-spawning, 23% spawning, and 10% spent. The maturity composition of females longer than 40 cm FL was 0% immature, 13% developing, 54% pre-spawning, 10% spawning, and 23% spent. The large percentage of spent females indicated that the survey timing was late. The average GSI for pre-spawning females was 0.16. The abundance estimate for Sanak Trough of 16 million pollock weighing 31,400 t, based on catch data from 2 trawl hauls and acoustic data from 91 nmi of survey transects, was the second lowest in the time series.

Acoustic backscatter was measured along 134 nmi of survey tracklines along the shelf break from Sanak Island to Unalaska Island. No walleye pollock were observed. Pacific ocean perch were found in low concentrations over bottom depths of 200-300 m from and were caught in the single trawl conducted.

The MACE Program also conducted winter EIT surveys aboard the *Oscar Dyson,* targeting walleye pollock along the shelfbreak southeast of Chirikof Island, in the Shelikof Strait area, and in Marmot Bay. The shelf break was surveyed during 20-22 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 22-28 March along parallel transects spaced 7.5-nmi apart. Marmot Bay was during 29-31 along parallel transects spaced 1- or 2-nmi apart.

Very few walleye pollock were located along the shelf break southeast of Chirikof Island. However, dense Pacific ocean perch acoustic backscattering was detected in this area. The 19 walleye pollock captured in the AWT hauls ranged from 35 to 60 cm FL with a mode of 43 cm FL. None of the walleye pollock were in a spawning or spent condition, but the small sample size prevented further analysis of these data. The abundance estimate for the area from Chirikof Island to the mouth of Barnabas Trough was 600 thousand pollock weighing 400 t, based on catch data from 6 trawl hauls and acoustic data from 145 nmi of survey transects.

In the Shelikof Strait area, the densest walleye pollock aggregations were detected within the Strait proper between Cape Kuliak and Wide Bay. Most walleye pollock were generally located within 50 m of the seafloor over bottom depths exceeding 200 m. Trawl hauls conducted within Shelikof Strait proper contained a mixture of age groups, with age-1 and -2 fish dominating most catches by number. Between the mouth of the Strait and the Semidi Islands, catches were distributed between age 1, age 2, and older fish. Older fish heavily dominated catches at the southernmost end of the survey area between the Semidi Islands and Chirikof Island. The unweighted maturity composition for males longer than 40 cm FL was 0% immature, 45% developing, 44% pre-spawning, 10% spawning, and 1% spent. The maturity composition of females longer than 40 cm FL was 0% immature, 52% developing, 39% pre-spawning, 6% spawning, and 3% 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 47 cm. The average GSI for mature pre-spawning females was 0.13. The pollock abundance estimate for Shelikof Strait was 1.8 billion pollock weighing 266,000 t, based on catch data from 12 trawl hauls and acoustic data from 692 nmi of survey transects.

The densest pollock aggregations in Marmot Bay occurred northwest of Spruce Island in midwater layers between 50 m and 75 m in depth over bottom depths of 100-175 m, with most fish ranging in length from 33 to 42 cm FL. The unweighted maturity composition for males longer than 40 cm FL was 0% immature, 11% developing, 27% mature pre-spawning, 61% spawning, and 1% spent. The maturity composition of females longer than 40 cm FL was 0% immature, 33% developing, 59% pre-spawning, 8% spawning, and 0% spent. 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 42 cm. The average GSI for mature pre-spawning females was 0.14. The abundance estimate for Sanak Trough was 35 million pollock weighing 19,800 t, based on catch data from 4 trawl hauls and acoustic data from 91 nmi of survey transects.

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 *Oscar Dyson* 7-13 March 2009, 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 1,870 nmi^2 of the Central Bering Sea Convention Specific Area.

Most of the adult pollock biomass (86%) was concentrated north of Samalga Pass with a minor component distributed northeast of Umnak Island (14%). Based on catch data from five trawl hauls, the pollock size composition in both regions ranged between 41 cm and 70 cm FL, and was characterized by a dominant mode at about 55 cm FL. The unweighted maturity composition for males was 0% immature, 0% developing, 77% pre-spawning, 22% spawning, and 1% spent. The female maturity composition was 0% immature, less than 1% developing, 97% pre-spawning, 1% spawning, and 1% spent. The average GSI for mature pre-spawning females was 0.17. The pollock abundance estimates for the southeastern Aleutian Basin area were 73 million fish weighing 0.110 million metric tons (t). This was the lowest abundance of fish estimated since these surveys began in 1988.

Summer echo integration-trawl survey on the eastern Bering Sea shelf

The MACE Program conducted an echo integration-trawl (EIT) survey of midwater walleye pollock (*Theragra chalcogramma*) between 9 June and 7 August 2009 aboard the NOAA ship *Oscar Dyson*. The survey design consisted of 31 north-south transects spaced 20 nautical miles (nmi) apart from Port Moller, Alaska across the U.S.-Russia Convention Line to the Cape Navarin area of Russia. The survey's primary objective was to collect 38 kHz echo integration and trawl information to estimate daytime midwater walleye pollock abundance and distribution. Additional survey sampling included conductivity-temperature-depth (CTD) and expendable bathythermograph (XBT) casts to characterize the Bering Sea shelf physical oceanographic environment, and supplemental trawls to improve species identification using multiple frequency techniques. Macrozooplankton and micronekton layers (principally euphausiids) were sampled and a new euphausiid index of abundance was computed from backscatter at 4 frequencies (18, 38, 120, and 200 kHz). Additionally, light level sensors, Simrad ME70 multibeam sonar, and a lowered echosounding system were utilized to measure underwater light levels, characterize the three-dimensional size and shape properties of juvenile fish schools, and to measure fish target strength, respectively. Seabird species abundances were recorded along transects.

Survey results showed that ocean conditions were cold in 2009, as in the previous three years, compared to 2000-2005. About two-thirds of the summed acoustic backscatter at 38 kHz observed during the 2009 survey was attributed to adult or juvenile walleye pollock. The remaining 38 kHz backscatter was attributed to an undifferentiated plankton-fish mixture, or in a few isolated areas, to Pacific ocean perch or unidentified fish. As in 2008, the majority of the pollock biomass in the U.S. Exclusive Economic Zone (EEZ) was located to the west and southwest of St. Matthew Island between the 100 m and 200 m isobaths. Estimated pollock abundance in midwater (between 16 m from the surface and 3 m off bottom) in the U.S. EEZ portion of the Bering Sea shelf was 8.08 billion fish weighing 0.924 million metric tons; in the Russian EEZ, there were 9.7 million fish weighing 0.005 million metric tons (<1% of the total midwater biomass). Of the pollock observed in the region east of 170°W (9.6% of total biomass) most were inside the Steller Sea Lion Conservation Area (SCA) and the predominant length mode was 55 cm. In the U.S. west of 170°W (89.8% of total biomass) modal lengths were 13, 31 and 23 cm, respectively. The percentage of walleye pollock biomass found to the west of 170°W has increased steadily since 2002. In Russia modal lengths were 43, 51, and 29 cm, with proportionally more adults and fewer juveniles than in adjacent U.S. waters.

Preliminary age results using a NMFS bottom trawl survey age-length key indicated that inside the U.S. EEZ, age-1 and -3 fish were dominant numerically (62% and 20%, respectively) and together represented 52% of the total biomass. Walleye pollock ages 4+ totaled only 6% of the population numerically and made up 36% of the total biomass. Analyses of walleye pollock vertical distribution indicated that 93% of adult biomass was within 40 m of the seafloor. Juveniles were found both near the seafloor and higher in the water column; 17% of juvenile biomass was within 50 m of the surface.

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

Epipelagic Trawl Surveys to Determine Abundance of Age-0 Walleye Pollock and Understand Impacts of Climate Change on Bering Sea Ecosystems - ABL

The eastern Bering Sea (EBS) shelf is a highly productive ecosystem, where atmospheric forcing, duration and extent of sea ice cover, and transport through ocean passes in Aleutian Islands dominate the physical processes on the shelf. Inter-annual variability in these processes is believed to influence the distribution, feeding, growth, and recruitment of important fisheries stocks. Physical oceanographic features (e.g. sea surface temperature (SST), fronts, mixed layer depth) and lower trophic level dynamics (e.g. primary production, zooplankton prey availability) also are critical to understanding migration, distribution, and survival of forage fish. Research on the interaction between physical oceanography, plankton, and forage fish such as age-0 walleye pollock (*Theragra chalcogramma*) and juvenile Pacific salmon (*Oncorhynchus spp.*) has been conducted annually by Auke Bay Laboratories Ocean Carrying Capacity (OCC) researchers in 2000–2009, with surveys planned for 2010 and onward. These surveys have been part of an international effort, the Bering-Aleutian Salmon International Survey (BASIS) program. Epipelagic trawl surveys have occurred each year in late summer/early fall (August-October) to assess the abundance and condition of these fish at the end of their early marine growth period and prior to their first winter.

The few large-scale studies of walleye pollock in the Bering Sea have mainly focused on their distribution in relation to sea-ice conditions (Wyllie-Echeverria 1995). In contrast, the BASIS time series on age-0 walleye pollock is presently the only shelf-wide data available during fall in the EBS. This time series provides integrated information on energy density, diet, abundance, and distribution in relation to changing ocean conditions. Such information coupled with an age-0 abundance index provides a unique opportunity to evaluate survival of juvenile walleye pollock relative to the reproductive output estimated from pollock stock assessments. In addition, these data are currently being considered by the North Pacific Fishery Management Council to help reduce the uncertainty in stock assessments for EBS walleye pollock.

Our BASIS results have been used to document the rapidly changing marine conditions in the EBS during the past eight years and provide baselines and analogues for different climate regimes. The EBS SST's underwent large-scale warming from 2002-2005 followed by substantial cooling in 2006-2009. These shifts altered fisheries distributions and have the potential to affect the overall ecology of this region. The extent of winter sea ice and its rate of retreat influences spring bloom dynamics, secondary production, and the spatial extent of the cold-water pool during the summer. Because most fish growth occurs during the summer, the winter and spring climatic forcing along with summer atmospheric and oceanographic conditions will dramatically affect fish distribution and production.

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b. Stock assessments

GULF OF ALASKA

The age-structured model developed using AD Model Builder and used for GOA W/C/WYK Pollock assessments in 1999-2008 is fundamentally unchanged. This year's pollock chapter features the following new data: (1) 2008 total catch and catch at age from the fishery, (2) 2009 biomass and age composition from the Shelikof Strait EIT survey, (3) 2009 biomass and length composition from the NMFS bottom trawl survey, and (4) 2009 biomass and length composition and 2008 age composition from the ADF&G crab/groundfish trawl survey. Model fits to fishery age composition data were good in most years. The fit of Shelikof Strait EIT survey age composition show large residuals at age 2 and age 3 in 2006-2009 due to inconsistencies between the initial estimates of abundance and subsequent information about the magnitude of these year classes. General trends in survey time series fit reasonably well and model fits to survey biomass estimates were similar to previous assessments. The model was unable to fit all the 2009 survey estimates simultaneously. Both the NMFS bottom trawl survey and the ADF&G surveys showed large increases in biomass in 2009, while the Shelikof Strait EIT showed only a slight increase and remains close to historically low levels. For a pollock population to increase by the amount indicated by the NMFS bottom trawl survey, recruitment to the population would have to have been very large, yet available information (including the length information from the NFMS and the ADF&G surveys) does not support recruitment of this magnitude.

The 2009 biomass estimate of Shelikof Strait fish ≥43 cm (a proxy for spawning biomass) increased by 60% from the 2007 estimate, apparently due to above average recruitment to the spawning population. Additional EIT surveys in winter 2009 covered the Shumagin Islands spawning area, Sanak Gully, Chirikof, and Marmot Bay. In comparison to 2008, biomass estimates were higher with the exception of Chirikof, where very few pollock were found. An exploratory survey along the shelf break from Sanak Island west to Unimak Island did not detect significant quantities of pollock. The 2009 ADF&G crab/groundfish survey biomass estimate increased 43% from 2008. The initial estimate 2007 year class is 1.7 times average recruitment, and was abundant in both Shumagin area and Shelikof Strait in the 2008 EIT surveys. Initial estimates of year-class strength are highly uncertain, and there have been several instances recently when an initial estimate of year class size decreased as more information accumulated.

The assessment author chose to use the same model as last year with three elements to make it more precautionary. This model fixed the NMFS bottom trawl survey catchability (q) at 1.0, applied a more conservative harvest rate than the maximum permissible F_{ABC} and set the 2007 year class equal to the average. These conservative elements reduce the recommended ABC to approximately 50% of the model point estimate. However, they seem warranted given the above average estimate of the 2007 year class, inconsistencies in the 2009 survey data, and the continued low spawning biomass in Shelikof Strait and other spawning areas.

The model results produced an estimated 2010 spawning biomass of 184,567 t, or 30% of unfished spawning biomass. The $B_{40\%}$ estimate is 248,000 t. This represents a 4% increase from the 2008 assessment, and reflects both the increase in mean weight at age during spawning and a decrease in average recruitment. Estimates of 2009 stock status indicate that spawning biomass remains low.

Pollock are not overfished nor are they approaching an overfished condition. Catches remain well below levels where overfishing would be a concern. Because model estimated 2010 female spawning biomass is below $B_{40\%}$, the W/C/WYK Gulf of Alaska pollock are in Tier 3b. The Plan Team accepted the author's recommendation to reduce F_{ABC} from the maximum permissible using the "constant buffer" approach (first accepted in the 2001 GOA Pollock assessment) and using an average value for the 2007 year class (the estimate was 70% above average). The projected 2010 age-3+ biomass estimate is 756,550 t (for the W/C/WYK areas). Markov Chain Monte Carlo analysis indicated the probability of the stock being below $B_{20\%}$ will be negligible in all years. Therefore, the ABC for 2010 based on this precautionary model configuration, adjusted harvest control rule, and average 2007 year class is 77,150 t (F_{ABC} = 0.14) for GOA waters west of 140°W longitude. **The ABC is 75,500 for 2010** (reduced by 1,650 t to account for the Prince William Sound GHL). The 2010 OFL under Tier 3b is 103,210 t (F_{OFL}= 0.19). Southeast Alaska pollock are in Tier 5 and the ABC and OFL recommendations are based on natural mortality (0.30) and the biomass from the 2009 survey. The biomass from the 2009 NMFS bottom trawl survey increased to 41,088 t. This results in a **2010 ABC of 9,245 t**, and a **2010 OFL of 12,326 t**.

A presentation was made by the FOCI program at the November Plan Team meeting to assist in evaluating the magnitude of the 2009 year class of pollock in the GOA. This year most of the indices indicated the year class to be "average." The Plan Team felt that the direct observations of pre-recruit pollock have more influence on projection specifications than those derived from indirect observations (e.g., via covariates). For example, juveniles observed in the winter surveys generally provide more reliable estimates of subsequent year-classes. The Team requests that clearer scenarios on the application of the FOCI prediction for actual management be developed since the applicability to near-term management questions appear to be limited. Perhaps FOCI resources would be better applied to predicting medium term productivity changes that can be applied to pollock and other species.

The assessment was updated to include the most recent data available for area apportionments within each season (Appendix C of the GOA pollock chapter). The assessment accounted for results of vessel comparison experiments conducted between the *R/V Miller Freeman* and the *R/V Oscar Dyson* in Shelikof Strait in 2007 and in the Shumagin/Sanak area in 2008 which found significant differences in the OD/MF ratio. The estimated ratio for the Shelikof Strait was 1.132, while the ratio for the Shumagin and Sanak areas (taken together) was 1.31. When calculating the distribution of biomass by area, multipliers were applied to surveys conducted by the *R/V Miller Freeman* to make them comparable to the *R/V Oscar Dyson*. Adding the vessel comparison to the apportionment analysis is a transitional step until all recent surveys are done by the *R/V Oscar Dyson*.

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

EASTERN BERING SEA

New data in this year's assessment include the following:

- Updated total catch for 2008 and a preliminary estimate of the 2009 catch.
- Biomass estimates from the 2009 bottom trawl survey and the 2009 echo-integration trawl (EIT) survey. The estimate from the bottom trawl survey was 2.28 million t, down 25% from the 2008 estimate, and the lowest point in the 1982-2009 time series. The estimate from the EIT survey was 0.924 million t, down 7% from last year's survey, and the lowest point in the 1979-2009 time series.
- Age composition data from the 2009 bottom trawl survey, updated age composition data from the 2008 EIT survey, and preliminary age composition data from the 2009 EIT survey (based on the age-length key from this year's bottom trawl survey, supplemented with 100 otoliths from this year's EIT survey). The 2009 survey age compositions

confirm that the 2006 year class is of above-average strength, though not as strong as estimated previously.

- Age and size composition data and weight-at-age data from the 2008 fishery (in addition, age composition data from the first part of the 2009 fishery were used in sensitivity testing).

Consistent with the estimates produced in last year's assessment, age 3+ biomass of EBS walleye pollock declined steadily from 2003-2008 due to poor recruitment from the 2002-2005 year classes, with the age 3+ biomass for 2008 estimated to be the lowest in the time series since 1980 (one change from last year's assessment is that the 2001 year class, formerly estimated to be below average, is now estimated to be average). Spawning biomass is estimated to be 29% below *BMSY* in 2009. The 2006 year class is reliably estimated to be above average, however, so spawning biomass is projected to increase in the near future (15% below *BMSY* in 2010 and near *BMSY* by 2012, if the stock is fished at the maximum permissible ABC).

Updated analyses of survey and fishery data show a less optimistic increase compared to predictions from the 2008 assessment. While the form of the model remained the same, an improved method for projecting future weight at age was developed and accepted for application. The age-3 and older biomass has been declining since 2003, and the 2010 biomass is the lowest since 1980. Spawning biomass has been declining since 2004, but the current assessment indicates that 2009 should be a turning point, and the 2010 spawning biomass should increase by about 13%. The spawning biomass is projected to be near B_{msy} by 2012.

Walleye pollock in the eastern Bering Sea typically have been monitored with regular annual bottom trawl and biennial acoustic surveys. However, 2009 marked the fourth consecutive year that both surveys were conducted. The results of the 2009 bottom trawl survey suggested that pollock abundance was slightly higher than expectations (but was lower than the 2008 value). However, the acoustic survey data indicated that pollock abundance was lower than expected based on expectations from the 2008 assessment. Combining these results and recent fishery observer information in an integrated analysis indicated that a lower catch limit of 813,000 t for 2010 was appropriate given the new information. (Previous analysis indicated that the stock and management control rule would be above 1.0 million t for 2010.)

The updated estimate of B_{MSY} from the present assessment is 1.86 million t, compared to 1.92 million t from last year's assessment. Projected spawning biomass for 2010 is 1.32 million t, placing EBS walleye pollock in sub-tier "b" of Tier 1. As in recent assessments, the maximum permissible ABC harvest rate was based on the ratio between MSY and the equilibrium biomass corresponding to MSY. The harmonic mean of this ratio from the present assessment is 0.373, up from last year's value of 0.332.

The harvest ratio of 0.373 is scaled according to the Tier 1b formula and then multiplied by the geometric mean of the projected fishable biomass for 2010 (3.152 million t) to obtain the maximum permissible ABC for 2010, which is 813,000 t. This ABC is 88% higher than the 2010 yield of 433,000 t that would correspond to a Tier 3b strategy based on a $B_{40\%}$ value of 2.35 million t.

The OFL harvest ratio under Tier 1a is 0.421, the arithmetic mean of the ratio between MSY and the equilibrium fishable biomass corresponding to MSY. The product of this ratio, rescaled according to the Tier 1b formula, and the geometric mean of the projected fishable biomass for 2010 gives the OFL for 2010, which is 918,000 t. The current projection for OFL in 2011 given a 2010 catch of 813,000 t is 1.22 million t. The walleye pollock stock in the EBS is not overfished and is not approaching an overfished condition.

The Council reviewed and discussed the assessment prepared by AFSC scientists at the December meeting and was satisfied that the updated information and downward revision of the ABC was appropriate.

The prognosis for 2010 and beyond is for improved stock levels because the 2006 year class remains above average, and early indications are that the 2008 year class may also be high (based on the acoustic survey). While survey data continue to play a critical role for advising fisheries management, the Bering Sea Integrated Ecosystem Research Program (BSIERP) continues and is due to complete fieldwork in late 2010. This project is multifaceted and an important component will serve to evaluate current management practices in light of new information on ecosystem processes.

ALEUTIAN ISLANDS

There were no new data for this assessment, and the last Aleutian Islands survey was in 2006. The stock is estimated to be near $B_{30\%}$.

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11. Dogfish and Other Sharks

a. Research

Spiny Dogfish Ecology and Migration

Spiny dogfish are a long-lived, slow-growing species. Data collected from 2004-2007 in cooperation with the AFSC Sablefish Longline Survey, the Alaska Observer Program, the Alaska Department of Fish and Game, and the University of Alaska Fairbanks were examined to determine the growth, age structure, demographic characteristics, and ecology of the species in the Gulf of Alaska. Results suggest that spiny dogfish are among the slowest growing species of shark and grow to a larger size, older age, and mature later in the Gulf of Alaska than other regions in which they occur. Demographic analyses also suggest that the species has a low rate of natural mortality and fecundity, which combined with the age assessment suggest that the species can only tolerate a low level of fishing mortality. Diet analysis revealed that spiny dogfish feed primarily on shrimp and squid, but are also have a generalized diet and are opportunistic feeders. Spiny dogfish tend to feed on small fish and invertebrates when young and incorporate larger prey items as they grow, which is reflected in an increasing trophic level as the fish grows.

Scientists at the Auke Bay Laboratories have begun an annual tagging program for spiny dogfish including both numerical Peterson disk tags and pop-off archival tags. Eighty numeric tags and fifteen pop-off tags were deployed in Yakutat Bay in the summer of 2009, and four of the latter tags have transmitted data to date. Data from the four pop-off tags, which include temperature, depth, and geographic location, are still being analyzed.

b. Stock assessments

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

Sharks in Alaskan Waters

The shark assessment chapters from 2008 for the Bering Sea/Aleutian Islands (BSAI) and for Gulf of Alaska (GOA) were updated for the 2010 fishing year and presented to the North Pacific Fishery Management Council's Groundfish Plan Teams in November 2009.

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 1997–2007 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 2009 Eastern Bering Sea (EBS) shelf. Previous survey data were available from NMFS AFSC bottom trawl surveys in the EBS shelf (1979–2009), EBS slope (historical 1979-1991, and new time series 2002, 2004, 2008), and Aleutian Islands (1980–2006). Previous trawl survey data were available from NMFS AFSC bottom trawl surveys conducted triennially and biennially in the GOA (1984–2009).

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. Catch estimates from 2003-2009 were updated from the AKRO's Catch Accounting System. In the BSAI, average incidental catch of Pacific sleeper sharks from 1997–2007 (598 mt) represented 11.6% of the available Pacific sleeper shark biomass from BSAI bottom trawl surveys in 1996–2007 (total of the average biomass from three surveys was 5,168 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, 2004 and 2008) showed a substantial biomass of Pacific sleeper sharks on the EBS slope in 2002 (25,445 mt) but not in 2004 (2,260 mt) or 2008 (2,037 mt). The EBS shelf survey did not encounter sharks in 2007 or 2008 and the biomass estimates were zero, but the EBS slope survey did encounter sharks in 2008 (2,051 mt). In 2009 only spiny dogfish were encountered on the shelf survey and biomass was estimated at 72 mt. 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 1997–2007 (703 mt) represented 1% of the available spiny dogfish biomass from GOA bottom trawl surveys in 1996–2007 (average biomass of spiny dogfish in the surveys was 66,771 mt over the same years). The 2001 survey did not include 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 1997–2007 (316 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 37,821 mt). Average bycatch of salmon sharks from 1997–2007 (64 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 1996–2007.

Catch in unobserved fisheries is a major concern for shark species, in particular the halibut IFQ fisheries. A working group has been convened, headed by staff at the Auke Bay Laboratories and including staff from ADF&G, AFSC, and IPHC to address this issue. Results are expected to be presented in 2010 to the November Groundfish Plan Team and December Science and Statistical Committee meetings of the North Pacific Fishery Management Council.

For more information, contact Cindy Tribuzio at (907) 789-6007, cindy.tribuzio@noaa.gov.

Salmon shark life history

Sharks in Alaska waters are currently managed as a part of the 'Other Species' group by the North Pacific Fishery Management Council. Shark catches within the Gulf of Alaska (GOA) are dominated by three species, the spiny dogfish, *Squalus acanthias*, the Pacific sleeper shark, *Somniosus pacificus*, and the salmon shark, *Lamna ditropis*. While not the target of commercial fisheries, salmon sharks are captured by recreational fishers and as bycatch in several fisheries within the GOA. The stock assessment and management of this species is hindered by a lack of life history data to input into models. Parameters needed to support stock assessment include reproductive timing and periodicity, fecundity, and improved age and length at maturity estimates. The life history of this species is being examined by researchers at the Kodiak Laboratory. Salmon sharks captured incidentally in other fisheries are being collected and dissected to examine: length at maturity, fecundity, reproductive periodicity, age and growth, and diet. Eight salmon sharks have been collected to date and it is anticipated more salmon sharks will be examined in the upcoming fall pollock fisheries.

For further information please contact Dr. Christina Conrath (907) 481-1732.

14. Other Species

a. Research

Octopus life history – RACE Groundfish Kodiak/REFM collaboration

Initial stock assessments of octopus within the Gulf of Alaska have revealed that there is little life history information available for this group. RACE biologists at the Kodiak Laboratory in collaboration with REFM biologists in Seattle initiated a life history study of Giant Pacific Octopus during 2009. This study will co-occur with gear experimentation studies to examine the feasibility of an octopus fishery. During the fall pod cod fishery, 25 giant pacific octopus specimens were obtained. The condition of the reproductive tract was assessed and samples were preserved for future histological analysis. In addition structures for aging (beak, statolith, and stylet) were dissected out and preserved. Pictures were taken of the reproductive structures to be utilized in a guide to identifying the reproductive stage of octopus in the future. Additional octopus samples will be collected during spring and fall charters that will occur during April 2010 and during September and October 2010.

For more information, contact Dr. Christina Conrath, (907)481-1732.

15. Grenadiers

b. Stock Assessment

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

Grenadiers in Alaska
In 2009, a brief Executive Summary assessment was done for grenadiers in Alaska and incorporated as an appendix to the North Pacific Fishery Management Council's (NPFMC) annual Stock Assessment and Fishery Evaluation Report. The Executive Summary provided an update to the full assessment for grenadiers done in 2008 and presented new survey information and updated catches for 2009. Giant grenadier (*Albatrossia pectoralis*) is by far the most abundant grenadier in Alaska at depths <1,000 m, is the major bycatch species in directed fisheries for sablefish and Greenland turbot, and is the only grenadier species to warrant management concern in Alaska at present. Therefore, the assessments have been based on giant grenadier serving as a proxy for entire grenadier group. For the 2009 update, revised biomass estimates for giant grenadier were computed that included new longline survey and trawl survey data from 2009. These estimates are: eastern Bering Sea (EBS), 518,778 mt; Aleutian Islands (AI), 1,027,637 mt; and Gulf of Alaska (GOA), 597,884 mt. Similar to the 2008 full assessment, we applied an F=M=0.078 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, 30,349 mt; AI, 60,117 mt, and GOA, 34,976 mt. When these values are compared with the estimated catches of giant grenadier, it appears that giant grenadier are not being overfished at this time. However, the reported longevity, slow growth, and deep-sea habitat of this species make it susceptible to overfishing. 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.

The NPFMC for many years has categorized grenadiers as "not specified" (i.e. not included) in its Groundfish Management Plans. This means there are no regulations concerning grenadiers in Alaska, and fishermen have been free to catch as many as they want. Because of this "not specified" status, our recent assessments for grenadiers in Alaska and recommendations of OFLs and ABCs have not been official and are not binding. However, in response to NMFS guidelines developed to comply with the reauthorized version of the Magnuson-Stevens Fishery Conservation and Management Act, we recommended in 2009 that grenadiers be re-classified as "in the fishery", in which case an official assessment would be required. It is likely that a future

NPFMC amendment to the Groundfish Management Plans will change the management status of grenadiers in Alaska.

For more information, contact Dave Clausen at (907) 789-6049, dave.clausen@noaa.gov.

D. Other Related Studies

Recovery of Deep-Water Sponges and Sea Whips from Bottom Trawling

Deep-water habitat-forming biota is sensitive to anthropogenic disturbance. Interactions between bottom trawls and seafloor habitat have been the focus of much research in recent years. The relative effect of bottom trawls on benthic habitat depends on many factors including gear configuration, the geological characteristics of the seafloor, depth, and sensitivity of the habitat-forming species present. Stable deep-water habitats experience low levels of natural disturbance, are more susceptible to trawl effects, and recover more slowly than shallow-water habitats. The response of sessile benthic epifauna to trawl disturbance varies among taxa. In the short-term, deep-water sponges and anthozoans (corals, anemones, sea whips) are particularly sensitive to trawl disturbances. Little is known, however, about the long-term effects of trawl-induced damage to these important deep-water habitat-forming invertebrates. The objective of this study is to document moderate to long term recovery of deep-water sponges and sea whips following disturbance from fishing gear. Results from this study will resolve questions about the persistence of damage in the benthic ecosystem and could reduce the uncertainty of parameter estimates used within the Fujioka (2006) habitat impacts model. Improved accuracy of model output will provide fishery managers greater insight when evaluating fishery impacts and will aid in decision-making when contemplating habitat conservation measures, such as area closures.

In 1996, Freese et al. (1999) used a bottom trawl equipped with “tire gear” to examine short-term effects of trawling on benthic invertebrates in the Gulf of Alaska. This gear was similar to that used in the commercial rockfish *Sebastes* spp. trawl fishery. Eight trawls were made southwest of Salisbury Sound in southeast Alaska in an area where zero or minimal trawling occurred since the 1970s. In 1998, the area was officially closed to trawling. Based on video data collected through direct observations with the *Delta* submersible, Freese et al. (1999) found a significant decrease in density and an increase in damage to sponges (tentatively identified as the demosponges *Esperiopsis* sp., *Mycale* sp., and *Geodia* sp.) and sea whips (tentatively identified as *Stylea* sp.) in trawled versus reference sites. About 70% of large sponges and 55% of sea whips were damaged by a single trawl pass. In a follow up study one year post-trawl, no new colonization or evidence of repair or regrowth of sponges occurred (Freese 2001).

In 2009, the site was revisited to examine recovery dynamics of sponges and sea whips 13 years post trawling. In 1996, Freese et al. marked the trawl paths and submersible transects on the seafloor with flags attached to fiberglass stalks. Thirteen years later, we successfully relocated 12 of 14 markers and completed 7 transects within trawl paths as well as 7 reference transects outside trawl paths. These data will be used to compare sponge and sea whip disposition in trawled versus reference areas. Additionally, we obtained close-up video of individual sponges both inside and outside the trawl paths to further examine the incidence of injury and the rate of recovery of damaged sponges. In total, we completed 16 dives with the *Delta* submersible. In some areas, trawl evidence, including seafloor gouging, boulder displacement, and sponge damage, was still apparent. The original flags were no longer attached to their fiberglass stalks and the stalks were easily confused with sea whips. In order to facilitate the potential for continued monitoring of seafloor recovery, we deployed new markers that should be easier to find and more durable than the originals. Preliminary processing of the video transects was completed during the winter and spring of 2009/2010. Cursory data analyses revealed that the abundance of sponges was lower and the incidence of damaged sponges within trawled transects was higher than within the reference transects. Species composition also differed between trawl and reference transects.

For more information, contact Pat Malecha at (907) 789-6415 or pat.malecha@noaa.gov.

Recruitment and Response to Damage of an Alaskan Gorgonian Coral

Benthic habitats in deep-water environments experience low levels of natural disturbance and recover slower than shallow-water habitats. Deep-water corals are particularly sensitive to disturbance from fishing gear in part because they are long-lived, grow slowly, and are believed to have low rates of reproduction. Limited data exist that detail recruitment and recovery of deep-water corals. This information is key to understanding long-term effects of anthropogenic disturbances, such as commercial fishing, on the population dynamics of benthic habitat. The research described here will determine recruitment and recovery rates of the gorgonian coral *Calcigorgia spiculifera,* a species distributed broadly in the Gulf of Alaska and along the Aleutian Islands at depths that range from 18 to at least 329 m. *Calcigorgia spiculifera*, as well as many other gorgonian corals, is found in areas and depths that coincide with trawl and longline fisheries and is often damaged. The bauplan of *C. spiculifera* is similar to many other gorgonian corals commonly found throughout the North Pacific Ocean including *Fanellia* spp., *Plumarella* spp., and *Thouarella* spp. Therefore, sensitivity to disturbance, rate of recovery, and recruitment of *C. spiculifera* is likely to be similar to other gorgonian species and thus results from this research could be applied broadly. Recovery rate and recruitment data are lacking in the Fujioka (2006) habitat impacts model. Reduced uncertainty of model parameters will improve model predictions and will help guide fisheries managers in making decisions regarding benthic habitat conservation measures, including area closures. This research will assess the sensitivity and recovery of a deep-water coral, and it will provide necessary data to validate and improve the output of the Fujioka (2006) habitat impacts model.

In August 2009, a team of four divers located and tagged 48 *Calcigorgia spiculifera* colonies in Kelp Bay, southeast Alaska. Of that total, 9 colonies were fitted with settlement rings equipped with natural rock tiles. The settlement rings were epoxied to the seafloor and on future site visits, a subsample of the tiles will be collected and inspected for adhesion of coral planulae, i.e., recruitment. The remaining 39 tagged colonies were ascribed to three damage treatment groups and a control group to assess the sensitivity and recovery of disturbed coral. The damage treatments were designed to mimic actual damage that can occur from passing fishing gear. These treatments were performed *in situ* and included deflection, gorgonian excision, and branch severance. Video of each colony was recorded before and after the treatments were performed to establish baseline coral characteristics and to identify immediate treatment effects. The deflection treatment was completed by passing a simulated trawl footrope over each colony.

This resulted in immediate dislodgement of one coral colony. Subsequent monitoring of the damaged corals will detail the long-term effects of disturbance. This is a multi-year study that requires additional site visits and observations. Field operations are scheduled for June and September 2010 and additional site visits in 2011 and beyond if necessary.

For more information, contact Pat Malecha at (907) 789-6415 or pat.malecha@noaa.gov.

Nearshore Fish Assemblages in the Chukchi Sea near Barrow, Alaska

The Arctic is changing rapidly and information on fish populations is necessary to make informed management decisions regarding potential effects from development (e.g., oil and gas) and global climate change. This is especially true in shallow, nearshore habitats that are often ignored in fisheries surveys. To establish long-term monitoring sites and with support from Alaska's North Slope Borough, we sampled nearshore fish assemblages at six sites in the Chukchi Sea in August 2007, 2008, and 2009, and September 2009. At each site, fish were captured with two gear types: a beach seine in waters <5 m deep and a small bottom trawl at two depths (5 m and 8 m). A total of 15,030 fish representing 20 species were captured in 24 beach seine hauls, and 3,221 fish representing 23 species were captured in 48 trawl tows. Species composition differed by gear type, among years, and within 2009. Total beach seine catch was dominated by capelin (82%), and total trawl catch was dominated by Arctic cod (56%). Among years for both gear types (August only), capelin accounted for 96%, 4% and 27% of the total catch, whereas Arctic cod accounted for <1%, 46%, and <1% of the total catch. In 2009, total catch and species richness was greater in September (7,861 fish, 20 species) than in August (2,633 fish, 13 species). In addition to capelin and Arctic cod, other forage fish and subsistence species that we captured were Pacific sand lance, saffron cod, and rainbow smelt. Annual variability in catch and species composition can likely be attributed to different environmental conditions. For example, Arctic cod dominated the total catch only in 2008; this was the coldest year that we sampled (water temperatures <2.0° C and ice persisted until mid-August). The shallow, nearshore environment of the Chukchi Sea provides important habitat for many fish species and is extremely vulnerable to disturbance. Because changes in community structure are expected from continued warming and loss of sea ice in the Arctic, with unknown consequences to existing stocks and food webs, long-term monitoring of nearshore fish assemblages is warranted.

For more information, contact Scott Johnson at (907) 789-6063, scott.johnson@noaa.gov.

Bycatch Studies – RACE Conservation Engineering

Salmon Excluders

Two cruises were conducted under exempted fishing permits, in March and August of 2009, to test improved excluder devices. Due to concerns over clogging in the excluders, the versions tested in 2009 used a panel that blocks escape portals during regular towing and opens them during scheduled periods of slower towing ("flapper excluders"). Many of these devices are currently being used in the fishery, but the most recent version provided by a major net manufacturer had not been tested for effectiveness. A September 2009 test used that version, which places the excluder just ahead of the codend, further back in the net than previous excluders. NMFS cameras and sonars were provided for both cruises, and we participated in all planning and several outreach workshops. We also partially funded a workshop at the flume tank in St. Johns, Newfoundland for October 2009.

Reduce trawl damage to seafloor invertebrates

In October 2009, the North Pacific Fishery Management Council (NPFMC) recommended implementing regulations requiring modified sweeps for Bering Sea flatfish fisheries. These sweeps were developed over the last five years by a collaboration of RACE Division scientists and the Bering Sea bottom trawl fleet. Work in this area in 2009 focused on providing research results to the NPFMC and other stakeholders as they decide whether to require these trawl sweep modifications for the Bering Sea flatfish fisheries. We also conducted research to explore variations of the sweep modifications that would help fishermen transition to their use. A nine-day research cruise in June tested whether smaller-diameter sweep cables, which would alleviate handling problems associated with the modifications, would still effectively herd flatfish.

Crab Mortalitity Rates After Trawl Encounters

From August 8 - 24, scientists aboard the F/V *Pacific Explorer* from the Conservation Engineering and Shellfish groups of the AFSC's Resource Assessment and Conservation Engineering Division collected data to estimate the mortality rates of red king crab (*Paralithodes camtsactcus*) after passage under the groundgear of commercial bottom trawls. This followed the methods of similar research on Tanner and snow crabs in 2008. Crabs were recaptured after passing under the central and side sections of a trawl footrope, as well as after contacting the sweeps ahead of the trawl. Crabs were also assessed after capture by a similar net fished ahead of the trawl, to estimate and account for the effect of capture and handling. Finally, we evaluated the effectiveness of modifications to sweeps and footrope that were expected to reduce crab mortality. More than 3,700 crabs from 73 trawl hauls were assessed for reflex impairments, while more than 738 were assessed and then held in onboard tanks to establish the association between these impairments and the probability of mortality. This research was primarily supported by a grant from the North Pacific Research Board, with additional support form the NMFS Bycatch Reduction Engineering Program and National Cooperative Research Program.

Industry Video Systems to Speed Fishing Gear Improvements

Five underwater video systems continue to be used by the fishing industry to allow them to directly evaluate their own modifications to fishing gear. These systems saw relatively light use in FY 2009. A principal factor in this reduction is that a number of vessels and fishing companies have acquired their own systems. Apparently, at least some of them found the video provided by NMFS systems useful enough that they wanted the capability available full time.

For more information, contact Dr. Craig Rose at (206)526-4128.

RACE Habitat Research Team

[Section has not been updated for 2010]

For additional information, see http://www.afsc.noaa.gov/RACE/groundfish/hrt/default.php or contact Dr. Bob McConnaughey, (206) 526-4150.

E. Other Items

GIS Resources

Data
Etopo1 (http://www.ngdc.noaa.gov/mgg/global/global.html)
"ETOPO1 is a 1 arc-minute global relief model of Earth's surface that integrates land topography and ocean bathymetry. It was built from numerous global and regional data sets, and is available in "Ice Surface" (top of Antarctic and Greenland ice sheets) and "Bedrock" (base of the ice sheets) versions. Historic ETOPO2v2 and ETOPO5 global relief grids are deprecated but still available."

Large Marine Ecosystems (LME) (http://www.lme.noaa.gov/)
"Large Marine Ecosystems (LMEs) are relatively large areas of ocean space of approximately 200,000 km² or greater, adjacent to the continents in coastal waters where primary productivity is generally higher than in open ocean areas."

Bing Maps and other data for use in Arcview and ArcInfo (http://resources.esri.com/help/9.3/arcgisonline/about/start.htm#map_types.htm#)
"ArcGIS users can access a collection of online basemaps, imagery, and overlays from ESRI. Standard maps are available at no cost to ArcGIS users for internal use or for non-commercial external use. A subscription fee is required for users who wish to publish applications that use ArcGIS Online maps for commercial use."

NOAA's National Geophysical Data Center (NGDC) has been building high-resolution digital elevation models (DEMs) of select U.S. coastal regions. For more information see http://www.ngdc.noaa.gov/dem/ and http://www.ngdc.noaa.gov/mgg/inundation/tsunami/inundation.html.

New GIS Tools
Simple Vector Renderer from Buck Stockhausen (William.Stockhausen@noaa.gov) Plot vector quantities in ArcGIS using the right symbols. The jar file is an Arc Engine extension for ArcGIS Desktop that accounts for geographic transformations and frame rotations. This is still in development, so Buck is interested in any feedback you might have. Also, he would appreciate an acknowledgment on any figures you produce using it.

Hawth's Analysis Tools for ArcGIS is now changing to Geospatial Modeling Environment (GME) and is available at http://www.spatialecology.com/gme/. "The Geospatial Modeling Environment (GME) is a platform designed to help to facilitate rigorous spatial analysis and modeling. GME provides you with a suite of analysis and modeling tools, ranging from small 'building blocks' that you can use to construct a sophisticated work-flow, to completely self-contained analysis programs. It also uses the extraordinarily powerful open source software R as the statistical engine to drive some of the analysis tools. One of the many strengths of R is that it is open source, completely transparent and well documented: important characteristics for any scientific analytical software. GME has dependencies on three other software packages: R, StatConn, and ArcGIS."

Software
ESRI's Arcview and ArcInfo version 10 is arriving in June. Some of the major enhancements include a new search engine for documentation, the ability to check out licenses, a time slider that enables one to step through time enabled layers, and automate map production with Python and map books. For additional information see http://www.esri.com/software/arcgis/whats-new/new-features.html.

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

APPENDIX I - Alaska Fisheries Science Center Groundfish-Related Publications and Documents In Press – January 2009 through April 2010
(AFSC authors in bold text)

Alaska Fisheries Science Center (AFSC) Peer-Reviewed Journal Reports and Technical Memoranda in 2009 (AFSC authors are in bold).

Note: Listings of 2009 Groundfish Stock Assessment Reports and AFSC Processed Reports are accessible by following the links provided below to the appropriate AFSC web page.

ADAMS, C. F., **R. J. FOY**, J. J. KELLEY, and K. O. COYLE.
2009. Seasonal changes in the diel vertical migration of walleye pollock (*Theragra chalcogramma*) in the northern Gulf of Alaska. Environ. Biol. Fishes 86:297-305.

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2009. Systematic review of the genus *Bothrocara* Bean 1890 (Teleostei: Zoarcidae). Ichthyol. Res. 56:172–194.

ANDREWS, **A. G.**, and **R. J. FOY**.
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Submitted. Growth and natural mortality of dark rockfish, *Sebastes ciliatus* (Tilesius, 1813), in the western Gulf of Alaska. Marine and Coastal Fisheries: Dynamics, Management and Ecosystem science.

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(in press) Silent ships sometimes do encounter more fish. 1) Vessel comparisons during winter pollock surveys. ICES Journal of Marine Science. doi:10.1093/icesjms/fsp299

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M. Ottmar
C. Ryer
M. Spencer
C. Sweitzer
R. Titgen

Research Fishing Gear
D. King*

B. Baker
S. Borrego
Vice - Harrington
A. Harvison
S. McKillip
J. Smart

RACE/REFM/FMA Admin. Support Group
D. Cocking*

L. Anderson
Vice - Dear
J. Finley
E. McQueen
Vice - Bush
S. Oliver
J. Stebbins

Research Associates
K. Bahl - JISAO
D. Bidder - contractor/Kodiak
M. Doyle - JISAO
J. Horne - UW
M. Kookish - contractor/Seattle
LT (jg) Lomnicky (NOAA Corps)
S. Schneider - contractor/Seattle

*Program Manager
**Project Leader
S student

April 2008

REFM DIVISION ORGANIZATION CHART

(as of December 16, 2008)

Division Directorate
P. Livingston
(Division Director)

Deputy Director
D. Ito
(NEPA/FOIA Coordinator)

International Coordinator (AFSC & AKR)
L. Low

REFM/RACE/FMA Support
D. Cocking -- Supervisor
L. Anderson
E. McQueen
D. Muldoon
J. Stebbins

Property Management
B. Goiney

IT Staff
S. Wennberg
M. Blaisdell

Fisheries Interactions Team
L. Logerwell -- Supervisor
L. Conners
S. McDermott
P. Munro
S. Neidetcher
K. Rand

Contractors and Students
J. Nielsen

Status of Stocks and Multispecies Assessment
A. Hollowed -- Program Manager
S. Barbeaux
M. Dorn
A. Greig
J. Ianelli
S. Lowe
O. Ormseth
J. Pearce
R. Reuter
P. Spencer
W. Stockhausen
G. Thompson
J. Turnock
T. Wilderbuer

Contractors and Students
T. A'mar
L. Arnold
N. Bacheler
B. Black
J. Murphy
H. Shen
C. Spital
K. Thompson

Resource Ecology and Ecosystems Modeling
K. Aydin -- Program Manager
T. Buckley
S. Fitzgerald
S. Giachas
G. Lang
T. TenBrink
M. Yang

Contractors and Students
J. Boldt
R. Hibpshman
I. Ortiz
A. Whitehouse
S. Zador

Age and Growth
D. Kimura -- Program Manager
C. Kastelle
J. Short
C. Hutchinson
D. Anderl -- Project Leader
J. Brogan
C. Johnston
B. Matta
B. Goetz -- Project Leader
I. Benson
C. Gburski
C. Piston

Economics and Social Sciences Research
R. Felthoven -- Program Manager
M. Dalton
B. Garber-Yonts
A. Haynie
T. Hiatt
D. Lew
J. Sepez
C. Seung

Contractors and Students
H. Lazrus
J. Lee
D. Poljak

Visiting Scientists
C. I. Zhang
B. D. Yoon

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	Rockfish, Sablefish, Stock Assessment, Effects of Fishing
John Karinen	Gulf of Alaska Groundfish
Mitch Lorenz	Essential Fish Habitat
Chris Lunsford	Rockfish, Sablefish, Stock Assessment, Longline Survey
Pat Malecha	Groundfish Ecology, Effects of Fishing
Cara Rodgveller	Sablefish, Rockfish, Longline Survey, Grenadiers
Tom Rutecki	Sablefish, Webmaster, Outreach
Kalei Shotwell	Groundfish Habitat, Rockfish, Stock Assessment
Robert Stone	Seafloor Ecology, Effects of Fishing, Coral and Sponge Life History
Cindy Tribuzio	Sharks, Stock Assessment

Other ABL Staff Working on Groundfish-related Research

Scott Johnson	Essential Fish Habitat, Forage Fish
John Thedinga	Essential Fish Habitat, Forage Fish
Christine Kondzela	Rockfish Genetics
Sharon Hawkins	Forage Fish Genetics
Ed Farley	Epipelagic Trawl Survey in Bering Sea, Age-0 Walleye Pollock

CANADA

British Columbia Groundfish Fisheries and Their Investigations in 2009

Prepared for the 51st Annual Meeting of the
Technical Sub-Committee of the Canada-United States
Groundfish Committee
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May 2010

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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, B.C., 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	Mr. Mark Saunders
Marine Ecosystems & Aquaculture	Dr. Laura Brown

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

Groundfish	Mr. Greg Workman
Invertebrates	Mr. Jim Boutillier
Pelagic Fish Research & Conservation Biology	Mr. Jake Schweigert
Applied Technologies	Mr. Ken Cooke
Aquaculture and Environmental Research	Dr. Steve MacDonald

Groundfish research and stock assessments are conducted in the Groundfish Section and groundfish ageing and hydroacoustic work are conducted in the Applied Technologies Section. The Canadian Coast Guard operates DFO research vessels. These research vessels include the *W.E. Ricker, J.P. Tully, Vector* and *Neocaligus*. A replacement vessel for the *W.E. Ricker* has been delayed until 2013 or beyond.

The Pacific Region Headquarters (RHQ) of Fisheries and Oceans Canada is located at 401 Burrard Street, in Vancouver (BC, V6C 3S4). Management of groundfish resources is the responsibility of the Pacific Region Groundfish Coordinator (Ms. Tamee Mawani) within the Fisheries and Aquaculture Management Branch (FAM). Fishery Managers receive assessment advice from MEAD through the Pacific Scientific Advice Review Committee (PSARC). The Chair of PSARC (Ms. Marilyn Joyce) advises the Regional Management Committee on stock status and the 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.dfo-mpo.gc.ca/science/advice-avis/index-eng.html

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.

Managers implemented a "Canadian Groundfish Integration Pilot Project" in the 2006/2007 fishing season as a three year pilot. This pilot has now been incorporated into fisheries management. The program focuses 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 catch of non-directed species. Details can be viewed in the 2009/2010 integrated fisheries management plan at http://www-ops2.pac.dfo-mpo.gc.ca/xnet/content/MPLANS/MPlans.htm#Groundfish

A shift in the funding of industry collaborations, particularly in conducting cooperative surveys, was required after the *Larocque* court decision of June 23, 2006. Prior to the *Larocque* decision, compensation provided to fishers for their data collection services took the form of the proceeds of the unavoidable fish kills in the research surveys, less any samples retained for detailed scientific analysis. In instances where these proceeds did not cover the cost of the research survey, the department allowed fishers to catch additional fish for payment purposes. Post – Larocque these "top up" payment fishing activities are no longer possible. Larocque Relief Funding, to replace fish allocations, was provided in 2007 and will continue to fund surveys through 2012. Details at http://www.dfo-mpo.gc.ca/Science/newpoli-polinouv/guidance-conseils-eng.htm

B. Multispecies or ecosystem models

Groundfish Staff participated in the Strait of Georgia Ecosystem Research Initiative Project during a two week hydroacoustic/trawl survey during February of 2009.

The Central Theme of this Ecosystem Research Initiative is "The Strait of Georgia in 2030", i.e. what might the Strait of Georgia be like in 2030. Responding to this challenge of ***imagining the future***, or ***constructing scenarios***, involves: 1) understanding how this ecosystem works, 2) identifying the various drivers of change most likely to determine future conditions, and finally 3) analyzing the future responses of the system under the influences of these drivers of change. The research conducted within this Initiative is designed to align with the Departmental goals of ensuring a healthy and productive aquatic ecosystem in the Strait of Georgia, and to support sustainable fisheries and aquaculture in the Strait. This research initiative currently comprises over thirty research projects and involves over fifty researchers. Details at http://www-sci.pac.dfo-mpo.gc.ca/sogeri/default_e.htm

In a separate unrelated research project the relationship between reduced oxygen concentration in BC coastal waters and the distribution of groundfish species was investigated. Concurrent with the shallowing of the oxygen minimum layer in coastal waters there has been a shift in groundfish species distributions to shallower waters. The change is most pronounced for species normally found below 150 m depth and is areas most exposed to the open ocean, e.g. the west coasts of Vancouver Island and the Queen Charlotte Islands.

C. By species

1. Pacific cod

a. Research program

Dr. Robin Forrest is a new Research Scientist hired on in 2009 with the retirement of Alan Sinclair. No new research was conducted on Pacific cod in 2009. Collection of ageing structures is planned for 2010.

b. Stock assessments

No new stock assessments for Pacific cod were conducted in 2009 nor planned for 2010.

2a. Rockfish – slope

a. Research programs

Originally, the Slope Rockfish Program focused on the assessment of rockfish species living on the marine continental slope of British Columbia. Over the past decade our group has morphed into a multi-purpose body that tackles a variety of issues: stock assessment, COSEWIC listing requirements, oceanographic exploration, software development for the R statistical platform, and scientific research in marine ecological modelling. There is a fair degree of inter-program collaboration.

The Groundfish Section at the Pacific Biological Station conducts a mosaic of synoptic surveys that covers most of British Columbia's ocean bottom ecosystems, including those on the continental shelf and slope. The survey team gathers information on abundance and biology (lengths, weights, maturity, otoliths, etc.). The Slope Rockfish Program, headed by Andrew Edwards and including Rowan Haigh, focuses on the development of models and software tools for the analysis of data pertaining to groundfish and other species. We also retain the interest of two eminent scientists – Jon Schnute (scientist emeritus) who contributes considerable time and expertise; and Paul Starr who works for the Canadian Groundfish Research and Conservation Society (CGRCS) and plays an integral role in the stock assessments assigned to our program.

In 2009, we spent a great deal of time automating rockfish catch reconstruction back to 1911. This exercise appears simple enough, but disparate data sources, incomplete information, multiple fisheries, and various computer storage platforms made the process time consuming. A complicated function programmed in R that taps into various DFO databases (SQL and Oracle) now reconstructs catch history for any rockfish species in approximately four minutes. The code is ever-changing as we discover new quirks and hidden bugs. However, this new algorithm offers an efficient alternative to collating all the information by hand in a bewildering Excel spreadsheet. Interested parties can download the R code from: http://code.google.com/p/pbs-fishery/source/browse/#svn/branches/buildCatch.

Another major undertaking saw an upgrade to our R package *PBSmodelling*. Rob Kronlund (DFO Groundfish), who is now a co-author of the package's User Guide, provided numerous ideas for design extension to the Graphical User Interface (GUI) component after using it to evaluate fishery management strategies with his colleagues Sean Cox (Simon Fraser University, BC) and Jaclyn Cleary (DFO Pelagics). *PBSmodelling* now includes various new widgets (droplist, table, spinbox, include, notebook, image, progressbar), bug fixes, and other improvements that give users greater control over GUIs designed for exploring and demonstrating analyses with R. The upgrade also includes greatly enhanced versions of our functions to support project development (e.g., an option manager) and creating interactive lectures (via XML scripts in the *talk description files*). Alex Couture-Beil, who now pursues graduate studies in robotics at Simon Fraser University, added the new programming code that contributes to this significant upgrade. *PBSmodelling* can be found on CRAN at: http://cran.r-project.org/web/packages/PBSmodelling/index.html.

b. Stock assessments

In 2009, our team continued work on a catch-at-age population model for Pacific ocean perch (*Sebastes alutus*, a.k.a. POP) in Queen Charlotte Sound (QCS). Meetings with a DFO steering committee resulted in a decision to expand the study area from the traditional Goose Island Gully to the entire QCS basin. Two other potential areas for assessment – west coast Queen Charlotte Islands and west coast Vancouver Island – will be assessed at a future time once we settle on some standard methodologies. Data on growth shows that female L_∞ remains consistently 4 cm larger than that for males; therefore we employ a two-sex model. Ages from the commercial fishery and those from research cruises are treated separately. The commercial ages are weighted by trip catch weight within quarters and by quarterly commercial catch within years. Historical survey indices of abundance are linked to modern indices through defensible manipulation.

c. Research activities for 2010

At some point the team plans on hiring a Co-op student to work on a project of interest to the group. This may entail implementing an MSE (management strategy evaluation) framework for either POP or for data-limited species. Additionally, a separate summer student may help to reformat some of our example GUIs using a recently implemented notebook widget in *PBSmodelling*.

In 2010 we will complete the POP assessment. Preliminary work has been done using Coleraine (an interface for the program ADMB). The two data source (abundance indices and proportions-at-age) are iteratively re-weighted depending on CVs. Currently, the equations and resulting ADMB code from the 2001 assessment are being modified to deal with several issues (e.g. two sexes, not using unreliable surface-ageing data). Meanwhile, groundfish management has indicated that the next assessments will focus on redbanded rockfish (*S babcocki*) and yellowmouth rockfish (*S. reedi*). The latter is facing scrutiny by COSEWIC and may be listed as "threatened".

The PBS suite of R packages continues to grow in size and functionality. See the summary page by Jon Schnute and the "Links" to PBS package development repositories on Google Code: http://code.google.com/p/pbs-software/.
R packages compiled and ready to roll can be found on CRAN:
http://cran.r-project.org/.

