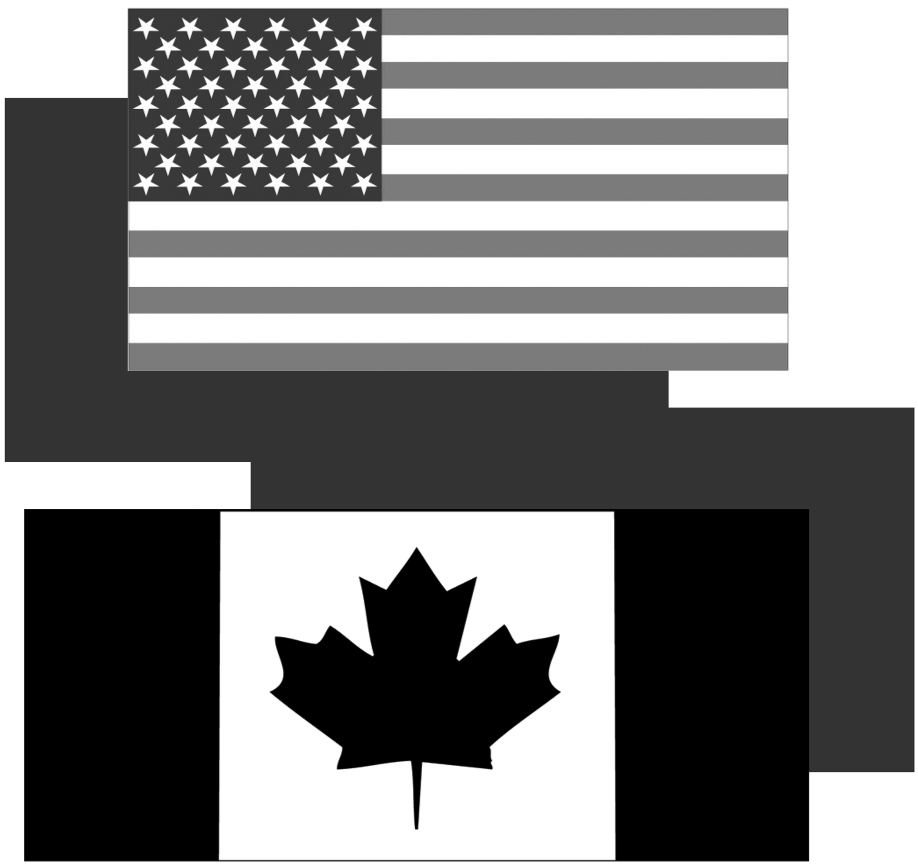
Report of the Technical Subcommittee
of the
Canada-United States Groundfish Committee
Forty-Ninth Annual Meeting of the TSC
May 6-7, 2008
Seattle, Washington



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

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A. Overview and Terms of Reference

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

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

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

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

The TSC has exhibited considerable flexibility in reacting to the diverse problems of the dynamic groundfish fishery off western Canada and the United States. It has coordinated coastwide fishery statistics and research projects; created working groups to deal in depth with specific problems; scheduled workshops at which appropriate specialists met to jointly deal with specific problems and exchange data and information; and provided an on-going forum for exchange of data, procedures, and regulations. The TSC has identified problems associated with the utilization and management of groundfish resources of importance to both countries; often well in advance of public or agency awareness. The concerns expressed in 1962 by the TSC over the development of foreign fisheries and recommendations for stock assessments were significant. TSC-coordinated Canada-U.S. research on Pacific ocean perch provided the basis for negotiation of bilateral fishing agreements between the United States and Japan and the USSR. Furthermore, the continually updated information provided the basis for quotas imposed in 1977 by Canada and the United States when they both promulgated their 200-mile zones of extended jurisdiction.

B. Executive Summary

The TSC met **May 6-7, 2008** in **Seattle, Washington** at the Hotel Nexus. The meeting was hosted by the National Marine Fisheries Service -- Alaska Fisheries Science Center (Mark Wilkins) and chaired by Cleo Brylinsky, Alaska Department of Fish and Game. As is done each year, participants review previous year (2007) research achievements and projected current year (2008) research for each agency.

There continues to be significant informal collaboration between U.S. and Canadian staff in the research and stock assessment of such species as yellowtail, canary, yelloweye rockfish, sablefish, and more extensively, Pacific whiting.

Nevertheless, the TSC suggested that assessment and management of these and other groundfish populations that co-exist near national boundaries would benefit from closer collaboration. One means for achieving this would be to include staff from both countries at all pre-assessment workshops of both nations. This would help to ensure that all relevant data are brought to bear on each assessment of transboundary species and also act to stimulate long term collaborative research. This recommendation was sent out in the annual "Letter to Supervisors", and we have agreed to leave it to each agency to act upon this recommendation as they deem appropriate.

The TSC again noted the ongoing work of the Committee of Age Reading Experts (**CARE**) (http://care.psmfc.org/). TSC appreciates the work of CARE and recognizes that a direct link between the assessment biologist and the ageing lab is the most efficient means of requesting species ageing exchanges.

The TSC thanks the Sablefish Working Group for attempting to facilitate closer collaboration among the different research agencies. These efforts appear to have been partially successful thanks to the interagency Sablefish Workshop which was held at the AFSC in Seattle in February, 2007. The TSC suggests that further efforts be left to the principal sablefish researchers in each agency and that the Working Group be disbanded.

Field Data Acquisition Workshop Working Group: Mark Wilkins reported that the long-planned field data acquisition workshop had again been cancelled due to uncertain funding. However, the steering group had agreed to push forward and schedule it for late this fall. The group discussed best options for the date and agreed upon the first week of December as the best choice. The workshop announcement will be distributed to Pacific coast fisheries agencies very soon. *[Editors note: The workshop will now take place April 1-3, 2009 in Seattle Washington. For further information contact Mark Wilkins mark.wilkins@noaa.gov A website has been established for the workshop, go to https://tundra.iphc.washington.edu/edat/default.htm.*

The Trawl Survey Working Group, composed of trawl survey scientists from DFO and NMFS (both AFSC and NWFSC), has met annually since 2003 (officially sanctioned as a TSC Working Group since 2005) to share information and coordinate bottom trawl surveys in the North Pacific. They did not meet in 2008 but plan to continue these valuable meetings in the future.

The GIS Working Group: A recent query as to the interest level for a GIS workshop failed to raise a significant response. There have been several other small workshops up and down the coast. GeoHab, which meets annually, opted not to include this as a proposed "side workshop".

The next meeting of the TSC will be held May 5 and 6, 2009, in Juneau, Alaska, at the Alaska Fisheries Science Center's Auke Bay Lab. Dave Clausen, elected as the TSC Chair for 2009-2010, will host and chair the 2009 meeting.

C. Minutes of the Technical Subcommittee

Forty-Ninth Annual Meeting of the TSC
May 6-7, 2008
Hotel Nexus
2140 N. Northgate Way
Seattle, WA 98133

Mark Wilkins AFSC, host & rapporteur
Contact: Mark.wilkins@noaa.gov

Tuesday, May 6

I. Call to Order - Cleo Brylinsky (ADF&G), TSC Chair, called the meeting to order at 8:30 am May 6, 2008.

II. Appointment of Secretary - Mark Wilkins volunteered to record the minutes of the meeting.

III. Introductions - Attending the meeting, representing their respective agencies, were:

Alaska Department of Fish & Game

Cleo Brylinsky, TSC Chair	Sitka	907-747-6688	cleo.brylinsky@alaska.gov
Kristen Munk, CARE rep.	Juneau	907-465-3054	kristen.munk@alaska.gov

Washington Department of Fish & Wildlife,

Theresa Tsou	Olympia	360-902-2855	Tien-Shui.Tsou@dfw.wa.gov

Oregon Department of Fish & Wildlife

Bob Hannah	Newport	541-867-0300x231	bob.w.hannah@state.or.us

California Department of Fish & Game

Traci Larinto	Los Alamitos	562-342-7111	tlarinto@dfg.ca.gov

Fisheries and Oceans, Canada

Rick Stanley	Nanaimo	250-756-7134	rick.stanley@dfo-mpo.gc.ca
Lynne Yamanaka	Nanaimo	250-756-7211	lynne.yamanaka@dfo-mpo.gc.ca
Gary Logan	Vancouver	604-666-9033	gary.logan@dfo-mpo.gc.ca
Adam Keizer	Vancouver	604-666-3279	adam.keizer@dfo-mpo.gc.ca

National Marine Fisheries Service, Alaska Fisheries Science Center

Mark Wilkins	Seattle	206-526-4104	mark.wilkins@noaa.gov
Dave Clausen	Juneau	907-789-6049	dave.clausen@noaa.gov

National Marine Fisheries Service, Northwest Fisheries Science Center
Aimee Keller Seattle 206-795-5860 or 206-860-3460 *aimee.keller@noaa.gov*

International Pacific Halibut Commission
Claude Dykstra Seattle 206-634-1838 x213 *claude@iphc.washington.edu*
Eric Soderlund Seattle 206-634-1838 x230 *eric@iphc.washington.edu*

Pacific States Marine Fisheries Commission
Stephen Phillips Portland 503-595-3100 *stephen_phillips@psmfc.org*

IV. Approval of 2007 Report

The report of the 2007 meeting, which was printed and distributed in November 2007, was unanimously approved. The group expressed its appreciation to Stephen for the timely finalization and distribution of the report.

V. Approval of 2008 Agenda

During the early part of the meeting, we added two items for discussion under agenda item *VII. E. Other Items* – marine mammal predation on fish species and the issue of using scuttled ships to "enhance" the habitat of Marine Protected Areas.

VI. Working Group Reports

A. Committee of Age Reading Experts (CARE)

Kris Munk reviewed the executive summary of the April 1-3 2008 CARE Workshop that was held at the Pacific Biological Station in Nanaimo, BC, hosted by the Canadian Department of Fish and Oceans. She pointed out that historically the biennial CARE workshops have been scheduled the same year as the Western Groundfish Conferences (WGC) and that this has caused difficulties in justifying travel funds to both events in the same year for some researchers. CARE has addressed this dilemma by changing their biennial meeting schedule to years opposite the WGC and will transition to the new schedule beginning in 2009, with subsequent meetings scheduled for 2011, 2013, etc.

Recent (early 2008) age structure exchanges included sablefish (among CDFO-Nanaimo, NMFS-PSMFC-Newport, and ADFG-Juneau), which has seen improved comparability among agencies over recent years, and yelloweye rockfish (among WDFW-Olympia, NMFS-PSMFC-Newport, and ADFG-Juneau). Detailed results of these exchanges have not yet been reported, but Kris commented that there was generally good precision.

CARE workshop participants recognized that a fair number of age reading experts were approaching retirement age. Results of a poll taken among age readers revealed that approximately 51% were likely to retire within 10 years and 19% were likely to retire within 5 years. This degree of turnover within the profession, in addition to the several years of training required to achieve competency, should present a significant concern to agencies that have age reading laboratory staff. CARE wanted to highlight this issue so that these agencies might be more aware of the impending shortage of competent age readers.

CARE made four recommendations to itself at the recent workshop including the aforementioned change to the biennial workshop schedule, adding disclaimer and citation information to their website, creating a trial web-based discussion forum, and expediting dissemination and approval of workshop minutes. Lastly, Kris mentioned the upcoming International Otolith Symposium scheduled to take place in Monterey, California, in 2009.

B. Sablefish Working Group Report

Last year Cleo had reported on the sablefish workshop that was held in Seattle at the AFSC on February 21-23, 2007. Among the issues that had been discussed at that workshop were tagging/migration studies. Participants had identified a coastwide migration model for sablefish as a potential project for interagency/international collaboration. During this year's discussion Cleo noted that, although several agencies have made an effort to promote and encourage sablefish tagging studies, those efforts have been largely unsuccessful. We discussed possible reasons why more collaborative interest in sablefish research hasn't been generated recently. Cleo highlighted one potential project involving installing arrays of telemetry sensors capable of picking up signals from sonic tags. She mentioned two areas as sites where this approach could be effective – near the south end of Chatham Strait and in Prince William Sound. Offers of support for cooperative research have been put forth, but little interest has developed. Traci cautioned that some sonic tags have been found to broadcast within the audible range of marine mammals, which can attract those predators directly to the tagged fish, much to the detriment of the recovery rate. Mike Shane, Hubbs-SeaWorld Research Institute, can offer more details on this phenomenon. Dave C mentioned that ABL had done some archival sablefish tagging projects and had some data. Claude also mentioned that IPHC shares data relating to sablefish that are collected during the halibut surveys and other IPHC research projects. Kris commented that CARE age readers were disappointed when plans fell through for the sablefish age determination workshop that had been scheduled in conjunction with the large-scale sablefish workshop that Michael Schirripa had been promoting a few years ago. Since that workshop did not happen, CARE formed a working group at their 2008 meeting and set some goals. This ad hoc group will compare size at known-age of 0 and 1 year olds, for populations ranging from Oregon to Alaska. They will also conduct a comprehensive age structure exchange with each of four agencies (ADFG, CDFO, NMFS-AFSC, and NMFS-NWFSC/PSMFC) providing a sample of 20 specimens from their locale. For a portion of the specimens, each agency will annotate images with interpreted annuli and transition zones. Sablefish age readers noted that age structures from different stocks of a species can exhibit different, distinct patterns, and that this may contribute to "error" in these exchanges. Gary L indicated that industry groups would likely support collaborations on these types of sablefish research projects and asked what seemed to be impeding it. Members informed him about the history of planning recent sablefish workshops, explaining that the vision of the larger-scale workshop wasn't supported by the interest level of the community of scientists currently working on sablefish, despite the efforts TSC had made to stimulate it. Discussion ensued on the value of TSC encouragement of sablefish tagging studies from the aspect of how relative catches in different national/state zones reflects on learning more about immigration and emigration rates. Gary commented that this is an important issue, especially as we face the reductions in catch that are already in the works. Cleo reported that, at the 2007 workshop, Rob Kronlund (PBS) had been a supporter of such tagging work, but wanted to first define clear objectives for it. At that time nobody was willing to take on that task. A recommendation to disband the Sablefish Working Group was proposed and discussed and Rick Stanley was asked to prepare a recommendation from TSC to itself (see Section X. 2008 Recommendations).

C. Trawl Survey Working Group Report

This group, composed of trawl survey scientists from DFO and NMFS (both AFSC and NWFSC) has met annually since 2003 (officially sanctioned as a TSC Working Group since 2005) to share information and coordinate bottom trawl surveys in the North Pacific. They did not meet in 2008 but plan to continue these valuable meetings in the future.

D. Field data acquisition workshop

Mark reported that this long-planned workshop had again been cancelled due to uncertain funding, however the steering group had agreed to push forward and schedule it for late this fall. The group discussed best options for the date and agreed upon the first week of December as the best choice. The workshop announcement will be distributed to Pacific coast fisheries agencies very soon. Having reviewed the topic headings proposed for the workshop, IPHC representatives added that they are capturing landings data with an application developed by staff member Heather Gilroy. This is part of an interagency collaborative effort with ADFG and NOAA, and is known as eLandings (http://elandings.alaska.gov/).

E. GIS workshop

A recent query as to the interest level for a GIS workshop didn't get much of a response. There have been several other small workshops up and down the coast. GeoHab, which meets annually, didn't want to include any side workshops.

F. Other

Yelloweye rockfish: Traci reported that California is struggling with rebuilding plan for yelloweye. The only additional data that researchers have managed to gather on this species comes from the IPHC's setline surveys and the rockfish enhancement stations they've added, including 18 in Washington and 20 in Oregon. The main concern is that the opportunities to collect data are drying up. The small amount of OY is split among surveys, recreational catch, and commercial catch. Gary & Lynne – Need to keep an eye on this issue to monitor the effects of draconian management. Use of tagging studies to help answer key questions were discussed. As with many deep-living rockfish species, damage from decompression barotrauma is an issue during tagging studies. Claude reported that the IPHC plans to try deflating the air bladders and deploy fish with archival tags to study their survivability. Traci also proposed programs to train fishers to deflate the airbladders of discarded fish to enhance their ability to recompress and return to depth. In light of the interest expressed during this conversation, we agreed that we need to maintain the Yelloweye Rockfish Working Group in readiness to address specific objectives or tackle issues that arise. Issues that need to be discussed include how we extend the interest in the issues surrounding this species to a broader audience and who we should include. Ian Stewart (NMFS, NWFSC) is scheduled to conduct the 2009 yelloweye rockfish stock assessment for the Pacific Fishery Management Council and should be included. Kris suggested that an age reader familiar with this species also be included.

VII. Other Topics

A. Ageing- Capture of Metadata in a Database

Rick pointed out that information is being lost through missed opportunities to capture accessory data associated with the ages developed by readers. A database needs to be developed that defines the fields that would be important to retain information for. Some in the group felt that this topic had been discussed adequately in 2007 and could be removed from the agenda.

B. Marine Reserves

Gary reported that his office hears numerous reports and charges that fishing takes place within marine reserves. There is not enough enforcement or monitoring and violation by blatant abusers is still problematic. Traci reported that reserves in the south-central coast region of California have been finalized and those in the north-central coast are being implemented. A symposium was recently held to discuss reserves in the Channel Islands region. Now that these are in place, CDF&G is moving into the education/enforcement phase. Bob reported that Oregon is working on a major initiative by the governor's office and agreement is foreseen by the end of the year. The agreement hopes to establish "Heritage Sites", but the purposes are as yet unclear. There is a lot of passion but much work remains to define the scientific objectives. Lynne reported the establishment of a reserve at Bowie Seamount, which has taken since 1999 to accomplish. Sablefish harvests still continue there, however. Gary added that part of the issue is that the DFO is unclear about the direction they want to proceed with this.

C. Genetics and Stock Structure

Aimee reported that the NWFSC is investigating the area around Pt. Conception, CA, as a transition zone separating stocks of various species. Studies are being planned, but species have not yet been selected. Mark remarked that the RACE Division at AFSC now has a working genetics lab staffed by two trained geneticists, who are always open to considering collaborative research projects. Contact for the lab should be made through Dr. Mike Canino, (Mike.Canino@noaa.gov) 206-526-4108. Lynne reported that there is some indication that stocks of yelloweye rockfish found on the west side of Vancouver Island are distinct from those in inside waters. A decision to consider listing yelloweye through the COSEWIC process was deferred because the boundary between the stocks could not be delineated. Lynne also mentioned that the DFO genetics lab examined harbor seal scats at haul-out sites and identified fish prey to species, particularly rockfish. These methods are useful for determining species consumed, especially where hard parts be only be used to identify fish to family. Aimee mentioned a non-lethal hook sampler method of collecting tissues. She also mentioned recent work that is looking at a possible new species of rockfish, similar to vermilion, being described with the proposed name sunset rockfish. Theresa mentioned that WDFW researchers are looking at black rockfish stock structure.

D. Western Groundfish Conference 2008 Report-highlights

Those who attended the Western Groundfish Conference in Santa Cruz, February 4-8, reported that it was an excellent conference and a lot of fun. Kris noted her presentation of a bomb radiocarbon age validation study which suggests good consistency in accurate age reading across eight species including black, dusky, rougheye, and yelloweye rockfish, as well as sablefish and geoduc. Juneau will be the venue for the next Western Groundfish Conference in 2010 and it will likely be held later in the year, perhaps April or May.

E. International Observer Conference

This was held in May 2007 in Victoria, BC, Canada. Claude reported that there was good attendance, a broad range of topics was discussed, and safety was a primary focus. Other highlights included camera technology and enhancements of a wide variety of sampling technologies. Rick’s impression was that there was a shift in the tone of the conference away from quantity of coverage toward quality assurance of the data collected. An M.Sc. candidate at Simon Fraser Univ. is analyzing trawl observer data for evidence of observer bias that might be related to on-board coercion. Dave asked whether halibut fishery is subject to observation. Claude told us that there is about 10% coverage in Canada plus universal on-board camera surveillance.

F. GeoHab 2008 Report-highlights

Cleo reported on the recent meeting of GeoHab (http://www.geohab.org/) in Sitka on April 29-May 2. The meeting attracted 87 participants from 12 countries. Session topics included high seas MPAs, deepwater coral and sponge habitats, engaging the public, and classification schemes (proprietary and universal). The next meeting will be in 2009 in Trondheim, Norway.

VIII. Review of Agency Groundfish Research, Assessment, and Management

A. Agency Overviews

1. CDFG

Marija Vojkovich now directs the marine program. Tom Barnes is the manager. A current focus is on the Marine Life Protection Act.

2. ODFW

Patti Burke resigned as director of the marine program. The shellfish program has been reconstituted. They are working on refilling Steve Parker's position, concentrating on finding someone skilled analytically over field expertise. That selection is expected to be announced shortly.

3. WDFW

Two key people have left the marine staff. Brian Culver retired and Tom Jagielo resigned.

4. CDFO, PBS

Jeff Fargo stepped down from his position as the Section Head of Groundfish to resume his work on flatfish biology. Ted Perry will be retiring soon. A new ship to replace the Ricker is in the works and expected to arrive on the scene in December 2010 and be operational sometime in 2011. Two ships are being built for DFO. Laroque decision – quota allocation to groups working in collaboration is no longer permitted. Laroque Relief Funding comes from Ottawa.

5. CDFO Manager

Gary introduced himself and Adam. Current staff includes 2 quota officers and 3 species coordinators.

6. NMFS, AFSC

Described the opening ceremony for the Ted Stevens Marine Research Institute (TSMRI) which included a catered lunch, open house, and protesters. Although the physical facility is known as TSMRI, the AFSC Division located there will be known as Auke Bay Laboratories (a minor change from Auke Bay Laboratory).

7. ADFG

A new analyst, Alison Sayer, is on board working on several issues from databases to fish.

8. NMFS, NWFSC

Dezhang Chu was hired as leader of the acoustic survey group, having come from Woods Hole Oceanographic Institute. The vacancy for the overall survey program manager still has not been filled. Jason Cope and Melissa Haltuch have been hired to join the stock assessment team.

9. IPHC

Bill Clark is retiring and Steven Hare is shifting over to fill that position. Juan Valero has been hired.

B. Multispecies Studies

1. WDFW

Ecosystem Ecopath Ecosim

2. NMFS, NWFSC

Researchers are studying the hypoxic zones that have been appearing off the coast. During the surveys they observed no catch or catches of dead animals at five stations. Staff have teamed with OSU researchers to investigate further. There appears to be a gradient of hypoxic conditions and catches appear to increase as oxygen content increases. They've been looking at an area extending about 60 miles north and south of Cape Perpetua in the 30-100 m depth range. Significant correlations have been found between the degree of hypoxia and the abundance of 11 species.

3. NMFS, AFSC

Work is being done to standardize our species identification protocols particularly as they apply to invertebrates caught during our trawl surveys. Food web research by the Resource Ecology and Ecosystem Management Program, presented in the agency report, is especially pertinent to multispecies studies. The REFM Division's Fishery Interaction Team is planning a baseline exploratory survey to the Beaufort Sea this August.

4. ODFW

Bob highlighted some of the passive acoustic work that they've been doing with rockfish species in the area off Depoe Bay and Siletz Bay. Canary rockfish are showing lots of vertical and horizontal movement while yelloweye, quillback, tiger, and black rockfish are more stationary. They've been trying some airbladder inflation experiments to simulate and understand more about the physiological effects of barotrauma. Lynne asked what they saw in regard to trauma from blood gases from the artificial inflation. Bob said the primary question they're looking to answer relates to eye damage from either the blood gases or the gas escaping behind their eyes. The rate of ascent appears to make a big difference in the severity of the eye damage. More work has been done on selective flatfish trawls regarding how they work and how to improve the legal definition of them.

5. WDFW

Theresa described the Puget Sound trawl survey, which rotates among three main areas on a three-year schedule. The agency is switching to monitoring a set of index sites every year. Randomly selected sites will be added in certain geographic area if there is a management need or as the budget permits.

6. DFO

Mention of the Strait of Georgia trawl survey being conducted by Ian Perry.

7. CDFG

Traci talked about ROV monitoring programs in the Channel Islands and in nearshore ecosystems. An NGO applied for an Exempted Fishing Permit through the Council process to use vessels with LE trawl permits to test the use of trap and hook-and-line gears to take sablefish in the central region.

8. ADFG

Working on upgrading their DSR research database which consists of all the records from the Delta submersible. Data was collected in 2007 for continued monitoring of the Pinnacles Marine Reserve.

C. By Species

1. Pacific Cod

a) ADFG

The directed fishery was conducted as usual but the Department closed two statistical areas in season because of concern that too much of the quota would come from those two areas.

b) AFSC

Mark referred folks to agency report section on larval and juvenile cod research by Fisheries Behavior Program staff in Newport, OR.

c) IPHC

The Commission collected additional data about Pacific cod capture during their setline surveys in the Bering Sea and provided these data to the NMFS/AFSC cod stock assessment team results. In 2008, they provided AFSC's cod stock assessment analyst with length frequencies from their most recent season's survey stations along the Bering Sea shelf edge.

2. Nearshore Rockfish

a) DFO

Lynne described some gear trials with the NMFS/WHOI AUV together with the DFO Phantom ROV mounted with a Didson. Photo stills from the AUV were mosaiced. The monitoring and assessment of Rockfish Conservation Areas will involve UBC Professor Jon Shurin and three grad students. Two species of rockfish, yelloweye and quillback, are being brought before the COSEWIC process. Rockfish Conservation Areas – 20% habitat outside; 30% inside were completed in Feb 2007. These are no fishing area used as a spatial management tool to protect inshore rockfish from harvest. Work with Bryan Black (Oregon State University) on otolith chronologies of yelloweye rockfish has been completed for the Bowie Seamount and Triangle Island areas.

b) ADFG

They continue using the Delta submersible to assess fish in rocky habitat. They are seeing decreased densities of rockfish. They are also using results of the IPHC setline survey expanded sampling to help assess rockfish stocks.

c) WDFW

Their rockfish research plan was underfunded before the rockfish research license fee was implemented, limiting their research activities. Coastal yelloweye rockfish and black rockfish have been the focus and the Puget Sound rockfish conservation plan is moving forward. Coastal rockfish assessment shows the health of black rockfish stock is OK and no action is necessary. They see an up and down trend for yelloweye rockfish from the IPHC setline survey results. They are looking for causes, which may include oceanographic conditions. They have refined their sampling program and improved precision of their estimates. License fees (both commercial and recreational) have been increased to help fund research. Gary and Traci weighed in on their respective agencies' experience with raising license fees, relating how difficult it is to accomplish.

d) ODFW

PIT tag data has now been included in the model for black rockfish stock assessment, which resulted in an increase in the abundance estimate. Oregon's analysis of IPHC setline data for yelloweye rockfish is showing them a declining trend in abundance. They are examining this and other data for evidence of localized depletion effects.

3. Shelf Rockfish

a) CDFG

Traci mentioned two experimental fishing permits for chilipepper rockfish.

b) NWFSC

Assessments of canary and yelloweye rockfish stocks show slight increases in abundance. Aimee presented some summary slides of these results.

c) DFO

Rick discussed some elements of the bocaccio assessment they are preparing. With respect to catch reconstruction, they are examining the salmon troll fishery removals in the 1950s through 1980s which may have been significant. They are also attempting to reconstruct bycatch in the halibut fishery. In the assessment, they are attempting to estimate trawl catchability through interviews with fishermen.

4. Slope Rockfish

a) AFSC

Dave reported that ABL's Pat Malecha is using an "aquarium" codend, developed with the help of the RACE net loft staff in Seattle, on a surface trawl to collect live young-of-the-year rockfish with minimal damage from net capture. He also mentioned that the central Gulf of Alaska bottom trawl fishery for slope rockfish is now based on a cooperative harvest system that has replaced the 'derby' system of the past. Staff at ABL, in collaboration with Jay Orr, RACE Division systematist, are working on accurate field identification to distinguish blackspotted and rougheye rockfish. Mark reported on the RACE Groundfish project addressing the issues surrounding estimating groundfish abundance in areas that can't be sampled using bottom trawl surveys. A group of scientists are working to develop methods to acoustically classify grounds within survey areas of the Gulf of Alaska as trawlable or untrawlable, then devise methods to determine groundfish densities within the untrawlable regions. Similar investigations are taking place at the NWFSC, also.

b) ODFW

Josie Thompson is working on validating aurora rockfish ageing using methods developed by Bryan Black (OSU). She re-aged fish armed with knowledge about when to expect small growth increments (annuli), which resulted in more confidence in the growth curves. Lynne mentioned that she's also worked with Bryan correlating ages of trees, geoducs, and rockfish. Kris noted that 1997 was the year that saw the biggest growth increments noted, particularly for sablefish.

c) DFO

Andrew Edwards has been hired to fill Jon Schnute's position after Jon retired.

5. Thornyheads

a) DFO

Gary reported that NGOs are wanting to see catches restricted based upon the destructiveness of trawling and suspected overfishing. Rick asked whether any agency is currently ageing thornyheads in production mode, noting that a particular problem is the density of annuli in compressed zones. Kris replied that her shop is ageing in production mode and noted that they've seen a maximum age of 119 years, though they're likely to find older fish. Kris also mentioned that ADFG has completed, but not yet published, age validation work on thornyheads using the bomb radiocarbon method, which suggests accurate age reading. Neither AFSC nor NWFSC is ageing in production mode, though comparisons are being done between radiometric and radiocarbon validation methods.

6. Sablefish

a) ADFG

Alaska has two internal waters fisheries. ADFG uses a mark/recapture survey in the Chatham Strait fishery. The fleet wanted them to produce a research report documenting how that survey was done and how results were used for assessing the stock. Consequently, instead of conducting a new stock assessment, their efforts will be spent publishing this documentary report. This leaves them with the question of how to set a quota by the first of June. Likely the quota will be set consistent with last year, unless better information becomes available.

b) AFSC

Dave C. discussed that assessments show sablefish are declining in abundance and the decline is expected to continue through 2012. Killer whales still impact the AFSC longline survey operations and results and sometimes whole stations of data have to be tossed out. He also mentioned that a tagged sablefish had been recovered that had been at liberty for 35½ years (tagged in 1972 by NMFS in Chatham Strait and also recovered in Chatham Strait). In 2009, a short experiment will be conducted with a chartered longliner to see how many sablefish and grenadier occur at depths >1,000 m, which is beyond the maximum depth sampled in the AFSC longline survey.

c) NWFSC

The west coast stock assessment reflects some improvement due to strong 1999 recruitment.

7. Flatfish

a) NWFSC

The arrowtooth flounder stock, never having been overfished, is looking healthy. Not much fishing is done on this species because of its lack of appeal. The English sole stock continues to increase, having seen good recruitment since the 1999 year class. Stocks seem to be recovering, although CVs around the estimates are variable at around 20%.

8. Lingcod

a) ADFG

Despite not seeing much controversy surrounding lingcod last year, they anticipate issues arising during the upcoming Board of Fisheries cycle. Apportionment among user groups is the most likely problem area. Anecdotal data from the salmon troll fleet indicates that there are many big lingcod on the outer coast north of Sitka and that they cause problems on the troll gear.

b) WDFW

Theresa reported that some enhancement efforts are taking place at a hatchery at Manchester. There are concerns regarding the effects of enhancement on predation.

c) DFO

Georgia Strait fishery has been closed since the mid 1990s until a recent opening. The current opening is being carefully monitored. There's a need to look at lingcod diets and determine the effects of rebuilding the lingcod stocks on the health of rockfish stocks. Cleo added that they should also check to see whether sablefish are also being eaten.

9. Pacific Whiting

a) CDFG

Traci reported that information on the bycatch of rockfish and salmon in the hake fishery are detailed in the state's TSC report.

b) NWFSC

There is some controversy over the value of q (catchability) that is being used by the modelers. Hake catch was high in 2005 and 2006 but there has not been much recruitment in the past couple of years. Nevertheless, abundance has remained relatively high. 2008 estimates of spawning biomass are lower compared to last year's assessment.

10. Walleye Pollock - No reports were given regarding Walleye Pollock.

11. Dogfish

a) AFSC

Dave reported that ABL hired Cindy Tribuzio to take over shark stock assessments since Dean Courtney left to work on an advanced degree.

b) IPHC

To counter the effects of dogfish saturating hooks during their setline survey, they're experimenting with magnets and mischmetals (rare earth metals) to keep the sharks away from the gear. Studies show that dogfish avoid hooks in the presence of these additives while halibut show no avoidance. There doesn't seem to be any evidence of a pollution issue. Mark referred to information in the AFSC report on similar work being done by the Fisheries Behavioral Ecology group in Newport, OR.

Wednesday, May 7, 2008

12. Pacific Mackerel and Sardines

a) WDFW

Commercial sardine fishermen are becoming concerned about the stocks and will be getting a private consultant to work on an independent survey.

13. Skates

a) NWFSC

A successful assessment was conducted on longnose skate by Vladlena Gurtseva (NWFSC, Newport). Theresa reported that there are concerns about how skate are aged and the difficulties in handling the fish by one port sampler in the field. Rick reported that Sandy MacFarlane at PBS is ageing skates.

b) AFSC

Mark highlighted the recent publication by Alaska Sea Grant of the Field Guide to Sharks, Skates, and Ratfish of Alaska by three RACE Groundfish scientists with a colleague from Texas A&M University.

14. Other Species

a) ODFW

Bob reported that the status of eulachon is being evaluated for listing as threatened or endangered and that staff are working on how to mitigate bycatch of the species.

b) IPHC

Claude and Eric reported on a number of IPHC's investigations.

- Work is being done investigating elemental 'fingerprints' of otoliths looking for signatures that can be tied to different nursery, feeding, or fishing grounds. The technique utilizes laser ablation of various portions of the otolith.
- Their investigations utilizing pop-up archival (PAT) tags are elucidating seasonal migration patterns and the timing of when tagged fish (likely mostly females, since

tagging is concentrated on larger fish) return from the spawning grounds to the summer feeding grounds. Costs run about $5,000/tag. Tags report via a satellite link when they pop to the surface after being released from the fish at a programmed time. Better data is available if the physical tag can be recovered and returned to IPHC. 24 fish were released in the Bering Sea and results showed no surprises from past knowledge. 120 PAT tags will be released in the Bering Sea in 2008 in response to concerns of fishers' interpretations of PIT tagging results from 2004 tagging, which seem to indicate to them that there are many more fish than managers believe. It's hoped that PAT tagging will fill in data gaps to help answer these questions.

- Related to another type of archival tag with light sensor capability, work is being done to solve some problems relating to the fish's attempts to rid themselves of the tags. These tags are being used to look into vertical excursions thought to be related to spawning releases. Taggers are using veterinary ultrasound to determine sex of the fish in order to concentrate on tagging females. Trying various coatings to minimize the problem. Fish appear to be encapsulating the tag in mesentery, apparently in preparation to extrude it. In one case it had entered the vas deferens. Also looking at external application of the tags, which are designed to last about 3 years.
- Hook size and spacing studies show larger hooks and wider spacing yield better catches. Yelloweye rockfish bycatch is higher with smaller hook spacing.
- IPHC is collaborating with state agencies to collect more rockfish catch data from their setline survey by adding stations and collecting catch data on all species from subsets of their gear.
- Using DIDSON technology ("acoustic camera" that requires no light) to investigate hooking success. They are seeing that there are usually about two attacks on a hook for each hooking. This helps them understand results of their setline survey more completely.
- Swivel experiment measuring swiveled gangions vs fixed gangions, looking at effects of rolling fish tangling gear.
- More oceanographic information is being collected during their survey using SeaBird instruments. Added an oxygen sensor to one of their units in 2006 so they're now collecting temperature, salinity, depth, chlorophyll, oxygen, and pH. Addition of the oxygen sensor helped them detect hypoxic areas. Money to upgrade other units dried up so they couldn't deploy this capability to all survey vessels. The eventual plan is to deploy sensor at each station, requiring 10-15 minutes/cast. Claude said that these units could possibly be loaned out to other agencies when not needed at IPHC. They plan to share the oceanographic data and are working out a format. Rick mentioned that DFO deploys SeaBird with oxygen sensor (no chlorophyll sensor) on the trawl during trawl surveys.
- Removal sampling pilot study. In order to assess any fishing-down effect at survey stations, offal and discards were discarded after moving some distance off station instead of at the station itself. The purpose was to measure catch depletion rates and bycatch as other species were removed.

- Electronic vessel monitoring (NPRB et al).
- Workshop in fall 2008 will be held to promote an open public discussion of the coastwide vs closed area assessments and the use of SSA survey results as an apportionment tool.

c) DFO

Humboldt squid – Gary asked whether these squid were continuing their aggressive northerly movement. Traci reported that they are being seen in the recreational charter fishery off California. A short discussion was held about the potential effects of the squid in coastal waters of Oregon and Washington.

D. Other Related Studies

a) AFSC

Mark described the work of the Working Group on Bottom Trawl Survey Improvement (WGBTSI) within RACE Division's Groundfish Assessment Program looking critically at all aspects of bottom trawl surveys for ways to improve performance and results. This is an ongoing project which focused its attention in 2008 on improving the accuracy and precision of survey effort measurements.

b) NWFSC

Aimee briefly described their work on developing an autonomous underwater vehicle (AUV), looking at the effects of herding during trawling, and work on a hook and line survey by John Harms. They are using cameras to examine how fish behave around the trawl to help understand limitations of trawl surveys.

E. Other Items

a) DFO

Update on integrated groundfish management in B.C. Rick described the Pilot Groundfish Integration Project in B.C., which is looking at documenting catches (including discards) by various sectors of the commercial hook-and-line and trap fisheries. Key objectives are conservation and industry viability. One of the key elements is effective monitoring. Auditing in the electronic monitoring involves checking random footage of fisher handling activities (10%) and comparing with the information recorded by fishers in their logs for the matching events. Logbooks are scored at 3 levels:

1. Acceptable – may go back out fishing
2. Needs Improvement – may go back to fishing, but... (may require small fine/processing cost).
3. Unacceptable – Fishers may have to pay for full video review.

Results of the pilot project show that it works well and suggests that resulting estimates of catches and discards are unbiased. The bottom line is that they're getting 100% monitoring for about 20% of the cost through a random audit rather than full review or using 100% observers.

Marine mammal predation - Gary brought up the issue of the effects on fishing of predation by seals, asking to what degree this has caused problems. Some fishers have developed strategies to draw predators away from active fishers using decoy fishing vessels, etc. A short discussion ensued ranging from the sinking of boats and docks in California harbors to predation in the vicinity of dams to the challenges man faces coexisting with natural competitors. Agencies are hesitant to meet this issue head-on for fear of consequences and reprisals. User groups are voicing opinions more openly, however, although some through anonymous calls. A main topic of discussion involved how we can account for this depredation in our assessments of fish populations. Eric offered that observer programs might be able to provide information on this. Dave related some of the experiences and challenges posed by sperm and killer whale predation on ABL's sablefish longline surveys.

Artificial reefs in Marine Protected Areas - Gary raised the question as to whether other agencies had been asked to allow creation of artificial reefs in MPAs. Their office was approached by the Artificial Reef Society with a request to sink a ship in a rockfish conservation area (RCA). DFO's initial reaction was to refuse, insisting on maintaining a pristine marine environment. Lynne supported the reaction since, in her view, it amounted to dumping garbage in an RCA. Stephen related some of his past experience working in the area of artificial reef development in the Rigs to Reefs program. Traci related that some artificial reef development is being done in California in the name of diver enhancement but it may be changing the environment in a way we don't want to.

b) CDFG

Traci mentioned that a Workshop on Data-Poor Assessments would be held in October or November, probably focusing on rockfish species.

IX. Progress on 2007 Recommendations

A. From TSC to Itself

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

Sablefish working group - *"Cleo will follow up with members of the sablefish workshop to see where the next steps will be."* Rick will provide a recommendation for TSC to Itself for 2008.

GIS working group - *"Lynne will follow up with the steering committee members of the GIS workshop to see if there is any interest in convening a GIS methods/tools section at the GEOHAB meeting in Sitka in 2008."* Lynne did follow up on this by asking GEOHAB organizers whether there was any interest in such a session. The idea failed to raise any interest with the group. Lynne will provide a recommendation for TSC to Itself for 2008.

B. TSC to Parent Committee - No recommendations were made.

C. TSC to CARE

(2006 Recommendation) "TSC will rely on fishery managers and stock assessment authors to interact directly with their ageing lab supervisors to communicate with CARE for ageing exchanges. TSC appreciates the work of CARE and recognizes that a direct link between the assessment biologist and the ageing lab is the most efficient means of requesting species ageing exchanges." Since CARE had not met since before the 2006 TSC annual meeting, this was their first opportunity to respond to TSC's 2006 recommendation.

X. 2008 Recommendations

A. From TSC to Itself

The TSC thanks the Sablefish Working Group for attempting to facilitate closer collaboration among the different research agencies. These efforts appear to have been partially successful, however the TSC suggest that further efforts be left to the principal sablefish researchers in each agency and that the Working Group be disbanded.

1. GIS working group - At present the GIS working group is not planning any workshops. Participants in the last workshop continue to share ideas and methods through informal means. Should the need arise again, a workshop could be convened.

2. Use of telemetry technology for fish movement studies - Although there was no recommendation proposed, the group discussed telemetry ideas and possible ways we can support efforts to advance this technology. Claude mentioned that he would send participants the URL for a forum about tracking beasts with satellite

transponders. He later sent that link with the following message: "The site [listed below http://www.toppcensus.org/] has some interesting data presentations, and it also lets you tunnel into the specific data (or it did back in late 2006). The data set is much bigger than the animated critters on the main map when you first open the site and involves many top 'predators'." Bob noted that they would like to know how to contact agencies that have put acoustic tags out in case their array detects one of their fish.

We also discussed the possibility of a sponsoring a workshop on trawl surveys to help elevate the visibility of the issues that the TSC Trawl Survey Working Group and similar work groups have been grappling with.

B. TSC to Parent Committee - No recommendations were made.

C. TSC to CARE - No recommendations were made.

XI. Schedule and location of 2009 Meeting

Dave Clausen was unanimously selected to chair TSC for the 2009 and 2010 meetings. We scheduled the next annual meeting for Juneau on May 5-6, 2009.

XII. Other

The meeting was adjourned at approximately noon, May 7, 2008.

D. Parent Committee Minutes

Minutes of the 49th Annual Meeting
of the
Canada-US Groundfish Committee
(aka "Parent Committee")

I. Call to Order

Chair Mr. Stephen Phillips, PSMFC, represented the US (for Randy Fisher, PSMFC), and Gary Logan, DFO, represented Canada, called the meeting to order at 11:00 Wednesday, May 7, 2008. Also in attendance: Mark Wilkins (NMFS, AFSC Seattle), Cleo Brylinsky (ADFG), and Dave Clausen (NMFS, AFSC Auk Bay)

II. Stephen Phillips was appointed secretary for the meeting.

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

IV. Adoption of April 2007 Parent Committee meeting minutes: The minutes were adopted as presented.

V. Progress on 2007 Parent Committee Recommendations

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

   Action: There has not been sufficient interest from member agencies to move this topic forward. We assume that the TSC will discuss the possibility of a workshop again at its 2009 meeting and the Parent Committee will take appropriate action at that time.

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

Action: The TSC will send an annual meeting summary letter to all is member agencies after its 2008 meeting. The issue of collaboration between US and Canadian staffs will be raised.

VI. 2008 Parent Committee Recommendations

There were no recommendations

VII. Meeting Location

Dave Clausen, Auke Bay Lab, AFSC/NMFS/NOAA, offered to host the 2009 meeting in Juneau, Alaska. Dave Clausen is the new chair of the TSC. The proposed dates are May 5-6, 2009.

VIII. Other Business

a. The Parent Committee thanks Mark Wilkins for hosting the meeting.

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

E. Agency Reports

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

Agency Reports

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1. ALASKA FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE

2. CANADA, BRITISH COLUMBIA GROUNDFISH FISHERIES

3. COMMITTEE OF AGE READING EXPERTS (CARE)

4. INTERNATIONAL PACIFIC HALIBUT COMMISSION (IPHC)

5. NORTHWEST FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE

6. SOUTHWEST FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE

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

8. STATE OF OREGON – DEPARTMENT OF FISH AND GAME

9. STATE OF WASHINGTON – DEPARTMENT OF FISH AND WILDLIFE

10. STATE OF CALIFORNIA – DEPARTMENT OF FISH AND WILDLIFE

Alaska Fisheries Science Center
of the
National Marine Fisheries Service

2008 Agency Report
to the
Technical Subcommittee
of the
Canada-US Groundfish Committee

May 2008

Compiled by
Mark Wilkins, Tom Wilderbuer, and David Clausen

VIII. REVIEW OF AGENCY GROUNDFISH RESEARCH, ASSESSMENTS, AND MANAGEMENT IN 2007

A. Agency Overview

Essentially all groundfish research at the Alaska Fisheries Science Center (AFSC) is conducted within the Resource Assessment and Conservation Engineering (RACE) Division, the Resource Ecology and Fisheries Management (REFM) Division, the Fisheries Monitoring and Analysis (FMA) Division, and the Auke Bay Laboratory (ABL). The RACE and REFM Divisions are divided along regional or disciplinary lines into a number of 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.