2b. Rockfish – shelf

a. Research programs in 2009

In collaboration with Dr. Murdoch McAllister and Dr. Robyn Forrest at the University of British Columbia and Dr. Martin Dorn of the National Marine Fisheries Service, a meta-data analysis of steepness of rockfishes was completed. This paper has been accepted with revisions by the Canadian Journal of Fisheries and Aquatic Sciences. Results have been incorporated in the 2009 stock assessment update of canary rockfish.

b. Stock assessments in 2009

The canary rockfish stock assessment was updated and approved at a December 2009 meeting of the Pacific Science Advisory Review Committee. It will be published in the CSAS series with a 2010 publication date.

The update was consistent with the previous assessment indicating a rebuilding trend from low levels observed in about 2004. Additional rebuilding is indicated and now estimates that the population is most likely in the healthy zone as defined by DFO PA, unlike the previous assessment where it was estimated to within the cautious zone. Over the longer term, spawning biomass will continue to increase if annual harvests are kept below 900 t/y. The authors comment that, as with many assessments, the results are highly uncertain. The assessment also did not attempt to reconstruct bycatch estimates from other historical fisheries. Inclusion of additional historical catches will lead to lower estimates of current biomass relative to target and limit reference points and to higher estimates of long-term yield. Furthermore, while three surveys have shown a recent upturn, the length of the upturn is short and may not be sustained.

Science staff continued to collaborate with management staff in the preparation of briefing notes for the Minister regarding whether to accept the threatened listings for canary rockfish and bocaccio. The committee on Status of Endangered Species in Canada (COSEWIC) had recommended a "threatened" designation for both populations based on earlier work. The Government of Canada is currently considering the recommendations and must publish a final decision by the fall of 2010.

c. Research activities planned for 2010

Staff continued to work with Dr. Murdoch McAllister on a study of the adequacy of the current survey array. Using the a Recovery Strategy for bocaccio as a case example, the study attempts to determine if the precision of the current array of surveys will provide adequate indexing to support a Recovery Strategy, or, stated differently, how precautionary does the management control have to be within the Recovery Strategy given the imprecision of survey indices that will be used to monitor the recovery.

d. Stock assessments in 2010

No shelf rockfish assessments are planned for 2010.

2c. Rockfish – inshore

a. Research programs in 2009 and planned for 2010

Surveys

Inside (PMFC Area 4B)
A research longline survey was designed for the Inside waters East of Vancouver Island in 2003. 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 and survey blocks were stratified by area and depth (41 – 70 m and 71 – 100 m) and selected for sampling at random. The longline survey is now designed to cover the Inside waters (4B) over three years. Two series of surveys throughout the Inside waters were completed in 2009. Twenty-five days of DFO ship time are allocated in August and September for this survey in 2010.

A Phantom HD2+2 remotely operated vehicle (ROV) was acquired by the DFO and has been used to develop visual survey methods for inshore rockfish. A forward looking video camera (paired lasers), DIDSON sonar unit, scanning sonar, and ultra-short baseline (USBL) underwater acoustic positioning are standard equipment used on the ROV for visual surveys. Surveys to assess inshore rockfish stocks in and adjacent to the Rockfish Conservation Areas (RCAs) were conducted in February and November 2009 in the southern portion of the Inside waters. ROV surveys will continue in 2010 in the northern portion of the Inside waters.

Outside (PMFC Areas 3CD, 5ABCDE)
Since 2003, a third technician has been deployed on the annual International Pacific Halibut Commission (IPHC) Area 2B setline survey to collect hook-by-hook catch data and conduct biological sampling of non-halibut catch (Yamanaka et al. 2004, 2007, Lochead et at. 2006, Obradovich et al. 2008). The third technician has been supported by Larocque funds since 2007 and will continue in 2010.

In collaboration with the halibut industry, a research longline survey was designed and conducted in the outside 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 are targeted annually. The survey covers the coastwide Outside waters over two years, alternating annually between the north and the south. Three chartered fishing vessels conduct this survey between August 15 and September 15. In 2009, the southern portion of BC was surveyed, completing two full cycles of the BC survey. There are plans for a 2010 survey in the northern region. This survey is supported by Larocque funds.

Collaborative research

Three years of NSERC funding (2009 – 2011) has been awarded to Dr. Jon Shurin of the University of British Columbia (UBC), in collaboration Parks Canada, Pacific Halibut Management Association (PHMA) and DFO, to conduct research to assess the effectiveness of RCAs in maintaining and enhancing inshore rockfish stocks in BC. Two MSc students and a PhD student began their field work on projects related to the assessment and management of RCAs for inshore rockfish in BC in the summer of 2009 and winter of 2009/2010.

Dr. Marie Etienne from the AgroParisTech in France is on sabbatical with Dr. Murdoch McAllister at UBC and is working on various projects in her field of expertise: spatial statistics. Dr. Etienne has been working together with Dr. McAllister's PhD student Shannon Obradovich and the inshore rockfish program to develop an abundance index from research longline catch data that accounts for hook competition and saturation. The catch data from the Inside longline surveys as well as directed hook-timer experiments are being used to test various models and help differentiate between competing scenarios.

b. Stock assessment

The National Advisory Process (NAP) and Committee On the Status of Endangered Wildlife In Canada (COSEWIC) status reports were prepared for yelloweye and quillback rockfishes (Yamanaka et al. 2006a, 2006b). COSEWIC reviewed the status of yelloweye rockfish in November 2008 and recommended a Special Concern status. Quillback rockfish was also reviewed by COSEWIC in the fall of 2009 and COSEWIC has recommended a Threatened status. http://www.cosewic.gc.ca/eng/sct1/searchform_e.cfm

A yelloweye rockfish (Inside stock) stock assessment is due to be presented to the Pacific Science Advice Review Committee (PSARC) in July 2010. A coastwide quillback rockfish assessment will be initiated in the Fall 2010.

c. Management

In 2007, the RCA strategy was completed with 20% of rockfish habitat closed in Outside waters and 30% of rockfish habitat closed in Inside waters. RCAs are used as a spatial management tool to protect inshore rockfish. Fishing activities likely to catch rockfish are prohibited within these areas http://www-comm.pac.dfo-mpo.gc.ca/pages/consultations/fisheriesmgmt/rockfish/default_e.htm

3. Sablefish

a. Research activities in 2009 and planned for 2010

The Sablefish Research and Assessment Survey Program includes the following program components:

(1) A **Traditional Standardized Program** (1990-2009) that includes standardized sets at nine (9) offshore fishing localities and biological sampling. Starting in 1990, one

set was made in each of five (5) depth intervals in each locality. Since 1999, additional shallower and deeper depth intervals have been added, removed and changed. However, the 5 core intervals have remained the same over time. Catch rates from these core sets extend a stock abundance index series and sablefish are sampled for data on size and growth.

(2) A **Traditional Tagging Program** (1991-2007, hiatus in 2008-2009) that captures sablefish for tagging and release at historical tagging locations. Sets are made in the 9 traditional standardized program localities as well as five (5) tagging-only localities. The protocol for this program is to release a specified number of tagged fish in each locality. Low catch rates in some areas in previous years have resulted in survey vessels being required to re-set additional strings in an area. Tag-recoveries from these sets can be used for studying movement, obtaining estimates of gear selectivity, and deriving an index of tagging-based abundance.

(3) **A Randomized Tagging Program** (2003-2009) that captures sablefish for tagging and release following a depth and area stratified random survey design. The catch rate data can be used to derive an index of stock abundance. Tag-recoveries can be used for deriving estimates of gear selectivity, studying movement, and deriving an index of tagging-based abundance. The survey also provides biological samples. These sets were introduced in 2003 and are being assessed for their ability to serve as a replacement for the traditional standardized survey and tagging programs.

(4) An **Inlets Program** (1995-2009) that includes standardized sets at four (4) mainland inlet localities. Sablefish are tagged and released from inlet sets and are sampled for biological data.

The annual Research and Stock Assessment Survey Program will be conducted in the fall of 2010.

b. Stock assessment activities in 2009 and planned for 2010

Sablefish is scheduled for a stock assessment in 2010; no assessment was conducted in 2009 following the 2008 assessment (Cox and Kronlund 2008, Cox et al. 2009, Cox and Kronlund 2009). Sablefish stock assessment and management in British Columbia is conducted collaboratively by DFO and the Canadian Sablefish Association. The collaboration is formalized as a Joint Project Agreement that identifies the respective responsibilities of the two parties and provides a mechanism for joint contributions to fishery management and science activities for sablefish. Annual survey activities are conducted using fishing vessels chartered from the sablefish longline trap fleet.

Catch rates from the fall 2009 standardized survey declined by ~33% from 2008, and are ~26% of the most recent high observed in 2003. The 2009 stratified random survey declined ~33% from 2008, which followed a ~30% increase from 2007 to 2008. Since 2003, declines in these indices suggest that sablefish in British Columbia may be approaching the low abundances experienced in 2001 to 2002 when a quota reduction from 4,000 t to 2,450 t was implemented. Subsequent to the 2002 reduction, the quota was increased to 3,000 t for the directed sablefish

2003/2004 fishing year (Aug 1-Jul 31) and reached 4,600 t for the 2005/2006 fishing year as trap fishery and survey catch rates increased. The quota for the 2006/07 fishing year was reduced to 3,900 t and was similarly reduced to 3,300 t for the 2007/08 fishing year mainly as a result of declining survey indices of abundance and tagging estimates of exploitable biomass. The quota was set at 2,450 t for the 2008 fishing year. The 2008/2009 sablefish fishing year was adjusted to start February 21, 2008 and end February 20, 2009 to establish a common fishing year for all groundfish sectors. The quota was set at 2,300 t for the 2010/11 fishing year.

Stock assessment modeling in 2010 will continue work to support the management strategy evaluation process used in 2008 by extending the operating model to account for (*i*) sablefish population dynamics, (*ii*) fishery monitoring systems including two fishery-independent surveys, fishery catch-per-unit-effort for each commercial gear type, and biological sampling of age-proportions for both surveys and fisheries (where available); and (*iii*) retained and discarded catch by fishing gear. Fishery reference points will be developed to ensure the conservation objectives are aligned with the new Canadian Sustainable Fisheries Framework policy and eco-certification processes (sablefish in British Columbia are currently under Marine Stewardship Council review for eco-certification).

4. Flatfish

In 2009-10 the flatfish program includes the addition of Brian Krishka and Bill Andrews.

a. Stock Assessment in 2009

No new flatfish stock assessments were prepared in 2009

b. Research programs planned for 2010

Program staff will participate in the Groundfish Synoptic trawl surveys off the west coast of Vancouver Island in June and the west coast Gwaii Haanas (Queen Charlotte Islands) in September. Biological data will be collected for all groundfish species caught. Vessels involved are the *CCGS W.E. Ricker* off the west coast of Vancouver Island and a chartered commercial vessel off the west coast Gwaii Haanas.

In preparation for stock assessment, data from the commercial fishery and research surveys will be compiled for all commercial flatfish species. Age composition data will be assembled for all flatfish species and samples for ageing in 2010/11 have been selected for the ageing lab. The Program Head will produce a summary of life history characteristics, biomass estimates and fisheries reference points for flatfish species by the end of 2010. This will facilitate flatfish stock assessment after Jeff Fargo retires at the end of 2010. A report summarizing historical and current information on commercial flatfish species in the Strait of Georgia is also being compiled.

5. Pacific hake

a. Stock Assessment in 2010

The 2010 harvest advice was prepared jointly by Canadian and US scientists. There were two assessments reviewed by the Pacific Hake Stock assessment review (StAR) panel; one prepared by Canada and one by US scientists. Each assessment employed a model to generate harvest advice. Canadians used a less complex age structured production model (TINSS) while US scientists used Stock Synthesis 3 (SS3).

When evaluating the assessments and available data sources, the StAR panel decided to discard all survey catch-at-age data, due to the lack of a formal acoustic backscatter sub-sampling protocol. The StAR panel also discarded the 2009 acoustic survey biomass index due to the difficulty in distinguishing the acoustic signatures of Humboldt squid and Pacific hake resulting in a highly uncertain 2009 estimate.

The shift in temporal and spatial distribution of Pacific hake has continued with the majority of catch taking place in the third quarter (July-Sept) in Queen Charlotte Sound (PMFC 5A and 5B). Historically, the Canadian fishery occurred off the west coast of Vancouver Island (PMFC 3C and 3D) and although there was some catch there, the numbers are much smaller than in the years preceding 2007. A significant number of vessels continue to fish in the Strait of Juan de Fuca, targeting smaller, younger fish. There is no sign of a significant upcoming recruitment event.

Scientists from Canada were invited to attend the Pacific Fisheries Management Council's (PFMC) meetings in Sacramento, CA, in March, 2010 to present their assessment results to the Science and Statistics committee of the PFMC. Dr. Steve Martell from the UBC, Fisheries Centre, presented an overview of the TINSS model, while Ian Taylor present the results of the SS3 model. The SSC forwarded both sets of results to the PFMC as equally plausible states of Nature. Greg Workman addressed the council and advocated precaution in selecting a coast wide TAC given that the stock is currently at its lowest level on record, has been subject to very high levels of fishing mortality over the preceding five years, that current recruitment appears to be average or below average and that the impact of Humboldt squid, on the abundance of Pacific hake is unknown. After hearing the testimony of several stakeholders the panel came to a consensus on an Allowable Biological Catch (ABC) of 455,000 metric tonnes and an optimal yield of 262,500 mt. These values were arrived at by averaging the results of the two assessments.

6. Elasmobranchs

a. Research programs in 2009

From 2003-2006, over 18,000 big skate (*Raja binoculata*) were tagged and released in three regions in British Columbia. Generally, 75% of the recaptured fish were recaptured within 21km of the tagging location. Long-range movements (up to 2340 km) were undertaken by a small percentage (1.5%) of the recaptured fish. Tagged big skate were recaptured in waters off of Oregon, Washington, throughout the Gulf of Alaska and the Bering Sea. In 2009, these data were published in King and McFarlane (Fisheries Research 101 (2010) 50–59).

b. Stock assessment(s) in 2009

A stock assessment of the spiny dogfish (*Squalus acanthias*) for both the inside stock (Strait of Georgia, PMFC 4B) and outside stock (PMFC 3C through 5E) of spiny dogfish was completed in collaboration with Vincent Gallucci and Ian Taylor of the School of Aquatic and Fisheries

Sciences. This stock assessment employed generalized Schaefer and Pella-Tomlinson surplus production models to estimate the current biomass of each stock. Model runs using intermediate *r* values and allowing the model to estimate *K* were recommended for consideration in assessing the status of the inside and outside stocks and selecting yield limits. This stock assessment will be reviewed through PSARC on May 17, 2010.

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 is monitored by species and area in order to ensure that the 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 (PMFC 5C/D) big skate in 2002/03, which was continued in 2006/2007 through to 2010/2011. Out of this cap, the trawl fleet has a quota of 567 t, with no quota for the hook and line/trap fleet (N/A). 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.

d. Research activities for 2010.

Age and growth characteristics of big skate (*Raja binoculata*) and longnose skate (*Raja rhina*) are being evaluated in collaboration with Chris Gburski from the Alaska Fisheries Science Centre. Specifically, age discrepancies found between big skate in BC and Alaska and published in two recent papers (McFarlane and King 2006; Gburski et al. 2007) have raised questions regarding potential differences in process and interpretation of rajid vertebral centra between research groups, as well as the possibility of real differences in life history parameters between regions. Big skates in BC were found to reach a much greater maximum age (26 years) than those in the Gulf of Alaska (15 years). Questions of geographical differences in growth and of differences in sampling or age estimation criteria between studies will be examined by ageing a random subset of sectioned centra from Alaska (n = 31 big skate, n = 27 longnose skate) and comparing growth curves obtained by researchers from BC with those obtained previously by researchers from Alaska. Attempts are also being made to locate archival skate vertebrae from museum collections for validation using bomb radiocarbon analysis. Reference chronologies are available for the northeast Pacific showing peaks in radiocarbon concentrations in Pacific halibut and rockfish otoliths in the late 60s and early 1970s. A comparison of radiocarbon levels from growth rings milled from archived skate vertebrae with reference chronology values might be possible to verify formation dates, provided suitable skate specimens can be located. Obtaining a better understanding of age and growth of big and longnose skate and how parameters might change among regions is important to the future management of all species of skate in BC waters.

The basking shark (*Cetorhinus maximus*) was listed as endangered under Canada's Species at Risk Act (SARA) on March 17th, 2010. As part of the recovery strategy, efforts to increase the number of reported sightings were started in March 2010. A phone-in and web-based sightings network was implemented in 2007 and is on-going. Sightings posters and letters inviting private businesses, visitor centres, Fisheries and Oceans offices, First Nations, and other interest groups to participate in reporting have so far been mailed to over 200 addresses this year. Also new this year, “basking shark business cards” were created so that sightings network information might be readily at-hand for those working and playing on the water. Multiple presentations on the ecology, history, and current status of the basking shark are planned in order to increase awareness of the both DFO sightings network and our ongoing efforts towards research and recovery. Greater collaboration with established marine mammals monitoring and sightings programs will also hopefully yield greater reporting of basking sharks in BC waters.

A blue shark (*Prionace glauca*) tagging survey will be conducted off the west coast of Vancouver Island in July/August 2010 using archival satellite tags. Two fin-mounted SPOT5 (smart position or temperature transmitting tags) and four WC-MINIPAT 1xAA Argos-linked Pop-Up Archiving tags will be deployed on male blue sharks. This augments a 2007 survey which was able to deploy 10 tags on females. The anticipated duration of the current program with CLS America for use of the Argos collection system (Argos DCS) is 24 months, with a possibility of extension.

Life history studies have been started on brown cat shark (*Apristurus brunneus*) and the spotted ratfish (*Hydrolagus colliei*), both species of Chondrichthyes for which little biological information is available worldwide. The overall objectives of the brown cat shark study are to (1) describe the reproductive and maturity characteristics of the brown cat shark in BC waters, (2) determine age and growth characteristics of the brown cat shark in BC waters, and (3) use demographic analyses to determine the susceptibility of this species to decline in BC waters based on current mortality estimates. For the spotted ratfish, a study is underway to help elucidate some questions on the general reproductive biology, distribution, and catch of spotted ratfish in Canadian Pacific waters. Efforts will also be made to age the spotted ratfish using dorsal spines.

7. Lingcod

a. Research programs in 2009

A surplus production model for five management units of outside lingcod (*Ophiodon elongatus*) were developed in 2009. The data used and model outputs (along with WINBUGS coding) are publised as Cuif, McAllister and King, 2009. Canadian Technical Report of Fisheries and Aquatic Sciences 2861. These models were not used to provide management advice, but will be updated for stock assessment advice for November 2010.

b. Stock assessment(s) in 2009

No assessments were conducted on lingcod stocks in 2009. A lingcod outside stock assessment using surplus production and catch-age models is underway for November 2010.

c. Research activities for 2010

A lingcod (*Ophidodon elongatus*) egg mass survey was conducted by DFO SCUBA divers at Snake Island Reef and Entrance Island Reef in the Strait of Georgia between February 15th and

February 25th, 2010. This survey was undertaken to add to the existing time series from Snake Island Reef, one of the primary index sites, and to provide an ongoing source of biological and relative abundance information for Strait of Georgia lingcod, as recommended in the 2003 stock assessment framework.

D. Other related studies

1. Statistics and Sampling

a. Biological sampling and database work in 2009

Principal Statistics and Sampling activities in 2009 included the ongoing population of the groundfish biological database (GFBio). This database now includes almost 8,400,000 specimens. Data entry activities continue to concentrate on the input of current port sampling and observer biological data and recent research cruises. The groundfish trawl fishery continues to be covered by 100% dockside and virtually 100% observer coverage. These observers also provided 265 length/sex/age samples and 112 length samples in 2009. Port samplers provided an additional 84 samples, 79 samples with ageing structures (length/sex/age/weight) and 5 without structures (length/sex/weight). The focus of their sampling efforts was from those fisheries not covered by at-sea observers.

b. Catch monitoring

The Groundfish Integrated Pilot Project continued in year 4 in 2009, and was designated a permanent program. The process, which includes 100% at-sea monitoring and dockside monitoring for hook and line vessels, successfully monitors all catch, both landed and discarded. A review of the catch data accuracy for yelloweye rockfish has been published in Marine and Coastal Fisheries Journal. Operational elements and aspect of data quality were presented at the ICES Annual Symposium in Berlin in September 2009. Staff also continued to play a key role in development a new Regional Catch Monitoring information system.

Since 2007 all regional groundfish harvest data have been stored in the Fisheries Operations System (FOS) database. Groundfish Science staff have now developed a view of the FOS database that transforms and simplifies selected groundfish catch and effort data. The view (GFFOS) facilitates access and standardizes extractions for science and groundfish management staff. GFFOS is structured like a database which maximizes the flexibility of staff in developing ad hoc queries. It follows the same model as other Groundfish databases currently in use to simplify extractions and improve understanding of the data. GFFOS includes data from fisher logbooks, observer logbooks, electronic monitoring of fishing vessels, and dockside monitoring of landings. Staff also developed an MS Access frontend for the GFFOS "database" and a users' manual.

c. Field work in 2009

Staff participated on various bottom trawl surveys including the Hecate Strait and Queen Charlotte Sound groundfish trawl surveys, the West Coast Vancouver Island and Queen Charlotte Sound shrimp trawl surveys, as well as the Pacific hake hydroacoustic surveys. This group also included the port sampling activity (1.8 person-years) in the Vancouver and Prince Rupert areas.

Staff continued to develop GFBioField, adding integrated GIS capabilities and enhanced ability to capture and summarize GPS and net sensor data. The system is now being evaluated for adoption in the Maritime, Newfoundland, and Quebec regions. It was demonstrated to DFO staff from the East Coast as well as at the TSC sponsored workshop on electronic data capture hosted by Mark Wilkins of NMFS in March 2009.

d. Proposed field work for 2010

Port sampling will continue in 2010, as will staff participation in the bottom trawl surveys to the west coast of Haida Gwaii (Queen Charlotte Islands) and the West Coast of Vancouver Island Charlotte Sound, as well as shrimp trawl surveys in Queen Charlotte Sound and the west coast of Vancouver Island, and the lingcod nest survey in the Strait of Georgia.

e. Proposed catch monitoring research and development in 2010

Staff will continue to participate in regional catch monitoring and database management activities. Staff will also be collaborating with Dr. Robyn Forrest (Groundfish-DFO) and Dr. Marie Etienne of the Paris-Agricol University in France on a study of whether fishery independent trawl surveys and fishery dependent catch data (trawl CPUE) can be blended to provide enhanced estimates of relative abundance over time.

2. Ecological Risk Assessment for the Effects of Fishing

In 2010, Groundfish Science staff will be exploring how the Ecological Risk Assessment for the Effects of Fishing (ERAEF) model developed for Australian Fisheries could be used to set priorities for science activities within the Groundfish Section. This approach is based on the premise that the relative risk incurred by groundfish stocks and their ecosystems due to human-induced impacts (e.g., fisheries) should be an important consideration when scheduling the provision of science advice. ERAEF assesses the impact posed by a fishing activity on the ecosystem using a hierarchical approach to risk assessment that moves from a comprehensive but qualitative analysis of risks at Level 1, through to a more focused and semi-quantitative approach at Level 2, and finally to a highly focused quantitative “model-based” approach at Level 3. Assessments only extend to the next level if risk is judged to be above a threshold, which allows the three levels to act as a series of filters to efficiently screen out low risk activities. ERAEF has the potential to serve as a basis for ecosystem-based management since risk can be assessed for ecosystem components extending beyond traditional target species (e.g., bycatch species, habitats). To investigate how the Australian framework could be adapted to the context of BC groundfish fisheries, a pilot study ERAEF analysis will be conducted for a portion of the bottom-trawl fishery in Hecate Strait, BC in 2010.

3. Deep water corals

In June 2009, DFO participated in the “Finding Coral Expedition” funded by the Living Oceans Society (www.findingcoral.com). Thirty (30) Nuytco Deep Worker submersible dives were conducted at eight (8) locations from Queen Charlotte Sound to Dixon Entrance. Research objectives were to: document species richness and abundance of deep sea corals, document occurrences of deep sea corals, identify fish and invertebrates associated with deep sea corals and document and identify habitat perturbations in areas with coral records.

Sixteen species of coral were recorded, the most frequently encountered was red tree coral (*Primnoa pacifica*), other corals included bubblegum (*Paragorgia spp*), sea fan (*Swiftia spp*) and bamboo (*Isidellae spp.* and *Lepidisis spp*). Hydrocorals (*Stylaster spp*), cup corals, sea pens and sea whips were also common.

Invertebrates from several taxa were observed in association with deep water corals, including crabs, shrimp, sea stars, anemones, brittle stars, and feather stars. Nudibranch eggs were found attached to a red tree coral colony, and both the orange peel nudibranch (*Tochuina tetraquetra*) and southern spiny star (*Hippasteria spinosa*) were observed feeding on red tree coral polyps.

In high relief rocky habitats three species of rockfish were observed in close association with red tree coral including blackspotted rockfish (*Sebastes melanostictus*) , shortraker rockfish (*Sebastes borealis*), and redbanded rockfish (*Sebabstes babcocki*). In low relief cobble habitats smaller (juvenile) rockfish including redbanded, rosethorn (*S. helvomaculatus*), sharpchin (*S. zacantrus*), and rougheye rockfish (*S. alutianus*) were noted in association with small hydrocorals. On soft bottom the most frequently observed species were the shortspine thornyhead (*Sebastelobus alaskanus*) and Arrowtooth flounder *(Atheresthes stomias).*

Human impacts were noted at five of the dive sites. These impacts included multiple trawl tracks on a known trawling ground (Mid-Moresby Gully), suspected trawl tracks at three others, as well as pieces of lost fishing gear including trawl wire, longline groundline, and downrigger cable.

APPENDIX 1. REVIEW OF CANADIAN GROUNDFISH FISHERIES

1. Commercial fisheries

All catch figures for the 2009 calendar year are preliminary. Canadian domestic trawl landings of groundfish (excluding halibut) in 2009 were 86,206 t, a decrease of 12% from the 2008 catch. The major species in the trawl landings were Pacific hake (65%), yellowtail rockfish (5%), Pacific ocean perch (5%), and walleye pollock (4%),. Principal areas of trawl production were 3C (31%), 5B (17%), 4B (17%), 3D (11%), and 5A (9%).

Canadian landings of groundfish caught by gear other than trawl in 2009 totalled 9,848 t. Landings of sablefish by trap and longline gear accounted for 3,006 t, approximately 47% by trap gear, 50% by longline gear and 3% by unspecified. Landings of species other than sablefish by trap, longline, handline and troll gear accounted for 6,842 t (52% dogfish, 27% rockfish and 13% lingcod).

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 2009 these surveys covered the months of February to September. Provisional estimates of 2009 catches, landings and discards, for this 8-month period were 18,493 fish for lingcod, 23,601 fish for all rockfish species, 367 fish for halibut, 4,085 fish for rock sole, 5,457 fish for starry flounder, 8,168 fish for dogfish, 3,164 fish for greenlings, and 3,569 fish for other groundfish species.

For the Strait of Juan de Fuca catch estimates have been generated from creel surveys and fishing lodge reports for the entire year. Provisional estimates of 2009 catches are 11,395 fish for lingcod, 15,329 for all rockfish species, 5,957 fish for halibut, 1,943 fish for rock sole, 2,063 fish for other flatfish species,11,694 fish for dogfish, 4,007 fish for greenlings, and 3,191 fish for other groundfish species.

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 2009 catches were 14,424 fish for lingcod, 28,251 fish for all rockfish species, 29,497 fish for halibut, 2,770 fish for dogfish, 901 fish for greenlings, and 795 fish for other groundfish species.

In Johnstone Strait catch estimates have been generated from creel surveys and fishing lodge reports for June to August. Provisional estimates of 2009 catches were 2,118 fish for lingcod, 13,028 fish for all rockfish species, 5,701 fish for halibut, 1,072 fish for rock sole, 793 fish for other flatfish species, 1,050 fish for greenlings, 625 fish for dogfish and 2,806 fish for other groundfish species.

3. Joint-venture fisheries

There were no joint-venture fisheries for Pacific hake off British Columbia in 2009.

4. Foreign fisheries

There were no national or supplemental fisheries for Pacific hake off British Columbia in 2009.

APPENDIX 2. PARTIAL LIST OF GROUNDFISH RELATED REPORTS PUBLISHED IN 2008/09.

PRIMARY

Cox, S.P. and A.R. Kronlund. 2008. Practical stakeholder-driven harvest policies for groundfish fisheries in British Columbia, Canada. Fisheries Research 94(3), p. 224-237.

Cuif, M, M. McAllister, and J.R. King. 2009. Development of a Surplus Production Model Applicable to British Columbia Offshore Stocks of Lingcod (*Ophiodon elongatus*). Canadian Technical Report of Fisheries and Aquatic Sciences 2861. 86 p.

Edwards, A.M. 2008. Using likelihood to test for Lévy flight search patterns and for general power-law distributions in nature. *Journal of Animal Ecology*, **77**: 1212-1222.

Forrest, R.E., M.K. McAllister, M.W. Dorn, S.J.D. Martell, and R.D. Stanley. *In press* Hierarchical Bayesian estimation of productivity and reference points for Pacific rockfishes (Sebastes spp.) under alternative assumptions about the stock-recruit function. Can. J. Fish. Aquat. Sci.

Gross, T., Edwards, A.M., and Feudel, U. 2009. The invisible niche: weakly density-dependent mortality and the coexistence of species. *Journal of Theoretical Biology* **258**: 148-155.

King, J.R. and G.A. McFarlane. 2009. Movement patterns and growth estimation of big skate (*Raja binoculata*) based on tag-recapture data. Fish. Res. 101: 50-59.

McAllister, M.K., R.D. Stanley and P. Starr. *In press* Modeling trawl survey catchability for B.C. bocaccio (*Sebastes paucispinis*): a combined expert driven – empirical approach. Fish. Bull.

Stanley, R.D., N. Olsen, and A. Fedoruk. 2009. The accuracy of yelloweye rockfish catch estimates from the British Columbia Groundfish Integration Project. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 1:354–362.

Yamanaka, K.L., Logan G. 2010. Developing British Columbia's Inshore Rockfish Conservation Strategy. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 2:28–46.

OTHER PUBLICATIONS

Cooke, K. and Yamanaka K. L. 2009 Preliminary Catch Summary from the Northern Portion of the Pacific Halibut Management Association Research Surveys in 2006 and 2008. 31 p. Presented to the PHMA for their annual general meeting.

Cox, S.P. and A.R. Kronlund. 2009. Evaluation of interim harvest strategies for sablefish (Anoplopoma fimbria) in British Columbia, Canada for 2008/09. DFO. Can. Sci. Advis. Sec. Res. Doc. 2009/042. 87 p.

Cox, S.P., Kronlund, A.R., and M.R. Wyeth. 2009. Development of precautionary management strategies for the British Columbia sablefish (Anoplopoma fimbria) fishery. DFO. Can. Sci. Advis. Sec. Res. Doc. 2009/043. 161 p.

DFO. 2009. Recovery Potential Assessment for bocaccio (*Sebastes paucispinis*). Can. Sci. Advis. Sec. Sci. Adv. Rep. 2009/040.

DFO. 2009. Recovery Potential Assessment for canary rockfish (*Sebastes pinniger*). Can. Sci. Advis. Sec. Sci. Adv. Rep. 2009/041.

Haigh, R. and Starr, P. 2008. A review of yellowmouth rockfish *Sebastes reedi* along the Pacific coast of Canada: biology, distribution, and abundance trends. *Canadian Science Advisory Secretariat, Research Document* 2008/055. 97 pp.

Haigh, R. and Starr, P. 2008. A review of darkblotched rockfish *Sebastes crameri* along the Pacific coast of Canada: biology, distribution, and abundance trends. *Canadian Science Advisory Secretariat, Research Document* 2008/056. 88 pp.

Obradovich, S.G., Yamanaka, K.L., Cooke, K., Lacko, L.C., and Dykstra, C. 2008. Summary of non-halibut catch from the Standardized Stock Assessment Survey conducted by the International Pacific Halibut Commission in British Columbia from June 4 to July 7, 2007. Can. Tech. Rep. Fish. Aquat. Sci. 2807: x + 83 p

Olsen, N., Rutherford, K.L., Stanley, R.D., and Wyeth, M.R. 2009. Queen Charlotte Sound groundfish bottom trawl survey, July 7th to August 8th, 2009. Can. Manuscr. Rep. Fish. Aquat. Sci. 2899. vi + 69p.

Olsen, N., Rutherford, K.L., Stanley, R.D., and Wyeth, M.R. 2009. Hecate Strait groundfish bottom trawl survey, May 22nd to June 19th, 2007. Can. Manuscr. Rep. Fish. Aquat. Sci. 2900. vi + 48p.

Olsen, N., Rutherford, K.L., Stanley, R.D., and Wyeth, M.R. 2009. West Coast Vancouver Island groundfish bottom trawl survey, May 26th to June 22nd, 2008. Can. Manuscr. Rep. Fish. Aquat. Sci. 2902. vi + 50p.

Olsen, N., Rutherford, K.L., Stanley, R.D., and Wyeth, M.R. 2009. Hecate Strait groundfish bottom trawl survey, May 26th to June 21st, 2009. Can. Manuscr. Rep. Fish. Aquat. Sci. 2901. vi + 49p.

Stanley, R.D., P. Starr, and N. Olsen. 2009. Stock assessment for canary rockfish (*Sebastes pinniger*) in British Columbia waters. Can. Sci. Advis. Sec. Res. Doc. 2009/013.

Stanley, R.D., L. Lacko, R. Kronlund, K. Rutherford, N. Olsen, M. Wyeth. 2008. Data quality in FOS-Groundfish. Paper commissioned by Gary Logan, GMU.

Stanley, R.D., M. McAllister, P. Starr, and N. Olsen. 2009. Stock assessment for bocaccio (*Sebastes paucispinis*) in British Columbia waters. Can. Sci. Advis. Sec. Res. Doc. 2009/055.

Starr, P.J. 2009. Petrale sole (*Eopsetta jordani*) in British Columbia, Canada: Stock Assessment for 2006/07 and Advice to Managers for 2007/08. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/070. ii + 134 p.

Starr, P.J. 2009. English Sole (*Parophrys vetulus*) in British Columbia, Canada: Stock Assessment for 2006/07 and Advice to Managers for 2007/08. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/069. ii + 149 p.

Yamanaka, K. L. and L. C. Lacko. 2008. 2004 Research Catch and Effort Data on Nearshore Reef-fishes in British Columbia Statistical Area 12. Can. Tech. Rep. Fish. Aquat. Sci. 2803: ix + 45 p.

Yamanaka, K.L., Obradovich, S.G., Cooke, K., Lacko, L.C., and Dykstra, C. 2008. Summary of non-halibut catch from the Standardized Stock Assessment Survey conducted by the International Pacific Halibut Commission in British Columbia from May 29 to July 22, 2006. Can. Tech. Rep. Fish. Aquat. Sci. 2796: viii + 58 p

APPENDIX 3. GROUNDFISH STAFF IN 2009/10

Schon Acheson	Technician, Groundfish port sampling
Bill Andrews	Technician, Flatfish
Kristina Anderson	Technician, Groundfish port sampling
Karina Cooke	Technician, Database and Surveys, Inshore and Shelf Rockfish
Andrew Edwards	Program Head Slope Rockfish, Statistical and mathematical modeling, stock assessment
Jeff Fargo	Program Head Flatfish stock assessment and biology
Rob Flemming	Biologist, GIS specialist, Inshore rockfish
Robin Forrest	Research Scientist, Stock assessment, Hake, Pacific Cod
Chris Grandin	Program Head Hake
Rowan Haigh	Biologist, Statistical and exploratory data analysis, Slope Rockfish
Kendra Holt	Biologist, Stock assessment, ERAEF
Gail Jewsbury	Technician, Data, Health and Safety
Jackie King	Research Scientist, Lingcod, Elasmobranchs, Climate studies
Brian Krishka	Biologist, database support and analysis, Flatfish
Rob Kronlund	Program Head Sablefish, analytical programs
Lisa Lacko	Biologist, GIS specialist and database manager
Romney McPhie	Biologist, Lingcod, Elasmobranchs
Brock Medlar	Technician, Sablefish
Wendy Mitton	Technician, Sablefish
Norm Olsen	Biologist, programmer/GIS, groundfish statistics, Shelf rockfish
Kate Rutherford	Biologist, database manager, groundfish statistics, Shelf rockfish
Rick Stanley	Program Head Shelf rockfish stock assessment and biology, groundfish statistics.
Greg Workman	A/Section Head
Malcolm Wyeth	Biologist, Groundfish surveys and Port sampling
Lynne Yamanaka	Program Head Inshore rockfish research and stock assessment

IPHC Research Program:

Review of 2009 Projects and Proposals for 2010

The International Pacific Halibut Commission Staff

Introduction

This document reviews research conducted by the IPHC staff in the past year as well as research proposed for the upcoming year. The report is divided into two sections, with the first section reviewing the status of research projects conducted in 2009. The second section presents the preliminary staff research proposals for 2010. Information is provided on when each project was initiated, the anticipated completion date, 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 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 appropriations funding or carryover from 2009;

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 through staff time alone or if sufficient funds are available 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 2009

Research conducted by the IPHC staff during 2009 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.

2009 Research Highlights

Shoreside PIT tag detection
The dockside detection program by IPHC scan samplers continued in 2009, 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 25 October, over 22 million pounds (45% of total landings) have been scanned. The number of tags recovered in 2009 totals 186 from the 2003 primary experiment, 128 from the 2004 releases, and 12 from the September 2003 double tag experiment (releases totaled 2,662). The latter project was conducted to confirm the PIT tag shedding rates observed during earlier holding experiments in Seward. The recovery rate for this experiment is now 27%. This was the final year of scanning.

Genetics and population structure
Research on population structure through genetics research continued in 2009 with additional sample analysis under the supervision of Dr. Lorenz Hauser at the University of Washington's Marine Molecular Biology Laboratory. The project was initiated in 2002 to investigate the genetic population structure in northeast Pacific spawning populations using non-selected nuclear microsatellite markers, and was later expanded to include more powerful markers under selection (ESTs) and maternally-inherited mitochondrial DNA (mtDNA). The population analyses have not detected significant genetic structure and the present results support the hypothesis that a genetically well-mixed population exists from at least the Queen Charlottes through the southeast Bering Sea and eastern Aleutian Islands. However, recent analyses by Nielsen et al. (June 2009, *Conservation Genetics Online*) describe significant genetic population structure that may originate from a population barrier between Adak and Attu (i.e., at Amchitka Pass) and we have yet to complete our analysis of samples from the western Aleutians and eastern Russia (the Kuril Islands and southern Sea of Okhotsk). It is also possible that the results presented by Nielsen were spurious and resulted from inclusion of sex-linked markers within an analysis characterized by unequal sex ratios; our final analysis is designed to account for addressing this possibility in their data, should significant western Aleutian population structure not be detected, using a larger and balanced sample population. In addition to the population analyses, work in 2009 elaborated upon the observation that three of the sixteen microsatellite alleles screened to date display a sex-linked pattern of genotype frequencies. Detailed analyses were carried out on these three loci and they were found to be sufficiently correlated to sex in Pacific halibut females such that they may prove useful in assigning sex to individuals as validation or augmentation of the numerical length-at-age method presently used to estimate sex ratio in market samples. A manuscript has been drafted describing the sex-linked alleles and presenting the analysis comparing genetic sexing accuracy to the length-at-age methodology.

PAT tagging in Aleutian Islands and Bering Sea

A PAT-tagging project was initiated in 2008 to investigate why so few PIT tags were recovered from Area 4 and investigate the possibility that eastward migration is higher south of Unimak Pass than north of it. Primary hypotheses for low PIT tag recovery rates in Area 4 include high rates of movement into the Gulf of Alaska, onto the broad eastern Bering Sea flats, into the Bristol Bay closed area, or westward into Russian waters. Of particular importance in the present experiment is that PAT tags do not need to be physically recaptured in order to generate accurate endpoint locations. This eliminates spatial recovery biases arising from regional differences in reporting or tag detection, while allowing recovery of data even if fish move into unfished areas. In addition, archived depth and light data can often be used to assess seasonal migration status and determine whether fish may have dispersed away from the tagging and recovery locations while at liberty. A total of 115 halibut were tagged throughout the Bering Sea and Aleutian Islands during the 2008 setline survey and 17 tagged in 2009 at the Pribilof and St. Matthew islands. All tags were programmed to report location exactly 365 days after tagging in order to assess interannual dispersal in the absence of seasonal migration components. Seventy-eight tags from the 2008 deployments broadcast during the summer of 2009, either after one full year at liberty (n=71), or during the summer from water depths that indicated they had returned to shallow water and were no longer on winter grounds (n=7). There was evidence of fish having emigrated to Russian waters via the contiguous northern shelf of the Bering Sea (n=3), dispersing onto the eastern flats (n=2), and into the closed area (n=4 summer-to-summer, n=8 summer-to-winter). There was no evidence of movement from the Bering Sea into the Gulf of Alaska (GOA), but of the fish tagged south of Unimak Pass (n=14) there was considerable dispersal into Area 3 (n=3), Area 2 (n=1), and northward from the GOA into the Bering Sea (n=3).

Fishery-recovered archival tags

Research on the use of fishery-recovered archival tags on halibut, which began in 2006, continued in 2009 with two studies aimed at developing attachment protocols for future field deployments. A total of 24 halibut ranging from 66-89 cm in length were collected during June and placed in captivity at the Oregon Coast Aquarium along with 11 individuals approximately 55 cm that have been in captivity for several years. Thirty-one fish were tagged on November 4-5, with a variety of both internally-implanted and externally-affixed tags. External mounts included through-body, opercular, and dart-and-tether. Internal implantation followed the protocol established during the 2006-07 holding experiment. The fish will be regularly monitored for growth and behavioral effects over a period of at least one full year post-tagging. Additionally, 200 fish were captured south of Kodiak Island during September 2009, and tagged with either an internal (n=100 fish) or external (n=100) dummy archival tag, in addition to an opercular wire tag. Fishery recoveries will provide a long-term comparison of relative recovery probabilities associated with internal versus external tagging, integrating differences in fish mortality, tag shedding, and differential detection rates between tag treatments. To date, two tagged fish have been recovered; both bore internal tags, which were recovered along with the opercular wire tags.

Pacific Ocean Shelf Tracking (POST)

IPHC participated in the deployment of four sets of receiver-transmitter systems during August 2009, as part of the POST (Pacific Ocean Shelf Tracking) collaboration with NMFS Auke Bay and ADF&G. The receiver-transmitter systems were originally to be deployed at depths of 150, 300, 500, and 700 m. Weather and operational difficulties prevented deployment to the deepest offshore station, so an alternate nearshore station of similar depth was substituted. We also experienced difficulty using a synthetic aperture sonar system to precisely locate the transmitter nodes, although deployments are very close to design guidelines. Receiver-transmitters systems were deployed in depths of approximately 160, 300, 500, and 560 m. The receivers will be retrieved after approximately one year and the stored data analyzed to determine future plans for the use of this technology.

Mortality predictors for trawl-caught halibut (RAMP)

IPHC also participated in a study conducted by the North Pacific Fisheries Foundation (NPFF) to collect data from trawl-caught halibut for evaluating the effects of fishing practices on estimated discard mortality. The reflex action mortality predictors (RAMP) method uses reflex actions (six in this study) to produce a numerical condition score. The RAMP procedure is similar in concept to the existing IPHC condition factor scoring used by NMFS observers for estimation of discard mortality rates, but there are no survival correlates for the RAMP indices, as there are for the IPHC scoring. No tag-recapture studies have been conducted using the RAMP procedures so the relationship of RAMP scoring and survival of discarded fish is unknown. The at-sea research was conducted aboard the F/V *Seafisher* during August in the Bering Sea. Unfortunately, too few halibut were caught to provide sufficient data for analysis, so NPFF expects to conduct a second cruise in April-May, 2010. IPHC intends to participate in that cruise as well.

Electronic monitoring on Alaskan halibut fleet

Anticipated final data collection in our joint project with the North Pacific Groundfish Observer Program (NPGOP) to evaluate the use of electronic monitoring (EM) in the Alaskan halibut fishery did not occur, as we were unable to arrange for the necessary voluntary vessel participation. The long term focus of this research is to improve the understanding of the ecosystem impacts of halibut fishing through improved monitoring of longline fishery bycatch and to provide data on mortality of bycatch species for input to stock assessments. In this study, we are comparing and evaluating the effectiveness of EM and the current monitoring methods of the NPGOP to operate effectively on commercial longliners in Alaskan waters. This was a cooperative study with the commercial fishing industry and relied on our ability to sample on various vessel configurations. We were unable to sign up the number of vessels needed for the experimental design. Only four vessels, three in the Area 3A and one in Area 4, took an observer and accompanying video system. Over 230 sets were monitored among the four vessels. Archipelago Marine Research (Victoria BC) was contracted to provide the EM system hardware and installation, and to provide the video analysis. The aligned datasets have been provided to NMFS for the analysis. A final report is expected by April 2010.

Bomb radiocarbon curve for Bering Sea

In 2009, the staff was approached by staff from the fish aging unit at NMFS with a proposal to construct a Bering Sea bomb radiocarbon curve. Several agencies have used the halibut radiocarbon curve created in 2003 by IPHC staff to successfully validate their age determination methodologies. Those comparisons have been made between fish caught in the GOA and a halibut radiocarbon curve constructed with samples from the GOA. However, NMFS has been unsuccessful in using the GOA halibut radiocarbon curve to validate age determination methodologies for several Bering Sea flatfish. NMFS proposed several possible explanations for this difference and offered to share the costs of constructing a Bering Sea curve. In mid 2009, we began selecting otoliths from ages 1-6 halibut caught during 1954-1981 from the Bering Sea, and as with the first bomb radiocarbon validation study, a set of older halibut also from the Bering Sea will be used to validate the microstructural ageing technique. Upon completion, both the GOA curve and the Bering Sea curve will be compared to determine the initial onset of ^{14}C into both systems.

Water column profilers

Water column profilers were deployed for the first time on all IPHC survey vessels this year. This is the result of a grant from NOAA for the purchase of profilers in 2008. The profilers collect data on depth, salinity, temperature, dissolved oxygen, pH, and fluorescence (chlorophyll-a concentration) throughout the water column, which will provide a unique and valuable annual snapshot of oceanic conditions above the continental shelf over most of the northeast Pacific Ocean and parts of the Bering Sea and Aleutian Islands. A total of 1,245 casts were made in 2009. (A series of preliminary isosurface plots can be viewed in the following location http://www.iphc.washington.edu/halcom/pubs/rara/2009rara/papers/439.pdf)

Cooperative work: Data collection from bycatch species on IPHC survey

Cooperative data collection continued on the assessment surveys in 2009. On the Area 2A surveys, cooperative studies continued with Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW) to collect rockfish (*Sebastes* spp.) bycatch data. In addition, this year we worked with WDFW to fish supplemental stations designed to further enhance the understanding of rockfish status in these areas. On the Area 2B survey, IPHC worked with the Canadian Department of Fisheries and Oceans (DFO) to provide a third biologist on our survey vessels to collect hook by hook occupancy information for all species, and otoliths, maturities, and lengths for rockfish (except thornyheads). Cooperative work with the Alaska Department of Fish and Game (ADF&G) resulted in the collection of whole-haul catch data for yelloweye rockfish from survey vessels operating in the Fairweather survey region of Area 3A and in the Sitka, Ommaney and Ketchikan charter regions of Area 2C. Finally, at the request of the NMFS Alaska Fisheries Science Center Pacific cod assessment team, and as part of a developing effort to collect bycatch information on the Pacific cod in the western regions of our survey, length frequency data were collected on incidentally caught Pacific cod in the 4A Edge and 4D Edge charter regions

Whale interactions

Additional data was collected on the 2009 surveys in an effort to increase our understanding of the scope and impact of whale interactions with longline gear, and in particular the impact on setline surveys. Gear damage was noted on every set, and additional data were collected when marine mammals were in the area. The protocols for this data collection were developed in concert with other agencies, in particular the NMFS sablefish survey team, who is struggling with quantifying the impact of sperm whale depredation on its surveys.

Intern: Ultrasound for at-sea sex determination and maturity assessment

Finally, IPHC hired an intern in 2009 to assist in the use of veterinary ultrasound to assess female maturity while aboard survey vessels. The student, from the University of North Carolina, successfully identified ovarian characteristics that can be used to distinguish between mature and immature females, which in the future may allow us to selectively target fish for tagging programs on the basis of maturity. Her results represent a component of a larger manuscript detailing the use of ultrasound for at-sea sex determination and maturity assessment. This manuscript will be published in the scientific literature, likely some time in 2010.

Other activities

Other field activities in 2009 included (1) placing staff aboard the NMFS trawl surveys in the Gulf of Alaska and Bering Sea to collect otoliths and data on the relative abundance of juveniles, (2) continued collection of halibut tissue samples on the surveys for studies on mercury and other contaminants by the Alaska Department of Environmental Conservation, and (3) collection of seabird occurrence data on the surveys. The staff was also involved with several ongoing otolith aging studies examining the nature of false annuli, and an examination of the timing of annulus formation through marginal increment analysis.

2009 Grants & Contract Research

NMFS Auke Bay Lab (ABL) has had a sablefish data collection program for several years and IPHC has been contracted by NMFS to assist 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 628.00) during the IPHC port sampler's logbook interview. Sablefish data are entered by IPHC staff, edited, and an electronic summary provided to the ABL scientists. Vessels are assigned a unique code in the summarized data to preserve confidentiality. The SOW was renewed for 2009.

IPHC received several grants in 2009. NMFS provided a grant for the incremental increase in port sampling costs due to the IFQ program (Project 300.00-81). IPHC also received a grant from NPRB to partially cover its costs associated with the study examining the use of electronic monitoring (video) of the halibut fishery off Alaska (#654.11-84).

2009 Research Publications

IPHC staff noted in **Bold** type.

Loher, T., and Blood, C.L. 2009. Dispersion of Pacific halibut (*Hippoglossus stenolepis*) summering off British Columbia and the US Pacific Northwest, evaluated via satellite archival tagging. Can. J. Fish. Aquat. Sci. 66(9): 1409-1422.

Yoshizaki, J., Pollock, K.H., Brownie, C., and **Webster, R.A**. 2009. Modeling misidentification errors in capture-recapture studies using photographic tags of evolving marks. Ecology. 90: 3-9.

SECTION II:
CONTINUING RESEARCH

1. NMFS trawl survey: At-sea data collection
Start Date: 1996
Anticipated ending: Continuing
Personnel: L. Sadorus, A. Ranta, S. Hare

A series of NMFS trawl survey data on halibut, parallel to our assessment survey data, is extremely valuable 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 2010, a sampler will be deployed in the Bering Sea.

2. Water column profiler project (General survey)
Start date: 2000
Water column profiler project (Oregon)
Start date: 2007
Water column profiler project (Coastwide)
Start date: 2009
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 provides 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. Since 2001, IPHC has successfully deployed a SeaBird SBE-19 water column profiler during the annual stock assessment survey (#610.11). A second profiler was added to the program in 2007 (#610.12). In 2009, a NOAA grant provided for the complete outfitting of all chartered survey vessels, resulting in a complete coastwide deployment. Annual costs are directed towards maintenance and calibration of the profilers, and data preparation necessary for submission to the National Ocean Data Center.

3. 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.

4. Genetic population structure of Pacific halibut assessed via nuclear microsatellite diversity – lab work by UW

Start Date: 2002
Anticipated Ending: Continuing
Personnel: T. Loher, L. Hauser and H. Galindo (UW-MMBL), other staff as needed

The eastern north Pacific halibut resource is presently managed under the assumption that a single fully mixed population exists from California through the eastern Bering Sea. This belief rests largely upon studies that indicate that drift of larvae to the northwest is balanced by migration of juveniles and adults to the southeast, over broad geographic expanses. In 2002, a project was initiated to investigate genetic population structure in the northeast Pacific using non-selected nuclear microsatellite markers, and in 2004 the study was expanded to spawning groups from British Columbia, the central Gulf of Alaska, and southeast Bering Sea. In February 2007, the 2004 locations were resampled to address concerns about of a lack of temporal replicates, and analysis of those samples continued through December 2007. Increasing the number of microsatellites analyzed and filling gaps in the data set resulted in little change from prior work, although increasing sample sizes did result in increased levels of significance. At the end of 2007 we deemed the microsatellite work to be largely complete, with the conclusion that these markers may simply not be very powerful for detecting population structure in halibut, which has large amounts of larval mixing. Since that time, further investigation of some other genetic markers has shown that they may be more powerful than microsatellites. Twenty-five "expressed sequence tags" have been screened, and these tags are found in regions of DNA that are responsible for coding proteins and that may therefore be driven by evolution in different directions in different ocean basins. Four mitochondrial DNA (mtDNA) regions have been sequenced, which are maternally-inherited and have proven useful in other species for investigating sex-biased migration and demographics in relation to climate change. This work will continue through 2010.

5. PAT tagging: Summer 2008 and 2009 releases (Area 4)

Start Date: 2008
Anticipated Ending: 2010
Personnel: T. Loher, A. Seitz (UAF), sea samplers

A PAT-tagging project was undertaken in 2008 to investigate why so few PIT tags were recovered from Area 4 and investigate the possibility that eastward migration is higher south of Unimak Pass than north of it. A total of 115 halibut were tagged throughout the Bering Sea and Aleutian Islands during the 2008 setline survey and 17 tagged in 2009 at the Pribilof Islands and St. Matthew. All tags were programmed to report location exactly 365 days after tagging in order to assess interannual dispersal in the absence of seasonal migration components. Recoveries to date total 78. Project costs in 2010 are for anticipated satellite transmission time.

6. Bering Sea age validation study utilizing ^{14}C radiocarbon
Start Date: 2009
Anticipated ending: 2010
Personnel: S. Wischniowski, T. Loher, NMFS personnel

Radiocarbon, or ^{14}C bomb carbon, has been used successfully in the past on several fish species as a validation of absolute age assignment. This project would be a collaborative study between IPHC and the NMFS Alaska Fishery Science center as a follow-up to the 2003 aging study conducted on Gulf of Alaska halibut otoliths. Costs to complete the study are based on otolith preparation and accelerated mass spectroscopy (AMS) time, with expenses shared by both agencies.

7. Histology: Analysis of gonad staging
Start: 2004
Anticipated Ending: Continuing
Personnel: T. Geernaert, C. Dykstra, other staff as needed

The IPHC Stock Assessment surveys assess maturity of halibut based on visual criteria established in the early 1990s 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 82 cm but, area-wide, there have been several large 100+ cm females whose gonadal characteristics classify them as immature (never spawned). The assessment survey data also suggest that fish in the southern latitudes (Area 2B) mature earlier and possibly spawn earlier than 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. In total, nearly 240 gonad pairs were collected and we will be analyzing multiple sites from each sample. Three different histological subsamples have been prepared, and test measurements from sample sites are being made. We have assigned additional staff to this project and further measuring will take place in 2010.

8. 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. The Alaska Division of Public Health updated their advice on fish consumption in 2007 with some restrictions on the number of meals of halibut for women of child bearing age and young children.

Since 2002 the IPHC has submitted 1161 samples for testing by ADEC. The mean level of total mercury for these samples has been 0.340 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 2009 with a targeted collection of 60 samples (15 fish between 10-20 lbs, 15 fish between 20-40 lbs, 15 fish between 40-100 lbs, and 15 fish greater than 100 lbs.) from each of three regions (Yakutat, Chignik, and upper Sanak) during the setline survey. ADEC has expressed interest in further assessments of contaminant occurrence in halibut in 2010.

9. Archival tagging: Pilot studies (Area 2B releases)
Start Date: 2006
Anticipated ending: Continuing
Personnel: T. Loher

This study is investigating migratory behavior and environmental conditions experienced by two components of stock: small adult (primarily male) and late pre-recruit halibut, as well as larger adults including reproductive females. The work is a complement to PAT (satellite) tagging studies and seeks to expand our knowledge to components of the population that have not been studied with PAT tags due to apparent size constraints (i.e., males and pre-recruits) and to obtain multi-year data for larger fish. The objectives for each stock component are slightly different, but do not require separate studies. Externally attached, rather than surgically implanted, archival tags are being used. The tags were applied to all females above 90 cm and all fish above 100 cm during August-September 2008 in Area 2B. Project costs in 2010 are for the anticipated recoveries. Premium rewards are being offered to encourage recoveries.