Retirements of key leadership staff at the Center in 2007 and 2008 led to some familiar faces sitting in new positions. Deputy Science Director Jim Coe retired at the beginning of January and Dr. Bill Karp was selected to fill that position. Karp's promotion vacated the position of FMA Division Director, which has now been filled by Martin Loefflad. Lists or organization charts of groundfish staff of these four Center divisions are included as Appendices II - V.

RACE DIVISION

In 2007 the primary activity of the Resource Assessment and Conservation Engineering (RACE) Division continued to be fishery-independent stock assessment surveys of important groundfish species of the northeast Pacific Ocean and Bering Sea. Regularly scheduled bottom trawl surveys in Alaskan waters include an annual survey of the crab and groundfish resources of the eastern Bering Sea shelf and biennial surveys of the Gulf of Alaska (odd years) and the Aleutian Islands and the upper continental slope of the eastern Bering Sea (even years).

Two major bottom trawl surveys of groundfish resources were conducted during the summer of 2007 by RACE Groundfish Assessment Program (GAP) scientists; the annual eastern Bering Sea shelf survey and the biennial Gulf of Alaska survey. In 2008 GAP scientists will again conduct the annual Bering Sea shelf survey and the Bering Sea upper continental slope survey. Funding shortages necessitated cancellation of the 2008 Aleutian Islands survey.

RACE scientists of the Habitat Research Team (HRT) continue research on essential habitats of groundfish. In FY06, the focus was on evaluating acoustic backscatter and benthic infauna community as predictors of groundfish distribution. Details on the work of the HRT can be found under *D. Other Related Studies.*

The Midwater Assessment and Conservation Engineering (MACE) Program conducted winter echo integration-trawl (EIT) surveys of midwater pollock abundance in the Shumagin-Sanak area in February 2008 and around Chirikof-Shelikof Strait in March 2008. A summer survey of pollock on the eastern Bering Sea shelf was conducted in June and July 2007. MACE staff and other RACE survey personnel continued work on the intervessel calibrations between the *Oscar Dyson* and the *Miller Freeman* with work on this project during the February 2008 survey of the Shumagin-Sanak area. Research cruises investigating bycatch issues continued.

A number of new staff were hired at the RACE Division's Kodiak Fisheries Research Facility. Dr. Robert Foy was selected as the new manager of the Shellfish Assessment Program there. Dan Urban and Dr. Christina Conrath were hired to fill vacancies associated with a mix of research on shellfish and groundfish issues.

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 2007, no foreign vessels were allowed to catch or process fish in the U.S. EEZ off the coast of Alaska. The FMA Division trained and deployed 723 observers to 296 vessels and 22 shore plants in Alaska. These observers spent 35,335 days collecting data in 2007. 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 has created a database of information from Daily Fishing Logs and Daily Catcher Processor Logs for vessels between 60 and 125 ft in length that participated in the flatfish fishery of the Gulf of Alaska during 2005. The logbook data will initially be used to examine observer coverage patterns. The project is limited in scope and is not planned be conducted on a long term basis.

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

AUKE BAY LABORATORY

The Auke Bay Laboratories (ABL), located in Juneau, Alaska, is a division of the NMFS Alaska Fisheries Science Center (AFSC). In 2006, what was formerly called ABL's "Groundfish Assessment Program" changed its name to the "Marine Ecology and Stock Assessment Program" (MESA), a name which more accurately reflects the varied tasks and research of this group. The MESA Program is primarily involved with research and assessment of sablefish and rockfish in Alaska and with the study of fishing effects on the benthic habitat. Presently, the program is staffed by 16 scientists, including 15 permanent employees and 1 term employee. One new staff member was recently added to the program, Cindy Tribuzio, who will work on sharks and stock assessment. Five employees in other ABL programs have also been involved with groundfish-related research in the past year.

In 2007 field and laboratory research, ABL's MESA Program, in cooperation with the AFSC's RACE Division, conducted the annual NMFS sablefish longline survey in Alaska. Other field and laboratory work by ABL included: 1) continued juvenile sablefish studies, including routine tagging of juveniles and electronic archival tagging of a subset of these fish; 2) a genetics study to determine species identification and stock structure of young-of-the-year rockfish from offshore waters of the Gulf of Alaska and eastern Bering Sea; 3) a laboratory study of habitat preferences for young-of-the-year slope rockfish; 4) a study on the effect of maternal age on viability of quillback rockfish larvae; and 5) an investigation of giant grenadier reproductive biology.

Ongoing analytic activities involved management of ABL's sablefish tag database, analysis of sablefish logbook and observer data to determine fishery catch rates, and preparation of seven status of stocks documents for Alaska groundfish: sablefish; Gulf of Alaska Pacific ocean perch, northern rockfish, pelagic shelf rockfish, rougheye rockfish, and shortraker rockfish and "other slope rockfish"; and Bering Sea and Aleutian Islands sharks. Other major analytic activities during the past year were: 1) convening a sablefish workshop at the AFSC in Seattle involving stock assessment scientists from various U.S. and Canadian agencies on the Pacific Coast; and 2) completing a major analysis and report on coral distribution in the Aleutian Islands and possible fishing impacts.

In June 2007, the majority of Auke Bay Laboratory staff, including all but two of the MESA Program, moved to the new laboratory facility at Lena Pt., north of Auke Bay. This facility, named the Ted Stevens Marine Research Institute, was dedicated by Senator Stevens and other dignitaries in a ceremony on August 21, 2007. A small number of ABL employees have remained at the old facility at Auke Bay, which still retains a boat dock and a specimen storage building, although most of the office and laboratory space there will be leased to other government agencies. The name of the Auke Bay Laboratory has been changed to the "Auke Bay Laboratories" to reflect its location at more than one campus.

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

B. Multispecies Studies

1. Research

Bering Sea Crab/Groundfish Bottom Trawl Survey – RACE

The twenty-sixth in the series of annual bottom trawl surveys of the eastern Bering Sea (EBS) continental shelf was completed on 2 August 2007 aboard the AFSC chartered fishing vessels *Arcturus* and *Aldebaran*. Scientific staff from the AFSC, Alaska Department of Fish and Game, and the International Pacific Halibut Commission participated in the survey and completed standardized biological sampling of crab and groundfish resources at 376 stations. Three-hundred fifty-six of these stations have been sampled annually since 1982, and the additional 20 stations in the northwest have been sampled every year since 1987 to investigate the northern distribution and abundance of opilio crabs and commercial fish species in response to the changing climate.

Bottom temperatures on the EBS shelf were on average cooler in 2007 as compared to 2006, and the cold pool (≤2°C) extended farther south and east toward the Alaska Peninsula and into Bristol Bay.

The largest catches of walleye pollock were concentrated along the northwest outer shelf and near the Pribilof Islands where bottom temperatures were above 0°C; large catches of walleye pollock were also observed north of the Alaska Peninsula near Unimak Island. Ninety-five percent of the trawl catches contained walleye pollock and the estimated total biomass increased to 4.16 million metric tons (t) in 2007 from 2.85 million t in 2006. Catches of walleye pollock from the inner and middle shelves were composed mainly of 1-year olds that ranged in size from 10 to 20 cm. Similar to walleye pollock, Pacific cod were broadly distributed across the EBS shelf and caught at nearly all stations. Total biomass declined for the second straight year (0.42 million t); however, numbers of Pacific cod ranging in size from 10 to 20 cm were almost four times greater compared to 2006, which suggests there may be a large incoming year class. For all flatfishes except for yellowfin sole, the annual trend of total biomass declined from 2006 to 2007, but trends were less clear because of the variance associated with these estimates.

In addition to abundance and biomass estimates, analyses of size and age composition will be completed for selected commercial groundfish species using collections of 64,903 length measurements and over 8,000 age structures. There were 22 special research projects conducted during the 2007 trawl survey. For one of these projects, the *Arcturus* collected midwater acoustic data from transects across sampling grid cells where there were high densities of walleye pollock. The AFSC Midwater Assessment and Conservation Engineering (MACE) Program is evaluating the feasibility of using acoustic data from annual EBS trawl survey trawl charter vessels for estimating the midwater component of walleye pollock biomass during years without acoustic surveys. The Groundfish Assessment and Recruitment Processes Programs are also collaborating on the routine collection of bongo plankton samples from the EBS survey charter vessels. Plankton tows were conducted once daily from the *Arcturus* during the first and second legs. The goal is to expand coverage of plankton tows to include both vessels for the entire survey area.

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

Fall 2007 EBS Slope Habitat Studies and Survey Equipment Testing Cruise

The RACE GAP completed a habitat and fisheries research cruise along the Eastern Bering Sea slope region from Bering Canyon to Pervenets Canyon aboard the NOAA Ship *Miller Freeman*. This was a 12 day cruise with multiple objectives that took place in October 2007. Data collected included: 1) ecology of Alaska and Aleutian skate nurseries; 2) age structure and ovary collection of Kamchatka and Bering flounders; 3) rockfish habitat mapping and sampling; 4) study of visual pigments in deepwater fishes; 5) Alaska skate migration patterns; 6) fall plankton sampling of slope region, and 7) assessment of new survey trawl mensuration equipment.

For further information please contact Dr. Jerry Hoff, (206)526-4580.

Gulf of Alaska Biennial Groundfish Bottom Trawl Survey – RACE

The fifth in the series of biennial bottom trawl surveys of Gulf of Alaska (GOA) groundfish resources was conducted from May 25 through August 7, 2007. Prior to establishing a biennial schedule in 1999, groundfish resources in the GOA had been surveyed by the RACE Division triennially between 1984 and 1999. The GOA triennial surveys covered the continental shelf out to 500 m depth, but only included portions of the continental slope in 1984 (to 825 m) and 1987 (to 750 m). The GOA survey has been repeated on a biennial schedule since 1999. The primary focus of the biennial groundfish surveys is to build a standardized time series of data designed to assess, describe, and monitor the distribution, abundance, and biological condition of various GOA groundfish stocks. The biennial surveys were designed to cover the continental shelf and slope between the Islands of the Four Mountains (170°W long.) and Dixon Entrance (U.S.-Canada border in SE Alaska) out to the 1,000 m depth contour. While the 1999 survey succeeded in sampling the entire area, the 2001 survey area was reduced because the Division's survey responsibilities were stretched across three major areas that year under limited funding. Consequently, the 2001 survey area did not include the area east of 147°W long., nor did it extend deeper than 500 m. The 2003 survey covered the entire geographic range, but vessels were only capable of sampling to depths of 700 m. The entire geographic and depth extent of the survey area was covered in 2005 and again this year.

Sampling was conducted aboard three chartered commercial trawlers, the *Gladiator*, the *Sea Storm,* and the *Vesteraalen*, which each worked 75 days between May 25 and August 7. The survey period was divided into four legs of 18-20 days each. Sampling began near the Islands of Four Mountains and progressed eastward on the continental shelf and slope to the U.S.-Canada border in SE Alaska. A total of 825 stations were allocated among 54 depth and geographic strata and were preselected randomly from a grid of potential sites overlaying the survey area. If rugged bottom or heavy commercial fishing prevented sampling a station, a nearby alternate station was selected. Of the 892 attempted standard survey tows, 820 were successfully completed, ranging in depth from 16 to 903 m.

Over the entire survey area, the most abundant species in 2007 were, in order, arrowtooth flounder, Pacific ocean perch (POP), giant grenadier, Pacific halibut, walleye pollock, flathead sole, Pacific cod, and northern rockfish. Abundance has apparently decreased for most of these species since 2005; declines ranged from 10% for POP to 17% for pollock, giant grenadier, and halibut to 24% for cod and 37% for northern rockfish. The arrowtooth flounder abundance held steady since 2005. Of these major species, only flathead sole exhibited an apparent increase in estimated abundance of 31%. Other notable changes were dramatic increases in the apparent abundance of Pacific hake (69%) and spiny dogfish (238%).

Arrowtooth flounder and POP were the two most abundant species in both the Eastern and Central Gulf of Alaska. While arrowtooth were also the most abundant species in the Western GOA, POP fell to third most abundant species in that area, surpassed by giant grenadier. Estimates of abundance, distribution, and size composition from the survey results have been provided to stock assessment analysts for updates to the annual SAFE Report of the NPFMC's GOA Plan Team.

Water temperatures observed during the 2007 survey exhibited a much different pattern than previous GOA surveys, as cooler water infiltrated shallower depths, often with warmer water below. Water temperatures from GOA surveys, adjusted to remove the effect of date of collection on water temperature through the use of a general linear model, are shown in Figure x1, binned by half-degree longitude and depth (depth increments were finer at shallower depths to capture the rapid changes in water temperatures often seen in these depths). The very warm near-surface temperatures that were observed in 2003 and 2005 were largely absent in 2007. In all years prior to 2007, water temperatures at depths greater than 400 m have generally been cooler than 4 degrees C. In 2007, water warmer than 4 degrees C extended to almost 600 m most of the time. The pattern of water temperatures in 2007 more closely resembles the pattern in 1993 than any other year, although the intrusion of colder water into shallower depths is much more pronounced in 2007.

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

Groundfish Systematics Program - RACE

Throughout 2007, James Orr and Duane Stevenson have continued work on the taxonomy and systematics of several families of fishes, most recently skates, snailfishes, rockfishes, sculpins, eelpouts, and manefishes. Orr visited Japan in winter 2007 as a visiting professor with the Kyoto University Museum, where he examined museum specimens in collections around Japan and collaborated with Japanese ichthyologists. Stevenson, with coauthors Orr, Jerry Hoff, and John McEachran, has produced a field guide to the cartilaginous fishes of Alaska published by Alaska Sea Grant. Their skate work has continued with the description of a new species from the western Aleutian Islands within a taxonomic revision of the subgenus *Arctoraja*, a group of four species ranging across the North Pacific Ocean. As well as morphological data, this work will also include the important corroborative genetic results obtained by RACE geneticist and coauthor Ingrid Spies. Orr and Stevenson both participated in the annual meeting of the Charles Henry Gilbert Ichthyological Society in Eatonville, where they presented papers on the identification of chondrichthyan fishes in Alaska and the systematic relationships of pipefish and related families based on ontogeny. Orr's research on snailfishes has expanded with the publications of descriptions of two new species of *Careproctus*, with Katherine Maslenikov of the University of Washington Fish Collection, and the preparation of a manuscript on two new species of *Paraliparis*, with Zach Baldwin, an undergraduate intern from the University of Washington. Orr's work with Sharon Hawkins of Auke Bay Laboratory on the recognition, identification, and nomenclature of *Sebastes melanostictus* and *S. aleutianus* (the blackspotted and rougheye rockfishes) is in press. A study of the phylogenetic relationships of all genera of deep-sea anglerfishes, with senior author Ted Pietsch of the University of Washington, was published. Stevenson's most recent research on eelpouts has focused on completing a systematic revision of the genus *Bothrocara*, a large group of species ranging throughout cold, deep waters of the Pacific Ocean in both the northern and southern hemispheres, in collaboration with M. Eric Anderson, from the South African Institute of Aquatic Biodiversity, and Gento Shinohara, of the National Science Museum, Tokyo. He has also nearly completed an examination of morphological variation in the black eelpout, *Lycodes diapterus*, from across its entire range in the North Pacific, a project with Boris Sheiko of the Institute of the Russian Academy of Sciences, St. Petersburg. His earlier publication of a range extension and morphological review of the manefish, *Caristius macropus*, with Dave Csepp, has led to his beginning a worldwide revision of the family Caristiidae with Chris Kenaley, from the University of Washington, Karsten Hartel, from Harvard University, and Ralf Britz, of the British Museum of Natural History. Stevenson also participated in a midwater survey of the northern Gulf of Alaska. A result of this survey will be the publication of papers with Nate Raring on the distribution and abundance of the midwater fishes encountered, including range extensions and systematic reviews of several species with Raring and Kenaley.

Stevenson, Orr, and Hoff, together with John McEachran (Texas A&M University), published "Field Guide to Sharks, Skates, and Ratfish of Alaska," a new guide to the chondrichthyan fishes of Alaska through Alaska Sea Grant. This 85-page, spiral-bound, water-resistant book contains a detailed identification key, as well as up-to-date distribution and biological information for the nine species of sharks, 15 skates, and one ratfish found in Alaska waters. Color photos, illustrations, distribution maps, and life history details are provided for each species. The book also includes a guide to shark teeth and a key to egg cases. Ketchikan artist Ray Troll produced original cover art that illustrates all the species presented in the book. For examples of pages from the book, see the Alaska Sea Grant website at http://seagrant.uaf.edu/bookstore/pubs/SG-ED-57.html.

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

Recruitment Processes Program *No 2008 updated report by press time.*

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.

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

Fisheries Behavioral Ecology Program - RACE

The Fisheries Behavioral Ecology Program based in Newport, Oregon conducts experimental research designed to understand the role that behavior plays in regulating distribution, abundance growth, and survival of fish species and their interactions with fishing methods and gear. The goal of the Program is to provide the critical information needed to improve survey techniques, to improve predictions of population abundance and survival, and to conserve populations of economically significant marine resource species and their habitats. Research conducted during 2007 continued under long-term research themes related to bycatch stress and basic studies in fish ecology relevant to the performance of fishing gear, definition of essential habitat, and recruitment processes.

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

Age and Growth Program – REFM

The Age and Growth Program of the REFM Division serves as the Alaska Fisheries Science Center's ageing unit for groundfish species. The program currently consists of a biometrician, age validation researcher, IT/data specialist, and 9 age readers. Ages are usually determined from otoliths, but scales, finrays and vertebrae are sometimes used. Ageing protocols and production statistics for the Age and Growth Program at the AFSC can be found on the Age and Growth Program website (www.afsc.noaa.gov/REFM/Age/default.htm).

Data provided by the program are used in stock assessment modeling, which contributes to the estimation of the allowable catch of many commercially important groundfish species. These species include walleye pollock, Pacific cod, sablefish, Pacific ocean perch, northern, rougheye, and dusky rockfishes, Atka mackerel, yellowfin sole, rock sole, rex sole, and misc. sole and rockfish species, and big and longnose skates. Increasingly, the program is ageing non-commercial species, which either are possible candidates for commercial harvest, or may be important in monitoring the broader ecosystem. These species currently include yellow Irish lords, sculpin (great, plain, warty, and bigmouth), giant grenadier, eulachon, and capelin).

Research in the Age and Growth Program in 2008 has focused on the following areas:

1. Craig Kastelle, Delsa Anderl and Dan Kimura are completing a manuscript documenting results on C-14 age validation of Dover sole from the Gulf of Alaska. The bomb carbon method provides strong support of the Dover sole ageing criteria used at the AFSC, although difficult specimens were shown to have significant ageing error. Papers on the application of C-14 to other species will follow.
2. Charles Hutchinson and Delsa Anderl are documenting methods being developed for the ageing of giant grenadier (*Albatrossia pectoralis*). This species is turning out to be difficult to age and it is hoped that we can validate our ageing methods using C-14. Distinct otolith shapes were uncovered, and AFSC staff geneticist, Ingrid Spies, has shown that these otolith shapes do not represent different species.
3. Charles Hutchinson and Betty Goetz have been involved in standardizing the ageing of shortraker rockfish, so that ageing can be done on a production, rather than a research basis. Again, ageing of this species is proving difficult and we hope that C-14 can be used to improve our method of ageing and eventually validate ageing criteria for this species. Partial C-14 results are mixed, and more samples are planned.
4. We are collaborating with Bryan Black (Oregon State University) on the ageing of shortspine thornyheads using dendrochronology. The Age and Growth Program will supply otolith samples from the Gulf of Alaska and conventional ageing assistance from Charles Hutchinson and Betty Goetz. It is hoped that dendrochronology can provide guidance which will help establish ageing criteria for this species.
5. Craig Kastelle is collaborating with NWFSC on the age validation of petrale sole using C-14. Craig's role will be to core approximately 50 petrale sole otoliths. Petrale sole may serve as a C-14 reference chronology for Pacific coast groundfish species.

Ageing of fish from otoliths underwent a kind of revolution during the early 1980s. It was found that older specimens of many species aged from otolith surfaces were being underaged. At the AFSC, we began applying the new break and burn method of ageing otoliths around May 1981. The break and burn method entails taking a transverse cross section by breaking, or usually sawing the otolith in half, and then exposing the transverse surface to an alcohol flame. This process makes finer marks associated with later annual marks more visible than viewing from the otolith surface. At the AFSC, when applying the break and burn method, clear otoliths may still be aged using otolith surfaces. The proportions that are broken and burned vary by species, and can to a large extent be dependent on the year the otoliths were aged. The percentages broken and burned were typically low in the early 1980s, then increases and plateaus in the 1990s. However, the percentage broken and burned for rockfish is typically high in all years. Jon Short has added statistics for this bit of ageing history to the Alaska Fisheries Science Center website under the Age and Growth Program in the category of Statistics and then Ageing Method.

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

Resource Ecology and Ecosystem Modeling - REFM

2008 TSC Report – Multispecies Studies

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

Groundfish Stomach Sample Collection and Analysis - The Resource Ecology and Ecosystem Modeling Task (REEM) continued regular collection of food habits information on key fish predators in the North Pacific. Collection of groundfish stomach samples is primarily through the RACE bottom trawl and echo-integration/trawl surveys. Additional samples that broaden our spatial and seasonal coverage are obtained through the Observer Program and through coordinated studies with other agencies. In 2007, REEM collected samples and data during bottom trawl 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, 7,342 stomachs were collected from the EBS and 4,036 stomachs were collected from the GOA and Aleutian Islands (AI). Laboratory analysis was conducted on 8,867 fish stomachs from the Bering Sea and 1,870 fish stomachs from the GOA and AI. At-sea analysis was conducted on 1,256 fish stomachs from the Bering Sea and 2,027 fish stomachs from the GOA. The REEM predator-prey database was updated with 36,000 records in 2007. Complete database details can be found at http://www.afsc.noaa.gov/REFM/REEM/data/default.htm.

Predator/Prey Interactions and Fish Ecology - Food habits data is a key input into REEM multispecies and ecosystem modeling efforts, which rely on diet composition matrices from these data in order to produce yearly estimates of predation mortality for key species. Patterns in the predator-prey data are examined based on predator species, predator size and spatial distribution, and trends in seasonal and interannual predator-prey interactions are analyzed.

An analysis of spatial patterns of arrowtooth flounder population growth, predation, and dynamic habitat characteristics in the EBS was started in October 2007. Multiple lines of evidence suggest that changes in the EBS climate are leading to distributional shifts and changes in recruitment of fish populations. For example, arrowtooth flounder have quadrupled since the early 1980s in the EBS, in contrast to other groundfish species there. Recently, recommended catches for EBS walleye pollock have been reduced, in part due to concerns about the growing threat of arrowtooth flounder predation of juvenile pollock. Thus, one goal of the study is to improve our understanding of the impact of arrowtooth flounder to commercial fisheries in the EBS. To meet this goal, physical and biological habitat characteristics, specifically dynamic characteristics associated with water temperature and foraging, that are correlated with arrowtooth flounder biomass trends at individual trawl stations sampled in the EBS are being identified and spatial variations in arrowtooth flounder diet and length classes analyzed. Early data exploration has shown that the distribution of arrowtooth flounder is extremely sensitive to bottom temperatures; they are rarely found in waters with bottom temperatures colder than 0º C. Annual changes in arrowtooth flounder distribution are negatively correlated with the extent of the cold pool of bottom water over the EBS shelf, thereby potentially affecting their overlap with prey, such as juvenile pollock. Additional data exploration has indicated that while increasing in overall biomass, arrowtooth flounder have expanded their range to the northwest and that this expansion has been dominated by larger individuals. In addition, consumption of pollock by arrowtooth flounder appears to be greatest in the northwest portion of their range (Fig. 1). This analysis will provide information about the potential for arrowtooth flounder to further increase their distribution and abundance in the EBS and help to predict future responses to climate and fisheries management actions.

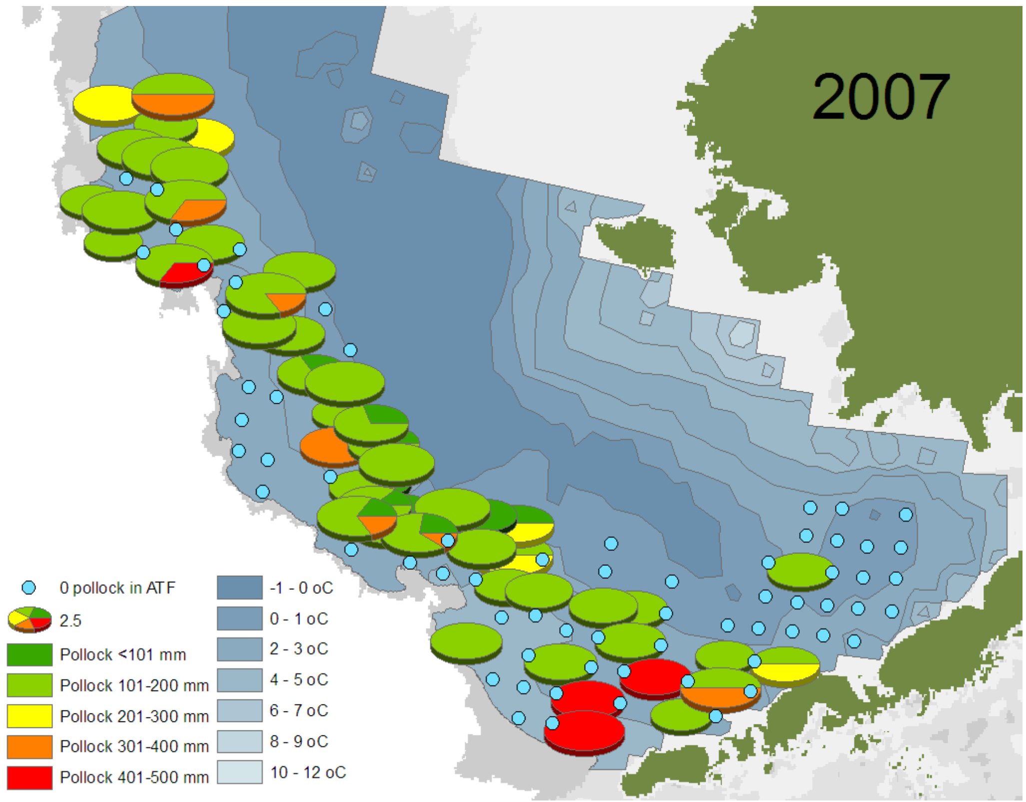


Figure 1. Proportional numbers of walleye pollock found in arrowtooth flounder stomachs at sampled trawl stations in the EBS during summer, 2007. Small blue dots indicate stations where sampled arrowtooth flounder stomachs contained no pollock.

Another study examined the geographic distribution and diet prevalence of polychaete worms (Figure 2) consumed by marine fishes in Alaskan waters. The main fish predators of polychaetes included Alaska plaice, northern rock sole, yellowfin sole, Dover sole, rex sole and flathead sole. Indices of polychaetes abundance (expressed as percentage of total stomach contents weight) by sub-region were estimated to show the relative abundance of polychaetes consumed each year by groundfish in both the EBS and GOA. Polychaetes abundance ranged from 1% of flathead sole stomach contents to 71% of Alaska plaice stomach contents in the EBS. In the GOA, Polychaetes abundance ranged from 1% of flathead sole stomach contents to 57%

of rex sole stomach contents. Estimates of the total amount of polychaetes consumed by groundfish populations during each summer feeding season of each year ranged between 93,111 metric tons (t) in 1999 and 27,705 t in 1990 for the GOA. In the EBS, the estimates ranged between 2,632,022 t in 1994 and 914,382 t in 1985.

Figure 2. Polychaetes (Family Scalibregmidae) extracted from a southern rock sole (*Lepidopsetta bilineata*) stomach.

Life history parameters will be a key component in the development of the next generation of multispecies models. Investigations to provide new and updated information on size-at-age, age-at-maturity, spawning season, fecundity, and natural mortality are being conducted on several important but typically non-target species by various groups at AFSC.

REEM is focusing on improving the life history parameters for several species of large-mouthed sculpins. A total of 784 otoliths from the yellow Irish lord and 682 otoliths from the warty sculpin have been aged. Ageing has begun for the plain sculpin and is on-going for the bigmouth sculpin. Ageing of plain sculpin and great sculpin otoliths will begin in 2008. A number of warty sculpin specimens have been aged through surface reading, but more commonly, the break and burn method has been used on this and other sculpin species. However, thin sectioning was determined to be a more appropriate method for ageing yellow Irish lords than the break and burn method. Quality control has been maintained throughout the ageing process by the Age and Growth Program Group Leader. Although time intensive for new species, the development of ageing criteria and recognition of different patterns has been established for each species with the exception of the plain sculpin. The maximum age for the yellow Irish lord in samples analyzed was estimated to be 28 years from a female collected in the AI and an age of 18 years was estimated for a female warty sculpin collected in the EBS. Natural mortality values were estimated and reported in the 2007 BSAI sculpin stock assessment based on some of this work. Using Hoenig's (1983) regression equation where mortality is a function of maximum age, values ranged from 0.15 for females of the yellow Irish lord to 0.47 in females of a previously aged sculpin of the EBS, *Gymnocanthus pistilliger*.

Approximately 500 ovary samples have been processed from five sculpin species. Histological preparation has been initiated by a laboratory contractor. Analysis is underway on samples received to assess maturity stage. Based on the review of the histology of about 275 samples for the yellow Irish lord collected during the months of June and July, several stages exist (Figure 3). It appears that the spawning period begins in mid-July to early August in both the EBS and AI. The length of the spawning period is still under investigation, as more samples will need to be collected around this time period. Length- and age-at-maturity estimates will be available for the yellow Irish lord after final processing of the 2006 and 2007 survey samples. A greater sample size is needed for other sculpin species to assess maturity. Observations from samples collected during the summer indicate that ovaries are in a resting or spent stage for the *Myoxocephalus* sculpins. These observations were validated through a review of histology. A few great sculpin ovaries (from specimens > 55cm) collected in late January through early March 2007 by observers in the EBS were large and full of eggs indicating a possible winter spawning period. Ovary stages of bigmouth sculpin are still being reviewed. Fecundity will be investigated in 2008 for selected species.

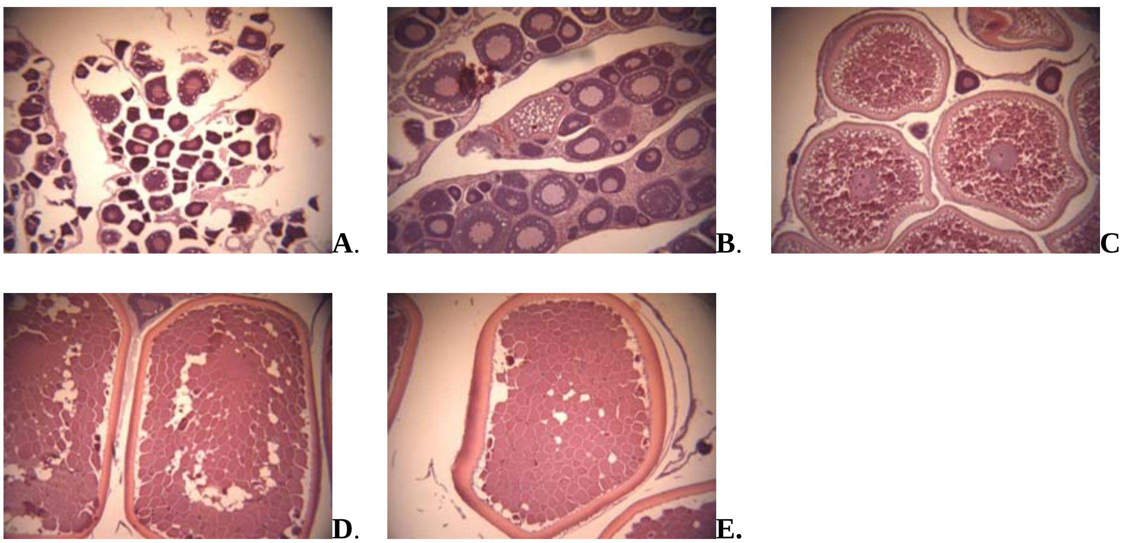


Figure 3. Photomicrographs of yellow Irish lord ovaries histological cross-sections stained with haematoxylin and eosin. A) early perinuclear stage; B) late perinuclear; C) early vitellogenesis oocyte; D) vitellogenesis or advanced yolk oocyte with migratory nucleus; E) vitellogenesis oocyte near hydration, nucleus has disappeared, yolk nearly fused throughout oocyte. Note: Post-ovulatory follicles stage or a "spent" stage absent from initial sample collection.

As part of Essential Fish Habitat research, REEM scientists developed a method for mapping predicted growth rates from stomach contents analysis overlaid with the energetic costs of foraging as determined from bioenergetics models for walleye pollock. These maps are being made for the range of observed conditions (e.g. "cold years" vs. "warm years"). These maps will be created so as to be readily available to other modeling efforts; e.g. for coupling with spatially explicit lower trophic level production models and fish migration models. A substantial literature review was performed gathering data on prey quality (caloric density) from available sources, and a bioenergetics model was implemented for pollock which makes direct use of diet composition and water temperature data in the groundfish food habits database. The initial results of this work are currently being examined and reviewed.

Seabird - Fishery Interaction Research - REEM scientists participated in the ongoing development of the National Bycatch Report by providing information on fisheries, fishery monitoring, and related seabird bycatch for the Alaska Groundfish fisheries. Personnel also coordinated with the Washington Sea Grant Program (WSGP) as they completed their study to characterize the aspects of the Alaskan Groundfish Trawl Fleet that effect seabird interactions, including an effort assessment of trawl warp and third wires. That component was done under contract to the AFSC, and fulfills a requirement under the Short-tailed Albatross Biological Opinion. WSGP will be publishing their report. REEM also participated in a review of the U.S. Fish and Wildlife Service (USFWS) draft Conservation Action Plan for Black-footed and Laysan Albatross. This report should help guide research and management efforts related to the seabirds of conservation concern for many years.

REEM continued to collect point count, or stationary seabird sighting data during groundfish surveys and scientific cruises in the North Pacific. Training was also provided to the Northwest Fisheries Science Center West coast groundfish team to continue collaborative work between the two Science Centers. Seabird sighting protocols call for birds to be noted only when they occur within a specific area. However, we are very interested in all sightings of the endangered short-tailed albatross.

Seabird sighting transects were conducted during the R/V *Oscar Dyson*'s Ice Seal Cruise in the Bering Sea. This work is part of a collaborative program with the USFWS Office of Migratory Birds Management in Anchorage. This was the first time seabird sighting transects had been conducted on the R/V *Oscar Dyson*. Bering Sea pack ice is an important environment for seabirds, and is used extensively by Northern Fulmars, Common and Thick-billed Murres, Least and Crested Auklets, Glaucous Gulls, and other species.

REEM collaborated on Albatross research conducted during 2007. The goals of the research were to sample feathers (for delta-15N analysis as an index of diet) in such a way as to link foraging patterns (inter-annual and intra-annual variation) and diet (specifically a "fisheries-associated" diet indicated by elevated delta-15N values) primarily to reproductive success. Secondary goals were to link foraging and diet to age, breeding status, gender, and relative influence on reproductive success of mate's diet. At long-term demographic plots monitored by the USFWS at Midway Atoll, samples were collected from breeders and pre-breeders (six and seven years old) visiting the colony to practice courting rituals. By taking very small feather samples from different feathers and different locations along primary feathers for stable isotope analysis, the trophic level at which birds feed can be determined for multiple months and for multiple years (up to four years) for each bird sampled. Results from the analyses of stable isotope values in feathers from Laysan Albatrosses nesting on Midway Island in 2007 confirm that the delta-15N values of birds sampled on the colony differ, on average, from values of birds salvaged from longline fisheries in Alaska and Hawaiian waters. This paves the way for interpreting whether a fisheries-derived diet is correlated with reproductive success in Laysan Albatrosses.

This research suggests that the anticipated increase in oceanographic variability in the North Pacific due to global climate change may cause both a decline in the reproductive success of the Laysan albatross, and possibly the Black-footed albatross, and an increase albatross bycatch rates in Alaskan fisheries. The stable isotope analyses and published information on albatross movements indicate the most successful Laysan albatross breeders forage almost exclusively in deep, mid-oceanic waters - especially within the North Pacific Transition Domain, even during the non-breeding season. In contrast, less successful breeders and non-breeders also forage along continental shelves, including those of Alaska. When marine habitats change due to oceanographic variability (e.g., when a distinct oceanographic feature such as the North Pacific Chlorophyll Front becomes more variable, as it did during the El Nino year of 1998), food appears to become less available to Laysan albatrosses (and possibly Black-footed albatrosses), forcing breeders to forage farther from their breeding colonies, perhaps in unfamiliar waters. As travel distances increase, evidence from other albatross species indicates that reproductive success declines. Large-scale shifts in foraging location are important and relevant to concerns about seabird bycatch because the highest seabird bycatch rates for Alaskan waters since 1993 occurred in 1998. Thus, as habitat quality deteriorated in the central North Pacific in 1998, it appears that more Laysan albatrosses may have travelled to Alaskan waters to feed, increasing incidental mortality.

Multispecies and Ecosystem Modeling - Research on spatial food webs of the AI combines historical information on human interactions with the AI ecosystem with ecosystem-level and fine-scale modeling of ecosystem processes in the fisheries management region. It also completes a "three region" comparative picture of the food webs of the Bering Sea, GOA, and AI ecosystems which has been developed by REEM over the last several years. It is now possible to compare and contrast processes between these ecosystems (Fig. 4) as well as allowing the detailed examination of processes occurring within the AI archipelago (Fig. 5). In addition, this research played a central role in developing a Fisheries Ecosystem Plan (FEP) for the AI.

A working draft of the AI FEP was presented to the North Pacific Fishery Management Council by the AI FEP team (http://www.fakr.noaa.gov/npfmc/current_issues/ecosystem/AIEFP307.pdf). The FEP was the result of a multi-agency collaboration, including participants from the AFSC REEM program, the AFSC SSMA program, the NMFS Alaska Regional Office, the NOAA Pacific Marine Environmental Lab, the Alaska Department of Fish and Game, the USFWS, the North Pacific Research Board, and North Pacific Council staff. The draft AI FEP describes the ecosystem in terms of historical, physical, biological, socio-economic, and management relationships, and uses the description of these relationships to identify key interactions in the ecosystem. Examples include the interaction of water temperature with biological processes, the interaction of fisheries with predator prey relationships, and the interaction of international shipping with local ecology. For each interaction, a set of ecosystem indicators was identified to evaluate whether the interaction was changing relative to our current knowledge of the ecosystem. Some ecosystem indicators already exist for the AI, but others identified by the team still need to be developed. The FEP team evaluated the relative probability of each interaction occurring and what type of ecological and economic impacts might arise from each interaction within a qualitative risk assessment framework. The results of this exercise are currently being refined so that interactions identified as both high probability and high risk can be brought to the attention of the Council to provide context for their fishery management decision making process. The team envisions that ecosystem indicators developed for the AI might be incorporated within the Ecosystem Considerations SAFE to be annually reviewed by the Council.

Overall, REEM food habits data and ecosystem model results contributed directly to 18 stock assessments included in the 2007 SAFE documents for the North Pacific Fishery Management Council. Assessments for BSAI arrowtooth flounder, EBS flathead sole, EBS walleye pollock, AI walleye pollock, BSAI cod, and AI Atka mackerel incorporated results from the EBS and AI ecosystem models. Ecosystem model results were also included in the BSAI squid and other species assessments for squids, skates, sculpins, and octopus. Linkages between BSAI arrowtooth and EBS pollock were reviewed again this year, and recent data indicate that arrowtooth are an increasingly important predator of pollock in the EBS (although not at the scale observed in the GOA). Seven stock assessments incorporated information from the GOA ecosystem model: GOA walleye pollock, thornyhead rockfish, and skates have since 2005, and this year the GOA rex sole, flathead sole, Dover sole, and arrowtooth flounder assessments incorporated model results. All seven GOA assessments reported diet composition and total consumption of prey species, and the GOA arrowtooth assessment included annual estimates of prey consumption for GOA survey years between1984 and 2005. In addition, the Alaska sablefish assessment incorporated recent diet data from the GOA, and may incorporate further diet information and possibly ecosystem model results in future assessments.

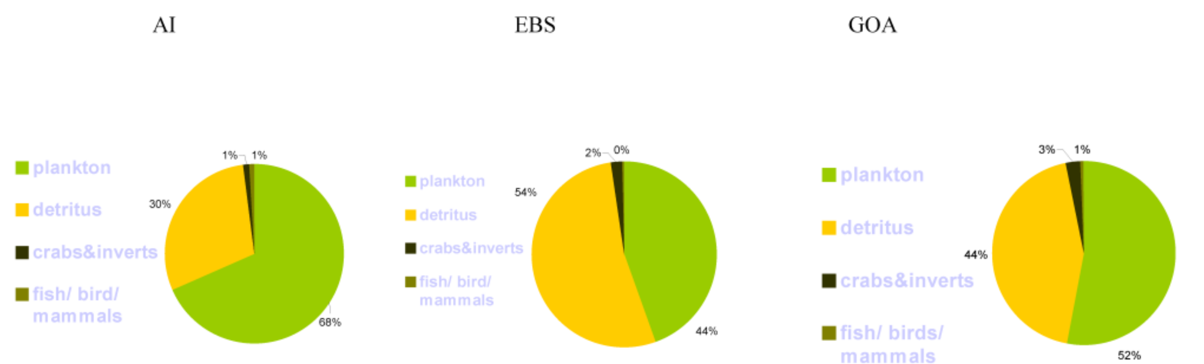


Figure 4. Relative total consumption of major prey types in three Alaskan marine ecosystems. From left to right: Aleutian Islands (AI), eastern Bering Sea (EBS), and Gulf of Alaska (GOA).

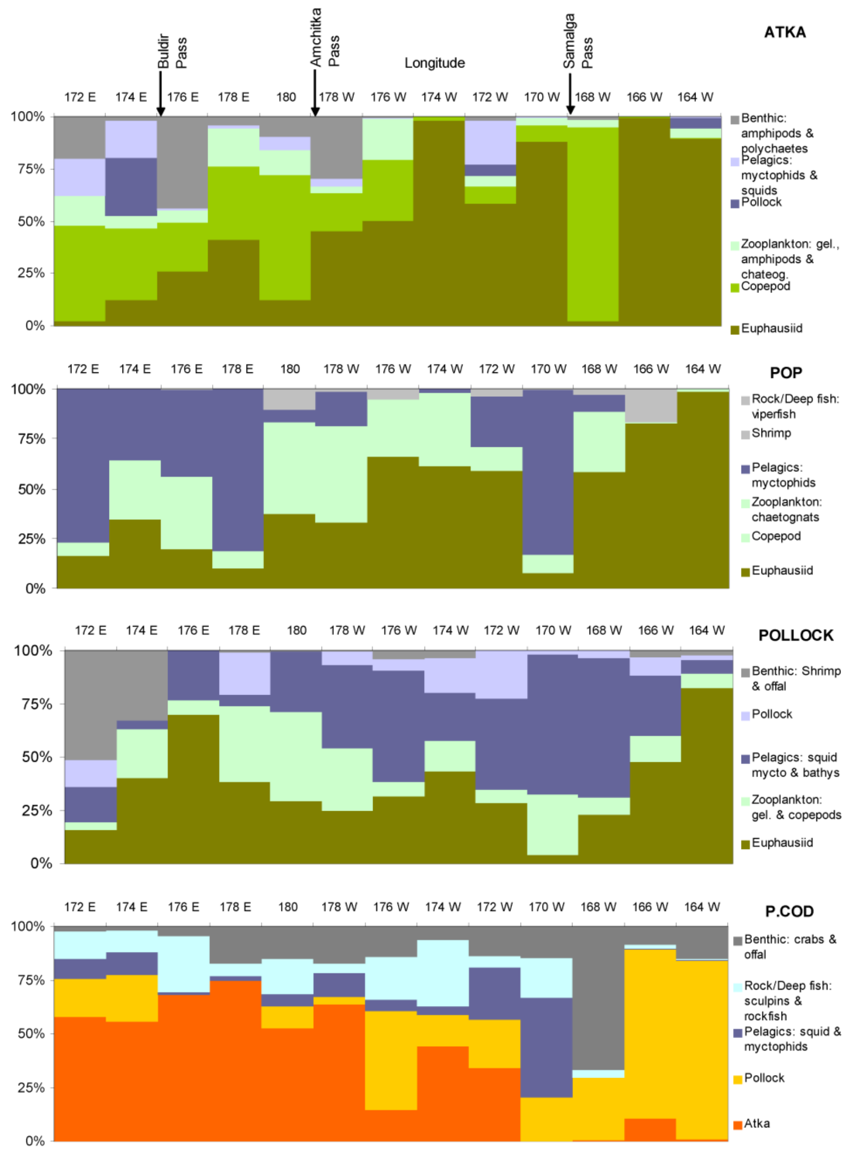


Figure 5. Important prey of four major groundfish species in the Aleutian Islands, shown by 2° longitude blocks across the island chain. Predators from top to bottom: Atka mackerel, Pacific ocean perch, walleye pollock, and Pacific cod.