10. Archival tags: Holding tank experiments examining mounting protocols
Start Date: 2009
Anticipated ending: 2010
Personnel: T. Loher

This study is investigating alternate mounting protocols for the externally-mounted archival tags. The 2008 releases in Area 2B were our first experience with using an external mount, and that process suggested some revisions and improvements could be possible which would reduce any effect the tags may have on the fish's behavior. Additional improvements to tag design may also be helpful in creating a different mounting device. A total of 30 halibut ranging from 75-90 cm have been captured via hook-and-line and transported live to the Oregon Coast Aquarium (OCA). Following tagging, fish will be reared for 12-18 months, treated regularly for parasites, examined regularly to assess healing and/or relative infection rates among mounting types, and behavior monitored. At the end of the holding period, fish will be measured to assess relative growth among treatment groups, and tags will be removed to examine the effects of the tag mounts on the tissue and musculature at the attachment site, or internal interactions in the case of an internal-external-streamer modification. The results would support the anticipated use of this type of technology in subsequent years.

11. Archival tags: 2009 releases of dummy test tags
Start Date: 2009
Anticipated ending: 2010
Personnel: T. Loher

External and internal tag recovery rates are being tested in the field release of archival test tags.. In August-September 2009, 200 fish were tagged off southern Kodiak Island (in Areas 3A and 3B), half with external tags and half with internal implants. All fish were also tagged with a bright pink cheek tag, and rewards of $100 will be given for all tags recovered. To date, a single tagged fish has been recaptured; it had received an internal implant, and both of its tags were recovered. FY10 expenses consist of tag rewards.

12. Species identification of amphipods frequenting Pacific halibut
Budget: $ 1,000
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., whether there are 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 last year of data collection for this stage of the project was 2006. The 2007 summer intern performed initial analysis of interannual occurrence and virulence. Additional work will be directed at correlated variables.

13. Alaska fishery electronic monitoring – pilot study
Start Date: 2008
Anticipated ending: 2010
Personnel: G. Williams, B. Leaman, J. Cahalan (NMFS Observer Program), B. Karp (NMFS)

This research tested alternate methods of monitoring the Pacific halibut longline fishery in order to improve our understanding of the ecosystem impacts of halibut fishing. The majority of vessels operating in this fishery are not currently required to carry observers. The long term focus of this research is to improve the understanding of the ecosystem impacts of halibut fishing through improved monitoring of longline fishery bycatch and to provide data on mortality of bycatch species for input to stock assessments. In this study, we compared and evaluated the effectiveness of electronic monitoring (EM) and the current North Pacific Groundfish Observer Program (NPGOP) monitoring methods to operate effectively in a commercial longline (hook-and-line) setting in Alaskan waters. This was a cooperative study with the commercial fishing industry and relied on our ability to sample on various vessel configurations.

The project was not as successful in 2008 and 2009 in getting as many vessels to participate as expected. Only four vessels, three in the Area 3A and one in Area 4, took an observer and accompanying video system. Over 230 sets were monitored among the four vessels. Archipelago Marine Research (Victoria, BC) has provided aligned data sets from the video data for subsequent comparison with the observer sampling. Analysis will be completed in 2010. Project costs are for the required attendance at the Alaska Marine Science Symposium in January, 2010 to present results.

14. RAMP bycatch mortality study
Start Date: 2009
Anticipated ending: 2010
Personnel: G. Williams, B. Leaman, K. Hallgren (IPHC sea sampler), T. Loomis (NPFF)

In 2009, the North Pacific Fisheries Foundation (NPFF) was granted an experimental fishing permit (EFP) to collect data from trawl-caught halibut for evaluating the effects of fishing practices on estimated discard mortality. The reflex action mortality predictors (RAMP) method uses reflex actions (six in this study) to produce a numerical condition score with seven possible outcomes ranging from 0.0 – 1.0, where 1.0 = fully impaired fish with no reflex responses. At present, no RAMP mortality estimates exist for commercially caught trawl halibut bycatch, though laboratory studies have been completed by Dr. Michael Davis (NMFS) in Newport, Oregon. The RAMP procedure is similar in concept to the existing IPHC condition factor scoring used by NMFS observers for estimation of discard mortality rates, but there are no survival correlates for the RAMP indices, as there are for the IPHC scoring. No tag-recapture studies have been conducted using the RAMP procedures so the relationship of RAMP scoring and survival of discarded fish is unknown.

The study took place during August 8-16 in the Bering Sea aboard the catcher-processor F/V *Seafisher*, with the goal of sampling 75-100 halibut of up to 65 cm in length. The scientific crew included an IPHC sampler. Halibut were to be sampled for reflex impairment through a representative range of actual commercial trawling operations and sorting times, and then held for three days on board ship to measure delayed mortality. Data were also collected for towing conditions, total catch per tow, environmental conditions on the trawl and on deck, sorting times, and standard viability scores used by NMFS observers. While the at sea data collection and holding of live halibut was successful, the sampling goal of assessing and holding 75-100 halibut was not met. This was probably due to the area and target species (arrowtooth flounder), as not enough halibut were caught. In addition, most of the fish that were caught were too large for the holding tanks. NPFF has obtained an extension of the EFP to redo the study during the yellowfin sole fishery in April-May, 2010. IPHC intends to also participate in that cruise.

Proposed New Research

1. Archival tags: Preparation for coastwide release

Start Date: 2011 or 2012
Anticipated ending: Continuing
Personnel: T. Loher, B. Leaman, R. Webster, J. Forsberg

In preparation for a coastwide release of archival tags in 2012, the staff has been working with Lotek Wireless (St. John's, NL) on a specific tag design and configuration for IPHC use. Although no field activity is planned for 2010, Lotek is continuing their work on our requirements and construction. Results from the 2009 release of dummy archival tags in Area 3A and the examination of several mounting protocols on fish being held at the Oregon Coast Aquarium will feed into the design of the tag and its attachment to the fish.

2. Archival tags: Site selection in Area 4B

Start date: 2010
Anticipated ending: 2010 for tag releases; 2012 for tag recoveries
Personnel: T. Loher, J. Forsberg, survey team

Recovery rates of PIT tags released in the Aleutians have been quite low, without evidence of recovery hotspots. This suggests that if archival tags were deployed in the Aleutians without first attempting to locate appropriate release sites, we would likely recover relatively few of those tags. This would result in either too few data to draw any conclusions regarding behavior in the region or require that a very large number of tags be initially deployed. Given that archival tags cost $500-1200 each, resorting to a very large deployment would be financially prohibitive. This proposal represents a test-deployment to be conducted with relatively inexpensive conventional wire tags in the summer of 2010 in advance of more expensive archival tagging, asking a single question: can at least two deployment sites be determined in the Aleutian Islands, one within the Andreanof Islands group and one within the Near-Rat Islands group, where tag recovery rates are high enough to warrant future archival tag deployments? While the archival tags will not be restricted to deployment in the Aleutian Islands in future studies, this project is necessary to determine if it is practical to deploy them in this region.

Other 2010 Research – Contracts and Grants

1. **Alaska port sampling**
Granting agency: NMFS
Start Date: 2002
Anticipated ending: Continuing
Personnel: H. Gilroy, M. Larsen, L. Erikson

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.

2. Water column profiler project (Coastwide)
Start date: 2009
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 provides 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. Since 2001, IPHC has successfully deployed a SeaBird SBE-19 water column profiler during the annual stock assessment survey (#610.11). A second profiler was added to the program in 2007 (#610.12). In 2009, a NOAA grant provided for the complete outfitting of all chartered survey vessels, resulting in a complete coastwide deployment. Annual costs are directed towards maintenance and calibration of the profilers, and data preparation necessary for submission to the National Ocean Data Center.

3. Alaska catcher vessel logbook and sablefish data collection
Contracting agency: NMFS
Start Date: 1999
Anticipated ending: Continuing
Personnel: L. Erikson, 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. Logbook data are entered by IPHC staff, matched with landings records, and provided electronically with a summary to the ABL scientists. In the summarized data, the vessels are assigned a unique code to preserve confidentiality.

4. Alaska fishery electronic monitoring – pilot study
Start Date: 2008
Anticipated ending: 2010
Personnel: G. Williams, B. Leaman, J. Cahalan (NMFS Observer Program), B. Karp (NMFS)

This study compares and evaluates the effectiveness of electronic monitoring (EM) and the current North Pacific Groundfish Observer Program (NPGOP) monitoring methods to operate effectively in a commercial longline (hook-and-line) setting in Alaskan waters. This was a cooperative study with the commercial fishing industry. IPHC is partnering with the NMFS North Pacific Groundfish Observer Program and Pacific States Marine Fish Commission in this study. This section serves to acknowledge the grant received by IPHC from the North Pacific Research Board.

Research Conducted Without Direct Funding

1. Estimation of halibut abundance from mark-recapture data
Personnel: R. Webster, B. Leaman, S. Hare

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. 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 2005-2007 followed a similar pattern. The 2009 recoveries will be added to the analysis this year.

2. Whale sightings by the commercial fishery off Alaska while hauling gear
Personnel: L. Erikson, port samplers
Start: 2007
End Date: Under review

Beginning in 2007, IPHC U.S. commercial fishery logbooks were modified to facilitate the collection of whale sightings while hauling gear. This is a pilot project to determine if sighting information can be collected and if accurate information can be obtained. This information could help to set a baseline for sightings. A review of other programs will be conducted to see where information is collected, available, and stored. Additionally whale sighting data collected during the grid survey can be reviewed along with known depredation activity on the grid survey sets. Data will be reviewed and results provided in the 2009 RARA.

3. Seabird occurrence project
Start Date: 2002
Anticipated ending: Continuing
Personnel: T. Geernaert, Washington State Sea Grant

During the stock assessment surveys, sea samplers count the number of seabirds in the vicinity of the vessels following gear retrieval. Sampling after the haul addresses the question of where and when certain seabird species occur. These data have been used to identify appropriate seabird deterrent requirements in certain geographic locations. Data have also been collected, using the same protocol, on the NMFS and ADF&G sablefish surveys. IPHC has developed a database to store seabird occurrence data and the collection project is ongoing.

4. Seabird data repository (Project 643.00)
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.

5. Data from incidentally captured species on the assessment surveys

Start Date: 2003
Anticipated ending: Continuing
Personnel: C. Dykstra, T. Geernaert, E. Soderlund, E. White, sea samplers, agency staff

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 retained and marked externally with a Floy T-bar anchor tag and the tag number is recorded with the set and skate of capture (since 2006) information. All marked fish are retained so state biologists can collect additional data shore side. Marketable fish are sold. The IPHC then provides each agency with the effort information collected as part of the normal survey data collection.

In 2009, IPHC worked with WDFW to fish supplemental stations designed to further enhance the understanding of rockfish status in these areas. Eighteen stations were fished off Washington (a continuation of similar studies from the previous three years). Three skates of gear were fished at each station as a precautionary approach due to the exploratory nature of these stations and concerns about the low overall quota for yelloweye rockfish. Activities at each station were identical to those on standard IPHC stations except that halibut were only sampled for length and prior hooking injury and then released alive; rockfish were handled as described above.

Area 2B
In 2009, IPHC worked with the Department of Fisheries and Oceans Canada (DFO) to provide a third biologist on IPHC survey vessels to collect hook-by-hook occupancy information for all species. Otoliths, maturities, round weights, and lengths were collected for all rockfish except thornyheads. This is the seventh year of this cooperative program and continued collaboration is anticipated.

Area 2C and eastern 3A
In 2009, IPHC enumerated all yelloweye rockfish captured on survey, at the request of the Alaska Department of Fish and Game (ADFG), for operations in the Fairweather, Sitka, Ommaney, and Ketchikan charter regions. The 2009 work was scaled back from what was done in 2008, which required an additional sampler to collect hook-by-hook occupancy information for all species, plus otoliths, sex, and lengths for all yelloweye rockfish. This project built upon cooperative work started with ADFG in 2007 and future collaboration is anticipated.

6. Electronic reporting project for commercial landings in Alaska

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

IPHC, ADF&G, and NMFS staffs have continued to refine the web-based Interagency Electronic Reporting System (IERS). For halibut, the system reduces duplicative reporting resulting from the current requirements of completing ADF&G fish tickets and NMFS/RAM quota share reports, and has been operational since May 2006. 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. Industry personnel and agency staff have provided feedback on the operation and the application is continuously being modified, including the incorporation of additional fisheries and tender landings. Agency staffs have been to yearly trainings or workshops on the program. In 2009, the focus will be on continued training with the processors. Costs represent system maintenance costs, software purchase and development, steering committee meetings, and travel costs.

7. Electronic logbooks
Start: 2010 (postponed from 2008)
End Date: Pilot project
Personnel: H. Gilroy, L. Erikson, K. MacTavish

IPHC and NMFS/AKR are collaborating to determine the feasibility of an electronic logbook and to establish the specifications needed for contractors. The Commission staff will also be reviewing other programs to decide if another geographic location (Area 2B or 2A) is an appropriate place to start an electronic logbook program.

Research Topics for 2011

1. Catchability symposium
Personnel: B. Leaman, S. Hare, R. Webster, J. Valero

The issue of common catchability for IPHC setline survey gear across all areas of the coast is a key component of the use of survey data for biomass apportionment. This assumption is used by management agencies around the world. While many agencies, including the IPHC, have examined data to determine if the assumption is met, there has never been a comprehensive test of the assumption across a stock's range for longline fisheries. We intend to convene a symposium of scientists and technology developers to determine if it is possible to conduct a coastwide experiment validating the catchability assumption.

Northwest Fisheries Science Center

National Marine Fisheries Service

NOAA Fisheries

Agency Report to the Technical Subcommittee

of the Canada-U.S. Groundfish Committee

April 2010

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 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, 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; and employ advanced technologies for new assessments.

During 2009, FRAMD continued to: implement a West Coast observer program; build a survey program that conducts 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 habitat 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

1. Research

a) Estimating the NWFSC survey trawl herding and footrope escapement

Data collected during the NWFSC trawl survey are the primary source of fishery-independent data included in stock assessments and are vital in determining current and projected stock size. The survey produces annual swept-area biomass estimates that are calculated using the area swept by the trawl to estimate the density of fish; these estimates are then expanded to the full survey area. Understanding the distance and width that the trawl is effectively fishing is important for producing an accurate calculation of the area swept in relation to the capture of a particular species. Currently, area swept is calculated using the distance over which the net is determined to be on the bottom and the width between the wings of the net. However, previous experiments describe herding over areas greater than the portion of the trawl between the wings. If fish are actively avoiding or being herded by the trawl net, the effective area swept may be smaller or larger, respectively, resulting in the need to modify the area-swept calculation.

In 2009, the NWFSC undertook a pilot study to use video to examine the trawl warps (the cable running from the trawl doors to the wing extension of the footrope) while the Aberdeen Trawl was fishing under standard procedures. The video camera work was conducted aboard the F/V Raven between August 22 and 24. A combination of historical NMFS survey catch data and fishermen's knowledge of the fishing grounds was used to locate areas where the project was likely to find target flatfish species. An underwater video camera was attached at each of three different positions along the starboard warp of the survey net to try to observe trawl performance along this portion of the gear, generally, and to capture visual evidence of herding, specifically.

The first priority was to position the video camera system at several locations above the 90-foot section of the lower bridle or sweep closest to the trawl wing. The plan was to fly the camera and light frame from the upper cable bridle. This has been done successfully by the Alaska Fisheries Science Center. To start, representative video was collected from 3 points along the 90' section of sweep. The second priority was to position the video camera system at several locations above the 90-foot section of the bridle or sweep closest to the trawl door. This portion of the sweep has no upper bridle. The plan was to fly the camera and light frame from a 200-ft long Spectra line that ran from the door end of the sweep to the leading edge of the upper starboard wing. This has also been done successfully by the Alaska Fisheries Science Center, but is much more difficult to "dial in." As with priority one, we collected representative video from 3 points along this 90-foot section of sweep. The third priority was to collect video observations of fish behavior in association with the trawl doors.

Initial emphasis was placed on obtaining adequate views of the target areas of the sweeps. Once we began to collect adequate video, we closed the trawl codend and began sampling to provide groundtruthing for the video. Post processing the video is currently underway to determine: 1) the number of fish that go over or under mud gear versus the number herded, 2) direction of herding, 3) changes in performance during hall back, 4) when the sweeps contact the bottom and how consistent is contact over the 200-foot interval, and 5) fish behavior around doors.

Closer examination of the video footage is currently underway to collect information on the movement and behavior of fish in response to the warps, and data from this will be used to provide information for stock assessments and to plan a more extensive project to address this issue in the future, if possible.

For more information, please contact Keith Bosley at Keith.Bosley@noaa.gov

b) U.S. west coast temporal and regional summer groundfish assemblages: 1977 to 2008

Investigators: J. Cope and M. Haltuch

Multispecies interactions are increasingly being considered when developing sustainable fisheries practices for the U.S. west coast groundfish fishery, highlighting the need for identification of spatial and temporal groundfish assemblages. Previous groundfish assemblage analyses using fishery independent survey data have either focused on particular groups (i.e. *Sebastes*) or limited geographic regions within the groundfish fishery and have not used the most recently available data. We use hierarchical and non-hierarchical agglomerative clustering methods on presence-absence and log+1 transformed CPUE data to identify groundfish assemblages for the full spatial extent of the west coast groundfish triennial survey from years 1977-2001. Persistent and predictable co-occurring assemblages were detected by both methods through most years of the survey, while the magnitude at which species were caught together was also investigated. Members of an assemblage may therefore occur together, but not necessarily at the same magnitudes. These findings are relevant to marine resource managers because they can be directly applied to formulating bycatch models and in evaluating the implementations of spatial management measures, such as marine protected areas.

For more information, please contact Dr. Jason Cope at Jason.Cope@noaa.gov

c) Using meso-habitat information to improve abundance estimates for West Coast groundfish: a test case at Heceta Bank, Oregon

Historical *in situ* observations of benthic fishes and invertebrates represent an opportunity for establishing fishery-independent benchmark estimates of abundance from specific time points and in both trawlable and untrawlable habitats. Depending on the original intended purpose of a given study, the direct count data may be non-random in nature. The objective of this research is to show how a new method for treating such data was used by combining *in situ* fish observation data and a habitat map to estimate fish abundance. We evaluated whether increased resolution of habitat information could improve the precision of population estimates. For this study we used an existing and previously published data set from Heceta Bank, Oregon. Heceta Bank is one of the largest rocky banks along the US west coast containing a diverse array of habitats supporting numerous species of commercially important groundfish, including a diverse assemblage of rockfishes (*Sebastes*). We looked at fish observations relative to the variables of habitat type, depth, backscatter intensity and relative elevation (i.e., topographic position index [tpi]) and post-stratified the data according to levels of sampling effort. We also looked at two levels of habitat detail: four habitat types, and “hard” vs “soft” substrate. We then calculated the density and variance of fish species for each habitat type and then estimated fish abundance for a select group of groundfish species. Based on these results it appears that improved precision of more geographically comprehensive abundance estimates may be achieved through pre-survey stratification based on currently available habitat information.

For more information please contact Julia Clemons at Julia.Clemons@noaa.gov

d) Demersal fish species composition and biomass in relation to the oxygen minimum zone along the U.S. West Coast

The goal of this research is to provide information of use to fisheries manager to aid in assessment of fish populations in the face of future climate changes. Various models driven by increased greenhouse gases and higher temperatures predict a decline in oceanic dissolved oxygen (DO) as a result of greater stratification and reduced ventilation of waters below the thermocline. Since spreading of low oxygen waters is currently underway and predicted to increase, understanding the impacts on higher trophic levels is essential. Shoaling of the oxygen minimum zone (OMZ) is expected to produce complex ecosystem-level changes in the California Current System Direct hypoxia-related effects are expected on demersal fish and benthic invertebrate species depending on their oxic requirements where the OMZ contacts the continental margin. The onshore movement of the OMZ could lead to habitat compression for species with higher oxygen requirements while perhaps allowing expansion of species tolerant of low bottom DO concentrations. These events need to be considered when managing our nation's fisheries.

In 2009, the NWFSC sampled a range of oxygen conditions extending from the upper to the lower limit of the OMZ as well as across the boundaries of the OMZ. We collected data on the composition, distribution, and biomass of demersal groundfish species in relation to bottom oxygen concentration within the Eastern North Pacific OMZ along the U.S. West Coast from May 23 – July 27, 2009 (pass 1) and August 26 – Oct. 25, 2009 (pass 2). We measured bottom oxygen concentrations on 192 tows conducted during the first half of the 2009 West Coast Groundfish Bottom Trawl Survey (WCGBTS) and 182 tows conducted during the second half of the survey. Our preliminary results indicate that DO ranged from 0.07 to 3.88 ml l^{-1} during pass 1 with 128 stations experiencing hypoxic conditions (DO < 1.43 ml l^{-1}). During pass 2, near bottom DO ranged from 0.08 to 4.33 ml l^{-1} with 104 stations located in hypoxic waters. Throughout this project, the NWFSC has collaborated with a group of physical oceanographers at Oregon State University to develop procedures and protocols for integrating the collection of oceanographic quality temperature, salinity, and dissolved oxygen data into the WCGBTS. Figure 1 shows bottom DO levels in the northern portion of the study site during both the first and second half of the survey. Hypoxic levels are seen at greater depths along the DO minimum zone during both periods, with an apparent shoreward movement of low DO waters during the second portion of the survey (August – October).

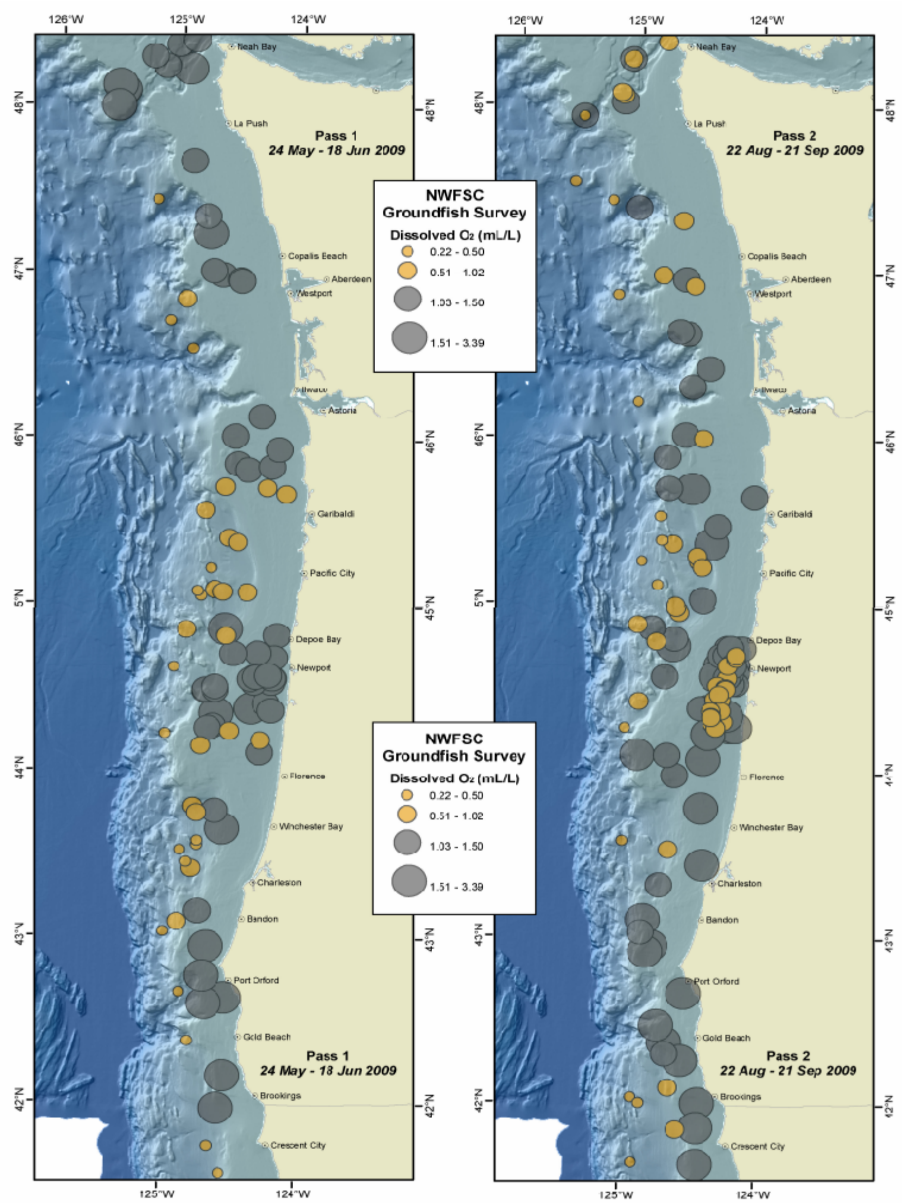

Figure 1. 2009 sampling station by survey pass: North of Crescent City. The size of the circles are proportional to the concentration of bottom DO (ml l^{-1}) and clearly show low oxygen in deep water within the DO minimum zone as well as low oxygen at shallower depths offshore of Newport Oregon. Low DO appeared to move shoreward as the summer progressed.

For more information, contact Aimee Keller at (206) 795-5860, Aimee.Keller@noaa.gov.

e) Development of a Quantitative Optic Trawl Analysis System (QUOTAS)

The goal of this research effort is to improve accuracy and reduce uncertainty of fish stock assessments by developing a non-lethal, efficient method of gathering data on important management species over wide areas via a deployed integrated optical camera system (Figure 2). The priorities for FY09/10 were: 1) to test a single unit consisting of camera, laser diodes, and flash (CLF) components and build a benchtop prototype; 2) to assemble a complete prototype using 6 cameras; and 3) to integrate the 6 camera system into the cod end of a trawl net and test in trawling operation. The funds were secured in a competitive bid contract which was awarded to GSA vendor Sound and Sea Technologies in Seattle. The camera and laser diode components are undergoing preliminary testing and trials. The design for the flash circuitry will quickly follow for the benchtop prototype. This NWFSC effort supports the national Advanced Sampling Technology Working Group initiative to improve NMFS's ability to monitor protected marine resources without using conventional, lethal trawling methods.

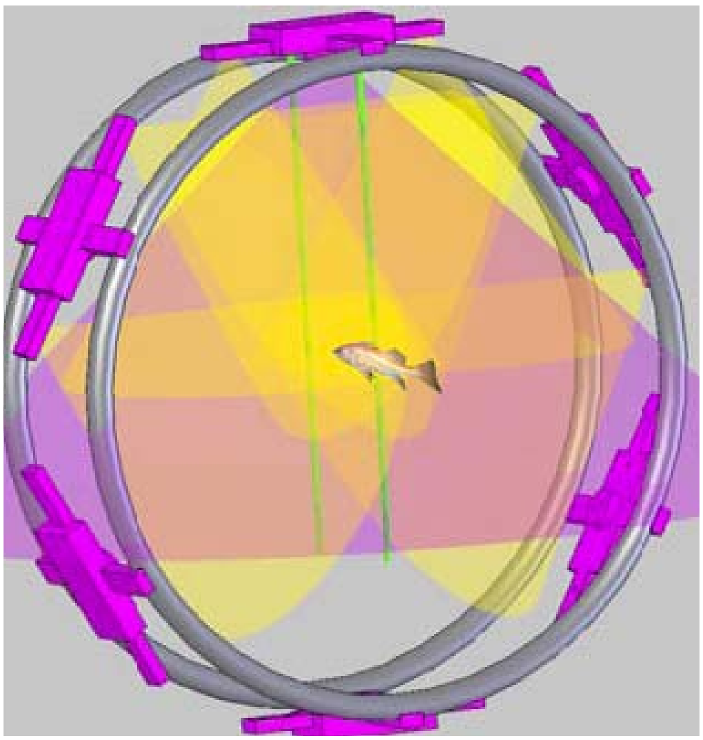

Figure 2. Diagram illustrating the configuration of the QUOTAS. A total of 6 CLF units will be activated in a group of 3 to illuminate sequentially the sample volume bounded by the ring frame. The laser pair on each CLF will be used to size the illuminated targets.

For more information please contact Victor Simon at: Victor.Simon@noaa.gov

f) Demersal fish abundance in relation to an offshore hypoxic zone along the U.S. west coast

In August 2009, as part of the West Coast Groundfish Bottom Trawl Survey, FRAMD examined the abundance of benthic organisms in a known hypoxic area off the Oregon coast. Since 2002, seasonal hypoxia has been observed extending over an area greater than 700 km^2 offshore of Newport, Oregon. Although observed each summer, the intensity of hypoxia has varied with the greatest temporal and spatial extent noted in 2006. The Northwest Fisheries Science Center annually conducts a groundfish survey from Washington to California (55 to 1,280 m) using a stratified random design. A few stations generally fall within the hypoxic area and in 2006 FRAMD observed exceedingly low fish biomass here. Consequently in August 2009, FRAMD dedicated 3-days of the groundfish survey to examining the abundance of demersal fish and invertebrates within the hypoxic zone in greater detail, as was initially done in 2007. Working collaboratively with colleagues from Oregon State University, we identified the geographic extent of the

2009 hypoxic zone. A Seabird SBE19-plus was attached to the trawl gear to monitor oxygen concentration during each tow. We sampled 14 stations along 2 depth contours (70 and 80 m) and additionally measured bottom DO via 31 CTD casts within the sampling area off OR. All catch was identified and weighed with stomach and tissue samples taken from selected species. Dungeness crabs from each tow were measured, weighed and assigned a condition code. During the 3-day survey, bottom oxygen concentrations at all stations ranged from 0.55 to 1.48 ml l^{-1} and was hypoxic along 12 tow tracks. Preliminary results indicate that total catch (kg) and bottom dissolved oxygen (DO, ml l^{-1}) levels for 2009 were significantly related as seen for all depths combined and (Figure 3).

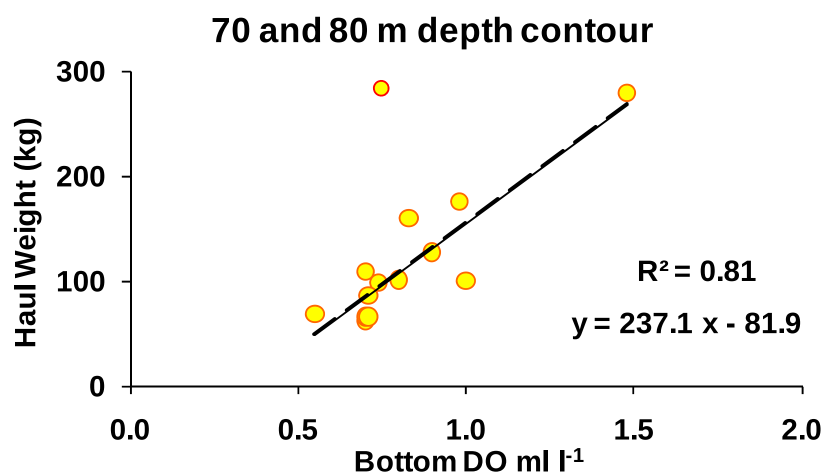

Figure 3. Relationship between haul catch (kg) and mean bottom oxygen concentration (DO, ml l^{-1}) along the tow track within the hypoxic zone.

For more information please contact Dr. Aimee Keller at Aimee.Keller@noaa.gov.

g) Accuracy of sex determination for northeastern Pacific Ocean thornyheads (*Sebastolobus altivelis* and *S. alascanus*)

Determining the sex of thornyheads (*Sebastolobus alascanus* and *S. altivelis*) can be difficult under field conditions. We assessed our ability to correctly assign sex in the field by comparing results from field observations to results obtained in the laboratory through both macroscopic and microscopic examination of gonads. Sex of longspine thornyheads was more difficult to determine than that of shortspine thornyheads and correct determination of sex was significantly related to size. By restricting the minimum size of thornyheads to 18 cm for macroscopic determination of sex we reduced the number of fish with misidentified gender by approximately 65%.

For more information please contact Erica Fruh at Erica.Fruh@noaa.gov.

h) Catch composition in the NMFS west coast bottom trawl survey as a predictor of habitat complexity

For many assessments of west coast fish stocks, an annual bottom trawl survey is the main source of fishery-independent information on biomass trends. Unfortunately, these biomass estimates are made under the assumption that densities of fish observed in the trawl catches are uniform across all benthic habitats. From *in situ* habitat studies, we know however that density can vary significantly in relation to various habitat types. The recent availability of coast wide maps of surficial geologic habitat off the west coast has provided the opportunity to explore trawl survey catch rates in the context of seafloor characteristics. For this study, we compared catch-per-unit-effort data for select species of demersal fishes and benthic invertebrates to the habitat types encountered during the trawl. These trawls were conducted between 2003 and 2009 by the Northwest Fisheries Science Center as part of an annual trawl survey of commercially important groundfishes. The species used in this analysis were chosen due to their ubiquitous distributions and strong affinities to certain benthic habitat types – either soft, unconsolidated sediments or hard, rocky outcrops. We hypothesize that for trawls that encounter a variety of habitats, the catch composition will reflect those changes in habitat type. For instance, we expect to see species with affinities to hard, rocky habitats if the trawl crosses those types of habitat. If our hypothesis is correct, we hope to develop a model using catch composition as a predictor of greater habitat complexity, particularly in areas where habitat information is lacking.

For more information please contact Curt Whitmire at Curt.Whitmire@NOAA.gov

i) Reproductive parasitism of lithodid crabs by snailfishes off the western U.S.
Snailfish (Family Liparidae) are probably the most broadly distributed family of marine fishes, occurring in temperate and cold ocean waters from intertidal to depths below 7,700 m. Some snailfishes of the genus *Careproctus* have the unique reproductive strategy of depositing their eggs in the branchial chambers of large lithodid crabs, probably via an ovipositor. The relationship has been described as parasitic, with effects on crabs ranging from no obvious damage to major gill compression and necrosis of half (an entire side) of the gills. Records of carcinophily consist of observations of eggs (and/or larvae) in crabs, but generally the fish involved are unidentified because the eggs have no distinguishing features, and snailfish are too similar in morphology to allow identification of embryos. West Coast U.S. occurrences have been reported.

We initiated a pilot study during the 2007 NWFSC groundfish trawl surveys to collect data on the presence of snailfish eggs in the branchial chambers of crabs captured in the survey trawls, to identify adult snailfishes collected on the survey, to use genetic methods to match eggs to adults, and to initiate further studies of carcinophily. We included a non-lithodid group of crabs with potential commercial value, tanner crabs of the genus *Chionoecetes*, but 807 crabs were checked for the presence of snailfish eggs and none were found. Snailfish eggs were found in three different lithodid species out of six that were collected and checked in 2007. The study was continued in 2008 and 2009 checking only lithodid species for egg masses. Five different lithodid species out of the ten that were collected in 2008 had egg masses, three of which (*Paralithodes rathbuni*, *Paralomis multispina*, and *Glyptolithodes cristatipes*) were the first recorded instances of parasitism. Five different lithodid species out of the seven that were collected in 2009 had egg masses. At least seven different species of snailfish in three genera were collected during the 2007 survey, including one (*Paraliparis pectoralis*) that is rare in collections. Visual analysis of the egg masses suggests there are at least two different liparid species depositing their eggs in crabs. The most common species collected was *C. melanurus.* Females collected had ovarian eggs ranging from undeveloped to 4.9 mm in size, suggesting that spawning may be protracted, even if periodic. Genetic analysis of egg masses and tissue samples taken from adult snailfish to identify which species laid the eggs was completed for 2007 samples. All of the egg masses were determined to belong to just one species, *C. melanurus*. Information on the relative frequency of occurrence of parasitism was determined for 2007 and 2008, and the rates for each year, respectively, were as follows: *Lopholithodes foraminatus* 12.9% and 4%; *Lithodes couesi* 2.1% (2007); *Paralithodes californiensus* 7.2% and 6%; *G. cristatipes* 9% (2008); *P. rathbuni* 1% (2008), and *P. multispina* 1% (2008). Genetic analysis of egg masses is underway for 2008 and 2009. This work will both help clarify the natural history of two groups of species distributed worldwide: snailfishes and lithodid crabs, and, we hope, lead to clarification of the evolution of this unique behavior.

For more information please contact Keith Bosley at Keith.Bosley@noaa.gov

j) Estimates of Pacific halibut bycatch and mortality in IPHC Area 2A in 2008 West Coast

During 2009, the estimate of Pacific halibut bycatch and mortality in the bottom trawl fishery was updated through the calendar year 2008. The estimate of halibut bycatch and mortality in the bottom trawl fishery is based upon the method developed in the Pikitch et al. (1998) paper and the report for 1999 (Wallace, 2000) with the addition of using halibut condition as recorded by the West Coast Groundfish Observer Program (WCGOP). This analysis used halibut bycatch rates observed during the 2008 calendar year from WCGOP. These rates are stratified by season, depth, latitude, and level of arrowtooth flounder catch; then multiplied by the amount of trawl effort in each stratum, which was derived from the 2008 Oregon and Washington trawl logbooks.

For more information please contact John Wallace at John.Wallace@noaa.gov

k) Length-based reference points for data-limited situations: applications and restrictions

Investigators: J. Cope and A. Punt

Current fisheries management policies generally require assessing stock status, a difficult task when population and fisheries data are limited. Froese (2004) offered three simple metrics (P_{mat}, P_{opt}, P_{mega}) based on catch length compositions by which to monitor population status relative to exploitation. They are intended to avoid growth and recruitment overfishing, but there was no quantitative linkage to stock status and calculation of future sustainable catches. We attempt to make this connection by exploring the relationship of these measures (collectively referred to as P_x) to fishing mortality and spawning biomass. The relationships are compared specifically to current target (0.4 SB_0) and limit (0.25 SB_0) reference points used for the U.S. west coast groundfish fishery using simulations based on a deterministic age-structured population dynamics model. Sensitivity is explored to fishery selectivity, life history traits and recruitment compensation (steepness). Each P_x measure showed a wide range of possible values depending on fishery selectivity, steepness, and the ratio of the length at maturity (L_{mat}) to the optimal fishing length (L_{opt}). The values of P_x suggested by Froese (2004) as being compatible with sustainable fishing are not always sufficient to insure stock protection from overfishing. Moreover, values for P_x cannot be interpreted adequately without knowledge of the selectivity pattern. A new measure, P_{obj} (the sum of P_{mat}, P_{opt}, and P_{mega}) is introduced to distinguish selectivity patterns and construct a decision tree to develop indicators of stock status. Heuristic indicator values are presented to demonstrate the utility of this approach. Although several caveats remain, this approach builds on the recommendations of Froese (2004) by giving further guidance related to interpreting catch length composition data under variable fishery conditions without collecting additional information. It also provides a link to developing harvest control rules to inform proactive fisheries management under data-limited conditions.

For more information, please contact Dr. Jason Cope at Jason.Cope@noaa.gov

l) Drawing the lines: Resolving fishery management units with simple fisheries data

Investigators: J. Cope and A. Punt

The task of assessing marine resources should begin with defining management units. Often this step is overlooked or defined at temporal scales irrelevant to management needs. Additionally, traditional methods to define stock structure can be data intensive and/or cost prohibitive and thus not available for emerging or data-limited fisheries. We present an approach that uses commonly available fisheries data (catch and effort) to delineate management units for dynamically independent populations. Spatially-explicit standardized indices of abundance are grouped using a two-step partitioning cluster analysis that includes abundance index uncertainty. This 'management unit estimator' (MUE) is tested via simulation and found generally to recover the true number of management units across data of different temporal length, sample size, and quality. Management units are then determined for four species with varying ecologies, fishery histories, and data issues that exemplify the challenges of applying this method to messy data sets. Defining management units via relative abundance incorporates changes in population connectivity in relation to current removals and environmental conditions, and creates consistency of index use within assessments. The two-step clustering approach is simple and widely applicable to situations wherein the clustering metric contains uncertainty.

For more information, please contact Dr. Jason Cope at Jason.Cope@noaa.gov

m) Feeding ecology of juvenile rockfish off Oregon and Washington as indicated by diet and stable isotope analysis

Investigators undertook a study of the feeding habits of juvenile rockfish (genus *Sebastes*) collected off Oregon and Washington during GLOBEC (2002) and NOAA Predator (2006) surveys. The predominant species collected in both years were darkblotched (*S. crameri*), canary (*S. pinniger*), yellowtail (*S. flavidus*), and widow (*S.*

entomelas) rockfishes. Analysis of gut contents by % number revealed that darkblotched rockfish had a high degree of variability in their diets, consisting of gelatinous zooplankton (2002), several life-history stages of euphausiids (2006), as well as hyperiid amphipods and copepods (2002, 2006). Canary, yellowtail, and widow rockfishes had a high degree of dietary overlap, because of common utilization of copepods and euphausiids. There was less overlap in diets between species when % wet weight was examined, with only canary and widow rockfish showing significant similarities (2006). Additionally, nitrogen stable isotope analyses confirmed that there was a 1.5‰ difference between years, and all fish from the same year were feeding at nearly the same trophic level. In both years, carbon signatures were of an off-shore origin, and darkblotched were enriched relative to all other species. Non-metric multidimensional scaling revealed significant differences in diet with increasing distance from shore. Taken together, these results advance our understanding of some of the important environmental factors that affect young-of-the-year rockfish during their pelagic phase.

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n) Taxonomic and genetic identification of fisheries bycatch of deep-sea corals during the 2009 West Coast Groundfish Bottom Trawl Survey

The purpose of this project is to contribute to ongoing efforts toward establishing a voucher collection for deep-sea corals from the West Coast. Deep-sea corals are often components of trawling bycatch, though their brittle skeleton and slow growth make them particularly vulnerable to such impacts. An understanding of their population structure is critical to ascertaining the effects of habitat loss and genetic connections among distant populations, both of which are important to the 2006 Magnuson-Stevens Act directive and the NMFS federal mandate. An initial species inventory of deep-sea corals off the United States coastline is a necessary first step toward a comprehensive understanding of the ecology and distribution of this diverse species assemblage; however, the taxonomic identification of corals to the species level is often problematic. In some cases morphologically similar specimens may only be distinguished from one another using microscopic skeletal structures. In other cases, the taxonomic delineations of some families are so confused that accurate species-level designations are currently impossible. The use of genetic information combined with morphology is likely the best approach to decipher evolutionary patterns in these species. In FY2009 we received funding from the NOAA Deep-Sea Coral Research and Technology Program to support the collection of coral specimens during the 2009 West Coast Groundfish Survey, as well as DNA sequencing of specimens from previous years (2007-2008) of the same surveys. In addition, we began creating scanning electron microscope (SEM) images of some of the specimens, which will be linked to the original specimen for our Voucher Collection. These SEM images will help morphological taxonomists identify the species collected in these surveys. The linked DNA data, SEM images, and morphologically verified specimens will serve not only as an essential resource for coral researchers and other stakeholders, but also as a foundation for future research efforts at the Northwest Fisheries Science Center (NWFSC) aimed at understanding the biogeography and ecology of coral species in these deep-sea communities.

Initial DNA sequencing of the 2007-2008 specimens has been completed, and preliminary analyses are underway. Various species of sea pens make up the bulk of the specimens collected, but there are also a number of gorgonian corals in the collections as well. A significant number of those gorgonians fall into a group putatively identified as *Swiftia* spp., but the taxonomy of this group is equivocal. Given the numbers of *Swiftia* found in the trawls, we began by concentrating our efforts with this difficult group. SEM images from several *Swiftia* specimens have been produced and initial sequence information suggests there may be phylogenetic associations relating to colony morphology. We are in contact with a morphological taxonomist (Beth Horvath) at the Santa Barbara Museum of Natural History, who will assist in determining species-level designations for these specimens.

For more information, please contact Ewann Berntson at Ewann.Berntson@noaa.gov

2. Stock Assessment

a) Stock assessment model development

Stock Synthesis (SS) is an assessment model in the class termed integrated analysis. SS is built with a population sub-model that simulates a stock's growth and mortality processes, 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. SS includes routines to estimate MSY and exploitation levels that correspond to various standard fishery management targets. It supports assessments spanning several geographic areas and can use tag-recapture data. A customizable harvest policy is used to conduct a forecast in the final phase of running the model. The model is coded in ADMB (www.admb-project.org). SS is now in version 3 (SS_v3) and is included in the NOAA Fisheries Assessment Toolbox (http://nft.nefsc.noaa.gov/) incorporating a graphical user interface developed by Alan Seaver (NEFSC).

In 2009, usage of SS expanded significantly in the Atlantic. It is now being used for assessments of reef fish and pelagic fish in the Southeast, pink shrimp in the Gulf of Mexico, tunas and billfishes in the international Atlantic, surfclam and dogfish in the Northeast, and northern hake off France. In support of this expanded usage, several features were added to bridge the transition from strictly age-based assessments.

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

b) Deriving objective data weighting for age- and length-composition data in stock assessments using post-model and simulation results

Integrated age-length structured stock assessment models derive estimates of management quantities by fitting to multiple sources of observed data, including indices of abundance, and age and length compositions. The relative weighting of these likelihood components is often an important contributor to uncertainty, but there is currently no clear objective approach to determine these weights. Model "tuning" is often applied, with the goal of achieving internal consistency between assumed data weighting and model fit. Tuning relies on reasonable starting values for input sample sizes to appropriately allocate lack of fit to process and observation error. Focusing on age- and length-composition observations from trawl survey data, we compare the effective sample sizes derived from assessment models fit to actual data in 2005 and 2007 with theoretical effective sample sizes based on simulation. We find that effective sample size is best represented as a function of both the number of fish and the number of hauls sampled. We develop guidelines for tuning of these data sources that should increase objectivity and reliability of stock assessment model results.

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c) The Promise and pitfalls of using climate data in fish stock assessment

Investigators: Melissa A. Haltuch, André E. Punt

Concurrent declines in demersal fish stock abundances and shifts in long-term average environmental conditions in the Pacific have been well documented. Furthermore, highly variable stock-recruitment curves indicate environmental or other factors affect recruitment to fisheries. Thus, management advice that ignores environmental forcing of recruitment may cause stocks to be over- or under-harvested. The efficacy of including environmental impacts on recruitment in management models is important if stock assessment methods are to consider ecosystem interactions. Simulation testing is used to determine the statistical power of currently-used stock assessment methods to correctly identify long-term decadal-scale environmental forcing of recruitment. The ability of the stock assessment methods to balance type I and type II error rates suggests that methods used most commonly in practice tend to lead to lower total error rates. In this study, the promise of integrating environmental data directly into stock assessments is outweighed by the pitfall of high type I error rates, suggesting that the conventional means of avoiding spurious correlation are insufficient.

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d) Growth variability of the splitnose rockfish (*Sebastes diploproa*) in the Northeast Pacific Ocean: pattern revisited

Investigators: V. Gertseva, J. Cope and S. E. Matson

Understanding patterns of somatic growth within populations greatly contributes to fisheries stock assessment and helps determine the proper model structure. Splitnose rockfish was reported as having a striking pattern of latitudinal growth variability from studies conducted in the 1980s. We investigated variation in growth parameters of splitnose rockfish by latitude using recent data from the NOAA Fisheries Groundfish Survey (2003-2008), current ageing techniques and advanced modeling and statistical methods to provide an updated understanding of growth along this species' latitudinal range. Age data generated from sectioned otoliths were fit to a von Bertalanffy growth function incorporating ageing error. Growth parameters were estimated for each of five International North Pacific Fisheries Commission areas along the U.S. west coast. Generalized linear models and Akaike's Information Criteria were used to evaluate hypotheses for growth parameter relationship with latitude. We found that splitnose rockfish exhibited a cline in asymptotic length (L_∞) with L_∞ increasing with rising latitude. We also found that although the growth coefficient (k) was smallest in the Conception INPFC area, there was no apparent cline along the coast; a northward cline in k has previously been reported in the literature. We propose that differences in fishing intensity could be responsible for cline in L_∞, as higher fishing pressure in the south could skew the size distribution of the population in that region, and reduce southern L_∞ estimates. We also attribute slower growth in the Conception area to the oceanographic characteristics and low productivity of the area south of Point Conception.

For more information, contact Dr. Vladlena Gertseva at Vladlena.Gertseva@noaa.gov

e) Lessons learned in incorporating spatial dynamics in west coast groundfish stock assessments

Investigators: J. Cope and I. Stewart

The recognition of low dispersal rates, spatially variable biological traits, differential fishing pressure, and heterogeneous habitats has highlighted the need to incorporate smaller-scale population dynamics into larger-scale stock assessment areas. Spatial considerations are often avoided because of data limitations or poor understanding of key parameters (e.g. movement). The Pacific Fishery Management Council's biennial assessment cycle yielded a range of methods employed to address spatial structure in 2009 stock assessments and management. We illustrate this range with results for two species, cabezon (*Scorpaenichthys marmoratus*) and yelloweye rockfish (*Sebastes ruberrimus*). In each case, data availability and life history information led to different approaches to spatial structure and therefore information about stock status and reference points for fishery management. We suggest that "going spatial" provided needed insight into population dynamics and offer some general conclusions about making reasonable spatial modeling choices for management-oriented stock assessments.

For more information, please contact Dr. Jason Cope at Jason.Cope@noaa.gov

f) The relationship between MSY fishing rates (F_{MSY}) and productivity indices

Investigators: W. Patrick, J. Cope, and R. Methot

The 2009 revision of the National Standard 1 Guidelines describe a hierarchal approach to prescribing precautionary catch recommendations (i.e., Overfishing Limit (OFL) $\geq$ Acceptable Biological Catch (ABC) $\geq$ Annual Catch Limit). This research focuses on the specification of the ABC, which is the scientific recommendation for a level of catch that would prevent overfishing. To do this, it must take into account any scientific knowledge about the stock, and uncertainty in the estimate of OFL (where OFL = F_{MSY} * current biomass). The F_{MSY} is typically based on proxies and incompletely accounts for all biological factors that could influence the true F_{MSY}. It has been proposed that indices of stock productivity, which potentially consider more factors than are directly accounted for in F_{MSY} proxy calculations, could contribute to the scaling of the buffer between OFL and ABC. In extreme data-poor situations, it is possible that a productivity measure could be the sole source of information with which to set ABC relative to historical catch levels. As a first step, we investigated the strength of the relationship between productivity indices and commonly used measures of F_{MSY}. The goal is to determine if productivity measures could serve as a proxy for F_{MSY} in data-poor situations and could provide useful supplementary information for scaling ABC relative to OFL even in more data-rich situations.

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g) Reconciling stock assessment and management scales under conditions of spatially-varying catch histories

Investigators: J. Cope and A. Punt

Spatial homogeneity is often the exception, not the rule, for many marine populations. Data limitations or biological knowledge gaps, though, often drive the assumption of limited stock structuring. Such mismatch of management units and biological stock structure may compromise management goals. Spatial considerations thus remain a major challenge in providing managers with the best information for responsible and responsive management. This study offers a quantitatively evaluation of spatial stock structure assumptions on the performance of stock assessments relative to management scales. Catch histories, not biological differences, are used to create stock structure. Simulation testing is based on an operating model of 'true' population states of nature that vary only in catch history across 9 regions. Stock assessments under various data scenarios are then performed on regions either as one aggregated assessment, or at finer area scales defined by zonal catch differences. The median absolute relative error of the terminal spawning biomass depletion is used as a performance statistic. One area stock assessments demonstrated low bias and high precision under all catch scenarios when stock structure is ignored, but perform poorly when applied to areas with differing regional catch histories. Separate area assessments grouped by zonal catch differences performed best under these circumstances, despite lower data quality, indicating the importance of identifying stock structure for management purposes. We suggest a focus on explicitly defining management units prior to conducting stock assessments with a concomitant resolve to increase data provisions at the resolution of management needs.

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h) Analysis of fishery-independent hook and line-based data for use in the stock assessment of bocaccio rockfish (*Sebastes paucispinis*)

Investigators J.H. Harms, J.R. Wallace, and I.J. Stewart

Fishery-independent surveys are an important source of information for stock assessment and management worldwide. Research surveys often use trawl gear to capture commercially valuable species and calculate indices of relative abundance or density. However, many species of interest do not occur in direct contact with the bottom, or occur in areas where high-relief habitat precludes trawl operation. This research was undertaken during a standardized hook and line survey for rockfish conducted by NOAA

Fisheries' Northwest Fisheries Science Center in the Southern California Bight. The survey uses fishing gear similar to that used in many recreational fisheries to sample approximately 120 locations covering a wide range of depths and habitats. To provide an example of how these data can be analyzed for direct inclusion in stock assessments, we standardize catch rates of bocaccio rockfish from 2004 – 2008 using a Bayesian Generalized Linear Model to account for site, fishing time, survey vessel, angler, and other statistically significant effects. Results indicate that the bocaccio stock vulnerable to this survey in the Southern California Bight has shown a relatively flat trend over recent years. Length-frequency distributions indicate the presence of several strong cohorts that should be detectable in future stock assessments of bocaccio for use in U.S. West Coast groundfish management. This survey is the only available tuning index for the adult portion of the bocaccio population in recent years as historically-used recreational catch per unit effort indices have been compromised due to changes in bag limits and other management restrictions.

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C. By Species, by Agency

The PFMC currently operates under a biennial schedule for the development of stock assessments and management guidance. Table 1 lists the species for which full assessments were conducted in 2009 and the dates of the Stock Assessment Review (STAR) Panels convened to review those assessments. Summaries for assessments conducted by the NWFCS are included in the following sections.

Table 1. 2009 Review Schedule for Full Groundfish Assessments.

STAR PANEL	STOCK	AUTHOR(S)	STAR PANEL DATES	STAR PANEL LOCATION
Whiting	Pacific whiting	Owen Hamel Ian Stewart	February 3 - 6	Seattle, WA
1	Petrale sole Splitnose rockfish	Melissa Haltuch Vlada Gertseva	May 4-8	Hatfield Marine Science Center Barry Fisher Bldg., Room 101, 2032 SE Oregon State University Drive, Newport, OR 97365
Updates	Pacific Ocean Perch Canary Rockfish Darkblotched rockfish Cowcod	Owen Hamel Ian Stewart John Wallace E. J. Dick	June 10-11	PFMC Council Meeting Spokane, WA
2	Bocaccio Widow	John Field Xi He	July 13-17	Southwest Fisheries Science Center 110 Shaffer Road Santa Cruz, CA 95060
3	Lingcod Cabezon	Owen Hamel Jason Cope	July 27-31	Seattle, WA
4	Yelloweye rockfish Greenstriped rockfish	Ian Stewart Alan Hicks	August 3-7	Seattle, WA

1. Shelf Rockfish – West Coast

a) Stock Assessments

Full assessments of yelloweye rockfish, widow rockfish, bocaccio and greenstriped rockfish were conducted in 2009. Updates of the 2007 canary rockfish and cowcod rockfish assessments were also conducted in 2009.

Canary rockfish - update: The 2009 updated assessment reports the status of the canary rockfish (*Sebastes pinniger*) resource off the coast of the United States from southern California to the U.S. - Canadian border using data through 2008. As in 2007, the resource is modeled as a single stock. The historical period (<1981) of the catch history for canary rockfish has been substantially revised for this updated assessment. Historical reconstruction estimates from efforts by CDFG and NOAA scientists were made available and replaced existing estimates which dated back to the 2005 and earlier assessments. These older estimates assumed a constant percentage of canary rockfish in the total California landings, whereas the improved estimates now available allowed for changes in this percentage over time and fishing areas accounting for shifts in the fishery and the lower occurrence of canary in Southern California waters. The net result of this revision was a 24% reduction in the total estimated canary catch from 1916-2006 with most of this reduction occurring prior to 1968. The remaining model data sources are unchanged, but updated to reflect the most recent data collected since the 2007 assessment.