Ecosystem models provide a structured framework for addressing uncertainty and unintended consequences in fisheries management decision making. The cross disciplinary nature of developing, improving and implementing ecosystem models, linking physical to biological processes over a variety of spatial and temporal scales, requires a great deal of collaborative effort. REEM personnel organized, chaired, and participated in several meetings, symposia and workshops during the year with the goal of improving our Resource Ecology and Ecosystem Modeling research.

Ecosystem Considerations - Major trends in the climate included a relatively cold winter and spring in the Bering Sea, resulting in a large cold pool, with pronounced warming in late spring. The amount of ice and the extent of the cold pool can affect production and distribution of marine organisms. Westerly wind conditions in the AI region suppressed poleward flow of warm Pacific water through the Aleutian passes, thereby contributing to the anomalously cold conditions in the southern Bering Sea from winter into early spring. These winds reversed in the spring, enhancing northward flow, likely contributing to the warming of the southern Bering Sea from spring into summer. During spring, anomalously low sea level pressure was present in the central GOA, which promotes anomalous downwelling in the coastal zone, and a relatively strong Alaska Coastal Current. GOA summer survey temperatures indicate cooling of surface waters and warming of deeper waters, supporting the idea that there was anomalous mixing on the GOA shelf. A major conclusion from the analysis of other indices and information regarding fishing effects on ecosystems and ecosystem trends is that no apparent adverse effects of fishing on the ecosystems have been documented to date. Concerns about high bycatch of salmon in the Bering Sea pollock fishery, however remain, and the Council is addressing these.

Hydrographic structure is a dynamic feature that profoundly affects patterns in distributions, productivity and interactions among species over the EBS continental shelf. The depth-temperature profile during the spring-summer warming season over the EBS shelf represents an integration of mixing and stratifying forces. Depth-temperature profile data have been collected annually over the EBS shelf since 1982 during the EBS Bottom Trawl Survey conducted by the Resource Assessment and Conservation Engineering division. From each depth-temperature profile we are calculating statistics that describe potentially important habitat characteristics of the hydrographic structure. These characteristics are generally related to nominal temperatures, strength of stratification, and layering of the water column, which in turn help define types of water masses, fronts between them, and pelagic habitat. We are investigating possible relationships between species distributions and interactions with respect to these water column characteristics. In addition, these descriptive statistics lend themselves to the creation of annual indices of water conditions integrated over the EBS shelf, with the caveat that survey timing differs somewhat among years.

REEM coordinated the Ecosystem Considerations report, a part of the Stock Assessment and Fishery Evaluation, was updated and finalized during the fall 2007 and presented to the North Pacific Fisheries Management Council. In September 2007, 22 contributions were updated and 6 new contributions were added to the report. In November and December 2007, 28 contributions were updated and 3 new contributions were added to the final report. New contributions include information on marine mammals, the AI, fishing effort, and human demographics. All of this updated and new information can be accessed on the Ecosystem Considerations website: http://access.afsc.noaa.gov/reem/ecoweb/index.cfm.

Many of the physical environmental indices in the Ecosystem Considerations report were updated. For example, the PDO, the leading mode of North Pacific sea surface temperature variability (SST), transitioned from moderately positive in early 2006 to moderately negative in the summer/early fall of 2006 and has slowly increased to weakly positive values during the summer of 2007. When the PDO is positive SST anomalies tend to be positive along the North American coast, extending to the south-EBS. The Bering Sea experienced a relatively cold winter and spring (2007). The presence of sea ice together with below normal ocean temperatures likely resulted in the first ice edge primary production bloom since 1999. Despite the presence of ice in the Bering Sea, there was a record low total area of sea ice in the Arctic in the summer of 2007. Unlike the northern Bering Sea and Arctic Ocean hot spots, the rate of warming in the southern Bering Sea is slowing down, suggesting a large natural variability component to recent extremes in addition to a background anthropogenic contribution toward warmer temperatures.

Some biological indices were also updated in this draft of the Ecosystem Considerations report. For example, demersal groundfish species in the BS/AI and GOA had above-average recruitments from the mid- or late 1970s to the late 1980s, followed by below-average recruitments during most of the 1990s. There is an indication for above-average recruitment from 1994-2000 (with the exception of 1996). In the GOA, recruitment has been below average across stocks since 2001. Annual groundfish surplus production in the EBS and GOA decreased between 1978 and 2005. Declines in production may be a density-dependent response to observed increases in biomass and aging populations of groundfish. The EBS groundfish community appears to have fewer small individuals and more large individuals through time (Figure 6a). The community size spectrum (CSS) slope became less negative and the CSS intercept decreased from 1982-1987, primarily due to significant changes in the slopes and intercepts of non-target fish over time (Figures 6b and 7). This would imply that, overall (and particularly for nontarget fish), the groundfish community has fewer small individuals and more large individuals through time. Factors other than fishing, such as the regime shift in 1976/77, may have had an influence on the community size spectrum.

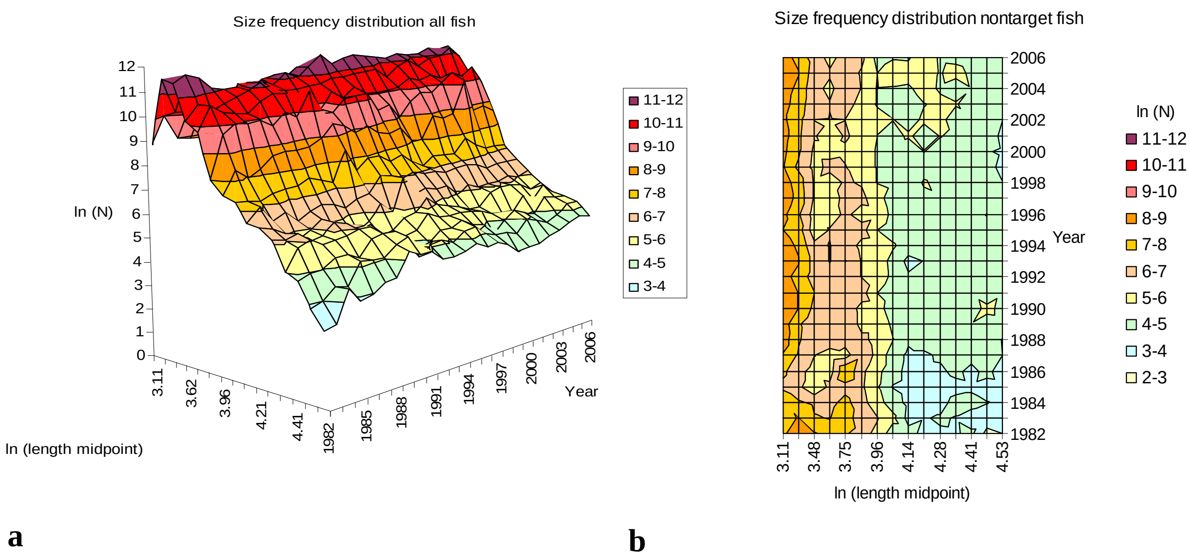
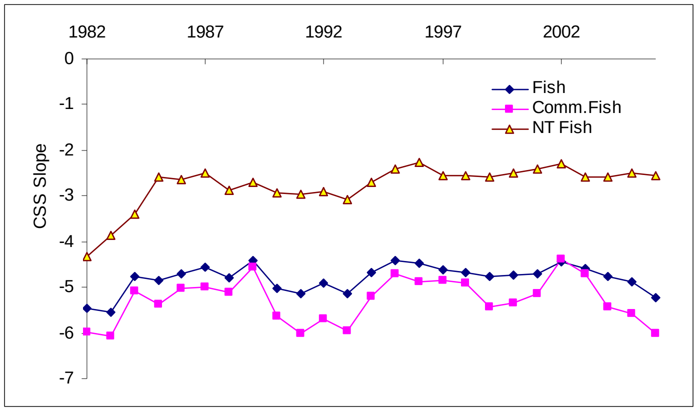


Figure 6. Eastern Bering Sea demersal fish (20-90 cm) community size spectrum (CSS), 1982-2006, for all fish in 3-D (a) and for non-target fish only in 2-D (b).

a



b

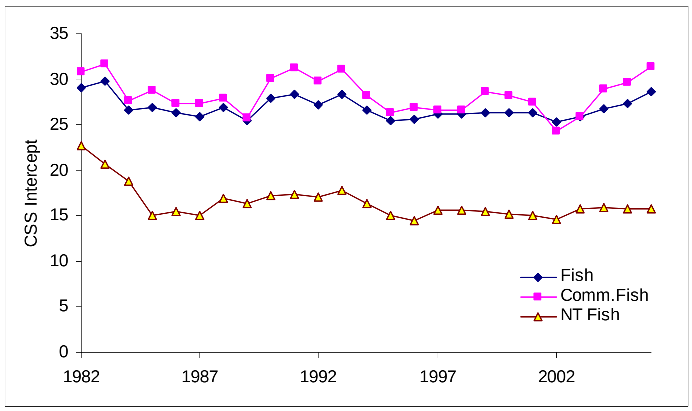


Figure 7. Eastern Bering Sea demersal fish (20-90 cm) community size spectrum (CSS), 1982-2006, changes in slope (a) and intercept (b) of the CSS, 1982 to 2006.

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

2. Stock Assessment

Status of Stocks and Multispecies Assessment Task – REFM

The Status of Stocks and Multispecies Assessment Task is responsible for providing stock assessments and management advice for groundfish in the North Pacific Ocean and the Bering Sea. In addition, Task members conduct research to improve the precision of these assessments, and provide technical support for the evaluation of potential impacts of proposed fishery management measures.

During the past year, stock assessment documents were prepared by the Task for the Gulf of Alaska and Bering Sea/Aleutian Islands Groundfish Plan teams of the North Pacific Fishery Management Council and for the groundfish management team of the Pacific Fishery Management Council.

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

The Fishery Interaction Team (FIT), a part of the Status of Stocks and Multispecies Assessment Task, in the REFM Division, conducts studies to determine whether commercial fishing operations are capable of impacting the foraging success of Steller sea lions either through disturbance of prey schools or through direct competition for a common prey. The present research focus is on the three major groundfish prey of sea lions: walleye pollock, Pacific cod and Atka mackerel.

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

The second way that FIT investigates the potential effects of commercial fishing on sea lion prey is by studying fish distribution, behavior and life history at spatial scales relevant to sea lion foraging (tens of nautical miles). This scale is much smaller than the spatial scales at which groundfish population dynamics are usually studied and at which stocks are assessed. This information is needed to construct a localized, spatially-explicit model of sea lion prey field dynamics that can be used to predict spatial and temporal shifts in the distribution and abundance of sea lion prey and potential effects of fishing on these prey fields.
FIT researchers collaborate with other AFSC scientists who are studying Steller sea lions and their prey, such as scientists in the Resource Ecology and Ecosystem Modeling program and the National Marine Mammal Lab. For more information on the FIT program, contact Dr. Libby Logerwell or access the following web link:
http://www.afsc.noaa.gov/REFM/Stocks/fit/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

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

- **Alaska Recreational Fisheries Demographic Data -** Jennifer Sepez
  For further information, contact Jennifer.Sepez@noaa.gov
- **Amendment 80 Head and Gut Catcher/Processor Sector Economic Data Collection -** Brian Garber-Yonts and Ron Felthoven
  For further information, contact Brian.Garber-Yonts@NOAA.gov or Ron.Felthoven@NOAA.gov
- **BSAI Crab EDR Validation Audit -** Ron Felthoven and Brian Garber-Yonts
  For further information, contact Ron.Felthoven@NOAA.gov or Brian.GarberYonts@NOAA.gov
- **BSAI Crab EDR Data: Protocols for Confidentiality and Data Quality -** Brian Garber-Yonts
  For more information contact Brian.Garber-Yonts@NOAA.gov
- **Collecting Regional Economic Data for Alaska Fisheries -** Hans Geier and Chang Seung
  For further information, contact Chang.Seung@NOAA.gov
- **Common Property, Information, and Cooperation: Commercial Fishing in the Bering Sea -** Alan Haynie, Kurt Schnier, and Rob Hicks
  For further information, contact Alan.Haynie@NOAA.gov
- **Comprehensive Socioeconomic Data Collection for Alaskan Fisheries** - Ron Felthoven
  For further information, contact Ron.Felthoven@NOAA.gov
- **Demand for Halibut Sport Fishing Trips in Alaska -** Dan Lew
  For further information, contact Dan.Lew@NOAA.gov
- **Effects of Rationalization on Processor Competition -** Alan Haynie and Harrison Fell
  For further information, contact Alan.Haynie@NOAA.gov
- **Experimental Design Construction for Stated Preference Choice Experiments -** Dan Lew
  For further information, contact Dan.Lew@NOAA.gov
- **Estimating Global Trade from Pacific Fisheries for Regional Economic Models -** Mike Dalton
  For further information, contact Michael.Dalton@noaa.gov
- **Estimating Heterogeneous Capacity and Capacity Utilization in a Multi-Species Fishery -** Ron Felthoven
  For further information, contact Ron.Felthoven@NOAA.gov
- **Estimating Economic Impacts of Alaska Fisheries Using a CGE Model –** Edward Waters and Chang Seung
  For further information, contact Chang.Seung@NOAA.gov

- **Examining Dynamic Impacts of Alaska Fisheries within Time Series Modeling Framework -** Sung Ahn and Chang Seung
  For further information, contact Chang.Seung@NOAA.gov
- **Fishing Revenue, Productivity and Product Choice in the Alaskan Pollock Fishery** - Ron Felthoven
  For further information, contact Ron.Felthoven@NOAA.gov
- **Gulf of Alaska Halibut IFQ and Small Remote Fishing Communities -** Dan Lew and Jennifer Sepez
  For further information, contact Jennifer.Sepez@NOAA.gov
- **Integrating Bering Sea and Gulf of Alaska Climate Data for Socioeconomic Research -** Mike Dalton and Alan Haynie
  For further information, contact Michael.Dalton@noaa.gov or Alan.Haynie@noaa.gov
- **Integrating Trip and Haul-Level Fishing Data -** Alan Haynie
  For further information, contact Alan.Haynie@noaa.gov
- **Interactive Metadata Project -** Ron Felthoven and Terry Hiatt
  For further information, contact Ron.Felthoven@NOAA.gov or Terry.Hiatt@NOAA.gov
- **Modeling Spatial Location Choice with a Generalized Nested Logit Model -** Alan Haynie and David Layton
  For further information, contact Alan.Haynie@NOAA.gov
- **Nonconsumptive Value of Steller Sea Lion Protection** - Dan Lew
  For further information, contact Dan.Lew@NOAA.gov
- **North Pacific and West Coast Fisheries Community Profiles -** Jennifer Sepez
  For further information, contact Jennifer.Sepez@NOAA.gov
- **Post-Rationalization Restructuring of Alaska Crab Fishery Crew Opportunities -** Jennifer Sepez
  For more information, contact Jennifer.Sepez@noaa.gov
- **Promoting Key Economic and Social Scientific Concepts to Fisheries Managers -** Alan Haynie
  For further information, contact Alan.Haynie@NOAA.gov
- **Predicting Fishing with Vessel Monitoring System (VMS) Data -** Alan Haynie and Patrick J. Sullivan
  For further information, contact Alan.Haynie@NOAA.gov
- **Protected Marine Species Economic Valuation Survey -** Dan Lew
  For further information, contact Dan.Lew@NOAA.gov

More details on these projects have been compiled in a separate report from the Economic and Social Sciences Research Program entitled: *Research and Data Collection Project Summaries and Updates, 2007*.

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

C. By species, by agency

1. Pacific Cod

a. Research

Larval recruitment – RACE FBE Newport - In 2006, the Fisheries Behavioral Ecology Program (FBEP) began a multi-year research program with support from the North Pacific Research Board to develop spatially-explicit models of growth potential for Pacific cod larvae and juveniles in the Bering Sea with respect to climate change. Laboratory experiments demonstrated that matches and mismatches in prey were important to growth and survival, but these effects were mediated by temperature and specific periods in larval development. Data from these experiments are being incorporated into models using field data on larval and juvenile distributions, temperature and primary productivity (SeaWiFS/MODIS Aqua data) to examine population-level consequences of changing environmental conditions in the North Pacific. This project component is being conducted in a collaborative effort between AFSC's Fisheries Behavioral Ecology Program and Oregon State University oceanographers, and is anticipated to be finished in fall of 2008.

Success from experimental studies in 2006 and 2007 prompted FBEP researchers to extend their research into examining the effects of prey quality on Pacific cod larval growth and survival. The importance of prey quality on larval fish survival has largely been ignored in fisheries, but it is anticipated to be an emerging issue in the wake of prey assemblage changes resulting from climate change and ocean acidification. Collaborations between researchers at Memorial University of Newfoundland, Oregon State University and AquaNutrition are now established to produce diets of carrying lipid/fatty acid composition and determine how such diets are incorporated into the tissues of Pacific cod larvae. The first of a series of prey quality experiments were initiated in March 2008.

Juvenile habitat – RACE FBE Newport - Studies of habitat associations in juvenile Pacific cod were continued in 2007 using a combination of seines and baited cameras across 24 sites in Kodiak. In 2006, age-0 fish were abundant in nearshore macrophytes (*Laminaria* and *Zostera*) particularly during the earliest post-settlement stages, and then expanded into open habitats at greater depths with size during the first summer. Laboratory experiments showed that preferences for structurally complex habitats are strongest when potential predators are present. In 2007, researchers examined the diel and seasonal components of habitat by age-0 and age-1 Pacific cod and, using additional funding by HEPR, these same sites will be continually monitored to 2010. The annual survey will provide an annual recruitment index which can then be compared with local catch indices to determine the degree of local connectivity among juvenile and adult Pacific cod populations around Kodiak.

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

b. Stock Assessment

BERING SEA/ALEUTIANS
The present assessment is a revision of last year's assessment, incorporating an analysis of a combination of model runs with different configurations. The 2007 EBS shelf bottom trawl survey resulted in a biomass estimate of 424,000 t, down 18% from the 2006 estimate (518,000) and the lowest observed for the 25 year time series. There was, however, the presence of a presumed strong 2006 year class as many 1 year old fish were captured in the survey. The 2006 Aleutian Islands estimate of 92,500 t was 19% lower than the 2004 estimate.

The assessment authors took into consideration the results of a public work shop and preliminary SAFE Report in developing 4 versions of the analytical model for the 2007 assessment. The following points may be made to distinguish these 4 models: Model 1 was developed to respond to requests of the SSC where, among all the other model parameters, the natural mortality (M) is to be based on external analyses of life history parameters which resulted in $M = 0.34$; Model 2 is the same as Model 1 except that M is fixed at 0.37 (that was used in previous year's assessments); Model 3 is the same as Model 1 except that M is estimated internally; and Model 4 which differs from Model 1 in several respects to respond to public comments on the use and fitting of the data.

The assessment document indicated nine major categories of new input data from applications of updated data from the fisheries and surveys. The following new pieces of data stand out: 1) a new biomass for Pacific cod was estimated at 424,000 t from the 2007 EBS shelf bottom trawl survey (this biomass is 18% lower than the 2006 survey estimate and is the all-time low in the time series), and 2) the numbers of fish for 2007 was estimated by the survey at 713 million fish, up about 86% from the 2006 estimate. This dramatic increase in numbers of fish is due primarily to higher recruitment of the 2006 year class as age 1 fish in the survey. The addition of this new data point to the series of survey population numbers from 1979-2006 has a material impact on the projection of Pacific cod population numbers and biomass into the future.

The main features and challenges of the Pacific cod assessment, however, are still the fitting of the data to the four assessment models. Because all of the models seem to perform reasonably well in terms of fitting the data, the authors used the following three major criteria for selection of the best model to represent the dynamics of the stock. These criteria are: The model should use a reasonable value of M: The model should estimate mean trawl survey lengths for ages 1-3 that are close to the first 3 modes from the long-term average trawl survey size composition. The model should estimate a reasonable average for the product of trawl survey catchability and trawl survey selectivity for the 60-81 cm size range.

Based on these criteria, Model 1 was selected by the authors to best represent the population dynamics of the BSAI Pacific cod stock. The Plan Team agreed with this selection and added the following comments: All selectivity curves estimated by the 4 models appear reasonable, except for the IPHC longline survey selectivity curve.

Increasing the number of parameters from 4 to 6 still did not overcome the stated problems with estimating selectivity. Model 4 ignores age data. It makes little sense to discard data that provides information on relative cohort strength, even if the fit is "not very good". Relying on length data alone is not as informative as incorporating age data because there is not a one-to-one relationship between length and age, except for the youngest ages.

Models 1, 2, 3 and 4 have biomass and recruitment trends that are similar. These models differ primarily in values of M (except that Model 4 has other structural differences). The implication of the model results is that the data are sufficient to estimate trends, but the biomass scalar is sensitive to values of M. The best estimate of M is 0.34. It is based on a derivation from standard functional relationships for the life history of Pacific cod reported by Jensen (1996). This value compares favorably with data and parameter estimates from other reports (e.g., Beverton and Holt (1963)).

For model selection, Model 3 actually fits the data best, but the model was not selected because its M value (0.22) was too low. Model 2 (M=0.37) was not selected because it did not meet criterion 3. Model 4 was not selected because M=0.46 was judged to be too high. The 2008 ABC of 150,000 t, resulting from model 1, is a decline from 176,000 t in 2007. This ABC drop is consistent with the 18% decline in the NMFS survey biomass from 2006 to 2007, which currently is at its historic minimum. Five consecutive year classes of the EBS Pacific cod stock from 2001-2005 (that ranged from 204-399 million age zero fish) are noticeably below the 30-year average year class strength (658 million age zero fish from 1977-2006). However, the 2006 year class appears to be more than 2 ½ times higher than the average recruitment. The female spawning biomass for 2008 and 2009 are projected to be at about 29% of the unfished female spawning biomass; at least until the strong 2006 year class can contribute substantially to spawning from 2010.

The spawning biomass is projected to continue a slow decline from 2007 to 2009 before the strong 2006 year class would boost the female spawning biomass from 398,000 t during the 2008-09 period to 454,000 t in 2010 and 542,000 t in 2011. This projected increase in biomass and upward trend of stock status are predicated on the continued strength and contributions of the 2006 year class. This 2006 year class indicator is still an early indicator and it must be tracked carefully as the year class follows through the population in time.

According to criteria set by the SSC, this stock qualifies for management under Tier 3, where reliable estimates of B40%, F40%, and F35% exist for the stock. The updated point estimates of B40%, F40%, and F35% from the present assessment are 540,000 t, 0.31 and 0.37, respectively. Pacific cod specifically qualifies for management under sub-tier "b" of Tier 3 because the projected biomass for 2008 (398,000 t) is below B40%. The Council set the 2008 ABC at 176,000 t for 2008 and the OFL (under Tier 3b) at 207,000 t. The stock is not overfished nor approaching an overfishing condition.

GULF OF ALASKA

A single model was presented this year. There were several changes in the input data: Catch data for 2006 were updated, and preliminary catch data for 2007 were incorporated. Size composition data from the 2006 commercial fisheries were updated, and preliminary size composition data from the 2007 commercial fisheries were incorporated. Relative abundance in numbers from the GOA bottom trawl surveys from 1984-2007 was incorporated. In the past, relative abundance in biomass was used in the model. Age composition data from the 1996, 1999, and 2001 GOA bottom trawl survey were incorporated. Now five years of age data, including 2003 and 2005.

The model was implemented in new software, Stock Synthesis 2.0c. There were many changes in model assumptions, which are detailed in the BSAI cod assessment under Model 1. The model used in the GOA was similar, except that *M* was fixed at 0.38 (based on age at maturity; former GOA value was 0.37), *Q* was fixed at 0.98 (based on archival tag data, former GOA value was 1.00), trawl survey selectivity is length-based and constrained to be asymptotic (same as previous years for GOA), fishery selectivities are unconstrained (same as previous years for GOA), mean length-at-age data are included (same as previous years for GOA), fishery selectivities applied to the entire time series, rather than in "eras" as in previous assessments, survey selectivity now has time varying selectivity for ascending limb parameters, fisheries defined for each of three gears for each of three seasons (for a total of 9 fisheries instead of the previous 4), and the model starts in 1977 (rather than 1976).

The numeric abundance estimate from the 2007 survey was up 37% from the 2005 estimate. However, the biomass estimate from the 2007 survey was 233,310 t, down 24% from the 2005 estimate. The reason for the difference in trend between the two measures of abundance was the occurrence of large numbers of very small fish in the 2007 survey. Hence, the model is estimating above average recruitment for the 2006 year class, but this estimate is uncertain as it has been observed only from the survey. Based on the model, the projected 2008 female spawning biomass for the GOA stock is 108,000 mt, down about 15% from last year's estimate for 2007 and below the *B40%* value of 121,000 mt. The projected 2008 age 3+ biomass is 295,000 t, down about 21% from last year's projection for 2007. Compared to the 2006 assessment, this model predicted higher historic biomass levels and lower current biomass levels.

ABC setting for 2008 focused on the uncertainty in the stock's status relative to $B_{40\%}$, A Tier 5 calculation was used based on 2007 survey biomass of 233,310 t and the updated *M* of 0.38 (which was estimated outside the model based on published estimated age at maturity for GOA Pacific cod). Therefore, F_{ABC} is equal to 75% of *M*, or 0.38 * 0.75 = 0.285, and F_{OFL} is equal to *M* (0.38). The resulting ABC for 2008 and 2009 is 66,493 t, and the OFL for 2008 and 2009 is 88,658, rounded to 88,660 t. Based on the recommended specifications and catch in recent years, catch is unlikely to exceed OFL so the stock is not subject to overfishing. It is not possible to determine the status of Tier 5 stocks with respect to overfished conditions. The Team concurred with the author's recommendation to apportion the 2008 and 2009 ABC according to the average of biomass distribution in the three most recent surveys. For the Team's recommended ABC level, this gives: Western GOA 25,952 t, Central GOA 37,901 t and Eastern GOA 2,660 t.

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

3. Shelf Rockfish

a. Research

GULF OF ALASKA

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 black rockfish larvae (*Sebastes melanops*) based on samples collected off Oregon. 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.

Our objectives are to collect quillback rockfish (*Sebastes maliger*) with hook-and-line in Southeast Alaska and measure their oil globules from photographs of developing larvae. Because black rockfish larval survival in Oregon was linked to oil globule size and maternal age, we wanted to examine the relationship between maternal size and age with other rockfish species in Alaska. Quillback were chosen because they are abundant and easy to capture inshore in Southeast Alaska. Because quillback live in relatively deep water, they are an ideal prototype for developing our methodologies for similar studies of slope rockfish species that live offshore in Alaska.

Since 2006, we have collected pregnant quillback rockfish with hook-and-line from April-June. Photographs of the fresh larvae were taken in the field for measurements of oil globules. Otoliths were collected and are being aged at the AFSC REFM Division age and growth lab in Seattle. The 2006 samples were analyzed for their protein, lipid, and water content as well as their fatty acid concentrations. Because larvae from different females are at various stages of development, the developmental stage will be a covariate in future analyses. More samples are needed to determine the relationship between developmental stage and oil globule size. To try to bypass this obstacle, we plan to transport live mothers to the laboratory this spring and attempt to raise the embryos to late stages of development so that measurements can be made from all larvae at the same developmental stage. In case this is not successful, photographs of the larvae will also be taken at sea. This year, a draft manuscript using the 2006 samples was written on the changes in body composition and fatty acid profile during quillback rockfish embryogenesis.

Secondarily, we will be collecting embryos and parental muscle tissue samples from the same specimen to examine multiple paternity in quillback rockfish. Multiple paternity may be a way of maximizing diversity to attempt a better chance of at least a portion of a female's offspring surviving in a variety of environmental conditions. Some laboratory studies have found multiple paternity in a brood of rockfish larvae from one female, indicating that females can spawn and store sperm from multiple males. We have the opportunity to examine multiple paternity rates in the field in quillback rockfish. Because the females will be aged as part of the maternal age effects projects, we will also be able to correlate female age with multiple paternity practices.

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

b. Stock Assessment

GULF OF ALASKA

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

In March 2007, the North Pacific Fishery Management Council took final action to remove dark rockfish from both the GOA FMP (PSR Complex) and BSAI FMP (other rockfish complex). Removing the species from the Federal FMP serves to turn full management authority of the stock over to the State of Alaska in both regions. At this time, the rules to implement these FMP amendments have not yet been finalized, and it is unlikely the effective implementation date will occur before January 2009. Therefore, it would not be until 2009 that dark rockfish would be removed from Federal management (including the associated contribution to OFLs and ABCs under the respective complexes in both regions) and full management authority would be turned over to the State.

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 2007, 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 dark, widow, and yellowtail rockfish. For dusky rockfish, the age-structured model used is the same as last year's author-recommended 2005 model with updated fishery and survey data.

For the pelagic shelf rockfish assemblage, ABC and OFL for dusky rockfish are combined with the ABC and OFL for dark, widow, and yellowtail rockfish. For the 2008 GOA fishery, we recommend a maximum allowable ABC for the pelagic shelf rockfish of

5,227 mt. This ABC is similar but slightly lower than last year's ABC of 5,542 mt. The stock is not overfished, nor is it approaching overfishing status.

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

4. Slope Rockfish

a. Research

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

Species Identification of Young-of-the-Year Rockfish and Population Genetic Structure of Pacific Ocean Perch Collected in Offshore Waters of the Gulf of Alaska and Bering Sea - Young-of-the-year (YOY) *Sebastes* rockfish were collected as "bycatch" during Auke Bay Laboratories (ABL) Ocean Carrying Capacity surveys of juvenile salmon in the Gulf of Alaska (GOA) in 1998, 2000–2003, and in the Bering Sea in 2002. The YOY rockfish were caught in rope trawls towed near the surface in offshore waters of both regions. Species identification of more than 2,000 specimens using mitochondrial DNA (mtDNA) analysis by ABL scientists in cooperation with Dr. Gharrett of the University of Alaska Fairbanks (UAF) and a subset of several hundred specimens using morphological analysis by Dr. Arthur Kendall (retired from AFSC's RACE Division) revealed that the majority of the rockfish are Pacific ocean perch (*S. alutus*; POP). Twelve other species were also identified: black, darkblotched, dusky, northern, redstripe, rougheye, sharpchin, shortraker, widow, yelloweye, yellowmouth, and yellowtail rockfish. With funding from the North Pacific Research Board, Dr. Gharrett and graduate student Lisa Kamin are completing examination of the population structure of the POP using a suite of microsatellite DNA markers to determine the extent of genetic divergence between year-classes and between geographic locations. Preliminary results indicate significant geographic variation, limited inter-annual variation, and limited lifetime movement.

Two papers focusing on species description at this life history stage using genetic variation and morphological features have been published. We anticipate a third report that will compare the geographic distribution of species in these collections around the Gulf of Alaska within and between years.

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

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Live Capture of Young-of-the-Year Slope Rockfish - As young-of-the-year, slope rockfish can be found in the upper water column over abyssal depths. Eventually, they adapt to a demersal life and are associated with the benthos. The relationship between juvenile slope rockfish and benthic habitat is poorly understood due to the depths at which the fish reside, which is usually greater than 150-200 m. In 2007, scientists from Auke Bay Laboratories Marine Salmon Interactions (MSI) Program and the Marine Ecology and Stock Assessment (MESA) Program took part in research activities aimed at capturing live young-of-the-year slope rockfish. The ultimate objective of the project is to identify habitat utilization of juvenile slope rockfish amongst various benthic habitat types such as sponge and coral.

In September, 33 surface trawls were performed onboard the Alaska Department of Fish and Game's vessel *Medeia*. Trawling took place up to 60 nautical miles offshore of Southeast Alaska between Icy Point and Cape Ommaney. The trawl was equipped with an aluminum aquarium codend (livebox) that directed fish and invertebrates into a calm water-filled holding chamber. Once on deck, live specimens were transferred from the aquarium codend to holding tanks with running seawater. At the conclusion of the cruise, live rockfish were transferred to the ABL Little Port Walter Marine Station and placed in the station's behavior laboratory. Of the 230 rockfish captured, about 95% survived the trawling process including fish as small as 14 mm.

An estimated eight or nine different species of rockfish were captured, although genetic analyses will confirm species identifications. The aquarium codend caught other live species as well, including juvenile and adult salmon, Pacific saury, larval rex and Dover sole, and Pacific herring. Many unidentified small squid were also captured live. The greatest biomass in the catch was attributed to jellyfish, primarily A*equorea* sp.

Once acclimated to conditions in the behavior lab, the rockfish were observed in four distinct habitat types (coral, sponge, cobble, and gravel) under both daytime and nighttime conditions. This study will build on previous work that focused on quillback rockfish, a demersal shelf rockfish. These assessments will be helpful in determining the relative productivity of various habitats and will aid in establishing priorities for their protection.

For more information, contact Pat Malecha at (907) 789-6000.

Rockfish Distribution Analyses Applied to Survey Design - RACE Groundfish scientists undertook an analysis of rockfish distributions in trawl surveys in Alaska with application to fishery independent survey design and station allocation. Dr. Chris Rooper presented this research at the Annual Science Conferences of ICES in Helsinki, Finland in September. The ongoing studies are intended to determine alternative sampling methods for estimating rockfish biomass. Rockfish species are notoriously difficult to assess using standard bottom trawl surveys due to the propensity of many species to occur in rocky high relief areas. In the first part of the analysis, assemblages of rockfish species were defined based on similarities in their distributions along environmental gradients using bottom trawl survey data. Then, data collected on a 2004 underwater video study were analyzed and densities of the species in the Aleutian Islands shelf-break assemblage (northern rockfish, dusky rockfish and juvenile Pacific ocean perch) were measured at nine transects. Based on the variance of these density estimates the sample size needed to conduct a Gulf of Alaska wide video survey of untrawlable areas was calculated. The authors predicted that a sample size of 774 video transects would be adequate to survey the Aleutian Shelf-break assemblage over hard bottom areas in the GOA.

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

Research on Untrawlable Portions of Bottom Trawl Survey Areas Conducted in Gulf of Alaska - Biennial bottom trawl surveys conducted in the Gulf of Alaska by the National Marine Fisheries Service (NMFS) are a primary data source for estimation of commercial groundfish abundance. These surveys follow a stratified-random sampling design. A persistent problem in the accurate estimation of groundfish biomass using trawl surveys is the unknown (but presumed large) amount of the continental shelf that is not fishable with standard survey gear. Current bottom trawl surveys in the Gulf of Alaska include substantial areas that cannot be sampled with standard survey trawls due to characteristics of the seafloor. Many of these areas have been identified while searching for trawlable bottom during the standard trawl surveys, but these efforts suffer from two problems. First, since survey stations are defined by a 25 km^2 grid superimposed on the survey strata, the data collected to date do not allow sufficient granularity to examine trawlability on a fine scale. Another problem has been the subjective nature of the designation process for untrawlable bottom. Different observers, with varying levels of experience in overall bottom trawling and use of the survey net and using different acoustic systems, make subjective decisions as to whether or not there is a reasonable probability of completing a successful observation at a particular station. Inevitably, this leads to inter-vessel and inter-annual differences in the results of this process. To address this problem, a more objective and fine-scale method of evaluating the trawlability of the bottom with respect to the standard survey net would be very desirable.

The main impetus for the April 2007 cruise aboard the NOAA ship *Oscar Dyson* was to evaluate the utility of acoustic and ancillary data in the development of a more objective method of determining bottom trawlability. The scientific objectives of the cruise included estimating the critical angle differentiating trawlable and untrawlable bottom; evaluating the ability of split-beam echosounders to detect slopes in both alongship and athwartship directions and to detect substrate hardness/roughness; investigating the effect of water depth on perception of slope; examining how the interplay between hardness and roughness affects trawlability; evaluating the importance of heave, pitch, and roll data on acoustic data quality in the estimation of trawlability; and evaluating how the use of multiple frequencies improves the estimation of trawlability

All operations were conducted during 11-23 April aboard the R/V *Oscar Dyson*. Acoustic data were collected continuously along a series of transects with a Simrad ER60 echo integration system incorporating five centerboard-mounted transducers (18 kHz, 38 kHz, 70 kHz, 120 kHz, and 200 kHz). A drop camera system with strobe lighting was used for video validation of acoustic data.

Nearly the entire cruise time was spent conducting over 3,000 km of acoustic transects over areas of interest. All of the planned transects in Kasaan and Glacier Bay were completed. The remaining time was spent conducting acoustic transects over historical tow and search paths in offshore waters, while slowly transiting towards Kodiak. All together, over 50 GB of acoustic data were collected for analysis. It is expected that this data collected will provide a rich source of information to meet the scientific objectives of the project. Data analysis will take place in the upcoming months. Vessel motion data were successfully collected throughout the cruise as well. A total of 13 CTD casts were made. The camera work was very successful on the first deployment and outstanding video images were acquired of the seafloor, but the camera system subsequently failed and could not be repaired in the field.

Research on this issue continues during 2008 with a short cruise scheduled aboard the NOAA ship Miller Freeman July 1-9 in the Gulf of Alaska between Dutch Harbor and the Shumagin Islands. Further research on the acoustic techniques is the main focus, associated with drop video camera work to collect ground-truthing information on the substrate.

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

b. Stock Assessment

BERING SEA AND ALEUTIAN ISLANDS

Pacific ocean perch (POP) – Pacific ocean perch assessments are conducted on a two year cycle to coincide with the Aleutian Islands survey cycles. Since the survey was not conducted in 2007, a full stock assessment was not performed. Instead, catch data were updated and the projection model was re-run using results from the 2006 assessment model as the starting point.

Projection results indicate that the estimated spawning biomass is projected to decline slightly from 155,000 t in 2007 to 153,000 t in 2008 and further to 150,000 t in 2009. 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 132,500 t, 0.059, and 0.070 respectively. There are reliable estimates of the 2007 spawning biomass (B), $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ and B>$B_{40\%}$ (153,000 t > 133,000 t). Therefore the POP reference fishing mortality is defined in Tier 3a. For this tier, F_{ABC} is constrained to be $\leq F_{40\%}$, and F_{OFL} is constrained to be equal to $F_{35\%}$. The ABC associated with the $F_{40\%}$ level of 0.059 is 21,700 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition. For 2008, the recommended ABC is 21,700 t, and the OFL is 25,700 t.

The details of the full assessment completed in 2006 can be found in last year's report.

Northern rockfish - Northern rockfish assessments are conducted on a two year cycle to coincide with the Aleutian Islands survey cycles. Instead, catch data were updated and the projection model was re-run using results from the 2006 assessment model as the starting point.

Projected age 3+ biomass increased from 204,000 t in 2006 to 212,000 t in 2007 estimates (a 4% increase). The SSC has determined that this stock qualifies for management under Tier 3 due to the availability of reliable estimates for $B_{40\%}$ (52,000 t), F40% (0.045), and F35% (0.053). Because the female spawning biomass of 73,500 t is greater than B40%, sub-tier "a" would be applicable, with FABC $=F_{40\%}$ and $F_{OFL} = F_{35\%}$. Under Tier 3a, the maximum permissible ABC is 8,180 t, which is the authors' and Plan Team's recommendation for the 2008 ABC. Under Tier 3a, the 2008 OFL is 9,740 t for the Bering Sea/Aleutian Islands combined. The Plan Team continues to recommend setting a combined BSAI OFL and ABC. As the TAC has routinely been lower than the ABC, the TAC of the previous year was assumed as the 2008 catch, in order to make projections to 2009. Model projections indicate that this stock is neither overfished nor approaching an overfished condition. The details of the full assessment completed in 2006 can be found in last year's report.

Shortraker/rougheye rockfish - Since an Aleutian Islands survey was not conducted in 2007, a full update of the stock assessment was not performed this year. Instead, an interim assessment was produced by updating the catch data and re-running the projection model using the results from the 2006 assessment model as a starting point. The projected estimate of 2007 shortraker biomass is 18,900 t, down 8% from 2006. The estimate of 2007 rougheye biomass is 10,800 t, down 4% from 2006.

The SSC has previously determined that reliable estimates of biomass and natural mortality exist for shortraker and rougheye rockfish, qualifying the species for management under Tier 5. The F_{ABC} was set at the maximum permissible level under Tier 5, which is 75% of M. Accepted values for M for these stocks are 0.025 for rougheye rockfish and 0.030 for shortraker rockfish, resulting in F_{ABC} values of 0.019 and 0.023 for rougheye and shortraker, respectively.

The biomass estimates for 2007 are 18,900 t for shortraker rockfish and 10,800 t for rougheye rockfish, leading to BSAI OFLs of 564 t for shortraker and 269 t for rougheye, and ABCs of 424 t for shortraker and 202 t for rougheye. It is not possible to determine whether these species are overfished or whether they are approaching an overfished condition because they are managed under Tier 5. The details of the full assessment completed in 2006 can be found in last year's report.

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

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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 2006's assessment for the 2007 fishery) when there is only new catch information, we run only the projection model with updated catch data for single-species age-structured assessments. In odd years (like 2007), we run a full assessment with all new survey and fishery data accumulated since the last full assessment. New data in the 2007 model included the 2005 survey age composition, 2006 fishery age composition, 2006 and estimated 2007 fishery catch, and 2007 survey biomass estimates. The 2005 and 2007 survey biomass estimates were relatively large and have greater precision than the estimates in the early 1990s, and have begun to influence the model estimates upward. Recruitment appears relatively strong in the last decade. For the 2008 fishery, we recommend the maximum allowable ABC of 14,999 mt from the updated model. This ABC was slightly higher than last year's ABC of 14,636 mt. Female spawning biomass remains above $B_{40\%}$, with projected biomass stable.

In 2007, the Central Gulf of Alaska Rockfish Pilot Program was implemented to enhance resource conservation and improve economic efficiency for harvesters and processors who participate in the Central Gulf of Alaska rockfish fishery. This is a five year rationalization program that establishes cooperatives among trawl vessels and processors which receive exclusive harvest privileges for rockfish management groups. The primary rockfish management groups are northern rockfish, Pacific ocean perch, and pelagic shelf rockfish. Potential effects of this program on Pacific ocean perch include: 1) extended fishing season lasting from May 1 – November 15; 2) changes in spatial distribution of fishing effort within the Central GOA; 3) improved at-sea and plant observer coverage for vessels participating in the rockfish fishery; and 4) a higher potential to harvest 100% of the TAC in the Central GOA region. Preliminary results have shown a higher market price for POP as well as attaining catches closer to TAC.

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

Northern rockfish - For northern rockfish, a new model was accepted in 2006 for recommending 2007 ABC. This configuration was almost identical in 2007, except for a few minor adjustments to make it consistent with other Gulf of Alaska rockfish models. The model continues to show a slow decline in spawning biomass, mainly due to what appears to be a lack of recruitment. Survey biomass estimates continue to be highly uncertain for northern rockfish. For the 2008 fishery, we recommended the maximum allowable ABC of 4,550 mt for the Gulf of Alaska. This ABC was down slightly from last year's recommended ABC of 4,940 mt. This stock is not overfished nor approaching an overfished condition; however, spawning biomass projections indicate a slow decline.

For more information contact Jon Heifetz at (907) 789-6054.

Rougheye rockfish - In Alaskan waters, adult rougheye rockfish (*Sebastes aleutianus*) inhabit particularly steep, rocky areas along the upper continental slope between 300 – 500 m depth. Adults often co-occur with shortraker rockfish (*Sebastes borealis*) in trawl or longline hauls. Rougheye rockfish have been managed as "bycatch" only species since the creation of the shortraker/rougheye rockfish management subgroup in the Gulf of Alaska in 1991. In 2005 we formalized the use of the generic rockfish model as the primary assessment tool for rougheye rockfish. Additionally in 2005, Gulf of Alaska rockfish were moved to a biennial stock assessment schedule to coincide with the AFSC biennial trawl survey in this region. In even years (such as 2006's assessment for the 2007 fishery) when there is only new catch information, we run only the projection model with updated catch data for single-species age-structured assessments. In odd years (such as 2007), we perform a full assessment using all new survey and fishery data accumulated since the last full assessment.

New information for the 2007 model included updated estimates of 2006 and 2007 fishery catch, 2002 and 2006 fishery length compositions, 2007 trawl survey biomass estimates, 1984, 1993, 1996, and 2005 trawl survey age compositions, 2006 – 2007 AFSC longline survey relative population weights, and 2006 – 2007 longline survey size compositions. The projected ABC derived from the recommended model for 2008 is 1,286 mt which is about 30% higher than last year's ABC of 988 mt. The increase in ABC is likely due to the large amount of new data added to the model, particularly the historic trawl survey ages which allowed for a more reliable estimate of mean recruitment. The catchability for both surveys decreased, resulting in an overall increase in the biomass time series. Additionally, the trawl survey catchability is more inline with other estimates of rougheye catchability based on empirical observations. This increase is also supported by the above average most recent trawl and longline survey biomass estimates. Potential higher recruitments are estimated for recent years; however, these estimates are highly uncertain given the lack of information on recent year classes. Female spawning biomass is well above B40%, with projected biomass stable.