As in 2007, the base case assessment model includes parameter uncertainty from a variety of sources, but underestimates the considerable uncertainty in recent trend and current stock status. For this reason, in addition to asymptotic confidence intervals (based upon the model's analytical estimate of the variance near the converged solution), two alternate states of nature regarding stock productivity (via the steepness parameter of the stock-recruitment relationship) are presented. The base case model (steepness = 0.51) is considered to be twice as likely as the two alternate states (steepness = 0.35, 0.72) based on the results of a 2007 meta-analysis of west coast rockfish (M. Dorn, personal communication). In order to best capture this source of uncertainty, all three states of nature will again be used as probability-weighted input to the rebuilding analysis. Given the change in this update caused by the revised historical California catch estimates, future assessments are likely to be sensitive to additional revised estimates from ongoing efforts in Oregon and Washington should they prove appreciably different from the time-series used here.

The updated data resulted in a slightly more pessimistic view of the recent stock recovery trajectory, just inside the lower 95% confidence interval from the 2007 assessment. Addition of the fully revised catch history reduced the scale of the entire time-series estimate of spawning biomass by an average of 14% (19% in the first 10 years of the series and 47% in the last 10). The central portion of the time-series estimates remained largely unchanged (~1960-1990). Based on the revised catch series, canary rockfish were very lightly exploited until the early 1940's, when catches increased and a decline in biomass began. The spawning biomass experienced an accelerated rate of decline during the late 1970s, and finally reached a minimum (12% of unexploited, slightly below the estimate of 13% from the 2007 assessment) in the mid-1990s. The canary rockfish spawning stock biomass is estimated to have been gradually increasing since that time, in response to reductions in harvest and above average recruitment in the preceding decade. However, this trend is very uncertain. The estimated relative depletion level in 2007 is 21.7% (below the estimate of 32.4% from the 2007 assessment) and 23.7% in 2009 (~95% asymptotic interval: 16-28%, ~75% interval based on the range of states of nature:

9-40%), corresponding to 6,170 mt (5,642 in 2007, 54% of the 2007 estimate of 10,544 mt). The base model asymptotic interval for 2009 spawning biomass remains broad: 4,385-7,955 mt, and the states of nature interval: 2,459-10,244. After a period of above average recruitments, recent year-class strengths (1997-2008) have generally been low, with only 4 of the 12 years (1999, 2001, 2006, and 2007) producing large estimated recruitments. Because of the limited number of years they have been observed, the strengths of the 2006-2007 year classes are subject to greater uncertainty than other strong recruitment events in the last 30 years. As the larger recruitments from the late 1980s and early 1990s move through the population in future projections, the effects of recent poor recruitment may tend to slow the rate of recovery.

The abundance of canary rockfish was estimated to have dropped below the *SB40%* management target in 1983 and the overfished threshold in 1990. In hindsight, the spawning stock biomass passed through the target and threshold levels at a time when the annual catch was averaging more than twice the current estimate of the MSY. The stock remains slightly below the overfished threshold (unlike the 2007 estimate), although the spawning stock biomass still appears to have been increasing since 1999. The degree of increase is very sensitive to the value for steepness (state of nature), and is projected to slow as recent (and largely below average) recruitments begin to contribute to the spawning biomass. Fishing mortality rates in excess of the current F-target for rockfish of *SPR50%* are estimated to have begun in the late 1970s and persisted through 1999. Recent management actions appear to have curtailed the rate of removal such that overfishing has not occurred since 1999, and recent SPR values are in excess of 70% (> 90% since 2003). Relative exploitation rates (catch/biomass of age-5 and older fish) are estimated to have been less than 1% since 2001. Following the 1999 declaration that the canary rockfish stock was overfished, the canary OY was reduced by over 70% in 2000 and by the same margin again over the next three years. Managers employed several tools in an effort to constrain catches to these dramatically lower targets. These included: reductions in trip/bag limits for canary and co-occurring species, the institution of spatial closures, and new gear restrictions intended to reduce trawling in rocky shelf habitats and the coincident catch of rockfish in shelf flatfish trawls. In recent years, the total mortality has been slightly above the OY (higher in retrospect based on current methods used for total mortality estimates), but well below the ABC. Since the overfished determination in 1999, the total 9-year catch (749 mt) has been 14% above the sum of the OYs for 2000-2006. This level of removals represents only 34% of the sum of the ABCs for that period. The total 2008 catch (40.5 mt) is <1% of the peak catch that occurred in the early 1980s. Current medium-term forecasts predict slow increases in abundance and available catch, with OY values for 2011 and 2012 lower than those predicted from the 2007 assessment.

Canary rockfish: The complete versions of: Status of the U.S. Canary Rockfish Resource in 2009 (Update of 2007 assessment model) and Rebuilding Analysis for Canary Rockfish Based on the 2009 Updated Stock Assessment can be viewed online at: http://www.pcouncil.org/groundfish/stock-assessments/current-stock-assessments/

For more information on the canary rockfish assessment please contact Dr. Ian Stewart at Ian.Stewart@noaa.gov.

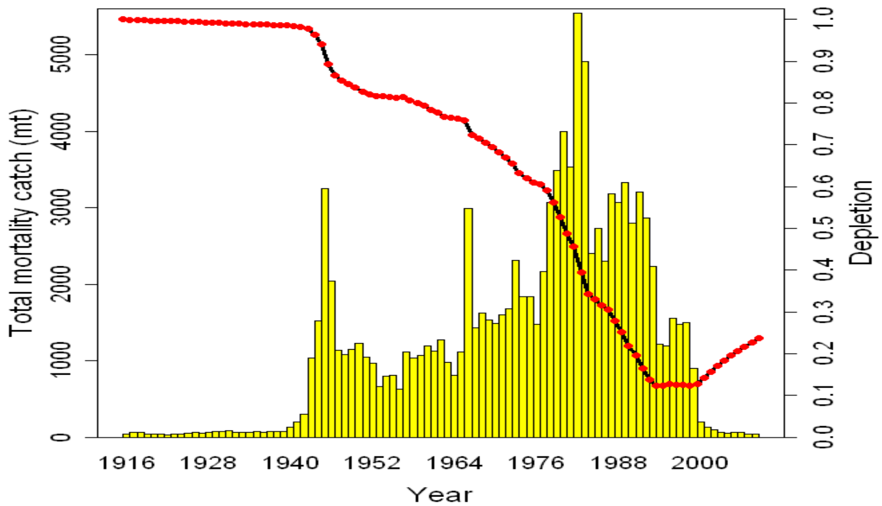

Figure 4. Level of estimated depletion (line) and total catch (bars) for canary rockfish, 1916-2009.

Greenstriped rockfish: This assessment reports the status of the greenstriped rockfish (*Sebastes elongatus*) resource off the continental coast of the United States from the U.S.-Canadian border in the north to the U.S.-Mexican border in the south. Within the assessment area the resource is treated as a single stock due to the lack of biological and genetic data supporting the presence of multiple stocks, although greenstriped rockfish from Southern California may exhibit different growth and maturity patterns.

Greenstriped rockfish have not often been targeted by any fishery, mainly due to its small size and short product shelf life, thus discards as well as landings are an important component of the total fishing mortality on the stock. The majority of landings of greenstriped rockfish have occurred in the trawl fishery, but a small proportion has been observed in recreational fisheries and even smaller amounts in hook and line and net fisheries. Discards have been higher than 77% in trawl fisheries and near 99% in fixed gear fisheries. This introduces a considerable amount of uncertainty in the total fishing mortality for greenstriped rockfish because discards are rarely reported, and are estimated from observed landings. Annual landings of greenstriped rockfish were less than 60 mt until the mid 1960s when foreign trawl fleets began fishing in U.S. waters. Subsequently, the development of the domestic fleet replaced the foreign fleets and resulted in increased landings and discards, peaking in the mid 1980s before dropping to very low levels with the implementation of management measures in the late 1990s.

The assessment for greenstriped rockfish showed that the stock in the U.S. West Coast is currently at 81% of its unexploited level and, therefore, is not overfished. The spawning output reached a low in the late 1990s before beginning to increase throughout the last decade. The estimated depletion has remained above the 40% of unfished spawning output target and it is unlikely that the stock has ever fallen below this threshold. However, throughout the 1970s, 1980s, and 1990s the exploitation rate and *SPR* have generally increased and occasionally exceeded current estimates of the harvest rate limit ($SPR_{50\%}$). More recently, though, low exploitation rates on greenstriped rockfish in the last decade and evidence of recent above average recruitment is resulting in an increase in spawning output to near unexploited levels. The annual total removals (landings plus discards) and estimated depletion for greenstriped rockfish are presented in Figure 5.

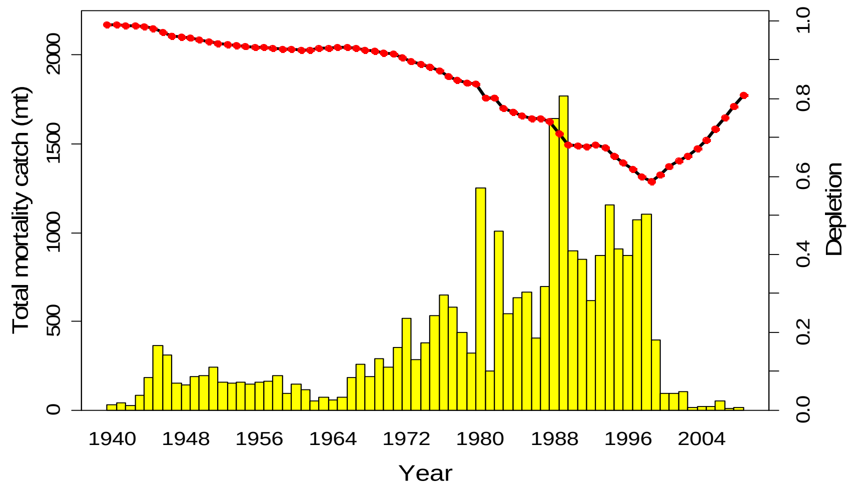

Figure 5. The time-series of total removals (bars) and estimated depletion (line) for greenstriped rockfish, 1940–2009.

Greenstriped rockfish: The complete version of "Status of greenstriped rockfish (*Sebastes elongatus*) along the outer coast of California, Oregon, and Washington" can be found online at: http://www.pcouncil.org/groundfish/stock-assessments/

For more information on the greenstriped rockfish assessment, please contact Allan Hicks at Allan.Hicks@noaa.gov.

Yelloweye rockfish: The 2009 assessment reports the status of the yelloweye rockfish (*Sebastes ruberrimus*) resource off the coast of the United States from southern California to the U.S.-Canadian border using data through 2008. The resource is modeled as a single stock, but with three explicit spatial areas: Washington, Oregon and California. Each area is modeled simultaneously with its own unique catch history and fishing fleets (recreational and commercial) but the dynamics follow the current understanding of yelloweye stock structure: large stocks linked via a common stock-recruit relationship with negligible adult movement among areas.

Yelloweye rockfish catches were estimated from a variety of sources, but are very uncertain due to the relatively small contribution of yelloweye to rockfish market categories and the relatively large scale of recreational removals. Catches include estimates of discarding after 2001 when management restrictions resulted in nearly all yelloweye caught by recreational and commercial fishermen being discarded at sea. Estimated catches increased gradually throughout the first half of the 20th century, with the exception of a brief period of higher removals around World War II. Catches peaked in 1982 at 421 mt, with removals in excess of 200 mt estimated for all years between 1977 and 1997. Uncertainty in catches is treated explicitly throughout this analysis. The model data sources include catch, length- and age-frequency data from six state-specific recreational and commercial fishing fleets. Biological data are derived from both port and on-board observer sampling programs. Yelloweye catch in the IPHC long-line survey for

Pacific halibut is also included via an index of relative abundance for Washington and for Oregon as well as length- and age-frequency data. Oregon recreational charter observer data from discarded yelloweye were used to construct a recent index of relative abundance (2004-2008) and length-frequency observations. The National Marine Fisheries Service (NMFS) Northwest Fisheries Science Center (NWFSC) trawl survey relative biomass indices and information from biological sampling, as well as the triennial trawl survey are included. Externally estimated model parameters, including those defining weight-length, maturity, and fecundity relationships, are revised from values used in previous assessments. The assessment explicitly accounts for the small degree of dimorphic growth as well as markedly different exploitation histories among geographic areas (Washington, Oregon and California). Due to sparse and poorly informative age- and length-frequency data, recruitment is modeled as a deterministic process. Key parameters including natural mortality, stock-recruitment steepness and all growth parameters are estimated.

Although the base case assessment model captures some uncertainty via asymptotic intervals, uncertainty from two sources is reported through alternate states of nature bracketing the base case results and included explicitly in the decision table. The magnitude of the estimated catch time-series was found to have a large influence on the perception of current stock size and the estimate of steepness of the stock-recruit relationship was closely linked to the projected recovery rates. Alternate values of each were selected to bracket the best estimates with marginal probabilities one-half as likely. For historical catch these values, 75% and 150% of the estimated catch series prior to 2000, were subjective, but reflect both the lack of a comprehensive catch reconstruction in Washington and the change in likelihood of the fit to data sources over a reasonable range of catch levels. For steepness the 12.5th and 87.5th percentiles were calculated from the likelihood profile as a proxy for the probability distribution about this point estimate. The most optimistic and pessimistic of the nine combinations from these two axes (weighted 6.25% each relative to 25% for the best estimate on each dimension) are reported in this document and all combinations used to provide a more realistic degree of uncertainty for future projections, decision tables and rebuilding analyses.

A fecundity relationship is used for yelloweye specifying that spawning output per unit weight increases with fish weight; therefore all reference to spawning output is in terms of eggs produced, instead of spawning biomass. Yelloweye rockfish are estimated to have been lightly exploited until the mid-1970’s, when catches increased and a rapid decline in biomass and spawning output began. The relative spawning output reached a minimum of 15.8% of unexploited levels (slightly above the estimate of 12.1% from the 2007 assessment) in 2000. Yelloweye rockfish spawning output is estimated to have been gradually increasing since that time in response to large reductions in harvest. Although the relative trend in spawning output is quite robust to uncertainty in the estimated removals, the spawning output trajectory on an absolute scale is very sensitive. The estimated relative depletion level in 2007 is 19.2% (slightly above the estimate of 16.4% from the 2007 assessment) and 20.3% in 2009 (states of nature: 17.3-23.5%), corresponding to 201.5 million eggs. The range over states of nature reflects the very large uncertainty in the absolute scale of the estimated time-series for spawning output:

128.3-353.0 million eggs. The aggregate spawning output estimates mask the spatial heterogeneity included via the area-specific dynamics: relative spawning output has differed markedly among the three states, with California having the largest spawning output at unexploited equilibrium, followed by Oregon and then Washington. Currently, Oregon is estimated to have the largest spawning output, followed by California, then Washington. Relative depletion also varies dramatically by state, with California estimated to be at 16.4% of unexploited conditions, Oregon, 22.5%, and Washington, 27.3%.

The coast-wide abundance of yelloweye rockfish was estimated to have dropped below the *SB40%* management target in 1989 and the overfished threshold in 1994. In hindsight, the spawning output passed through the target and threshold levels with annual catch averaging almost five times the current estimate of the *MSY*. The coast-wide stock remains below the overfished threshold, although the spawning output is estimated to have been increasing since 2000 in response to reductions in harvest. The degree of increase is largely insensitive to the magnitude of historical catch and only moderately sensitive to the value for steepness, but the absolute scale of the population reflects alternate removal series very closely. Fishing mortality rates are estimated to have been in excess of the current *F*-target for rockfish of *SPR50%* from 1976 through 1999. Recent management actions have curtailed the rate such that recent SPR values are in excess of 60% over the last eight years. Relative exploitation rates (catch/biomass of age-8 and older fish) are estimated to have been at or less than 1% after 2001. Before 2000, yelloweye rockfish were managed as part of the *Sebastes* Complex, which included all *Sebastes* species without individual assessments, ABCs and OYs. In 2000, the *Sebastes* Complex was divided into three depth-based groups (north and south of 40° 10' N. latitude), and yelloweye rockfish were managed as part of the minor shelf rockfish group until 2002. Since then, there has been species-specific management, and total catch has been below both the ABC and OY for yelloweye each year. These catch levels represent a 95% reduction from average catches observed in the 1980s and 1990s. Managers have constrained catches by eliminating all retention of yelloweye rockfish in both commercial and recreational fisheries, instituting broad spatial closures (some specifically for moving fixed-gear fleets away from known areas of yelloweye abundance), and creating new gear restrictions intended to reduce trawling in rocky shelf habitats and the coincident catch of rockfish in shelf flatfish trawls. Since 2002, the total 6-year catch (88.5 mt) has been only 63% of the sum of the OYs for 2002-2008 and only 29% of the sum of the ABCs for that period. The total 2008 catch (16.7 mt) is estimated to be just 4% of the peak annual catch that occurred in the early 1980s.

Data for yelloweye rockfish are sparse and relatively uninformative, especially regarding current trend. Historical catches are very uncertain, as yelloweye comprise a small percentage of overall rockfish removals and actual species-composition samples are infrequently available for historical analyses. Currently available fishery-independent indices of abundance are imprecise and not highly informative. It is unclear whether increased rates of recovery (or lack thereof) will be detectable without more precise survey methods applied over broad portions of the coast. Fishery data are also unlikely to produce conclusive information about the stock for the foreseeable future, due to lack of retention and active avoidance of yelloweye among all fleets. For these reasons, it is unlikely that the major uncertainties in this assessment will soon be resolved.

Current medium-term forecasts predict increases in coast-wide abundance under the SPR=71.9% rebuilding strategy, however these increases are largely driven by the California and Oregon portions of the stock. In fact, the Washington portion is projected to remain at current levels under recent allocation of catch; however, this result is likely to be sensitive to future revision of the estimated Washington historical catch series. The estimated OY values for 2011 and 2012 are larger (20.9, 21.2) than those predicted from the 2007 rebuilding analysis (13.9, 14.2).

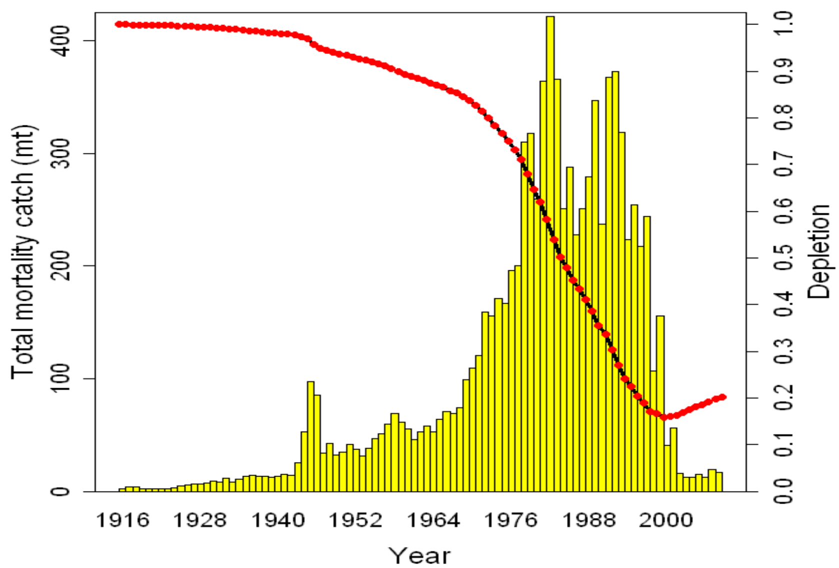

Figure 6. Level of estimated depletion (line) and total catch (bars) for yelloweye rockfish, 1916-2009.

Yelloweye rockfish: The complete versions of: Status of the U.S. Yelloweye Rockfish Resource in 2009 and Rebuilding Analysis for Yelloweye Rockfish Based on the 2009 Stock Assessment can be viewed online at:
http://www.pcouncil.org/groundfish/stock-assessments/current-stock-assessments/

For more information on the yelloweye rockfish assessment please contact Dr. Ian Stewart at Ian.Stewart@noaa.gov

Widow rockfish: The widow rockfish assessment was conducted by the Southwest Fisheries Science Center (SWFSC). The complete version of: Status of the widow rockfish resource in 2009 can be viewed online at:
http://www.pcouncil.org/groundfish/stock-assessments/current-stock-assessments/

Bocaccio: The bocaccio assessment was conducted by the SWFSC. The complete version of: Status of bocaccio, *Sebastes paucispinis*, in the Conception, Monterey and Eureka INPFC areas for 2009
http://www.pcouncil.org/groundfish/stock-assessments/current-stock-assessments/

Cowcod: The cowcod update was conducted by the SWFSC. The complete version of: Updated status of cowcod, *Sebastes levis*, in the Southern California Bight can be viewed online at:
http://www.pcouncil.org/groundfish/stock-assessments/current-stock-assessments/

2. Slope Rockfish

a) Stock assessments

Slope rockfish assessments conducted during 2009 included an update of the 2007 darkblotched rockfish assessment, a second update of the 2005 Pacific ocean perch assessment, and a full assessment of splitnose rockfish.

Darkblotched rockfish –update: This assessment applies to the darkblotched rockfish (*Sebastes crameri*) for the combined U.S. Vancouver, Columbia, Eureka and Monterey INPFC areas. The largest landings (removals between 2,300 and 4,200 metric tons) of darkblotched were taken from 1966-1968, primarily by foreign vessels. From 1969 to 1981, the fishery proceeded with more moderate landings of between 200 and 1,000 mt per year, with the foreign fishery ending in 1977. A second peak in landings occurred between 1982 and 1993, with landings exceeding 1,100 mt in 10 of 12 years, reaching over 2,400 mt in 1987. Management measures reduced landings to below 950 mt since 1994, below 400 mt since 1999, and below 200 mt in recent years. This update used the SS model, version 3.03a and data through 2008. Based on this assessment, darkblotched rockfish on the West Coast remain below the overfished threshold, but the spawning biomass appears to have increased steadily over the past 7 or 8 years to 27.5% of the unfished level. Since 2001, overfishing occurred only once, with estimated catch exceeding the ABC by 12 mt (5.0%) in 2004.

A number of sources of uncertainty were explicitly included in this assessment. For example, allowance was made for uncertainty in natural mortality and the parameters of the stock-recruitment relationship. There were also other sources of uncertainty that were not included in the current model, including the degree of connection between the stocks of darkblotched rockfish off British Columbia and those in PFMC waters; the effect of the PDO, ENSO and other climatic variables on recruitment, growth and survival of darkblotched rockfish; and gender-based differences in survival. With the stock extending northwards into Canadian waters, management and assessment of stock status might be improved through greater cooperation with British Columbia.

The recruitment pattern for darkblotched rockfish is similar to that of many rockfish species, with highly variable recruitment from year to year. With a few exceptions, the 1980s and 1990s provided rather poor year-classes compared with average historical recruitment levels. Although the 1999 and 2000 year-classes appear to be two of the four largest year-classes since 1975, they are only now reaching the age of 50% maturity, and will not be fully mature for another decade (when their fecundity will also be over 3 times what it is now). As a result, the full impact of these recruits will not be felt for years to come. The exploitation rate (percent of biomass taken) on fully-selected animals peaked historically near 14% in the intensive foreign fishery of the mid-1960's. The exploitation rate dropped by the late 1960's, but increased slowly and steadily from the late 1970's to 1987, at roughly 15%, and stayed high until 1998, with the continuing decline in exploitable biomass. Over the past 10 years the exploitation rate has fallen from a peak of 16% in 1998 to under 2%. This stock remains overfished and a rebuilding analysis was conducted. Recent recruitment and levels of depletion are presented in Figure 7.

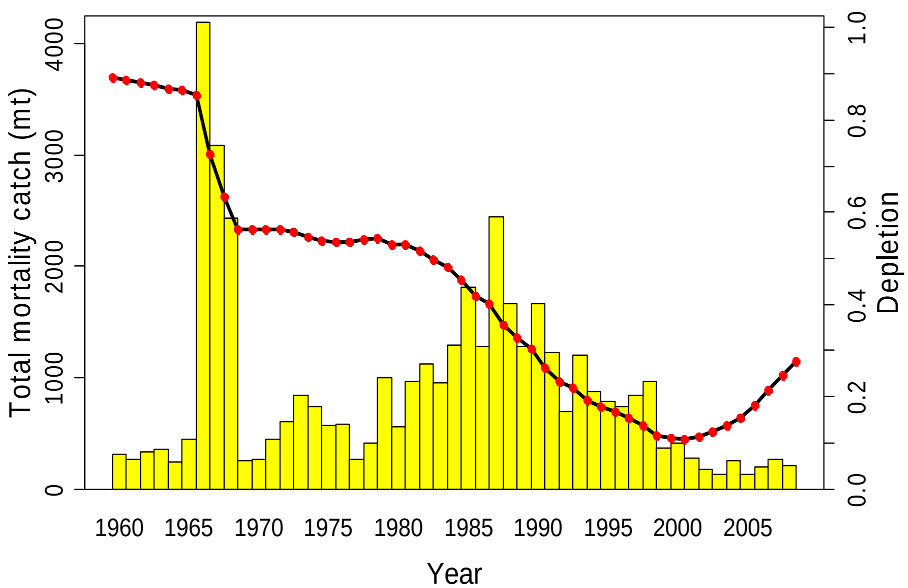

Figure 7. Level of depletion (line) and total catch (bars) for darkblotched rockfish, 1960-2009.

Darkblotched rockfish: The complete version of: Status and Future Prospects for the Darkblotched Rockfish Resource in Waters off Washington, Oregon, and California as Updated in 2009 can be viewed online at: http://www.pcouncil.org/groundfish/stock-assessments/current-stock-assessments/

For more information on this assessment contact John Wallace at: John.Wallace@noaa.gov.

Pacific ocean perch – update: This assessment update applies to the Pacific ocean perch (*Sebastes alutus*) (POP) species of rockfish for the combined U.S. Vancouver and Columbia INPFC areas. Catches are characterized by large removals of between 5,000 and 20,000 mt during the mid-1960's, primarily by foreign vessels. The fishery proceeded with more moderate removals of between 1,100 and 2,200 metric tons per year from 1969 through 1994, with the foreign fishery ending in 1977. Management measures further reduced landings to below 900 metric tons by 1995, with subsequent landings falling steadily until reaching between 60 and 150 metric tons per year from 2002 through 2008. Total catch, including discard, is estimated to be between 80 and 180 metric tons since 2002. This assessment is an update and uses the same model as in the 2003, 2005 and 2007 assessments, a forward projection age-structured model. New data and changes to the data used in the previous assessment are as follows. Catch data for

2002-2006 were updated using total mortality estimates from the observer program. New catch data were added for 2007 and 2008. The 2007 and 2008 NWFSC slope survey indices were added. Fishery age compositions from 2004-2006 were updated, with new 2008 age compositions added. 2007 length compositions were used in place of age compositions on account of substantial issues with the quality of age assignments for that year of data. The 2001-2006 NWFSC slope survey age compositions were recalculated, and the 2008 compositions added. Due to the ageing issues mentioned above, the 2007 NWFSC slope survey length compositions were used in place of age compositions.

A number of sources of uncertainty are explicitly included in this assessment. For example, allowance is made for uncertainty in natural mortality, the parameters of the stock-recruitment relationship, and the survey catchability coefficients. However, sensitivity analyses based upon alternative model structures / data set choices in the 2003 and 2005 assessments suggest that the overall uncertainty may be greater than that predicted by a single model specification. There are also other sources of uncertainty that are not included in the current model. These include the degree of connection between the stocks of Pacific ocean perch off British Columbia and those in PFMC waters; the effect of the PDO, ENSO and other climatic variables on recruitment, growth and survival of Pacific ocean perch; gender differences in growth and survival; a possible nonlinear relationship between individual spawner biomass and effective spawning output and a more complicated relationship between age and maturity. A reference case was selected which adequately captures the range for those sources of uncertainty considered in the model. Bayesian posterior distributions based on the reference case were estimated for key management and rebuilding variables. These distributions best reflect the uncertainty in this analysis, and are suitable for probabilistic decision making.

For West Coast rockfish, a stock is considered overfished when it is below 25% of virgin spawning biomass. Currently, the spawning stock is believed to be near 30% of the unfished level; roughly 50% higher than the low of 20% reached in 1997. Despite the modest rate of increase over the last decade, POP is expected to reach the rebuilding target (40% of the unfished level) within the next 10-12 years. POP has not been subject to overfishing since 2000. Although catches were generally near or below harvest guidelines during the 1990s, the current assessment suggests that exploitation rates throughout most of the 1980s and 90s were higher than those identified in more recent assessments as sustainable. POP are essentially managed on a regional basis, as they occur almost exclusively off of Oregon and Washington for the West Coast. Management and assessment of stock status might be improved through greater cooperation with British Columbia, as the stock extends northward into Canadian waters. Recent catch and levels of depletion are presented in Figure 8.

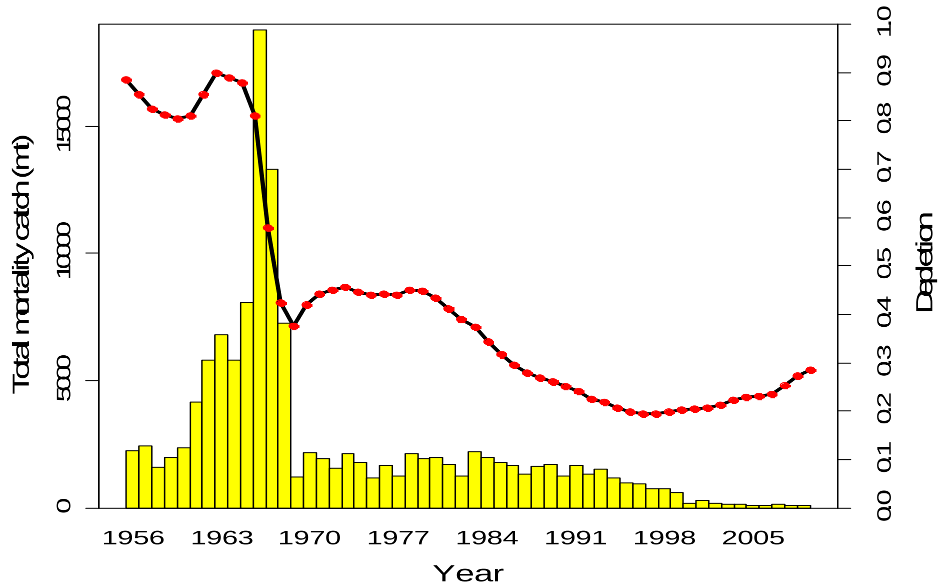

Figure 8. Level of catch (bars) and depletion (line) for Pacific ocean perch, 1950-2009.

Pacific Ocean Perch: The complete version of: Status and Future Prospects for the Pacific Ocean Perch Resource in Waters off Washington and Oregon as Assessed in 2009 can be viewed at: http://www.pcouncil.org/groundfish/stock-assessments/current-stock-assessments/

For more information on this assessment contact Dr. Owen Hamel at: Owen.Hamel@noaa.gov.

Splitnose rockfish: This assessment reports the status of the splitnose rockfish (*Sebastes diploproa*) resource off the continental coast of the United States from the U.S.-Canadian border in the north to the U.S.-Mexican border in the south. Within the assessment area the resource is treated as a single stock due to the lack of biological and genetic data supporting the presence of multiple stocks. Nevertheless, management decisions on a coast-wide population need to account for effort concentration, since abundance is higher in some areas such as off central California.

Splitnose rockfish have not been targeted by commercial fisheries, but have historically been taken as bycatch in the fishery for Pacific ocean perch, a species with which splitnose rockfish co-occurs, and fisheries for mixed slope rockfish or other deepwater targets. Trawl landings on average comprise 90% of annual catches, with 80% of fish landed in California. Only 10% of splitnose rockfish on average are caught by non-trawl commercial fisheries. The vast majority of non-trawl landings are caught by net gear, and only a small portion is caught by hook-and-line in the sablefish fishery. This species is rarely taken in the recreational fishery. Because of their small size, splitnose rockfish have a limited market and are often discarded. Over the last twenty years, trawl discard rates ranged between 27% and 80% of the total catch. Landings peaked in the 1960s, when foreign trawl fleets operated in U.S. waters, and reached 5,313 mt in 1967. The highest catch by domestic fleets was in 1998, when 1,526 mt of splitnose rockfish was landed. For the last ten years landings were relatively low and ranged between 65 and 274 mt.

The assessment shows that the stock of splitnose rockfish in the U.S. West Coast is currently at 66% of its unexploited level and, therefore, not overfished. As estimated in 2009, the spawning output showed a small decline prior to 1950, when splitnose rockfish were lightly exploited using mostly non-trawl gear with zero discard. With the development of the Pacific ocean perch fishery, spawning output of splitnose rockfish began to decline and exhibited a sharp drop in the 1960s, when foreign trawl fleets targeted Pacific ocean perch in the current U.S. EEZ. In the 1980s and 1990s splitnose rockfish spawning biomass continued to decrease as a result of relatively low recruitment and removal by domestic trawl and non-trawl fisheries, with a large portion of trawl catches being discarded. The spawning biomass reached its lowest level (35.8% of its unexploited level) after large domestic removals in 1998, when the increased availability of splitnose rockfish led to higher than usual catches. Since 1999 however, the splitnose spawning output is estimated to have increased in response to below-average removals and above-average recruitment during the last decade. The time-series of recent total removals (landings plus discards) and estimated depletion for splitnose rockfish are presented in Figure 9.

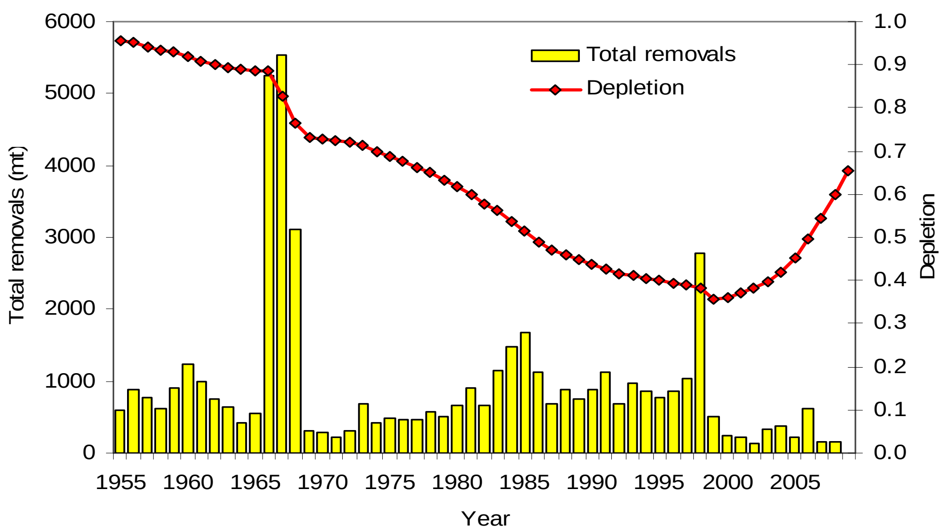

Figure 9. The time-series of recent total removals (bars) and estimated depletion (line) for splitnose rockfish, 1955-2009.

Splitnose rockfish: The complete version of "Status of the U.S. splitnose rockfish resource in 2009" can be found online at: http://www.pcouncil.org/groundfish/stock-assessments/

For more information on the splitnose rockfish assessment, contact Dr. Vladlena Gertseva at Vladlena.Gertseva@noaa.gov

3. Flatfish

a) Stock assessment

Petrale sole: This assessment reports the status of the petrale sole (*Eopsetta jordani*) resource off the coast of California, Oregon, and Washington using data through 2008. While petrale sole are modeled as a single stock, the spatial aspects of the coast-wide population are addressed through geographic separation of data sources/fleets where possible and consideration of residual patterns that may be a result of inherent stock structure. There is currently no genetic evidence suggesting distinct biological stocks of petrale sole off the U.S. coast. The limited tagging data available to describe adult movement suggests that petrale sole may have some homing ability for deepwater spawning sites but also have the ability to move long distances between spawning sites and seasonally.

The earliest catches of petrale sole are reported in 1876 in California and 1884 in Oregon. Recent annual catches during 1981–2008 range between 1,244–2,854 mt (Figure 10). Petrale sole are almost exclusively caught by trawl fleets. Non-trawl gears contribute less than 2% of the catches. Based on the previous 2005 assessment, subsequent OYs were reduced due to 2,499 mt. From the inception of the fishery through the war years, the vast majority of catches occurred between March and October (the summer fishery), when the stock is dispersed over the continental shelf. The post-World War II period witnessed a steady decline in the amount and proportion of annual catches occurring during the summer months (March-October). Conversely, petrale catch during the winter season (November–February), when the fishery targets spawning aggregations, has exhibited a steadily increasing trend since the 1940's. Since the mid-1980s, catches during the winter months have been roughly equivalent to or exceeded catches throughout the remainder of the year (Figure 10).

Petrale sole were lightly exploited during the early 1900s but by the 1950s the fishery was well developed and showing clear signs of depletion and declines in catches and biomass (Figure 10). The rate of decline in spawning biomass accelerated through the 1930s–1970s reaching minimums generally around or below 10% of the unexploited levels during the 1980s and 1990s. The petrale sole spawning stock biomass is estimated to have increased slightly from the late 1990s, peaking in 2005, in response to above average recruitment. However, this increasing trend has reversed since the 2005 assessment and the stock has been declining, most likely due to strong year classes having passed through the fishery. The estimated relative depletion level in 2009 is 11.6% (~95% asymptotic interval: ±4.8%, ~ 75% interval based on the range of states of nature: 9.4-13.8%), corresponding to 2,937.6 mt (~95% asymptotic interval: ±832.7 mt, states of nature interval: 2,407.8-3,468.1 mt) of female spawning biomass in the base model. The base model indicates that the spawning biomass has been below 25% of the unfished level continuously since 1953.

Note that the PFMC chose to change the proxy harvest rate and relative biomass reference points after the final acceptance of this stock assessment. The previously defined reference points are: B_{msy} target of B40%, the MSST of B25%, and the F_{msy}

proxy of F40%. Documents from the STAR panel review of this assessment, the PFMC SSC and council decisions describe the process that lead to a redefinition of the proxy harvest rate and relative biomass reference points such that the B_{msy} target is now B25%, the MSST is B12.5%, and the F_{msy} proxy is F30%. Petrale sole are considered overfished under these reference points and catches have been restricted for 2009 and 2010 and a rebuilding plan for petrale sole is complete.

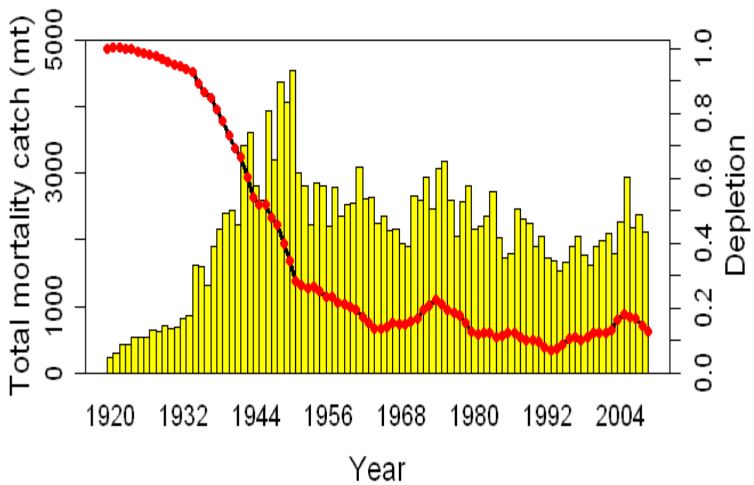

Figure 10. Time series of depletion (line) and catch (bars) for petrale sole.

Petrale sole: The complete version of: Status of the U.S. petrale sole resource in 2009 can be viewed online at: http://www.pcouncil.org/groundfish/gfstocks.html

For more information on the petrale sole assessment, contact Dr. Melissa Haltuch at Melissa.Haltuch@noaa.gov

4. Pacific hake

a) Stock assessments

There were two stock assessments used for Pacific hake management in 2010. One developed by Dr. Steve Martell (University of British Columbia), which was endorsed by the Pacific Fishery Management Council's (PFMC) Stock Assessment Review (STAR) process, and an update of the 2009 stock assessment conducted by the Northwest Fisheries Science Center (NWFSC; Stewart and Hamel, 2010). The Scientific and Statistical Committee (SSC) was unable to reach consensus regarding which model formulation reflected the best available science for Pacific whiting this year and was consequently forced to put both models forward as best available science without assigning weights to either.

Both assessment models estimated that the Pacific hake spawning stock biomass has declined in recent years following the decline of the very strong 1999 year-class and is currently in the precautionary zone (below the $SB_{40\%}$ target and above the $SB_{25\%}$ overfished threshold). The resulting optimal yield (OY; the target catch, which is then partitioned 73.88% to the U.S. fishery and 26.12% to the Canadian fishery) values for

2010 from the two models were 186,000 mt (NWFSC) and 550,000 mt (Martell). These values are less than the corresponding values reported in the assessment documents (224,975 mt and 617,700 mt respectively) because those values would lead to predictions of stock depletion to below $0.25B_0$ in 2011. If the NWFSC model is correct, and a catch exceeding 186,000 mt is taken, the stock is predicted to drop below the overfished threshold. In contrast, if the Martell model is correct, taking a catch of 186,000t will lead to forgone yield. The SSC emphasized that the assessment of whiting was highly uncertain; there is uncertainty regarding which model is better, uncertainty regarding which data sources are best included in assessments of whiting, and uncertainty due to the presence of a new but voracious predator species (Humboldt squid).

Based on the SSC's recommendations, the Pacific Council adopted an OY for 2010 of 262,500 mt and an allowable biological catch (ABC, the overfishing limit) of 455,550 mt. Under the terms of the U.S. – Canada Pacific whiting treaty, the U.S. allocation equates to 193,935 mt. The National Marine Fisheries Service is negotiating with the treaty tribes for their 2010 allocation, which will be set aside from the U.S. OY. The Council also decided to set aside 3,000 mt of Pacific whiting yield to accommodate incidental bycatch in non - whiting fisheries and research catch this year. The whiting sector allocations (i.e., 24% to motherships, 34% to catcher - processors, and 42% to shoreside whiting) will be decided once the treaty allocation is decided. The next Pacific hake assessment process will be conducted in early 2011.

Pacific hake: The two Pacific hake stock assessments can be viewed online at: http://www.pcouncil.org/groundfish/stock-assessments/current-stock-assessments/

For more information on the Pacific hake assessment please contact Dr. Ian Stewart at Ian.Stewart@noaa.gov.

5. Other species

a) Stock assessments

Cabezon: This is the third full assessment of the population status of cabezon (*Scorpaenichthys marmoratus*) off the west coast of the United States. The first assessment was for a state-wide California cabezon stock in the year 2003 (Cope et al. 2004). The second assessment (Cope and Punt 2006) considered two sub-stocks (the northern California sub-stock (NCS) and the southern California sub-stock (SCS)), demarcated at Point Conception, CA. The current assessment retains the two California sub-stocks, also evaluating the population as a coast-wide California stock (CAS), and extends the assessment to a third sub-stock for cabezon in the waters off of Oregon (ORS). Separation of these spatial sub-stocks is based on distinguishing localized population dynamics, preliminary population genetics results, and is supported by spatial differences in the fishery (the NCS has been the primary area from which removals have occurred), the ecology of nearshore groundfish species, and is consistent with current state management needs.

Cabezon removals were assigned to six fleets in each California sub-stock (two commercial and four recreational) and four fleets in Oregon (two commercial and two recreational) for each sub-stock because each of these fleets targets a different component of the population. The California time series begin in 1916, with the onset of commercial landings, while Oregon begins in 1973, with the start of the recreational fishery. Historical recreational removals for California were based on the reconstruction used in Cope and Punt (2006), while the staff of the Oregon Department of Fish and Wildlife supplied the historical Oregon recreational time series. Historically, vessel-based recreational catch (private and charter) has been the primary reported source of biomass removals of cabezon. Commercial catch has become a major source of removals in the last 15 years because of the developing live-fish fishery in both California and southern Oregon (Figures 11-13). Commercial discard mortality, assumed negligible in the last assessment, is included in this assessment. Because cabezon are caught primarily in the nearshore fishery and are believed to not suffer from barotrauma, discard mortality is assumed to be low.

Cabezon were lightly exploited until the 1940s in California, particularly in northern California (Figure 11). Catches began to increase in southern California in the 1960s (Figure 12). This increase in catch caused a relatively large decline in spawning biomass. In Oregon, the take of cabezon did not begin in earnest until the 1970s, which in turn has also caused a decline in spawning biomass (Figure 13). The estimated depletion levels for NCS and SCS are 45% (± 7%) and 60% (± 14%), respectively. Estimated depletion for ORS sub-stocks is 52% (± 10%). Greatest uncertainty is found in the smaller SCS and ORS sub-stocks.

Though much of the declines in cabezon populations correspond to removals by the recreational fishery sectors, the added impact of the live-fish fishery is also witnessed in declines through the mid- to late-1990s in all sub-stocks.

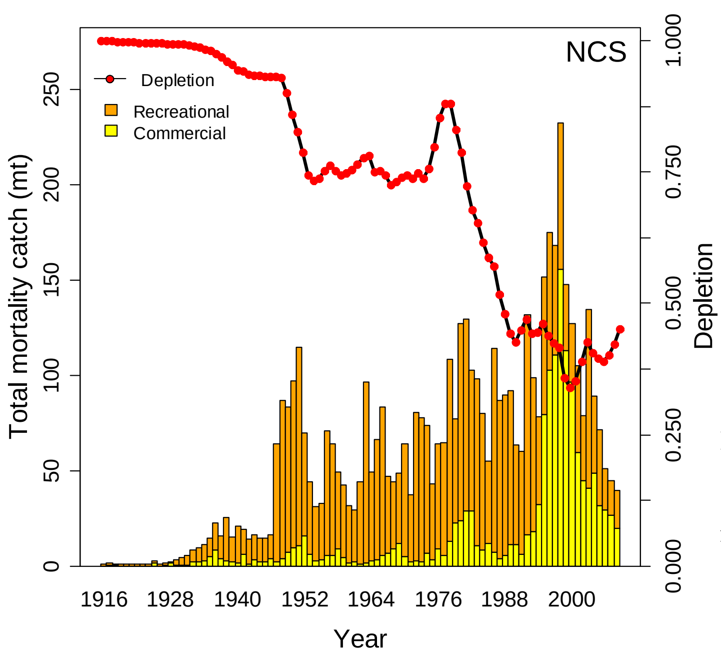

Figure 11. Time series of removals (bars) for commercial and recreational fisheries and estimated depletion (line) for the northern California cabezon stock (NCS), 1916-2009.

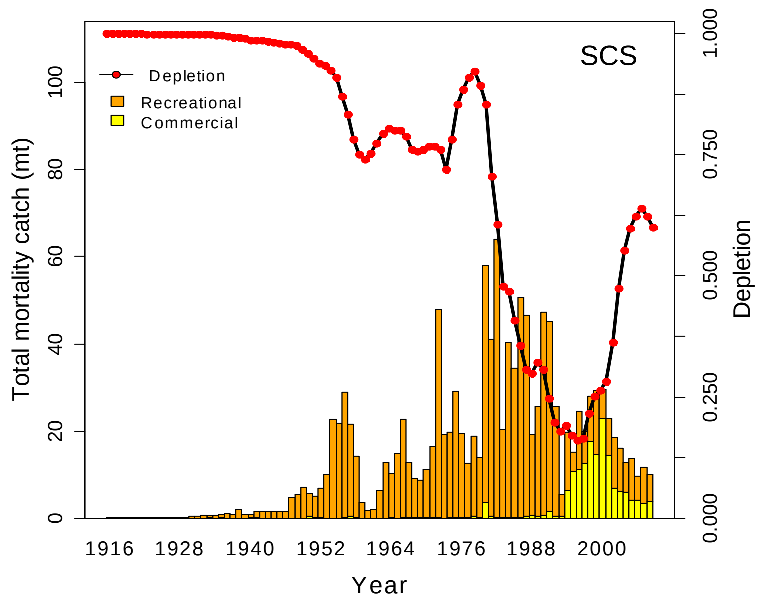

Figure 12. Time series of total removals (bars) for the commercial and recreational fisheries and estimated depletion (line) for the southern California cabezon stock (SCS), 1916-2009.

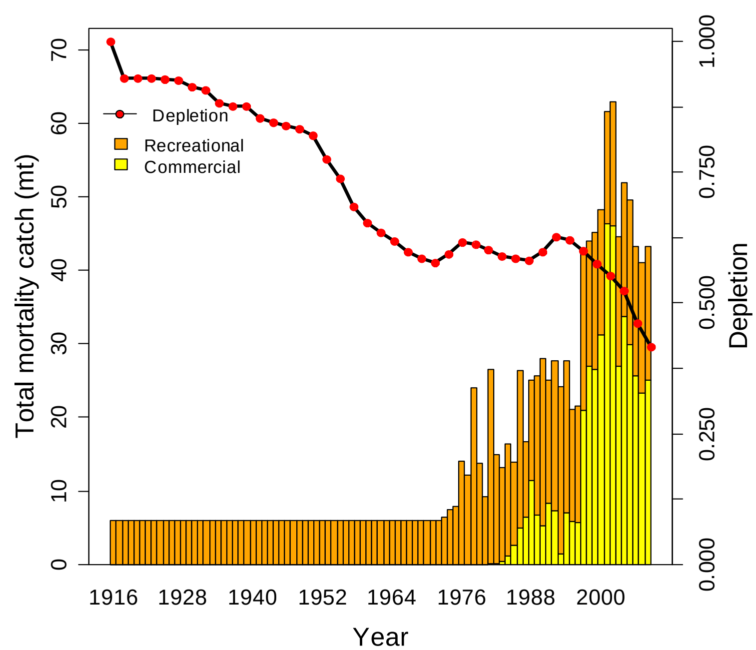

Figure 13. Time series of total removals (bars) for the commercial (yellow) and recreational fisheries (orange) and estimated depletion (line) for the Oregon cabezon stock (ORS), 1916-2009.

Cabezon: The complete version of: Status of Cabezon (*Scorpaenichthys marmoratus*) in California and Oregon Waters as Assessed in 2009 can be viewed online at: http://www.pcouncil.org/groundfish/stock-assessments/current-stock-assessments/

For more information on the cabezon assessment, contact Dr. Jason Cope at Jason.Cope@noaa.gov

Lingcod: This assessment applies to lingcod (*Ophiodon elongatus*) off the West Coast of the United States, and is conducted as two separate assessments of (1) lingcod off of Washington and Oregon (the North stock), and lingcod off of California (the South stock). The largest landings off California were 2,749 mt in 1980 (nearly equally divided between the commercial and recreational fleets). For Washington/Oregon, the largest landings were 3,443 mt in 1983 (with over 90% of the landings coming from the commercial fleet). Landings exceeded 1,400 mt for the years 1971-1991 in the South and the years 1973-1994 in the North. Landings have declined significantly over the past two decades, with the average landings over the past 10 years being 298 mt in the North and 405 mt in the South. For each stock, two fisheries are modeled: the commercial fishery and the recreational fishery. Landings are included from 1928-2008, with equilibrium landings estimated for the commercial fisheries prior to 1928. Since the fishery off of California developed earlier, the equilibrium catches are an order of magnitude higher there (341 metric tons (mt) in California vs. 36 mt for Washington/Oregon). Catch (total mortality) is similar to landings for most of the time series. However, discard rates and therefore estimates of mortality due to discard for the commercial fishery have been quite high relative to landed catch in recent years due to regulations.

This assessment used the Stock Synthesis (SS) model, version 3.03a. Lingcod has been modeled using various age-structured forward-projection models since the mid-1990s. The previous assessment was conducted in 2005 in SS2. Data used in the base models for the current assessment include the following: Commercial and recreational landings data from 1928-2008, with information on prior catch informing the "equilibrium" landings level; Commercial discard rates from 2002-2007; Triennial survey indices for the years 1980-2004 (every 3rd year); NWFSC survey indices for the years 2003-2008; commercial logbook CPUE indices for the years 1976-1997 (North) or 1978-1997 (South); PSMFC Dockside (recreational) boat survey index 1980-1989, 1993-1997 (South); Commercial length composition data for 1965-2008 (North) or 1978-2008 (South); Commercial discard length composition data for 2003-2007 (North) and 2004-2007 (South); Recreational length composition data for 1993-2008 (North) or 1987-2008 (South); Triennial length composition data for 1986-2004 (North) or 1989-2004 (South); NWFSC length composition data for 2003-2008. Age data were available and used in sensitivities but not in the base models due to issues with outliers and possible aging bias. The data used in sensitivities include: Commercial conditional age-at-length data for 1980-2008 (North) and 1987-2008 (South); Recreational conditional age-at-length data for 1999-2008 (North); Triennial conditional age-at-length data for 1992-2004 (North) or 1995-2004 (South); NWFSC survey conditional age-at-length data for 2003-2008.

A number of sources of uncertainty were explicitly included in this assessment. There were also other sources of uncertainty that were not included in the current model, including the degree of connection between the two lingcod stocks and also between the northern stock and the stock off British Columbia; the effect of the PDO, ENSO and other climatic variables on recruitment, growth and survival of lingcod. A reference case was selected based on extensive model testing and an attempt was made to balance the sources of uncertainty. In addition, an attempt was made to make the North and South models as equivalent as possible. In this regard, fixed and estimated parameters are largely the same for the two assessments. The data supporting the assessment of the Northern stock is of somewhat higher quality and is more consistent than those for the Southern stock, thus the results of the assessment for the Southern stock are more uncertain, especially regarding the current depletion level.

For West Coast rockfish, a stock is considered overfished when it is below 25% of virgin spawning biomass. Currently, the spawning stock is believed to be near 70% of the unfished level in both the Northern and Southern stocks. Lingcod has not been subject to overfishing since 2003. Management and assessment of stock status might be improved through greater cooperation with British Columbia, as the stock extends northward into Canadian waters. Recent catch and levels of depletion are presented in Figures 14 and 15.

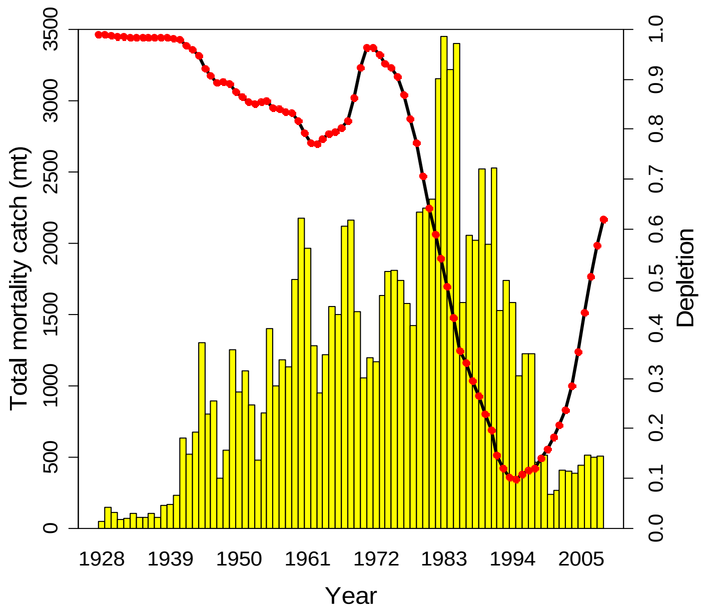

Figure 14. Level of catch (bars) and depletion (line) for lingcod North of 42ºN, 1928-2009.

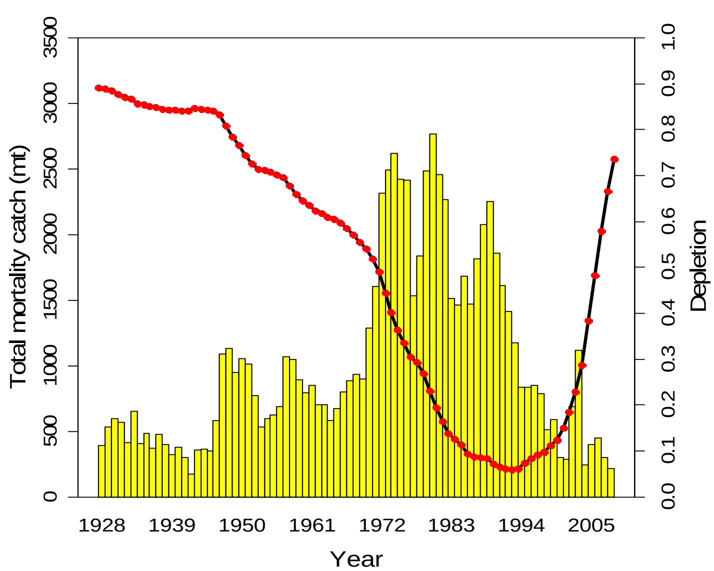

Figure 15. Level of catch (bars) and depletion (line) for lingcod South of 42ºN, 1928-2009.

Lingcod: The complete version of: Status and Future Prospects for the lingcod Resource in Waters off Washington and Oregon as Assessed in 2009 can be viewed at: http://www.pcouncil.org/groundfish/stock-assessments/current-stock-assessments/

For more information on this assessment contact Dr. Owen Hamel at: Owen.Hamel@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 Oregon State University, College of Oceanic and Atmospheric Sciences 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. The data portal houses an ever expanding array of information including but not limited to geological and geophysical data, 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://pacoos.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.

The functionality of the PaCOOS data portal is continually being improved and new data sets are being added. This year updates to survey information have been added and habitat information has been updated.

For more information, contact Elizabeth.Clarke@noaa.gov (206-860-3381) or Chris Goldfinger at gold@coas.oregonstate.edu (541-737-5214)

2. Bycatch Reduction Research

The Northwest Fisheries Science Center (NWFSC) sought funding in 2008 and 2009 to support staffing for a fishing gear technician in the NWFSC's Habitat and Conservation Engineering (H&CE) group within the NWFSC's Fishery Resource Analysis and Monitoring Division. Working with our fisheries research partner, the Pacific States Marine Fisheries Commission (PSMFC), the NWFSC hired a gear technician who is stationed at the NWFSC's field station in Newport, Oregon. This technician focuses on gear research, assists the group coordinator in the continued development of the NWFSC's bycatch reduction research, and collaborates with other NMFS and regional gear researchers.

In 2009, the NWFSC and PSMFC developed and began field testing of an open escape window bycatch reduction device (BRD) to reduce ESA-listed Chinook salmon and rockfish (genus *Sebastes*) bycatch (e.g., darkblotched, canary, and widow) in the Pacific whiting fishery (Figure 16). The development of this BRD benefited from extensive interactions with scientists, especially those from the Alaska Fisheries Science Center, commercial fishermen, and gear manufacturers working in the Pacific Northwest and Alaska. This BRD design consists of two mesh panels, positioned near the codend of a midwater trawl, which direct

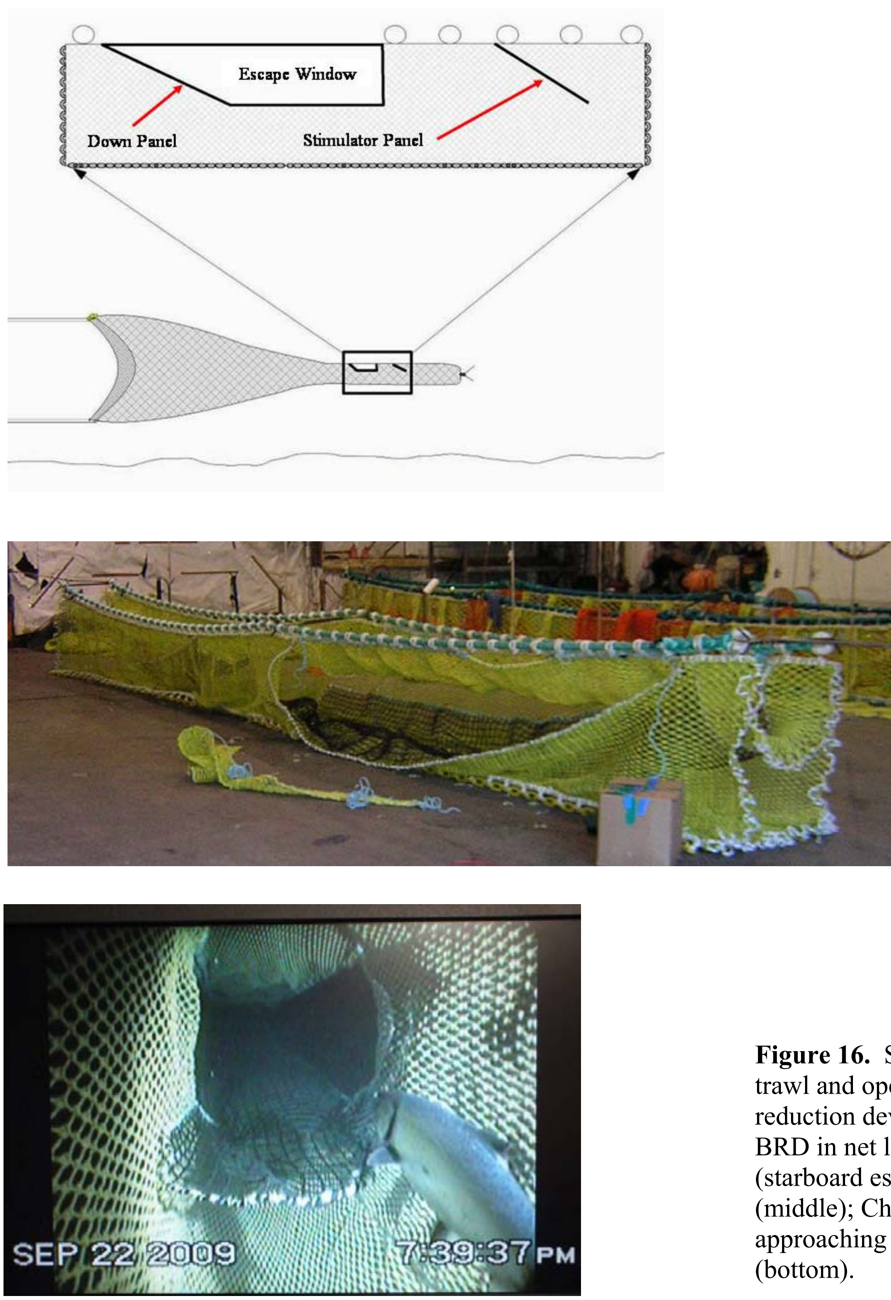

Figure 16. Schematic view of midwater trawl and open escape window bycatch reduction device (BRD) (top); completed BRD in net loft in Newport, Oregon (starboard escape panel removed) (middle); Chinook salmon (ca. 80 cm) approaching BRD's escape window (bottom).

actively swimming fish toward an open escape window on the top and upper sides of the net. This BRD is designed so that fish displaying strong swimming abilities (e.g., salmon and rockfish) can escape through the open windows, whereas fish exhibiting weak swimming abilities (e.g., Pacific whiting) will pass into the codend. During September 2009, the HC&E group conducted a five-day research cruise aboard a trawler engaged in the Pacific whiting fishery. Chinook salmon behavior within the BRD was documented with an autonomous video camera. A total of eight salmon were observed, with five salmon (> 62%) escaping via the BRD. Because trawling was conducted with an open codend and the video camera system could not record the total duration of every tow, we were unable to determine whether the remaining three salmon escaped using the BRD. Planning is currently underway to conduct further development and testing of the open escape window BRD concept in the Pacific whiting midwater trawl fishery as well as other Pacific coast trawl fisheries. Results from 2009 demonstrated the capability of the open escape window BRD to release Chinook salmon before capture. More extensive testing of the BRD under varied fishing conditions with successful results would be the first step in applying this bycatch reduction concept in the Pacific whiting fishery. One recent fishing industry collaboration grew out of the NWFSC's interactions with the conservation engineering group at the Alaska Fisheries Science Center and regional net lofts in the Pacific Northwest. A resulting technology transfer was the development of a variation on the BRD by a Seattle area net loft and its testing in Alaska's walleye pollock fishery. Results from tests during 2009 and lessons learned are currently being exchanged between Pacific coast and Bering Sea gear technologists and will be applied in gear development for next year's field season.

In addition to the above work on flexible sorting grids, the NWFSC has continued work on two ongoing bycatch reduction research projects. The first ongoing project is collaboration with the gear research group at the Oregon Department of Fish and Wildlife (ODFW) and is focused on observations of fish behavior in the vicinity of the footrope of the bycatch-reducing selective flatfish trawl, using a dual-frequency identification sonar (DIDSON) ultrasonic camera. Reducing bycatch in commercial fishing gear requires an understanding of the behavior of fish interacting with the gear. The use of lights may confound observations of fish behavior in the proximity of fishing gear. The DIDSON uses ultrasound to form images of fish, as well as the gear, surrounding structures, and the seafloor. The DIDSON was used to examine diel behavior differences in roundfish along a 12-meter section of the footrope on the starboard wing of the flatfish trawl. During FY09, data extraction was completed for individual fish tracks from all of the archived DIDSON data collected in 2006 and 2007. Movements of individual roundfish were tracked, providing a continuous measurement of distance from the footrope. Analysis of fish tracks revealed that during the day, roundfish remained farther from the footrope, maintained a relatively constant distance, and showed less variation in direction. At night, fish approached the footrope at a sharper angle and displayed a more abrupt change in speed and direction. These behavioral differences suggest that herding efficiency and gear selectivity are different between day and night fishing.

In FY09, the NWFSC continued a pilot project to integrate seabed classification with commercial fishing activities to investigate whether this type of information would be useful in reducing bycatch in Pacific coast groundfish fisheries. This project is being conducted in the vicinity of Morro Bay, California as a collaboration between the NWFSC's HC&E group and West Coast Groundfish Observer Program, the Nature Conservancy, and Oregon State

University's Active Tectonics and Seafloor Mapping Lab. The goal of the project is to capture bottom type using a Quester Tangent QTC VIEW simultaneously with bottom trawling. This project will consider questions such as, can high-quality data be collected during normal fishing operations to inform NMFS about bottom type with minimal impact on fishing operations, and will patterns in bycatch relate to specific seafloor classifications? Building on work completed in FY2008, this project entered a second phase of field work in September 2009, employing a newly installed dual frequency echosounder matched to a Quester Tangent QTC View 5.5 system. The field work for the phase II portion of the project will continue through February 2010.

For more information, contact Waldo Wakefield at Waldo.Wakefield@noaa.gov, (541) 867-0542 or Bob Hannah at Bob.W.Hannah@state.or.us, (541) 867-0300

3. Cooperative Ageing Unit

The Cooperative Ageing Project (CAP) provides direct support for U.S. West Coast groundfish stock assessments by providing ages derived primarily from otoliths. In 2009, CAP aged the following species: Dover sole, curlfin sole, petrale sole, canary rockfish, Pacific ocean perch, darkblotched rockfish, redbanded rockfish, splitnose rockfish, greenstriped rockfish, Pacific hake, and sablefish.

For more information, please contact Dr. Jim Hastie at Jim.Hastie@noaa.gov

4. Resource Surveys

a) U.S. West Coast Groundfish Bottom Trawl Survey

The NWFSC conducted its twelfth annual bottom trawl resource survey for groundfish off the coasts of Washington, Oregon, and California. The objective of the 2009 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 October. Each vessel was chartered for 11-12 weeks with the *Ms Julie* and *Noah's Ark* surveying the coast during the initial survey period from May to July. The *Excalibur,* and *Raven* operating in tandem, surveyed the coast during a second pass from mid-August to late October. The survey area was partitioned into ~12,000 adjacent cells of equal area (1.5 nm long. by 2.0 nm lat., Albers Equal Area projection) with each vessel assigned a primary subset of 188 randomly selected cells to sample. An Aberdeen-style net with a small mesh (1 1/2" stretch) liner in the codend was used for sampling. The survey followed a stratified random sampling scheme with 15-minute tows within 2 geographic strata (80% N of Pt. Conception, CA and 20% S) and 3 depth strata. The depth strata were: shallow (30-100 fms), middle (100-300 fms), and deep (300-700 fms). The sample design consisted of 752 sampling locations, with a minimum of 30 tows per strata.

In 2009, 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) 1) Genetic variation in the natural population of sablefish and development of a genetic map for sablefish – University of Victoria, BC, Canada; 3) Preliminary work on mercury detection in selected species of groundfish off WA -Division of Environmental Health Washington State Department of Health; 4) Age, growth, and reproductive biology of the starry skate, *Raja stellulata* - Moss Landing Marine Laboratories; 5) Collection of Pacific black dogfish, *Centroscyllium nigrum* specimens - Moss Landing Marine Laboratories; 4) Feeding ecology of the roughtail skate, *Bathyraja trachura*.; 6) Collection of all unusual or unidentifiable skates, sharks, or chimaeras - Moss Landing Marine Laboratories; 7) Collection of biological data and specimens of the deepsea skates, *Bathyraja abyssicola*, and broad skates, *Amblyraja badia* - Moss Landing Marine Laboratories.

Several other research initiatives were undertaken by the Survey Team including: 1) Use of stable isotopes and feeding habits to examine the feeding ecology of rockfish (genus *Sebastes*); 2) Fin clip collection for various shelf rockfish species; 3) Collection of stomachs for selected species including: Pacific hake and various rockfish; 4) Collection and identification of cold water corals; 5) Determination of sexual parasitism of crabs (carcinophily) in the northeast Pacific Ocean; 6) Fish distribution in relation to bottom dissolved oxygen concentration in the oxygen minimum zone; 7) Video study observing the interaction of flatfish with trawl sweeps; 8) Fish distribution in relation to bottom dissolved oxygen concentrations in a known hypoxic area off OR; 9) Composition and abundance of benthic marine debris collected during the 2009 West Coast Groundfish Trawl Survey from May to October 2009; and 10) Collection of ovaries from Pacific hake and canary rockfish to assess maturity.

For more information please contact Dr. Aimee Keller at Aimee.Keller@noaa.gov.

b) Autonomous Underwater Vehicle (AUV) Surveys

The Northwest Fisheries Science Center (NWFSC), in collaboration with researchers at Woods Hole Oceanographic Institution (WHOI), and the Pacific Islands Fisheries Science Center is developing a SeaBED type Autonomous Underwater Vehicle (AUV) to overcome the difficulty of monitoring fish populations in rocky areas. Traditional fish monitoring techniques, such as trawls 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.

The SeaBED-class AUV is unlike more traditional AUV's in that its twin-hull design provides greatly enhanced stability for low-speed photographic surveys. Built by Woods Hole Oceanographic Institute (WHOI), SeaBED is designed to autonomously follow the terrain approximately 3-4 meters (m) above the sea floor, collecting high resolution color imagery while maintaining a forward speed of 0.25 – 0.5 m sec^{-1}. SeaBED is approximately two meters long and weighs nearly two-hundred kilograms. It has two main pressure housings, a top hull and a bottom hull. With a maximum depth range of 2,000 m, and maximum single-dive time of 6 – 8 hours, SeaBED can be used to survey habitats ranging from shallow coral reefs to deep groundfish environments.

During several missions in both Hawaii and California, new camera configurations and new cameras were added and tested. An Imagenex Delta T multibeam sonar was also added to the vehicle to allow near bottom multibeam mapping. Research cruises are now being planned for spring and summer of 2010 during which the occurrence, distribution and abundance of coldwater corals and sponges in key areas of the west coast will be examined.

For more information, contact Dr. Elizabeth Clarke at Elizabeth.Clarke@noaa.gov

c) Southern California hook-and-line survey

In early Fall 2009, FRAM personnel conducted the sixth 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) and the southern California sportfishing industry aimed at developing an annual index of relative abundance and time series of other biological information for structure-associated species of rockfish (genus *Sebastes*) such as bocaccio (*S. paucispinis*), greenspotted rockfish (*S. chlorostictus*), and the vermilion rockfish complex (e.g., *S. miniatus* and *S. crocotulus*) within the SCB.

The F/V *Aggressor* (Newport Beach, CA) and F/V *Mirage* (Port Hueneme, CA) were each chartered for 12 days of at-sea research, with nine biologists participating during the course of the survey. The two vessels sampled a total of 120 sites ranging from Point Arguello in the north to 60 Mile Bank in the south. Approximately 2,800 lengths, weights, fin clips, and otolith pairs were taken representing 34 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 designed 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. A total of 392 of these hooks were used during the course of the 2009 hook and line survey. An underwater video system was deployed opportunistically at sites to gather imagery of the seafloor for future analyses correlating catch rates of key species with specific habitat types. This camera system has also been deployed in other applications including direct visual observations of pelagic fish schools to be compared with contemporaneous acoustic backscatter data.

Other ancillary projects conducted during the 2009 hook and line survey included the collection of tissue samples from bocaccio for stable isotope analysis to compare trophic feeding levels inside and outside of marine reserves and the preservation of several rockfish and flatfish specimens for a genetic voucher program conducted by the University of Washington and for species identification training for the West Coast Observer Program.

For more information please contact John Harms at John.Harms@noaa.gov

d) 2009 Joint U.S.-Canada hake acoustic survey and the processing of the collected data

The Joint U.S./Canada Integrated acoustic and trawl survey was conducted from June 29 to Aug. 23, 2009 by the U.S. Team (NWFSC/FRAMD) on the NOAA ship *Miller Freeman*, and from Aug. 12 to Sep. 10, 2009 by the Canadian Team (DFO/PBS) on the *CCGS W.E. Ricker*. The data collected during the survey were processed to provide an estimate of the abundance and spatial distribution of the coastal Pacific hake stock shared by both countries. The survey covered the slope and shelf of the Pacific coast from approximately 35.7º N to 55.7ºN with acoustic transects spaced 10-20 nm apart. The U.S. team onboard the *Miller Freeman* surveyed up to 48.4ºN, and the Canadian team on the *Ricker* completed the region from 48.5ºN to 55.7ºN. The survey resulted in 121 transects with over 3,877 miles of acoustical transect. Pacific hake were observed from approximately 37ºN to 55º N (Dixon Entrance), close to the northern extent of the survey. Data were collected on 18-, 38-, 120-, and 200-kHz EK60 echo sounder on the *Miller Freeman*, and 38 and 120 kHz EK60 echosounder on the *Ricker*. Midwater and bottom trawls were conducted to verify size distribution and species composition and to obtain biological information (i.e. age composition, sex).

A total of 129 successful trawls (91 by U.S.) resulted in a total catch of 35,592 kg (28,672 kg from U.S.). One of the major findings is that a significant amount of Humboldt squid was found during the 2009 hake survey, with total catch weight of 28,137 kg (26,531 kg from U.S.). The data analysis was completed by Dec. 15 to provide necessary information to the hake stock assessment group. The estimated total biomass of Pacific hake was 1.46 million metric tons. The stock was dominated by hake with mean length about 40 cm (3-4 year old cohort). Due to the presence of Humboldt squid, the variance estimated with the method proposed by Jolly-Hampton was 16.3%, or about 50% more than that from the 2007 hake survey.

Also on the joint U.S./Canadian survey, the NWFSC Video Plankton Recorder (VPR) was used to give a complete picture of the plankton community, including gelatinous zooplankton not identifiable from net tows. The goal of this work is to identify plankton that affects acoustic backscatter during hake surveys.

Figure 17.
NWFSC Digital Video Plankton Recorder

For more information, contact Dr. Dezhang Chu at Dezhang.Chu@noaa.gov

e) Joint PWCC-NMFS hake pre-recruit survey

A joint Pacific Whiting Conservation Cooperative and FRAMD pre-recruit survey was conducted in 2009 to determine the spatial distribution and abundance of young-of-year (YOY) Pacific hake along the U.S. West Coast. The survey was conducted from May 7 to June 8, 2009 and covered the area from 36º 30'N to 48ºN at 30 nm intervals. A minimum of 5 trawl stations were sampled on transects located at 30 nm intervals with stations located over waters between approximately 50 m and 1,000 m depth, with hauls taken over bottom depths of 50, 100, 200, 300, and 500 meters at each transect. The survey was conducted using the research gear and survey protocol developed by the NMFS Santa Cruz laboratory for surveys of juvenile rockfish (*Sebastes* spp.). The net has a 86' headrope length and was rigged to fish at 30 m depth. The net tapers from the opening to a cod-end of 1/2" mesh that is lined with a 3/8” mesh liner. Trawling is conducted at night with the headrope at 30 m at a speed of 2.2 to 2.5 kt. Trawl tow duration at depth is 15 minutes, counted from the time the net reaches the 30 m fishing depth.

All fish and invertebrates captured were identified to the lowest taxonomic level and enumerated. All hake caught were counted and measured and data summarized and transferred to the NWFSC within 3 months of the end of the survey. Rockfish collected were bagged, labeled, frozen and delivered to the NWFSC for identification. YOY Pacific hake numbers were found to be low, suggesting a relatively weaker year class than in recent years. Additionally, spawning appears to have returned to a more southerly distribution.

For more information, contact Dr. Dezhang Chu at Dezhang.Chu@noaa.gov

5. NOAA Program: Fisheries And The Environment (FATE)

Project Title: Development of a Real-Time Tool for Predicting the Location of Pacific hake (*Merluccius productus*)

Investigators: Dr. Melissa Haltuch (NWFSC), Dr. Carrie Holt (DFO, Nanaimo), Dr. Elizabeth Clarke (NWFSC), and Dr André E. Punt (NWFSC)

Predicting species distributions has utility for survey planning. Specifically, if a tool were available to predict where the density of migratory target species was highest a few weeks before a survey is conducted (without using data on the species itself), survey effort could be distributed to minimize (expected) variance. The benefits of modifying designs for surveys which target a mix of species may be low. However, substantial benefits in terms of more precise estimates of abundance could be possible for surveys which target single species, such as the acoustic surveys for Pacific hake (*Merluccius productus*) off the west coasts of the U.S. and Canada. These surveys form a key basis for the stock assessment and hence management advice for this species (e.g. Helser and Martell 2007; Helser *et al.* 2008).

The spatial distribution of Pacific hake is known to exhibit inter-annual variation and this has consequences for monitoring, assessment, management and utilization of this species. Considerable research on Pacific hake has been undertaken (see, for example, the review by Ressler *et al*. 2007). For example, it is known that a larger proportion of the stock migrates into Canadian waters during El Niño events, apparently due to intensified northward transport during the period of active migration (Dorn 1995; Agostini *et al*. 2006), while ocean-basin scale regime shifts have also been used to explain inter-annual variability in migration (Benson *et al.* 2002; Field 2004). Changes in spatial distribution are explicitly accounted for in stock assessments for Pacific hake by allowing fishery selectivity for the U.S. and Canadian fleets to vary through time, but such changes do not directly impact how the fishery is monitored for assessment purposes.

The project addresses several of the aims of the FATE program. Specifically, the development of a modeling tool that can forecast species distributions on short time-scales using environmental data partially addresses the aim "to construct the next generation of forecasting tools". In addition, this tool will allow environmental data to be used when crafting management decisions and when planning surveys. The results of stock assessments should be more precise and reliable if surveys can be designed that are more precise than those currently undertaken. This is particularly relevant to Pacific hake which is a transboundary stock, the assessment of which has been contentious in recent years, and for which indices of abundance from acoustic surveys are the main sources of information on abundance.

For more information, contact Dr. Melissa Haltuch at Melissa.Haltuch@noaa.gov

6. Ecosystem Studies

a) Fish Ecology Division Summary Report

The Fish Ecology Division conducted five monthly field surveys in 2009 for larval fishes using plankton nets and juvenile fishes using trawls. This was the most successful year to date, with all transects and 99 out of the 100 planned ichthyoplankton tows completed. All larval fish have been sorted and identified for 2009 and the juvenile fishes have been identified from all but the September cruise in 2009. Preliminary results have shown a substantial increase in the abundance of rockfishes in plankton nets and trawls in the last few years so that they dominate the fish composition presently. Due to the fact that there are potentially so many (>60) rockfish species present off the Oregon coast and that they are so difficult to visually differentiate at early stages, the division been working with Oregon State University geneticists to use genetic techniques to identify several thousand rockfish juveniles from 2005-2009. At least 24 species and several species groups have been identified in this analysis to date. Genetic techniques will soon be applied to larvae which are already sorted, measured, and preserved in alcohol. There have also been moderate increases in flatfish larvae/juveniles of several commercially important species. Perhaps the most striking change for 2009 was the finding of substantial numbers of Humboldt squid, a more tropical species, in the sampling area. Although observed every year squid were particularly abundant this past year. Division personnel are presently working on a manuscript which will document this finding and consider the potential impact of this voracious predator.

Products:

- Poster presentation at the 2009 annual Larval Fish Conference in Portland, OR (7/24/09) entitled, "An investigation of the response of fish larvae to decadal changes in environmental forcing factors off the Oregon coast." Toby D. Auth, Richard D. Brodeur, Heather L. Soulen, Lorenzo Ciannelli, and William T. Peterson.
- Poster presentation at the 2009 annual Larval Fish Conference in Portland, OR (7/24/09) entitled, "Winter Ichthyoplankton abundance: predictor of summer prey fields and ultimate survival of juvenile salmon?" Elizabeth A. Daly, Toby D. Auth, Richard D. Brodeur, and William T. Peterson.
- Oral presentation at the Gilbert Ichthyological Society meeting in Washington (10/09) entitled, "Genetic Identification of Larval/Juvenile *Sebastes* Samples for Stock Assessment" Johansson, M.L., T.A. Britt, C.A. Vanegas, M.N.C. Litz, J.R. Hyde J.R., M.A. Banks, and R.D. Brodeur.
- Oral presentation at the 2009 Annual PICES Conference in Jeju, Korea (10/09) entitled, "Ichthyoplankton as indicators of climate change and recruitment variability of marine fishes and salmon along the northwest coast of the US." Richard D. Brodeur, Toby D. Auth, Elizabeth A. Daly, and William T. Peterson.
- Auth, T.D. 2009. Importance of far-offshore sampling in evaluating the ichthyoplankton community in the northern California Current. *CalCOFI Rep.* 50:107-117.
- Phillips, A.J., R.D. Brodeur, and A.V. Suntsov. 2009. Micronekton community structure in the epipelagic zone of the northern California Current upwelling system. *Prog. Oceanogr*. 80:74-92.
- Parnel, M.M, R.L. Emmett, and R.D. Brodeur. 2008. Ichthyoplankton community in the Columbia River Plume off Oregon: effects of fluctuating oceanographic conditions. *Fish. Bull.*106:161-173.
- Toole, C.L., R.D. Brodeur, C.J. Donohoe, and D.F. Markle. MS. Seasonal and interannual variability in the community structure of small demersal fishes along the central Oregon coast. In revision to *Mar. Ecol. Prog. Ser.*
- Contributed multiyear data on juvenile fishes to a section of the North Pacific Marine Science Organization Ecosystem Status Report that will be published in 2010.

For more information, contact Dr. Rick Brodeur or Dr. R. Emmett at Rick.Brodeur@noaa.gov and Robert.Emmett@noaa.gov

b) A Synthesis of diets and trophic overlap of marine species in the California Current

A key step toward ecosystem-based management is to better understand how interactions within food webs affect species of commercial and conservation importance. The NWFSC compiled comprehensive diet information and food web analysis for major taxa within the California Current ecosystem, including fish, marine mammals, birds, and invertebrates (Dufault et al. 2009).

Dufault et al. (2009) synthesized 75 published diet studies from this ecosystem and calculated representative diets for each species or aggregated functional group. They assessed diet relatedness using hierarchical cluster analysis and calculated diet overlaps based on percent similarity index (PSI). Both analyses were performed on functional group data and also separately for each vertebrate species.

Cluster analysis identified distinct feeding guilds and revealed both intuitive and novel diet similarities between several species and functional groups. One intuitive example is that functional groups preying on euphausiids, a key forage species in the California Current, show a high amount of overlap. A novel example is the significant diet overlap of shallow small rockfish and baleen whales (e.g., grey whales [*Eschrichtius robustus*]), both of which consume large amounts of benthic invertebrates.

Functional groups were highly significant in explaining the PSI differences between species, which suggests that key ecological interactions will be preserved in ecosystem models that use these functional groups. A visual representation of the complete food web and calculation of food web statistics suggest that there are strong similarities between the food webs of the California Current and the Benguela Current, a similar upwelling-driven eastern boundary current off the southwest coast of Africa.

For more information please contact Dr. Isaac Kaplan at Isaac.Kaplan@noaa.gov

c) NOAA's Fisheries Service proposes federal protection for three Georgia Basin rockfish species

NOAA's Fisheries Service proposed to list three populations of rockfish in Puget Sound and the Strait of Georgia for protection under the Endangered Species Act. A final decision on the three will be made in April 2010.

The Georgia Basin populations of two of the rockfish species – canary and yelloweye – are proposed for "threatened" status. A third rockfish species – bocaccio – is proposed as "endangered." An endangered species is at high risk of extinction; a threatened species is vulnerable to extinction in the near future and in need of protection.

Populations of all three rockfish species in the Georgia Basin, which encompasses Puget Sound and the Strait of Georgia, have been harvested at high levels, depleting their numbers. Rockfish, which are bottom dwellers, typically live long lives, and mature and reproduce slowly, making them especially vulnerable to overfishing.

Rockfish make up a substantial portion of the federally managed commercial bottomfish harvest off the West Coast, especially off the coast of California. Rockfish harvests in Puget Sound, by contrast, are managed by the state and the commercial catch there has been substantially restricted since the early 1990s, although there is still a small recreational harvest.

According to NOAA scientists, rockfish population growth has also been hampered by other fisheries unintentionally catching the stock and by environmental factors, such as loss of eelgrass beds, pollution and abandoned fishing gear that continues to catch fish.

If these rockfish are listed for Endangered Species Act protection next in 2010, the agency's initial focus would be on fishing practices in Puget Sound. There is currently a broad state and federal effort to improve the sound's water quality and nearshore habitat through the Puget Sound Partnership, which is aimed at conserving all marine life, including rockfish. Resident killer whales, Chinook salmon, chum salmon, steelhead and bull trout are already protected in the sound under the ESA.

The proposed listing is in response to a petition from an Olympia resident who asked the agency in 2007 to list Puget Sound populations of five species of rockfish. In addition to the three proposed today, the petition also included greenstriped and redstriped rockfish. Agency scientists have said the greenstriped and redstriped rockfish are at a "low risk" of extinction, and protection under the ESA was not needed at this time.

For more information on this action please see http://www.nwr.noaa.gov/Other-Marine-Species/index.cfm

d) Genetic evaluation of stock structure and population bottlenecks in the severely depleted cowcod

Investigators: J. Hess, P. Chittaro, A. Elz, L. Gilbert-Horvath, J. Carlos Garza , V. Simon

Cowcod (*Sebastes levis*) range from Oregon to Baja California and are currently assumed to be one continuous population. Since 2004, it has been on the National Marine Fisheries Service "Species of Concern" list due to its dramatic decline in abundance (<3.4% - 16.3% of historical biomass). The following questions were addressed: 1) Are there population subdivisions within the species, specifically, between two marine biogeographic regions separated by Point Conception, and 2) Have cowcod populations experienced loss of genetic variation due to a reduction in population size? Sixteen variable microsatellite loci were genotyped and ~500 bp of the mitochondrial control region were sequenced for 294 fish distributed throughout the species range. We observed significant structure when fish were grouped into two regions separated by Point Conception (FST=0.066). However, upon further inspection, an individual-based spatial analysis using Bayesian cluster assignment of the microsatellite genotypes localized this genetic break further south (FST=0.092), corresponding to separation between a Channel Islands region versus the mainland. These results indicate a minimum of two management units in this species. In general, cowcod show low genetic diversity compared to other rockfishes. However, cowcod stocks do not appear to exhibit detectable loss in genetic variation, despite declines in abundance.

For more information please contact Paul Chittaro at Paul.Chittaro@noaa.gov.

e) Differential somatic growth rates and population subdivision of regions separated by Point Conception, CA, in a depleted rockfish, cowcod (*Sebastes levis*)

Investigators: P. Chittaro, J. E. Hess, J. Carlos Garza, and V. Simon

Cowcod rockfish (*Sebastes levis*), a once commonly harvested (commercially and recreationally) species within Californian waters, was declared overfished in 2000, and added to the National Marine Fisheries Service Species of Concern list in 2004. To assist in the conservation of this species, we used otolith microchemistry and microstructure to obtain information related to population structure and the spatial variability of juvenile somatic growth. We hypothesized that a location of large upwelling near Point Conception, CA may act as a dispersal barrier for cowcod rockfish, resulting in population structure (currently, fisheries managers assume a single continuous population). If population structure is detected, we hypothesized that juvenile somatic growth rates would differ among populations owing to the different environments each population resides. To address these objectives we used archived collections of otoliths that were obtained throughout the species range. Using trace element concentrations from whole otoliths we identified two populations of cowcod rockfish that were separated at Point Conception. Further, based on otolith microstructural analyses we detected significant differences in juvenile somatic growth rates between these two populations. These results suggest that a management approach, which considers two populations with differential growth rates, may better assist the rebuilding of this species.

For more information please contact Paul Chittaro at Paul.Chittaro@noaa.gov

7. Acoustic Modeling and Research

a) Codend video camera system

One challenging but crucial element of fisheries acoustic surveys is to obtain accurate groundtruthing of the echo returns. However, it is extremely difficult, if not impossible, to determine the depth at which each species is caught. Therefore, it is problematic when multiple scattering layers are present. In addition, small organisms, such as siphonophores which are strong acoustic scatterers, are missed by regular midwater trawls. To address these issues and to achieve more objective interpretation of the acoustic data, Lisa Bonacci (FRAM acoustics team), along with Waldo Wakefield (Habitat), have constructed a Codend Video Camera System and conducted a pilot study during the summer of 2008 by mounting the system in the codend of an open midwater trawl which enabled us to look at several scattering layers during each tow. From the preliminary data analysis, it was found that this method appeared to provide improved knowledge of acoustic backscatter observed during fisheries acoustic surveys.

The camera system was used during the 2009 Hake survey where it provided non-extractive sampling and information on multiple scattering layers. It was particularly helpful in areas where hake and Humboldt squid were both present which made it difficult to assign species composition to some of the observed regions of backscatter. In some cases the camera system enabled scientists to find a layer of hake under a layer of Humboldt squid that would have been difficult to distinguish with only a closed net tow. Also, in some cases this system was able to be used in place of a bottom trawl in areas where potential bycatch was a concern. Overall, the camera system provided valuable groundtruthing information and will continue to be used during future hake acoustic surveys. Figure 18 presents an example of the analysis of a typical camera tow with analyzed results superimposed.

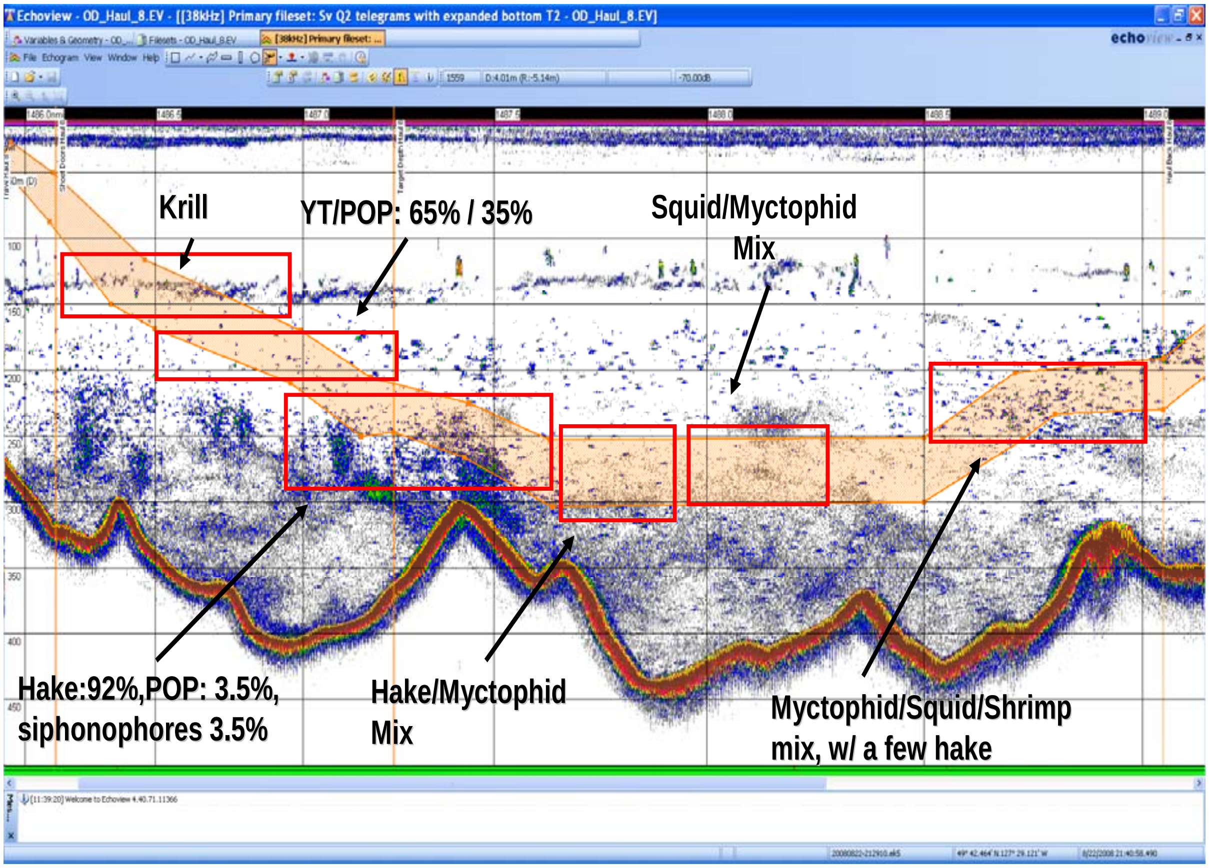

Figure 18. An example of an open-codend camera trawl with analyzed results superimposed. Shaded area represents the estimated area (lateral view) covered by trawl net during the trawl operation. The tow was actually conducted during 2008 Inter-vessel calibration (IVC) cruise.

This system was also used in March of 2009 during a pilot study lead by Lisa Bonacci with co-PI Waldo Wakefield to test the feasibility of using a survey method of acoustics and codend video camera system for widow rockfish (and other rockfish in untrawlable areas). Eleven sea days of field work took place on the F/V *Excalibur*. Sixteen successful tows were completed and more than 800 nautical miles of acoustic trackline data were collected. Review of video footage showed that fish could be clearly seen, identified, counted, and measured. Bycatch was minimal on most tows. Based on the sampling results, a set of future survey locations off of central and northern Oregon was identified. Additionally, the best time of day for towing was also determined. This appears to be a viable non-extractive survey method for widow rockfish. Future work will include pilot work at potential survey sites in the waters off of Washington and California.

For more information, contact Dr. Dezhang Chu at Dezhang.Chu@noaa.gov

b) Acoustic Imaging Microtome System (AIMS)

To quantify changes in swimbladder shape and volume of swimbladder-bearing fish relative to pressure changes, we propose to develop an Acoustic Microtome Imaging System (AMIS). The apparatus that holds the array and allows the array to slide along the Y-axis has been partially built. A 3D conceptual plot of the AIMS is illustrated in Figure 19. The design of the drive electronics is underway and will be completed by the end of FY 2010.

The expected outcomes from the proposed research include: (1) obtaining *in situ* and high resolution (~1mm) 3D acoustic images of fish swimbladders for both physoclistic and physostomous fish over a depth range from the sea surface to as deep as 300 m; (2) increasing our capability to size and possibly classify swimbladder-bearing fish remotely by means of acoustic resonance classification, (3) significantly strengthening our ability to model the target strengths of swimbladder-bearing fish at different depths and frequencies, and (4) improving the estimation accuracy and/or reducing the estimation uncertainty of the spatial and temporal density distributions, and population abundance of swimbladder-bearing fish.

The success of the AIMS will strengthen our ability to predict the target strength of swim bladder-bearing fish and consequently improve the accuracy of stock assessments performed by acoustics surveys.

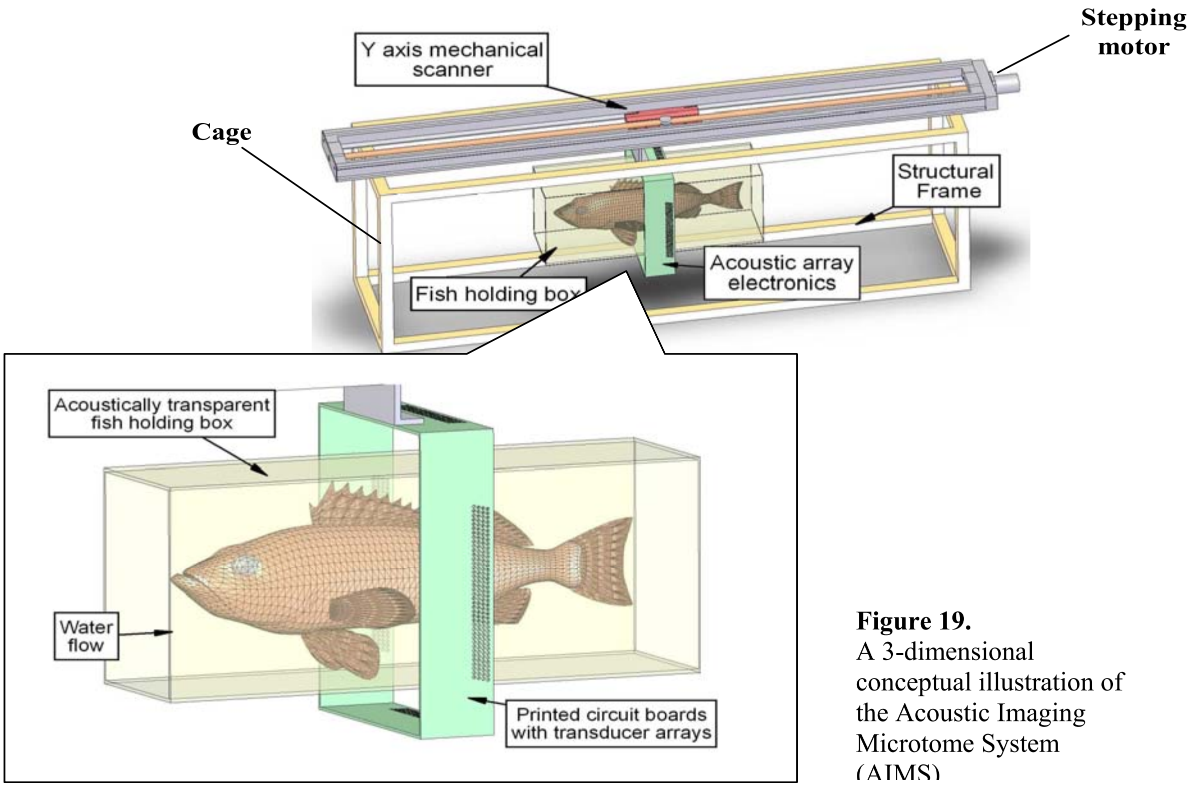

Figure 19. A 3-dimensional conceptual illustration of the Acoustic Imaging Microtome System (AIMS)

For more information please contact Dr. Dezhang Chu at Dezhang.Chu@noaa.gov

c) Automated Shipboard Acoustic Calibration System (ASACS)

This is a project funded by NMFS Advanced Sampling Technology Working Group (ASTWG). The objective of the project is to use state-of-art technologies to improve and expand data collected on existing surveys and to develop new technologies that could be used to initiate new surveys for monitoring groundfish. This project was initiated in early FY08 and tested during the 2008 Inter-vessel calibration (IVC) cruise. In 2009, we improved the system performance by updating both hardware and software. We added tension detection capability to the downrigger motor controllers and increased the wire measure resolution from 2.5 cm to 1 cm. We also revised our GUI based software to make it more flexible functionally and easier to operate. The acoustic calibrations were conducted in Elliott Bay before and after the 2009 Integrated Hake Acoustic and Trawl Survey. The on axis calibration was very easy. The sphere swing operation to map the beam pattern was challenging but was accomplished successfully (Figure 20).

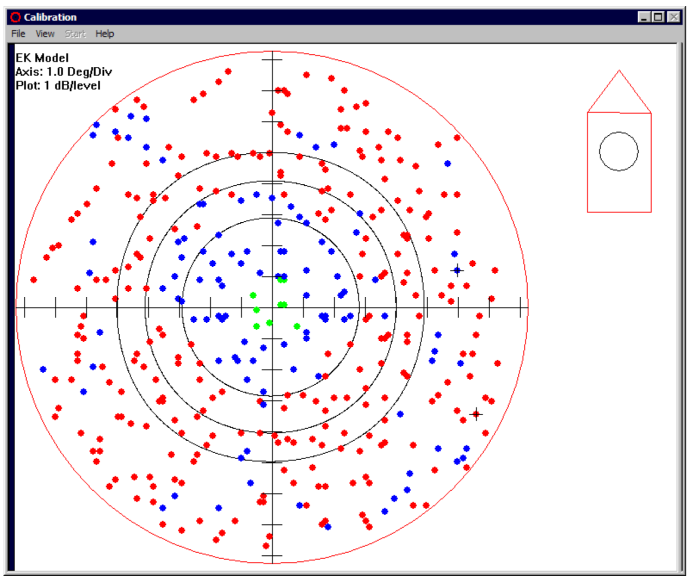

Figure 20. Field calibration swing results of the 18-kHz echosounder. The calibration sphere is a 64-mm diameter copper sphere. Blue dots represent the measured beampattern values that are below the current beampattern values while the red dots mean that the measured values are higher than the current beampattern values.

d) Statistical characterization and classification of fish school clutter

The long-term goal of this research is to transition our results into operational active acoustic systems for reducing false alarm rates due to fish clutter. A remaining key element toward transitioning our results to an operational system involves prediction of statistics of fish patch size. It will address an important issue for fisheries acoustics: to enumerate the fish based on the echo statistics, especially when fish distribution is dispersed and only a few number of fish will be insonified simultaneous. It was found that beampattern can influence the echo statistics significantly and make the fish echo distribution strongly non-Rayleigh (Figure 21). In theory, the different probability density function (PDF) of fish echo can be used to determine the numerical density of fish acoustically.

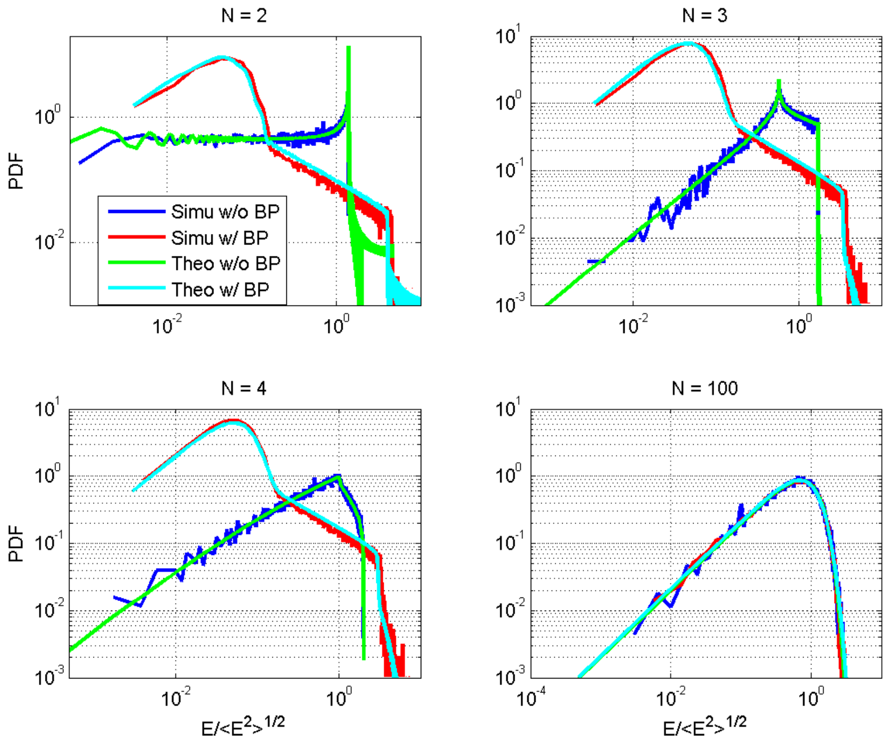

Figure 21. Numerical simulations and the theoretical predictions of echo probability density function (PDF) with and without beampattern effect. N is the number of targets in the acoustic beam, and E is the echo amplitude.

8. Economic Data Collection and Analysis

a) Commercial Fishing Economic Cost-Earnings Data

During 2009, the West Coast limited entry trawl and limited entry fixed gear cost earnings surveys were fielded. Survey response rates of about 65% for limited entry trawl fleet and 55% for the limited entry fixed gear fleet were obtained. These data will be merged with data from other sources such as PacFIN landings data and vessel registration data to produce an updated cost earnings data set for the limited entry fleet. These data will be used to develop inputs for the regional economic model being developed by economists at the NWC, and to support a project to estimate potential changes in the generation and distribution of economic rent as the limited entry trawl fishery moves under a catch share management regime.

The NWC also continued working with the data collected in the previous limited entry trawl and limited entry fixed gear surveys. A study co-authored by NWC staff and two Iowa State University professors found that the number of vessels operating in the groundfish trawl fishery is likely to decrease by 50% to 66% when the groundfish trawl fishery is placed under a catch shares management regime, resulting in annual cost savings of $18 million to $22 million. This study was used in the Pacific Fishery Management Council's Trawl Rationalization EIS and published by Marine Resource Economics. This paper is available as Lian, C., R. Singh, and Q. Weninger, "Fleet Restructuring, Rent Generation, and the Design of Individual Fishing Quota

Programs: Empirical Evidence from the Pacific Coast Groundfish Fishery", *Marine Resource Economics*, Volume 24, pp.329-359.

For more information please contact Dr. Carl Lian at Carl.Lian@noaa.gov

b) Survey of the Economic Value of Sport Fishing

During 2009, econometric models were estimated using the Washington and Oregon recreational angler survey data. The models show the effect of changes in catch by species, size, and bag limits on the value of a recreational fishing trip. In addition, changes in value predicted by this model serve as an input to a related model predicting participation in the fishery. The NWC is currently gathering fishery data that will be used as baseline data in model simulations.

A comparison of the effectiveness of experimental designs used in these types of surveys was conducted as part of the survey design and is currently under review.

For more information please contact Dr. Todd Lee at Todd.Lee@noaa.gov or Dr. Leif Anderson at Leif.Anderson@noaa.gov

c) Regional Economic Impact Analysis

The Input Output Model for Pacific Coast fisheries underwent a CIE review last October. The model is intended to calculate the backward-linked multiplier effects of changes in fishing harvest. Subsequent to the CIE review, the model was presented to the Scientific and Statistical Committee (SSC) of the Pacific Fishery Management Council. Both the CIE and SSC reviews were favorable, and the model is expected to be used for the Council's groundfish specification process during 2010. The documentation of the model that was presented at the CIE and SSC review will be modified and published as a NOAA technical memo.

There will be ongoing improvements to the model as additional data are made available. The second phase of development will be to incorporate recreational fishing into the model, and to expand the coverage of commercial fleets. Additionally, the model will be used as a starting point for the development of a computable general equilibrium model.

One source of new data will be the Western Community Survey, which is a survey of business and households in eight communities along the west coast. The survey will obtain data such as the 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 marine resources. Fielding of the survey began in January 2010 and will continue through March 2010.

For more information please contact Jerry Leonard at Jerry.Leonard@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 2009 on groundfish fleets along the entire west coast.

a) NWFSC U.S. West Coast At-Sea Hake Observer Program

The At-Sea Hake Observer Program deploys two fisheries observers on each of fifteen at-sea Pacific hake processing vessels for every fishing day. Observer sea days exceeded 850 days at sea in 2009, a sharp decline from 1,500 sea days in 2008 as a result of a diminished hake quota. Due to low total catch limits on some bycatch species in this fishery, observer data are crucial to the successful management of the fishery. The 2009 season saw the introduction of bycatch quotas divided among the mothership, catcher-processor, and shoreside sectors. This change will allow management to end fishing for a specific sector if a bycatch allocation is reached, while the other sectors remain open to catch their respective hake quotas. Widow, darkblotched and canary rockfish species each have specific bycatch quotas for the hake fishery. The 2009 hake season was successfully fished to the total hake allocation without exceeding any of the specific bycatch caps.

Recent developments in the at-sea Pacific hake fishery have led to restrictions on several bycatch species which have changed the nature of this fishery and therefore the At-Sea Hake Observer Program (A-SHOP). Additionally, interest has increased about the type and quantity of data being collected by the observers and this has driven changes as well. The result is an increasingly complex work load, which now requires the observers to be more involved in making minute-by-minute decisions about their sampling, and to prioritize and manage their time. This increase in data collection has created new challenges for the observers and has required the program to make changes in the sampling protocols, as well as to modify the actual training of the observers. Historically the observers have collected vessel and haul information, species composition samples, marine mammal and endangered species samples and sighting data, and biological data on the target species. Recent additions to the data collection include an increase in species composition sample size from 33% to 50% for most tows, and a full haul census when there are large amounts of an overfished species present. Biological data, including age structures, are collected on nine rockfish species including: canary, yelloweye, bocaccio, Pacific ocean perch, darkblotched, widow, yellowtail, rougheye and shortraker. Coded wire tag data and samples are collected from both Chinook and coho salmon and genetic samples are collected from all Chinook salmon and sturgeon. Occasionally, additional data for special projects are also collected. The A-SHOP is continually evolving and changing to help the observers adapt to this increased sampling demand and to help ensure that the highest quality data are collected, along with a reasonable maximum amount of data without causing observer fatigue.

For more information please contact Vanessa Tuttle at Vanessa.Tuttle@noaa.gov

b) NWFSC West Coast Groundfish Observer Program

During 2009, the West Coast Groundfish Observer Program deployed observers in bottom trawl and fixed-gear fisheries along the entire U.S. West Coast, exceeding 2,900 observer days at sea on over 300 vessels. The observer 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. The program observes both federally managed and state managed fisheries and in 2009, ten distinct fishery sectors were observed. In 2010, the observer program will begin covering the Washington Pink shrimp fishery (Oregon and Northern California pink shrimp fisheries have been covered since 2004, with the exception of 2006). Due to its unique data collection circumstances, the program continues to stress safety and data quality.

c) Data and analytical reports

The WCGOP collects at-sea data from limited-entry trawl and fixed-gear fisheries as well as from open access nearshore, prawn/shrimp, California halibut, and deep water fixed-gear fisheries. The WCGOP's goal is to improve total catch estimates by collecting information on the discarded catch (fish returned overboard at-sea) of west coast groundfish species. The data are used in assessing and managing a variety of groundfish species.

Summaries of data collected on observed trips are routinely published on the NWFSC web site. Several fleet-specific reports, which are detailed in the table below, were completed during the fall and winter of 2009.

Report Title	Fisheries in Report	Date Range of Data
Data Report and Summary Analyses of the U.S. West Coast Limited Entry Groundfish Bottom Trawl Fishery, Oct 2009	Limited Entry Groundfish Bottom Trawl	January 1, 2008 – April 30, 2009
Data Report and Summary Analyses of the U.S. West Coast Non-Nearshore Fixed Gear Groundfish Fishery, Oct 2009	Limited Entry Sablefish-endorsed fixed gear, Limited entry non-sablefish-endorsed fixed-gear, open access fixed-gear	January 1, 2008 – April 30, 2009
Data Report and Summary Analyses of the U.S. West Coast Nearshore Fixed Gear Groundfish Fishery, Oct 2009	California nearshore fixed-gear, Oregon nearshore fixed-gear	January 1, 2008 – April 30, 2009
Data Report and Summary Analyses of the U.S. West Coast California Halibut Trawl Fishery, Oct 2009	California halibut bottom trawl	January 1, 2008 – April 30, 2009
Data Report and Summary Analyses of the California and Oregon Pink Shrimp Trawl Fisheries, Oct 2009	California Pink Shrimp Trawl, Oregon Pink Shrimp Trawl	January 1, 2008 - December 31, 2009
Estimated 2008 Discard and Total Catch of Selected Groundfish Species	Limited Entry Groundfish Bottom Trawl, Limited Entry Sablefish-endorsed fixed gear, Limited entry non-sablefish-endorsed fixed-gear, open access fixed-gear, California nearshore fixed-gear, Oregon nearshore fixed-gear, California halibut bottom trawl, California Pink	January 1, 2008 – December 31, 2008

	Shrimp Trawl, Oregon Pink Shrimp Trawl, At-Sea Midwater Hake Trawl, Research catch, EFP catch, tribal, recreational	
Observed and Estimated Total Bycatch of Salmon in the 2008 U.S. West Coast Groundfish Fisheries	Limited Entry Groundfish Bottom Trawl, Limited Entry Sablefish-endorsed fixed gear, Limited entry non-sablefish-endorsed fixed-gear, open access fixed-gear, California nearshore fixed-gear, Oregon nearshore fixed-gear, California halibut bottom trawl, California Pink Shrimp Trawl, Oregon Pink Shrimp Trawl	January 1, 2008 – December 31, 2008
Observed and Estimated Total Bycatch of Green Sturgeon in the 2002-2008 U.S. West Coast Groundfish Fisheries	Limited Entry Groundfish Bottom Trawl, Limited Entry Sablefish-endorsed fixed gear, Limited entry non-sablefish-endorsed fixed-gear, open access fixed-gear, California nearshore fixed-gear, Oregon nearshore fixed-gear, California halibut bottom trawl, California Pink Shrimp Trawl, Oregon Pink Shrimp Trawl	January 1, 2002 – December 31, 2008
Pacific Halibut Bycatch in IPHC Area 2A in the 2007 Groundfish Trawl Fishery.	Limited Entry Groundfish Bottom Trawl	January 1, 2008 – December 31, 2008
Observed and Estimated Total Bycatch of Pacific Halibut in the 2002-2008 U.S. West Coast Groundfish Non-Nearshore Fixed Gear Fishery	Limited Entry Sablefish-endorsed fixed gear, Limited entry non-sablefish-endorsed fixed-gear, open access fixed-gear	January 1, 2002 – December 31, 2008

All reports can be obtained at:
http://www.nwfsc.noaa.gov/research/divisions/fram/observer/datareport/index.cfm.