As per comments by the North Pacific Fishery Management Council's Scientific and Statistical Committee in December 2005, a preliminary sensitivity analysis was conducted in the 2006 rougheye rockfish assessment. Data for the rougheye model substantially increased for the 2007 assessment; therefore, we included a more thorough sensitivity analysis on the relative influence of the trawl and longline survey estimates as well as trawl survey age and longline survey length compositions. The trajectory of female spawning biomass (SSB) was relatively similar over all model runs; however, the magnitude of SSB depended on the specification of precision of input data. We altered the specified precision by changing the assumed CV for each data source. In general, model estimates were robust to only altering the precision on the trawl survey biomass estimates or the longline survey length compositions. Estimates of SSB increased with a moderately high precision on the trawl survey biomass coupled with decreased precision on the longline survey biomass or a decrease in weight on the trawl survey age compositions. Model estimates decreased with high precision on only the longline survey or high precision on the trawl survey age compositions.

In two scenarios, B_{2008} fell below $B_{40\%}$. The first scenario was very high precision on only the longline survey. In this case, the relatively low weight of the catch index allowed the model to predict highly anomalous values resulting in fairly low fit to the catch data. The second scenario was very high precision on the trawl survey biomass combined with very high weight on the trawl survey age compositions. In this second case, trawl survey selectivity shifts to the right and catchability increased dramatically, resulting in reduced overall biomass trajectory. In the future we may consider increasing the weight on the catch index to increase robustness of the model to the assumed specification of precision. We may also explore the effects of increasing the age bins as we update the size-at-age matrix and weight-at-age vector when considering model assumptions.

We continue to monitor the progress of species identification between rougheye and blackspotted (*Sebastes melanostictus*) rockfish. Blackspotted was only identified as a species separate from rougheye in 2006; previously, both forms had been classified as rougheye rockfish. In 2007, the Gulf of Alaska trawl survey began separating rougheye rockfish from blackspotted rockfish using a species key developed by the AFSC's J. Orr. Biomass estimates by area of the two species somewhat support the broad southern and northern distribution of rougheye versus blackspotted rockfish in that blackspotted estimates were higher in the western GOA and rougheye estimates were higher in the eastern GOA. However, both species were identified in all areas, implying some overlap throughout the GOA. Overall, more blackspotted rockfish were identified than rougheye. This was particularly true in the central GOA where blackspotted rockfish estimates were 20% higher than rougheye rockfish estimates. Genetic results of two-day sampling experiments on the longline survey in 2005 and 2006 are in progress and may be useful for determining particular habitat preference of the two species and for confirming onboard species identification.

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

Shortraker and other slope rockfish - Shortraker rockfish and "other slope rockfish" are distinct management categories in the Gulf of Alaska (GOA), but their assessments are presented in a combined report because both assessments are based on biomass estimates from trawl surveys, instead of modeling. "Other slope rockfish" are comprised primarily of sharpchin, harlequin, silvergray, and redstripe rockfish, plus a number of minor species. Rockfish in the GOA have been moved to a biennial stock assessment schedule to coincide with data from the AFSC biennial trawl surveys in the GOA. In 2007, a trawl survey was conducted in the GOA, and a full assessment was done for both shortraker rockfish and for "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 2003, 2005, and 2007 surveys) was used to determine current exploitable biomass. This results in an exploitable biomass of 39,905 mt for shortraker rockfish and 90,283 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 2008 of 898 mt for shortraker rockfish and 4,297 mt for "other slope rockfish". Compared with ABCs in 2006 and 2007, these are both slight increases.

Shortraker rockfish have long been considered one of the most difficult rockfish species to age. In 2005, the AFSC REFM Division's Age and Growth Task developed a new, experimental technique for ageing otoliths of this species. In early 2007, this technique was used for the first time for "production ageing" of a sample of shortraker rockfish from the 2005 GOA trawl survey. The maximum age was 116 years, and the estimated mean population age in the GOA was quite old, 44 years. Tentative plans are to use carbon-14 ageing techniques to verify the ageing method. If the age verification is successful and additional samples can be aged, development of an age-structured model for shortraker rockfish may begin in the next couple of years.

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

5. Thornyheads

b. Stock Assessment

GULF OF ALASKA
Gulfwide thornyhead biomass declined 10% in the 2007 GOA trawl survey compared with the 2005 trawl survey. However, most of this decrease was observed in the western GOA. The 2007 trawl survey biomass declined 45% and 11% in the Western and Central Gulf areas, while the Eastern Gulf biomass increased 15%.

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

The 2007 survey data is used to calculate ABC and OFL under Tier 5. The 2007 GOA trawl survey biomass estimate of 84,774 t, was multiplied by $0.75M$ (=0.0225) for an ABC recommendation of 1,910 t and $M = 0.03$ for an OFL recommendation of 2,540 t. Area apportionments for thornyhead ABC in 2008 is as follows.

Western	**Central**	**Eastern**	**Total**
267	860	783	1,910

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

6. Sablefish

a. Research

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

2007 Sablefish Longline Survey - The AFSC has conducted an annual longline survey of sablefish and other groundfish in Alaska from 1987-2007. The survey is a joint effort involving two divisions of the AFSC: ABL and RACE. It replicates as closely as practical the Japan-U.S. cooperative longline survey conducted from 1978-94 and also samples gullies not sampled during the cooperative longline survey. In 2007, the twenty-ninth annual longline survey of the upper continental slope of the Gulf of Alaska was conducted, along with a similar survey of the eastern Bering Sea. One hundred-fifty-two longline hauls (sets) were completed between June 2, 2007 and September 1, 2007 by the chartered fishing vessel *Ocean Prowler*. Sixteen kilometers of groundline were set each day, containing 7,200 hooks baited with squid.

Sablefish was the most frequently caught species, followed by giant grenadier, arrowtooth flounder, shortspine thornyhead, and Pacific cod. A total of 79,461 sablefish were caught during the survey. Sablefish, shortspine thornyhead, Greenland turbot, spiny dogfish shark, and lingcod, were tagged and released during the survey. Length-weight data and otoliths were collected from 2,219 sablefish and over 139,000 lengths were collected from six different species including 74,000 sablefish lengths. Killer whales took fish from the longline at seven stations in the Bering Sea and five stations in the western Gulf of Alaska. For the first time during the survey time series, killer whales also took catch from a station in the central Gulf of Alaska. Geographically, this is the farthest east the survey has ever recorded killer whale depredation. Sperm whales were often present during haul back and were observed depredating on the longline at eleven stations in the eastern Gulf and two stations in the central Gulf of Alaska.

Several special projects were conducted during the 2007 longline survey. An AFSC intern from the University of Washington participated on a survey leg collecting coral specimens for identification and preservation. A seabird occurrence study was conducted for the sixth year which helps to address where and when certain seabird species occur in Alaska waters. Spiny dogfish and lingcod were tagged with archival temperature/depth tags and sleeper sharks were tagged with satellite tags. Genetic samples and whole specimens of sablefish were collected in the Bering Sea and eastern Gulf of Alaska for population structure analysis. A grenadier study was conducted throughout the survey to examine potential morphology differences between big eye and small eye giant grenadier. 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 marine mammal observer was on board during the fifth survey leg in the Gulf of Alaska to collect photo identification of sperm whales, record dive behavior observations, and collect biopsy samples for genetic and fatty acid analysis. Sperm whales interacting with the survey vessel near Sitka were also tagged with satellite tags in a cooperative project with SEASWAP. Finally, a two-day gear experiment was conducted near Yakutat to compare the catching efficiency of standard survey gear to autoline gear.

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

Auke Bay Laboratory Sablefish Tag Recovery Program - Processing tag recoveries and administration of the reward program continued during 2007. Total sablefish tags recovered for the year so far are 546, which includes 516 tagged as adults and 18 tagged as juveniles. U.S. tags recovered in Canada in 2007, not yet received, should bring the total for the year to around 600. One fish at liberty for 35.5 years was recovered in 2007; it was released and recovered in Chatham Strait. Another fish out for 32 years was released off Prince William Sound and recovered off Cape Ommaney.

Tags from shortspine thornyhead, Greenland turbot, and Pacific sleeper shark are also maintained in the Sablefish Tag Database. Eight thornyhead, two turbot, and two sleeper shark tags were recovered in 2007; the turbot tags were both electronic archival tags. The archival tags record data on depth of the fish and on water temperature for up to 11 years, depending on the frequency of observations. Besides adult sablefish (603) and Greenland turbot (156), archival tags have been implanted in juvenile sablefish (406), shortspine thornyheads (203), Pacific sleeper sharks (135), spiny dogfish (166), and lingcod (41) in recent years. To date, 104 adult sablefish, ten turbot, and two spiny dogfish with archival tags have been recovered.

Releases in 2007 included 3,804 adult sablefish, 681 shortspine thornyhead, 82 turbot (including 38 with archival tags), 41 lingcod (all archival), 67 spiny dogfish (all archival), and 161 juvenile sablefish (99 archival).

Two more sablefish tagged and released on seamounts in 1999 and 2000 were recovered in 2007, and a third fish recovered in 2005 was turned in late, bringing the total of seamount to continental slope recoveries to 25. All but one of the 23 tags with known recovery data have been recovered northwest of their release positions.

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

Juvenile Sablefish Studies - Juvenile sablefish studies have been conducted by the Auke Bay Laboratories in Alaska since 1984 and were continued in 2007. A total of 62 juvenile sablefish (age 1+) were tagged with spaghetti tags and released during a cruise of the NOAA vessel *John N. Cobb* at St. John Baptist Bay near Sitka between May 14-20, 2007. During the same cruise, an additional 99 juvenile sablefish were implanted with electronic archival tags. Approximately 264.5 rod hours were recorded. This relatively small bay is the only known location in Alaska where juvenile sablefish have been consistently found on an annual basis.

The electronic archival tags will provide information on juvenile sablefish behavior and habitat during their transition from nearshore rearing areas to the age at which they are intercepted by the fishery. Since 2003, a total of 406 electronic archival tags have been released on juvenile sablefish in St. John Baptist Bay. These tags record the temperature and depth experienced by the fish and are designed for recovery in the commercial fishery when the fish are age 2+ or greater. We expect and hope to start seeing some archival returns in the 2008 fishery. The juvenile sablefish cruise will be conducted again this year from May 14-20.

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

Sablefish Workshop - In 1983 and 1993, sablefish symposia were held that brought together scientists to share information and discuss future needs of sablefish research in the North Pacific. In 2004, a meeting was called at the Western Groundfish Conference to discuss the formation of a sablefish working group which would work to organize a third sablefish symposium. In the interim, an informal sablefish workshop was held February 21-23, 2007 at the Alaska Fisheries Science Center, Seattle. The purpose of the workshop was to bring together sablefish assessment scientists from the United States and Canada to exchange information, describe ongoing work, identify new avenues for research, and investigate cooperative research opportunities.

Twelve participants attended the meeting representing the Alaska Fisheries Science Center, Northwest Fisheries Science Center, Alaska Department of Fish and Game, Fisheries and Oceans Canada, Sigma Plus Consulting, and Simon Fraser University. Each agency provided general overviews of the sablefish stocks, fisheries, and management in their respective jurisdictions. Roundtable discussions were held that focused on specific topics such as stock assessment, survey methodologies, life history studies, harvest strategy evaluations, and recruitment processes. The group found many similarities in the major issues facing each management area and agreed on future collaborations on stock assessment and migration studies.

For more information or a copy of the report, contact Dana Hanselman at (907) 789-6626.

a. Stock Assessment

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

Relative to the 2006 assessment, the substantive changes in the 2007 assessment were the incorporation of updated growth information and the development of prior distributions for catchability. The 2007 sablefish assessment showed that sablefish abundance in Alaska increased during the mid-1960's due to strong year classes from the 1960's. Catches peaked at 53,080 mt in 1972, and abundance subsequently dropped during the 1970's due to heavy fishing. The population recovered due to exceptional year classes from the late 1970's; spawning abundance peaked again in 1987. The population then decreased again as these exceptional year classes died off. The survey abundance index decreased 14% between 2006 and 2007, a change which followed a 13% increase between 2005 and 2006. The fishery abundance index was down 8% from 2005 to 2006 (2007 data not yet available). Relative abundance in 2007 was the lowest seen on the domestic longline survey (1% lower than 2000). Spawning biomass was projected to decline through 2012. Projected 2008 spawning biomass was 37% of unfished biomass. The 1997 year class is fully mature and should account for 18% of 2008 spawning biomass. The 2000 year class likely is appearing to be larger than the 1997 year class and should also comprise 18% of 2008 spawning biomass.

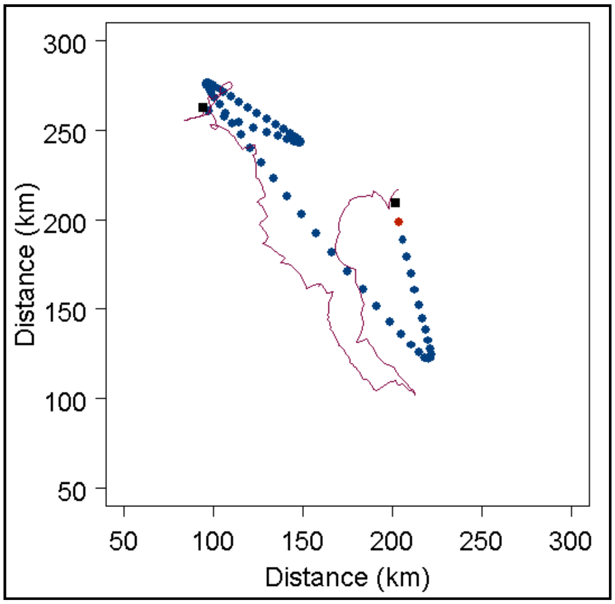
We recommended a 2008 ABC of 18,030 mt for sablefish in federally managed waters of Alaska, based on an adjusted $F_{40\%}$ strategy. This ABC was slightly lower than the 2006 and 2007 ABCs which were 21,000 and 20,100 mt respectively. Changes in area apportionment for this year were much more modest compared to the large changes seen in last year's assessment. The largest relative change this year occurred in the Western GOA due to sizeable decreases in both the survey CPUE in 2007 and the fishery CPUE in 2006. Future work will concentrate on updating other biological parameters, such as maturity, simulation testing, and considering environmental variables as proxies for recruitment.

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

7. Flatfish

a. Research

Tracking the seasonal migration of individual northern rock sole in the eastern Bering Sea - Although the basic aspects of the seasonal migration of northern rock sole in the eastern Bering Sea has been revealed from 1960s era Japanese mark-recapture studies, details about the timing and routes of these migrations is lacking. Members of the Groundfish Assessment Program have attempted to provide such detailed information by tracking the migrations paths of individual fish using two distinct methods. Two of 150 rock sole tagged with archival tags were subsequently after 10 and 16 months at liberty, each providing hourly observations of water depth. It was recognized that rock sole left the bottom at night in excursions lasting up to 6 hours. These excursions were more frequent during certain times of the year and were often clearly related to the direction of tidal currents predicted by an oceanographic model. This behavior is similar to that reported for other flatfish, such as plaice, that often migrate using Selective Tidal Stream Transport. To determine if rock sole were using this mechanism, a STST model was developed in which, starting from the release location, rock sole drifted in the direction of the prevailing tidal current during each excursion and additionally swam at a specified speed in the same direction. The summation of these movements created a migration trajectory. By iteratively varying the swimming speed, a speed of 47 cm /sec (1.4 body lengths / sec) minimized the distance between the end of the track and the tag recovery position. This hypothesized track positioned the fish within 1 km of the recovery position after swimming more than 350 km in a clear, rapid, southern migration just prior to the known spawning season. The second way of tracking the fish was to determine a sequence of position estimates using a technique known at the Tidal Location Method in which tide height information collected by the archival tag when the fish remains in direct contact with the bottom for extended (> 3 days) periods is



matched to the tide height variation predicted by an oceanographic model over a spatial grid. A type of cubic smoothing is then used to connect the position estimates into a migration trajectory. As shown the figure the trajectory determined by TLM (dots) is quite similar both in its path and timing to that produced using STST (solid line) even though the two methods are totally independent. Such individual based migration information has the potential to aid in the development of area-specific management models.

For further information contact: Dave Somerton (206) 526-4116 or Dan Nichol (206) 526-4538.

Habitat Studies - A five year field survey for juvenile flatfishes conducted with a towed camera sled in nursery grounds of Kodiak was completed in 2006. This survey was designed to provide a spatially-explicit analysis of distribution and habitat association at several spatial scales, from 10's of kilometers to <1 meter, considering a wide range of environmental variables explore (depth, sediments, biogenic structure, etc). Importantly, this survey represents a valuable tool for generating hypotheses exploring the factors controlling nursery quality for juvenile flatfish. For example, it was observed that the abundance of larger, potentially predatory, flatfish was positively related to depth. This led to speculation that predation risk for juvenile flatfish would also increase with depth. This hypothesis was tested in 2007 through a field manipulation in which 214 juvenile flatfish (age-0 yr Pacific Halibut) were live hooked and tethered on the seafloor across 3 depths (5, 10 and 15 m) in 2 Kodiak nurseries. Numbers of juveniles recovered after 30 min confirmed that predation intensity increased with depth, confirming a hypothesis central our understanding as to how shallow water nurseries function for a wide variety of species.

Feeding and growth - Examination of the spatial and temporal variation in growth rates of northern rock sole continued in 2007 with monthly sampling at three Kodiak Island nursery sites. This was the coolest year in the study, and growth rates were well below those observed in 2005. Variation in growth rates among sites was consistent with previous year's observations. The rank order of growth rates across sites has been maintained across the three years of study. A comprehensive analysis of the spatial and temporal variation in growth of age-0 northern rock sole is presently underway. This work is being extended to examine the potential differences in energetic condition of rock sole among the nursery sites. Preliminary analyses of condition factors indicates that fish at the site with the fastest growth rates also have the highest energy reserves. This suggests even greater differences in recruitment potential among sites than indicated from growth rates alone.

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

b. Stock assessments

BERING SEA

Yellowfin sole - The 2007 stock assessment incorporates the 2007 catch and survey biomass, the age compositions from the 2006 survey and 2006 catch and an update of weight-at-age estimates using biological data through 2006. The 2007 EBS bottom trawl survey resulted in a biomass estimate of 2,150,000 t, an increase of about 1% from the 2006 point estimate. The stock assessment model indicates that the stock has been slowly declining over the past twenty years, although still at a high level, due to recruitment levels which are less than those which built the stock to high levels in the late 1960s and early 1970s. The time-series of survey age compositions indicate that only 6 of the past 15 year classes have been at or above the long term average. The 2007 catch of 116,100 t represents the largest flatfish fishery in the United States and the average exploitation rate has been 4% the past five years for this stock. This assessment features an estimate of the relationship between survey catchability and annual mean bottom water temperature and also estimates a Ricker form of the spawner recruit relationship within the model. Results indicate that catchability, averaged over 25 years, = 1.17.

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 303,000 t. As in last year's assessment, 1978-2002 spawner recruit data were used as the basis to determine the Tier 1 harvest recommendation. This provided an $F_{ABC} = F_{harmonic}$ mean $F_{msy} = 0.19$. The $F_{OFL} = F_{MSY} = 0.2$. The product of the harmonic mean of F_{MSY} and the geometric mean of the 2008 biomass estimate produced the recommended ABC of 248,000 t and OFL of 265,000 t.

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

Northern rock sole - Changes to the input data for the 2007 assessment include addition of the 2006 fishery age composition, 2006 survey age composition, the 2007 catch biomass and 2007 trawl survey biomass point estimate and standard error. The 2007 bottom trawl survey resulted in a biomass estimate of 2,032,950 t, an 8% decrease from last year's estimate of 2,215,000 t. The assessment continued the investigation of catchability (*q*) began in 2002. As in past assessments, a value of 1.4 obtained from a trawl "herding" experiment was used as the mean of a prior distribution on *q*. The updated value from this assessment gives a *q* estimate of 1.5. Natural mortality was estimated as a free parameter (with q constrained as stated above) giving the best fit at M = 0.15. The model estimates that the biomass of rock sole has increased the past four years after declining from a peak value observed in 1995. The increase is due to strong recruitment from the 2001, 2002 and 2003 year classes which are now contributing to the population biomass. The model estimates the 2007 biomass of rock sole at 1,756,000 t, an increase of 6% over 2006 and about 6% less than the peak level observed in 1995.

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.

The SSC has determined that northern rock sole qualifies as a Tier 1 stock; therefore the 2008 assessment was calculated using Tier 1 methodology. In 2006, the SSC selected the 1978-2001 spawner-recruit data set for the Tier 1 harvest recommendation. Increasing to a Tier 1 management strategy resulted in a large increase in ABC and OFL estimates over the 2006 assessment values. The Tier 1 2008 ABC harvest recommendation is 301,000 t (F_{ABC} = 0.177) and a 2008 OFL of 304,000 t (F_{OFL} = F_{MSY} = 0.179). 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 2007 trawl survey biomass estimate of 571,000 t was a 12% decrease over last year's estimate of 645,000 t. Survey biomass has been relatively stable over the past four years compared to the decrease observed from 1998-2000.

The 2007 stock assessment model estimates that the age 3+ biomass decreased from 809,000 t in 2006 to 796,000 t in 2007, a 2% decrease. However, the trend between assessments represents a greater decreasing trend, as the 2006 assessment estimate for 2007 was 875,000 t, so the decrease in 2007 estimated biomass estimated in 2006 vs. 2007 is 9%. This is a stock which has been in a slow decline since a peak level of 1,032,000 t in 1994 due to below average recruitment in recent years.

In response to SSC comments, the author examined the distribution of Bering flounder with respect to the fishery. The northerly distribution of the species did not seem to overlap the spatial distribution of the fishery, although mismatch in seasonal timing of the survey versus the fishery means that this is not conclusive. The SSC has determined that reliable estimates of $B_{40\%}$ (140,000 t) $F_{40\%}$, (0.28) and $F_{35\%}$ (0.34) exist for this stock, thereby qualifying the stock for management under Tier 3. Given that the projected 2008 spawning biomass of 251,000 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2008 were calculated under sub-tier "a" of Tier 3. F_{ABC} was set at the $F_{40\%}$ (0.28) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2008 ABC of 71,700 t. The OFL was determined from the Tier 3a formula, where a $F_{35\%}$ value of 0.34 gives a 2008 OFL of 86,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

Alaska plaice - The 2007 assessment incorporated the 2007 shelf survey biomass estimate (421,765 t) and the 2007 catch data into the stock assessment model as well as the 2006 survey age composition. The survey biomass estimate was 32% lower in 2007 than in 2006 (2006 estimate was higher than recent values). The stock is estimated to be at a high and stable level with relatively stable recruitment since the 1970s and a low level of harvest which is typically bycatch from other target fisheries. Recent good recruitment from the 2000 – 2002 year classes may increase the biomass in the near future. In response to a request from the SSC, the length/age conversion matrix was extended from 45 to 60 cm. Catchability investigations do not indicate a temperature effect as shown for some of the other shelf flatfish.

Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, therefore qualifying it for management under Tier 3a of the BSAI Groundfish FMP. The updated point estimates are $B_{40\%}$=145,000 t, $F_{40\%}$ = 0.59, $F_{35\%}$ = 0.81. These are high values for flatfishes, but these values are the consequence of Alaska plaice maturing before recruiting to the fishery. Given that the projected 2007 spawning biomass of 335,000 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2008 were calculated under sub-tier "a" of Tier 3. Projected harvesting at the $F_{40\%}$ level gives a 2008 ABC of 194,000 t. The OFL was determined from the Tier 3a formula, which gives a 2008 OFL of 248,000 t. Model projections indicate that this species is neither overfished nor approaching an overfished condition. Reference fishing mortality rates are lower than in previous years due to a shift in the model's estimate of fishery selectivity. The sensitivity of the spawning-per-recruit fishing reference point to the change in fishing selectivity is not unexpected, given that the age at 50% maturity is approximately 8.5 and the natural mortality rate (0.25) is relatively high compared to other flatfishes. Because the age at 50% selection in the fishery is 10.4, Alaska plaice has the potential to spawn twice before it recruits to the fishery. Additionally, the high natural mortality of 0.25 indicates that the lifetime spawning/recruit potential is rapidly being reduced at the ages of highest fishing selectivity. There continues to be relatively stable recruitment of Alaska plaice from the late 1970s through the present, with an apparently large 2002 year class.

Other flatfish - The "other flatfish" complex currently consists of Dover sole, rex sole, longhead dab, Sakhalin sole, starry flounder, and butter sole in the EBS and Dover sole, rex sole, starry flounder, butter sole, and English sole in the AI. Starry flounder, rex sole, and butter sole comprise the vast majority of the species landed. For example, Starry flounder and rex sole comprised 90% of the “other flatfish” catch in 2007. Because of insufficient information about these species, no model analyses are possible. The latest assessment incorporates 2007 total catch and discard and 2007 trawl survey information. The 2007 EBS bottom trawl survey resulted in biomass estimates of 149,497 t, an increase from the estimate of 149,292 t from the 2006 survey and the highest observed since 1980. The biomass of these species in the Aleutian Islands is 16,400 t from the 2006 survey, the highest observed since 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 2008 ABC of 21,600 t for the “other flatfish” species. The corresponding 2008 OFL is 28,800 t. It is not possible to determine whether the “other flatfish” complex is overfished or approaching an overfished condition because it is Tier 5 and not managed under Tiers 1-3. Insufficient information about these species makes model analysis impossible.

The SSC requested an evaluation of species-specific natural mortality rates for the species in this complex. Therefore species-specific natural mortality rates are used for the species for which they are available. Estimates of *M* for the GOA were used for Dover sole (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. Therefore this is probably not an issue of concern.

Greenland turbot - The Bering Sea slope survey gives the primary estimate of Greenland turbot biomass, but has not conducted since 2004 due to funding deficiencies. This year’s Greenland turbot assessment model included updated 2007 catch data and biomass and length composition estimates from the 2007 EBS shelf survey. Also included in the assessment are updated, aggregated longline survey data index for the EBS and Aleutian Islands.

The 2007 EBS shelf trawl survey biomass estimate was down by about 20% from the 2006 estimate, however, the past 3 year average is at about 75% of the long term mean. The 2006 Aleutian Islands bottom trawl survey estimate was 20,900 t, an increase of 85% from the 2004 survey estimate and is above the 1991-2006 average level of 17,100 t. Model results based on these surveys and data from longline and trawl fisheries result in an estimate of the current 2007 female spawning biomass at 58,100 t, a steady decline from the high biomass values of the early 1980s which resulted from the strong recruitment of the late 1970s. While improvements to the assessment modeling have been made, and there appears to be some favorable recruitment patterns in the past several years, fishing mortalities consistent with recent history are recommended for

ABCs until another slope survey can be completed as well as more analyses to evaluate the modeling approach.

The newer implementation of Stock Synthesis 2 was used for modeling. The current implementation of the model retains the key assumption of former models that the slope trawl survey is an absolute index representing 75% of the Greenland turbot stock in US waters. An updated mortality estimate of 0.112 supersedes the 0.18 used in the past. Compared to previous models, selectivity was allowed to change more over time for some surveys and fisheries, resulting in improvements of some residual patterns. The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock. Updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 38,200 t, 0.51, and 0.67, respectively. Projected spawning biomass for 2008 is 58,100 t. Greenland turbot therefore qualify for management under Tier 3a. The maximum permissible value of F_{ABC} under this tier translates into a 2008 ABC of 12,200 t. Although there appears to be some favorable recruitment in recent years, fishing mortalities consistent with recent history are recommended for ABCs until another slope survey can be completed. Thus, the author recommended setting the 2008 ABC at a value less than the maximum permissible. Using F_{ABC} = 5-year average catch, results in a 2008 ABC of 2,540 t corresponding to a full selection fishing mortality rate of 0.09. The OFL fishing mortality rate is computed under Tier 3a, $F_{OFL} = F_{35\%} = 0.67$, and translates into a 2008 OFL of 15,600 t.

Arrowtooth flounder - The present assessment continues to utilize catchability as a function of the annual average bottom temperature during the EBS shelf trawl survey and also uses the EBS shelf trawl survey sex ratios as prior information to estimate sex-specific population numbers at age. New for this year was the incorporation of the 10 Aleutian Islands surveys biomass and size compositions into the assessment model. This year’s EBS shelf bottom trawl survey resulted in a biomass estimate of 546,500 t, an 18% decline from the very high point estimate which resulted from the 2006 survey. 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 0.33. With the stock assessment model configured in this way, the population biomass was estimated at 1,780,000 t.

The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, thereby qualifying arrowtooth flounder for management under Tier 3. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 345,000 t, 0.24, and 0.30, respectively. Given that the projected 2008 spawning biomass of 994,000 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2008 were calculated under sub-tier “a” of Tier 3. The F_{ABC} was set at the $F_{40\%}$ (0.24) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2008 ABC of 244,000 t. The OFL fishing mortality rate under Tier 3a is $F_{35\%}$ (0.30), which translates to a 2008 OFL of 297,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

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

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

GULF OF ALASKA

Arrowtooth flounder - The 2007 survey biomass estimate for Gulf of Alaska arrowtooth flounder was 1,939,055 t, a 2% increase from the 2005 survey. This biomass estimate and the length composition from the 2007 survey were added to the stock assessment model, as well as the 2005 survey age composition. In addition, the age-length conversion matrix was updated with mean length at age data for 1984 to 2005 to better model growth.

The stock assessment model estimate of 2007 age 3+ biomass of 2,256,000 t is based on abundance estimates derived from an age structured model and indicates that the population is at a historical (past 40 years) high level, but has now leveled off from increasing over the past 20 years. Data from halibut trawl surveys in the 1960’s, groundfish trawls in the 1970’s, and NMFS triennial trawl surveys from 1984 to 2007 were included in the model. Similar to the previous assessment, the model matched the observed higher proportion of females in the larger size intervals of both survey and fishery data by allowing males a higher mortality rate than females.

The ABC estimate was based on Tier 3a calculations due to the fact that the estimated 2008 female spawning biomass (1,275,310 t) is greater than the $B_{40\%}$ estimate (489,500 t). Therefore, F_{OFL}=$F_{35\%}$ =0.222 and F_{ABC}= $F_{40\%}$ = 0.186 resulting in an ABC recommendation of 226,470 t. The overfishing level for arrowtooth flounder is estimated to be 266,900 t. The ABC is apportioned among regulatory areas in proportion to biomass distributions in the 2007 trawl survey as follows:

Western	**Central**	**West Yakutat**	**East Yakutat/SE**	**Total**	
30,817	167,936	15,245	12,472	226,470	2008

Gulf of Alaska flatfish - New data for the 2007 flatfish assessment included the 2007 NMFS bottom trawl survey biomass estimates and the 2007 catch. The 2007 survey biomass estimates were used to calculate ABC's for 2008 for all species except Greenland turbot and deepsea sole, where the mean catch from 1978 to 1995 was used. The survey sampled to 700 m depth while the distribution of these deep water species extends deeper. Dover sole, the main constituent of the deep water group, is now assessed in using an age structured model. These stocks remain lightly harvested relative to their estimated biomass because the annual catch is almost always less than the TAC levels which are typically set less than the ABC.

The flatfish group is subdivided into arrowtooth flounder, deep water flatfish, flathead sole, rex sole and shallow water flatfish. Flathead sole and arrowtooth flounder, and rex sole are presented in separate assessments using age-structured models. The 2007 exploitable biomass for each group (except for those species with age-structured models) is based directly on results from the 2007 NMFS trawl survey. Survey abundance estimates for the shallow water flatfish complex were higher in 2007 compared to 2005 for northern rock sole, southern rock sole, sand sole, starry flounder, butter sole and Alaska plaice. The 2007 survey abundance estimates were less than 2005 for yellowfin sole and English sole. The overall survey abundance estimates for the shallow water group increased by 70,824 t from 2005 to 2007.

ABC and OFL were calculated by species, with individual species identified as Tier 4, 5, or 6 depending upon the available data. The ABC's for northern and southern rock sole were estimated based on Tier 4 with $F_{ABC}= F_{40\%}$ (Southern rock sole $F_{40\%}$=0.162; Northern rock sole $F_{40\%}$=0.204) and $F_{OFL}=F_{35\%}$ (southern rock sole $F_{35\%}$=0.192; northern rock sole $F_{35\%}$=0.245) while other flatfish ABC's were estimated with F_{ABC}=0.75 M and F_{OFL}=M (Tier 5). Overall, the shallow water flatfish ABC increased from 51,450 t in 2007 to 60,989 in 2008. TACs are annually set below the ABC levels.

Survey estimates of Dover sole biomass increased from 213,221 t in 2005 to 280,990 in 2007. The stock assessment model for Dover sole indicated that age 3+ biomass estimates increased 9% from 2007 to 2008 (297,353 to 324,197) and that female spawning biomass estimates increased about 6%. Recruitment may have been high in 2002 and catches remain well below the TAC. The 2008 ABC using $F_{40\%}$ = 0.38 was estimated at 44,735 t, and the 2008 OFL using $F_{35\%}$= 0.494 was estimated at 55,787 t.

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

2008 ABC area apportionment

Flatfish group	Western	Central	WYAK	EYAK/SEO	Total
Deep water	690	6,721	965	527	8,903
Shallow water	26,360	29,873	3,333	1,423	60,989

Flathead sole - The 2007 survey biomass estimate for flathead sole was 280,290 t, a 31% increase over the 2005 point estimate of 213,213 t. This new biomass estimate and the survey length data, as well as updated catch biomass and length comps were included in the assessment model. In addition, maturity parameters were updated and estimates of reference fishing mortality were estimated from spawner per recruit analysis. The 2008 biomass estimate from the age-structured model was 324,200 t, continuing a stable trend since the mid 1980s.

The projected 2008 female spawning biomass is estimated to be well above the $B_{40\%}$ level therefore flathead sole ABC and OFL are calculated using Tier 3a calculations. Under this definition, $F_{OFL}=F_{35\%}$, and F_{ABC} is less than or equal to $F_{40\%}$. The ABC for 2008 using $F_{40\%} = 0.38$ was estimated at 44,735 t (increase of 5,625 t from 2007). The overfishing level using $F_{35\%} = 0.494$, results in 55,787 t. Area apportionments of flathead sole ABC's for 2008 (using $F_{40\%}$) are based on the fraction of the 2007 survey biomass in each area:

Western	Central	West Yakutat	East Yakutat/SE	Total
12,507	28,174	3,420	634	44,735

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

As of press time, the MACE Program had not submitted an update report of their 2007/2008 research activities.

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

b. Stock assessments

GULF OF ALASKA

The age-structured model developed using AD Model Builder and used for GOA pollock assessments in 1999-2006 is fundamentally unchanged for the 2007 assessment. This year's pollock assessment features the following new data: (1) total catch and age composition from the 2006 fishery; (2) biomass and age composition from the 2007 Shelikof Strait echo integration trawl (EIT) survey; (3) biomass and length composition from the 2007 ADF&G crab/groundfish trawl survey, and (4) biomass and age composition from the 2007 NMFS bottom trawl survey, and (5) 2007 catch.

The model estimate of spawning biomass in 2008 is 145,101 t, which is 26% of unfished spawning biomass and below $B_{40\%}$ (221,000 t), thereby placing Gulf of Alaska pollock in sub-tier "b" of Tier 3. Estimates of stock status in 2008 indicate a 7% decline in spawning biomass from 2007. These results are consistent with survey trend estimates (38% decline in the Shelikof Strait EIT survey, 20% decline from the 2005 NMFS trawl survey, and a 11% increase in the ADFG trawl survey). The dip in spawning biomass is expected to be short-lived, as projections indicate an increase in spawning biomass after 2008. These results depend critically on the magnitude of the 2004 – 2006 year classes, which appear to be near or above average, but are still uncertain. The author's 2008 ABC recommendation for pollock in the Gulf of Alaska west of 140° W longitude is (W/C/WYK) is 53,590 t, a decrease of 16% from the 2007 ABC. This recommendation is based on a more conservative alternative to the maximum permissible F_{ABC} introduced in the 2001 SAFE. The OFL in 2008 is 72,110 t. In 2009, the recommended ABC and OFL are 71,580 t and 95,940 t, respectively.

The same model was used as last year to provide management advice. This model fixed trawl survey catchability (q) at 1.0 and estimated other catchabilities. Although the likelihood is higher for models with q closer to 0.8, the change in likelihood is small (less than 1) between models with q fixed at 1.0 or estimated. Fixing q at 1.0 results in a more precautionary estimate of spawning biomass and therefore ABC than other models. As was done last year, the authors recommended to reduce ABC from the maximum permissible using the "constant buffer" approach (first accepted in the 2001 GOA pollock assessment). Therefore, the ABC for 2008 based on this precautionary model configuration and adjusted harvest control rule is 53,590 t (F_{ABC} =0.13) for GOA waters west of 140 degrees W. longitude (Note that this ABC recommendation is already reduced by 1,650 mt to account for the Prince William Sound GHL).

The model results produced an estimated 2008 spawning biomass of 145,101 t, or 26% of unfished spawning biomass. The $B_{40\%}$ estimate is 221,000 mt. Because model estimated 2008 female spawning biomass is below $B_{40\%}$, Gulf of Alaska pollock are in Tier 3b. The projected 2008 age-3+ biomass estimate is 558,000 t. Markov Chain Monte Carlo analysis indicated the probability of the stock being below $B_{20\%}$ to be less than 1% in 2008 and subsequent years. The 2008 OFL under Tier 3b is 72,110 t (F_{OFL} = 0.17).

Southeast Alaska pollock are in Tier 5 and the ABC and OFL recommendations based on natural mortality (0.30) and the biomass from the 2007 survey, which was 37% higher than the 2005 estimate. This results in a 2008 ABC of 8,280 and a 2008 OFL of 11,040 t.

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

EASTERN BERING SEA

Consistent with the estimates produced in last year's assessment, the abundance of EBS walleye pollock has declined steadily since 2003 due to poor recruitment from the 2001-2005 year classes. This string of five consecutive poor year classes is unprecedented in the known history of the stock which has sustained a fishery with annual removals of more than 1 million metric tons for 22 of the past 24 years.

New data in this year's assessment include the following: The total catch for 2006 was updated and a preliminary estimate of the 2007 catch was available. Biomass estimates from the 2007 bottom trawl survey and the 2007 echo-integration trawl (EIT) survey. The estimate from the bottom trawl survey was 4.3 million t, up 42% from the 2006 estimate. The estimate from the EIT survey was 1.88 million t, up 20% from last year's survey. Although both survey estimates are higher than last year's, both are substantially below the long-term means for their respective time series. Age composition data from the 2007 bottom trawl survey, updated age composition data from the 2006 EIT survey, and preliminary age composition data from the 2007 EIT survey (based on the age-length key from this year's bottom trawl survey). The 2007 survey age compositions give evidence of a large 2006 year class and five consecutive years of poor recruitment.

Also included are age and size composition data and weight-at-age data from the 2006 fishery. The new weight-at-age data resulted in a significant decrease in the 2006 mean weights at age relative to the values used in last year's assessment.

Changes in model structure include the following:
-Length composition data (not just age composition data) can now be used in the model. -
-Relative abundance at age 1 in the EIT survey is now estimated separately (as an independent recruitment index) from the other age groups.
-The survey abundance index used for tuning the model was changed from age 1+ numbers to age 2+ numbers.
-The catch/biomass ratio used in applying the Tier 1 harvest control rules now uses "fishable biomass" (the sum of the product of selectivity-, weight-, and numbers-at-age) for the denominator instead of age 3+ biomass. This makes the computation less sensitive to fluctuations in incoming year class strength.

The stock assessment model results indicate that spawning biomass is estimated to be 4% above B_{MSY} in 2007 (1.9 million t) but projected to be 28% below B_{MSY} in 2008 (1.4 million t). The age 3+ biomass for 2007 is estimated to be the lowest in the time series since 1980 and is projected in 2008 to be at 41% (4.4 million t) of the past 15 year average due to the poor recruitment to the stock for five consecutive years (2001-2005).

Although preliminary indications are that the 2006 year class is well above average, spawning biomass is unlikely to exceed B_{MSY} until 2010. The SSC has determined that reliable estimates of B_{MSY} and the probability density function for F_{MSY} exist for this stock. Therefore, EBS walleye pollock qualify for management under Tier 1. The assessment author has concluded that the Tier 1 reference points continue to be reliably estimated.

The updated estimate of B_{MSY} from the present assessment is 1.88 million t, compared to 2.06 million t from last year's assessment. Projected spawning biomass for 2008 is 1.38 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 0.341, significantly higher than last year's value of 0.243. The difference is due to a change in the biomass measure used in the denominator of the ratio, from age 3+ biomass (in last year's assessment), to fishable biomass (in this year's assessment). The lead author noted that this method change results in the same average yield but with less inter-annual variability.

The harvest ratio of 0.341 is scaled according to the Tier 1b formula and then multiplied by the geometric mean of the projected fishable biomass for 2008 (4.77 million t) to obtain the maximum permissible ABC for 2008, which is 1.17 million t. This ABC is more than double the 2008 yield of 555,000 t that would correspond to a Tier 3b strategy based on a $B_{40\%}$ value of 2.63 million t and an $F_{40\%}$ value of 0.51.

Arguments in support of setting the 2008 ABC at 1.17 million t included the following:
- The stock qualifies for management under Tier 1, so the maximum permissible Tier 1 ABC should have priority unless there is a compelling reason to set a lower ABC.
- The Tier 1 harvest control rules already have a built-in precautionary adjustment for stocks that fall below *BMSY*.
- Uncertainty is already factored into the Tier 1 harvest control rules.
- A 2008 ABC of 1.17 million t would already constitute a very large (16%) reduction from the 2007 ABC of 1.394 million t and would result in greater short-term catch stability than a lower ABC. The biomass is expected to rebuild to B_{MSY} under the maximum permissible ABC about as fast as it would under more conservative strategies.

Arguments in support of an ABC lower than 1.17 million t included the following:
- A 2008 ABC of 1.17 million t would imply an all-time high spawning exploitation rate. Keeping the 2008 ABC at or below about 1 million t would not exceed the all-time high spawning exploitation rate.
- There are many examples of strong year classes being produced when biomass is near *B40%*, but only one strong year class has been produced at a biomass lower than the projected 2008 value, implying that it would be desirable to increase biomass sooner rather than later.
- The stock rebuilt successfully from a similarly low level in the late 1970s and early 1980s when catches were limited to 1 million t or less.

- The possibility of a retrospective bias calls for additional precaution.
- The five-year string of consecutive poor recruitments spawned between 2001 and 2005 is unprecedented, also calling for additional precaution.

The SSC supported the authors' recommendation of a 1 million t ABC for 2008. A 2008 ABC of 1 million t would correspond to a harvest ratio of 0.21 and an $F_{39\%}$ harvest rate (compared to Tier 1A ABC rate of $F_{32\%}$). The current projection for maximum permissible ABC in 2009 given a 2008 catch of 1 million t is 1.07 million t. The OFL harvest ratio under Tier 1a is 0.422, 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 2008 gives the OFL for 2008, which is 1.44 million t. A 2008 OFL of 1.44 million t would correspond to a harvest ratio of 0.30. The current projection for OFL in 2009 given a 2008 catch of 1 million t is 1.32 million t. The walleye pollock stock in the EBS is not overfished and is not approaching an overfished condition.

ALEUTIAN ISLANDS

The assessment model chosen for this year is similar to the model accepted by the SSC last year. Age 2+ biomass is estimated to have increased from 1999 to 2004, after which it has been stable. Spawning biomass is estimated to have been increasing slowly since 1999. The 2000 year class is estimated to have been well above average (third largest in the time series), and preliminary indications are that the 2005 and 2006 year classes may be slightly above average. Spawning biomass for 2008 is projected to be 82,300 t.

The SSC has determined that this stock qualifies for management under Tier 3. Given that spawning biomass has been increasing and is above the *B40%* value of 51,500 t, the author recommends setting 2008 ABC at the maximum permissible value (Tier 3a, with *F40%*=0.20) of 28,200 t. Assuming a 2008 catch equal to the ABC, the maximum permissible ABC for 2009 is projected to be 22,700 t. Following the Tier 3a formula with *F35%*=0.24, OFL for 2008 is 34,000 t. The projected OFL for 2009 is 26,100 t. The walleye pollock stock in the Aleutian Islands is not overfished and is not approaching an overfished condition.

BOGOSLOF

Survey biomass estimates since 2000 have all been lower than estimates prior to 2000, ranging from a low of 198,000 t in 2003 to a high of 301,000 t in 2000. The 2007 estimate is the highest since the 2000 estimate. The SSC has determined that Bogoslof pollock qualified for management under Tier 5. The maximum permissible ABC under Tier 5 is 75% of the product of the natural mortality rate (0.20) and biomass, giving a value of 36,000 t. For several years, the SSC has used a much more conservative approach. The SSC formula uses a biomass-adjusted harvest rate rule (with 2,000,000 t estimate as a reference stock size) and an estimate of F_{ABC} based on growth, natural mortality, and maturation rate. If the formula used by the SSC is applied, the resulting fishing mortality rate is 0.022, giving a 2008 ABC of 7,970 t. The overfishing level under

Tier 5 is the product of the natural mortality rate and biomass, giving an OFL of 58,400 t for 2008. As a Tier 5 stock, it is not possible to determine whether Bogoslof pollock is overfished or whether it is approaching an overfished condition.

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

11. Dogfish

a. Research

NMFS Auke Bay Laboratory and University of Alaska Fairbanks Joint Research on Spiny Dogfish in the Gulf of Alaska - Scientists from the Auke Bay Laboratories, the University of Alaska Fairbanks School of Fisheries and Ocean Sciences, and the University of Washington School of Aquatic and Fishery Sciences continued a joint study on spiny dogfish (*Squalus acanthias*) in the Gulf of Alaska. Little is known about the life history or ecological role of spiny dogfish in the North Pacific despite the fact that they comprise a relatively large biomass in coastal northeast Pacific waters.

Spiny dogfish are a long-lived, slow-growing species. Length at age data collected from 2004-2007 in cooperation with the AFSC Sablefish Longline Survey, the Alaska Observer Program, and ADF&G and UAF surveys were examined to determine the growth and age structure 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 in 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. The age, growth, and demographic analyses are being compiled for the annual Stock Assessment and Fishery Evaluation (SAFE) report for sharks in the Gulf of Alaska.

For more information, contact Cindy Tribuzio at (907) 789-6415.

14. Other Species

a. Research

Maturity, Fecundity, Growth, and Natural Mortality of Giant Grenadier in Alaska - Because giant grenadier are not a commercially important species, there has been little research directed at their life-history. However, considerable numbers are taken as bycatch and discarded in fisheries for sablefish and Greenland turbot in Alaska. In addition, the large abundance of giant grenadier on the continental slope makes them very important ecologically in this habitat. The objectives of this study were to describe the ovarian development of giant grenadier, as well as examine their growth, maturity-at-age, and natural mortality. We sampled giant grenadier from the Gulf of Alaska during the summer AFSC longline survey in 2004 and 2006 and found that their spawning period is likely protracted because ovaries were observed in every stage of development. The age-at-50% maturity was 24.9 when histology was used to aide in ovarian staging and 21.7 when only visual staging at-sea was used, a difference of 3.2 years. The pre-anal fin length-at-50% maturity (length from the tip of the snout to the start of the anal fin) was 26 cm when histology was used for staging. At-sea staging resulted in incorrectly staging 15% of immature fish as mature and 18% of mature fish as immature. Because ovarian walls can thicken after maturity is reached, we were able to successfully place 31% of ovaries with an unknown maturity status into a category based on wall measurements. Total fecundity ranged from 35,000-231,000 (mean = 106,761, Std = 58,687). The estimate of maximum age was 58 years, but giant grenadier may live even longer than this because specimens larger than those sampled for this study have been caught on the AFSC longline survey. Estimates of natural mortality ranged from 0.052-0.106 and estimates of total mortality were 0.047 and 0.149. Therefore, our data indicates that giant grenadier are a long-lived, late-maturing species, with low natural mortality. Basic knowledge of these life history parameters were previously unknown and will be essential for the future management of giant grenadier in Alaska.

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

Social behavior as related to coloration changes in Atka mackerel - Bob Lauth is investigating color variability of Atka mackerel and the temporal expression of different color patterns as they relate to observed social behavior. Direct observations of Atka mackerel exhibiting different color patterns and social behaviors during daily vertical migrations and during reproductive and non-reproductive periods were made *in situ* with underwater video cameras, and with animals that were in captivity at the Alaska Sealife Center. Bob made a presentation of this research at the Atka Mackerel Research Symposium held at the AFSC from 29-30 April.

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

Annual Gulf of Alaska Mesopelagic Survey Completed - In March, the Groundfish Assessment Program (RACE Division) conducted its second annual Mesopelagic Survey. The mesopelagic zone, which ranges from 200 – 1,000 m, is home to many small, deepwater fish species (e.g., lanternfish and deep-water smelts), as well as many midwater invertebrates that form a forage base for a variety of demersal and pelagic fish species, marine mammals, and seabirds.

The 2008 Mesopelagic Survey was conducted from March 12 – 18 as the first part of a two-part cruise aboard the NOAA ship *Miller Freeman*. During the survey a total of six stations, spaced approximately 40 nm apart, were sampled along the shelf break between Kodiak and Middleton Islands in the Gulf of Alaska. The gear used to sample these stations was the large, midwater Aleutian Wing Trawl (AWT) with a 1/2” stretched-mesh liner in the codend. Each station was sampled with a daytime and a nighttime series of tows, each series consisting of three tows at 250, 500, and 1,000 m depths. The trawl was towed at 3 knots for 30 minutes once it had reached its target depth.

After the catch was brought aboard, all organisms were sorted to the lowest taxonomic group possible, then counted and weighed. The most common species were frequently sub-sampled. Length frequencies, stomach samples and voucher specimens were then collected. Favorable weather and good sampling conditions made for a successful cruise, enabling us to complete 33 out of 36 possible tows.

For more information, contact Nate Raring at (206) 526-4502.

b. Stock Assessment

Shark Bycatch in Alaskan Waters - The shark bycatch assessment chapters from 2006 for the Bering Sea/Aleutian Islands (BSAI) and for Gulf of Alaska (GOA) were updated for 2007 and presented to the North Pacific Fishery Management Council's Groundfish Plan Teams in November 2007.

Incidental catch estimates for sharks are now available from the NMFS Alaska Regional Office (AKRO). Incidental catch for sharks was updated with the most recent AKRO estimates, and incidental catch from the years 1997–2005 was established as a baseline for identifying options for setting future sustainable incidental catch limits for sharks in the BSAI and GOA. Bottom trawl survey biomass data were updated for the 2007 Eastern Bering Sea (EBS) shelf. Previous survey data were available from NMFS AFSC bottom trawl surveys in the EBS shelf (1979–2005), EBS slope (historical 1979-1991, and new time series 2002, 2004), and Aleutian Islands (1980–2006). GOA bottom trawl survey biomass data were updated for 2007. Previous trawl survey data were available from NMFS AFSC bottom trawl surveys conducted triennially and biennially in the GOA (1984–2005).

There are currently no directed commercial fisheries for shark species in federally or state managed waters of the BSAI or GOA, and most incidentally captured sharks are not retained. In the BSAI, average incidental catch of Pacific sleeper sharks from 1997–2005 (445 mt) represented 2.6% of the available Pacific sleeper shark biomass from BSAI bottom trawl surveys in 1996–2007 (total of the average biomass from three surveys was 17,070 mt). Historically, BSAI survey catches of Pacific sleeper sharks were rare, and abundance trends from the surveys were unreliable as evidenced by the high uncertainty in the biomass estimates. However, the new EBS slope bottom trawl survey (2002 and 2004) showed a substantial biomass of Pacific sleeper sharks on the EBS slope in 2002 (25,445 mt) but not in 2004 (2,260 mt). The EBS slope survey has not been conducted since 2004 due to budget constraints. The EBS shelf survey did not encounter sharks in 2007 and the biomass estimates were zero. Spiny dogfish and salmon sharks were rarely encountered in commercial fisheries or bottom trawl surveys in the BSAI. Therefore, spiny dogfish and salmon sharks were not assessed separately in the BSAI.

In the GOA, average bycatch of spiny dogfish from 1997–2005 (422 mt) represented less than 1% of the available spiny dogfish biomass from GOA bottom trawl surveys in 1996–2007 (average biomass of spiny dogfish in the surveys was 66,771 mt). The 2001 survey did not include all areas of the Eastern GOA; hence, it may not be comparable with the other surveys for species such as spiny dogfish which appear to be relatively abundant in the Eastern GOA. Average bycatch of Pacific sleeper sharks from 1997–2005 (313 mt) represented less than 1% of the available Pacific sleeper shark biomass from GOA bottom trawl surveys 1996–2005 (average biomass of Pacific sleeper sharks was 37,821 mt). Average bycatch of salmon sharks from 1997–2005 (63 mt) was relatively small, and GOA bottom trawl survey biomass estimates for salmon sharks were unreliable because salmon sharks were only caught in four hauls from 1996–2007.

For more information, contact Cindy Tribuzio at (907) 789-6415.

Grenadiers in Alaska - In 2006, a comprehensive assessment was done for the first time for grenadiers in Alaska and incorporated as an appendix into the North Pacific Fishery Management Council's (NPFMC) annual Stock Assessment and Fishery Evaluation Report. This assessment was needed because of the possible inclusion of grenadiers in the NPFMC's Groundfish Management Plans and also because of the relatively large numbers of grenadiers that are taken as bycatch in other directed fisheries. Presently, grenadiers are not "specified" in these management plans. Thus, no previous assessments have been done, fishermen are free to catch as many of these fish as they want, and there is no official tracking of catch by management. In 2007, it was decided that a new, full assessment was not necessary, and thus only an executive summary was prepared. This provided updated catch and survey information, but did not change the ABCs recommended in the 2006 assessment.

Giant grenadier appears to be the only grenadier species to warrant management concern in Alaska at present. Survey information indicates that giant grenadier is the most abundant fish on the continental slope at depths 400-1,000 m in all surveyed areas of Alaska except the eastern Gulf of Alaska. As such, it has a significant role in the slope ecosystem and is an important predator in this habitat. Although there has been little or no directed fishery for giant grenadier in Alaska, substantial numbers are taken as bycatch and discarded in the sablefish and Greenland turbot longline fisheries. Discard mortality is 100%. Estimated annual catches of giant grenadier in Alaska based on observer data have ranged between 11,000 mt and 21,000 mt in the years 1997-2007. By geographic region, these catches averaged 2,924 mt in the eastern Bering Sea (EBS), 2,275 mt in the Aleutian Islands (AI), and 10,791 mt in the Gulf of Alaska (GOA).

In the assessment, data from AFSC bottom trawl and longline surveys were used to compute corresponding biomass estimates of giant grenadier as follows: EBS, 546,453 mt; AI, 1,363,858 mt; and GOA, 486,627 mt. The assessment applied an F=M=0.057 approach to these biomass estimates to compute overfishing levels (OFLs) for giant grenadier in each region, and then multiplied the OFLs by 0.75 to compute the following ABCs: EBS, 23,361 mt; AI, 58,305 mt, and GOA, 20,889 mt. When these values are compared with the estimated catches of giant grenadiers, it appears that giant grenadiers are not being overfished at this time. However, the reported longevity, slow growth, and deep-sea habitat of this species makes it susceptible to overfishing. Furthermore, a high proportion of the catch is likely female because mostly female giant grenadier live at the depths where the commercial fishery operates. Disproportionate removal of females by the fishery could put stocks of giant grenadier at greater risk. Because of these special concerns for susceptibility of giant grenadier to overharvest, fishery managers should closely monitor future catches to ensure that overfishing does not occur.

The AFSC REFM Division Age and Growth Program attempted to age giant grenadier for first time in 2006-2007 based on otoliths collected during the 2004 and 2006 NMFS longline surveys in the GOA for an age of maturity study. A total of 357 fish were aged, and ages ranged from 14 to 58 years. The maximum age of 58 is very close to the maximum age of 56 that was reported for the only other age study of giant grenadier. The aging procedure developed by the Age and Growth Program is considered experimental, and tentative plans are to conduct a carbon-14 age validation study to confirm the ages.

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

D. Other Related Studies

Deep Sea Coral Distribution and Habitat in the Aleutian Archipelago

A unique feature of the benthic environment of the Aleutian Archipelago is a highly diverse and abundant coral and sponge community. Coral abundance far exceeds that reported for other high latitude areas of the world, and there are many endemic species. During this past year, we completed the final report on our study of corals in the Aleutian Islands funded primarily by the North Pacific Research Board. Habitat mapping of seventeen sites covering 2,600 km^2 at depths of 30 – 3,800 m coupled with visual observations to 2,950 m were used to collect biological information and develop predictive models that relate coral and sponge distribution to environmental characteristics. Habitats dominated by bedrock and cobble supported the highest densities of corals. Diversity of corals and sponges increased from deep to shallow water. For the predictive model, explanatory variables included depth, slope, and rugosity, with depth and slope being the most important factors. Models of coral and sponge presence/absence north of the Aleutian Islands Archipelago were more successful than models south of the Archipelago. The most damage and disturbance to coral and sponge communities occurred at depths < 800 m which generally corresponded to the depth limit of the majority of fisheries that use bottom contact gear. There was a consistent positive relationship between damage and disturbance levels and intensity of bottom trawling, whereas results varied for other gear types. Some commercial fish and crab species aggregate in habitats where corals are abundant, making these habitats at risk to fishing gear impacts. Protective measures implemented in the Aleutian Islands include restricting bottom trawling to historically fished areas. While this protective measure may halt the expansion of bottom trawling to areas not fished, the conservation of coral and sponge habitat in fished areas is still of primary concern.

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

Population Structure of Forage Fish in Alaskan Waters Using Genetic Methods

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

Preliminary laboratory analysis has focused on capelin and Pacific herring. Capelin samples from Bering Sea and southeast Alaska collections have being analyzed for a suite of about 30 microsatellite DNA markers. Initial results suggest strong population genetic structuring at this geographic scale. The Bering Sea collection appears to be from a single population; the SE Alaska collections appear heterogeneous and require further investigation. The possible ESA listing of Lynn Canal Pacific herring led to genetic analysis of collections from northern SE Alaska, Sitka Sound, southern Prince of Wales Is., and Prince William Sound. Nine collections have been analyzed for 13 microsatellite markers, with an additional 12 markers to be added. Additional samples collected in 2008 will be examined.

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

Seasonal Distribution and Habitat Use of Forage Fish in Nearshore Waters of Prince William Sound, Alaska

Nearshore fishes were sampled at eight locations in western Prince William Sound (PWS) in July and late August 2007 to determine distribution and diel habitat use. At each location in July, fish were sampled with a beach seine in 3 shallow water (<5 m deep) habitats (eelgrass, kelp, bedrock outcrops); these same sites had been previously sampled in April, July, and September 2006. Total catch was over 5 times greater in July 2007 (28,957 fish) than in July 2006 (5,274 fish); one large seine haul of saffron cod (11,482 fish) and one large seine haul of herring (13,078 fish) accounted for most of the catch in July 2007. Inclusive of all sampling periods, a total of 50,241 fish representing 47 species were captured in 119 beach seine hauls. Four species accounted for 92% of the total catch–in decreasing order of abundance those species were saffron cod, Pacific herring, pink salmon, and capelin. Of the total catch of fish from all sampling periods, 69% were captured in eelgrass, 24% in kelp, and 7% in bedrock outcrops. For forage fish, catches of herring and capelin were highest in eelgrass and kelp. Most herring and capelin captured were young-of-the-year. The schooling behavior and patchy distribution of capelin and herring best describe the infrequent but often large catches of these species.

At each location in August 2007, fish were sampled at low tide with a beach seine in one eelgrass and one understory kelp site; day and night sampling was separated by an average of 62 h. A total of 629 fish representing 20 species were captured during the day and 552 fish representing 30 species at night. Catches between day and night were similar, but the composition of fish species and mean size of fish changed. Species richness was the same in eelgrass during the day and night (mean = 6 species/site), whereas in kelp, species richness was greater at night (mean = 8 species/site) than during the day (mean = 4 species/site). Mean fork length of fish in kelp increased from 107 mm in the day to 121 mm at night and increased similarly in eelgrass from 71 mm in the day to 114 mm at night. Saffron cod, tubesnout, crescent gunnel, manacled sculpin, bay pipefish, Pacific herring, and padded sculpin accounted for about 90% of both day and night catches in kelp and eelgrass. In kelp, herring was the most abundant species during the day (38% of catch), and saffron cod was the most abundant species at night (42% of catch). In eelgrass, saffron cod was the most abundant species during the day (57% of catch) and night (40% of catch). Diel sampling indicates similar fish abundance in nearshore vegetated habitats during day and night, but the number of fish species in kelp habitat increased at night.

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

Experimental Bycatch Studies – rapid decompression and vision – RACE FBE Newport

Fishes can experience rapid decompression during capture resulting in overexpansion of the swim bladder and injuries to multiple organs (barotrauma), including severe exophthalmia ("pop-eye"). Fishes may also be subjected to asphyxia and extended exposure to direct sunlight prior to release. Increased rates of post-release mortality have been documented, but little is known about possible sensory deficits resulting from events accompanying capture. To address this issue, electroretinograhy was used to measure the changes in retinal light sensitivity, flicker fusion frequency, and spectral sensitivity of black rockfish and Pacific halibut resulting from rapid decompression (from 4 atmospheres absolute [ATA] to 1 ATA) or 15 minutes exposure to simulated sunlight. In spite of inducing exophthalmia, rapid decompression had no measurable influence on the visual function of black rockfish. In contrast, exposure to bright light significantly reduced the visual function of Pacific halibut, predominately by affecting a photopigment absorbing most strongly at 550 nm (green) wavelength. This detriment is likely to have severe consequences for post-release foraging success. Our data also show that the visual system of Pacific halibut has characteristics typical of species adapted to function well in low light environments. These characteristics may underlie their vulnerability to injury resulting from exposure to bright light.

Bycatch Reduction – reducing shark catches on longlines – RACE FBE Newport

Spiny dogfish comprise a significant unwanted bycatch on demersal longlines set for halibut and cod in shelf waters of the east and west coasts of North America. A laboratory study was conducted in the AFSC Newport Laboratory to test whether either rare-earth magnets or metal alloys can deter elasmobranch catch. Experiments were made with spiny dogfish and with Pacific halibut in pairwise tests of the rare-earth materials and inert controls. Dogfish attacked and consumed baits tested with cerium mischmetal at a lower frequency than controls. Times to attack the baits were significantly higher in the presence of mischmetal, as were numbers of approaches before first attack. Magnetic fields were detected by the dogfish but they provided no protection for baits in feeding trials. Pacific halibut showed no reaction whatsoever to the rare-earth magnets or cerium mischmetal. A subsequent fishing trial conducted in the Gulf of Alaska showed that dogfish bycatch was reduced 20% when hooks were protected with cerium mischmetal. Reduction in the catch of longnose skate was higher, about 50%. Disadvantages in using mischmetal in commercial operations are expense, hazardous nature, and relatively rapid hydrolysis in seawater.

Fishing gear performance – RACE FBE Newport

Trawl ground-gear can damage the seafloor by dislodging and/or removing macro-invertebrates that provide habitat for demersal groundfish. The RACE division is developing experimental trawl sweeps that ride several inches above the sediment surface, thus reducing damage to seafloor macro-invertebrates, while minimizing loss of catch. Results of laboratory experiments confirm that under ambient illuminations herding by flatfishes (northern rock sole and Pacific halibut) can be initiated by sweeps that are suspended off the bottom. However, the efficiency of sweeps, regardless of height off bottom, is decreased when fish cannot see, as more fish are lost both over and under the sweep. Since ambient light conditions on the seafloor can vary dramatically with depth and turbidity, as well as time of day, these experiments suggest that capture efficiency of both commercial and survey gear may vary considerably. Along Measurement of ambient light at fishing depth may be an important parameter that needs to be measured and incorporated into survey methodologies.

Surveys with underwater vehicles – RACE FBE Newport

Under-water vehicles, including ROVs, AUVs, submersibles and towed sleds, are increasing being utilized in fisheries research for studying fish behavior, characterizing habitat and even conducting surveys over bottom where traditional gear is impractical. All means of enumerating fish involve bias, yet little is known regarding bias attributable to fish behavior for visual transects conducted using under-water vehicle (UVs). Experiments were conducted in a 10.7 m long tank to assess the behavioral response of 8 north Pacific groundfish species to a light stimulus simulating the approach of a UV, under ambient illumination simulating both daytime and nighttime at the depths where each species commonly occurs. The 8 species examined included sablefish, Pacific halibut and lingcod, as well as 5 members of the genus *Sebastes*. Movement (either away or towards the light stimulus) and changes in general activity varied greatly among species. The most active species, sablefish, became agitated and moved away from the looming light source, while the least active, Pacific halibut and lingcod, typically remained stationary. Of the 5 rockfish species, 3 demonstrated a significant influence of ambient light level on responsiveness. Yelloweye rockfish avoided the looming light under low ambient light, but were attracted under high ambient light. These results suggest that bias differs among species, being greatest for those that are highly active and mobile. Further, for other species ambient light may modulate bias, such that researchers need to be cautious about comparing results for surveys conducted at different depths and/or time of day.

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

RACE Habitat Research Team

Research by the RACE Division Habitat Research Team (HRT) addresses Congressional mandates to describe and identify essential fish habitat (EFH) of federally managed species in Alaska. In practice, systematic trawl survey data are used to designate EFH as those areas supporting the highest relative abundance. This presumes that density data reflect habitat utilization, and the degree to which a habitat is utilized is assumed to be indicative of habitat value. Subsequent characterization of the habitat in these areas requires systematic mapping of the relevant biotic and abiotic variables, and the development of quantitative habitat models. The research themes of the HRT include: (1) the identification of suitable predictor variables for building quantitative habitat models, (2) the development of tools for mapping these variables over large areas, and (3) the investigation of activities with potentially adverse effects on EFH, such as bottom trawling. In FY07, habitat biologist Mark Amend moved to the private sector and was replaced by Steven Intelmann. Mr. Intelmann was previously a Habitat Mapping Specialist at the NOAA Olympic Coast National Marine Sanctuary and brings considerable hydrographic/acoustic expertise to the HRT. Later this year, NOAA Corps hydrographer LT John Lomnickey will complete his three-year assignment as a Benthic Mapping Specialist, the first such cross-over billet between NOAA hydrography and fisheries. His replacement, ENS Meghan McGovern is scheduled to report in June 2007.

The main research focus in FY07 was on evaluating acoustic backscatter and benthic infauna community as predictors of groundfish distribution. Results of a study in 2002 in Bristol Bay to model the relationship between processed side scan sonar backscatter data and groundfish distributions were published (Yeung and McConnaughey 2008). Results of another study in 1999 in the eastern Bering Sea (EBS) to model the relationship between single-beam echosounder backscatter and groundfish distributions will soon be available (McConnaughey and Syrjala). Acoustic data collected in 2006 during the multi-mission hydrographic-fisheries experiment (“FISHPAC”) in the EBS were processed and prepared for analysis. Processing of the infauna and sediment grab samples collected during FISHPAC 2006 was completed, and analysis is proceeding on the inter-relationships between sediment type, infauna community, and the distribution of groundfish. Meanwhile, preparations are underway for the second FISHPAC experiment in FY08, during which the study area will be extended northwards of FISHPAC 2006.

2007 HRT Research Activities

Long-range fisheries sidescan sonar (LRSSS) R&D - The broad scope of the EFH mandate requires an efficient process for identifying and mapping habitat. Although research indicates surficial sediments affect the distribution and abundance of many groundfish species, direct sampling with benthic grabs is prohibitively expensive over large areas. Similarly, it has been estimated that remote sensing with conventional multibeam echosounders will require over 545 years and $5 billion to acquire data for mapping the U.S. EEZ. The development of a Long Range Side Scan Sonar (180 kHz) capable of very broad coverage (1.2 km swath) addresses the need for greater efficiency when mapping and characterizing the seafloor for fisheries and habitat research. Research and development of the LRSSS and its fiber-optic interface has been progressing since 2004. A prototype LRSSS was successfully deployed and data were acquired during the 2006 FISHPAC experiment in the southeastern Bering Sea. The Factory Acceptance Test for the first of two LRSSS systems is ongoing with delivery of the first system scheduled for Spring 2008. In addition to side scan sonar, the LRSSS towfish also carries an independent single beam echosounder, an integrated multibeam echosounder, and a triplet of optical scatter sensors that measures the concentration of chlorophyll-a, dissolved organics and total particulates.

Acoustic backscatter for Essential Fish Habitat characterization (FISHPAC) - The first FISHPAC field experiment was conducted in the EBS in the summer of 2006 aboard the NOAA ship FAIRWEATHER[1]. The scientific objective of the cruise was to evaluate the utility of acoustic backscatter data for characterizing EFH, while simultaneously comparing the performance of five different sonar systems. The five systems included two hull-mounted multibeam echosounders on FAIRWEATHER (50 kHz, 100 kHz); a high-resolution interferometric side scan sonar (455 kHz), the prototype LRSSS (180 kHz), and a vertical incidence echosounder (38 kHz) mounted on the LRSSS towfish. Multiple passes were made along 720 nm of survey tracklines spanning strong gradients of groundfish abundance that are represented in a time series of fixed-station annual trawl survey catches. Three sampling devices - (1) a Free Fall Cone Penetrometer (FFCPT), (2) a SEABed Observation and Sampling System (SEABOSS), and (3) a Towed Auto-Compensating Optical System (TACOS) - were used at selected stations on the tracklines to groundtruth acoustic backscatter and assemble a mutifaceted understanding of the seafloor. The performance of each acoustical system will be evaluated based on the degree of statistical correlation between normalized backscatter and fish density. The benefits and costs of each system will be compared to identify the most appropriate system for broad-scale mapping of the EBS shelf. Acoustic data are being processed in collaboration with FISHPAC research partners at the University of New Hampshire Center for Coastal and Ocean Mapping and the NOAA Pacific Hydrographic Branch. Approximately 920 nmi of unique trackline data were acquired using the FAIRWEATHER's two multibeam echosounders. These bathymetry data have been processed and formally submitted for NOAA nautical chart updates. FFCPT data, TACOS imagery, and SEABOSS imagery have been processed. Infauna identification and sediment grain size analyses have been completed. The second FISHPAC experiment will be conducted in 2008 with the same objectives and experimental design to

[1] See http://www.afsc.noaa.gov/RACE/surveys/cruise_archives/cruises2006/results_FW-FISHPAC2006.pdf

acquire habitat and acoustic data north of the 2006 study area. Coverage of the entire EBS with the most cost-effective acoustic system is targeted in the future.

Reconnaissance mapping with side scan sonar - A reconnaissance of Bristol Bay seafloor habitats was undertaken in 2002 using a high-resolution 455 kHz side scan sonar (Klein model 5410). The reconnaissance effort was centered on an 800 mi^2 area of central Bristol Bay that has never been surveyed by NOAA hydrographers. A 150 m swath of bathymetric data and imagery was collected along survey lines totaling nearly 600 linear miles. In addition to providing spatial context for the ongoing trawl impact study in Bristol Bay, the survey also intersected 18 RACE Division trawl survey stations and followed 78 mi of seabed previously classified using a *QTC View* single beam acoustic system. Imagery was systematically groundtruthed using an underwater video camera and van Veen grab samples. Acoustic variables from *QTC* software processing of raw digital backscatter data were used in multiple linear regression to model individual species abundance from bottom-trawl survey data. The acoustic variables are the three Q-values (Q1, Q2, Q3) representing the first three principal components of the data derived from image analysis of backscatter echoes, and a complexity metric (compx) measuring the variance of Q-values in a geographic area. Habitat models for flathead sole, Pacific cod, walleye pollock, red king crab, basket star, and sponges include acoustic variables as significant predictors. For these six taxa, full models explained 67-86% of variability in abundance, with 9-54% of that total contributed by the acoustic predictors (Yeung and McConnaughey 2008). The results suggest that acoustic data could advance habitat research for some bottom-associated marine species.

Evaluating single beam echosounders for synoptic seabed classification - Nearly 8 million digitized echo returns from the seafloor were simultaneously collected at two frequencies (38 and 120 kHz) along a 9,000 nm trackline in the EBS during a 1999 hydroacoustic fishery survey on the NOAA ship MILLER FREEMAN. The acoustic data have been processed with QTC algorithms to produce continuous variables, namely the first three principal components (the Q-values Q1, Q2 and Q3). These results have been merged with 23 years of RACE trawl survey data from the EBS shelf (1982-2004). Statistical analyses using generalized additive models (GAM) showed significant contributions of the continuous acoustic variables to the best habitat models for eight species of fish and two species of crab: Alaska plaice, yellowfin sole, flathead sole, rock sole, arrowtooth flounder, Pacific halibut, Pacific cod, walleye pollock, snow crab, and opilio crab. The full models explained 28-77% of variability in abundance, with 2-13% of that contributed by the acoustic variables (McConnaughey and Syrjala, in prep.). The results presented here are similar to, but less compelling than the study using side scan sonar in Bristol Bay. Taken together, the studies suggest there are important differences in the relative costs and benefits of different acoustic systems and these should be considered when developing plans for broad-scale (EEZ) seabed mapping. Collaborative research with QTC has also resulted in a fully-automated objective classification process based on the Q-values, involving a new application of the Bayesian Information Criterion (BIC). An optimal classification scheme for the EBS shelf has been identified (14 distinct classes of bottom types for 38 kHz data).

Short-term trawling effects and recovery monitoring in the EBS - This ongoing multi-year study is a process-oriented investigation of short-term effects and recovery using a BACI experimental design. The study area is located within the Crab and Halibut Protection

Zone 1 closed area in Bristol Bay. During a 35-day cruise in 2001, 6 pairs of predesignated 10-mi long research corridors were sampled before and after a trawling disturbance with commercial gear (NETS 91/140 Aleutian cod combination). Quantitative assessments of epifauna and infauna populations were undertaken before and after trawling. The experimental and control corridors were also surveyed before and after trawling using a Klein 5410 side scan sonar system. The corridors were revisited in 2002 to monitor recovery. There was no commercial trawling event in 2002. A total of 36 epifauna trawls, 72 infauna grabs, 72 sediment grabs, and one side scan survey per corridor were performed. Combined, these data quantify recovery in the experimental corridors after one year using corrections for temporal variability measured in the control corridors. The experimental design for this study will accommodate one additional series of epifauna sampling and multiple years of grab sampling after 2002; the final recovery monitoring event is tentatively scheduled for Summer 2009. Processing of all 2001 and 2002 samples has been completed and analysis is in progress. Preliminary observations indicate a very diverse epifaunal community (approximately 90 distinct taxa) on very-fine olive-gray sand at 60 m depth. The seafloor appears to be brushed smooth in the 2001 side scan imagery, probably due to the sizable storm waves and strong tidal currents that regularly disturb the area. Occasional video deployments on the trawls indicated somewhat greater complexity. Derelict crab pots are scattered throughout the study area and there is evidence of extensive feeding by walrus (Bornhold *et al.* 2006[2]). The physical effects of trawling were not dramatic due to the tightly compacted coarse-sand condition of the seabed, however distinctive patterns were detectable in the post-trawl sidescan surveys that were not present in imagery collected prior to trawling.

Infauna community for Essential Fish Habitat characterization – The development of habitat models for managed species in the EBS is hampered by a lack of basic environmental and ecological information. In particular, there is a critical need for studying benthic infauna as a component of essential fish habitat (EFH) and a link in fisheries productivity. Benthic infauna constitute substantial portions of the diets of many fishes, crustaceans, mollusks, marine mammals and seabirds at various ontogenetic stages. Since food availability is a strong driving force in habitat selection, the structure of the infauna community can be a useful predictor of favorable habitat for fish/invertebrate predators. Benthic infauna are also key indicators of biodiversity, as well as the primary group used in monitoring anthropogenic and natural changes in benthic, especially soft-bottom, environments. The HRT is collaborating with the Resource Ecology and Ecosystem Modeling (REEM) program (Mei-Sun Yang) of the AFSC Resource Ecology and Fisheries Management (REFM) division to study the infauna community in the EBS for EFH characterization. The initial steps are to describe the spatial patterns of the infauna community and associated habitat characteristics, and to spatially link these variables to groundfish distributions. Next, functional relationships will be established and incorporated into habitat models for individual groundfish species. The first data set was acquired during the 2006 FISHPAC survey. Infauna grab samples were collected at 26 selected stations on the tracklines and are being analyzed in relation to habitat variables and groundfish distribution using multivariate ordination methods. Additional grab sampling is planned during the 2008 FISHPAC survey, extending coverage north of the 2006 survey. Collection of the stomachs of selected flatfish species such as yellowfin sole is also planned in parallel during the RACE

[2] Bornhold, B.D., C.V. Jay, **R.A. McConnaughey**, G. Rathwell, K. Rhynas and W. Collins. 2006. Walrus foraging marks on the seafloor in Bristol Bay, Alaska – a reconnaissance survey. Geo-Marine Letters 25: 293-299.

summer bottom trawl survey in 2008 at the locations of grab sampling. A primary objective of the 2008 study is to directly establish habitat usage by matching stomach contents of groundfish to the available prey field.

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

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

Research Related to Improving Bottom Trawl Surveys

Working Group for Bottom Trawl Survey Improvements (WGBTSI) - Reducing Error in Area Swept Estimates - In January 2006, the Groundfish Assessment Program (GAP) formed a Working Group for Bottom Trawl Survey Improvements (WGBTSI) to assess our survey methodology in the context of the best available science. The primary goal of the WGBTSI is to critically review GAP bottom trawl surveys and to make recommendations for reducing systematic errors in survey procedures and data analyses. Between December 2007 and May 2008, the group focused on reviewing the manner in which various types of data are collected during surveys. Data types considered were:

1) Catch data where issues include weighing big catches, splitting and sorting, and collecting mixture subsamples;
2) length data where issues include collecting random sample, number of fish needed, and collecting separate length samples from juveniles and adults;
3) Specimen data where issues include otoliths (random vs. stratified by size, number of fish needed, separating juveniles from adults), and length-weight parameters;
4) Environmental data where issues include what data we collect now and what data we should collect; and
5) Acoustic data to augment trawl data we collect.

At the final meeting before field season begins, we discussed how we might fit all these factors as well as those previously discussed, together to create the Ideal New Bottom Trawl Survey.

For additional information please contact Stan Kotwicki, (206) 526-6614.

E. Other Items

GIS Resources

Data - Shuttle Radar Topography Mission (SRTM), SRTM30_PLUS: STRM30, Coastal & Ridge Multibeam, Estimated Topography Higher resolution gridded world elevation data combined with improved data from Sandwell Lab. More information is available at http://topex.ucsd.edu/WWW_html/srtm30_plus.html and ftp://topex.ucsd.edu/pub/srtm30_plus/README.V3.0.txt.

> "Ocean data are based on the Smith and Sandwell global 2-minute grid between latitudes ± 72 degrees. Higher resolution grids have been added from the LDEO Ridge Multibeam Synthesis Project and the NGDC Coastal Relief Model. Arctic bathymetry is from the International Bathymetric Chart of the Oceans (IBCAO) [Jakobsson et al., 2003]."
> Quoted from: http://topex.ucsd.edu/WWW_html/srtm30_plus.html

Software – Two free useful tools for ESRI ArcGIS desktop - Tools for Graphics and Shapes available from:
http://www.jennessent.com/arcgis/arcgis_extensions.htm or
http://arcscripts.esri.com/details.asp?dbid=15376 includes a large suite of tools for calculating geometric attributes of vector features and for selecting and naming graphics. This extension offers tools for calculating the true area and centroid of polygons as they lay on the sphere, thereby avoiding errors caused by projection distortions. There are also tools to calculate true lengths of polylines as they lie on the spheroid, using Vincenty's equations. The manual thoroughly explains all algorithms used to calculate geometric attributes on the sphere and spheroid.

If you need to calculate a line from a coordinate value using distance and azimuth (bearing), check out the Military Analyst extension as well as the Military Analyst toolbox, available from http://www.esri.com/software/arcgis/extensions/militaryanalyst/index.htm
After installation start ArcMap and turn on the extension through Tools-Extension. Next add the toolbar through View-Toolbars-Military Analyst. From the Military Analyst toolbar, select Geodesy Calculator to place a graphic on your map using location, distance, and azimuth.
To convert your table of locations, distances and azimuths to lines (shapefile) add the military analyst toolbox to your project. Open up ArcToolbox, right click on ArcToolbox and select "Add Toolbox…". In the window that opens, navigate to C:\Program Files\ArcGIS\ArcToolbox\Toolboxes. Select Military Analyst Tools.tbx and select open. In ArcToolbox you now have Military Analyst tools.

Look here for the Geometry folder. Inside here is the tool "Table to GeodesyLine" which will enable you to convert your table of locations, distances and azimuths to lines.

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

APPENDIX I - Alaska Fisheries Science Center Groundfish-Related Publications and Documents In Press – January 2007 through April 2008

(AFSC authors in bold text)

Alaska Fisheries Science Center (AFSC) Peer-Reviewed Journal Reports and Technical Memoranda in 2007 (AFSC authors are in bold).

Note: Listings of 2007 Groundfish Stock Assessment Reports and AFSC Processed Reports are accessible by following the links provided below to the appropriate AFSC web page.

[This appendix is currently preliminary and organize by workgroup. It will be compiled and revised later.]

Auke Bay Laboratories Groundfish-Related (ABL authors in bold) Publications and Papers, Jan 1, 2007 - Mar 31, 2008

Clausen, D. M and **J. T. Fujioka.** 2007. Variability in trawl survey catches of Pacific ocean perch, shortraker rockfish, and rougheye rockfish in the Gulf of Alaska. In J. Heifetz, J. DiCosimo, A. J. Gharrett, M. S. Love, V. M. O'Connell, and R. D. Stanley, (eds.). Biology, assessment, and management of north Pacific rockfishes. Alaska Sea Grant, University of Alaska Fairbanks. p 411-428.

Clausen, D. M. 2007. Shortraker and other slope rockfish. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 735-780. North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 99501-2252.

Clausen, D. M. 2008. The giant grenadier in Alaska. In A. M Orlov and T. Iwamoto (eds.). Grenadiers of the world oceans: biology, stock assessment, and fisheries. Amer. Fish. Soc. Symposium 63. (in press).

Courtney, D. L., J. N. Ianelli, **D. Hanselman**, and **J. Heifetz**. 2007. Extending statistical age-structured assessment approaches to Gulf of Alaska rockfish (*Sebastes* spp.). In J. Heifetz, J. DiCosimo, A. J. Gharrett, M. S. Love, V. M. O'Connell, and R. D. Stanley, (eds.). Biology, assessment, and management of north Pacific rockfishes. Alaska Sea Grant, University of Alaska Fairbanks. p 429–449.

Fujioka, J.T., **C. R. Lunsford, J. Heifetz,** and **D. M. Clausen.** 2007. Stratification by echosounder signal to improve trawl survey precision for Pacific ocean perch. In J. Heifetz, J. DiCosimo, A. J. Gharrett, M. S. Love, V. M. O'Connell, and R. D. Stanley, (eds.). Biology, assessment, and management of north Pacific rockfishes. Alaska Sea Grant, University of Alaska Fairbanks. p 473-492.

Gharrett, A. J, A. P. Matala, E. L. Peterson, **A. K. Gray**, Z. Li, and **J. Heifetz**. 2007. Distribution and population genetic structure of sibling rougheye rockfish species. In J. Heifetz, J. DiCosimo, A. J. Gharrett, M. S. Love, V. M. O'Connell, and R. D. Stanley, (eds.). Biology, assessment, and management of north Pacific rockfishes. Alaska Sea Grant, University of Alaska Fairbanks. p. 121-140.

Hanselman, D. H, C. R. Lunsford, J. T. Fujioka, and **C. J. Rodgveller**. 2007. Alaska sablefish assessment for 2008. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 195-312. North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 99501-2252.

Hanselman, D., J. Heifetz, J. T. Fujioka, S. K. Shotwell, and J. N. Ianelli. 2007. Gulf of Alaska Pacific ocean perch. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 563-622. North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 99501-2252.

Hanselman, D., P. Spencer**, K, Shotwell,** and R. Reuter**.** 2007. Localized depletion of three Alaska rockfish species. In J. Heifetz, J. DiCosimo, A. J. Gharrett, M. S. Love, V. M. O'Connell, and R. D. Stanley, (eds.). Biology, assessment, and management of north Pacific rockfishes. Alaska Sea Grant, University of Alaska Fairbanks. p 493–511.

Heifetz, J., C. Rodgveller, D. Courtney, **C. Tribuzio**, and K. Goldman. 2007**.** BSAI Sharks. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands region, p. 1033-1080. North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501-2252.

Heifetz, J., D. Hanselman, D. Courtney, and J. Ianelli**.** 2007. Gulf of Alaska northern rockfish. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 623-674. North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 99501-2252.

Heifetz, J., D. Woodby, J. Reynolds, and **R. P. Stone.** 2007. Deep sea coral distribution and habitat in the Aleutian Archipelago. North Pacific Research Board Final Report 304, 303p.

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- **Hoff, G.R.** (In Press – July 2008) A nursery site of the Alaska skate Bathyraja parmifera in the eastern Bering Sea Fishery Bulletin.
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- **Stevenson, D. E.** and B. Sheiko. In Review. Clarification of the *Lycodes diapterus* species complex (Perciformes: Zoarcidae), with comments on the subgenus *Furcimanus*. Copeia.
- **Weinberg, K. and S. Kotwicki** (equal authorship). In review. Factors influencing net width and sea floor contact of a survey bottom trawl. Fisheries Research

RACE Groundfish Assessment Program, Habitat Research Team

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RESOURCE ASSESSMENT AND CONSERVATION ENGINEERING DIVISION
ORGANIZATION CHART
2006

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- Deputy Director: R. Nelson*
- Secretary: R. Erickson

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- K. Weinberg
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- J. Orr
- N. Raring
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- B. Laurel
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January 2006

APPENDIX III.--RESOURCE ECOLOGY AND FISHERIES MANAGEMENT DIVISION

Patricia Livingston -- Director

Loh Lee Low -- Deputy Director

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Goiney, Bernie	Anderl, Delsa	Conners, Liz	Buckley, Troy	Haynie, Alan
	Benson, Irina	Dorn, Martin	Derrah, Christopher	Hiatt, Terry
	Gburski, Chris	Greig, Angie	Lang, Geoffrey	Lew, Dan
	Goetz, Betty	Gaichas, Sarah	Yang, Mei-Sun	Sepez, Jennifer
	Hutchinson, Charles	Ianelli, James		Seung, Chang
	Johnston, Chris	Logerwell, Libby		
	Kastelle, Craig	Lowe, Sandra		
	Foy, Dan	Munro, Peter		
	Kautzi, Lisa	Pearce, Julie		
	Shockley, Wes	Spencer, Paul		
	Short, Jonathan	Thompson, Grant		
	Piston, Charlses	Turnock, Jack		
	Brogan, John	Stockhousen, Buck		
		Wilderbuer, Thomas		
		Neidetcher, Sandi		
		McDermott, Susanne		

ADP

Blaisdell, Mark

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Revised April 2005

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

2007 Alaska Fisheries Science Center Supplement

Research and Data Collection
Project Summaries and Updates, 2007

Alaska Recreational Fisheries Demographic Data
Jennifer Sepez
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Recreational fishing draws significant participation in Alaska by in-state and out-of-state participants. The activity generates considerable revenue, may have substantive ecosystem impacts, and adds further complexity to allocation decisions. In this research a demographic profile of recreational fishing in Alaska is presented, based on data from the Alaska Department of Fish and Game's license sales database from 1993-2005 and a NOAA Fisheries survey of licensed marine anglers in Alaska in 2002. Information such as age, gender, race/ethnicity, education, income, and number of days fished were evaluated. Alaska resident anglers differ from out-of-state anglers in all of these categories. Expansion in the recreational fishery over the last decade, as indicated by increase in license sales, was driven almost entirely by out-of-state participants. These demographic differences and growth trends help shape a fuller understanding of the fishery that is the basis for informed management decisions. Presentations of these data so far include:

Little, J. and J. Sepez. 2006. "Demographics of Recreational Fisheries in Alaska." Poster presented at Society for Human Ecology meetings, Bar Harbor, October 2006. ftp://ftp.afsc.noaa.gov/posters/pLittle01_demographics.pdf

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Amendment 80 Head and Gut Catcher/Processor Sector Economic Data Collection
Brian Garber-Yonts and Ron Felthoven
**For further information, contact Brian.Garber-Yonts@NOAA.gov or Ron.Felthoven@NOAA.gov*

Beginning in 2008, the non-AFA Trawl catcher/processing (CP) sector will be rationalized under a fishery cooperative program. Under the terms of the June 2006 Council motion, a mandatory socioeconomic data collection program will be implemented for the entire sector. Key elements of the Amendment 80 problem statement are the reduction of bycatch and improved utilization of groundfish. Socioeconomic data are needed to assess whether the cooperative formation addresses the goal of mitigating the costs associated with bycatch reduction, to understand the economic effects of the Amendment 80 program on vessels or entities regulated by this action, and to inform future management actions. The program will collect cost, revenue, ownership, and employment data on an annual basis. During 2nd Quarter, 2007, ESSRP scientists developed draft data collection instruments and, in collaboration with NMFS Alaska Region staff, prepared regulatory text and draft Paper Reduction Act (PRA) documentation to support the data collection program. Data collection for the H&G fleet is expected to begin in 2009.