For more information, please contact Janell Majewski at Janell.Majewski@noaa.gov

d) Tracking species range expansion as an indicator of climate change using observer data

One possible consequence of climate change is an alteration in species distribution ranges. However, identifying such alterations can be difficult. Since 2001, the West Coast Groundfish Observer Program (WCGOP) has deployed fisheries observers year-round, along the contiguous West Coast of the United States. This has provided a large data set which can be used to track shifts in species distributions and help to identify the effects of oceanographic phenomena including climate change. To aid in identifying distribution pattern shifts, the WCGOP has recently added latitudinal and depth range parameters to its database. This enables the program to quickly identify any species found outside of its usual range and to monitor such occurrences to determine if they are anomalous or indicate a trend.

For more information, please contact Allen Cramer at Allen.Cramer@noaa.gov

e) Observer-collected data for integrating seafloor classification with commercial fishing activities to potentially reduce bycatch in groundfish fisheries

The NOAA NMFS Northwest Fisheries Science Center continued a pilot project initiated in spring 2008 to integrate seabed classification with commercial fishing activities to investigate if this type of information would be useful for reducing bycatch in west coast groundfish fisheries. This project is being conducted in the vicinity of Morro Bay, CA where the Nature Conservancy (TNC) has launched a project using a private fishing agreement with a longer-term goal for developing a more sustainable trawl fishery in the Central Coast. The project represents collaboration between the NWFSC's Habitat and Conservation Engineering group and the West Coast Groundfish Observer Program, The Nature Conservancy, Oregon State University's Active Tectonics and Seafloor Mapping Lab, and the Quester Tangent Corporation. The goal of the project is to capture information about bottom habitat type using a Quester Tangent QTC VIEW system simultaneously with bottom trawling. Questions to be considered include: can high quality data be collected during normal fishing operations to gather information about bottom habitat type and have minimal interference with fishing operations; do patterns in bycatch relate to specific seafloor habitats and/or classifications; can seafloor data help assist with habitat mapping for west coast groundfish?

For more information, please contact Janell Majewski at Janell.Majewski@noaa.gov

f) Bycatch trends over time in the limited entry groundfish fishery

The West Coast Groundfish Observer Program (WCGOP) was initiated in the fall of 2001 with the goal of improving estimates of total catch and discard through at-sea observation of the groundfish fishery. The program has now collected a substantial amount of bycatch information, which is incorporated into management. Bycatch ratios are computed annually by the WCGOP program and are one of several components used to produce fleet-wide mortality estimates for groundfish species. Trends in observed bycatch and discard over time are evaluated for selected rockfish species, using bycatch ratios, fleet-wide mortality estimates, and the spatial distribution of discard.

For more information, please contact Marlene Bellman at Marlene.Bellman@noaa.gov

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NMFS Southwest Fisheries Science Center

NOAA FISHERIES
NATIONAL MARINE FISHERIES SERVICE

Draft Agency Report to the Technical Subcommittee

of the Canada-U.S. Groundfish Committee

June 2010

Edited by Steve Ralston, E.J. Dick, and John Field

With contributions from David Demer, Carlos Garza, John Hyde, Xi He, Alec MacCall, Donald Pearson, Cynthia Thomson, Susan Sogard, and Mary Yoklavich

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 acting Science Director is Dr. Usha Varanashi, and the Deputy Director is Kristen Koch. All three SWFSC laboratories have supported the essential needs of the NMFS and the Pacific Fishery Management Council (PFMC) for groundfish, including as active members of the PFMC's Scientific and Statistical Committee (SSC), the Groundfish Management Team, 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. George Watters), the Protected Resources Division (led by Dr. Lisa Ballance), and the Fisheries Resources Division (led by Dr. Russ Vetter). 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 at 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 much 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. Stephen Ralston) 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, salmonid ocean and estuarine ecology, habitat ecology, and molecular ecology of fishes. Specific objectives of the 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 at 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) providing professional services (many of which fall into 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. The 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

Juvenile Surveys
The Fisheries Ecology Division (SWFSC) successfully completed the 27th year of its annual May-June survey of the distribution and abundance of pelagic juvenile rockfishes aboard the NOAA R/V Miller Freeman. This marked the first time the survey was completed on a vessel other than the NOAA R/V David Starr Jordan, which was retired in late 2008. Objectives of the survey include collecting data for use in estimating future recruitment to rockfish and other groundfish stocks, and otherwise monitoring the general state of the physical and biological environment (including krill, other forage fish, and physical oceanographic conditions). Results from the 2009 survey indicated a greater abundance of age-0 rockfish (*Sebastes*) relative to the preceding four years, which produced the lowest catch rates of young-of-the-year (YOY) in the history of the survey (Figure 1). Even so, the abundances of YOY rockfish, market squid, and YOY Pacific hake, were barely at their long-term average values, despite apparently greater production of krill and seemingly cool, productive ocean conditions. The trends observed in these four indicator groups are consistent with trends across a number of other taxa. Ongoing efforts will characterize these assemblages and their relationship to oceanographic conditions in the California Current.

Data from these surveys are used in rockfish and, in the past, Pacific hake stock assessments as indices of age-0 recruitment. Current assessments use an abbreviated time series of data developed from the period with full coastwide coverage (i.e., including data from a comparable midwater trawl survey of the northern portion of the US west coast that is conducted jointly by the NWFSC and the Pacific Whiting Conservation Cooperative). Indices from the coastwide survey were used in stock assessments of bocaccio, widow, and canary rockfish that were completed in 2009, and have been used for other species as well (chilipepper, shortbelly, and blue rockfish).

A spatial analysis of encounter rates of YOY groundfish has recently been completed using the combined SWFSC/NWFSC coastwide dataset, which is now being prepared for publication. Results show that the distribution of juvenile fish was highly unusual in 2005 and, to some degree, 2006 as well (Figure 2). Whereas the majority of species are typically encountered most often in the core region of the survey (i.e., 35-40°N lat.), in those years there was as a notable absence of fish in that area. Those two years were also years of greatly depressed total abundance (Figure 1). Conversely, encounter rates to the south and, especially to the north, were substantially elevated. Significantly, 2005 and 2006 were years that the Sacramento River fall run Chinook salmon stock collapsed and it is noteworthy that ocean entry occurs at 38°N during May-June. Thus, it is interesting to speculate that the failure of those salmon year-classes was due to a critical lack of forage at ocean entry. Ocean conditions in 2005 were very peculiar due to: (1) delayed onset of the spring transition to the upwelling season and (2) anomalous winter poleward geostrophic flow anomalies along the entire US west coast.

Data from the SWFSC juvenile rockfish survey were also recently used to evaluate the consequences of fishing down adult rockfish stocks on seabirds that depend heavily on juvenile rockfish as a source of forage during the breeding season. This work tested the hypothesis that fishing has decreased juvenile rockfish availability and thereby limited seabird productivity. This was done by quantifying relationships between observed juvenile rockfish relative abundance and seabird productivity. The analysis used stock assessment models to estimate the relative abundance of juvenile rockfish in the absence of fishing and compared differences in seabird productivity that would have resulted without rockfish fisheries. Results show that while the relative abundance of juvenile rockfish has declined to approximately 50% of that expected in the absence of fishing, seabirds achieved 75% to 95% of the their un-impacted levels of productivity, depending upon the species of bird and other model assumptions (Field *et al*. In press). These results are consistent with the premise that the impacts of local rockfish fisheries on seabird productivity are less than impacts that have occurred to the prey resources themselves due to ocean climate and the ability of seabirds to buffer against changes in prey availability through prey-switching and other behavioral responses.

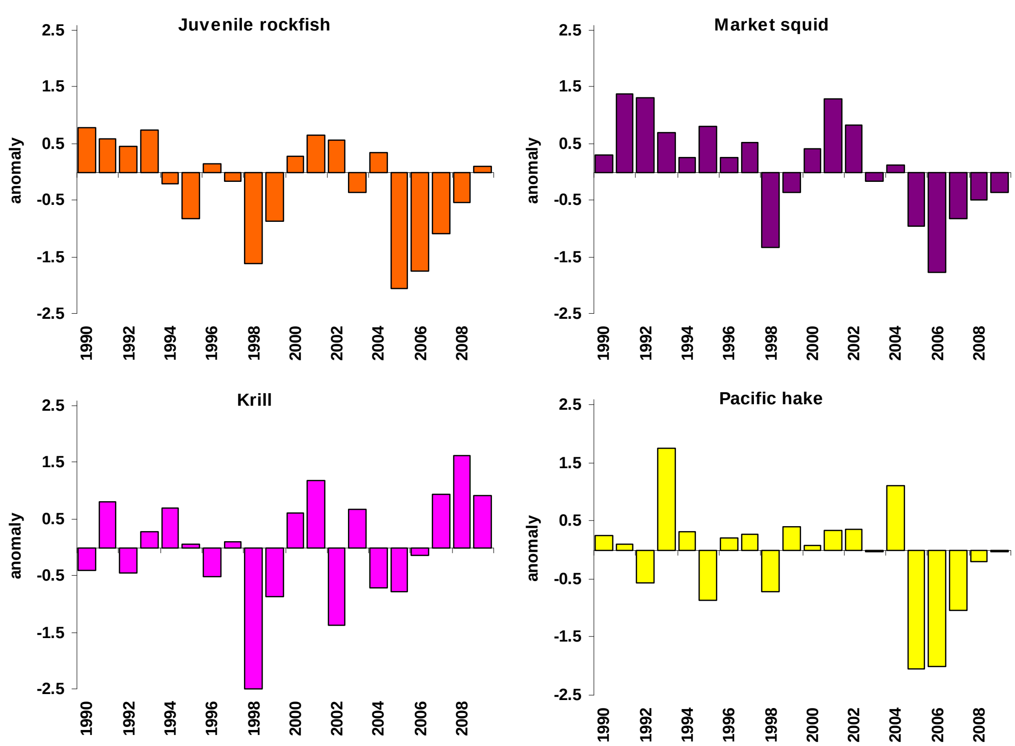


Figure 1: Standardized anomalies of the log of mean values by year for four key forage species that are well sampled in the SWFSC juvenile rockfish midwater trawl survey (figure reflects catches in the historical Central California core survey area from 1990-2009 only).

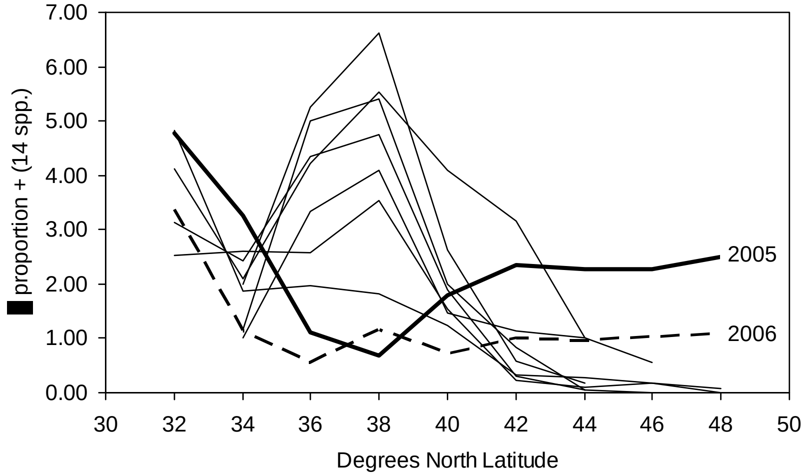


Figure 2: Encounter rates of YOY groundfish in the coastwide midwater trawl survey (2001-2009). Depicted is the proportion positive encounters, stratified by latitude and year, summed over 14 species.

Adult Surveys
The Collaborative Optically-assisted Acoustical Survey Technique (COAST) was developed by the Advanced Survey Technologies Group to survey rockfish dispersions and abundances, by species, throughout the Southern California Bight (SCB). The technique uses historical fishing maps to initially define the survey sites; active-acoustics to map the distributions and estimate the abundances of rockfish, by species, using information about the proportions of rockfish species at each site and distributions of their lengths, estimated from video and still images. The cameras are deployed from a remotely operated vehicle (ROV). The physical oceanographic habitat is sampled using a CTD with a dissolved oxygen sensor and an ADCP; the seafloor is also imaged and classified using new multi-frequency biplanar interferometric techniques. COAST was used to survey rockfishes at 44 sites distributed throughout the SCB in 2004/5 and 2007/8. Data analysis was refined using new techniques in 2009. Terms of reference were drafted for a review of COAST by the Center for Independent Experts.

2. Stock Assessment Support

The Fisheries Ecology Division (FED) is currently the SWFSC lead for stock assessments of groundfish for the PFMC, and supports stock assessment science through the maintenance of data systems and the development of new analytical techniques. The FED works closely with the Pacific States Marine Fisheries Commission (PSMFC) and 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. In addition to maintaining the CalCOM database and supporting port sampling and landings estimation, the FED has participated in the PFMC process since its inception. FED staff scientists have been represented on the Groundfish Management Team (GMT) in every year since its establishment, and have also been active participants in the Scientific and Statistical Committee (SSC) for the PFMC.

New Methods for Assessing Data-Poor Stocks

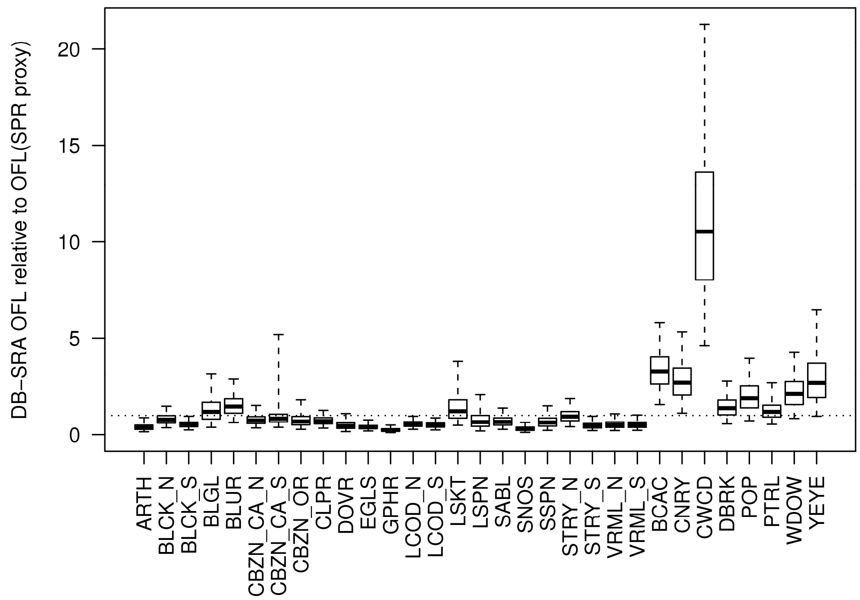
MacCall (2009) developed a simple method for estimating sustainable yields called Depletion-Corrected Average Catch (DCAC). The method is applicable to data-poor stocks where little more than a catch history is available. Using an approach similar to DCAC, Dick and MacCall (In Prep.) developed an extension of the stochastic stock reduction analysis approach of Walters *et al*. (2006) called Depletion-Based Stock Reduction Analysis (DB-SRA). This method is suitable for assessment of data-poor stocks if approximate catches are known from the beginning of the fishery. DB-SRA was applied to 30 data-rich stocks to determine the effectiveness of the method (Figure 3).

DB-SRA was also applied to over 40 previously unassessed stocks (Dick and MacCall, In prep.) and was recommended by the Pacific Fishery Management Council's Scientific and Statistical Committee as the basis for setting overfishing levels and Annual Catch Limits for those stocks. Prior to application of this method, optimal yields for unassessed stocks were primarily based on average or maximum catch statistics.

A simulation study is also being conducted by FED staff to examine utilization of data from Marine Protected Areas (MPAs) to assess population status. The study is a cooperative research effort with Kristen Honey (a Ph.D. student at Stanford University) and intends to use dynamic SPR (spawning potential ratio) within MPAs and outside of MPAs to assess population status and to evaluate the effectiveness of MPAs for data-poor species management.

Quantifying Scientific Uncertainty in Groundfish Stock Assessments

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended in 2007 requires the establishment of Annual Catch Limits (ACLs). An ACL represents a numerically specified upper limit on total fishing mortality that should not be exceeded and forms the basis for invoking accountability measures to rectify chronic overfishing. In addition, the Act requires that the Scientific and Statistical Committees (SSCs) of the regional Fishery Management Councils recommend Acceptable Biological Catch (ABCs) to their respective Councils that account for "scientific uncertainty" in estimates of overfishing limits (OFLs). This new requirement effectively adds a new step in setting catch levels. In particular, the application of F_{MSY} (or its proxy) to biomass values from a stock assessment now defines the OFL, which is functionally identical to the definition of ABC previously used at the Pacific Fishery Management Council (PFMC). As before, annual catches in excess of the OFL constitute overfishing. However, the new guidelines defines ABC as an annual catch amount that is reduced from the OFL in order to account for scientific uncertainty in the development of management advice by SSCs to their Councils. The expectation under the Guidelines is that scientific advice that is relatively uncertain will result in ABCs that are relatively lower, all other things being equal, i.e., a precautionary reduction in catch will occur due purely to scientific uncertainty.



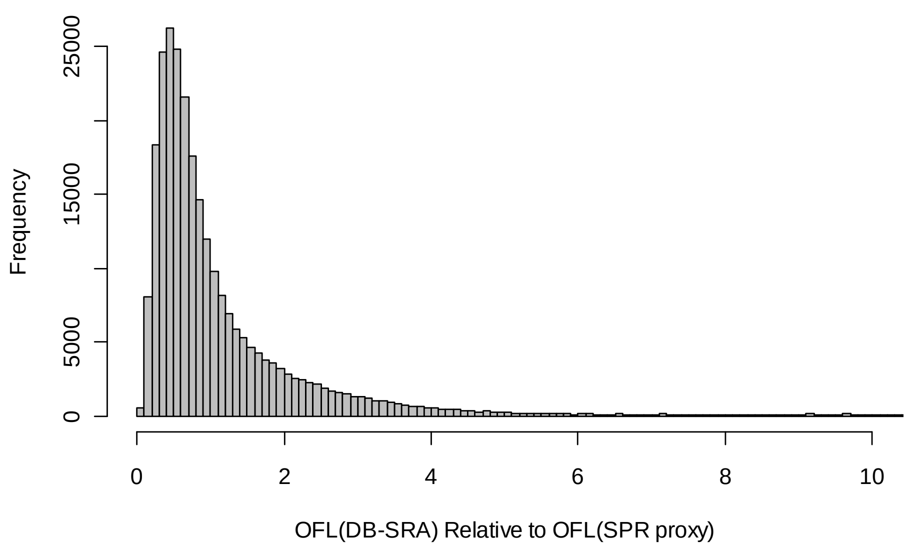


Figure 3. (Upper) DB-SRA estimates of OFL for 31 species, scaled relative to OFL(SPR proxy) estimates from the most recent assessment. Box-and-whisker plots characterize the median, IQR, and 95% intervals of the distributions. The reference line at unity represents agreement with the assessment's point estimate. Uncertainty in the assessment estimate of OFL is not considered. (Lower): Distribution of OFL from DB-SRA, integrated across 31 stocks and scaled relative to the assessment estimates for OFL (SPR proxy). The upper tail is not fully displayed to better illustrate the dominant values of the distribution.

Staff at the SWFSC FED have been involved in efforts within the SSC at the PFMC to quantify scientific uncertainty and to develop an ABC control rule that can be used as a basis for reducing harvest as a function of uncertainty and risk tolerance. There are a variety of uncertainties in developing an OFL, including: (1) biomass uncertainty, (2) harvest rate uncertainty, (3) stock projection uncertainty, and (4) ecosystem uncertainty. Given the short time frame required by the MSA to implement the required elements of the law, however, the PFMC SSC has focused exclusively on biomass uncertainty in the current management cycle, but is expected to incorporate additional variance components as these procedures mature. Those efforts have considered year-specific variation in biomass estimates derived from repeat assessments of the same stock as a composite measure of within assessment statistical variation, as well as model specification uncertainty, given the variation in analytical teams, models, reviewers, data sources, etc. that occurs when stock assessments are periodically repeated (see Figure 4). Biomass variability was estimated for 17 groundfish and coastal pelagic species (CPS) and, from a meta-analytic perspective, uncertainty (log-scale variance) was similar over four broad taxonomic groupings, i.e., rockfish, roundfish, flatfish, and CPS. Thus, the data were further pooled and a single lognormal distribution representing total biomass uncertainty was generated (mean=0.00, stdev=0.36). That distribution was then back-transformed to the arithmetic scale with associated cumulative probabilities. An ABC control rule for data-rich stocks was then tabulated, expressing the required reduction in ABC relative to OFL as a function of a policy decision pertaining to the risk of overfishing (P*). The PFMC adopted a maximum allowable P* of 0.45 for data-rich stocks and set 2011-12 ABCs based on that level of risk.

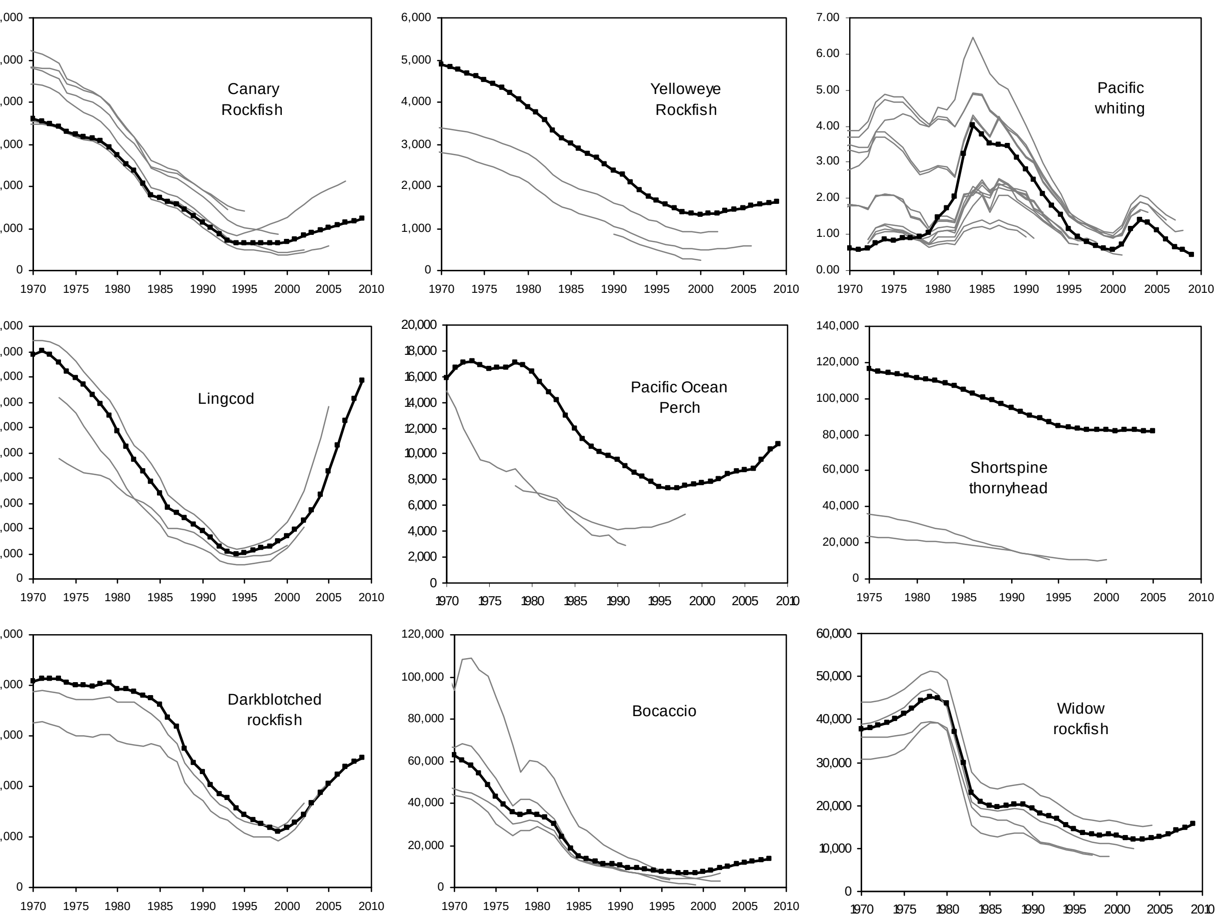


Figure 4. A comparison of biomass trajectories from repeat assessments of nine different groundfish stocks. The bold line is the most recent assessment completed.

Improved Access to Landings Data – Support of the California Cooperative Groundfish Survey

The FED has supported the California Cooperative Groundfish Survey since 1978. One of the key areas of support has been in the area of data management. FED staff recently completed a major overhaul of the website (http://calcomfish.ucsc.edu). The primary purpose of the website is to enable port samplers to enter data directly into the CALCOM database. A secondary purpose of the website is to allow end-users easy access to data. Recent improvements to the website include: (1) allowance for sablefish, whiting, and elasmobranch samples to be entered into the database, (2) allowance for Quota Species Monitoring (QSM) data to be entered and processed by the system, (3) increase in the amount and types of data available to end-users, (4) improved data quality and timeliness, and (5) reduction in work load for data managers. End-users can now download the following information from the website: (1) landing estimates from block summary, catch reconstruction, and commercial expansions, (2) age and length compositions, (3) access or inventory of otoliths, and (4) download all available documentation. In addition to accessing CALCOM through the website, users can request more complete access to sample data via ODBC connections to the database.

Digitization of Historical Landings Data and Catch Reconstruction Efforts

FED staff obtained funding from the NOAA Climate Data Modernization Project (CDMP) to support ongoing efforts at recovery of landings data. These funds have been used to convert microfiche and printed data into electronic format. To date the following data have been put into the database: (1) monthly block summary data from 1931 - 1968, (2) annual trawl log summary data from 1927 - 1957, and (3) landing receipts for the following years: 1951, 1955, 1957, 1960, 1965, 1967, and 1968 (1969 onwards have been available for many years). At the present rate of digitization, landing receipts for all years from 1951 to present should be available within three years.

Last year a variety of both full and update groundfish stock assessments were completed for the PFMC and a concerted effort was made to incorporate comprehensive catch reconstructions in the assessments when possible. To that end, staff at the SWFSC Fisheries Ecology Division completed a reconstruction of California commercial and recreational groundfish landings going back to 1935 and created a database to disseminate the information (Ralston *et al*. In press). Those results were used extensively in stock assessments of canary rockfish, yelloweye rockfish, bocaccio, splitnose rockfish, and others. In some instances incorporation of the historical catch data had a marked affect on estimates of stock status, in both favorable (bocaccio) and unfavorable (canary rockfish) directions. Staff will continue to improve the catch reconstruction estimates as more of the recovered data are keypunched under a grant from the NOAA CDMP.

Effects of Model Misspecification on Assessment Results

FED staff have completed a study using population simulations to examine effects of age-dependent mortality and selectivity on stock assessments. This study compares stock assessment results with simulated data with different assumptions concerning natural mortality and selectivity functions that are often used in west coast groundfish stock assessments. The study shows that mis-specified mortality and selectivity can have large effects on important assessment results, particularly OFL. A draft of this study has been completed and is to be submitted to an external journal for publication.

Influence of Climate on Productivity of Groundfish Populations
The FED is currently involved in efforts to evaluate climate effects on fish growth and productivity, with support from the FATE program and in collaboration with researchers at the NWFSC. The working hypothesis for this study is that poor feeding conditions during warm oceanographic regimes result in trade-offs affecting bioenergetic allocation patterns by females, leading to reduced growth and fecundity. Ongoing efforts include addressing these research questions by expanding on process studies relating environmental conditions to growth and fecundity (including collection of large amounts of age and fecundity data through fieldwork during the project years), by using these results to modify existing bioenergetics models, and by incorporating findings from these efforts into existing stock assessment models of west coast groundfish. The primary focus of these studies are chilipepper (*Sebastes goodei*), for which time-varying growth was modeled in the most recent assessment, yellowtail rockfish (*S. flavidus*), for which a subtantial amount of fecundity data over multiple time periods is available, and brown rockfish (*S. auriculatus*), a relatively data-poor nearshore species that can be subject to varying environmental "regimes" in aquaria. These refinements should improve future assessments by increasing precision and decreasing uncertainty, and improve on a greater mechanistic understanding of how climate drives changing productivity in marine resources.

C. BY SPECIES, BY AGENCY

3. Shelf Rockfish

Research

Modeling Rockfish Fecundity in Stock Assessments
A meta-analysis of rockfish fecundity was completed by members of the Groundfish Analysis Team (GAT) at the Fisheries Ecology Division (FED) to better characterize the reproductive output of exploited rockfish populations. Completed in early 2009, the results from this study have subsequently been incorporated into several rockfish stock assessments (*Sebastes paucispinis, S. elongatus, S. diploproa*, and *S. rubberimus*). General findings of the meta-analysis indicate that target harvest rates are sensitive to changes in relative fecundity with size and that Bayesian hierarchical models are a useful tool to inform predictions of fecundity at size, quantify uncertainty about those predictions, and provide predictive distributions of model parameters for unobserved species.

Sounds of Captive Rockfishes
Sound production by many fish species has been studied extensively, but little is known about sound production by rockfishes (genus *Sebastes*), and only a few species have been reported to be soniferous. To determine if additional rockfish species produce sounds, passive acoustic recordings were made during 2007/08 at Hubbs-SeaWorld Research Institute and Southwest Fisheries Science Center in tanks containing bocaccio (*S. paucispinis*), cowcod (*S. levis*), starry rockfish (*S. constellatus*), and sunset rockfish (*S. crocotulus*) (Širović and Demer 2009). Three distinct sounds were recorded in tanks containing only *S. paucispinis* and two of those sounds occurred at different rates during light and dark conditions. Their common characteristics were low frequency (below 800 Hz), short duration (4 s), and low source levels (103–113 dB re: 1 Pa

at 1 m). Also, there was evidence that one or more other species produced sounds. These findings indicate that more rockfishes produce sounds, and suggest passive acoustics could be a useful tool for remotely monitoring their populations.

Rockfish Sounds and Their Potential use for Population Monitoring in the Southern California Bight

The SWFSC is a leader in the development of non-lethal methods to assess and monitor rockfish stocks off Southern California. From August to October 2007, the ship-based COAST survey was augmented with two passive-acoustic moored recorders. One collected data at the 43-Fathom Bank for 46 days, while the other was serially deployed at 13 locations for shorter periods (1–8 d). Passive-acoustic data were analyzed for the presence of rockfish sounds. Potential sources of five pulsing sounds were identified from the optically estimated species compositions at each location, as well as from known rockfish recordings collected in aquaria. All sounds had a low frequency (<900 Hz). Some were short, individual pulses (_0.1 s), others were repetitive. A repetitive pulsing from bocaccio (*S. paucispinis*) was the most commonly recorded sound and it occurred mainly at night. The daily calling rates at each site were quantitatively compared with the rockfish abundance estimates obtained from the active-acoustic survey, and they were positively correlated. The feasibility of using passive-acoustic tools to efficiently monitor changes in rockfish abundance was explored (Širović *et al*., 2009). The principal challenges in using passive acoustics for population monitoring are determining which species make which sounds, and under which behavioral conditions these occur, and characterizing the large variations in these sounds. The bocaccio sounds might be a good signal for monitoring the recovery of this overfished stock in the SCB, because of its frequent occurrence and long-term persistence. In addition, the sounds from speckled rockfish (*S. ovalis*) may be a good indicator of their abundance, or species with which they aggregate.

A Statistical-Spectral Method for Echo Classification

The frequency dependence of sound-scatter intensity is commonly exploited to classify fish, zooplankton, and the seabed observed in acoustic surveys. Although less utilized, techniques based on the statistics of echo amplitudes can also be used to extract information. A hybrid, statistical-spectral method for target identification (SSID) was developed by the Advanced Survey Technologies Group, which incorporates information contained in both the signal amplitudes and phases (Demer *et al*. 2009). The SSID uses multi-frequency echo statistics from individual time-space intensities (pixels) to identify general scattering types, before applying model-based identification schemes for target identifications. The SSID is used for fine-scale separation of acoustic backscatter from demersal fish and the seabed and estimating seabed depth, within-beam slope, hardness and roughness, and the height of the dynamic acoustic dead zone. Using data from Collaborative Optically-assisted Acoustical Survey Technique (COAST) surveys, the SSID provides information about rockfish distributions, abundances, and their seabed habitats. New protocols for processing COAST survey data were developed and applied.

Concurrent Three-Dimensional Mapping of Demersal Fish and Their Seabed Habitat

The Advanced Survey Technologies Group has developed methods for concurrent three-dimensional mapping of demersal fish and their seabed habitat using the new Simrad ME70 echosounder. The Simrad ME70 multibeam echosounder was designed for quantitative fisheries research and is currently installed on each of the new, quiet, NOAA FSVs. The ME70 has configurable beams and transmits in the range 70–120 kHz to provide calibrated, acoustic-backscattering data throughout the detection range (fisheries mode, FM). With optional hardware and software, the ME70 can also collect soundings that potentially meet International Hydrographic Organization's S–44 Order 1 standards (bathymetric mode, BM). Furthermore, with custom algorithms and software, bathymetric data can be obtained from the ME70 operating in FM, and volume backscatter can be sampled from the ME70 operating in BM. This flexibility allows data to be concurrently collected on fish and their seabed habitat.

Assessments

Bocaccio (*Sebastes paucispinis*)

The 2009 stock assessment of bocaccio (*S. paucispinis*) was the first full assessment conducted since 2003, and as with most west coast groundfish assessments, used the Stock Synthesis model framework (Field *et al*. 2009). The assessment included the southern subpopulation, from south of Cape Blanco to the U.S./Mexico border, only. As with bocaccio assessments done over the past 10 years, results indicate that spawning output fluctuated significantly through the 1960s and 1970s, and declined rapidly through the rest of the 1980s and 1990s. These declines were primarily a result of high exploitation rates, although a period of anomalously poor recruitment appears to have taken place throughout most of the 1990s that intensified the magnitude of the decline. Since that time, fishing mortality has declined tremendously due to management restrictions, and the stock has been increasing at a fairly rapid rate coincident with a series of several year classes (1999, 2003, 2005) that were strong relative to the stock size. One major change in the model was the revised historical catch history, based on a suite of ongoing catch history reconstruction efforts the catch of bocaccio prior to 1950 was estimated to be less than assumed in previous models, contributing to a more optimistic estimate of relative abundance and productivity. The final model estimated that the current spawning output was 28% of the unfished level in 2009, and the rebuilding analysis indicated that under the fishing rate adopted in the most recent rebuilding plan, the population would be expected to be rebuilt by 2021, two years earlier than the median time to rebuild (2023) under the last rebuilding analysis (Field and He 2009). A manuscript providing additional details on bocaccio recruitment and the application of recruitment indices in the stock assessment will also be published in CalCOFI reports (Field *et al*. In revision).

Widow Rockfish (*Sebastes entomelas*)

A full stock assessment for widow rockfish was conducted in 2009. Unlike previous assessments that used ADMB direct codes, the Stock Synthesis program (SS3) was used in this assessment. All data and model structures were reanalyzed and reexamined and the assessment was reviewed by a STAR panel. The revised version of the assessment was submitted to the Pacific Fishery Management Council in August 2009. Since the species was declared to be overfished in 2001 and the population status in 2009 was still below desired management level, a rebuilding analysis was also conducted and its results were submitted to the Council for determining catch limits for 2011 and 2012.

Cowcod (*Sebastes levis*)

FED staff completed an updated assessment of cowcod (*S. levis*) in the Southern California Bight. The model was developed in Stock Synthesis II (SS2), and incorporated a revised time series of historical recreational landings (1928-1980). The final model estimated the 2009 spawning biomass to be approximately 4.5% of the unfished level (Dick *et al*. 2009a). For this stock in particular, there is an urgent need for an informative abundance index that can monitor the recovery of this stock, as past relative abundance information was derived from recreational CPUE time series that are now truncated due to a ban on retention and the establishment of the Cowcod Conservation Areas (CCAs) to rebuild the stock. A rebuilding analysis based on the updated stock assessment was also completed by FED staff (Dick *et al*. 2009b), estimating a median time to rebuild of 62 years (achieving target biomass with 50% probability in 2072).

Greenspotted Rockfish (*Sebastes chlorostictus*)
Staff at the SWFSC FED worked on developing a "data-moderate" approach to assessing a number of rockfish stocks in California. The approach relies on three types of input data: (1) catch (landings + discard), (2) life history information (natural mortality, growth, and reproductive parameters), and (3) length frequency data from the fishery. Because no trend indices are involved, the approach requires there to be a signal of the exploitation history in the length composition data. To test the method length composition data were simulated under an exploitation history similar to that which occurred in California over the last 30 years. The simulated data were then inputted to a stock assessment model that was implemented in the SS3 framework. Results of this feasibility study showed that under a variety of simulation conditions the approach is very capable of accurately estimating population trend, status, and abundance.

The method was then applied to the California greenspotted rockfish (*S. chlorostictus*) stock and findings were reviewed by a stock assessment review panel last year (Dick *et al*. In prep.). This species is important in both sport and commercial fisheries and has produced more landings than any California rockfish that has not been assessed. While clear patterns in the length-frequency data demonstrate a reduction in mean size and truncation of larger size fish during the 1980s and 1990s, with stabilization and recovery over the last 10 years, two factors prevented completion of a successful review. First, it was shown that growth of greenspotted rockfish varies spatially, with fish north of Point Conception being larger for their age than southern fish. There is also a suggestion that growth has changed over the last 30 years. Thus, to account for these factors a two-area model with time-varying growth is being developed. In addition, the size-at-entry to the fishery appears to have shifted to smaller fish as the population was fished. Whether due to changing size selectivity or retention, this aspect also requires further exploration and resolution before the assessment will be ready for use by management.

Bronzespotted Rockfish (*Sebastes gilli*)
Although not conducted as a part of the PFMC management cycle, the SWFSC FED developed a stock assessment for bronzespotted rockfish (*S. gilli*) in California waters, which underwent an independent review process that included a reviewer from the Center for Independent Experts (CIE) in September 2009. The bronzespotted rockfish is a rarely encountered, long-lived and slow growing species found primarily in southern California waters, and the assessment differs from most west coast groundfish assessments due to the lack of independent, informative indices of abundance. Insights into population status were largely gained by evaluating the relationship between the bronzespotted rockfish and cowcod (*S. levis*) fisheries, using a suite of data-poor modeling methods. It appears that the current abundance of bronzespotted rockfish is well below target levels, most likely on the order of 5% to 10% of the historical unfished abundance

(MacCall *et al*. In revision). Management actions that have been implemented by the Pacific Fishery Management Council since 2000 to protect cowcod and other Southern California rebuilding species (including a specific ban on retaining bronzespotted rockfish based on conservation concerns), offer a feasible path to the conservation and rebuilding of this low productivity stock.

D. OTHER RELATED STUDIES

2. Molecular Genetics

Staff from the Fisheries Resources Division and academic collaborators have begun development of genetic markers linked to functional metabolic genes for use in studies of rockfish species. Recent work in cod and other fishes has shown that markers linked to such genes under environmental selection can better define regional populations than traditional neutral microsatellite markers. As several environmental compartments are present along the west coast of North America we hypothesize that regional selective pressures on *Sebastes* spp. exist, particularly at early life stages. Marker development has proceeded well and initial application to studies on bocaccio is planned for later this year.

Work on the redefined vermilion rockfish (*S. miniatus*) was completed that examined gene flow between populations and calculated larval dispersal values using 782 bp of DNA sequence data from the mitochondrial cytochrome b gene of 681 vermilion rockfish sampled from 16 sites between Kyuquot Sound, Canada and San Quintin, Mexico. Significant genetic heterogeneity was found among sample sites ($FST = 0.0742$, $p < 0.001$). Isolation by distance analysis produced a strong and significant correlation, suggesting that average larval dispersal distance is on the order of 10's of kilometers (Hyde and Vetter 2009). Analysis of molecular variance showed strong and significant partitioning of genetic variance across the biogeographic boundary at Point Conception ($FCT = 0.0923$, $p < 0.001$). Additional genetic barriers were found across Cape Mendocino, Punta Colnett, Santa Monica Bay, and along the coast of Washington. These genetic barriers conform to oceanographic compartments previously proposed for the California Current ecological geography province and suggest natural management units for this species at Cape Mendocino and Point Conception.

Staff from the Fisheries Ecology Division have also been investigating population structure of several species of *Sebastes* - shortbelly, kelp, widow, blue and black rockfish - in the California Current using data from 14-17 microsatellite markers per species. These studies have revealed a general lack of population structure in the Central/Northern California portion of this ecosystem (Gilbert-Horvath et al. 2007; Petersen *et al*. in prep). However, in blue rockfish a substantial signal of population structure was confirmed to be due to the presence of two cryptic groups of blue rockfish with little gene flow between them. These groups have tentatively been referred to as incipient species and assigned the interim names blue-sided and blue-blotched rockfish. These two fishes were found to be broadly sympatric, with separation between them not geographically-based (Petersen *et al*. In revision).

3. SWFSC Current Habitat Activities

SWFSC/FED Habitat Ecology Team conducts research in response to the mandates of the Magnuson-Stevens Reauthorization Act of 2006, with a focus on deep-water California demersal communities. Our goal is to provide sound scientific information to ensure the sustainability of marine fisheries and the effective management of marine ecosystems, with objectives to: (1) improve stock assessments, especially of overfished rockfish species in complex habitats; (2) characterize fish and habitat associations to improve EFH identification; (3) contribute to MPA design & monitoring and to Marine Spatial Planning; and (4) understand the significance of deep-sea coral habitats.

Monitoring MPAs off Central California.
With funds from California Ocean Protection Council and collaboration of academic partners, we are collecting baseline data on demersal communities (fishes, invertebrates, habitats) in deep portions of new MPAs and reference sites. Deep-water habitats comprise 75% of the seafloor in state waters off central CA, and yet far less is known about these habitats than in shallow water. We couple seafloor habitat maps with visual surveys conducted from the manned submersible *Delta* (Figure 5). These quantitative, non-destructive survey methods are necessary for an ecosystem approach to the management of diverse communities on rocky areas of shelf and slope. Long-term monitoring is needed to fully evaluate the benefits of these MPAs.

Figure 5: Survey sites in and out of MPAs off central CA. Top inset: Submersible transect over map of rock outcrop. Bottom inset: Schematic of habitat patches (mud, boulder, cobble, sand) along submersible

Improving Stock Assessments.
Using these same techniques, we have developed an extensive database of habitat-specific fish abundance for over 100 species of demersal fishes off CA. We have produced the first-ever fishery-independent stock assessment for cowcod, and will do so for several other rockfish species. These surveys will need to be repeated periodically to improve the assessments.

We also are using these data to evaluate the performance of two underwater survey vehicles (the *Delta* submersible and Phantom DS4 ROV). We compare habitat-specific densities estimated from the survey cameras of both vehicles and we determine changes in fish behavior as potential reaction to the survey tools. Similar species were seen in the visual surveys using each vehicle, but identification of species was more difficult using the ROV than using the submersible. Although fishes reacted to both vehicles, more fishes reacted to the ROV (51%) than to the submersible (18%). In general, fishes that occur higher off the bottom had a greater reaction to either vehicle than those fishes on the seafloor. Understanding survey biases, such as the ability to detect and identify various species and the behavioral response of the fishes to each vehicle, will result in improved survey design and interpretation, more accurate abundance estimates, and can help in selection of appropriate survey tools for specific species.

Predicting Distribution of Benthic Macro-invertebrates.
As part of the California Seafloor Mapping Project (CSMP), the FED Habitat Ecology team has been collaborating with USGS and others to create a suite of maps detailing seafloor morphology and geology, and characterizing potential benthic habitats derived from high-resolution multibeam sonar data. We are using a towed camera sled to groundtruth these data and to survey biological components of the habitats. From presence/absence of macro-invertebrates associated with specific sediment types, depth, and latitude, we have developed multivariate models using logistic regression to predict the distribution of various species. Coupling these results with spatial information on bottom type and depth, we have created maps of probability of occurrence of these important components of seafloor communities. These maps will provide managers, policy makers, and the public with information that can be used in the conservation and management of sustainable marine resources.

NMFS' Marine Fisheries Habitat Assessment Improvement Plan (HAIP).
The FED Habitat Ecology group is leading a group of NMFS' scientists to develop the first nationally coordinated plan focused on marine fisheries aspects of habitat science. NMFS and all of its partners will benefit from and contribute to the success of the HAIP. This Plan will help to improve stock assessments and identification of EFH, and contribute to ecosystem-based management (EBM) and integrated ecosystem assessments (IEAs).

4. Economic Studies

The FED's Economics Team is developing a model of fishery dynamics using 1981-2007 vessel- and trip-specific data for all Pacific 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. A shift-share model is being used to evaluate the extent to which port-level changes in fishing activity are related to regional changes in all fisheries and changes in the particular fisheries active in that port. A paper is in preparation that describes model results.

The Economics Team is also conducting an analysis of the effect of the 2003 vessel buyback program on technical efficiency in the Pacific coast groundfish trawl fishery. A Bayesian approach to estimating technical efficiency is being used in this analysis.

The Economics Team is working in collaboration with the Environmental Research Division (ERD) on an analysis of the economic effects of the Rockfish Conservation Areas (RCAs) on California's groundfish trawl fleet. Using 1997-2005 trawl logbook data, landings receipt data, and regulatory information, ERD has created maps depicting the spatial distribution of trawl effort and harvest (pounds and ex-vessel value) before and after the RCAs were established. For each year after RCA implementation (2003), the maps also include layers that depict the particular RCA boundaries that applied in that year. The Economics Team is collaborating with ERD on research pertaining to adaptations by California groundfish trawlers to the RCAs in terms of spatial redistribution of effort and changes in fishing strategies. A paper on this topic is currently in preparation.

The Economics Team has completed separate economic surveys of southern and northern California recreational anglers. Both surveys involve collection of data on angler fishing patterns, preferences, expenditures and demographics. In addition, conjoint methods are being used in the southern California survey to determine angler preferences for rockfish versus other species, and in the northern California survey to determine angler preferences for differing combinations of groundfish regulations (bag limits, area and season closures); the survey was completed in 2009 and data analysis will occur in 2010.

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STATE OF ALASKA
GROUNDFISH FISHERIES

ASSOCIATED INVESTIGATIONS IN 2009

Prepared for the Fifty-first Annual Meeting of the Technical Subcommittee of the Canada-United States Groundfish Committee

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With new contributions from:
Cleo Brylinsky, Mike Byerly, Heather Barnhart, Barbi Failor, Dr. Kenneth J. Goldman, Samuel Hochhalter, Lee Hulbert, Mike Jaenicke, Scott Meyer, Matthew Miller, Kristen Munk, Nick Sagalkin, Gail Smith, Charles Trowbridge and Carrie Worton

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ALASKA DEPARTMENT OF FISH AND GAME
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STATE OF ALASKA GROUNDFISH FISHERIES AND ASSOCIATED INVESTIGATIONS IN 2009

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. The North Pacific Fisheries Management Council (NPFMC) took action in 1997 to remove black and blue rockfish from the Gulf of Alaska FMP and in 2007 to do the same with dark rockfish, 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. The State of Alaska manages some groundfish fisheries occurring in Alaska waters in parallel with NMFS, adopting Federal seasons and in some cases allowable gear types as specified by NMFS. 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) and Cook Inlet including the North Gulf District off Kenai Peninsula. 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, fisheries biologist, and one full-time fisheries technician located there. One full-time biologist, one full-time fisheries technician and one full time research analyst for this project are based in Douglas. Seasonal technicians and port samplers are employed in Petersburg, Ketchikan and Sitka. The project also receives biometrics assistance from the regional office in Douglas and from headquarters in Juneau.

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, dark rockfish 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 federally-managed fisheries; dockside sampling of sablefish, lingcod, Pacific cod, and rockfish landings; and logbook collection and data entry. Four resource assessment surveys were conducted during 2009. The Southeast Groundfish project is funded in part with NOAA Grant NA08NMF4070534.

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, five to six seasonal technicians, 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 serves as a member of both the North Pacific Fishery Management Council's Gulf of Alaska Groundfish Plan Team and Non-Target Species Committee. 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, Pacific cod pollock, lingcod, rockfishes, skates , sharks, and flatfishes. Stock assessment data are collected through port sampling, and through ADF&G trawl, 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. For some fisheries, logbook data are required and these are collected and data-entered to provide additional depth to harvest data.

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 trawl survey biologist, two seasonal fish ticket processing technicians, and several seasonal dockside samplers. A full-time area management biologist, an assistant area groundfish management biologist and a seasonal fish ticket processing technician are located in the Dutch Harbor office. Seasonal dockside sampling also occurs in Chignik, Sand Point, and King Cove. 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 (Dave Barnard) and the Gulf of Alaska Groundfish Plan Team (Nick Sagalkin).

d. Headquarters

The 1996 Magnuson-Stevens Act called for developing regional fishery databases coordinated between state and federal agencies. The Alaska Fisheries Information Network (AKFIN), created in 1997, accomplishes this objective. The AKFIN program provides the essential fishery catch data needed to manage Alaska's groundfish and crab resources within the legislative requirements of the Act in Section 303(a)5. Alaska has diverse data collection needs that are similar to other states but the extensive geographic area and complexity of fisheries management tools used in Alaska have resulted in AKFIN becoming a cooperative structure that is responsive to the needs to improve data collection. The Pacific States Marine Fisheries Commission (PSMFC) manages the AKFIN grant with the funding shared by the Alaska Department of Fish and Game's (ADF&G) statewide AKFIN contract and the PSMFC sponsored AKFIN Support Center (AKFIN-SC) in Juneau, Alaska. The ADF&G has primary responsibility for collecting, editing, maintenance, analysis, and dissemination of these data and performs this responsibility in a comprehensive program.

With few exceptions, groundfish resources in Alaska's Exclusive Economic Zone (from 3 to 200 nautical miles offshore) are managed by the National Marine Fisheries Service (NMFS), and groundfish within 3 nautical miles of shore are managed by the state of Alaska. Two fishery management plans (FMPs) require the collection of groundfish harvest data (fish tickets) in the north Pacific: the Gulf of Alaska Groundfish FMP, and the Bering Sea and Aleutian Islands Groundfish FMP. The AKFIN program is necessary for management and for the analytical and reporting requirements of the FMPs.

Implementation of the FMP for the Commercial King and Tanner Crab Fisheries in the Bering Sea and Aleutian Islands (BSAI) resulted in additional responsibilities for data collection, analysis, and reporting by the state, which manages the 17 stocks of crabs covered by the FMP.

The overall goal of ADF&G's AKFIN program is to provide accurate and timely fishery data that is essential to management, pursuant to the biological conservation, economic and social, and research and management objectives of the fishery management plans for groundfish and crab. The specific objectives are:

1) to collect groundfish fishery landing information, including catch and biological data, from Alaskan marine waters extending from Dixon Entrance to the BSAI.;
2) to collect crab fishery landing information, including catch and biological data, from the BSAI;

3) to determine ages for groundfish samples using age structures (as otoliths, vertebrae, and spines) arising from statewide commercial catch and resource survey sampling conducted by ADF&G;
4) to provide the support mechanisms needed to collect, store, and report commercial groundfish and shellfish harvest and production data in Alaska;
5) to integrate existing fishery research data into secure and well maintained databases with consistent structures and definitions;
6) to increase the quality and accuracy of fisheries data analysis and reporting to better meet the needs of ADF&G staff, AKFIN partner agencies, and the public, and to make more of this information available over the Internet while maintaining the department's confidentiality standards;
7) to provide GIS services for AKFIN fishery information mapping to ADF&G Division of Commercial Fisheries staff and participate in GIS and fishery data analysis and sharing with other AKFIN partner agencies;
8) to support economic analysis as needed prior to implementation of state and federal fishery regulations; and
9) to provide internal oversight of the AKFIN contract between the ADF&G and the Pacific States Marine Fisheries Commission (PSMFC).

Groundfish species include walleye pollock, Pacific cod, sablefish, skates, various flatfish, various rockfish, Atka mackerel, lingcod, sharks, and miscellaneous species. Crab species in the BSAI include red, blue, golden, and scarlet king crab; several Tanner crab species; snow crab; and hair crab.

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. A dockside sampling program provides for collection of accurate biological data (e.g., size, weight, sex, maturity, and age) and verifies self reported harvest information submitted on fish tickets from shoreside deliveries of groundfish throughout coastal Alaska and of crab in the BSAI region.

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 and the internet. 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 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.

The fishery information collected by the AKFIN program is not only essential for managers and scientists who must set harvest levels and conserve the fisheries resources, but it is also valuable for the fishermen and processors directly involved in the fisheries, as well as the general public. To meet those needs, the department has designed, implemented, and continues to improve database systems to store and retrieve fishery data, and continues to develop improvements to fishery information systems to provide data to other agencies and to the public.

The department also conducts economic analyses of these data for use in the NPFMC arena. The need for an economic analysis component of the AKFIN program arises from jurisdictional obligations, pressing economic needs, and impacts of environmental regulations. The ADF&G is the management agency for state fisheries under its jurisdiction, and also a lead agency in policy making for federal fisheries of the region through its role in the NPFMC and the Pacific Salmon Commission (PSC). Economic analysis of seafood and fishery management policy is essential for the state to determine how proposed policies will impact the industry, Alaska regions, and coastal localities of the state. The role of state staff is especially crucial under the rationalization plan currently being refined by the NPFMC, which will directly impact the state managed groundfish fisheries in the Gulf of Alaska.

Groundfish fishery milestones for this ongoing ADF&G AKFIN program are primarily the annual production of catch records and biological samples. In calendar year 2009 ADF&G AKFIN staff processed 17,842 groundfish fish tickets, collected 16,816 groundfish biological samples and measured 17,362 age structures (see tables below for regional breakdown). These basic measures of ongoing production in support of groundfish marine fisheries management by AKFIN funded ADF&G staff are representative of the level of annual productivity by the AKFIN program since it's inception in 1997. (Contact: Lee Hulbert)

Groundfish Fish Tickets Processed - Calendar Year 2009

ADF&G Region	
1 - Southeast	3,692
2 - Central	3,014
4 – Westward; Kodiak, AK Penn.	9,920
4 – Westward; BSAI	1,216
Total	17,842

Groundfish Biological Data Collection -
Calendar Year 2009

ADF&G Region	AWL Samples Collected	Age Structures Measured
1	3,881	13,278
2	7,675	1,667
4 - Kodiak	5,260	2,417
Total	16,816	17,362

Intergency Electronic Reporting 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). Beginning in 2001, these agencies developed a consolidated landing, production, and IFQ reporting from a sole source. This collaborative effort, the Interagency Electronic Reporting System (IERS), was developed with initial funding provided through the Pacific States Marine Fisheries Commission. The web-based reporting component of this system is ***eLandings*** and the desktop application for the at-sea catcher processor fleet is ***seaLandings***. Vessels using the seaLandings application email landing and production report to the centralized database as an email attachment.