BSAI Crab EDR Validation Audit
Ron Felthoven and Brian Garber-Yonts
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In collaboration with Pacific States Marine Fisheries Commission, ESSRP scientists have overseen a validation review of BSAI Crab EDR data by the accounting firm Aldrich, Kilbride and Tatone, LLC (AKT). Principal objectives of the validation exercise are to assess and quantify the measurement error associated with the EDR instruments and provide an incentive to maintain accuracy and rigor in reporting cost and earnings information. The validation review includes both random audits, based on a statistical sample of the EDR population, and non-random audits of EDRs identified on the basis of missing variables or outliers in reported information. As of March 2007, a portion of the audits remained incomplete due to non-response from submitters, who were referred to NMFS Alaska Region enforcement. AKT selected vessels or processors for audit based upon a statistical sample; for each vessel or processor selected for audit, detailed support was requested and examined for each year in which the selected vessel or processor submitted an EDR. Variables for audit were selected from those that could be validated by documented support. For each data variable requested, AKT critically evaluated the support provided against third party support, such as invoices or fish tickets; internally-generated information, such as crew settlement sheets, general ledger details, detailed internal reports, or financial statements; and estimates made, including the reasonableness of assumptions. AKT also noted when no support was available to evaluate the information. Preliminary results of the audit indicated that the information submitted in EDRs was generally well-supported by documentation and records. However, despite the specific definitions included in the EDRs, there is still variability in how information is reported based upon the ability to break down information in the manner requested in EDR forms. In addition, there is significant variability in the quality of supporting documentation to information submitted in the EDRs. A final revision of the audit report was completed in early 3rd quarter FY07 and used in development of data quality protocols for the crab EDR data and revisions to the EDR forms.

BSAI Crab EDR Data: Protocols for Confidentiality and Data Quality
Brian Garber-Yonts
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Based on public testimony and a recommendation from the Advisory Panel at the December

2006 meeting, the NPFMC passed a motion directing staff to develop protocols concerning data collected under the BSAI crab rationalization Economic Data Reporting (EDR) program. The protocols apply to two general areas: 1) maintaining data confidentiality and 2) assessing the quality of the data to ensure accuracy. ESSRP scientists prepared a discussion paper to outline the legal, regulatory, and administrative standards that apply to confidentiality and data quality, and remaining issues to be resolved in regard to crab EDR data. The paper sets forth the process that AFSC staff, in collaboration with Council and NMFS Alaska Region staff, will undertake to develop both sets of protocols to ensure that industry and Council concerns regarding the crab EDR program are addressed. The paper was presented at the March/April Council meeting and received the endorsement of the AP and Council (time limitations did not allow the SSC to receive a presentation of the paper). The protocols will be developed with public, industry, and scientific peer input, with workshops to be held during fall 2007.

Collecting Regional Economic Data for Alaska Fisheries

Hans Geier and Chang Seung*
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Regional or community economic analysis of proposed fishery management policies is required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA), National Environmental Policy Act (NEPA), and Executive Order 12866, among others. For example, National Standard 8 (MSA Section 301[a][8]) explicitly requires that, to the extent practicable, fishery management actions minimize economic impacts on fishing communities. To satisfy these mandates and inform policymakers and the public of the likely regional economic impacts associated with fishery management policies, economists need appropriate economic models and data to be used for implementing the models.

While there exist many regional economic models that can be used for regional economic impact analysis for fisheries (Seung and Waters 2006), much of the data required for regional economic analysis of fisheries are either unavailable or unreliable. IMPLAN (IMpact analysis for PLANning) is widely used by economists for implementing various regional economic models. However, for several reasons, it is not advisable to use unrevised IMPLAN data for analyzing U.S. fishery industries in general and Alaska fishery industries in particular. First, IMPLAN applies national-level production functions to regional industries, including fisheries. While this assumption may not be problematic for many regional industries, use of average production relationships may not accurately depict regional harvesting and processing technologies. Therefore, to correctly specify industry production functions, it is necessary to obtain primary data on harvesting and processing sector expenditures through detailed surveys or other methods. Second, the employment and earnings of many crew members in the commercial fishing sector are not included in the IMPLAN data because IMPLAN is based on state unemployment insurance program data which excludes those who are self-employed and casual or part-time workers. Therefore, IMPLAN understates employment in the commercial fishing sectors. Processing sector data is also problematic because of the nature of the industry. Geographical separation between processing plants and company headquarters often leads to confusion as to the actual location of reported employment. Finally, fishery sector data in IMPLAN are highly aggregated. Models using aggregate data cannot estimate the potential impacts of fishery management actions on individual harvesting and processing sectors. To estimate these types of impacts, IMPLAN commercial fishery-related sectors must be disaggregated into subsectors by vessel and processor type. This requires data on employment, labor income, revenues and expenditures (intermediate inputs) by vessels and processors. An additional problem with IMPLAN data in small rural economies like Alaska fishing communities is that data are often inaccurate because of the nature of rural enterprises and populations. Much of rural Alaska operates on a cash or exchange basis, thus much economic activity is not accounted for in conventional data sources. Community surveys are to be used to correct this anomaly in rural Alaska fishing communities (Holland *et al*. 1997).

In sum, while regional economic models for analysis of fisheries do exist, reliable data on fisheries-related economic sectors necessary to implement the models are lacking. The absence and/or deficiencies of these data have severely limited development of viable regional economic models for fisheries. Currently, two data collection projects are underway in the Southwest and Gulf Coast regions of Alaska.

In the two projects, we will collect data on employment, labor income, and costs for fishery industries. For information on employment and labor income, we will use mailout surveys to the fleet. For estimating information on costs, we will use two different methods. First, for much of the operating and ownership costs for vessels, we will use a "cost-engineering" approach in which boat builders and suppliers will be contacted with average vessel specifications, and asked to provide information on costs that these boats will incur. Second, interview and telephone calls will be made to suppliers of inputs to vessels (i.e., local businesses and fish processors).

To date, the following tasks have been completed for the two data collection projects. First, mailout survey questions for three different classes of vessels were developed. Also, the phone interview scripts for vessel owners were developed. Second, the procedures for sampling (unequal probability sampling and determining sample size) were constructed; using the sampling procedures, the optimal sample sizes for the three different vessel classes for each region were derived using Poisson variance. Third, the phone interview scripts for local businesses and fish processors were finalized. Fourth, the paper reduction act (PRA) packets (which include supporting statement) were prepared and submitted to OMB. Fifth, interviews were made with, or telephone calls were made to, boat builders/dealers (for cost engineering). Sixth, visits to processing plants (headquarters) were made to maintain the relationships that are important for data collection. Seventh, community visits were made to groundtruth the IMPLAN information.

The PRA packet for Southwest project was approved by OMB on July 30, 2007. The packet for the Gulf Coast project is still under review at OMB. Once the PRA packet for Gulf Coast project is approved, the schedule for the two projects is as follows: (1) conduct interviews and telephone calls to suppliers of inputs (local businesses and fish processors), (2) conduct Pareto sampling to determine the vessels to which the surveys will be sent, (3) mail out the surveys to vessels, (4) examine the statistical validity of the survey results, (5) revise IMPLAN data with the primary data estimated as above and balance the social accounting matrix (SAM), and (6) develop regional economic models such as input-output (IO) or computable general equilibrium (CGE) models.

It should be emphasized that a good deal of effort has gone into developing an appropriate sampling methodology for the ongoing regional economic data collection projects. Since the majority of gross revenue within each harvesting sector comes from a small number of boats, a simple random sampling (SRS) of boats would only include a small portion of the total ex-vessel values, and therefore, would be misleading. Therefore, an unequal probability sampling (UPS) method without replacement will be used. The objective of implementing the sampling task is to estimate the employment and labor income information for each of three disaggregated harvesting sectors using the ex-vessel revenue information provided by CFEC earnings data. Since each sector will be used as a separate economic sector in the IMPLAN model, we face three separate problems for three different sectors in sampling (and thus must use a UPS without replacement for each sector). Many methods exist in the literature for conducting UPS without replacement. One critical weakness with most of these methods is that the variance estimation is very difficult because the structure of the 2nd order inclusion probabilities is complicated. One method that overcomes this problem is Poisson sampling. However, the problem with Poisson sampling is that the sample size is a random variable, which increases the variability of the estimates produced. An alternative method that is similar to Poisson sampling but overcomes its weaknesses is Pareto sampling (which yields a fixed sample size).

As a result, there are two tasks that we need to accomplish to estimate the population parameters using the UPS. First, the optimal sample size needs to be determined. Second, once the optimal sample size is determined, the population parameters and confidence intervals need to be estimated. For the first task, we will use the Poisson *variance* (not Poisson sampling). For the second task, we will use a Pareto sampling method. In determining the optimal sample size, we will use information on an auxiliary variable (ex-vessel revenue). To estimate the population parameters, we will use actual response sample information on the variables of interest (employment and labor income). With inputs from experts in UPS sampling, a document detailing these sampling procedures has been completed and an Excel program has been developed to show these procedures using example data (2002 ex-vessel value data for the small boat sector).

When these two regional data collection projects are completed, another data collection project for the Southeast region will be conducted. The regional economic models developed with the data obtained via these projects as well as other available data are expected to provide policy-makers with useful information on the effects of fishery management policies on fishery-dependent communities.

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Common Property, Information, and Cooperation: Commercial Fishing in the Bering Sea

Alan Haynie, Kurt Schnier, and Rob Hicks
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A substantial theoretical and experimental literature has focused on the conditions under which cooperative behavior among actors providing public goods or extracting common-property natural resources is likely to occur. The literature identifies the importance of coercion, small groups of actors, or the existence of social norms as being conducive to cooperation. In this paper we investigate a natural experiment in which information on extractive activities with respect to a common property resource is relayed to all players. These players operate under an overall harvest total allowable catch (TAC), and consequently, one player's actions can have a deleterious effect on all players. The case we investigate is incidental catch (termed bycatch) of halibut by the Alaskan flatfish fishery, where participants voluntarily report bycatch information to an agent who then distributes data to the fleet. Consequently, fishermen know the extent to which other fishermen are avoiding bycatch, and are thereby able to observe efforts by other fishermen to avoid bycatch and to extend the fishing season for marketable fish species. Using a mixed logit model of spatial fishing behavior our results show that cooperative behavior is prevalent early in the season, but significant heterogeneity with respect to bycatch avoidance arises as bycatch TACs tighten.

Comprehensive Socioeconomic Data Collection for Alaskan Fisheries

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Many of the fishery management actions taken by the North Pacific Fishery Management Council (NPFMC) require various types of socioeconomic analyses before they can be implemented. Typically these analyses must examine a range of alternatives, and the associated nature, magnitude, and distribution of the economic, welfare, and sociocultural impacts of the proposed action(s). Specifically, economic analyses, including "benefit/cost" analysis, as well as regional and/or community impact analysis of proposed fishery management policies are required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the Endangered Species Act, the Marine Mammal Protection Act, the National Environmental Policy Act (NEPA), and Executive Order 12866, and other applicable Federal laws.

In addition, the 2006 reauthorization of the Magnuson-Stevens Fishery Management and Conservation Act (MSA) includes heightened requirements for the analysis of socioeconomic impacts and the collection of economic and social data. These changes eliminate the previous restrictions on collecting economic data, clarify and expand the economic and social information that is required, and make it explicit that the Councils *and* the Secretary of Commerce have the authority and/or responsibility to collect the economic and social information necessary to meet requirements of the MSA (and that either the Councils or the Secretary can initiate the collection of said socioeconomic data).

For these reasons satisfactory socioeconomic analyses are integral to myriad procedural requirements that help the NPFMC achieve their fishery management goals and abide by federal laws. It is clear that without access to the information needed to support many of the aforementioned analyses the associated legal documents may fail to meet established standards. In order to better address these concerns, as well as others pertaining to community impacts, the NPFMC passed an October 2006 motion to draft a comprehensive program for collecting revenue, ownership, employment, cost, and expenditure data for fisheries in and off Alaska.

In response, the Economic and Social Sciences Research Program (ESSRP) at the Alaska Fisheries Science Center (AFSC) coordinated a working group to propose a core set of data that is currently unavailable yet important for answering many of the questions raised when evaluating past and future management decisions, and conducting regulatory and legally mandated analyses. The working group was comprised of individuals representing the National Marine Fisheries Service (NMFS), Alaska Department of Fish and Game (ADF&G) and Commercial Fisheries Entry Commission (CFEC), NPFMC, NOAA GC, and Alaska Department of Commerce (ADOC). As with any working group, there were differences of opinion within the group. For this group, the differences were primarily over the level of detail that should be required in the data collection. However, all involved basically shared the same frustration over the lack of social and economic data and felt that we need to develop a comprehensive program. In an attempt to propose a feasible program and to decrease the perceived reporting burden, and taking into consideration what we've learned in collecting such information in the BSAI crab fisheries, the suggestions included in this paper are typically consistent with the minimum necessary level of detail/information requested by the group (some individuals or agencies requested that much more detailed information be collected). In the discussion paper we lay out these proposed data collection elements and provide a detailed discussion on the need for improved socioeconomic data collection for fisheries in and off Alaska.

Demand for Halibut Sport Fishing Trips in Alaska

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The halibut sport fishery in Alaska is quite large. In 2000, for instance, over 400,000 halibut were harvested by sport anglers in the state (Jennings, et al., 2006). In recent years, harvest in the recreational charter boat sector has exceeded the guideline harvest limit (GHL) in Area 2C (Southeast Alaska). In response, the North Pacific Fishery Management Council (Council) is considering several regulatory changes including, among other options, reducing the allowable catch in the charter boat recreational sector. Catch by non-charter boat recreational halibut anglers are not subject to the GHL and are accommodated through reductions in the commercial TAC. To assess the impacts of pending and potential regulatory changes on sport angler behavior, it is necessary to have estimates of the baseline demand for halibut fishing trips and an understanding of the factors that affect it.

To this end, Dan Lew has been working with Doug Larson (University of California, Davis) to develop and implement a survey that collects information about saltwater recreational fishing trips in Alaska. The project consists of three major phases. The first phase involves developing and pretesting the survey instrument. This phase includes testing the survey instrument using focus groups, cognitive interviews, and a formal pretest survey implementation. These activities were completed in 2006 following OMB approval. During the second phase, final versions of the survey are developed and implemented through a mail survey of Alaska sport anglers. The survey implementation followed a modified Dillman Tailored Design Method to maximize response. This phase of the project was completed in August 2007. The final phase of the project, in which data will be analyzed and results reported, is currently in progress.

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Effects of Rationalization on Processor Competition

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A vital step in predicting how communities will be impacted by fishery rationalization is to understand how rationalization will affect the landing port selection decision of fishers. To accomplish this one must first know how the competitive balance between spatially differentiated processors will change under rationalization. While spatial impacts on competition have been examined in the economics literature from both theoretical and empirical perspectives for a variety of industries, the issue has remained largely untouched with respect to the fish processing industry. The goal of this research is to develop a theoretical model of spatial competition for a fish processing sector and, through the use of simulation analysis, examine how rationalization is expected to impact the competitive behavior of processors under different assumed market and cost structures. In subsequent research, this theoretical model will form the basis for the development of an econometric methodology that will allow applied researchers to empirically estimate spatially weighted price response functions to determine how rationalization has impacted the competition in processing sectors for fisheries that have changed management from regulated open-access to some form of rights-based management.

The relationship between spatial location and pricing behavior has been analyzed for many decades. Ex-vessel pricing, however, introduces interesting market features that are not encountered in more traditional location models. First, location models are often framed as a competitive monopolist situation with no quantity constraints. Ex-vessel markets are often better characterized as monopsonistic markets and the markets are quantity-constrained by total allowable catch measures (TAC). Second, where more traditional location models consider the situation to be one of optimal location choice by competing monopolists, ex-vessel markets present situations where the competing monopsonists (processors) are stationary while the fishers are mobile. Therefore, the goal of this theoretical approach is to determine what pricing behavior processors are likely to exhibit under different assumptions about how fishers choose their fishing location. Monte Carlo simulations will be conducted to identify pricing paths under different model parameter values. Using these simulations we can also assess how our results are affected by assumed cost and market structures of the processor, the spatial abundance of resources, changes in climate, or area closures.

Experimental Design Construction for Stated Preference Choice Experiments

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Stated preference choice experiments, which involve respondents choosing between alternatives that differ in attributes, have been used primarily in the marketing literature to understand consumer preferences for market goods. In recent years, however, their usefulness for gaining insights into preferences for non-market goods has become apparent, and stated preference researchers are increasingly turning to choice experiments to value public goods (Alpizar, Carlsson, and Martinsson, 2001).

Adamowicz, Louviere, and Williams (1994) were the first to apply choice experiments to value public goods in a study of recreational opportunities in Canada. Since then, several studies have used choice experiment approaches to estimate use values for activities like hunting (Adamowicz, et al., 1997), climbing (Hanley, Wright, and Koop, 2002) and recreational fishing (Hicks, 2002; Oh, Ditton, Gentner, and Riechers, 2005). Choice experiments have also been used to estimate non-consumptive use values associated with forests in the United Kingdom (Hanley, Wright, and Adamowicz, 1998), forest loss due to global climate change (Layton and Brown, 2000) and Woodland caribou habitat in Canada (Adamowicz, et al., 1998).

A typical CE involves presenting respondents with two or more choice questions, each having a set of alternatives that differ in attributes. For each question, respondents are asked to select the alternative they like best. The choice responses are used to estimate a preference function that depends upon the levels of the attributes.

In constructing choice experiment questions, researchers must determine the set of attributes and attribute levels that respondents see in each question. This is a critical judgment, as a poor experimental design can preclude estimating important marginal effects, or conversely, a good design can significantly increase the precision of estimated parameters or provide justification for reducing the sample size. The latter is particularly important in light of the cost of carefully-constructed and tested stated preference surveys.

Dan Lew has been working with David Layton (University of Washington) and Bob Rowe (Stratus Consulting) to explore the role of model and parameter uncertainty and their effects on the statistical efficiency of stated preference choice question experimental designs. In July 2006, preliminary results from this research were presented at the Association of Environmental and Resource Economists (AERE) sessions at the 2006 annual conference of the American Agricultural Economics Association (AAEA) meeting in Long Beach, California. During 2007, this research was extended to explore the role of other design assumptions, such as the number of choices, sample size, and numbers of attribute levels, on efficiency of stated preference choice experiment designs.

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Estimating Global Trade from Pacific Fisheries for Regional Economic Models

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Products from Alaska fisheries are consumed around the world. Global demand for these products is an important source of income to Alaska fishermen, processors, and traders. The U.S. regional economic accounts (i.e. IMPLAN) distinguish between domestic versus foreign trade, but do not identify bilateral trade flows between partners. However, information about the volume and value of trade between partners is important for understanding the current, and historic, economic status of a fishery, and thus, for making reasonable projections about future economic conditions. A case in point is the recent surge in U.S. imports of Russian King crab. This goal of this project is to fill gaps in the U.S. regional economic accounts with a set of consistent benchmark data on bilateral trade in select fish products among the U.S., Canada, Mexico, Japan, China, South Korea, Russia, and Vietnam. These benchmark data were obtained or estimated using international trade data from 3 sources: i) U.S. Merchandise Trade Statistics, ii) U.N. Merchandise Trade Statistics, and iii) U.N. FAO Fisheries Statistics for Commodity Production and Trade.

The U.S. and U.N. merchandise trade accounts are classified according to the Harmonized Commodity Description and Coding System (HS), administered by the World Customs Organization in Brussels. The U.S. data are managed by the Foreign Trade Statistics Division of the U.S. Census Bureau. The U.S. data subdivide the 4 and 6 digit HS codes into 10-digit statistical reporting categories. The 10-digit categories (http://www.census.gov/foreign-trade/reference/codes/index.html#concordance) contain many specific categories for U.S. and Alaska fisheries, such as pollock roe and fillets; frozen king, snow, and other crabs; yellowfin sole, Pacific ocean perch, sablefish, lingcod, several types of salmon, and others. In particular, the U.S. data have the volume and value of exports and imports, over time, from each U.S. customs district to each country that is a U.S. trade partner. The FAO data have a similar, or in some instances, a more refined level of detail for fish commodities, and contain information on production and trade for all of the world's fisheries over time. However, the FAO data only give volume and value of aggregate exports and imports for each country, and thus, do not identify bilateral trade flows.

The U.N. Merchandise data are the global source for identifying bilateral trade flows, but these are available only at the HS 6-digit level. For example, a HS 6-digit code identifies frozen crabs, but not the species composition that is identified in the U.S. In addition, while the FAO and U.S. trade data appear to be fairly consistent, the U.N. Merchandise data do not always match well with the other sources. They also appear in some cases to be internally inconsistent in some cases with large differences between exports reported by one country, and corresponding imports reported by another. This type of consistency problem is almost always encountered with input-output (IO) data, and resolving inconsistencies in the international trade data was the primary analytical task in this project.

This project used HS 10-digit U.S. Merchandise data to quantify trade volume and value between the U.S. and each of its trade partners, with emphasis given to Canada, China, Japan, South Korea, Mexico, Russia, and the emerging markets of Vietnam. The 6-digit U.N. Merchandise data was used to construct a set of initial IO matrices of trade flows (with columns of exporting countries and rows of importing countries). A tested and appropriate numerical procedure was then applied to 'balance' these matrices, thus estimating a set of consistent bilateral trade flows from the initial IO matrices using the FAO export/import data as constraints. The next step in this research is to develop a dynamic CGE model with global trade among these countries, which is ongoing work.

Estimating Heterogeneous Capacity and Capacity Utilization in a Multi-Species Fishery
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Ron Felthoven at the AFSC has been working with Professors Kurt Schnier and Bill Horrace at the University of Rhode Island and Syracuse University, respectively, to develop a stochastic production frontier model that accommodates heterogeneous fishing production technologies within a fishery and internally partitions these different technologies into identifiable groups. One of the goals of this research is to investigate the impact of this more flexible model on measures of fleet capacity and capacity utilization in a multi-species fishery. In our research we propose a new fleet capacity estimate that incorporates complete information on the stochastic differences between each vessel-specific technical efficiency distribution. Results indicate that ignoring heterogeneity in production technologies within a multi-species fishery, as well as the complete distribution of a vessel's technical efficiency score, may yield erroneous fleet-wide production profiles and estimates of capacity. Furthermore, our new estimate of capacity enables out-of-sample production predictions predicated on either homogeneity or heterogeneity modeling which may be utilized to inform policy makers. This paper was submitted for publication at the *American Journal of Agricultural Economics*.

Estimating Economic Impacts of Alaska Fisheries Using a CGE Model
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Fixed-price models such as input-output (IO) and social accounting matrix (SAM) models are often used for analysis of fisheries. However, these models have several important limitations. In these models, prices are assumed to be fixed, and no substitution is allowed between factors in production or commodities in consumption. As a result, in cases where the fixed-price assumption may not be realistic, these models tend to overestimate impacts. Computable General Equilibrium (CGE) models overcome these limitations. In CGE models, prices are allowed to vary, triggering substitution effects in production and consumption. The CGE model therefore enables analysts to easily examine the economic welfare implications of a policy change. Furthermore, the CGE approach is generally more appropriate than other regional economic models for analyzing the impacts of a change in productive capacity of resource-based industries.

This project will build a CGE model of the Alaska economy with explicit recognition of the fishery sectors. The investigators will use IMPLAN and other available data. Once developed, the CGE model will be used to estimate the distribution and magnitude of economic impacts associated with harvesting, processing and support activities related to Alaska fisheries. Implementation will include the following steps:

1. Gather recent annual catch for Alaska fisheries from PacFIN, AKFIN, NORPAC and related data systems.
2. Gather summary data on the residence of owners and crews of vessels operating in Alaska fisheries and labor employed by Alaska seafood processors. Data sources include NOAA permits databases, Alaska Department of Labor reports, and other sources. (This

information is important for determining "leakage" of factor income paid to non-residents working in the Alaska economy.)

3. Gather information on cost structures and the locus of input purchases by vessels and processors involved in Alaska fisheries. Major sources of data will include review of relevant literature, and interviews with researchers and key industry informants.
4. Generate a Social Accounting Matrix (SAM) of the Alaska economy using IMPLAN, REIS data, and the information gathered in steps 1–3. The SAM will incorporate the latest comprehensive economic data available and will update and build on earlier work by Seung and Waters (see below).
5. Obtain estimates of the values of key parameters and elasticities governing economic relationships in the Alaska economy. These include aggregate industry supply functions, aggregate household demand functions, and aggregate commodity import and export propensities. The focus will be on those factors, commodities and services of particular importance to commercial fisheries-related economic activity. Sources of information include review of relevant literature and interviews with researchers.
6. Develop a CGE model of the Alaska economy using data assembled in steps 1–5.
7. Use the CGE model to estimate economic impacts of selected, relevant policy issues affecting commercial fishing and related activities in Alaska.
8. Prepare final report and develop drafts for possible publication.

Currently, steps 1-3 above have been completed; the fishery-related data needed to develop the CGE model are ready. The sub-contractors (Shannon Davis and Dr. Hans Radtke) prepared a draft report which documents data sources, summarizes the fishery-related data, and describes the procedures used for preparing the data. This report was reviewed by Dr. Edward Waters and Dr. Chang Seung. The remaining steps will be implemented beginning with development of the SAM and incorporation of the fisheries-related data into the SAM.

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Examining Dynamic Impacts of Alaska Fisheries within Time Series Modeling Framework

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Virtually all regional economic impact models developed so far for analysis of U.S. fisheries are static models. For example, frequently used input-output (IO) models, which have been implemented with IMPLAN for calculating regional economic impacts of fisheries, are static models. However, when the regional economic impacts of fishery management actions are calculated using single period, static models the results can be misleading since most of fishery management policies have permanent effects over time as the impacts occur over a number of periods. With static models, it is impossible to address *the timing of the impacts*, which needs to be considered in formulating fishery management policies. In addition, IO models predict always positive (negative) impacts with positive (negative) shocks to seafood industries. Fishery managers may be misled by relying on only one type of model (IO) in understating regional economic aspects of fisheries. An alternative approach that avoids these weaknesses of an IO model is to instead choose among time series models such as the vector autoregression (VAR) model, Bayesian VAR (BVAR) model, or cointegration model. Developing a time series model for Alaska fisheries will be an important milestone in research on estimating the regional dynamic impacts of fisheries. It will contribute to fishery managers' understanding of how the impacts of fishery policies will be distributed across time and better satisfy the requirements of National Standard 8.

Using borough-level historical monthly NAICS employment data (1991-2005) from the Alaska Department of Labor (ADOL), Chang Seung prepared several different datasets for each of eleven fishery-dependent boroughs or census areas and for each of two fishery-dependent regions (Southwest and Gulf Coast regions). In addition, state-level data from Bureau of Labor Statistics (BLS) was added to the datasets. Professor Ahn, a time series modeler at Washington State University, has conducted preliminary analyses of the borough-level, regional level, and state-level data. The preliminary analyses show that there are not many sectors or industries that exhibit unit root behavior. This led the investigators to analyze the state-level data within a VAR or BVAR framework. Currently, Professor Ahn and Chang Seung are trying to examine the forecasting performance using a VAR model with slightly different assumptions. Later in the project they will incorporate Bayesian information (i.e., relationships between industries obtained from IMPLAN data) in the estimation of the model to see if the forecasting performance improves. Using the model that produces the best forecasting performance, they plan to calculate the impulse response functions and multipliers to measure the impacts of industries including seafood industry.

A previous study at the AFSC did use a similar time series framework for regional economic analysis of Alaska fisheries (Seung 2007). However, the data available for the study covered a shorter time period (1990-2000) and did not perform comprehensive out-of-sample forecasts to validate the model. The results from the time series model to be developed will also be compared with those from economic impacts (multipliers) derived from IMPLAN, indicating the differences between the two alternative models (the IO model and the time series model).

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Fishing Revenue, Productivity and Product Choice in the Alaskan Pollock Fishery

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Economic performance measurement is a key element in evaluating the impacts of fishery management decisions, yet relatively little attention has been paid to this area in the fishery economics literature. The existing studies tend to focus on fish harvesting and technical efficiency, capacity utilization or quotas. Another important aspect of fishery performance, however, pertains to the revenue generated through fish processing, which is linked to both the way in which fish are harvested as well as the products produced from the fish.

In this study Ron Felthoven at the AFSC and Dr. Catherine Morrison Paul at the University of California, Davis econometrically estimate a revenue function, recognizing potential endogeneity and a variety of fishing inputs and conditions, to evaluate the factors underlying fishing revenues in the Alaskan pollock fishery. The authors find significant own-price supply responses and product substitutability, and enhanced revenues from the increases in season length and the number and duration of tows induced by the American Fisheries Act. They also find significant growth in economic productivity – higher revenues over time after controlling for observed productive factors and price changes, which exceeds that attributable to increased harvests. This paper was submitted for publication to the *American Journal of Agricultural Economics*.

Gulf of Alaska Halibut IFQ and Small Remote Fishing Communities

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Individual fishing quota programs, like other dedicated access privilege programs, are often criticized for their distributional consequences. In the Gulf of Alaska halibut fishery, many regulatory precautions were taken to preserve the character of the fishery. However, there is concern that fishing quota holdings are being reduced in small, remote Alaska fishing communities (SRFCs). Jennifer Sepez and Dan Lew have been working with University of Washington Ph.D. student Courtney Carothers to analyze quota share transactions from 1994 to 1999 to assess whether halibut fishing quota holdings are migrating away from SRFCs.

In this study, a community is a SRFC if it meets criteria based on population size, proximity to the coast, historical participation in Alaska fisheries, and designation as a rural area, which is a proxy for remoteness. Several size-based SRFC definitions are developed to account for sensitivity to population size threshold assumptions. The data show that quota share did leave the smallest SRFC communities over the five-year period, as evidenced by the net quota share change in these communities during that time. In more populated SRFC communities, the trend is generally reversed; that is, more quota share entered these communities than left. These results suggest the size of a SRFC community may influence whether its residents will sell or buy halibut IFQ and hence whether we see quota share leaving or entering the community in aggregate.

To more formally investigate the role of SRFC residency in decisions to buy or sell halibut quota share, the probability that an individual is a buyer or seller is modeled as a function of characteristics of the individual and analyzed using logit techniques. In this way, the influence of individual characteristics, such as age and the community's population, on buying and selling behavior can be separated from effects due to residency specifically in SRFCs. The logit results indicate that the marginal effect due to SRFC residency influences the decision to buy or sell more than one's age (other individual and transaction-specific effects were precluded from the model due to data limitations). The size of SRFC communities matters as well. Additional analysis is planned to explore the extent to which specific characteristics of communities contribute to buying and selling behavior more generally and to investigate the reasons underlying the observed buying and selling trends in SRFCs.

Integrating Bering Sea and Gulf of Alaska Climate Data for Socioeconomic Research

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Economists and social scientists at AFSC apply a variety of models to different socioeconomic problems and issues that affect Alaskan fisheries and communities. Researchers have begun to directly incorporate the effects of climate change into a number of these models, but do not have a straight-forward means for finding and evaluating climate data collected, organized, and analyzed by NOAA and other government agencies. As AFSC fisheries scientists better understand the relationship between changing climate and fish populations, we will be able to evaluate and predict the socioeconomic impacts of these changes. The goal of this project is to integrate spatial time-series data for several climate variables (e.g. sea surface temperature) into formats (e.g. comma delimited, MS Access, GIS) amenable to estimation with spatial econometric (i.e. predictive) models of fleet behavior. For example, one area where climate data will be immediately utilized is in fisher location choice models. These models incorporate observable information on the vessel characteristics, expected returns from choosing an area, and travel costs. The models can be significantly improved by augmenting them with area-specific information on ice coverage, winds, sea surface height, and potentially primary productivity. A second area of research will be to examine spatial correlation of economic fishery productivity and fine-scaled climate data. Another research area is to utilize the long time series of climate data that exhibit a high degree of spatial coherence, such as sea surface temperatures, into economic models of fishery dynamics. Our data sources include: 1) ocean temperatures and other information from satellite observations and multiple mooring sites in the Bering Sea and Gulf of Alaska, 2) air temperature and precipitation from terrestrial weather stations throughout the coastal areas of Alaska, and 3) the distribution of sea ice extent over time. The oceanographic and climate data are being georeferenced by latitude and longitude, and incorporated into a geographical information system (GIS). This GIS will be used by economists at AFSC, along with spatial time series for fishing effort, catch, and landings, to provide an empirical foundation for model development, estimation, and eventually, simulations of alternative management and climate scenarios.

Integrating Trip and Haul-Level Fishing Data

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An important area of work for the AFSC ESSRP is the collection of economic data that allows us to better understand and predict the behavior of fishermen and fishing enterprises. One area of data improvement that we have been pursuing over the last few years is an effort to integrate Observer Program data, which is at the haul level, with other sources of data on fishing trips such as where vessels choose to go when they depart and return to port. The following three projects briefly describe our recent efforts in this area.

Combining fish ticket and observer data to describe trips for pollock catcher vessels
One component of these efforts involves linking observer and fish ticket data for observed catcher vessels. Since 2000, the Observer Program database has contained an indicator that has facilitated data integration. We have worked with AKFIN to integrate observer and fish ticket data for all trips since 2000. Over the next year, we will work with AKFIN to integrate data for 1991-1999, which will allow for better historical analysis of vessel behavior in the context of changing environmental and regulatory conditions.

Trip-level data now available in the Observer Program database
For the first time, in 2007 the observer database now contains data on vessel trips. This information will allow us to better understand fishing location choices and how vessel behavior differs among season and fisheries. It will also allow us to track factors such as mechanical difficulties that lead to lost fishing time.

Examining fleet behavior with Vessel Monitoring System (VMS) data
VMS are required for vessels fishing for pollock, Pacific cod, and Atka mackerel and those vessels fishing in critical habitat in the Aleutians. VMS data provide very precise time-stamped location data that allows us to observe when vessels enter and depart port and how long they stay in port. Because there is such a large volume of data transmitted by the vessels it is a significant challenge to process the data. We have acquired funding from NMFS Office of Science and Technology to analyze the VMS data. This analysis will allow us to know the time spent and distance traveled for all trips, whether observed trips differ significantly from unobserved trips, and how long vessels remain in port during offloads. Additionally, we are working to examine whether we can systematically determine where fishing occurs from the analysis of VMS tracks. A publication summarizing this research is expected in 2008.

Interactive Metadata Project
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We have completed the prototype of a web-based, interactive metadata system that is available for use by ESSRP scientists. The system provides access to metadata for the most important fisheries databases that the ESSRP uses in its analysis and allows users to search the metadata both by categories of data and by specific keywords. The databases for which metadata are currently available include the blend, catch-accounting system, weekly production reports (WPR), and Federal Fisheries Permit listings maintained by the NMFS Alaska Regional Office; CFEC fish tickets from the AKFIN database; and commercial operators' annual reports (COAR) and commercial-vessel license listings collected and maintained by ADF&G. The system also provides access to some of the forms used to collect the various data and lists contacts at the agencies that maintain the data. The next phase of the project will expand the system to allow users at the AFSC to make data requests online, and for those with access to confidential data to be able to query the underlying data described by the metadata.

Modeling Spatial Location Choice with a Generalized Nested Logit Model

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A significant challenge in discrete choice modeling is developing high dimensional choice models that embed spatial correlation structure in the unobservables yet remain computationally tractable. In the economics literature two main points of departure in lower dimensional non-spatial choice models have been explored – Multinomial Probit models based on the multivariate normal distribution and mixed logit (or random parameters logit) which uses a basic conditional logit model and adds in random parameters that induce correlation across the alternatives. A third route exists that is based on McFadden's GEV model. This approach has seen relatively little research in economics beyond the family of nested logit models. In recent years there has been a resurgence in research activity in the transportation area, culminating in a variety of generalized nested logit (GNL) models in which the dependence of the unobservables can be modeled by allowing the nests to overlap each other. While there has been little work in modeling high dimensional spatial correlation, it turns out GEV models based on particular kinds of overlapping nesting structures are well-suited to capturing the type of spatial correlation structure commonly used in linear spatial models. Importantly, this model is tractable for a larger number of alternatives and can be run on available software packages. Here we develop a GNL with spatial correlation and apply the model to fisher location choice in the Alaska Bering Sea pollock fishery.

Nonconsumptive Value of Steller Sea Lion Protection

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Steller sea lions (*Eumetopias jubatus*) live in the North Pacific Ocean and consist of two distinct populations, the Western stock and the Eastern stock, which are separated at 144° W longitude. As a result of large declines in the populations since at least the early 1970s, in April 1990 the Steller sea lion (SSL) was listed as threatened throughout its range under the Endangered Species Act (ESA) of 1973 (16 U.S.C. 35). The decline continued through 2000 for the Western stock in Alaska, which was declared endangered in 1997, while the Eastern stock remains listed as threatened. Both the Western and Eastern stocks are also listed as depleted under the Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. 1362).

NMFS is the primary agency responsible for the protection of marine mammals, including Steller sea lions. Multiple management actions have been taken (e.g., 68 FR 204, 68 FR 24615, 69 FR 75865), and are being contemplated, by NMFS and the North Pacific Fishery Management Council to protect and aid the recovery of the SSL populations. These actions differ in the form they take (limits on fishing to increase the stock of fish available for Steller sea lions to eat, area restrictions to minimize disturbances, etc.), which stock is helped, when and how much is done, and their costs. In deciding between these management actions, policy makers must balance the ESA and MMPA goals of protecting Steller sea lions from further declines with providing for sustainable and economically viable fisheries under the Magnuson-Stevens Fishery Conservation Act (P.L. 94-265). Since Steller sea lion protection is linked to fishery regulations, decision makers must comply with several federal laws and executive orders in addition to the ESA and MMPA, including Executive Order 12866 (58 FR 51735), which requires regulatory agencies to consider costs and benefits in deciding among alternative management actions, including changes to fishery management plans made to protect Steller sea lions.

Public preferences for providing protection to the endangered Western and threatened Eastern stocks of Steller sea lions are primarily the result of the non-consumptive value people attribute to Stellar sea lions. Little is known about these preferences, yet such information is needed for decision makers to more fully understand the trade-offs involved in choosing between management alternatives. The amount the public is willing to pay for increased Steller sea lion stock sizes or changes in listing status is information that can aid decision makers to evaluate protection actions and more efficiently manage and protect these resources, but is not currently known.

NMFS is conducting a study to collect information that can provide insights into public values for protecting Steller sea lions. During 2004 and 2005, a survey instrument was developed with the assistance of experts in non-market valuation, environmental economics, and survey research, as well as fisheries scientists and researchers who study Steller sea lions. It was extensively tested using qualitative focus groups and one-on-one cognitive interviews conducted in Seattle, WA, Denver, CO, Sacramento, CA, Rockville, MD, and Anchorage, AK. Two formal pretests were conducted during Fall 2005 and Spring 2006 to assess the survey protocols. Subsequently, the survey instruments were revised to reflect updated information about Steller sea lions. The final survey implementation followed a modified Dillman Tailored Design Method to maximize response. It was completed during 2007 following Office of Management and Budget (OMB) approval.

Since threatened and endangered (T&E) species, like Steller sea lions, are not traded in observable markets, standard market-based approaches to estimate their economic value cannot be applied. As a result, studies that attempt to estimate these values must rely on survey-based non-market valuation methods, which involve asking individuals to reveal their preferences or values for non-market goods, such as the protection of T&E species, through their responses to questions in hypothetical market situations. One particular SP method, the contingent valuation (CV) method, has been the dominant approach for valuing T&E species. Although contingent valuation has been subject to much criticism, the NOAA Panel on Contingent Valuation found that despite its problems, "a well-conducted CV study provides an adequately reliable benchmark" (Arrow *et al.*, 1993) to begin discussions on appropriate values.

This study employs a choice experiment (CE), or stated choice, approach for eliciting economic values for Steller sea lions. CE methods are relatively new to the valuation of environmental goods, despite having a long history in the marketing and transportation fields (e.g., Louviere [1992]).[3] A typical CE involves presenting respondents with two or more choice questions, each having a set of alternatives that differ in attributes. For each question, respondents are asked to select the alternative they like best. The choice responses are used to estimate a preference function that depends upon the levels of the attributes.

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[3] Hanley, Wright, and Adamowicz (1998), Alpizar, Carlsson, and Martinsson (2001), and Hanley, Mourato, and Wright (2001) provide useful overviews of choice experiments in non-market valuation.

In this study, the stated choice questions take the following form: respondents are asked to choose between the status quo level of protection and two alternative protection programs that embody more protection, but at added costs. Each alternative program is described in terms of their results on each stock's population size and ESA status in 60 years. Since population and status projections are uncertain, three survey versions that embody different assumptions about the likely future Western population and ESA status were developed. One version assumes an increasing Western stock population, another assumes a stable one, and the final one assumes a decreasing population. Use of these alternative versions of the survey allows us to account for the uncertainty surrounding future stock sizes within our analytic framework.

Stated choice data collected through the survey are currently being analyzed and models are being developed to estimate preference functions for explaining choices between protection programs that differ in the levels of population sizes, ESA listing statuses, and costs. The estimated functions will provide NMFS and the NPFMC with information on public preferences and values for alternative Steller sea lion protection programs, and how several factors affect these values. This information can then be compared with program costs and other impacts when evaluating protection alternatives.

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North Pacific and West Coast Fisheries Community Profiles

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Community Profiles for West Coast and North Pacific Fisheries – Washington, Oregon, California, and other U.S. States by Norman, Sepez, Lazrus, Milne, Package, Russell, Grant, Petersen, Primo, Styles, Tilt, and Vaccaro has been released for public review in draft form. The individual profiles of 125 communities, along with introductory and methodological information, are currently available on the Northwest Fisheries Science Center's website at http://www.nwfsc.noaa.gov/research/divisions/sd/communityprofiles/index.cfm. The project is a joint effort between the Alaska Fisheries Science Center and Northwest Fisheries Science Center (NWFSC), with additional support from the Southwest Fisheries Science Center.

This is the follow up document to NOAA Technical Memorandum NMFS-AFSC-160, *Community Profiles for North Pacific Fisheries – Alaska*, which describes 136 communities located in the State of Alaska with involvement in North Pacific fisheries. AFSC community profiles for North Pacific Fishing Communities located in Alaska are available online at http://www.afsc.noaa.gov/Publications/techmemos.htm. Because a large number of communities that participate in North Pacific fisheries are located on the West Coast, it was more efficient to jointly profile these communities along with the other communities involved in fishing along the West Coast.

One hundred and twenty-five predominately West Coast communities were selected for profiling, from over 1500 communities in the contiguous United States and Hawaii which had some involvement in either commercial fishing in the North Pacific or along the West Coast, or some involvement in both regions. The 125 selected communities primarily include U.S. Census Places from: Washington (40 communities), Oregon (31 communities), California (52 communities), New Jersey (1 community), and Virginia (1 community). All of the profiled communities except for one (Valleyford, CA), had some involvement in North Pacific fisheries, either commercial, recreational, or both. Two communities, Seaford, Virginia, and Pleasantville, New Jersey, were selected for profiling solely because of their involvement in North Pacific fisheries.

The narrative profiles follow an outline nearly identical to the preceding Alaska profiles and include sections titled *People and Place* and *Infrastructure,* but distinguish between *Involvement in West Coast Fisheries* and *Involvement in North Pacific Fisheries. Involvement in West Coast Fisheries* details community activities in West Coast commercial fishing (landings delivered to community, processing, vessels, and permit holdings), sportfishing (sportfishing operators,

license vendors and revenue, and landings), and subsistence fishing. *Involvement in North Pacific Fisheries* details community activities in North Pacific commercial fishing (landings delivered by community residents, crew member licenses, and permit holdings), and sportfishing (businesses and licenses).
The profiles were reviewed by community representatives and volunteers affiliated with the Port Liaison Project (PLP). The PLP, administered by Oregon Sea Grant and funded by the NWFSC, is designed to connect members of the commercial fishing industry with fisheries researchers. Other members of the public who are knowledgeable about these communities reviewed and suggested corrections to the draft profiles.

Together with the Alaska profiles, this document provides a consolidated source for baseline social and fisheries information for the communities most involved in North Pacific fisheries. Consideration and analysis of fishing communities is mandated under National Standard 8 of the Magnuson-Stevens Fishery Conservation and Management Act. The profiles are in the final stages of publication as a NOAA NWFSC Technical Memorandum.

The article appears as Sepez, J. K Norman, A. Poole and B. Tilt. 2006. Fish Scales: Scale and Method in Social Science Research for North Pacific and West Coast Fishing Communities. *Human Organization* 65(3)280-293.

Post-Rationalization Restructuring of Alaska Crab Fishery Crew Opportunities
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Rationalization of the Bering Sea crab fishery in 2005 resulted in swift consolidation of the fleet from over 250 vessels to just 89. A large reduction in the ex-vessel prices paid for crab also occurred at this time. Among the most important impacts on communities has been the loss of crew jobs, estimated to be approximately 1350 positions in a University of Alaska study.

As the initial effects of the rationalization program begin to stabilize, it is important to understand the actual impacts of this program on crewmembers. Loss of crew jobs was a predicted effect, but the specifics of crew impacts are not understood in great detail. Beginning in the fall of 2007, this project will use ethnographic techniques to study current and former crewmembers, how they have been affected, and how their communities have been affected. This study will take place in Seattle, Dutch Harbor, Kodiak, and additional communities. Interviews will include specific issues (e.g., alternative income sources for displaced crew and what factors enable crewmembers to retain their jobs) that may be useful in understanding how crewmembers might be affected in other rationalization initiatives. Decision theory and occupational communities theory will provide the preliminary analytical framework for this research.

Promoting Key Economic and Social Scientific Concepts to Fisheries Managers

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NOAA Fisheries has recognized that the agency will benefit from increasing the role that social scientists play in fisheries management. The number of economists and social scientists in NOAA Fisheries has increased significantly over the last decade, but in many cases economists and other social scientists have not adequately conveyed their insights to fisheries managers with NOAA Fisheries, the fisheries management council community, or the larger academic fisheries science and policy communities.

At the annual meeting of the American Fisheries Society (AFS) in San Francisco, Alan organized a session with David Tomberlin of the NMFS Southwest Fisheries Science Center Santa Cruz lab. The session was titled "Fisher Behavior: State of the Art." This session featured talks from thirteen leading economists and fisheries scientists who focus on fleet dynamics and fisher behavior. The session provided a forum for exchange between researchers who utilize a variety of analytic approaches in a variety of empirical settings. The session was well-attended and allowed policy makers and fisheries scientists to better understand how economists and ecologists model and predict fleet behavior. In the future, we will continue to pursue opportunities to share economic techniques and insights with fisheries managers.

Predicting Fishing with Vessel Monitoring System (VMS) Data

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The National Marine Fisheries Service (NMFS) has expanded requirements that vessels fishing in the Pacific cod, Atka mackerel, pollock, and other fisheries own and operate a vessel monitoring system (VMS). The system sends each vessel's location to NMFS approximately every 20 minutes while the transmitter is operating. The VMS consists of two parts. A transmitter/receiver, installed on the vessel, which queries GPS satellites and downloads vessel position, as well as estimates the heading and speed. The transmitter then sends these data to NMFS via the Argos system of polar orbiting satellites.

Though the VMS tells NMFS the location of each participating vessel, it does not directly determine whether the vessel is fishing or not. However, when a vessel is fishing its course and speed are generally different than when the vessel is simply transiting an area. These differences produce a "signature" that indicates fishing is taking place. The nature of a given vessel's signature depends on many factors, including the gear type being used (trawl, hook-and-line, or pot), the type of vessel deploying the gear, and the length of time the vessel spends fishing. In addition to VMS, many vessels carry a NMFS-certified observer during 30-100 percent of their days at sea. Thus, NMFS can determine directly and independently whether or not fishing is taking place and can thus corroborate whether a given signature indeed demonstrates that fishing is taking place.

AFSC researchers wish to determine the extent to which the signatures can be used to accurately predict whether fishing is occurring are not. To the extent that a given signature can accurately predict whether fishing is taking place, NMFS wishes to use the signatures to develop computer algorithms that will automatically predict whether a given vessel is or was engaged in fishing operations. The predictive power of the developed algorithms should be expressed as a percentage of predicted fishing events that correspond to actual fishing events.

In previous work by Pat Sullivan for the NMFS Alaska Region, a number of techniques were explored to predict fishing for a select number of vessels. This current project builds upon that exploratory work and develops an operational algorithm. We plan to produce a final report suitable for peer-reviewed publication in the coming year.

Protected Marine Species Economic Valuation Survey

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Estimates of the economic benefits of protecting threatened and endangered marine species are often needed by resource managers and policy makers to assess the impacts of alternative management measures and policies that may affect these species. However, few estimates of the benefits of protecting marine species exist, and none exist for many species protected by NMFS. To begin filling this information gap, Dan Lew has begun working with several other NMFS economists on a non-market valuation survey research project to estimate the value of protecting several protected marine species.

Numerous cetacean, pinniped, sea turtle, and fish species have been selected for inclusion in the study, and preliminary survey materials are being developed. The survey will employ stated preference questions to gather information on public preferences for protecting these species. Several sets of focus groups to test preliminary survey materials have been conducted over the last two years. During 2007, changes to the survey and related materials were made based on the results of these groups and input from biologists providing review of the scientific information being presented. Due to the complexity of the issues and the number of species covered in the survey, the project has been divided into two phases, each involving the implementation of an Internet-based survey intended to collect stated preference information about a subset of the total species being studied. It is anticipated that focus group groups and other qualitative pretest activities for the first phase species will conclude in early 2008. The first phase survey implementation is expected to occur in 2008.

CANADA
British Columbia Groundfish Fisheries and Their Investigations in 2007

April 2008

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REVIEW OF AGENCY GROUNDFISH RESEARCH, STOCK ASSESSMENT, AND MANAGEMENT

A. Agency overview

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

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

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

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

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

Groundfish research and stock assessments are conducted primarily in the Groundfish Section and groundfish ageing and acoustics work are conducted in the Applied Technologies Section. The Canadian Coast Guard operates DFO research vessels. These vessels include the *W.E. Ricker*, *J.P. Tully, Vector* and *Neocaligus.* A replacement vessel for the *W.E. Ricker* is in the design phase, and if all goes according to plan, is scheduled to arrive in December 2010 and be operational in 2011.

The Pacific Region Headquarters (RHQ) of Fisheries and Oceans Canada are located at 401 Burrard Street, in Vancouver (BC, V6C 3S4). Management of groundfish resources is the responsibility of the Pacific Region Groundfish Coordinator (Mr. Gary Logan) within the Fisheries Management Branch, RHQ. Fishery Managers receive assessment advice from MEAD through the Pacific Scientific Advice Review Committee (PSARC). The Chair of PSARC (Mr. Al Cass) advises the Regional Management Committee on stock status and 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.pac.dfo-mpo.gc.ca/sci/psarc/ResDocs/res_docs_e.htm.

Trawl, sablefish, rockfish, lingcod, dogfish and halibut fisheries continue to be managed with Individual Vessel Quotas (IVQs). IVQs can be for specific areas or coastwide. Within the general IVQ context, managers also use a suite of management tactics including time and area specific closures and bycatch limits. Management plans can be viewed on the website at http://www-ops2.pac.dfo-mpo.gc.ca/xnet/content/MPLANS/MPlans.htm.

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

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 for the next few years. Details at http://www.dfo-mpo.gc.ca/science/new_policy/fishing_programs_e.htm

1. Multispecies or ecosystem models

See section B. 1. c. Multispecies trawl surveys

2. By species

1. Pacific cod

a. Research program

An age-determination protocol was developed for Pacific cod using fin rays as the ageing structure. The program is focusing on obtaining age frequency samples from synoptic bottom trawl surveys. In 2007, a collection was made for the survey in Hecate Strait providing a second annual sample in this region.

The Hecate Strait assemblage survey was conducted semi-annually from 1984-2003. The survey was redesigned and expanded its area of coverage in 2005. A summary report of the Hecate Strait assemblage survey results for the period 1984-2003 was recently published (Sinclair et. al 2007).

Trends in the spatial extent of the BC groundfish bottom trawl fishery and the overlap of this fishery with proposed and existing sponge reef closed areas was prepared (Sinclair 2007).

b. Stock Assessments

No new stock assessments for Pacific cod were conducted in 2007, or are planned for 2008.

2a. Rockfish - offshore

a. Research programs

Currently, DFO's groundfish program of synoptic surveys conducts all field research work for the slope rockfish species. A separate program, headed by Andrew Edwards (who replaces Jon Schnute), focuses on the development of models and software tools for the analysis of data pertaining to groundfish and other species. This year we published a paper (Schnute and Haigh 2007) on estimating mortality for stocks with limited available age-structure data. Additionally, Andrew has been wrapping up work concerning Lévy flights (Edwards *et al.* 2007) which are search patterns that have been attributed to many diverse animals and even fishermen. This general subject remains a source of scientific debate, and a recent *Nature* paper suggests that such patterns may be useful for modelling how fish redistribute themselves in response to fishing.

In 2007, we continued revisions on our packages *PBSmapping* and *PBSmodelling*, available as libraries for the statistical language R (Comprehensive R Archive Network, http://cran.r-project.org/). Numerous stock assessments and other reports on Canadian groundfish have used *PBSmapping* for portraying spatial information on maps. In contrast with expensive GIS packages like ArcView, this one is entirely free, as a user-contributed library for the free language R. We encourage our colleagues elsewhere to check this out, because it can be very effective for portraying detailed and summary spatial information from individual groundfish tows. (See Figure 1 for an example of tow information summarised using grid cells.)

In collaboration with Alex Couture-Beil, a brilliant graduate of Malaspina University-College, we developed a new R package (*ddesolve*) which solves systems of delay differential equations by interfacing numerical routines written by Simon Wood (University of Bath, UK), with contributions by Benjamin Cairns (University of Bristol, UK). These numerical routines first appeared in Simon Wood's solv95 program. (Coincidentally, Andrew's first foray into ecological modelling was an undergraduate summer research project with Simon Wood on the Ricker model.)

We also started work on a new R package called *PBSfishery* that provides routines for stock assessment and pre-screening COSEWIC documents. This packages utilizes *PBSmodelling* and *PBSmapping*, in conjunction with *PBSdata* (internal data package) and *RODBC*, to provide users with a GUI-driven system that produces useful data summaries from local and remote data files.

Following his retirement in September, Jon Schnute compiled his thoughts about Management Strategy Evaluation, based on historical developments over the last three decades. In a presentation to a workshop on ecosystem management (Schnute 2007), he described six distinct scientific approaches that have been adopted and subsequently rejected in the process of developing a modern paradigm for management.

b. Stock assessment

No stock assessments yielding quotas occurred in 2007. However, Rowan Haigh and Paul Starr completed preliminary drafts on yellowmouth rockfish *Sebastes reedi* and darkblotched rockfish *S. crameri* in BC coastal waters. This information was compiled for use by multiple clients, including potential writers of COSEWIC stock status reports.

c. Research activities for 2008

In September, 2007, Jon Schnute retired as head of this program. He sends best wishes to his colleagues and friends who happen to read this report; it's been a great privilege to work with such friendly and talented people. He continues working as a Scientist Emeritus by assisting research projects, mentoring new scientists, conducting R workshops, and behaving like a proverbial gadfly (http://en.wikipedia.org/wiki/Gadfly_(social)).

Jon's replacement is Dr. Andrew Edwards, who holds a Ph.D. in applied mathematics from the University of Leeds and has extensive experience working in ecological modelling. Andrew's duties with DFO started in August 2007. Research includes analysing patterns of discards in the commercial trawl fishery.

The slope rockfish team will continue to provide information for our two primary clients – DFO Groundfish Management and Environment Canada's COSEWIC. The former has already requested harvest advice for rougheye rockfish *S. aleutianus* and the two thornyhead species: longspine *Sebastolobus altivelis* and shortspine *S. alascanus*. The latter client awaits DFO's data summaries, now called COSEWIC Pre-Screening documents, for *S. reedi* and *S. crameri* so that COSEWIC contractors can finalize their Stock Status Reports.

Collaboration with Jon Schnute (scientist emeritus), will focus on directing students to enhance existing R packages or create new ones, possibly for Management Strategy Evaluation. Additionally, Jon, Andrew, and Rowan anticipate active participation in PBS' R Workshop series organized by Michael Folkes (research biologist). Andrew gave a one-day 'Introduction to R' course, and Jon has given two further workshops.

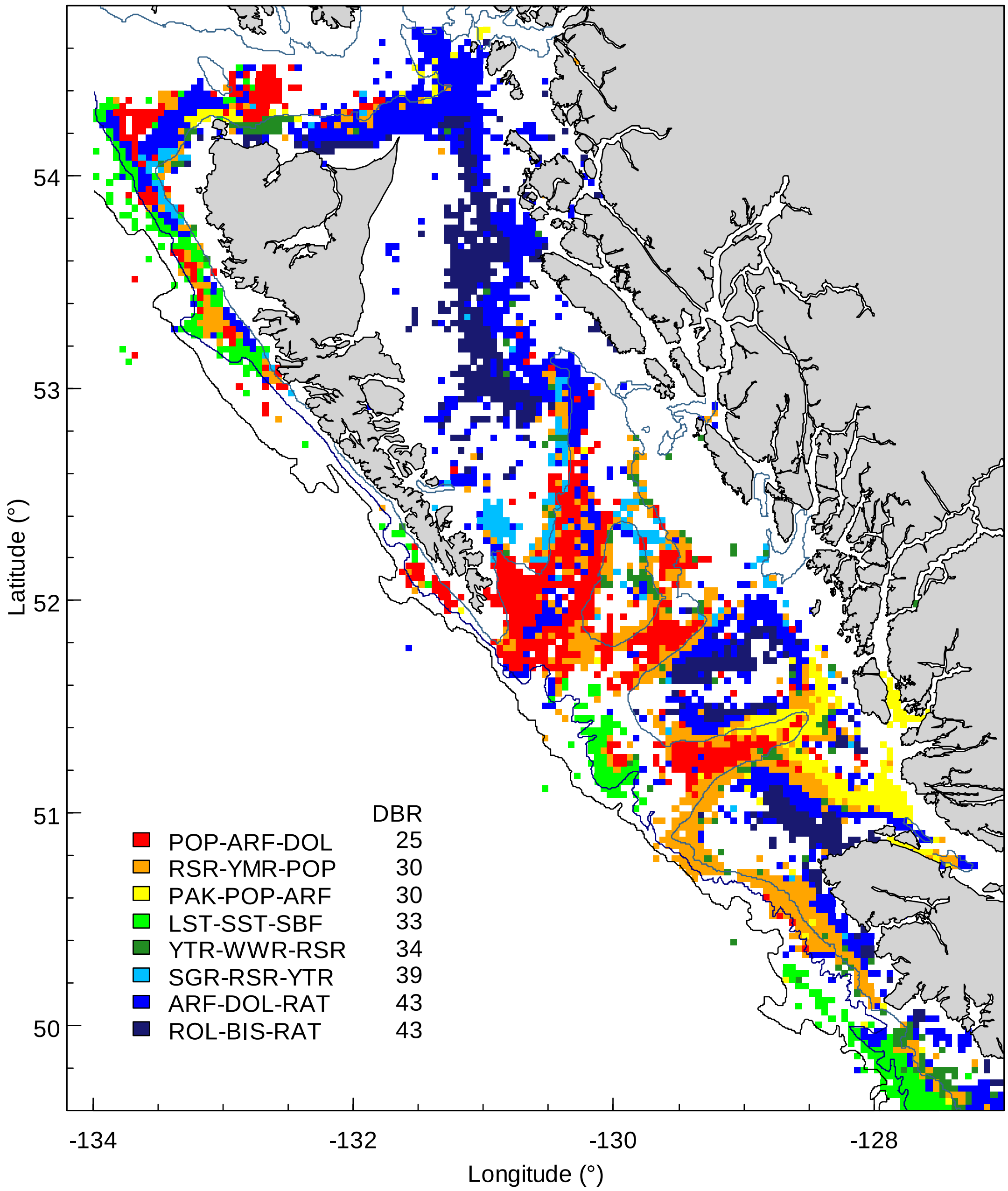

Figure 1. Groundfish groups identified by clara (clustering large applications) in R's package cluster and summarized using PBSmapping's spatial functions for the north and central coast of BC. Isobaths trace the 200, 1000, and 1800 m depth contours. The legend identifies eight clusters by the top three species comprising the medoids; the clusters are ordered by the contribution of darkblotched rockfish (**DBR**) to each medoid. Species codes:

ARF	arrowtooth flounder *Atheresthes stomias*,	**ROL**	rock sole *Lepidopsetta bilineatus*,
BIS	big skate *Raja binoculata*,	**RSR**	redstripe rockfish *Sebastes proriger*,
DOL	Dover sole *Microstomus pacificus*,	**SBF**	sablefish *Anoplopoma fimbria*,
LST	longspine thornyhead *Sebastolobus altivelis*,	**SGR**	silvergray rockfish *Sebastes brevispinis*,
PAC	Pacific cod *Gadus macrocephalus*,	**SST**	shortspine thornyhead *Sebastolobus alascanus*,
PAK	Pacific hake *Merluccius productus*,	**WWR**	widow rockfish *Sebastes entomelas*,
POP	Pacific ocean perch *Sebastes alutus*,	**YMR**	yellowmouth rockfish *Sebastes reedi*,
RAT	spotted ratfish *Hydrolagus colliei*,	**YTR**	yellowtail rockfish *Sebastes flavidus*.

2b. Rockfish – shelf

a. Research Programs in 2007

There was no new biological research directed on shelf rockfish species in 2007. Staff efforts were directed at stock assessment and the multiple species bottom trawl surveys (see below).

b. Stock assessments in 2007

A recovery potential assessment of canary rockfish was reviewed at the Pacific Science Advisory Review Committee in 2007. A "threatened" designation for the population of canary rockfish in Canada has been recommended by the Committee on the Status of Endangered Wildlife in Canada. If accepted by the Federal Minister of the Environment, this mandates development of a Recovery Strategy by late 2009. This assessment is intended to provide assessment elements and harvest advice for preparation of the Recovery strategy.

The assessment indicates that the stock has declined to between 15-35% of the original biomass. While it appears that the decline has been arrested in the last decade, it appears that rebuilding will require a reduction from the annual catches of 780-956 t over the last five years. Choice of rebuilding strategy is conditioned mostly by assumptions of the productivity of this population, more specifically the choice of "steepness" in the stock recruitment relationship, and secondarily by the timeframe of the recovery.

Nevertheless, application of the current harvest strategy under consideration by DFO[4] and depending on choice of steepness, the stock is currently in the critical ($<0.4B_{MSY}$) or cautious (($>0.4B_{MSY}$ and $<0.8B_{MSY}$) zones. Independent of the time frame for recovery, implementation of this strategy indicates a range of 8-595 t for an annual harvest, depending on which model runs (and steepness) is used.

c. Research activities planned for 2008

Staff will continue to participate in the data collection and the analysis of bottom trawl survey data. They will also author a Recovery Potential Assessment (RPA) for bocaccio in collaboration with Dr. Murdoch McAllister of the University of British Columbia. The Committee on the Status of Endangered Wildlife in Canada is considering recommending a threatened designation for canary rockfish in B.C. waters. Should this listing be accepted, DFO will also have to prepare an RPA for canary rockfish due in late 2009.

DFO staff will also collaborate with Dr. McAllister, Ms. Robyn Forrest, a PH.D candidate at U.B.C. and Dr. Martin Dorn (National Marine Fisheries Service) in a meta-data analysis of steepness of rockfishes.

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[4] DFO. 2006. A harvest Strategy Compliant with the Precautionary Approach. DFO Can. Sci. Advis. Sec. Advis. Rep. **2006/023**: 7 p.

2c. Rockfish – inshore

a. Research programs in 2007 and planned for 2008

Since 2003, an observer has been deployed on the 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, 2008 *in review*, Lochead et at. 2006). This program has been partially or wholly funded by industry prior to 2007. In 2007, in light of the Larocque decision, the Department funded the staffing of a third technician by the IPHC.

A longline survey, conducted in 2003 and 2004 in the northern portion of the Strait of Georgia (4B) Statistical Areas (SA) 12 and 13, was moved to survey the southern Strait of Georgia, SAs 14 – 20, 28 and 29 in August and September 2005 (Lochead and Yamanaka 2004, 2006, 2007). Survey locations were selected using a depth stratified (41 – 70 m and 71 – 100 m) random design. The longline survey is designed to cover the "inside" waters of Vancouver Island (4B) over three years starting in the north (SAs 12 and 13) in 2007, followed by the central areas in 2008 and the southern areas in 2009. Three weeks of ship time is allocated between August 15 and September 15 for this survey.

A Phantom HD2 remotely operated vehicle (ROV) was acquired by the Department and used in 2006 and 2007 to develop visual survey methods for inshore rockfish. A DIDSON sonar unit was mounted on the ROV in 2007. Through cooperation with Dr. Elizabeth Clarke (National Marine Fisheries Service) and Dr. Hanu Singh (Woods Hole Oceanographic Institute, WHOI), gear trials with the WHOI's autonomous underwater vehicle (AUV) and DFO's ROV were conducted in April 2007 aboard the *CCGS Vector*. Visual surveys to assess the new Rockfish Conservation Areas (RCAs) will commence in February 2009.

In collaboration with the halibut industry, a new longline survey was designed and conducted in the outside BC coastal waters with the northern half surveyed in 2006 and the southern half in 2007. 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. In 2008, the survey will be conducted in the northern portion of BC.

Three years of NSERC funding has been awarded to Dr. Jon Shurin of the University of British Columbia, 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. Plans are to support three PhD students working on projects related to the assessment and management of RCAs for inshore rockfish in BC.

b. Stock assessment

No stock assessments were prepared for inshore rockfish species in 2007 and no assessments are planned for 2008. 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. in press, in review). COSEWIC reviewed the status of yelloweye rockfish in January 2008 and will review quillback rockfish in the fall of 2008. No listing decisions have been announced as yet. http://www.cosewic.gc.ca/eng/sct5/index_e.cfm

c. Management actions for 2008

In 2007, the RCA strategy was completed with 20% of rockfish habitat closed outside 4B and 30% of rockfish habitat within 4B. RCAs are used as a spatial management tool to protect inshore rockfish. Fishing activities likely to catch rockfish are prohibited (http://www-comm.pac.dfo-mpo.gc.ca/pages/consultations/fisheriesmgmt/rockfish/default_e.htm)

3. Sablefish

a. Stock assessment activities in 2007

Sablefish stock assessment and management in British Columbia was conducted cooperatively in 2007 by Fisheries and Oceans Canada (DFO) and the Canadian Sablefish Association (CSA). This cooperative relationship is formalized as a Joint Project Agreement (JPA) that identifies the respective responsibilities of the two parties and provides a mechanism for joint contributions to fishery management and science activities for sablefish. Government management staff is in part funded by the CSA through the JPA. The CSA also contributes a portion of the cost of annual surveys and supports contracted analytical staff.

Catch rates from the fall standardized survey have declined by about 62% since a recent high in 2003. The 2007 stratified random survey declined about 30% from 2006 to 2007. Trap fishery catch rates in 2006 and 2007 are at about the level observed during the mid-2000 to mid-2002 period and much lower than those observed in the early 1990s. Catch rates from a survey in mainland B.C. inlets, where there is no directed sablefish fishing, have declined about 50% since a recent high in 2002.

b. Stock assessment activities planned for 2008

A paper describing the development of management strategy evaluation for B.C. sablefish will be reviewed in May 2008.

c. Research activities in 2007

-The annual research and stock assessment survey program was conducted in the fall of 2007 using two chartered commercial fishing vessels (Wyeth et al. 2006a, b). The traditional fixed locality standardized survey and tagging program was repeated using longline trap gear at offshore and mainland inlet sites. A new stratified random survey introduced as a pilot project in 2003 was continued in 2007. Like the fixed locality survey, the stratified random survey uses trap gear similar to that employed by the directed trap fishery. Sablefish were tagged and released, standardized catch rate data collected, and biological samples were obtained. The long-term intent is to replace the 1990-2007 fixed locality standardized survey and tagging program with the new stratified random survey that simultaneously accomplishes both stock indexing and tag releases.

d. Research activities planned for 2008

Research over the next several years will be devoted to completing development of management strategy evaluation for sablefish and continuing consultations on implementation.

4. Flatfish

Jeff Fargo will return to the Flatfish Program Head position in 2008.

a. Stock assessment and research activities

No flatfish assessments or directed flatfish research are planned for 2008.

5. Pacific hake

a. Stock Assessment in 2008

The 2008 stock assessment was prepared jointly by Canadian and US scientists. There were three models reviewed: 1) the Stock Synthesis 2 model (SS2), which was the only acceptable modeling option for the STAR panel, 2) An adaptive framework virtual population analysis (ADAPT-VPA); and 3) the TINSS model developed by Martell (UBC Fisheries Science Center). The same data were used in all three models, and all three showed comparable biomass trajectories. The SS2 model produced dome shaped selectivity for both the acoustic survey and commercial fishery whereas the VPA and TINSS produced an asymptotic selectivity curve for both datasets. As was the case in previous years, a major source of uncertainty in all models was the value of the catchability coefficient (q) for the acoustic survey.

The temporal and spatial distribution of Pacific hake has changed in the last several years, with the bulk of the Canadian fishery in 2006 and 2007 being conducted in Queen Charlotte Sound (areas 5A and 5B). Traditionally, the Canadian fishery has been conducted off the west coast of Vancouver Island (areas 3C and 3D). The 2006 and 2007 catches of hake in these two areas had a similar size and age composition, with the 1999 year class dominating the catches in both areas.

There is currently a stock delineation project taking place in B.C. to investigate the dynamics of hake stock in the Queen Charlotte Sound area, in particular its relationship to other, possibly local hake stocks that may be present in Canadian waters. This project included three surveys, in July and November 2007 and February 2008 where biological samples, including DNA samples, were collected. It is expected that the analysis of these datasets will be completed in 2008.

6. Elasmobranchs

a. Research programs in 2007

A tag/recapture program to examine stock discreteness of big skate was initiated in 2003. Although no skate were tagged in 2007, this program is on-going. As of December 2007, the total number of skates tagged and released is 17,108 fish, while 1,682 skates have been recaptured.

In 2007, basking sharks were listed as endangered off the coast of British Columbia by the Committee On the Status of Endangered Wildlife In Canada (COSEWIC). Efforts to coordinate the collection of sightings information were begun in 2007. Preliminary aerial surveys for basking sharks were conducted in September 2007 off the west coast of Vancouver Island and over Rivers Inlet (Queen Charlotte Sound) in order to document the occurrence (if any) of basking sharks in BC waters in areas of historic high densities.

The first blue shark tagging survey off the WCVI, to study the migratory behaviour of blue sharks, occurred in July 2007 in conjunction with NMFS and Tagging Of Pacific Predators (TOPP). Blue sharks over six feet long were tagged with archival and satellite tags; smaller sharks were tagged with spaghetti tags and injected with oxytetracycline (OTC). A total of 144 blue sharks were tagged and released.

b. Stock assessment in 2007

No assessments were conducted on BC elasmobranchs. A COSEWIC status report on basking sharks was submitted in April 2007.

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 for Hecate Strait (Area 5C/D) big skate in 2002/03, which was continued in 2006/2007. Out of this cap, the trawl fleet has a quota of 567 t. No quotas are in effect in other areas. In April 2004, a monthly landing limit (coastwide) of 5.7 t was implemented for longline vessels.

d. Research activities planned for 2008

The tagging program for big skate will be continued in 2008 with a tagging survey off the west coast of Vancouver Island in February.

A Recovery Potential Assessment (RPA) for basking sharks off the Pacific coast of Canada will be completed in 2008. Basking shark aerial surveys will continue in 2008, with flights to occur in May – September off the west coast of Vancouver Island and over Rivers Inlet (Queen Charlotte Sound). A newly established basking shark sightings network consisting of a website and toll-free reporting line will be advertised and monitored in 2008 to collect sightings information from the public.

A dogfish longline survey will be conducted in October 2008 to assess distribution and abundance of dogfish in the Strait of Georgia.

7. Lingcod

a. Research programs in 2007

A lingcod egg mass dive survey was conducted in the Strait of Georgia in March 2007.

b. Stock assessment

No assessment was conducted on lingcod stocks in 2007.

c. Research activities planned for 2008

No research activities are planned for lingcod in 2008.

B. Other related studies

1. Statistics and Sampling

a. Database work in 2007

Principal Statistics and Sampling activities in 2007 included the ongoing population of the groundfish biological database (GFBio). This database now includes about 7,750,000 specimens. Data entry activities continue to concentrate on input of current port sampling and observer biological data and recent research cruises. When time is available, the database is backfilled with research cruise data collected before 1997. This past year continued with considerable effort in the entry of historic rockfish research cruises and the entry of age data.

b. Sampling

The groundfish trawl fishery continues to be covered by 100% dockside and virtually 100% observer coverage. These observers also provided 305 length/sex/age samples and 114 length samples in 2007. Port samplers provided an additional 141 samples, 115 samples with ageing structures (length/sex/age/weight) and 26 without structures (length/sex/weight). The focus of their sampling efforts was from those fisheries not covered by at-sea observers. Port sampling staff provided groundfish identification training for fisheries officer trainees and resource management students at BCIT and UNBC, as well as logistic support (fish samples and expertise) to a number of programs at the Pacific Biological Station. Port sampling will continue in 2008, the program focus continues its shift to non-trawl species and the development of port sampling activities beyond Prince Rupert and Vancouver.

The Groundfish Integrated Pilot Project continued in year 2 in 2007. While the project is still maturing, it continues to appear that the process, which includes 100% at-sea monitoring and dockside monitoring for hook and line vessels, is being successful in monitoring all catch, both landed and discarded.

c. Multi-species Bottom Trawl Survey in 2007

Staff participated on three major multi-species bottom trawl surveys in 2007 as well as the west coast Vancouver Island shrimp trawl survey and Queen Charlotte Strait long line surveys.

The first survey was of Hecate Strait and Dixon Entrance (HS/DE) in May/June aboard the research vessel WE RICKER. This was the second survey in a new time series initiated in 2005. The survey objective was to complete 170 successful bottom trawl tows across four depth strata during the 28 days of ship time, unfortunately due to the trawl getting caught in the propeller mid survey only 140 stations were completed. Mean catch weight was down from 2005 to 290 kg per tow, 1103 samples comprising 26,491 specimens were collected.

The second survey, in Queen Charlotte Sound (QCS), was undertaken in July/August aboard the chartered commercial fishing vessel VIKING STORM. This was the fourth in the time series, previous surveys were conducted in 2003/04/05. The primary objective of the survey was to complete 240 successful bottom trawl tows from an initial selection of 309 possible stations distributed across 4 depth strata ranging from 50 m – 500 m depth. A total of 257 successful tows were completed during the course of the survey. This survey was almost entirely funded by the commercial groundfish industry through the Canadian Groundfish Research and Conservation Society (CGRCS). DFO provided logistic support, a chief scientist to run the survey, a senior technician to run the fish lab and post survey data processing. During this survey 1475 samples comprising 34,839 specimens were collected.

The third survey was undertaken in September/October of 2007 aboard the Chartered commercial fishing vessel NEMESIS off the west coast of the Queen Charlotte Islands (WCQCI). This was the second survey in this time series which was initiated in 2006. As in 2006 the objective of the survey was to complete 125 successful tows, but inclement weather and a lack of trawlable bottom limited the survey to 112 successful tows. This survey was made possible due to an infusion of monies in the form of Larocque relief funding. A contract was awarded to the Canadian Groundfish Research and Conservation Society (CGRCS) to conduct this survey their contract included chartering an appropriate commercial vessel and hiring seagoing technical staff. DFO provided senior seagoing science staff, equipment, and data processing. During the course of the survey 784 samples comprising 1,475 specimen were collected.

Staff participated on the Steering committee and Organizational board of the 5th International Fisheries Observer Conference in Victoria, May 2007.

d. Surveys program for 2008

Two major bottom trawl surveys are planned for 2008, one off the west coast of Vancouver Island and one off the west coast of the Queen Charlotte Islands. Staff will continue their participation in the shrimp trawl surveys in Queen Charlotte Sound and off the west coast of Vancouver Island.

In 2008 a paperless data collection system will be implemented. All data inclusive of fishing event, catch and biological will be captures electronically by logging data from bridge electronics (GPS, Sounder, and Net mensuration) and interfacing with electronic scales and measuring boards.

e. Proposed catch monitoring research and development in 2008

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

f. Proposed field work for 2008

Port sampling will continue in 2007, as will staff participation in the bottom trawl surveys to the west coast of Vancouver Island and the west coast of the Queen Charlotte Islands, and the shrimp trawl surveys in Queen Charlotte Sound and the west coast of Vancouver Island. Automated measuring boards will be introduced to the WCVI survey in 2008.

APPENDIX 1. REVIEW OF CANADIAN GROUNDFISH FISHERIES

1. Commercial fisheries

All catch figures for 2007 are preliminary. Canadian domestic trawl landings of groundfish (excluding halibut) in 2007 were 56,742 t, a decrease of 53% from the 2006 catch. This decrease was mainly accounted for by a 71% decrease in landings of Pacific hake. The major species in the trawl landings were Pacific hake (42%), Pacific ocean perch (8%), arrowtooth flounder (8%), yellowtail rockfish (7%), and walleye pollock (5%). Principal areas of trawl production were 5B (25%), 3D (15%), 5A (12%), 3C (12%) and 5D (11%).

Canadian landings of groundfish caught by gear other than trawl in 2007 totalled 8,964 t. Landings by sablefish trap and longline gear accounted for 3,192 t, approximately 66% by trap gear and 34% by longline gear. Sablefish accounted for slightly more than 89% of the landed amount. Landings of species other than sablefish by longline, handline and troll gear accounted for 5,772 t (62% dogfish, 13% lingcod and 11% rockfish).

2. Recreational fisheries

Each year, Fisheries and Aquaculture 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. There are also estimates of catch produced from fishing lodge reports. In 2007 data from these two sources was available for the months of January to December. Provisional estimates of 2007 catches, landings and discards, for this 12-month period were 12,010 fish for lingcod, 18,217 fish for all rockfish species, 468 fish for halibut, 6,471 fish for rock sole, 2,282 fish for starry flounder, 15,874 fish for dogfish, 1,758 fish for greenlings, 336 fish for cabezon, and 3,146 fish for other groundfish species.

In Juan de Fuca Strait catch estimates have been generated from creel surveys and fishing lodge reports. Data are available for January to December. Provisional estimates of 2007 catches were 7,873 fish for lingcod, 9,177 fish for all rockfish species, 3,185 fish for halibut, 12,579 fish for dogfish, 692 fish for rock sole, 364 fish for starry flounder, 475 fish for cabezon, 4,237 fish for greenlings, and 2,246 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 May to September. Provisional estimates of 2007 catches were 18,492 fish for lingcod, 30,463 fish for all rockfish species, 51,260 fish for halibut, 1,785 fish for dogfish, 265 fish for rock sole, 231 fish for starry flounder, 274 fish for cabezon, 226 fish for greenlings, and 296 fish for other groundfish species.

In Johnstone Strait catch estimates have been generated from creel surveys and fishing lodge reports for May to September. Provisional estimates of 2007 catches were 1,329 fish for lingcod, 7,403 fish for all rockfish species, 9,526 fish for halibut, 1,242 fish for dogfish, 561 fish for rock sole, 486 fish for starry flounder, 72 fish for cabezon, 1,281 fish for greenlings, and 768 fish for other groundfish species.

3. Joint-venture fisheries

In 2007, 26 Canadian catcher vessels delivered Pacific hake and incidental species to a single processing vessel in a co-operative fishing arrangement. This fishery took place off the southwest coast of Vancouver Island (Area 3C) and in Queen Charlotte Sound (Areas 5A and 5B). A total of 6,835 t of Pacific hake was processed by the Russian vessel. The catch breakdown by area was 72% from area 5B, 24% from area 5A, 4% from area 3D and less than 1% from area 3C. The quotas and catches are outlined below:

Nation	Species	Quota (t)	Catch (t)
Poland	Hake	10,040	6,835
	Pollock	incidental	1
	Rockfish	incidental	57
	Other	incidental	1

4. Foreign fisheries

There were no national or supplemental fisheries for Pacific hake off British Columbia in 2007.

APPENDIX 2. GROUNDFISH RELATED REPORTS PUBLISHED IN 2007/08.

1. Primary Publications

Andrews, A.H., Kerr, L.A., Cailliet, G.M., Brown, T.A., Lundstrom, C.C., and Stanley, R.D.. 2007. Age validation of the canary rockfish (*Sebastes pinniger*) using two independent otolith techniques: lead-radium dating and the bomb radiocarbon chronometer. Mar. Freshwater Res. 2007. 58:1-11.

Edwards, A.M., Phillips, R.A., Watkins, N.W., Freeman, M.P., Murphy, E.J., Afanasyev, V., Buldyrev, S.V., da Luz, M.G.E., Raposo, E.P., Stanley, H.E., and Viswanathan, G.M.. 2007. Revisiting Lévy flight search patterns of wandering albatrosses, bumblebees and deer. Nature, 449: 1044-1048.

Heifetz, J., J. DiCosimo, A.J. Gharrett, M.S. Love, V.M. O'Connell, and R.D. Stanley (eds.). 2007. Biology, Assessment, and Management of North Pacific Rockfishes. Alaska Sea Grant. AK-SG-07-01.

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

Koolman, J., Mose, B., Stanley, R.D., and D. Trager. 2007. Developing an integrated commercial groundfish strategy for British Columbia: insights gained about participatory management. Pp: 287-300 *In*: Heifetz, J., J. DiCosimo, A.J. Gharrett, M.S. Love, V.M. O'Connell, and R.D. Stanley (eds.). Biology, assessment, and management of North Pacific Rockfishes. Alaska Sea Grant Program. Alaska Sea Grant. AK-SG-07-01.

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

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

Schnute, J.T., and Haigh, R. 2007. Compositional analysis of catch curve data, with an application to *Sebastes maliger*. ICES Journal of Marine Science 64: 218-233.

Schnute, J. T., Maunder, M. N., and Ianelli, J. N. 2007. Designing tools to evaluate fishery management strategies: can the scientific community deliver? ICES Journal of Marine Science, 64: 1077–1084.

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

2. Other Publications

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

Haggarty, D.R., and King, J.R. 2007. Lingcod egg mass density survey in the Strait of Georgia, February – March, 2006. Can. Tech. Rep. Fish. Aquat. Sci. 2691: iv + 28 p. Abstract (HTML) or Full Document (PDF).

Haigh, R., and Schnute, J.T. 2007. Visualising observer data. p. 103-105 In McVea, T.A. and Kennelly, S.J. (ed.) Proceedings of the 5th International Fisheries Observer Conference, Victoria, BC, Canada, 15-18 May 2007. NSW Department of Primary Industries, Cronulla Fisheries Research Centre of Excellence, Cronulla, Australia, 412 pp. ISBN 978 0 7247 1861 7.

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

Olsen, N., G.D. Workman, and R.D. Stanley. 2007. Queen Charlotte Sound Groundfish Bottom Trawl Survey July 3rd to August 10th, 2003. Can. Manuscr. Rep. Fish. Aquat. Sci. 2782: 58 p.

Olsen, N., G.D. Workman, and R.D. Stanley. 2007. Queen Charlotte Sound Groundfish Bottom Trawl Survey July 5th to August 19th, 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2783: 60 p.

Olsen, N., G.D. Workman, and R.D. Stanley. 2007. Queen Charlotte Sound Groundfish Bottom Trawl Survey July 5th to August 19th, 2005. Can. Manuscr. Rep. Fish. Aquat. Sci. 2784: 58 p.

Olsen, N, Rutherford, K.L., Workman, G.D., and Stanley, R.D. 2007. Queen Charlotte Sound groundfish bottom trawl survey July 3rd to August 3rd, 2007. Can. Manuscr. Rep. Fish. Aquat. Sci. 2820: 60 + vi p.

Schnute, J.T. 2007. Management Strategy Evaluation - Theory and Application: Ruminations of a Blind Archeologist. National Workshop on Modelling Tools for Ecosystem Approaches to Management, October 22-25, Victoria, B.C., Canada. Workshop Report in preparation by the organizers.

Schnute, J., Couture-Beil, A., Haigh, R. 2007. A user's guide to the R library "ddesolve" version 1.00 – July 17, 2007. 17 pp. Available in R-package *ddesolve* (see ...\library\ddesolve\ddesolve-UG.pdf)

Schnute, J.T., Haigh, R., and Couture-Beil, A. 2007. Mathematical models of fish populations in marine reserves. Report on a collaborative project between Malaspina University-College and the Pacific Biological Station. 24 pp. Available in R-package *PBSmodelling* (see ...\library\PBSmodelling\examples\FishResDoc.pdf)

Sinclair, A., Krishka, B.A., and Fargo, J.. 2007. Species trends in relative biomass, occupied area and depth distribution for Hecate Strait assemblage surveys from 1984-2003. Can. Tech. Rep. Fish. Aquat. Sci.: 2749. 141 p.

Sinclair, A. 2007. Trends in groundfish bottom trawl fishing activity. Can. Sci. Adv. Sec., Res. Doc. 2007/006, 24 pp.

Stanley, R.D., N. Olsen, G. Workman, J. Cleary, W. de la Mare. 2007. A review of the Queen Charlotte Sound Groundfish Bottom Trawl Survey (2003-2005). Can. Tech. Rep. Fish. Aquat. Sci. 2709.

Stanley, R.D., P. Starr, N. Olsen, K. Rutherford, and S.S. Wallace. (in press). COSEWIC status report on canary rockfish *Sebastes pinniger*. Committee on the Status of Endangered Wildlife in Canada. Ottawa.

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

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

Surry, A.M. and King, J.R. 2007. Lingcod (*Ophiodon elongatus*) egg mass and reef fish density SCUBA survey in the Strait of Georgia, February 13 – 27, 2007. Can. Tech. Rep. Fish. Aquat. Sci: 2743: viii + 19 p. Abstract (HTML) or Full Document (PDF).

Surry, A.M., King, J.R., and Haggarty, D.R. 2007. Bottom trawl survey of young-of-the-year lingcod (*Ophiodon elongatus*) in the Strait of Georgia, *CCGS Neocaligus*, July 28 – August 9, 2006. Can. Tech. Rep. Fish. Aquat. Sci. 2740: x + 50 p. Abstract (HTML) or Full Document (PDF).

Swain, D.P., Sinclair, A.F., Hanson, J.M.. 2007. Evolutionary response to size-selective mortality in an exploited fish population. Proc. R. Soc. B. 274, 1015–1022.

Wallace, S., Campana, S., McFarlane, G.A., and King, J.R. 2007. COSEWIC assessment and status report on the basking shark *Cetorhinus maximus* (Pacific population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 34 p.

Westrheim, S. J. and Yamanaka, K.L. 2007. A comparison of stratified systematic and stratified random methods of estimating catch rates, by depth interval, for biomass estimation of Pacific Ocean Perch (*Sebastes alutus*) in Goose Island Gully, Queen Charlotte Sound, British Columbia. Can. Tech. Rep. Fish. Aquat. Sci. 2707: vii + 34 p.

Workman, G.D., N. Olsen, and K.L. Rutherford. 2007. West Coast Charlotte Islands groundfish bottom trawl survey, August 28th to September 25th, 2006. Can. Man. Rep. Fish. Aquat. Sci. 2804.

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 May 29 to July 22, 2006. Can. Tech. Rep. Fish. Aquat. Sci. *In press.*

Yamanaka, K.L., Lacko, L.C., Withler, R., Grandin, C. Lochead, J.L., Martin, J.C., N. Olsen, and S.S. Wallace. (in press). COSEWIC status report on yelloweye rockfish *Sebastes ruberrimus*. Committee on the Status of Endangered Wildlife in Canada. Ottawa.

Yamanaka, K.L., Lacko, L.C., Miller-Saunders, K., Grandin, C., Lochead, J. K., Martin, J.C., Olsen, N., and Wallace, S.S. (in review). COSEWIC status report on quillback rockfish *Sebastes maliger*. Committee on the Status of Endangered Wildlife in Canada. Ottawa.

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

APPENDIX 3. GROUNDFISH STAFF IN 2007/08

S. Acheson	Groundfish port sampling
W. Andrews	Elasmobranchs
K. Anderson	Groundfish port sampling
E. Choromanski	General stock assessment and biology, flatfish, field technician
K. Cooke	Database technician
J. Detering	Groundfish research technician
A. Edwards	Statistical and mathematical modeling, stock assessment
J. Fargo	Section Head, Flatfish stock assessment and biology
C. Grandin	Biologist, Hake
R. Haigh	Statistical and exploratory data analysis
V. Hodes	Elasmobranchs
G. Jewsbury	Groundfish technician
J. King	Lingcod, elasmobranchs, climate studies
B. Krishka	Biological data control and analysis, Pacific cod
R. Kronlund	Sablefish, analytical programs
L. Lacko	Database and GIS specialist, Inshore rockfish
G. A. McFarlane	Groundfish population dynamics and biology, fish/ocean interaction, elasmobranchs
W. Mitton	Sablefish
S. Obradovich	Biologist, Inshore Rockfish
N. Olsen	Biologist/programmer/GIS, Shelf rockfish
K. Rutherford	Biologist/database manager, Shelf rockfish
J. Schnute	Emeritus Scientist
A. Sinclair	Pacific cod assessment and ecosystem research
R. Stanley	Shelf rockfish stock assessment and biology, groundfish statistics.
M. Surry	Lingcod and Elasmobranchs
G. Workman	Multi-species trawl surveys, Port sampling, Observer programs
M. Wyeth	Sablefish stock assessment and biology
L. Yamanaka	Inshore rockfish stock assessment and biology

Committee of Age-Reading Experts
2007 Committee Report

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

May 6-7, 2008

Prepared by

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2006-2008 CARE Chairperson
Alaska Department of Fish and Game
Age Determination Unit
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CARE 2007 Report to the Technical Subcommittee of the Canada-USA Groundfish Committee

A. CARE Overview

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

CARE Workshop - CARE meets biennially at the "CARE Workshop" with workshops typically comprising a "business" day and generally 1.5 days for hands-on calibration at microscopes to review and standardize age reading criteria. The last biennial CARE Workshop was held April 18-20, 2006. There was no meeting held in 2007. The next CARE workshop is scheduled for April 1-3, 2008, hosted by and to be held at the CDFO's Pacific Biological Station.