The IERS has been in successful operation in the groundfish and IFQ halibut/sablefish fisheries since July 2006. Program standards and goals for this project have been met. The ADF&G is currently in the final phase to implement the system with salmon fisheries and hopes to have the system in use for all Alaska fisheries by 2011.

During 2009, the IERS recorded more than 26,000 landing reports in crab, groundfish and salmon fisheries.

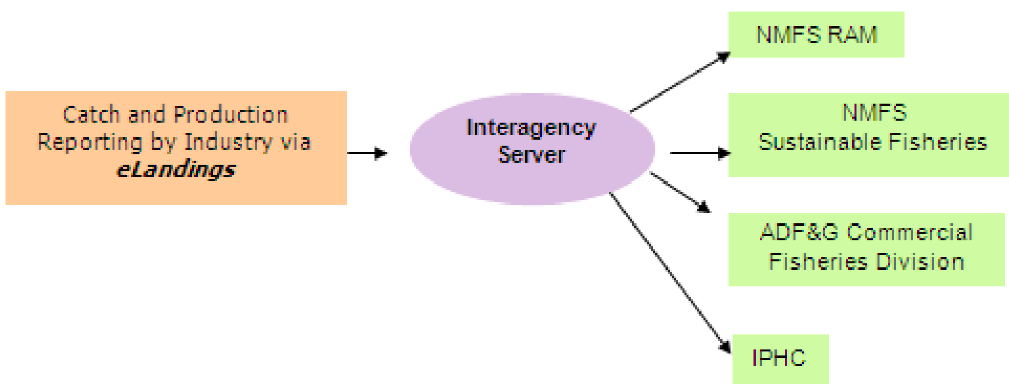
Alaska Department of Fish and Game personnel, funded by AKFIN, participate in the IERS project on the development, implementation, and maintenance levels. The IERS provides processors with a web-based online electronic catch and production reporting program. The IERS features include electronic landing and production reports, real time quota monitoring, immediate data validation, and printable (.pdf) fish ticket reports. To date, IERS is required in all groundfish and IFQ crab fisheries and extensively used in the Western Gulf and Bering Sea crab fisheries and halibut/sablefish IFQ fisheries – statewide. The ADF&G is implementing the ***eLandings*** System in salmon fisheries. Approximately seventy-five percent of all commercial landings occur to small and mid-sized tender vessels, at sea.

To accommodate tender landings from small salmon catcher vessels, the ADFG developed the ***tLandings*** application.   This application allows vessels with no internet connection to conduct electronic reporting using a laptop computer. The application and the data are stored on a 2 gb flash drive. When the tender delivers to the shoreside processor, in addition to the transfer of fish, the flash drive is handed off to the office staff.

Our approach, throughout this project has been staged implementation, which allows a small staff to successfully manage this ambitious project. We expect the IERS will be fully implemented in this fishery by the end of the 2012 season.

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 application. 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



The Interagency Electronic Reporting System 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.
- Consolidated trip level landing reports that accommodate fishery permit stacking.
- 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 IERS is extensively documented on a public and secure wiki at https://elandings.alaska.gov/confluence/

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 , seaLandings, and tLandings applications, with immediate data validation and business rules, has improved data quality and allows personnel to function at a higher level. User support on a 24/7 basis is being provided by NMFS Data Technicians and to GCI, an Alaska based telecommunications company.

Landing and production data are submitted to a central database, hosted by the State of Alaska, 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 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 and* pollock 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 2009. Age structures from 13,120 groundfish representing 13 species were received from statewide commercial and survey harvest sampling efforts. A total of 13,278 age data were released back to managers, which included data from samples received in previous years. Over 3,728 additional age data were produced through precision testing. A total of 31,000 otoliths (representing ≥16,305 specimens) were measured. The majority (>53%) of funding for this project is through the Alaska Fisheries Information Network, and the remaining is from State funding. Five people were employed for approximately 37 work months to age groundfish and invertebrate age structures or conduct associated work, for example, sample preparation, data entry, archiving, otolith measurements, and project work. Two employees are full-time and funded year round and other employees were seasonal.

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 to further guide release of age data; transgression of control limits direct reviewing of some or the entire sample.

In 2009 the ADU was in production status for all species received except for gadids from commercial fisheries. Aging of sablefish dominated the reading schedule. This is due to substantial increases in sampling of sablefish and the need for these data in age structured models. Effort continued toward increasing objective information (age structure measurements, age validation) to strengthen foundation of pattern interpretation for all species.

The ADU continued radiocarbon studies to validate age of species and identify regional differences in the radiocarbon signal. Staff have validated a subset of ages for at least 9 species to date, with an additional 6 species having some specimens processed with radiocarbon values occurring in the “non-ambiguous years” of the radiocarbon curve, which indicate accurate ages for these specimens. Validated species and their highest validated age are as follows: sablefish (48y), thornyhead (46y), dusky/dark (44y), black (43y), tiger (46y), shortraker (49y), rougheye (46y), redbanded (43y), and silvergrey (43y) rockfishes. Yelloweye and quillback rockfish were previously validated and published by Moss Landing Marine Lab, and used age data produced by ADF&G. In 2009, we continued to submit for radiocarbon analysis, black rockfish otolith core samples from 3 Alaska locales in order to evaluate regional differences in the bomb radiocarbon profile. Preliminary information suggests that the radiocarbon signal west of Kodiak may differ from the highly utilized radiocarbon reference curve for Southeast Alaska. Data from this research were presented at 2 scientific symposia: the 2009 Radiocarbon Conference, and the 2009 International Otolith Symposium.

The ADU also continued their culture of pollock from the 2006 year class. These fish have been under tank culture for 3.5y at the NMFS Auke Bay Marine Station, Juneau Alaska. Growth is monitored with quarterly live sampling of fish size and annual subsampling for otoliths. In 2009, ADU staff also tagged and released 1536 wild pollock in Auke Bay, for a 2 year total of 2535 tagged pollock. We recovered 5 tagged pollock; 2 of these were from releases made in 2008.

The ADU Oracle database *AegIS*, Age Information System, was used for logging in samples, importing and exporting of data, importing field data, and direct entry of age structure measurements. We commenced development of an online age structure invoicing system, *OASIS*, which is anticipated to be online in early 2010. Refinements to the ADU website (http://tagotoweb.adfg.state.ak.us/ADU/) were made and included an upgrade to the “Tagged Fish Alert” webpage which listed ADFG contact information in the event of recovery of a tagged fish and also a status of pollock tag recoveries. (Contact Kristen Munk)

2. Description of the State of Alaska recreational groundfish fishery program (Sport Fish Division)

ADF&G manages 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. No recreational fisheries are included in the Gulf of Alaska Fishery Management Plan.

Most management and research efforts are directed at halibut, rockfish, and lingcod, the primary groundfish species targeted by the recreational fishery. Statewide data collection programs include an annual mail survey to estimate overall harvest (in number) of halibut, rockfishes (all species combined), lingcod, Pacific cod, and sharks, and a mandatory logbook to assess harvest of selected species in the charter boat fishery. The statewide bottomfish coordinator (Scott Meyer) coordinates federal data requests and develops scientifically-based advice for assessment and management of halibut and groundfish.

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 was funded through state general funds and the Federal Aid in Sport Fish Restoration Act. 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 region wide Chinook salmon harvest studies project. The project leader is Mike Jaenicke, with assistant project biologists located in Ketchikan (Kathleen Wendt) and Juneau (Diana Tersteeg). The project biometrician (Sarah Power) is located in Juneau. A total of 25 technicians worked at the major ports in the Southeast region, where they interviewed anglers and charter operators and collected data from sport harvests of halibut and groundfish while also collecting data on sport harvests of salmon. Data collected on groundfish were limited to species composition, lengths of harvested rockfish halibut and lingcod, and sex of lingcod; no otoliths or other age structures were collected. Data were 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.

The Regional Management Coordinator and Area Management Biologists in Yakutat, Haines, Sitka, Juneau, Petersburg, Craig, and Ketchikan are responsible for groundfish management in those local areas. The demersal shelf rockfish and lingcod sport fisheries are managed under the direction of the Demersal Shelf Rockfish Delegation of Authority and Provisions for Management (5 AAC 47.065) and the Lingcod Delegation of Authority and Provisions for Management (5 AAC 47.060) for allocations set by the Alaska Board of Fish.

b. Southcentral Region Sport Fish

The **Southcentral Region** groundfish staff consisted of two Regional Management Biologists as well as 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, project assistant, 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 were collected from harvested halibut, rockfishes, lingcod, and sharks, and anglers and charter boat operators were interviewed for fishery performance information. All age reading was 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 three 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 conservative regulatory framework specifying bag and possession limits, seasons, and methods and means that are hoped to provide for sustained yield over the long term. Lack of stock assessment information coupled with increasing effort and harvest in several groundfish sport fisheries accentuate the need for a comprehensive management plan and harvest strategy.

Typical duties included 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, providing information to the Alaska Board of Fisheries, advisory committees, and local fishing groups, 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, Western, and Eastern Gulf of Alaska. Approximately 1,005 fish were tagged in 2009, bringing the total number of tags released to 16,437. By year's end, 48 tags had been recovered. 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.

b. Stock Assessment

No stock assessment programs were active for Pacific cod during 2009.

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 internal waters of Southeast Alaska are comprised of two areas, the Northern Southeast Inside Area (NSEI) and the Southern Southeast Inside Area (SSEI).The GHR was based on average historic harvest levels rather than on a biomass-based ABC estimate. This fishery is most intense in the winter months, in season management actions are small area closures intended to spread out the fleet and reduce the risk of localized depletions. Pacific cod in state waters 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 5 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. However, in 2009 a new BOF regulation became effective permitting use of longline gear in PWS. This change was largely in response to the very low levels of effort and harvest and the high level of interest from the longline gear group. With the exception of longline gear in PWS, 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 to15% and then 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. For the Cook Inlet Area the BOF also adopted a harvest cap for vessels >58' that limited harvest to a maximum of 25% of the GHL. The fishery management plans also provided for removal after October 31 of restrictions on exclusive area registrations, vessel size, and gear limits to increase late season production to promote achievement of the GHL. In addition, observers are occasionally used on day-trips to document catches and at-sea discards in the nearshore pot fisheries.

In February of 2006 the Alaska Board of Fisheries adopted a Pacific cod Management Plan for a nonexclusive Aleutian Islands District, west of 170° W longitude, state-waters fishery. Included within the plans were season, gear and harvest specifications. The fishery GHL was set by regulation at three percent based on the estimate of allowable biological catch (ABC) of Pacific cod as established by the NPFMC for the Bering Sea – Aleutian Islands area with a maximum of 70% of the GHL available before June 10. By regulation the fishery opened on or after March 15, at the conclusion of the initial parallel catcher-vessel trawl fishery for Pacific cod in the federal BSAI Area. Non-pelagic trawl, longline, jig and pot gear were all permissible in the 2006 fishery.

In October of 2006 the Alaska Board of Fisheries amended the Pacific cod Management Plan for the **Aleutian Islands**. Beginning in 2007 a new regulation set the opening date of the fishery at four days after the initial closure of the federal Bering Sea – Aleutian Islands catcher vessel trawl season. Additional regulations introduced new vessel size limits of 125' or less overall length for pot vessels, 100' or less overall length for trawl vessels and 58' or less overall length for longline and jig vessels. In 2009, vessels participating in the B season were restricted to under 60' overall length for all legal gear types.

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 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. In the Aleutian Islands trawl gear took 60% of the harvest, pot gear took 31%, and the remainder was split between longline and jig gear. Trawl gear was used primarily during the A season and pot gear in the B season.

Prior to 1993 much of the cod taken in **Southeast** was utilized as bait in fisheries for other species. In recent years in Southeast Alaska the Pacific cod harvest has been largely sold for human consumption. Specifically in 2009 less than 5% was recorded as being used for bait. In other areas of the state, Pacific cod are harvested in both state and federal waters and utilized primarily as food fish. Harvests of Pacific cod in the Southeast state-managed (internal waters) fishery during 2009 totaled 279 mt, the same as was landed in 2008.

The 2009 GHLs for the state-managed Pacific cod seasons in the Cook Inlet and Prince William Sound Areas of the **Central** Region were set at 1,182 mt and 221 mt, respectively. Harvest from the Cook Inlet Area state-managed Pacific cod fishery totaled 1,149 mt while the Prince William Sound Area harvest totaled 320 mt. This was the first year the PWS GHL has been achieved since the fishery began. The high harvest was attributable to the addition of longline as a legal gear and harvest rates that exceeded expectations. Harvest from the 2008 state managed Aleutian Islands Pacific cod fishery totaled 5,313 mt, 33 mt more than 2007. Harvest from the 2008 state managed fishery in the Kodiak Area totaled 4,735 mt, while 3,042 mt of cod were harvested in the Chignik Area, and the South Alaska Peninsula Area harvest totaled 6,133 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. Action by the Alaska Board of Fisheries during 2004 increased the Pacific cod allocation in the Cook Inlet Area to its maximum allowable 3.75% of the Central Gulf ABC, the maximum allowed under regulation and Prince William Sound remains at its minimum allocation of 10% of the Eastern Gulf ABC.

Estimates of the 2009 recreational harvest of Pacific cod are not yet available from the statewide harvest survey, but the 2008 estimates were 9,547 fish in **Southeast** and 15,224 fish in **Southcentral Alaska**. The average estimated annual harvest for the most recent five-year period (2004-2008) was 9,533 fish in **Southeast** Alaska and 11,611 fish in **Southcentral** Alaska. There are no estimates of average weight in the sport harvest in either region.

2. Rockfishes

Commercial rockfish fisheries 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) removed dark rockfish also from the PSR assemblage in the FMP and turned management of them over to the State effective January 1, 2009. Slope rockfish contain all other *Sebastes* species.

a. Research

In the **Southeast Region** port sampling effort for rockfish expanded in 2008 to include the sampling of DSR caught as bycatch in the IFQ halibut fishery. The mandatory logbook program for all groundfish fisheries continued. The logbook program is 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 2009 the directed fishery for demersal shelf rockfish (DSR) opened in the East Yakutat Section (EYKT) and Southern Southeast Outside (SSEO) areas of the Southeast Outside District (SEO). Length, weight and age structures were collected from 678 yelloweye rockfish caught in the directed fishery. The remaining areas of SEO, Central Southeast Outside (CSEO) and Northern Southeast Outside (NSEO), did not open to directed fishing because the portion of the TAC allocated to those areas was not large enough to support an orderly fishery. The directed fishery for DSR opened in internal waters but landings were minimal and no biological samples of yelloweye rockfish were collected from the internal waters fishery. Over 800 yelloweye rockfish landed as bycatch in the commercial halibut fishery were also sampled for AWL data throughout the halibut season in southeast Alaska.

Rockfish habitat mapping projects continue in the **Southeast Region**. The objective of this project is to continue to collect and evaluate data in the Eastern Gulf of Alaska for the purpose of identifying potential habitats 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. The most recent collections of data were from two areas in SSEO, Learmonth Bank and offshore of Cape Addington. The geologic interpretations for these areas were completed in 2009. (Contact Cleo Brylinsky).

Skipper interviews and port sampling of commercial rockfish deliveries in **Central Region** during 2009 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 and halibut fisheries, primarily slope and demersal shelf species. The directed jig fishery that targets pelagic rockfish begins July 1 and is normally the focus of rockfish sampling during the last half of the year. However, very limited fishing effort has drastically reduced sampling opportunities since 2006. 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. Additional sampling occurred during the Cook Inlet and PWS trawl surveys. (Contact Charles Trowbridge).

Work continued in 2009 on the development of a marine habitat GIS for **Central Region**. Additional NOAA multibeam bathymetry and backscatter data were collected. Bathymetry data were gridded and incorporated while preliminary attempts were undertaken to analyze the backscatter data. Margaret Spahn, ADF&G Homer, the lead on this project started a graduate program in September, 2007 at Oregon State University in geography to develop more skills to further this project. . Multibeam and side scan sonar projects continue to be one of the major focal areas of the Central Region commercial fisheries research program. The Nuka Island/Pye Island area was mapped in 2008; ROV assessment work on yelloweye rockfish and lingcod are occurring there and in Resurrection Bay in 2009.

Experiments were conducted in August, 2007 to test two assumptions of strip transect sampling with an ROV. The experiments assessed the responsive movement of rockfishes and lingcod to an ROV under different artificial light levels and assessed the detection of those animals. Results show that lingcod and yelloweye rockfish have very little response to the ROV (i.e. were not attracted to or moved away from it), even under differing light levels making it a valid tool for assessing abundance in these species. ADF&G is pursuing research on abundance estimates for these species in areas along the outer Kenai coast and Prince William Sound.; (Contact Mike Byerly or Dr. Ken Goldman).

The **Westward Region** continued its port sampling of the commercial rockfish and Pacific cod harvests in 2009. 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 Sonya El Mejiati). Staff from the Kodiak office has completed aging black rockfish otoliths through the 2009 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 and dark rockfish. The acoustic tagging of black rockfish and dark rockfish continued throughout 2009. An array of 18 moored receivers was deployed on the east side of Spruce Island, just north of the port of Kodiak. Tags were surgically implanted in 85 black rockfish and 55dark rockfish to monitor their daily and seasonal movements. In addition, hydroacoustic surveys of black and dark rockfish in the Eastside, Southeast, and Afognak Districts of the Kodiak Management Area were conducted in 2009 in an effort to generate biomass estimates and develop a management strategy for both black and dark rockfish. Surveys are planned for the Westide District of the Kodiak Area and the Chignik Management Area in 2010 (Contact Carrie Worton).

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 4,450 rockfish were sampled at Ketchikan, Craig, Klawock, Wrangell, Petersburg, Juneau, Sitka, Gustavus, Elfin Cove, and Yakutat in 2009 (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. Nearly 4,200 rockfish were sampled from the sport harvests at Seward, Valdez, Whittier, Kodiak, and Homer in 2009 (Contact Barbi Failor).

The Division of Sport Fish also conducted research into the effectiveness of deepwater release devices in reducing barotrauma-induced mortality of released demersal shelf rockfish. Objectives included estimation of 17-day survival probability (for multiple successive sample events) of yelloweye and quillback rockfish released with a deepwater release mechanism and estimation of the proportion of hook-and-line caught rockfish released at the surface that are able to submerge on their own. The goal of the project is to evaluate the efficacy of deepwater release devices for demersal rockfish species of concern in Alaska and to inform decisions on the potential role of including these devices or other harvest restrictions in the management of the fishery. Limited studies will continue in 2010 (Contact Sam Hochhalter).

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. A new density survey was conducted in EYKT in 2009. Yelloweye rockfish density for the current stock assessment is based on the latest best estimate by management area. The CSEO and SSEO areas were last surveyed in 2007 and 2005 respectively, NSEO was surveyed in 2001. Density estimates by area range from 1,068 to 2,196 adult yelloweye per km^2.

In the **Southeast Region** no black rockfish surveys were conducted in 2009.

In the **Westward Region** hydroacoustic equipment was deployed in a preliminary effort at stock assessment of black and dark rockfish. Surveyed areas included the Northeast Section of the Kodiak Management Area (contact Carrie Worton).

In the **Central Region** no rockfish stock assessment surveys were conducted in 2009.

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 Fisheries 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 (TAC) for DSR was allocated 84% to the commercial sector and 16% to the sport sector. At the 2009 Board of Fisheries meeting it was decided that the anticipated harvest of DSR in the subsistence fisheries would be deducted from the TAC before the split in allocation is made between commercial and sport fisheries. This change was not adopted in time for the 2009 fishery.

The 2009 TAC for DSR in SEO was 362 mt which resulted in an allocation of 304 mt to commercial fisheries and 58 mt to sport fisheries. A significant portion of the total commercial harvest is taken as bycatch mortality during the halibut fishery. We continue to use the method for bycatch determination we developed in 2006 to which recognizes the significance of depth as a component of the bycatch rate. Using this method the estimate of yelloweye that was anticipated to be caught as bycatch by the halibut fleet in outside waters in 2009 ranged from 72-209 mt (95%CI) with the point estimate at 141 mt. Because yelloweye comprised 96% of the landed catch of DSR we add 4% to this to account for other species. This brought the estimated catch for DSR in 2009 to 146 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 2009 was 136 mt which was just 7% under the estimation for DSR provided using the new method.

The commercial fishery for DSR in SEO opened in SSEO and EYKT in 2009 with 30 mt and 48 mt quotas respectively. Sport fishery harvest estimates have been used since 2005 to add to our knowledge of what we determine to be the total harvest of DSR in other fisheries. The preliminary estimate of total sport fishery removals for 2009 was 50 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 SSEOC, totaling 147 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 continues to have very little participation with 1.1 mt landed in directed and bycatch fisheries combined in 2009.

Shortspine thornyhead, shortraker rockfish, rougheye rockfish and redbanded rockfish may be taken as bycatch only (no directed fishing). A total of 96.5 mt of slope rockfish were landed in NSEI and SSEI during 2009. This is down slightly from 119 mt landed in 2008.

Rockfish in **Central Region's** Cook Inlet and PWS Areas are managed under their respective regulatory 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 68 mt GHL into a harvest cap for all rockfish species in Cook Inlet and PWS and adopted 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, 5% during the parallel Pacific cod season and 10% during other directed fisheries. Proceeds from rockfish landed in excess of allowable bycatch levels are surrendered to the State of Alaska. (Contact Charles Trowbridge)

The **Westward Region** has conservatively managed 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 Chignik Area; that area was also designated as super-exclusive for the black rockfish fishery beginning in 2003.

In 2009, 55 mt of black rockfish were harvested from seven sections in the Kodiak Area. Guideline harvest levels were attained in three sections. In the Chignik Management Area 6 mt of black rockfish were harvested. The 2009 black rockfish harvest in the South Alaska Peninsula areas remains confidential because of minimum participation. In 2009 no vessels made directed black rockfish landings in the Aleutian Islands Area. Fishers are allowed to retain up to 5% of black rockfish by weight incidentally during other fisheries. The incidental harvest in the Aleutian Islands Area is confidential due to limited participation. 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 is taken incidental to recreational fisheries for halibut or while trolling for salmon. Size limits have never been set for rockfish harvested in the sport fishery, although there has been a progression of bag and possession limit changes over the last 20 years.

For the 2007-2009 seasons, the entire **Southeast Alaska** region's sport bag and possession limit for pelagic rockfish was 5 fish per day, 10 in possession. The non-pelagic rockfish regulations were set as follows: 1) resident bag limit was 3 fish, only 1 of which could be a yelloweye; 6 fish in possession, of which no more than 2 could be yelloweye; all non-pelagic rockfish caught must be retained until the bag limit is reached; 2) nonresident bag limit was 2 fish, only 1 of which could be a yelloweye, 4 fish in possession, of which no more than 2 could be yelloweye; all non-pelagic rockfish caught must be retained until the bag limit is reached; and an annual limit of 2 yelloweye rockfish, which must be recorded in ink on the back of the sport fishing license or on a harvest record at the time of harvest; 3) Charter operators and crewmembers could not retain rockfish while clients are on board the vessel (Contact Robert Chadwick).

As a result of the pervasive lack of quantitative stock assessment information, rockfish regulations in **Southcentral Alaska** have been designed to discourage targeting of rockfish yet allow for retention of incidental harvest. Bag limits are lower for demersal and slope species because of their lower natural mortality rates. The bag limit in Cook Inlet was five rockfish daily, only one of which could be a non-pelagic species (DSR or slope). The bag limit in Prince William Sound was four rockfish, no more than one of which could be a non-pelagic species. The bag limit in the North Gulf Coast area was four rockfish daily, including no more than one non-pelagic 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.

d. Fisheries

Directed fisheries for demersal shelf rockfish and black rockfish occurred in **Southeast** in 2009. Effort in the directed black rockfish fishery was minimal with only 3 vessels participating. The directed DSR fishery in 2009 in outside waters was opened in two areas, EYKT and SSEO for a total harvest of 76 mt. There was also a directed DSR fishery in internal waters (SSEI and NSEI); the total harvest was 6.5 mt.

The total amount of rockfish (all species) taken as bycatch in all commercial fisheries conducted east of 140^0 W Longitude in 2009 in state and Federal water was 545 mt. DSR bycatch made in conjunction with the IFQ halibut fishery in outside as well as internal waters contributed 172 mt to this total. 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 2009 **Cook Inlet Area** directed rockfish fishery opened July 1 and closed December 31 with a harvest of 1.4 mt. Total rockfish harvest including bycatch to longline, pot and jig fisheries was 14 mt. Total rockfish harvest for the PWS Area rockfish bycatch-only fishery was 53.6 mt. This included a 10 mt incidental catch of demersal and slope rockfish from the walleye pollock trawl fishery and a 43 mt incidental harvest of demersal and slope rockfish primarily 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 reported harvest for the general category of "rockfish", and the charter vessel logbook recorded rockfish harvest in three categories - pelagic, yelloweye, and other non-pelagics. DSR are part of the "non-pelagic" category. Recreational rockfish harvest is typically estimated in numbers of fish. Estimates of the 2009 harvest are not yet available from the statewide harvest survey, but the 2008 estimates were 118,997 fish in Southeast and 107,388 fish in Southcentral Alaska. The average estimated annual harvest for the most recent five-year period (2004-2008) was 95,335 rockfish (all species) in Southeast Alaska and 96,858 fish in Southcentral Alaska.

Creel survey data for Sitka indicates that 4,500 individual yelloweye (approximately 16 mt) were retained by anglers in an area roughly equivalent to the CSEO in 2009. This is a 39% decrease in the estimated harvest (by number of fish) of yelloweye in Sitka compared to the 2008 season, and is 49% below 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) indicate that approximately 1,800 yelloweye (approximately 7 mt) were retained in 2009 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 (~86%) and SSEO (~69%), based on the 2009 projections.

3. Sablefish

a. Research

In 2009, 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.

In the NSEI survey, the 2009 overall CPUE (kg/hook) was 1.15, down slightly from 2008 (1.17). The most frequently encountered bycatch species were Shortspine thornyhead (*Sebastolobus alascanus*) and skates (*Raja* spp. and *Bathyraja* spp.) comprising 44% and 35% of the total bycatch count respectively. In the SSEI longline survey there has been a downward trend in CPUE since 2006. In 2009 CPUE was .36 kg/hook compared to .51 kg/hook in 2006. Spiny dogfish (*Squalus acanthias*) were the most abundant bycatch species, comprising 24% of the bycatch count. Skates (*Raja* spp. and *Bathyraja* spp.) were the next most abundant, comprising 18%.

The on-going 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) has been decreasing since 2005. In 2009 it was .14 round kg/hk compared to 0.17 round kg/hook in 2008. In 2005 the CPUE was .24 kg/hook. In the NSEI fishery, the overall CPUE adjusted for hook spacing expressed in round kg/hook was 0.35 in 2009 down from 0.41 in 2008. This drop is the first following a steady upward trend seen in fishery CPUEs for this area throughout the last decade.

In 2009, ADF&G continued a mark/recapture study in NSEI, tagging and releasing 7,071 sablefish. Pot gear was used to capture the fish from June 1st to 23rd one and a half months prior to the start of the fishery which commenced on August 15, 2009. Using pot gear to capture the fish for tagging has minimized the apparent "hook shyness" pattern of tag returns observed in 1997, 1998 and 1999 when longline gear was used to catch fish for tagging. Tagged fish are distributed by area and depth in proportion to the harvested commercial catch using logbook data from the three previous years (contact Deidra Holum).

Within **Central Region,** ADF&G initiated a limited tagging study in 1999 within PWS. Fish tagged were captured on the biennial bottom trawl survey. Tagging was continued through the 2003 survey. Longline surveys were conducted through 2006 and may be reconstituted in the future. (Contact Dr. Ken Goldman).

Skipper interviews and port sampling occurred in Whittier, Valdez, 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 Charles Trowbridge).

b. Stock Assessment

In **Southeast**, the department is using mark-recapture methods with external tags and fin clips to estimate abundance and exploitation rates for sablefish in the NSEI Subdistrict. Sablefish are captured with pot gear in June, 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. The Allowable Biological Catch (ABC) for 2009 was based on the 2008 Petersen–estimated number of sablefish fish in NSEI. The forecast for 2009 was made by decrementing the 2008 estimate to account for natural mortality, and adding a number of age-4 recruits equal to that of 2008. Each age class was converted to biomass using the average weight of that age class from the 2008 commercial fishery. The forecast for 2009 was 13,775,900 round pounds of sablefish. An $F_{45\%}$ (=0.104) harvest rate was applied to the point estimate of the forecasted biomass to give a preliminary ABC of 1,290,868 round pounds. This ABC represented a 20% decrease from the previous stock assessment done in 2006 and forecasted for 2007. 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 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 catch (Contact Dr. Ken Goldman).

c. Management

There are three separate internal water areas in Alaska which have state-managed limited-entry commercial sablefish fisheries. The NSEI and SSEI (**Southeast Region**), and the Prince William Sound Inside District (**Central Region**) each have separate seasons and guideline harvest ranges. In the Cook Inlet Area there is an open access sablefish fishery.

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) was set using an $F_{40\%}$ applied to the lower 90% confidence limit of the forecasted 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 base the quota on the recommendation put forward by the biometrician. There were 105 permit holders eligible to fish in NSEI in 2006. Data collected during 2006 was used to determine an updated stock assessment forecasted for 2007. The use of this updated stock assessment with the forecast for 2007 resulted in a drop in the TAC to 675 mt down 28% from the TAC used in 2006. There were 103 permit holders participating in the fishery in 2007. In 2008 the stock assessment from 2006 and the forecast for 2007 were used to set the TAC for the 2008 fishery. In 2008 there were 96 permit holders eligible to fish. A stock assessment was conducted in 2008 with a forecast for 2009 and is referenced in the "stock assessment" section of this report. New management measures were adopted for the determination of the 2009 ABC. The point estimate rather than the lower 90% confidence level was used, the amount of fish equal to the average of the previous three years of test fishing was decremented from the ABC and an $F_{45\%}$ harvest rate was used rather than an $F_{40\%}$ rate as in the past. The updated stock assessment combined with the changes listed above resulted in a 22% drop to the allowable harvest objective (AHO) for 2009. There were 88 permit holders eligible to fish in 2009. The Commercial Fisheries Entry Commission predicts that the number of permits will continue to be reduced and that the resulting number of permanent permits for this fishery will be approximately 76.

The SSEI quota was set at 288 mt for 2009, a 9% decrease from the 316 mt quota used from 2000 through 2008. 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 4 permits back into the fishery bringing the total permits to 32 (28 longline and 4 pot gear). For the 2009 fishery CFEC denied 4 permits leaving 25 longline and 3 pot permits allowed to harvest sablefish in this fishery.

During the February 2009 Board of Fisheries (BOF) meeting, the BOF made no changes affecting the regulation of commercial sablefish fisheries. The BOF did however establish bag and possession limits for sablefish in the sportfish fishery.

Commercial 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 Cook Inlet Area's North Gulf District and the Aleutian Island District, are open access in state waters, as the state cannot legally implement IFQ management at this time. The fishery GHLs are based on historic catch averages and closed once these have been reached.

The Southeast Alaska **sport fishery** for sablefish was regulated for the first time in 2009. Sport limits were initially established in 2009 at two fish of any size per day, 4 in possession, with an annual limit of 8 fish. These were subsequently modified to 4 fish per day, 4 in possession, and the annual limit of 8 fish was applied to nonresidents only. The creel surveys in Southeast Alaska began collecting information on the number of harvested sablefish at all sampled ports, and encountered a regional total of 19 harvested sablefish landed at the sampled ports during the 2009 season indicating that harvest in the non guided sport fishery is low. The number of sablefish harvested by the sport charter fleet was also requested by the department. These numbers were required to be recorded on the logbooks under the “other” column. Harvest in numbers from internal waters of Southeast Alaska reported on logbooks was 3,847 sablefish. There is some question about whether this number is a high or low estimate since the 2009 logbooks were not printed with “sablefish” but rather “other” for the column counted.

Within the **Central Region** the Cook Inlet North Gulf District sablefish GHL is set using an historic baseline harvest level adjusted annually by the same relative change to the TAC in the Central Gulf Area. The 2009 fishery GHL was 27 mt. In 2004 the BOF adopted sablefish fishery-specific registration, 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. In 2009, the commissioner’s permit requirement was removed by BOF action and regulations adopted which included a registration deadline, logbooks, and catch reporting requirements. 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 in 2003 into a shared quota 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 conduct dockside interviews and sample landings from these fisheries in the ports of Cordova, Whittier, Homer and Seward.

The GHL for the Aleutian Island District is set roughly at 5% of the BSAI TAC. The state GHL can be adjusted according to recent state-waters harvest history when necessary. From 1995 to 2000 the fishery opened concurrently with the EEZ IFQ sablefish fishery. In 2001 the Board of Fish changed the opening date of the state-waters fishery to May 15 so as to provide small vessel operators an opportunity to take advantage of potentially better weather conditions. From 1995 to 2000 all legal groundfish gear types were permissible during the fishery. Effective in 2001, longline, pot, jig and hand troll became the only legal gear types. Vessels participating in the fishery are required to fill out logbooks and processors are required to send the Department weekly processing reports.

The sablefish **sport fishery** in Southcentral Alaska was unregulated in 2009, with no bag, possession, or size limits. Port samplers throughout Southcentral Alaska encountered and sampled only one sablefish from the sport harvest.

d. Fisheries

In the **Southeast Region** the 2009 NSEI sablefish fishery opened August 15 and closed November 15. The 88 permit holders landed a total of 486 mt of sablefish. The fishery is managed by equal quota share; each permit holder was allowed 5.5 mt. The 2009 SSEI sablefish fishery opened June 1 and closed November 15. Twenty-seven permit holders landed a total of 270 mt of sablefish, each with an equal quota share of 10.3 mt. In SSEI 25 permits were designated to be fished with longline gear and the remaining three fished with pot gear. One of the longline permits did not fish in 2009. (Contact Cleo Brylinsky)

In the **Central Region** the 2009 open access sablefish fishery in the Cook Inlet North Gulf District opened at noon July 15 and closed at noon October 9, the latest season closing date since the management plan was adopted in 1998. Thirteen vessels harvested 25 mt. Despite similar fishing effort similar to previous years, very few landings achieved the 3,000 lb, 48-hour trip limit. In 2009, new season dates adopted by the BOF for PWS sablefish were April 15 – August 31. The new season opening date, one month later than in previous years, was adopted to reduce the opportunity for orca depredation on hooked sablefish which predominately occurred prior to May 1. The 2009 PWS harvest totaled 99.5 mt. Biological sampling, conducted in-season, gathered age, length, weight, sex and gonad condition data. Effort, location and CPUE information were gathered via mandatory logbooks. (Contact Charles 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% for trawl gear only, no bycatch is allowed for all other gear types. The 2009 Aleutian Island fishery opened on May 15, 2009. Additional requirements for the fishery include registration and logbook requirements. The GHL was set at 246 mt for the state managed fishery. The harvest from the 2009 Aleutian Islands sablefish fishery was 127 mt. The season remained open until the November 15 closure date (Contact Heather Barnhart).

4. Flatfish

a. Research
There was no research on flatfish during 2009.

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 pound weekly trip limit.

Within **Central Region** flatfish may be harvested in a targeted fishery only under the authority of a permit from the commissioner of ADF&G. The permit may stipulate fishing depth, seasons, areas, allowable sizes of harvested fish, gear, logbooks, and "other conditions" the commissioner deems necessary for conservation or management purposes.

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 eight years, with no harvest reported for the 2008-2009 season. The Southeast flatfish trawl areas are also the sites of a shrimp beam trawl fishery. In the past most of the Southeast harvest is starry flounder. NMFS manages the flatfish fishery and harvest in the state waters of **Westward Region**. No flatfish harvest permits were issued in **Central Region** during 2009.

5. Pollock

State-managed pollock is limited to the Central Region and Aleutian Islands

a. Research

Pollock continue to be a dominant species in the **Central Region** ecosystem. Assessment in 2009 included commercial fishery catch sampling. Skipper interviews and biological sampling of **Central Region** commercial pollock deliveries during 2009 occurred in Kodiak. 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 Charles Trowbridge).

Beginning in 1998, spatial patterns of genetic variation were investigated in six populations of walleye pollock from three regions: North America – Gulf of Alaska; North America – Bering Sea; Asia – East Kamchatka. The annual stability of the genetic signal was measured in replicate samples from three of the North American populations. Allozyme and mtDNA markers provided 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 consideration 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. This study was published in 2002 in the Fishery Bulletin (Olsen et al. 2002). (Contact Bill Templin).

b. Stock Assessment

No stock assessment work was conducted on pollock in 2009 (Contact Dr. Ken Goldman).

c. Management

Prince William Sound pollock fishery regulations were amended by BOF action and for 2009 included a January 13 registration deadline, logbooks, catch reporting, check-in and check-out provisions, and accommodation of a department observer upon request. The Prince William Sound Inside District is divided into three ‘sections” for pollock management: Port Bainbridge, Knight Island, and Hinchinbrook, with the harvest from any section limited to a maximum of

60% of the GHL. Additionally, the fishery is managed under a 5% maximum bycatch allowance that is further divided into five species or species groups. (Contact Robert Berceli). For **Cook Inlet** directed fishing for pollock is managed under a "Miscellaneous Groundfish" commissioner's permit. However, due to pelagic trawl closures associated with Steller sea lion conservation measures no directed fishing has occurred in the Cook Inlet Area since 2000.

d. Fisheries

The 2009 **Prince William Sound** fishery opened on January 20 with a GHL of 1,651 mt. The Hinchinbrook section closed by emergency order at 6:00 p.m. February 11 while the Knight Island and Bainbridge sections closed by emergency order at noon March 21. Total pollock harvest for all sections combined was 1,474 mt. Unlike past years when the bycatch was dominated by squid, fishery bycatch was dominated by rockfish and sharks at 9.6mt and 8.6 mt respectively.

6. Sharks

a. Research

In the **Central Region** spiny dogfish and Pacific sleeper sharks were tagged annually from 1997 to 2006 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, ten 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 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 Dr. Ken Goldman)

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. Few samples were collected in 2009, most from a modest salmon shark fishery in Prince William Sound. Interviews also provided estimates of the numbers of salmon sharks and spiny dogfish kept and released by ADF&G statistical area (Contact Barbi Failor).

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 Ken Goldman).

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 Cook Inlet Area regulations to provide for a directed fishery for spiny dogfish in the Cook Inlet area under terms of a permit issued by the commissioner.

Also in 2000 the BOF prohibited the practice of "finning", requiring that all sharks 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.

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 directed charter boat fishery for salmon sharks in Southcentral Alaska, primarily in Prince William Sound. Pacific sleeper sharks are occasionally caught but rarely retained.

d. Fisheries

The Department received no requests for permits to target spiny dogfish in Cook Inlet during 2009.

Estimates of **recreational shark harvest** in 2009 are not yet available from the Statewide Harvest Survey, but in 2008 an estimated 231 sharks of all species were harvested in Southeast Alaska and 686 were harvested in Southcentral Alaska. Confidence in these estimates is low. The statewide charter logbook program also required 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 2008, charter logbook data indicated harvests of 26 salmon sharks in Southeast Alaska and 68 salmon sharks in Southcentral Alaska.

7. Lingcod

a. Research

Beginning in the spring of 1996 and over the fourteen years since, in the **Southeast Region** 9,111 lingcod have been tagged and 446 fish recovered. Opportunistic tagging of 35 lingcod in Sitka Sound occurred during 2009. Length, sex and tagging location are recorded for all tagged fish. Dockside sampling of lingcod caught in the commercial fishery continued in 2009 in Sitka and Yakutat with over 520 fish sampled for AWL. Otoliths were sent to the ADU in Juneau for age determination. (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. Otoliths were sent to the ADU in Juneau for age determination. Gonad condition was generally not determined as nearly all fish delivered were delivered gutted (Contact Charles Trowbridge).

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 2009 included Juneau, Sitka, Craig/Klawock, Wrangell, Petersburg, Gustavus, Elfin Cove, Yakutat, and Ketchikan. Length and sex data were collected from 1,084 lingcod in 2009, 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 1,035 lingcod were sampled from sport harvest at Seward, Valdez, Whittier, Kodiak, and Homer in 2009. These ports accounted for the majority of recreational lingcod harvest in Southcentral Alaska (Contact Barbi Failor).

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 2000. Commercial logbook data for the period 2002-2009 shows CPUE in fish per hook hour trending up since 2000 in CSEO but down from 2008. In IBS, EYKT and NSEO the CPUE is relatively flat, SSEOC is difficult to evaluate in terms of CPUE because participation there is very minimal. In EYKT effort has been steady since 2002, CSEO had an increase in directed fishing from 2007 through 2009. The IBS super-exclusive registration area commercial quota was harvested almost exclusively by the directed fishery and as bycatch in the longline fisheries in 2008 and 2009.

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 commercial** 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. Resurrection Bay, near Seward is closed to commercial harvest of lingcod. In 2009, a new BOF regulation permitted retention of lingcod in PWS waters following closure of the directed season.

In **Southeast Alaska**, the sport fishery for lingcod prior to 2000 had a open season of May 1 to November 30, and a region wide 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 2009, lingcod bag limits for all anglers were one fish per day, one in possession. There were no size limits for resident anglers. Nonresident anglers were allowed to keep only fish between 30 and 35 inches and fish 55 inches or longer. Nonresidents were also constrained by a two fish annual limit. Seasons varied by area. (Contact Robert Chadwick).

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 region-wide from January 1 through June 30 to protect spawning and nest guarding lingcod. Daily bag limits are 2 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), bycatch in the other longline fisheries and as bycatch in the salmon troll fishery. At the 2009 Board of Fisheries meeting a regulation regarding lingcod bycatch was written such that managers in southeast can adjust the bycatch levels in- season to maximize the opportunity for current bycatch allocations to be met. For example, in years when the halibut catch limits are low the bycatch of lingcod can be set higher without the risk of going over the longline allocation. The directed fishery landed 130 mt of lingcod in 2009 and an additional 81 mt was landed as bycatch in other fisheries. The halibut longline fishery accounted for roughly 60% of lingcod bycatch in the Southeast Region and the salmon troll fishery accounted for 17%.

Central Region commercial lingcod harvests have primarily occurred in the North Gulf District of Cook Inlet and PWS. In 2009, the Cook Inlet GHL was 24 mt and the PWS GHL was 15 mt. Lingcod harvests in 2009 totaled 8.7 mt in Cook Inlet and 29 mt in PWS. The majority of the lingcod harvest in both areas resulted from bycatch to other directed (primarily halibut) longline fisheries. Both Inside and Outside Districts of PWS closed when the total harvest was approximately 18.6 mt and the balance of the harvest was bycatch to ongoing longline fisheries.

No directed effort occurred for lingcod in the **Westward Region** during 2009. A large jump in the amount of incidental harvest in the bottom trawl fisheries occurred in 2008. In response, ADF&G reduced bycatch limits in 2009 from 20% to 5%. Incidental harvest totaled 23 mt in 2007, 250 mt in 2008, and 39 mt in 2009. 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 2009 harvest are not yet available from the statewide mail survey, but in 2008 an estimated 11,899 lingcod were harvested in Southeast Alaska while 24,708 lingcod were taken in Southcentral Alaska. The average estimated annual harvest for the most recent five-year period (2004-2008) was 16,526 fish in Southeast Alaska and 19,812 fish in Southcentral Alaska.

8. Other species

In 1997 the BOF based 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. 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.

A data summary was conducted on skate species collected during **Central Region** historical large-mesh trawl, small-mesh trawl, and longline surveys, and commercial fisheries. The project 1) compiled historical ADF&G, NMFS, survey catch and biological data on skate species groups for southcentral Alaska; 2) summarized data to describe the spatial and temporal patterns of survey and fishery catches, and assessed spatial and temporal size and sex distributions for skate species; 3) assessed the feasibility of using ADF&G bottom trawl survey data to produce area-swept estimates of skate biomass; and 4) guided the collection of additional biological data on skate species. This data summary represented a first look at skate distribution, size composition, and survey catch-effort trends for Central Region. Strong regional trends were detected both within and among species and bathymetric trends among species. There were 3,509 skates sampled for biological data (size, weight, and maturity) and 1,595 vertebra collected for age determination. Age structures were sent to the NMFS, AFSC and Moss Landing Marine Lab. Results of the life history studies are now published on big and longnose skates (*Raja binoculata* and *R. rhina*, respectively). Biomass estimates for those two species were derived from the ADF&G biennial trawl survey in PWS and used to provide a fishery opportunity in 2009 for skates in PWS.

In 2009 Central Region received a capital budget increment of $55K to conduct a trial fishery for big and longnose skates in PWS. Fishery GHLs based upon trawl survey density data were used to set Inside District GHLs of 9 mt for big and 50 mt lb for longnose skates. Trawl survey density data were extrapolated based upon area to the Outside District and yielded GHLs of 13.6 mt and 68 mt for big and longnose skates. The fishery was announced with a registration deadline in order to gauge participation and commissioner's permits with stipulations for logbooks, reporting requirements and accommodation of a department observer were issued to 23 vessels. Management for the relatively small GHLs for big skate proved problematic with one GHL exceeded by a single landing. Five trips were observed and most deliveries sampled for size and sex. A total of 224 vertebrae samples were collected for age determination. Harvests of big skate totaled 21.4 mt and 37.6 mt from the Inside and Outside Districts. Longnose skate GHLs were not achieved in either district and harvest totaled 31.2 mt and 27.0 mt from the Inside and Outside Districts respectively. 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. The council has used the information in the design and analysis of regulations for the sport charter fishery.

C. Other Related Studies

Staff in the **Central Region** continued the development of an Oracle database, currently named "Sedna", for historical multi-species large-mesh and small mesh trawl survey data. Though these surveys originated as Tanner crab and shrimp surveys many groundfish species are captured and in fact compose most of the catches in recent years. They therefore, represent a valuable tool for monitoring groundfish population trends and collecting biological data. These database projects are error-checking, reformatting, and consolidating survey data for all years so they can be captured in a standardized database format to facilitate convenient access for analyses and timely reporting. All data are being additionally captured in a GIS for spatial analysis. The long-term goal is to have the database house all Central Region commercial fisheries survey and port sampling data in a GIS relational format.

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.

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 (including those from test fishing) from the Dixon Entrance area (Alaska statistical areas 325431, 315431, 325401, and 315401) has dropped since last year due to a decline in sablefish removals from that area. The table below lists the catch by species group from 1988 through 2009 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	26	Tr	9	138	Tr	148
2006	43	32	1	12	167	1	181
2007	32	31	Tr	19	165	1	184
2008	27	32	1	16	101	Tr	118
2009	29	34	1	18	132	2	153

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*, bryozoans 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.

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 receipt authority is approximately 600k), notably the sablefish longline assessments and mark-recapture work, the king crab survey, the herring fishery and some salmon assessments.

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 have been updated using ArcGIS 9.0 and the NAD83 datum. All data and map 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 9.0 for their GIS work.

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.php. (Contact Mike Plotnick)

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 2009 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	139	97	closed	283	40	23	3	closed
2005	17	53	closed	249	52	23	2	closed
2006	8	65	closed	241	97	8	0	closed
2007	2	83	closed	200	115	2	0	closed
2008	27	113	closed	190	91	2	0	closed
2009	37	87	closed	164	152	3	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. In 2008, catch and harvest were reported for each individual angler, along with their name and fishing license number (if required). Other data collected for each vessel trip included port of landing, statistical area 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 conducted a three-year evaluation of logbook data, including comparisons to an independent end-of-season survey of anglers, to estimates from the statewide harvest survey, and to data from onsite interviews. This evaluation was presented to the North Pacific Fishery Management Council in October and December 2009.

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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/region2/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
Demersal shelf rockfish stock assessment document:
    http://www.afsc.noaa.gov/refm/docs/2009/GOAdsr.pdf
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    http://www.cf.adfg.state.ak.us/geninfo/statmaps/charts.php

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APPENDIX I.

ALASKA DEPARTMENT OF FISH AND GAME
PERMANENT FULL-TIME GROUNDFISH STAFF DURING 2009.

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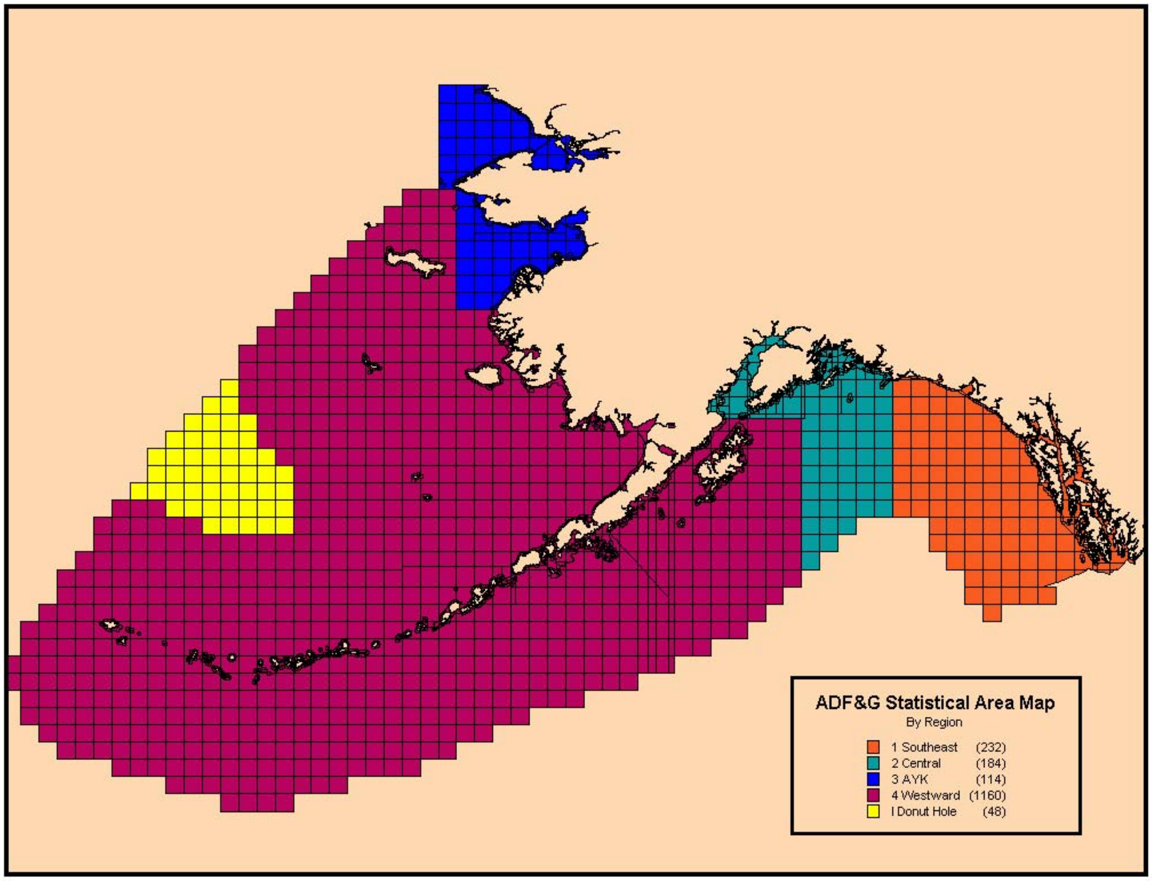
Appendix II.

Map Depicting State of Alaska Commercial Fishery Management Regions.



Appendix III.

Tissue samples of *Sebastes* species and pollock collected for genetic analyses and stored at Alaska Department Fish and Game, Gene Conservation Laboratory, Anchorage. Species, sampling location year collected, sample size, and tissue type are given.

Species	Location	Year	Sample size	Tissues
Yelloweye rockfish *Sebastes ruberrimus*				
	Gravina,Danger,Herring	1991	27	muscle, liver, eye
	Knight Is./Naked Islands area	1998	100	fin
	Whittier	2000	97	fin
		2000	50	fin
	Kachemak Bay	1999	58	fin
	Kodiak Island	1999	115	fin
	Resurrection Bay	1999	100	fin
	Fairweather Grounds	1999	100	fin
	Flamingo Inlet	1998	46	fin, larvae

Species	Location	Year	Sample size	Tissues
	Tasu Sound	1998	50	fin
	Topknot	1998	49	fin
	Triangle Island	1998	63	fin, larvae
	Sitka	1998	49	fin
	SE Stat Areas 355601, 365701 (CSEO)	1999	100	fin
Black rockfish *S. melanops*				
	Carpa Island	1998	40	fin
	Castle Rock near Sand Point	1999	60	fin
	Akutan	1999	100	fin
	Dutch Harbor	2000	6	fin
	Chignik	2000	100	fin
	Ugak Bay, Kodiak Island	1997	100	muscle, liver, heart, eye
	Eastside Kodiak Is.: Ugak and Chiniak Bays	1998	100	fin
	Southwest side Kodiak Island	1998	86	fin
	Westside Kodiak Island	1998	114	fin
	Kodiak Island	1996	2	muscle, liver, heart, eye
	North of Fox Island	1998	24	fin
	Resurrection Bay - South tip Hive Island	1997	82	muscle, liver, heart, eye, fin
	Yakutat Bay	2003	130	fin
	Valdez	2000	13	fin
		2001	50	fin
	Whittier	2000	16	fin
		2001	93	fin
	Oregon - Pacific Northwest	1999	50	muscle, liver, heart
	Washington - Pacific Northwest	1998	20	fin
	Sitka	1998	50	fin
	SE Stat Areas 355631, 365701 (CSEO)	1999	83	fin
	Sitka Sound Tagging study	1999	200	fin
Dusky rockfish *S. ciliatus*				
	Sitka	2000	23	liver, fin
		2000	23	fin
	Sitka Black RF Tagging study	1999	15	muscle, liver, heart, eye
	Harris Bay - Outer Kenai Peninsula	2002	37	muscle
	North Gulf Coast - Outer Kenai Peninsula	2003	45	fin
	Resurrection Bay	1998	3	fin
	Eastside Kodiak Is.: Ugak, Chiniak, Ocean Bays	1998	100	muscle, liver, heart, eye
	Kodiak Island	1997	50	muscle, liver, heart, eye

Species	Location	Year	Sample size	Tissues
Walleye pollock *Theragra chalcogramma*				
	Exact location unknown; see comments	1997	402	fin
	Bogoslof Island	1997	120	muscle, liver, heart
		1998	100	muscle
		2000	100	muscle, liver, heart
	Eastern Bering Sea	1998	40	muscle, liver, heart
	Middleton Island	1997	100	fin
		1998	100	muscle, liver, heart
		2000	100	muscle, liver, heart
	NE Montague/E Stockdale	1997	100	fin
	Orca Bay, PWS	1997	100	fin
	Prince William Sound	2000	100	muscle, liver, heart
	Port Bainbridge	1997	100	fin
		1998	100	muscle, liver, heart
	PWS Montague	1999	300	heart
	Eastern PWS	1999	94	heart
	Resurrection Bay	1998	120	fin
	Kronotsky Bay, E. Coast Kamtchatka	1999	96	muscle, liver, heart, eye, fin
	Avacha Bay	1999	100	
	Shelikof Strait	1997	104	muscle, liver, heart, eye, fin
		1998	100	muscle, liver, heart
		2000	100	muscle, liver, heart

OREGON'S GROUNDFISH FISHERIES AND INVESTIGATIONS IN 2009

OREGON DEPARTMENT OF FISH AND WILDLIFE

2010 AGENCY REPORT
PREPARED FOR THE May 5-6, 2010 MEETING OF THE TECHNICAL SUB-COMMITTEE OF THE CANADA-UNITED STATES GROUNDFISH COMMITTEE

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April 2010

OREGON DEPARTMENT OF FISH AND WILDLIFE

A. AGENCY OVERVIEW - MARINE RESOURCES PROGRAM

MRP Program Manager	Dr. Caren Braby
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Fishery Management	Gway Kirchner
Technical and Data Services	Maggie Sommer

The Marine Resources Program (MRP) is within the Oregon Department of Fish and Wildlife (ODFW) and has jurisdiction over marine fish, wildlife, and habitat issues coast-wide. MRP is headquartered at Newport in the Hatfield Marine Science Center, with field stations at the coastal cities 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 60 permanent and more than 70 seasonal or temporary positions. The current annual program budget is approximately $8 million, with about 70 percent coming from state funds including sport license fees, commercial fish license and landing fees, and a small amount of state general fund. Grants from federal agencies and non-profit organizations account for the remaining 30%.

B. MULTISPECIES STUDIES

1. Sport Fisheries Project

Sampling of the ocean boat sport fishery by MRP's Ocean Recreational Boat Survey (ORBS) continued in 2009. Starting in November 2005 major ports were sampled year round. We continue to estimate catch during unsampled periods in minor ports 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, cabezon and kelp greenling are also commonly landed. Oregon's fishery for Pacific halibut continues to be a very popular, high profile fishery requiring International Pacific Halibut Commission (IPHC), federal, and state technical and management considerations.

The ORBS program continued species composition and biological sampling (length and weight) of groundfish species at Oregon coastal ports during 2009. As part of a related marine fish research project active since 2003, otoliths were gathered from several species of nearshore groundfish including rockfish species, kelp greenling and cabezon, in addition to lingcod fin rays, for ageing studies. Staff also scanned Pacific halibut for PIT tags. Starting in 2001, from April through October, a portion of sport charter vessels have been 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 has been monitored inseason for catch limit tracking purposes. Inseason action was taken in 2009 to prohibit retention of cabezon by anglers fishing from boats. The shore fishery remained open. As in recent years the retention of canary rockfish and yelloweye rockfish was prohibited year round. Landings in the sport Pacific halibut fisheries were monitored weekly for tracking the status of catch limits. The majority of halibut continue to be landed into the central coast sub-area, with Newport the top port for landings. Other ODFW management activities included participation in the U.S. West Coast Recreational Fish International Network (RecFIN) process, data analysis, and public hearings to discuss changes to the management of Pacific halibut and groundfish fisheries for 2010 and 2011.

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 taken and surfperch made up the majority of shore-based catch by weight. Salmon dominate estuary boat landings by weight. Pacific herring historically have made up the majority of both shore-based and estuary boat landings by number of fish, but have not dominated catch in recent years.

ODFW is pursuing several funding opportunities to reinstate the shore and estuary sampling program.

Contact: Lynn Mattes (541) 867-0300 ext. 237 (Lynn.Mattes@state.or.us)

2. Commercial Fisheries Sampling Project

Data from commercial goundfish landings are collected throughout the year and routinely analyzed by ODFW to provide current information on groundfish fisheries and the status of the stocks. This information is used in management, including inseason adjustments of the commercial nearshore fishery, which is conducted in state waters. Species composition sampling of rockfish and flatfish continued in 2009 for commercial trawl, fixed gear, and hook and line landings. Biological data including length, age, sex, and maturity status continued to be collected from landings of major commercial groundfish species (Table 1).

Contact: Carla Sowell (541) 867-0300 ext. 222 (Carla.Sowell@state.or.us)

Table 1. Fish ticket landings, age and length data collected for major groundfish species

COMMON NAME	FISH TICKET METRIC TONS	NUMBER OF AGEING STRUCTURES COLLETED	NUMBER OF LENGTHS COLLECTED
Flatfish			
Arrowtooth flounder	2,842	1,269	1,421
Dover sole	7,457	2,327	3,147
English sole	171	961	1,051
Pacific sanddab	185	830	930
Petrale sole	1,013	1,671	2,952
Rex sole	389	1,540	1,780
Sand sole	48	440	440
Starry flounder	5	253	253
Other sole[1]	1	119	149
Rockfish			
Black rockfish	134	893	2,961
Blue rockfish	2	147	152
Yellowtail rockfish	34	636	852

Nearshore rockfish[2]	11	99	533
Shelf rockfish[3]	11	935	967
Slope rockfish[4]	121	3,641	3,711
Thornyhead species[5]	1,517	3,244	3,934
Other fish			
Cabezon	30	21	415
Greenling species[6]	21	35	1,147
Lingcod	105	242	1,049
Longnose skate	678	417	596
Other skate[7]	340	147	147
Pacific cod	51	34	36
Pacific grenadier	44	160	160
Pacific hake	28,571	1,139	5,139
Sablefish	3,304	3,591	3,851
Spiny dogfish	55	5	5
Rebuilding species			
Canary rockfish	3.4	489	490
Darkblotched rockfish	89.7	2,620	2,818
Pacific ocean perch	61.2	1,963	2,140
Widow rockfish	49.1	936	937
Yelloweye rockfish	0.4	19	19

/1 Other sole species are butter, curlfin, and rock sole
/2 Nearshore rockfish species are black and yellow, China, copper, gopher, grass, and quillback rockfish
/3 Shelf rockfish species are bocaccio, chilipepper, cowcod, greenspotted, greenstriped, pygmy, redstripe, rosethorn, rosy, silvergrey, speckled, stripetail, tiger, and vermilion rockfish
/4 Slope rockfish species are aurora, bank, blackgill, redbanded, rougheye, sharpchin, shortraker, splitnose, and yellowmouth rockfish
/5 Thornyhead species are longspine and shortspine thornyhead
/6 Greenling species are kelp, rock, and whitespotted greenling
/7 Other skate species are big, black, california, sandpaper, and starry skate

3. Developmental Fisheries Project

The Developmental Fisheries Program (DFP) and Developmental Fisheries Board (Board) were created by the 1993 Oregon State Legislature (Legislature) with the responsibility of making recommendations to the Oregon Fish and Wildlife Commission (Commission) on developing fisheries. State policy gives the Commission the authority to institute a management system for developmental fishery resources that addresses both long term commercial and biological values and that protects the long term sustainability of those resources through planned commercial development when appropriate (ORS 506.455).

In 2007, funding and staff-time was provided by the Legislature to evaluate the DFP with the overarching goal to make the program more efficient and cost-effective and while continuing to allow for the exploration and development of new, sustainable fisheries. Steps of the evaluation included a survey of the past and current permit holders and board members, formation and meetings of a diverse and productive Board, review and assessment of active developmental fisheries, historical logbook assessment, a fishery independent research project, and assessment of the program’s structure including funding sources, Board, staffing, and data storage. At-sea observing and market sampling for these fisheries began in March, 2008 and continued the duration of the evaluation, through June, 2009. These sampling efforts yielded information on landed catch and discard of hagfish and spot prawns, including length/weight, sex, and maturity data.

For the 2010/11 biennium the DFP received insufficient funding to continue a staffed and functioning program. At the end of 2009 the program was placed in a temporary suspension mode with no staff or funding to actively manage or assess any of the fisheries in the program, including the hagfish fishery. The Oregon Fish and Wildlife Commission decided to place four out of the five 2009 permitted fisheries on the Developmental Species B list, which means all effectively became open access with no permitting or landing restrictions for 2010. These fisheries include spot prawn, hagfish, ocean anchovy and ocean herring.

Contact: Gway Kirchner (541-867-0300) ext. 267 (Gway R.Kirchner@state.or.us)

4. Marine Finfish Ageing Unit

In 2009, the following primary tasks were completed by the age reading unit: the completion of production age reading for cabezon otoliths collected through 2008 for the recreational fishery and the maturity study, completion of production age reading for all kelp greenling samples collected through 2008, some commercial black rockfish production age reading, and subsample selection of all commercial and recreational lingcod fin rays for production age reading by WDFW. A summary report for the cabezon age reading project was compiled for future reference. The report included notes on why the thin-sectioning method was chosen, specific methods used, age reading guidelines, age reader precision statistics, and reference images.

Additionally, two new age and growth research projects were initiated in 2009. We are testing the usefulness of otoliths as an alternative structure for lingcod age determination by comparing the age data and precision statistics for otoliths with similar data for fin ray age structures, which require a significantly longer amount of time to collect and prepare. We are also working on a new and improved method for preparing longnose skate vertebral centra for age reading.

Contact: Josie Thompson (541) 867-0300, ext. 247 (Josie.E.Thompson@state.or.us)

5. Marine Reserves Project

In 2009, the Oregon legislature passed marine reserves legislation (HB 3013) that directs state agencies to implement marine reserve recommendations made by the Oregon Ocean Policy Advisory Council (OPAC), provides for funding of marine reserves work, and requires ODFW to develop a marine reserves work plan.

The specific call of the legislation is to implement the OPAC recommendations by:

(1) Adopting rules to establish two marine reserve pilot sites;
(2) Studying and evaluating potential marine reserves at three additional areas; and
(3) Supporting the development of a new marine reserve proposal at one final area.

ODFW has hired five marine reserves staff to work on implementation of HB 3013, and a marine reserves work plan was finalized in November 2009, for work to be conducted during the 2009-2010 biennium. A summary of completed and planned work follows.

Pilot sites:
- The two pilot sites have been established through state agency rule making. Harvest prohibitions will take effect on June 30, 2011.
- ODFW staff are working with scientific experts and pilot site community teams to develop biological and socioeconomic baseline studies and plans for long term monitoring at each site.
- ODFW staff are working with pilot site community teams and other agency staff to develop management plans for each site. Management plans will: incorporate biological and socioeconomic monitoring plans, include strategies for education and outreach, and include strategies for compliance and enforcement.
- Biological and socioeconomic baseline studies and year zero data for long term monitoring will be conducted starting in summer 2010 and completed by June 2011.
- ODFW will present a progress report to an interim legislative committee in November 2010.
- Reports on baseline studies and year zero of monitoring will be completed by June 2011.

Evaluation sites:
- Community teams representing diverse and balanced stakeholder interests, as prescribed in HB 3013, have been formed for each of the three evaluation sites and have been meeting since January 2010.
- Each team is to evaluate the original marine reserve site proposal recommended by OPAC, as to whether the site meets the sideboards established by Governor's Executive Order 08-07: the site is large enough to allow scientific evaluation of ecological benefits, but small enough to avoid significant economic or social impacts.
- State agency staff will compile and provide existing data and information to assist the community teams in their evaluation. New data may be collected depending on information needs, securing additional funds, and time.
- Community teams are to determine whether adjustments to the original proposed site must be made to meet sideboards.
- Community teams are to forward a final site recommendation to ODFW by October 2010.
- ODFW is to present a progress report to an interim legislative committee in November 2010.

Proposal site:
- The International Port of Coos Bay is leading a community effort to potentially propose a marine reserve site for further evaluation.

Contact: Cristen Don (cristen.n.don@state.or.us)

6. Marine Habitat Project

a. Hypoxia effects on seafloor communities

In 2009, personnel from ODFW's Marine Habitat Project partnered with the Partnership for Interdisciplinary Study of Coastal Oceans (PISCO) to document the ecological effects, including disturbance and recovery, of recently discovered hypoxia events on seafloor communities. We conducted a survey of seafloor biota offshore of Cape Perpetua (south of Newport) with a Remotely Operated Vehicle (ROV) during October 2009. In concert with PISCO's efforts to collect oceanographic data (e.g., temperature, salinity, dissolved oxygen content), which documented the spatial extent and degree of hypoxia in the study area over a seasonal time scale, we collected video footage of organisms occurring on the seafloor along a previously-established (i.e. "fixed") transect line. Our objective was to continue the nearly-annual time series of ROV video data along a fixed transect line. Hypoxic events did occur on the inner shelf in 2009, but the extent and duration of these events were not as extreme as in prior years (e.g., 2002 and 2006). We were able to document post-hypoxic conditions, and qualitative observations indicated that no significant die-offs of sessile or mobile species were detectable in 2009. We have monitored the Cape Perpetua reef complex regularly since 2000.

Contact: Mike Donnellan (Michael.D.Donnellan@state.or.us)

b. Resolving spatial scales of nearshore rocky reef groundfish-habitat relationships

We completed a ROV survey of fish-habitat affinities at Siletz Reef (offshore of Lincoln City in central Oregon). This study was undertaken to further progress towards our ultimate goal of habitat-based stock assessments for nearshore fish species. Using high-resolution bathymetry data and several bathymetry-derived explanatory variables (e.g., slope, rugosity, bathymetric position index) aggregated at varying spatial scales and species "presence" data gleaned from ROV surveys, we modeled the probability of occurrence of common groundfish species in unsampled areas of the reef. Models were constructed using Generalized Linear Models and General Additive Models, but model performance overall was relatively poor. Several possible reasons for the overall lack of model fit exist, such as improper specification, unknown important variables, and small sample size. A report on this work was completed during June 2009, and we plan to re-visit these analyses and contract with professional biostatisticians during late 2010.

Contact: Mike Donnellan (Michael.D.Donnellan@state.or.us)

c. Remotely Operated Vehicle survey of habitat and fish communities at Otter Rock

We surveyed benthic habitat and fish communities offshore of Otter Rock, a marine reserve slated for implementation in 2010, which is located on Oregon's central coast between Lincoln City and Newport. This survey was conducted in partnership with the United States Geological Service (USGS) and Oregon State University's Seafloor Tectonics Laboratory. USGS conducted a multibeam bathymetry survey of the area during summer 2008, and we conducted ground-truthing of the remote sensing data with our ROV during 2008 and conducted surveys of seafloor biota during 2008 and 2009. Of particular note was the discovery of a dense sand dollar bed with dimensions of approximately 5 km alongshore by 1 km wide. To our knowledge, this is the first documentation of extensive sand dollar beds offshore of Oregon. A written report for this work was completed during December 2009.

Contact: Mike Donnellan (Michael.D.Donnellan@state.or.us)

7. Groundfish Research Project

a. Maturity studies

We continued research begun several years ago to produce histologically verified female maturity data for a variety of species for which maturity data is unavailable or outdated. This work continued in 2009, with a focus on finalizing work on aurora and yelloweye rockfish and cabezon. An agency report is available summarizing the yelloweye rockfish and cabezon work (Hannah et al. 2009). A manuscript summarizing the aurora rockfish work is in review at Environmental Biology of fishes. Additional sampling of Pacific ocean perch was also conducted to examine interannual variation in abortive maturation (skip spawning) as a function of maternal age.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

b. Testing a "motion sensing" acoustic tag

We completed a brief study of surgically implanted "motion sensing" acoustic tags in two cabezon, released back into a passive receiver grid. The data showed that accelerometer tags could be very useful in determining survival of strongly demersal fish and provided better data for evaluating diel cycles in activity than depth data. No agency report is yet available for this brief study.

Contact: Bob Hannah (bob.w.hannah@state.or.us), or Polly Rankin (polly.s.rankin@state.or.us)

c. Movement of rockfishes using acoustic telemetry

We completed most of the data analysis for our multi-year acoustic telemetry study of demersal rockfish movements at Siletz Reef, Oregon. A manuscript is in preparation comparing the spatial and vertical movements of seven species of rockfish on this high-relief rocky reef on the open Oregon coast.

Contact: Bob Hannah (bob.w.hannah@state.or.us), or Polly Rankin (polly.s.rankin@state.or.us)

d. Discard mortality of rockfishes

We continued field work on 48 hour discard survival of a wide array of rockfish species using the single-fish, fish-friendly, caging system developed in 2008. To date, we have collected depth-specific discard survival information on 218 specimens from 8 different species, spanning a depth range of 60-210 ft. This work continues in 2010.

Contact: Bob Hannah (bob.w.hannah@state.or.us), or Polly Rankin (polly.s.rankin@state.or.us)

e. Development and testing of a video lander for studying demersal fishes on nearshore rocky reefs.

We began a project to determine the utility of using a video lander to study the abundance and distribution of demersal fish living on nearshore rocky reefs. Work in 2009 included building and testing of a prototype, followed by two revisions to the design and subsequent testing on a wide variety of rocky habitats. To date, it appears that a lander may be a useful tool for quickly and inexpensively evaluating presence/absence of many demersal rockfishes as well as primary and secondary habitat type on nearshore rocky reefs. The data generated are much less comprehensive than data from ROV surveys, but can be collected during very brief weather windows, in poorer weather and off much smaller research platforms.

Contact: Bob Hannah (bob.w.hannah@state.or.us), or Matthew Blume (matthew.blume@state.or.us)

f. Effects of barotrauma on rockfish physiology and survival in the laboratory

Alena Pribyl of Oregon State University completed her dissertation research on the physiological effects of barotrauma in Pacific rockfish. To date, one published paper has been produced from this work (Pribyl et al. 2009) and an additional two manuscripts are in preparation.

Contact: Alena Pribyl (OSU) or Contact: Bob Hannah (bob.w.hannah@state.or.us)

g. Demersal fish movements at a low-relief rocky reef subject to frequent hypoxia

We began work in 2009 on a planned 2010 study that will use acoustic telemetry methods to study the movements of demersal fishes at a low-relief rocky reef structure off Cape Perpetua, Oregon, where seasonal hypoxia has been documented for several years. The aspects completed in 2009 include initial receiver grid and mooring design and range testing.

Contact: Bob Hannah (bob.w.hannah@state.or.us), or Polly Rankin (polly.s.rankin@state.or.us)

h. Evaluating selective flatfish trawls

Work in 2009 focused on analysis of data collected in 2006-2008 using a DIDSON imaging sonar to study fish behavior in front of the trawl footrope as a function of light availability. This was a cooperative project with Waldo Wakefield and Mark Lomelli of NMFS Northwest Fishery Science Center.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

i. Shrimp trawl impacts on mud seafloor macroinvertebrate populations

In 2008, we completed publication of our 2007 study that used an ROV to study impacts of shrimp trawls on macroinvertebrate populations in mud habitats typically trawled by ocean shrimp fishers (Hannah et al. 2010). The primary focus of the study was to complete a baseline survey of the mud habitat areas in the vicinity of Nehalem Bank that have recently been closed to trawl gear, with the hope of monitoring changes over time as these areas recover from historical trawl impacts.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

j. Tests of Bycatch Reduction Devices (BRDs) with reduced vertical bar spacing

We conducted a brief field study in 2009 that examined how reduced spacing of vertical bars in rigid-grate BRDs reduced bycatch in shrimp trawls, with special emphasis on bycatch of eulachon smelt. Due to damage to one of the pair of nets, along with extremely low abundance of eulachon on the shrimp grounds, results were inconclusive. The data collected may prove useful if combined with additional hauls from future work.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

C. BY SPECIES

1. Aurora rockfish maturity, growth chronology, and age validation

Research results from our 2008 study on aurora rockfish growth chronology and age validation were combined with aurora rockfish maturity results for a manuscript entitled, 'Using cross-dating techniques to validate ages of aurora rockfish (Sebastes aurora): estimates of age, growth and female maturity'. This paper has been accepted for publication by the Environmental Biology of Fishes. The research project applied image analysis and dendrochronological techniques to indirectly validate the bands on aurora rockfish otoliths as "year marks". The study also showed a strong positive correlation between interannual otolith growth and the Northern Oscillation Index and a strong negative correlation with the Pacific Decadal Oscillation and a 1 year index of sea level. Growth chronology and cross-dating was also attempted for redbanded rockfish otoliths and the results, which are similar to those found for aurora rockfish, were presented at the International Otolith Symposium.

Contact: Josie Thompson (541) 867-0300, ext. 247 (Josie.E.Thompson@state.or.us)

2. Black rockfish PIT tagging

Historically, assessments of black rockfish have relied on CPUE data from recreational fisheries to estimate the trend of relative population abundance. However, these data are not robust to problems of sampling bias, or to changes in fishing distribution, bag limits, or fishing power. The need to independently estimate exploitation rates and population abundances 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. 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 released at depth. In 2009, 4058 PIT tags (12mm x 2mm) were inserted during 20 days of fishing near Newport, Oregon, bringing the total number of black rockfish tagged to 25,741 since the project began in 2002. Carcasses of black rockfish are counted and electronically scanned for tags year-round upon being landed by recreational fishers. In 2009, 88% of the black rockfish landed in Newport and 41% of those landed in Depoe Bay were scanned for tags. We recovered 391 tags in Newport and 2 tags in Depoe Bay. All eight tag cohort years were recovered. We have had good recoveries each year and exploitation rates are within expected assessment values of approximately 5%. However, survival rate estimates remain poor and imprecise, likely due to problems with non-mixing. If catch rates allow, the number of fish tagged in 2010 will increase in an effort to increase tag recoveries and decrease variation in parameter estimates. Black rockfish populations off Oregon and California underwent a full assessment in 2007. Results from this study were included in the 2007 assessment as an index of abundance for the assessed population and may be incorporated in future assessments.

Contact: Greg Krutzikowsky (greg.krutzikowsky@state.or.us)

3. Yellowtail rockfish Exempted Fishing Permit

In 2009 the Oregon Chapter of the Recreational Fishing Alliance (RFA-OR) in conjunction with the Oregon Department of Fish and Wildlife (ODFW) received an exempted fishing permit (EFP) from the National Marine Fisheries Service (NMFS) to test experimental recreational fishing gear to target under-utilized yellowtail rockfish while avoiding the overfished yelloweye rockfish on select charter fishing trips. The experimental terminal tackle gear has a long leader (30-60 feet) between the weight and hooks, with a float to keep the line vertical in the water column. Ten charter vessels from three sections of the Oregon coast were to conduct three trips each over the course of the fishing season, to distribute trips spatially and temporally. ODFW supplied onboard samplers for each trip to gather information on total catch, gear set up, location, and to collect biological information from retained fish.

Due to several delays, only 13 out of the anticipated 30 trips were conducted in 2009, on five vessels out of three ports. During those 13 trips, 137 anglers, experienced and novice alike, participated in the project catching 1,521 yellowtail rockfish, 312 widow rockfish, 80 canary rockfish, 0 yelloweye rockfish, 31 other rockfish and 17 other non-rockfish. Most anglers and charter captains thought the gear worked well, however it was easy to get two or more lines tangled. RFA-OR and ODFW have received an EFP to continue this work in 2010, hopefully completing more trips out of more ports.

Contact: Lynn Mattes (541) 867-0300 ext. 237 (Lynn.Mattes@state.or.us)

D. PUBLICATIONS

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Pribyl, A. L., C. B. Schreck, M. L. Kent and S. J. Parker. 2009. The differential response to decompression in three species of nearshore Pacific rockfish. North American Journal of Fisheries Management 29:1479-1486.

Thompson, J.E. and R.W. Hannah. (in press). Using cross-dating techniques to validate ages of aurora rockfish (Sebastes aurora): estimates of age, growth and female maturity. Environ. Biol. Fish.

E. PROJECTS PLANNED FOR YEAR 2009

1. Remotely Operated Vehicle (ROV) survey of habitat and fish communities at Redfish Rocks Marine Reserve and Marine Protected Area and associated reference sites

We plan to survey benthic habitat and fish communities at Orford Reef and Redfish Rocks Reef on Oregon's south coast. Orford Reef is a very important area for Oregon's state managed commercial groundfish fisheries and Redfish Rocks has been proposed as a state marine reserve. We have conducted ROV surveys in these areas previously, but for various reasons we have not yet been able to complete an exhaustive study of these reefs.

Contact: Mike Donnellan (Michael.D.Donnellan@state.or.us)

2. Kelp canopy distribution and biomass survey of Oregon's kelp beds

We plan to conduct a state-wide survey of canopy-forming kelp resources in Oregon during the seasonal peak in canopy abundance in fall 2010. This survey will involve high-resolution near-infrared aerial photography and vessel-based biomass sample collections. Kelp forests are highly productive and ecologically important habitats in Oregon's nearshore environment, and we plan to assess the extent to which the canopy distribution and biomass have changed since the last state-wide aerial survey in 1990 and targeted surveys of south coast reefs in 1996-1999.

Contact: Mike Donnellan (Michael.D.Donnellan@state.or.us)

3. Hypoxia effects on seafloor communities

With our collaborators associated with Oregon State University's Partnership for Interdisciplinary Study of Coastal Oceans program, we obtained an Oregon Sea Grant research grant during 2009 to continue and expand our time-series of ROV surveys and oceanographic measurements to document the ecological effects (e.g., community recovery) of recently discovered hypoxia events on seafloor communities. We plan to conduct ROV and oceanographic surveys at 3 sites along a hypoxia gradient from Cape Perpetua (south of Newport) to Siletz Reef (off Lincoln City) 3 times per year (pre-, during, and post-hypoxia season) for 2 years (2010-11). Other important components of this work include an analysis of fisheries data relative to hypoxia events, and outreach to the fishing community and the general public, the latter via development of an exhibit at the Hatfield Marine Science Center's visitor center.

Contact: Mike Donnellan (Michael.D.Donnellan@state.or.us)

4. Yelloweye retention EFP

The Pacific Fishery Management Council approved ODFW's request for an EFP to allow limited retention of yelloweye rockfish in Oregon's recreational charter boat fishery for the purpose of collecting age and maturity information. Vessels participating in the EFP will be required to turn over all retained yelloweye to a dedicated ODFW sampler in a whole and intact condition, and the total sample size will be limited to 100 fish. Currently the main source of this data is the IPHC setline survey, which does not capture any yelloweye less than about 40 cm in length. In addition to informing age based selectivity for the recreational fishery, we hope the smaller size of fish encountered in the recreational fishery will inform the lower portion of growth and maturity curves, and possibly provide a recruitment signal for the yelloweye stock assessment. Field work will be carried out over the summer of 2010.

Contact: Troy Buell (troy.v.buell@state.or.us)

5. Photograph based length estimation of recreational discards

Information on the size of fish discarded in Oregon's recreational bottomfish fishery is currently limited to data from 70-100 observed charter boat trips per year, and no data is available for the recreational halibut fishery. The goal of this project is to provide recreational fishermen the tools to document the size and potentially species composition of discarded fish. We plan to distribute known sized reference objects and cameras to both the charter and private boat fleets targeting bottomfish or halibut, and request that they photograph discarded fish with the reference object in the frame. After correcting for perspective distortion, the size of the fish may be estimated using the ratio of the reference object size and fish size measured in the photograph. Field work will be carried out over the summer of 2010.

Contact: Troy Buell (troy.v.buell@state.or.us)

6. Expanded IPHC setline survey

We plan to fund an additional 20 stations on the International Pacific Halibut Commission's (IPHC) 2010 setline survey. All stations will be located on the shelf in rocky habitat as defined by PFMC Essential Fish Habitat (EFH) designations. Stations will be randomly located, with the restriction that no station will be fished within 1.5 nautical miles of a standard IPHC station (measured between the station center points) in an effort to avoid bias associated with potential localized depletion of demersal rockfish species at annually fished stations. The objective of this project is to generate an index of abundance for assessing the yelloweye rockfish stock off Oregon. This is an extension of work carried out on the 2008 IPHC survey, and will likely continue on a biennial or triennial schedule.

Contact: Troy Buell (troy.v.buell@state.or.us)

7. Discard mortality of rockfishes

We plan to continue the cage survival work carried out in 2009 with a wide variety of rockfish species to increase sample sizes for most nearshore species and depth bins.

Contact: Bob Hannah (bob.w.hannah@state.or.us), or Polly Rankin (polly.s.rankin@state.or.us)

8. Testing a video lander on nearshore reefs

We plan to do additional tests of our video lander to determine how the device performs for surveying demersal fishes on nearshore rocky reefs off Oregon across different seasons. A second test of this device to try and evaluate an MPA boundary is also planned.

Contact: Bob Hannah (bob.w.hannah@state.or.us) or Matthew Blume (matthew.blume@state.or.us)

9. Cape Perpetua acoustic studies

We will use acoustic telemetry methods to study the movements of demersal fishes at a low-relief rocky reef structure off Cape Perpetua, Oregon, where seasonal hypoxia has been documented for several years. If hypoxia develops, we hope to determine how demersal fish respond to it. We also hope to estimate home range during non-hypoxic conditions.

Contact: Bob Hannah (bob.w.hannah@state.or.us), or Polly Rankin (polly.s.rankin@state.or.us)

10. Maturity studies

We plan on collecting additional maturity samples in 2010 from female Pacific ocean perch for a longterm study of abortive maturation. We also hope to draft a report summarizing histology-based maturity curves for quillback rockfish.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

11. Shrimp trawl impacts on mud seafloor macroinvertebrate populations

In 2010, we plan to use underwater video equipment to study interactions between shrimp trawl groundlines and epibenthic macroinvertebrates. Based on the video work, a comparison between trawl nets fishing a control and a modified groundline will be conducted to investigate the effects on shrimp catch and bycatch from a more "bottom-friendly" groundline.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

12. Reducing eulachon entrainment at the footrope of a shrimp trawl
We plan to conduct some experiments investigating how the forward belly and/or the footrope configuration of shrimp trawls can be modified to reduce entrainment of eulachon smelt.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

Washington Contribution to the 2010 Meeting of the Technical Sub-Committee (TSC) of the Canada-US Groundfish Committee

May 5th – 6th, 2010

Edited by:
Theresa Tsou

Contributions by:
Henry Cheng
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Kurt Stick
Farron Wallace

Washington Department of Fish and Wildlife

May 2009

Review of WDFW Groundfish Research, Assessment, and Management Activities in 2009

A. Puget Sound Area Activities

1. Puget Sound Groundfish Monitoring, Research, and Assessment

(Contact: Theresa Tsou 360-902-2855, tien-shui.tsou@dfw.wa.gov;
Wayne Palsson 425-379-2313, Wayne.Palsson@dfw.wa.gov) Marine Fish Science Unit

Staff of the Puget Sound Marine Fish Science (MFS) Unit includes Wayne Palsson, Robert Pacunski, Tony Parra, and Jim Beam. In addition, Courtney Adkins and Pete Sergeef work as MFS employees during the spring 2009 bottom trawl survey. Unit tasks are primarily supported by supplemental funds from the Washington State Legislature for the recovery of Puget Sound bottomfish populations. The main activities of the unit include the assessment of bottomfish populations in Puget Sound, the evaluation of bottomfish in marine reserves, and the development of conservation plans for species of interest. Groundfish in Puget Sound are managed under the auspices of the Puget Sound groundfish Management Plan (Palsson, et al. 1998).

a. Rockfish Conservation Plan

Twenty-eight species of rockfishes occur in the inland marine waters of Washington, here defined as Puget Sound. The Washington Department of Fish and Wildlife manages these species and 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. We completed a technical review on the Biology and Assessment of Rockfishes in Puget Sound (Palsson et al. 2009) that serves as a source document for the development of a Puget Sound Rockfish Conservation Plan.

In the technical report, we summarized 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 through 2007 (Palsson et al. 2009). Because the data sources are poor, we used an adaptation of the American Fisheries Society's Criteria for Marine Fish Stocks at Risk (Musick 1999, Musick et al. 2000) and available indices from fisheries dependent and independent surveys. 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, 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 majority of rockfish stocks or populations in Puget Sound were in the Precautionary condition, but several species once important to recreational fisheries in Vulnerable or Depleted status. The patterns of stocks status were generally similar between the two regions for the 17 species of rockfish examined. Seven (19%) of the 32 populations present in either North or South Sound were in Healthy status. Eighteen populations (56%) were in Precautionary status, while two populations (6%) were in Vulnerable status, and five populations (16%) were in Depleted status. Many of the Precautionary ratings reflected a lack of information regarding the population.

A draft of the Puget Sound Rockfish Conservation Plan (PSRCP) was prepared by a team of managers and scientists during 2008. In October 2009, WDFW released the draft in a draft Environmental Impact Statement under the auspices of the Washington State Environmental Protection Act. The plan identified four alternative actions under eight management policy areas including Natural Production, Habitat, Fishery Management, Ecosystem, Monitoring, Research, Outreach and Education, and Enhancement including artificial propagation and artificial reefs. The alternatives considered for each policy area ranged from status quo to options that were less or more conservative that the management actions being currently taken. The objectives for the PSRCP are as follows:

1. Provide a framework of policies, strategies and actions for preserving healthy stocks of rockfish in Puget Sound by restoring and maintaining their abundance, distribution, diversity, and long-term productivity in their natural habitats;
2. Seek to maintain rockfish populations throughout Puget Sound to achieve cultural, economic, and ecosystem benefits for current and future residents of Washington State in a manner consistent with the primary conservation goal;
3. Meet all federal and state laws, including treaty obligations;
4. Ensure policies are succinct, relevant, and easily understood by the public and Department employees;
5. Seek productive partnerships that help the WDFW achieve policy objectives;
6. Use the best available science, sound fisheries management, and professional judgment to achieve excellence in stewardship of public resources; and
7. Monitor and periodically report to the Washington Fish and Wildlife Commission and the public on the implementation and outcomes of Commission-approved policies.

WDFW identified initial, preferred alternatives that afforded greater conservation benefits to rockfish. The overarching approach is to manage naturally produced rockfish in intact habitats maintained by WDFW's habitat conservation approach of no net loss of habitat. All WDFW fisheries will be managed to maintain healthy stocks of indicator species of rockfish. Artificial, hatchery propagation will only be considered to bring depleted rockfish stocks to healthier levels, and artificial habitats will only be considered to restore or mitigate for degraded rockfish habitats. Rockfishes will be managed in an ecosystem context with greater efforts to understand food-web dynamics and the interactive effects of stressors. More comprehensive monitoring and research programs will be implement to inform managers and citizens that will lead to better evaluations of management actions and provide the basis for adaptive management. More extensive public outreach and education efforts will lead to rockfish being recognized for their important roles in the ecosystem throughout Washington.

During the initial 30 day comment period, a strong public opinion was voiced to provide more time for comment and to revise the plan with more citizen input. WDFW extended the comment period into 2010 and established a 13 member Rockfish Advisory Group comprised by recreational fishers, scuba divers, non-governmental organization representatives, and an academic. Their first meeting was held in late December. The group began to advise managers on several recreational regulation proposals aimed at reducing the harvest of rockfish. A revised PSRCP will be released in 2010 for comment and subsequent adoption by WDFW.

b. ESA Petition for Five Deep-water Rockfishes

In 2007, NOAA Fisheries received a petition to list yelloweye, canary, bocaccio, redstripe, and greenstriped rockfishes under the Endangered Species Act. NOAA accepted this petition and formed a Biological Review Team to evaluate distinct population segments and the risks of extinction. In April 2009, NOAA recommended that all five species constituted a distinct population segment within some portions of Puget Sound (Federal Register, April 23, 2009; vol. 74, No. 77, Pages 18516-18542). They did not recommend listing of greenstriped or redstripe rockfish but did recommend bocaccio be listed as endangered and yelloweye and canary rockfishes be listed as threatened under the terms of the federal Endangered Species Act. These three species have never been dominant in the groundfish harvest of Puget Sound, but have severely declined in frequency over the past thirty years. MFS staff continues to provide technical consultations and data to NOAA scientists and managers under provisions of the ESA.

c. 2008 San Juan Archipelago ROV survey

From 29 September to 26 November 2008, the MFS staff conducted an ROV survey of the rocky habitats within the San Juan Archipelago (SJA). The survey was designed using available high-resolution (1-5 m^2) geomorphic habitat maps developed by Dr. Gary Greene and his graduate students at the UCSB Moss Landing Marine Laboratories. These maps and some previous survey results provided a sampling frame of rocky habitats in the San Juan Islands. The survey area was stratified by depth along the 20-fathom contour to allow for comparisons to earlier drop-camera surveys of the region. A total of 207 transects were completed, ranging in depth from the surface to 250 m (820 ft), with an average length of 320 m. The most common species observed were kelp greenling, copper rockfish, quillback rockfish, Puget Sound rockfish, lingcod, and juvenile gadids. Other species observed with the ROV were yelloweye rockfish, bocaccio, widow rockfish, greenstriped rockfish, tiger rockfish, black rockfish, yellowtail rockfish, and brown rockfish. Approximately 50 hours of videotape were collected during the survey. Review and analysis of the videotapes was completed at the end of the 2009. Initial results found 420,000 quillback rockfishes and 535,000 copper rockfishes occur in the SJA. Standard errors for these common species were less than 14%. A manuscript is being prepared describing the methods and population survey results.

d. Continued investigation of the 2006 Recruitment Event of Young-of-the-Year Rockfishes in Puget Sound

During 2009, MFS staff reoccupied dive sites surveyed in 2006 that documented a remarkable settlement of post-larval, young-of-the-year (YOY) rockfishes in the inland waters of Washington. As in 2007-2008, divers observed very few YOY rockfish at the eighteen index sites in Central and Southern Puget Sound in 2008. Large numbers of now 2+ year-old copper and quillback rockfish were observed on adult habitats adjacent to several of the nearshore YOY sites. Also in 2009, MFS staff observed what appears to be an immigration of 2+ year- old black rockfish to Puget Sound and the San Juan Islands. MFS staff hypothesize that these fish are emigrating from waters along the Washington coast and western Strait of Juan de Fuca where large numbers of juvenile pelagic rockfishes were observed during the 2006 recruitment event. Divers are also following the recruitment of copper and quillback rockfishes that occurred in 2008 in Hood Canal.

e. 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. Between 2002 and 2006, low DO concentrations have become chronic, extending into nearshore waters and possibly becoming worse due to eutrophication. Mass mortality events of fishes and invertebrates (Fish Kills) in 1926 and 1963 likely have resulted from poor water quality in this fjord naturally prone to hypoxia. Marine Fish Science staff has been conducting regular surveys at the Sund Rock Marine Reserve Site since 2001, with additional surveys conducted when extreme hypoxic conditions arise. Monitoring at this site by MFS staff continued in 2009 to detect potential impacts to fish populations inhabiting the local area. Similar to 2007 and 2008, no extreme hypoxic events or fish kills were reported, thus 2009 can be classified as a low-impact year. MFS staff continued their participation in the Hood Canal Dissolved Oxygen Program as partners and scientists.

f. Bottom Trawl Surveys of Puget Sound

Since 1987, WDFW has conducted bottom trawl surveys in Puget Sound that have proven invaluable as a fisheries-independent indicator of population abundance for fishes living on unconsolidated habitats. These surveys have been conducted at irregular intervals and at different scales since 1987. Early surveys between 1987 and 1991 were synoptic surveys of the entire Puget Sound, later were stratified, random surveys focusing on individual sub-basins, and beginning in 2008 became synoptic again with stations at fixed sites.

From May 11th through June 11th, 2009, WDFW conducted a bottom trawl survey to assess the abundance of groundfishes in the inland marine waters of Washington (Puget

Sound). The survey area was divided into Puget Sound's oceanographic basins including the Eastern and Western Strait of Juan de Fuca, San Juan Archipelago, Strait of Georgia, Whidbey Basin, Central Puget Sound, Southern Puget Sound, and Hood Canal. The goal of the survey was to detect long-term changes in abundance of fishes living on or near the bottom and to characterize the structure of the fish communities. The specific objectives of this survey were to estimate the relative abundance, species composition, and biological characteristics of groundfish species at pre-selected, permanent index stations. Key species of interest include Pacific cod, walleye pollock, Pacific whiting, English sole, spiny dogfish, and skates, but all species of fishes and invertebrates will be identified and recorded.

This survey was the second "Index" survey of Puget Sound, a departure fromt the stratified –random designs use prior to 2008. This new design is used to assess changes in the relative abundance of key groundfish species because reoccupying fixed stations will minimize the variation in sea floor and habitat and provide more powerful inter-annual comparisons. For the new survey design, we divided each oceanographic basin into two geographic components (north and south or east and west) for representative coverage. We selected previously trawled stations within each component area from pre-existing depth zones such that one station would be occupied between depths of 30 to 240 feet, from 240 to 360 feet, and greater than 360 feet. Two replicate trawl samples were collected at each stations and were spaced several hundred meters apart to be close to each other but not directly over the first trawl location. We occupied 51 index stations during 2009 among eight oceanographic basins, two geographic component areas, and three depth zones (8 x 2 x 3). An additional set of three stations was planned for the central portion of Central Puget Sound to better represent this elongate basin.

While WDWF adopted a new survey design, the trawling procedure of the survey was similar to previous WDFW trawl surveys (Palsson et al. 2002, 2003). The 58-foot *F.V. Chasina* was the chartered sampling vessel, and it was equipped with an agency-owned 400-mesh Eastern bottom trawl fitted with a 1.25 inch codend liner. The net was towed at each station for a distance of 0.40 nautical miles at a speed of 1-3 knots, and the tows lasted approximately 12 minutes. Net openings ranged from 8 to 14 m depending upon depth and the amount of cable towing the net. The resulting catch was identified to species, weighed and enumerated, and most of the catch was returned to the sea. The density of fish at each station was determined by dividing the catch numbers or weight by the area sampled by the net. Some of the catch was taken for biological samples that were sampled on deck or preserved laboratory analysis.

During the 22 survey days, we occupied 51 stations and conducted 102 bottom trawls (Figure 1). Some 100,000 individual fish among 89 species weighing 14 mt were collected. Spotted ratfish, English sole, and walleye pollock were the most common species in the samples in terms of weight, but this year, Pacific cod were the eighth-most abundant species. The cod measured between 18 to 64 cm and averaged 28 cm in total length, corresponding to a fish beginning its second year of life. The cod were present in all basins and the pattern suggests a strong 2008 year class. The climate of 2008 was one of the coldest since the mid-1970s supporting the idea that for two decades, cod have been limited in abundance by a warm climate.

g. Marine Reserve Monitoring: Evaluation of No-Take Refuges for Rocky Habitat Fishes

WDFW has developed a system of 24 fully and partially protected marine reserves in Puget Sound, fourteen of which are significant for groundfish resources. As the system has expanded, MFS staff regularly monitors a core of the marine reserve sites on a frequent basis and visit other subtidal reserves on a periodic basis. This monitoring effort builds upon field research at many of these sites that was begun as early as 1986. The fieldwork consists primarily of scuba divers using standardized techniques to conduct visual censuses along a fixed strip transect at central Puget Sound sites or of the site "footprint" at south Puget Sound sites. Along with estimating fish density, divers measure individual fish, and in the case of lingcod, quantify nesting activity. Specific monitoring activities in 2009 included surveying a number of the Puget Sound reserves and comparable fished sites. Several reserves in central Puget Sound were visited six times during 2009 as an extension of a study initiated in 1995 that takes advantage of previous information collected at Orchard Rocks. Prior to 1998 when Orchard Rocks was declared a fully protected reserve, MFS staff conducted monitoring in 1986, 1987, and from 1995-1997. With the addition of a new fished-site treatment located 1 nm across the channel at Point Glover, the newly created Orchard Rocks refuge in a formerly monitored fished area provided MFS staff with an excellent opportunity to evaluate the before and after impacts of refuge creation with a comparable fished-site treatment. Monitoring at Zee's Reef and Colvos Passage that began in 2002 continued with six surveys conducted in 2009. Several of the sites showed a marked increase in the number of 2+ year-old copper and quillback rockfish at most sites, although brown rockfish continue to be the dominant species at most of the central Puget Sound sites, whereas a more even distribution of the three species was seen at the southern sites.

MFS staff also conducted scuba surveys at established sites in San Juan channel to examine the nesting success of lingcod in marine reserve and fished areas. An analysis of the data collected in 2009 and in the past several years shows that lingcod at the marine reserve sites continue to be larger, more abundant, and have higher nest densities than fish at non-reserve (i.e., fished) sites.

h. Acoustic-Trawl Surveys of Pacific Hake in Puget Sound

Puget Sound once supported thriving commercial fisheries of Pacific hake (*Merluccius productus)* where a thriving population occurred among the waters of Possession Sound, Saratoga Passage, Port Gardner, and Port Susan. The fisheries once harvested between 1,000 and 6,800 mt of hake per year between 1970 and 1986 but harvests declined to less than 300 mt in the late 1980s. The fishery was closed after 1991. Corresponding to the fishery declines, the population abundance assessed by acoustic-midwater trawl surveys declined from 28,000 mt in 1978 to 5,200 mt in 1991, the last year of a fishery. The Port Susan component of the population declined to only 1,300 mt in 2000, the same year that this species was being considered for protection under the Endangered Species Act. Although, hake in central Puget Sound were not listed, they remain an ESA candidate species and a Species of Concern under a NOAA Fisheries program. The commercial fishery and scientific activity historically focused on Port Susan and adjacent waters, but hake have also occurred regularly in Hood Canal but the nature of the population has not been specifically addressed. WDFW suspended its acoustic-trawls surveys in 2002 due to declining funds but partnered with NOAA Fisheries to conduct several surveys in Puget Sound in the winter of 2009. Three surveys bracketed the expected March time of peak spawning, and the surveys were expanded to not only include Port Susan and Possession Sound but Saratoga Passage as well as explore whether Pacific hake also spawned in northern Hood Canal. This project specifically sought to: 1) Assess the present abundance of hake in Port Susan and adjacent waters using acoustic-trawl technology and 2) collect age, maturity, and other biological information from Puget Sound and Hood Canal hake.

Surveys were conducted on the evening to morning periods of February, March, and April. An additional survey of northern Hood Canal was conducted in March 2009. All surveys were conducted between sunset and sunrise. Two vessels participated in the nigh-time surveys. A small research vessel conducted the acoustic survey, and a chartered commercial fishing vessel conducted the mid-water trawl survey. Mechanical problems delayed the acoustic survey of the Whidbey Basin in March until two days after the midwater trawl survey.

Of the three acoustic-midwater trawl surveys of the Whidbey Basin, the February survey resulted in the greatest estimated biomass of 2,700 mt (Figure 4). This biomass was 50% to 75% greater that the survey estimates March and April. The 2009 abundance of Pacific hake of in Port Susan, Possession Sound, and Port Gardner averaged 1,700 mt and was the second lowest abundance on record. Hake abundance once was over 15,000 mt in 1982, declined to between 2,800 and 8,100 mt in the 1990s, and decreased to only 1,300 mt in 2002, the lowest abundance ever.

Our survey in Hood Canal confirmed that spawning hake are present at the same time spawning hake are aggregated in Port Susan. The small specimens, likely corresponding to recruitment from the previous year indicates that a self-perpetuating stock may be present in Hood Canal. Genetic analysis of tissues taken during the surveys will test this hypothesis. Despite the prohibition of the hake fishery in Port Susan after 1991, the hake population in the Whidbey Basin has not recovered.

i. Other Activities

Tony Parra initiated a collaborative effort to describe a newly observed ecological phenomenon of small sculpins cleaning inside the mouths of lingcod. During surveys of marine reserves where larger lingcod are more common, WDWF divers have observed lingcod with their mouths agape. Further observations and photography found several species of sculpins inside the mouths or on the heads of the lingcod. While cleaner fish ecology has been described in several coral reef communities, the possible occurrence of these relationships in cold temperate communities underscores the subtle ecosystem relationships that need to be understood for ecosystem management.

2. Herring Stock Assessment (*Contact: Kurt Stick (360) 466-4345 ext. 243)*

Annual herring spawning biomass was estimated in Washington in 2009 using spawn deposition and acoustic-trawl surveys. WDFW Region 4 staff based in the Mill Creek and La Conner offices currently conduct these assessment surveys of all adult herring stocks in Washington's inside waters annually. Stock assessment activities for the 2010 spawning season are in progress.

The herring spawning biomass estimate for all Puget Sound stocks combined in 2009 is 13,298 tons (see table below). The cumulative total is an increase from the 2008 total of 11,038 tons, which is lower than the recent peak of 17,765 tons in 2006, and less than the mean cumulative total for the previous ten year (1999-2008) period of 14,256 tons.

The combined biomass of south/central Puget Sound (including Hood Canal) stocks in 2009 of 10,381 tons is relatively high, and is an increase from the 2008 total of 8,082 tons. Cumulative biomass of north Puget Sound stocks is currently at a low level of abundance. The spawning biomass of this region's largest, the Cherry Point stock, remained at a critically low level in 2009 at 1,341 tons; compared to a range of 3,100 to almost 15,000 tons between 1973 and 1995. Herring spawning activity for the Strait of Juan de Fuca region remained relatively low in 2009, with an estimated spawning biomass of only 251 tons.

PUGET SOUND HERRING SPAWNING BIOMASS ESTIMATES (SHORT TONS) BY STOCK AND REGION, 2000-2009.

						YEAR				
	2009	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**	**2001**	**2000**
Squaxin Pass	817	1025	557	755	436	828	2201	3150	1597	371
Wollochet Bay	359	45	35	27	67	52	152	106	133	142
Quartermaster Harbor	843	491	441	987	756	727	930	416	1320	743
Port Orchard-Port Madison	1755	1186	1589	2112	1958	700	1085	878	2007	1756
South Hood Canal	156	223	70	244	210	176	207	166	187	140
Quilcene Bay	3064	2531	2372	2530	1125	2342	916	2585	2091	2426
Port Gamble	1064	208	826	774	1372	1257	1064	1812	1779	2459
Kilisut Harbor	0	0	24	54	170	184	448	774	612	107
Port Susan	251	345	643	321	157	429	450	775	587	785
Holmes Harbor	1045	686	572	1297	498	673	678	573	275	281
Skagit Bay	1027	1342	1236	2826	1169	1245	2983	2215	2170	646
South-Central Puget Sound Total	10381	8082	8365	11927	7918	8613	11114	13450	12758	9856
Fidalgo Bay	15	156	159	323	231	339	569	865	944	737
Samish/Portage Bay	320	409	348	412	218	351	299	496	470	196
Int. San Juan Is.	0	60	33	285	41	67	72	158	219	128
N.W. San Juan Is.	0	0	0	0	0	0	13	131	62	90
Semiahmoo Bay	990	662	1124	1277	870	629	1087	1012	1098	926
Cherry Point	1341	1352	2169	2216	2010	1734	1611	1330	1241	808
North Puget Sound Total	2666	2639	3833	4513	3370	3120	3651	3992	4034	2885
Discovery Bay	205	248	42	1325	33	252	207	148	137	159
Dungeness/Sequim Bay	46	69	34	0	0	22	44	131	93	138
Strait of Juan de Fuca Total	251	317	76	1325	33	274	251	279	230	297
Puget Sound Total	13298	11038	12274	17765	11321	12007	15016	17721	17022	13038

3. Puget Sound Ambient Monitoring Program (PSAMP)
(Contact: Jim West 360- 902-2842, James.West@dfw.wa.gov)

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.

B. Coastal Area Activities

1. Coastal Groundfish Management
(Contact: Corey Niles, 360-249-1223, Corey.Niles@dfw.wa.gov),
IntergovernmentalResource Management

Activities Related to Pacific Fishery Management Council
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
(*Theresa Tsou 360-920-2855, tien-shui.tsout@dfw.wa.gov;*
Farron Wallace 360-902-2712, Farron.Wallace@dfw.wa.gov) Marine Fish Science Unit

Staff of the coastal Marine Fish Science (MFS) Unit includes Farron Wallace, Henry Cheng, Lorna Wargo, John Pahutski, Bob Le Goff, Donna Downs, Victoria Okimura, and Brian Walker. Unit tasks are primarily supported by the combination of state general and federal funds. The main activities of the unit include the assessment of groundfish populations off Washington coast, the monitoring of groundfish commercial landings, and the tagging project.

a. Black Rockfish Tagging Study
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 about 3,000 black rockfish annually. 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 immediate shedding or tag related mortality was observed during holding experiments during 1998, 1999 and 2003. Since 2002, commercial charter vessels have been used, including F/V Hula Girl, F/V Slammer and F/V Tequila Too. Since 2004, tagged and released fish increased to 4,000-7,000 annually. 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 were excluded from tag releases in 2007.

In 2009, all groundfish species caught during a tagging trip were double tagged with a single CWT and a single PIT tags. The CWT allows for significantly improved tag detection rates and the PIT tag allows for greater efficiency in identifying the individual fish since CWT do not have to be removed and read. Further, PIT tag loss rate is less than 1% as from our study and as described in other salmon tagging studies and other historical fisheries tagging studies. In 2009 we also included 5 index sites off central Washington coast to allow for longitudinal study in the near future that may reduce uncertainty of random sampling and other factors affecting the tagging experiment. In addition, we do not need to kill the fish to recover the CWT in at-sea experiments. Further, since we release any recaptured fish this permits us to evaluate longitudinal growth and individual variation of each fish. This experiment information is expected to provide unbiased information on bycatch CPUE and biomass trend of recreational black rockfish fishery.

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). If CWT's are detected the fish are then evaluated for PIT tags and all information is tracked on a daily basis.

b. Skate morphological study

In the past, management of skates (*Rajidae*) was considered a low priority mainly due to their low economic value. As a result, limited fishery data exist for skates and very little is known about skate's life characteristic traits. The paucity of data has prompted Washington Department of Fish and Wildlife (WDFW) to increase data collection for skate species in order to provide better science to support management decisions and stock assessments. Longnose and big skates are the most abundant skate species encountered off the Washington Coast, and are caught mainly as by-catch from commercial fisheries targeting other groundfish. However, more stringent regulations on many groundfish species have resulted in added fishing pressure on skates. Biological data collections for skates are difficult; the current method of obtaining total length (TL) measurement for skates is problematic due to their size, dorso-ventrally compressed shape and large pectoral fins. The maximum confirmed length is 203.9 cm TL and individual fish have been known to weigh up to 91 kilograms. Too often these biological sampling efforts have been thwarted because the skates were simply too large and heavy for technicians (who typically work alone), to move a skate into a position that would allow accurate length measurements to be collected.

In 2008, Donna Downs conducted a research project to determine if another scientifically and ergonomically sound measurement method for skates could be facilitated. Three alternative length measurements were investigated and regression analysis confirmed a tight correlation between total length (TL) and each alternative measurement. The coefficient of determination values were significant for longnose and big skate (R^2 = 0.96981, P value <0.05 and R^2 = 0.969112, P value < 0.05) respectively. All three alternative measurements depict a credible method for acquiring length-sex frequency data. Analysis did not reveal a significant difference between males and females with regards to size, resulting in these data being pooled. During the 2010 Annual Port Sampling meeting, Donna presented the research results and established the "*distance between spiracles length*" as the measurement method of choice. Efforts are now underway to implement this ergonomically-friendly measurement technique into the commercial groundfish sampling program. Donna has initiated the training of staff at Bellingham and Neah Bay Washington ports as well as working collaboratively with Yuk Cheng in writing a paper for peer-review publication.

c. Cooperative Rockfish Sampling Survey Update

A join rockfish longline survey with the International Halibut Commission (IPHC) was conducted annually since 2006. In 2006, there were 25 rockfish added to the existing 27 IPHC survey stations off Washington coast, whereas 18 rockfish stations were kept during 2007-2009. The locations of rockfish survey stations were selected based on an advanced systematic adaptive sampling framework that utilized historical rockfish catch from the IPHC survey stations, the Pacific Coast Groundfish EFH Mapper program, spot prawn logbook trawling data. The goals are to reduce the uncertainty of the estimation of catch per unit effort and to resolve the spatial confounding factors affecting the distribution of rockfish species.

d. Underwater Remotely Operated Vehicle Survey

Yelloweye information from the annual Washington IPHC survey has been incorporated into the Pacific Fishery Management Council's yelloweye rockfish stock assessment since the first assessment in 2001. However, abundance varies widely between years and this information has not been informative to the assessment model. In an effort to better understand IPHC survey covariates, WDFW conducted a ROV survey in collaboration with SRI International and the University of Washington during September 2008. The objectives of the survey were to gather data to establish habitat associations and explore catch rates of yelloweye rockfish across time and area. Area swept estimates were derived from precise navigation data collected from a Ring Laser Gyro and Doppler Velocity Log in conjunction with a three-beam video menstruation system.

Survey stations were selected based on information previously collected from a collaborative longline rockfish survey with the International Halibut Commission (IPHC). Stations are located in areas of known high abundance of yelloweye rockfish and one of the stations has historically produced more than 90 percent of the total yelloweye rockfish caught in the IPHC annual longline survey off Washington. Due to bad weather at the start of the survey, the first several days and six transects were completed in Puget Sound near San Juan Islands. The remaining twelve transects were conducted at the IPHC “rockfish stations” off Cape Flattery Washington. Transects were conducted between IPHC start and end points for skates set during the 2007 survey.

Review, data acquisition from digital video files and summarization of initial results has been completed. We had over 2,300 fish observations of at least 36 separate species, fifteen of which were rockfish. An interesting observation that was noteworthy is our observation of adult yelloweye social defense behavior when an individual was attacked by a large lingcod. A manuscript is being prepared describing the methods and survey results that will be completed by December, 2010.