Report Period - This report covers the work period January 1 – December 31, 2007. However, to promote timely reporting of work and recommendations occurring during the recent CARE workshop (April 2008), a separate Executive Summary of the 2008 CARE workshop is included in Appendix I.

B. CARE Subcommittee (Working Group) Reports

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

   The Manual/Glossary working group members develop age reading chapter sections or definitions for age-reading terms suggested by CARE members, which are subsequently approved by CARE members and added to the CARE Manual/Glossary.

   There is nothing new to report for calendar year 2007. All work was mostly completed in 2006 and previously reported in the CARE 2006 Committee Report to the TSC.

2. CARE Website – Anderl, Short (webmaster)

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

   2.1 Substantial work was completed on the CARE website. Updates (manual, etc) and edits were routinely made.

   2.2 A "content management system" (CMS) was installed to facilitate "freshness" of the website and archive-ability of information. Content is separate from design. The CMS software which was used, called "JOOMLA", is freeware.

C. CARE Agency Structure Exchanges

Age structure exchanges periodically occur to assess calibration among age-reading facilities, following which specimens with widely varying age estimates are reviewed and discussed. Exchanges are tracked by the CARE vice-chair. Data from exchanges are available upon request of the originator of the sample.

There were 6 age structure exchanges initiated in 2007. Species exchanged were sablefish, lingcod (fin rays), vermillion rockfish, and hake. An updated summary of these and other age structure exchanges made from 2006 thru 2008 are covered in Appendix I – Executive Summary, Table 2.

D. Recommendations CARE to TSC

CARE did not initiate any new recommendations because CARE did not convene a business meeting in 2007. The below lists new recommendations made by the TSC to CARE and also previous recommendations pending.

1. 2007 Recommendations
   - 1.1. TSC to CARE
     - 1.1.1. "The TSC will rely on fishery managers and stock assessment authors to interact directly with their ageing lab supervisors to communicate with CARE for ageing exchanges. TSC appreciates the work of CARE and recognizes that a direct link between the assessment biologist and the ageing lab is the most efficient means of requesting species ageing exchanges."
   - 1.2. CARE to TSC (na)
   - 1.3. CARE to CARE (na)

2. 2006 Recommendations
   - 2.1. TSC to CARE (none made)
   - 2.2. CARE to TSC
     - 2.2.1. The biennial CARE meetings have been held traditionally at the Seattle NMFS-AFSC facilities. The Pacific Biological Station (PBS), Nanaimo representatives offered to host the 2008 CARE meeting. Two reasons were given for this proposed departure. First, this invitation coincides with the PBS 100th anniversary (1908-2008). Second, agency travel policies can prohibit age readers from different participating agencies and labs to attend the CARE meeting at the Seattle AFSC facilities. The CARE requests TSC members to support this recommendation and encourage travel funding. This rotation will allow PBS to share in the hosting responsibilities and for greater CARE participation among their personnel. It would also appropriately acknowledge PBS's substantial contributions to the field of fish age and growth.
   - 2.3. CARE to CARE
     - 2.3.1. The CARE Age Structure Exchange (CASE) table presently identifies inter-agency exchanges occurring on species of interest to the TSC, or other inter-agency calibrations as needed. CARE recommends to itself to modify the CASE table and

process. We will continue to track structure exchanges per the CARE Charter, however, we will drop precision test results from the CASE table. We will develop a CASE invoice, accessible on the CARE website. Upon initiating an exchange, the originating agency will contact the CASE coordinator for an exchange id. number. The originating agency will conduct the exchange, fill out all information in the CASE invoice, and submit it to the CASE coordinator upon its completion. . The CASE coordinator or designee will update the website to allow linked access within the CASE table. Inclusion of precision statistics is optional.

2.3.2. CARE recommends making changes to the Summary of Age Reading Method, regarding format and information included. The current table info will be split into two tables; one to include "Methods" information (agency, species, method, validation, area, structure, validation & validation citation). The method, validation and citation columns would provide anecdotal information that will be updated. The method column would include all methods used historically or currently and provide dates when methods were adopted. The validation column would indicate method and extent (e.g. all ages, up to age 30, longevity) and the validation citation column would indicate dates and contact. The new 2nd table would include agency, species, calendar year and number of fish per species aged. Total fish and total species aged would be calculated. Numbers of reader involved per calendar year for all fish aged will also be included. It is recommended that this data would reside on the website and that a small relational database would house the data. A mechanism would be developed to query the database to assess the breadth and depth of expertise for species by agency for all species aged. Development of database will be in small steps. The Vice-chair will be responsible for updating both tables on an annual basis."

APPENDIX I

Executive Summary
2008 CARE Workshop

This Executive Summary of the recent 2008 CARE Workshop is appended to the '2007 CARE Annual Report to the TSC' in order to promote timely reporting of work that would otherwise not be reported till 2009, and to facilitate work and action to occur over the remaining year.

Overview

The 2008 CARE Workshop was held April 1-3 in Nanaimo, British Columbia at the Pacific Biological Station (PBS), hosted by Shayne MacLellan and the PBS Sclerochronology Lab staff. A total of 31 individuals representing 7 agencies attended (Table 1). An agenda from this workshop follows under Appendix I-A. This workshop was an active one, highlighted by: substantial group discussion on varied topics; 4 scientific presentations; notable accomplishments made by the working groups; deeper involvement by more CARE members including nomination to working groups and administration positions, especially those not having previously served in these roles; convening of a sablefish age-reading ad hoc working group; and significantly, a unanimous decision by the CARE to shift its biennial meeting cycle to an odd-year rotation opposite of the Western Groundfish Conference. There were no Recommendations made by CARE to the TSC; however, there are four Recommendations made by CARE to itself.

Working Groups and Reports

There were 2 working groups active prior to and reporting at the Workshop. Two additional working groups convened at this workshop, for a total of 4 working groups that will be active during the next rotation.

1. Manual/Glossary Committee, 2006-2008 (MacLellan, Goetz, Munk) – MacLellan reported on work completed from 2006-2008. MacLellan requested that she be replaced as working group lead. Betty Kamikawa (NMFS-NWFSC/PSMFC) will succeed MacLellan as group lead July 1, 2008. Highlights of work completed:

- Shayne MacLellan (CDFO) worked with John Sneva (WDFW) and Lisa Lysak to complete the lingcod and Dover sole CARE manual sections for presentation to CARE membership 2006 meeting. Both sections were approved by membership. Jon Short (NMFS-AFSC) worked with MacLellan to insert the new material seamlessly into the electronic version. Short updated the on-line manual at the CARE website December 2006.
- No progress has been made on developing the hake section for the CARE Manual.
- No new sections for the CARE Manual have been proposed.
- MacLellan, Betty Goetz (NMFS-AFSC) and Kristen Munk (ADFG) developed the wording for the term "dark/light boundary" which was inserted in the CARE Manual glossary section and updated to the CARE website December 2006.

2. Web Committee (Short, Anderl), 2006-2008 – Jon Short (NMFS-AFSC) reported on work completed and used a dynamic link to the CARE website to demonstrate these updates. The CARE website is being upgraded to include user-modifiable tables that also retain data history/succession. For example, the table "Summary of Age Reading Methodology", previously EXCEL-based and passed from one administration to the next, now resides on the CARE website. Content is searchable. Short requested that he be replaced as the working group lead. Nikki Atkins(NMFS-NWFSC/PSMFC) will commence as co-chair of the web committee along with Short.

3. Charter committee (Munk, MacLellan, Anderl/Goetz) – this working group reconvened to insert recent age structure exchange language into the Charter and make other minor edits, to be completed by the next workshop.

4. Sablefish Age Readers Ad hoc Working Group – The sablefish age readers convened an ad hoc working group to deepen documentation of sablefish age-reading criteria and fundamental differences between stocks from southern to northern extent of the species range. The goals for this group are outlined in Appendix I-B.

Age Structure Exchanges (Vice-chair: MacLellan)

Age structure exchanges were made in 2007 and the early part of 2008. Specifically, in 2007 there were 4 exchanges: hake (2), sablefish, and lingcod fins. In 2008 there were 3 samples exchanged: sablefish (2), and yelloweye rockfish (1). These data are available upon request of the "Coordinator" of the specific exchange sample. Table 2 lists the exchanges made from 2006 to 2008.

Business Session Highlights and Discussion:

- The 2006 CARE Workshop Meeting Minutes were passed, and soon will be uploaded to the CARE website. CARE expressed interest in more promptly approving minutes, and developed a recommendation to itself describing a process facilitating this.
- An informal poll of readers was taken to assess attrition. Readers were asked what their approximate date of departure (retirement, other) from age-reading responsibilities would be. A total of 31 age readers responded (out of a potential 40), over half of whom have "age-reading" as their primary responsibilities (eg, >6mo/y). Fifty-one percent will be departing age reading responsibilities in 10 years or less, with 28% departing in less than 7y, and 19% in less than 5y.
- Additional workshop discussion details will be forthcoming upon completion of the 2008 CARE Workshop Meeting Minutes.

Workshop and Hands-on Session Highlights and Discussion:

- A total of at least 31 readers reviewed 18 species. Session summaries will be transcribed and appended to the 2008 meeting minutes.
- Several readers from CDFO, WDFW, ADFG, and NMFS-NWFSC/PSMFC focused on calibration using recent age structure exchanges. Four structure exchanges occurred prior to the workshop with resolution work at the workshop: sablefish, yelloweye rockfish, hake, and spiny dogfish.
- "Recommendation working groups" focused on wording of CARE recommendations.
- A representative of Buehler demonstrated a production high speed diamond saw.

Recommendations C.A.R.E.~TSC

A. 2008 CARE to CARE

1. 2008CC-01 "Move CARE workshop to off-year from Western Groundfish Conference": The CARE recognizes that their biennial workshop coincides with the biennial Western Groundfish Conference, and that this co-occurrence creates competition for same-year travel money. This can prevent attendance to one or both, and where off-year travel budgets might be underutilized. CARE proposes to move their workshop out of phase to the Western Groundfish Conference. CARE will next convene in 2009, the adjustment year. This will begin the new biennial sequence of 2009, 2011, 2013, etc.
2. 2008CC-02 "Add CARE website disclaimer and citation information": CARE recommends adding site and citation information to the CARE website. A new link in the sidebar entitled "Site information" will open a page with the following information:

    "This website is subject to periodic update and data may not have been formally peer reviewed. If you have specific questions please contact the contributing agencies."

    "If you wish to cite the webpage the following format is suggested: Committee of Age Reading Experts (CARE). "Title of Page." Date accessed: <access date> <URL>".
3. 2008CC-03 "Create CARE trial forum": CARE recommends creating a three-year trial forum for the discussion of age reading topics by the CARE community and other age-reading personnel. Users of the forum would be required to set up a user name and password; anonymous commenting would be disabled. Specific categories would be created for different areas of discussion: Specific species (with Flatfish, Rockfish, Roundfish, Elasmobranches, and Invertebrates as sub-categories), Preparation Methods, Digital Imaging, Equipment, Other and Off Topic. Each user will be able to choose whether they receive e-mail notifications of posts for the entire forum, specific categories/sub-categories, individual discussions, or none at all. Nikki Atkins (NMFS-NWFSC/PSMFC) will act as Moderator of the forums.
4. 2008CC-04 "Expedite approval of meeting-minutes": CARE recommends expediting their approval of meeting-minutes. The CARE Chair will send an email to workshop participants asking to approve the minutes: Yes or NO. Workshop participants will be given 2 weeks to reply; if "out of office" emails are received by the Chair, the time frame will be extended per their discretion. Prior to approval, meeting-minutes will be sent out for editing/corrections to members (see Charter protocol). Meeting-minutes will not go out for approval until all edits are complete, and, will not be posted without approval.

B. 2008 CARE to TSC (none made)

C. 2007 CARE to CARE (none made)

D. 2007 CARE to TSC (none made)

E. 2007 TSC to CARE

1. 2007TC-01 TSC will rely on fishery managers and stock assessment authors to interact directly with their ageing lab supervisors to communicate with CARE for ageing exchanges. TSC appreciates the work of CARE and recognizes that a

direct link between the assessment biologist and the ageing lab is the most efficient means of requesting species ageing exchanges.

i. CARE 2008 Response: Acknowledged.

F. 2006 CARE to CARE

1. 2006CC-01 The CARE Age Structure Exchange (CASE) table presently identifies inter-agency exchanges occurring on species of interest to the TSC, or other inter-agency calibrations as needed. CARE recommends to itself to modify the CASE table and process. We will continue to track structure exchanges per the CARE Charter, however, we will drop precision test results from the CASE table. We will develop a CASE invoice, accessible on the CARE website. Upon initiating an exchange, the originating agency will contact the CASE coordinator for an exchange id number. The originating agency will conduct the exchange, fill out all information in the CASE invoice, and submit it to the CASE coordinator upon its completion. . The CASE coordinator or designee will update the website to allow linked access within the CASE table. Inclusion of precision statistics is optional.

    i. CARE 2008 Response: Mostly done. The CARE website currently does not have access to the CASE invoice or link to pdfs of data.

2. CARE recommends making changes to the Summary of Age Reading Method, regarding format and information included. The current table info will be split into two tables; one to include "Methods" information (agency, species, method, validation, area, structure, validation & validation citation). The method, validation and citation columns would provide anecdotal information that will be updated. The method column would include all methods used historically or currently and provide dates when methods were adopted. The <u>validation column</u> would indicate method and extent (e.g. all ages, up to age 30, longevity) and the validation citation column would indicate dates and contact. The new 2nd table would include agency, species, calendar year and number of fish per species aged. Total fish and total species aged would be calculated. <u>Numbers of readers involved per calendar year</u> for all fish aged will also be included. It is recommended that this data would reside on the website and that a small relational database would house the data. A mechanism would be developed to query the database to assess the breadth and depth of expertise for species by agency for all species aged. Development of database will be in small steps. The Vice-chair will be responsible for updating both tables on an annual basis."

    i. CARE 2008 Response: Mostly done. Underlined elements are incomplete or have been dropped.

G. 2006 CARE to TSC

1. The biennial CARE meetings have been held traditionally at the Seattle NMFS-AFSC facilities. The Pacific Biological Station (PBS), Nanaimo representatives offered to host the 2008 CARE meeting. Two reasons were given for this proposed departure. First, this invitation coincides with the PBS 100th anniversary (1908-2008). Second, agency travel policies can prohibit age readers from different participating agencies and labs to attend the CARE meeting at the Seattle AFSC facilities. The CARE requests TSC members to support this recommendation and encourage travel funding. This rotation will allow PBS to

share in the hosting responsibilities and for greater CARE participation among their personnel. It would also appropriately acknowledge PBS's substantial contributions to the field of fish age and growth.

i. CARE 2008 Response: Accomplished.

H. 2006 TSC to CARE (none made)

Table 1. *Attendees of the 2008 CARE Workshop, April 1-3, 2008, Nanaimo, British Columbia*

Attendee	Agency	City, State/Province
Kristen Munk	ADFG-ADU	Juneau, Alaska
Jodi Neil	ADFG-ADU	Juneau, Alaska
Phil Cowan	ADFG-Homer	Homer, Alaska
Willy Dunne	ADFG-Homer	Homer, Alaska
Marian Pfeil	ADFG-Homer	Homer, Alaska
Sonya Elmejjati	ADFG-Kodiak	Kodiak, Alaska
Karen Charles	CDFO	Nanaimo, British Columbia
Nora Crosby	CDFO	Nanaimo, British Columbia
Darlene Gillespie	CDFO	Nanaimo, British Columbia
Joanne Groot	CDFO	Nanaimo, British Columbia
Mary Jane Hudson	CDFO	Nanaimo, British Columbia
Diana Little	CDFO	Nanaimo, British Columbia
Shayne MacLellan	CDFO	Nanaimo, British Columbia
Sue Mahannah	CDFO	Nanaimo, British Columbia
Judy McArthur	CDFO	Nanaimo, British Columbia
Joan Forsberg	IPHC	Seattle, Washington
Linda Gibbs	IPHC	Seattle, Washington
Robert Tobin	IPHC	Seattle, Washington
Steve Wischniowski	IPHC	Seattle, Washington
Delsa Anderl	NOAA-AFSC	Seattle, Washington
Chris Gburski	NOAA-AFSC	Seattle, Washington
Charles Hutchinson	NOAA-AFSC	Seattle, Washington
Jon Short	NOAA-AFSC	Seattle, Washington
Nikki Atkins	NOAA-NWFSC/PSMFC	Newport, Oregon
Betty Kamikawa	NOAA-NWFSC/PSMFC	Newport, Oregon
Patrick McDonald	NOAA-NWFSC/PSMFC	Newport, Oregon
Omar Rodriguez	NOAA-NWFSC/PSMFC	Newport, Oregon
Josie Thompson	ODFW	Newport, Oregon
Lance Campbell	WDFW	Olympia, Washington
Sandy Rosenfield	WDFW	Olympia, Washington
Jennifer Topping	WDFW	Olympia, Washington

Table 2. CARE age structure exchanges and status from 2006-2008(May)								
CASE NO.	ORIGINATING AGENCY	COORDINATOR	COOPERATOR(S)	DATE INITIATE	SPECIES	SAMPLE n=	NO. READER	STATUS
06-001	ADFG	K. Munk	PSMFC,NMFS-AFSC,DFO,ADFG-Junea	Jan2006	Sablefish	24	4	complete
06-002	PSMFC	P. McDonald	PSMFC,NMFS-AFSC,DFO,ADFG-Junea	Jan2006	Sablefish	25	4	complete
06-003	CDFO	S. MacLellan	PSMFC,NMFS-AFSC,DFO,ADFG-Junea	Jan2006	Sablefish	20	4	complete
06-004	NMFS-AFSC	D. Anderl	PSMFC,NMFS-AFSC,DFO,ADFG-Junea	Jan2006	Sablefish	20	4	complete
06-005	PSMFC	O. Rodriguez	PSMFC, CDFO	Nov2006	Hake	100	2	complete
06-006	CDFO	S. MacLellan	CDFO, PSMFC	Nov2006	Hake	100	2	complete
07-001	ADFG	K. Munk	NMFS-PSMFC, CDFO	Dec2007	Sablefish	24	3	complete
07-002	ADFG-Homer	C. Russ	ADFG-Homer, CDFO	Dec2007	Lingcod	30	2	complete
07-003	CDFO	S. MacLellan	CDFO, ADFG-Homer	Dec2007	Lingcod	30	2	complete
07-004	ODFW	J. Thompson	ODFW, ADFG-Juneau	Apr2007	Vermillion rockfish	60	2	complete
07-005	CDFO	S. MacLellan	CDFO, NMFS-NWFSC	Nov2007	Hake	100	2	complete
07-006	NMFS-NWFSC	O. Rodriguez	NMFS-NWFSC, CDFO	Dec2007	Hake	100	2	complete
08-001	CDFO	S. MacLellan	CDFO, NMFS-PSMFC, ADFG-Juneau	Jan2008	Sablefish	20	3	complete
08-002	NMFS-PSMFC	P. McDonald	NMFS-PSMFC, ADFG-Juneau, CDFO	Jan2008	Sablefish	20	3	complete
08-003	ADFG-Juneau	K. Munk	ADFG-Juneau, CDFO, WDFW	Mar2008	Yelloweye rockfish	24	3	complete

IPHC Research Program:

Review of 2007 Projects and Proposals for 2008

The International Pacific Halibut Commission Staff

Introduction

This document reviews research conducted by the IPHC staff in the past year and proposed for the upcoming year. The report is divided into two sections with the first section reviewing the status of research projects conducted 2007. The second section presents the preliminary staff research proposals for 2008. Information is provided on when each project was initiated, the anticipated completion date, the annual cost, a description of the costs, and the purpose of the project. This report does not include ongoing staff tasks such as data collection and processing that are necessary for the management of the fishery.

Research projects are organized into three funding categories that reflect availability and source of research funds. Limited research requiring direct financial support from the Commission is possible under the basic $3.797 million (as of 2007) government appropriations, although a number of programs can be conducted using only the staff resources that are supported by the appropriations. The three funding categories are:

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

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

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

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

SECTION I:
REVIEW OF RESEARCH CONDUCTED IN 2007

Research conducted by the IPHC staff during 2007 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.

2007 Research Highlights

The PIT tag dockside detection program by scan samplers continued in 2007, 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 21 October, almost 24 million pounds (41% of total landings) have been scanned. The number of tags recovered in 2007 totals 276 from the 2003 primary experiment, 182 from the 2004 releases, and 59 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 24%. Of the 59 double-tagged fish recovered in 2007, no PIT tags were missing from heads with wire tags attached and in six recoveries, the wire tag had shed and only the PIT tag was found by scan samplers.

The Otolith Elemental Fingerprint (OEF) project (#620) has shown that, using age-2 halibut from western Alaska, the chemical composition of otoliths can be used to successfully distinguish and classify individuals within general geographic regions (Bering vs. Kodiak vs. Cook Inlet), with 80-90% accuracy. The spatial model developed over the last two years relies primarily upon oxygen and carbon isotope ratios and secondarily upon trace element data, thus completing the first phase of the project which was simply a proof of concept. During 2007, field effort was expended in Area 2B to locate juvenile nursery areas. A number of sites (east Cape Scott, north Hope Island, Goose Island Banks, Oval Bank, McIntyre Bay, Virago Sound) failed to produce early juvenile halibut, but age-0 and age-1 halibut were captured at three sites describing the length of Dogfish Banks, at Rose Point, Cape Ball, and Sandspit. This represented successful establishment and mapping of nursery research sites in Canadian waters, as well as establishing a southern range extension for Pacific halibut nursery grounds. After evaluating the results and potential for further resolution of stock identity in this project, the Commission's internal research review committee decided to stop any additional work on this project. The primary reasons were the inherent limitations of the equipment used to detect the elements, and although aimed at different life-history stages, the desire to pursue other means of establishing stock identity (e.g., genetic) which have greater potential for success.

Effort on the Genetics project (#621) continued in 2007 on two fronts. The first consisted of three vessel operations in February 2007 which collected tissue samples from spawning fish in the Queen Charlotte Islands (Area 2B), Portlock Bank (Area 3A), and Pribilof Canyon (Area 4). The sites were fished essentially simultaneously and produced genetic samples from 698 adult halibut. Subsequent additional time was provided by the vessel conducting the Area 4 work to collect additional samples from grounds north of Adak Island. These samples will be added to the present microsatellite analysis; other samples will be reserved for use in future work employing potentially more powerful markers such as single nucleotide polymorphisms (SNPs), expressed sequence tags (ESTs), and mitochondrial DNA (mtDNA).

The second component of the 2007 genetics studies was continued sample analysis under the supervision of Dr. Lorenz Hauser at the University of Washington's Marine Molecular Biology Laboratory. This lab work moves the present analysis closer to completion before we move on to potentially more promising markers. Our technician is presently "filling gaps" in the existing dataset (i.e., re-running samples from fish that did not properly amplify properly on the first analysis) and will also add a sixth site (Adak Island) to the analysis. Preliminary research using summer-collected samples (*see* IPHC Scientific Report #81) suggested greater isolation in the Aleutian Islands than elsewhere, and we now have samples from spawning season that will allow us to test this result more rigorously.

In 2007, two PAT tag experiments (#646.11 and #646.12) were scheduled to pop-up. The tags were put out during the 2006 setline survey: 18 fish tagged in Area 2A; 60 in Area 2B. The tags were programmed to release on one of three dates: February 1, February 15, or March 1, 2007. The study was designed primarily to answer questions regarding the relative amount of out-of-area interception likely to occur on alternative season opening dates. Fifty-six tags functioned as programmed and reported on their pop-up dates: twelve of the 2A releases and 44 from 2B. In addition, one of the premature releases from the Area 2A tagging reported its position on January 18, and could therefore be included in the 2A emigration estimate. From the Area 2A releases, a total of five fish (total emigration rate = 39%) emigrated northward; four had moved to 2B and one to northern Area 2C. There was no apparent difference in emigration rate by date. From the 2B releases, a total of three fish (total emigration rate = 7%) emigrated northward. These fish were all located in Area 2C at pop-up: one at Cape Ommaney on February 1, one in Clarence Strait on February 15, and one in northern Dixon Entrance on March 1. These results differed from analyses from earlier conventional tagging that suggested a much higher proportion of the fish might be found out-of-Area on the specified dates. Differences may have resulted from having tagging larger fish in the PAT study than in conventional tagging work, a change in behavior in the period between the studies, the relative seasonal timing of present and previous studies, or fishery recapture biases in conventional tagging that are absent in PAT studies. It should be recalled that the previous studies generally tagged fish in winter and subsequently recovered them on the summer feeding areas. We do not know, for example, whether fish tagged in Area 2C and subsequently recovered in Area 2B had moved from Area 2B to Area 2C in the autumn prior to tagging, or had been 2C residents up until being tagged and moved to 2B prior to final capture as part of their lifetime west-to-east migration. The seasonal timing of the PAT tag study eliminates this confusion. The light-based location data from PAT tags also provides at least the potential to examine seasonal movements in their entirety by generating additional winter locations to ascertain whether the fish emigrated westward and returned by the Pop-up date. It should be noted, however, that technical limitations make it unlikely to make such assessments for the eastern stock component.

A second PAT tag study had tags pop up in 2007. This study (#622) looked to see if halibut which reside in the Bering Sea during summer are likely to move to the Gulf of Alaska to spawn, or instead remain in the Bering Sea. Joint funding received from the Central Bering Sea Fishermen's Association (CBSFA), Aleutian Pribilof Island Corporation (APICDA) and the

North Pacific Research Board (NPRB) allowed us to deploy PAT tags on 24 fish at two sites in the eastern Bering Sea during the 2006 survey: twelve in Bering Canyon just north of Unimak Pass (4A), and twelve at Middle Canyon on the 4D Edge. Eight tags functioned properly from the 4D Edge release: seven of these fish were located close to their release locations on the pop-up date, and one had moved south into the Bering Canyon. Ten tags functioned properly from the 4A release: nine of these fish were located close to their release locations on the pop-up date, and one had moved eastward. The results are similar to former Bering Sea tagging in that they fail to support the hypothesis that halibut resident in the Bering Sea in summer move into the Gulf of Alaska (GOA) to spawn or contribute to GOA larval pools. In total, the Bering tagging experiment has generated winter locations for 42 adult halibut; all locations have been within the Bering Sea.

The pilot study (Project 650) on use of internal archival tags in halibut which began in 2006 continued in 2007. This pilot work represents a controlled test of the relative utility of three different models of internal archival tag that can be used on relatively small (60-99 cm) halibut. Since August 2006, 24 halibut ranging from 65-90 cm have been held in tanks at the Oregon Coast Aquarium in Newport. Three different tag varieties were tested on the fish: 1) Lotek LTD 1110, an 11 mm by 32 mm resin-body tag; 2) Lotek LTD 2310, a 16 mm by 76 mm silicon-coated stainless steel tag with a 24 cm external light stalk; and 3) Wildlife Computer MK9, a 17 mm by 67 mm resin-body tag with a 19 cm external light stalk. All tag varieties record temperature and depth, and the tags with light stalks are capable of recording ambient light for the purpose of estimating fish location. The one-year holding period has just concluded and fish will be sacrificed during the first week of December. They will be examined internally to assess any potential reactions to the internal tag, and we will also use this opportunity to determine the feasibility of non-invasive sex determination via veterinary ultrasound, so that future tagging can be conducted in a sex-specific manner. Follow-up work is being proposed for 2008 using this technology.

2007 also saw phase 2 of the hook size/spacing study (#641.11). Previous work in 2005 was conducted off Kodiak. In that study, catch rate by weight was an increasing non-linear function of hook spacing but no significant effect of hook size on catch rate was found. Hook size did have an effect on catch in terms of numbers of fish, with smaller hook sizes catching larger numbers of smaller fish. However, the 2005 Kodiak study experienced extremely high catch rates of halibut, and it is likely that significant hook size or spacing effects are masked by the very high availability of halibut. It was originally planned that the Kodiak fishing would be contrasted with a phase 2 experiment in an area of lower halibut density, such as in Canadian waters. Conducting this experiment off BC would have the added element of dogfish competition for hooks. However, recent Canadian court decisions pushed the 2007 experiment into Area 2C, where it was conducted in late July and early August. The data seem to be behaving better than during the 2005 experiment, and this is likely due to the lower density of halibut on the chosen fishing grounds. The CPUE of legal-sized halibut increased with increasing hook spacing, and generally increased with hook size. There is no clear relationship between the catch of sublegals and hook spacing, although sublegal catch does seem to be higher on the smaller hooks. The analysis will be completed in 2008.

IPHC has been involved in several cooperative studies which utilize the summer assessment survey and the catch of non-halibut species. 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. In 2007, IPHC and Washington Department of Fisheries received funding from Pacific States Marine Fish Commission (PSMFC) for the second year of a joint project with industry. The Washington survey region was expanded to include 18 special stations (ten of which where fished in 2006, and eight were new locations for 2007) to look at rockfish populations. Stations were selected by WDFW with the hope of targeting rockier bottom than traditionally fished by the standard survey stations in the Washington region, so as to better characterize rockfish abundance. Three skates of gear where fished at each station as a precautionary approach due to the exploratory nature of these stations and concerns for over fishing yelloweye rockfish. Activities at each station were identical to those on standard IPHC stations, and rockfish were handled as described above. A summary of this project will be submitted to PSMFC by the end of November 2007. Depending on those results, there may be a third season of sampling under this funding opportunity.

In 2007, IPHC worked with DFO to provide a third biologist on IPHC survey vessels to sample rockfish. While this is the fifth year of the extensive bycatch sampling program in Canada, it is the first year that the IPHC trained and deployed the third biologist (previous years the third was provided by Archipelago Marine Research Ltd.). The program was funded by industry (Pacific Halibut Management Authority). Data collected included hook by hook occupancy information for all species, and otoliths, maturities, and lengths for rockfish. Continued collaboration is anticipated.

In 2007, IPHC worked cooperatively with Alaska Department of Fish and Game (ADFG) to collect rockfish bycatch data. Rockfish caught in the Ketchikan, Ommaney, Sitka, Fairweather and Yakutat charter regions were marked with an external Floy tag and the tag number was recorded with the set and skate capture information. All marked fish were retained for sale. At the offload, state biologists (contract biologist for BC landings) would meet the vessel and sample the rockfish for length, weight, maturity, and the otolith. The IPHC then provides each agency with effort information collected as part of the normal survey data collection. This was a developmental year for this sampling effort and it evolved somewhat over the course of the season. As not all offloads were met by biologists, the IPHC samplers assisted with the data collection where possible. Additionally the work focused on demersal shelf rockfish (DSR), with the subsampling being constrained to those species. The IPHC did collect piece count observations for all rockfish involved despite the focus on DSR specimens.

The IPHC collected retention/non-retention information on Pacific cod for landings coming into Dutch Harbor and St. Paul. Survey vessels recorded the number and pounds of Pacific cod retained and discarded by survey station. This information was collected when the vessel initiated retention of Pacific cod, i.e., usually four days prior to the expected landing date. Additional subsamples from the retained Pacific cod were obtained opportunistically from the survey offloads by IPHC port sampling staff. This included piece count information and length data. This was part of a developing effort to collect bycatch information on Pacific cod in the western regions of our survey, where it makes up the largest component of our survey bycatch.

IPHC contracted with Dr. Al Stoner of the NMFS lab in Newport, Oregon to conduct lab trials observing halibut and spiny dogfish behavior in the presence and absence of magnets and mischmetals (#651). Dr Stoner found a significant decrease in dogfish attacks with the mischmetal but no effect on halibut behavior. A report from this study is currently in press. Field testing occurred in the summer of 2007 in Kachemak Bay, near Homer. In fishing trials, dogfish catches were reduced by about 15% using the mischmetal. However, neither the field trials nor the tank tests showed any significant effect on halibut catches.

A study to verify, by direct observation, the halibut hooking success curve for halibut on setlines took place in 2007 (#652). This curve has been estimated previously from tag release/recovery data and from a small set of direct observation data previously collected with an underwater video camera in shallow waters. The 2007 study leased a Didson (dual frequency identification sonar) sonar, and used a gear frame which was constructed in 2006 for the trap experiment. During a 10-day experiment out of Seward, 67 deployments of the Didson gear were made which witnessed over 50 halibut captures. The video data are expected to provide strong preliminary data to describe the halibut selectivity curve. The video files will be fully analyzed over this winter. Additional work is under consideration for 2008.

Finally, IPHC hired one intern (Project 618) in 2007. Ms. Kirsten Baltz (University of Alaska Fairbanks) worked May-August on a project titled “A spatial analysis of amphipod predation on longline-caught Pacific halibut”, which gave her an opportunity to spend time on a survey vessel collecting data. She presented his results to the staff, and her final report will be included in the 2007 RARA.

2007 Contract Research

NMFS Auke Bay Lab (ABL) has had a sablefish data collection program for several years and IPHC has assisted NMFS with the program. In 2003/2004, the program was reviewed and modified to meet the IPHC confidentiality policy and to encompass all vessels rather than just vessels greater than 60 feet. Under a Statement of Work (SOW), NMFS contracts IPHC to collect and review information on sablefish catches (Project 628) during the IPHC port sampler’s logbook interview. Sablefish data are entered by IPHC staff, edited, and an electronic summary provided to the ABL scientists. Vessels are assigned a unique code in the summarized data to preserve confidentiality. The SOW was renewed for 2007.

IPHC also received a grant from NMFS for the incremental increase in port sampling costs due to the IFQ program (Project 375). An application to ODFW for a grant to assist in the purchase of a water column profiler was approved in 2007. The grant, in the amount of $23,348, enabled data to be collected from the summer assessment survey vessel while operating in the Oregon survey region in 2007. Finally, a grant from NMFS was used to offset vessel charter costs during the field tests of mischmetal (Project 651). The grant was awarded through the agency’s emphasis on reducing bycatch.

2007 Research Publications

IPHC staff noted in **Bold** type.

Ames, R.T., **Leaman, B.M**., and Ames, K.L. 2007. Evaluation of video technology for monitoring of multispecies longline catches. N. Am. J. Fish. Mgmt. 27: 955-964.

Loher, T. *In Press.* Investigating variability in catch rates of halibut (*Hippoglossus stenolepis*) in the Pribilof Islands: Is temperature important? Deep Sea Research II.

Seitz, A.C., **Loher, T.**, and Nielsen, J.L. 2007. Seasonal movements and environmental conditions experienced by Pacific halibut in the Bering Sea, examined by pop-up satellite tags. Int. Pac. Halibut Comm. Sci. Rep. 84. 24 p.

Trites, A.W., A.J. Miller, H.D.g. Maschner, M.A. Alexander, S.J. Bograd, J.A. Calder, A. Capotondi, K.O. Coyle, E. Di Lorenzo, B.P. Finney, E.J. Gregr, C.E. Grosch, **S.R. Hare**, G.L. Hunt, J. Jahncke, N.B. Kachel, H. Kim, C. Ladd, N.J. Mantua, C. Marzban, W. Maslowski, R. Mendelssohn, D.J. Neilson, S.R. Okkonen, J.E. Overland, K.L. Reedy-Maschner, T.C. Royer, F.B. Schwing, J. X. L. Wang and A.J. Winship. 2007. Bottom-Up forcing and the decline of Steller sea lions in Alaska: Assessing the ocean climate hypothesis. Fish Oceanogr. 16:46-67

Yamanaka, K.L., Lochead, J.K., Cooke, K., Lacko, L.C. and **Dykstra, C.** 2007. Summary of non-halibut catch from the standardized stock assessment survey conducted by International Pacific Halibut Commission in British Columbia from May 31 to July 24, 2005. Canadian Technical Report of Fisheries and Aquatic Sciences 2689. 55 p

Section II:
Research Proposed for 2008

Projects to be carried out in 2008 consist of a continuation of several projects currently underway. Six new projects are being proposed by the staff. Selected continuing projects include:

1. Project 413.00 - PIT tag recovery efforts will continue in 2008 with the scan sampling program. Scanning will also continue on the assessment survey vessels. No other changes are planned for port coverage or duration of sampling. Planning for this activity is based on a March 1 – November 15 season. At this time, 2008 is expected to be the final year of scanning.

2. Project 621.00 - The study of the population genetic structure will continue in 2008 with the sample testing and analysis supervised by Dr. Lorenz Hauser (UW Marine Molecular Biology Laboratory). The FY2008 budget will allow for continued sample analysis by a technician in Dr. Hauser’s lab. We also are broadening the geographic scope by seeking samples from Atlantic halibut and also samples which have been offered by TINRO scientists in Vladivostok.

3. Project 652.11 – A second year of examination of the hooking success by halibut on longline gear, using the Didson sonar. This effort follows up on the 2007 study and seeks to gather additional video observations, and will also look at the success rate on smaller circle hooks.

4. Staff will also continue with other long-standing projects in 2007. These include the collaborative work on contaminants with ADEC (#642.00), placement of IPHC staff on the NMFS summer trawl surveys (#604.00), data collections with water column profilers on the assessment surveys (#610), and the undergraduate internship program (#618). The otolith marginal increment analysis (#626.00) is expected to be completed in 2008. Finally, the investigation of sleeper shark population structure and development of an aging technique (#630.00) will focus on lab work and genetic testing of samples.

Six new projects are proposed for 2008:

1. **Comparison of halibut catch rates on swivel gear and fixed hook gear** - IPHC has been collecting information on the use of swivels in the halibut fishery since 2001. In 2001, 34% of the trips used swivel snap gear in B.C. (Regulatory Area 2B). This number rose to 46% in 2002, to 62% in 2003, and dropped slightly to 58% in 2004. This study will determine the effect of using swivels on the catch rates of species subject to longline gear.

2. **PAT tag deployments in Area 4** - The staff is proposing to release PAT tags in Area 4 in 2008 in an effort to determine the reasons why so few PIT tags were recovered in the Bering Sea halibut fisheries. Recoveries to date of PIT tags are far below what was expected. The releases would be made in batches of 20 tags in each of the Area 4 survey regions during the summer assessment surveys, for a total of 100. The large number of releases is expected to provide sufficient recoveries to enable estimation of fish movements.

3. **Pilot application of archival tags in Area 2B** – This study will investigate migratory behavior and environmental conditions experienced by small adult (primarily male) and late pre-recruit halibut. These fish have not been studied with PAT tags due to the size constraints imposed by the large, bulky nature of the PAT tags, and to obtain multi-year data for larger fish. Externally attached, rather than surgically implanted, archival tags will be used in this project. The tags would be applied to all females above 90 cm and all fish above 100 cm, late in the season.

4. **Coastwide deployment of water column profilers on IPHC survey vessels** – The goal of this project is to implement a program to measure oceanic properties in the waters over the Alaskan, B.C., and the U.S. West Coast continental shelf that can be correlated to catch per unit effort (CPUE) of halibut as well as incidence of other groundfish species. Water column profilers that measure temperature, salinity, dissolved oxygen, pH, and florescence will be deployed at each station during the summer assessment survey. These data will provide an annual snapshot of nearshore oceanic conditions as well as valuable observational data for modeling and biological studies on recruitment and growth variability.

5. **Removal fishing to estimate catch probability** – The proposal is to conduct removal sampling as a technique for directly estimating catch probability at a sample of setline survey stations in one regulatory area in 2008. These data will allow us to model catch probability as a function of station and individual fish covariates, and compute a population index for the area that accounts for catch probability.

6. **Bycatch characterization in the Pacific halibut fishery off Alaska: A field test of electronic monitoring technology** – While previous work on the use of EM to monitor longline operations off Alaska demonstrated the potential for this technology, the research was conducted under research conditions and not commercial fishing conditions. In the commercial fishery a much broader range of environmental and physical factors affect the vessel operations. As a result, these methods are not yet proven under commercial fishing conditions off Alaska. Partial funding for this project has already been secured through the North Pacific Research Board, and is being carried out in cooperation with the NMFS Groundfish Observer Program and the Pacific States Marine Fisheries Commission.

Projects conducted under contract to other agencies or through research grants will be continued in 2007. IPHC port sampling activities in Alaska will continue being augmented by a grant from NMFS (Project 375.00), and IPHC port samplers in Alaska will collect sablefish logbook data for the NMFS Auke Bay lab (Project 628.00). NPRB has provided a grant to offset some of the costs associated with the electronic monitoring pilot study (new #6).

We are also awaiting word from ODFW on a proposal to add stations to the Oregon survey region to look at rockfish indices.

Funded Research

Project 413.00: PIT tagging study: Year 5 of tag recovery and scanning

Start Date: 2003
Anticipated ending: 2009
Personnel: J. Forsberg, C. Blood, G. Williams, B. Clark, A. Ranta, scan samplers

Scanning for PIT tags will continue in 2008. IPHC will hire samplers for Alaskan ports, while contracting with AMR for the Canadian ports and continuing to seek state and tribal assistance in Area 2A. Sampler duties include scanning commercial deliveries for PIT tags, and conducting regular tests of detection and piece (fish) counts to measure accuracy of sample data. Project costs are expected to be about the same as last year. Modest increases are expected in salaries (cola) and our contract with AMR for sampling in Area 2B.

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

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

A series of NMFS trawl survey data on halibut, parallel to our setline data, is extremely valuable to IPHC as a second fishery-independent data source for stock assessment. Trawl data are particularly useful because they include large numbers of juveniles (ages 3-7 yr) that do not appear in large numbers in the setline survey. Otoliths have been collected on the NMFS surveys since 1996 and provide relevant age information. These data are incorporated into a copy of the NMFS haul data, expanded to estimates of relative abundance and age/size composition by IPHC area (NMFS calculates estimates by INPFC area), and stored in a database at IPHC. Project cost is comprised of personnel and travel. In 2008, the staff is planning on placing one sampler aboard the NMFS survey vessel.

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

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

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

Project 610.12: Water column profiler project (Oregon grid)

Start date: 2007
Anticipated ending: Continuing
Personnel: L. Sadorus, S. Hare, P. Stabeno (NMFS PMEL)

Same equipment as in the previous project but used only on stations off the Oregon coast.

Project 618.00: Undergraduate Internship

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

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

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

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

Results from a preliminary population analysis of the summer 2002 samples suggested potential reproductive isolation in the Aleutians. Tissue samples were collected in winter 2004 to address the question of whether or not the Bering Sea is reproductively isolated from the Gulf. The analyses of these by Dr. Lorenz Hauser (UW - Marine Molecular Biology Laboratory) are nearing completion. His lab is also continuing with the testing and analysis of the summer samples from 2005 and 2006, and would also begin analysis of the winter 2007 samples. Efforts would also be made to obtain samples from Russia, and the Canadian Atlantic for comparison.

Project 630.00: Sleeper shark genetic studies

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

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

Mitochondrial DNA polymorphisms will be used as the initial genetic marker system to investigate population differentiation among the three sampling locations. We will initially attempt amplification using primers located within the proline tRNA and 12S rRNA regions of the mitochondria. These primers have been used to examine population genetic structure across a similar geographic range in blacktip sharks and yielded sufficient information to differentiate among nurseries of this species. Statistical analysis will be by way of X^2 and AMOVA probabilities of haplotype homogeneity across sampling sites. Extraction of mitochondrial DNA from skin samples, polymerase chain reaction (PCR) amplification and sequencing will occur in the Microbiology Lab at the Department of Microbiology, University of Victoria, B.C.

Project 636.00: Analysis of gonad staging on IPHC setline surveys (histology)

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

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

Project 642.00: Assessment of mercury and contaminants in Pacific halibut

Start Date: 2002
Anticipated ending: Continuing
Personnel: C. Dykstra, Alaska Department of Environmental Conservation (ADEC)

For the last few years, health officials and media have raised the profile of pollutant contamination in fish (methyl mercury, PCB's, pesticides). Since 2002, the IPHC has been working collaboratively with the Alaska Department of Environmental Conservation (ADEC) to collect halibut tissue samples to be analyzed for heavy metal and organic pollutant loading. The principal results from the 2002 collection led the Alaska Division of Public Health in 2003 to conclude that the concentrations of heavy metals in Alaskan Pacific halibut are not a public health concern. In 2004 the first results regarding organic pollutants (PCB's, pesticides) were released demonstrating that halibut had the lowest concentrations of the five species (including salmon and sablefish) examined. Since 2002 the IPHC has submitted 618 samples for testing by ADEC. The mean level of total mercury for these samples has been 0.348 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 2007 with a targeted collection of 60 samples (20 fish between 10-20 lbs, 20 fish between 20-40 lbs and 20 fish greater than 40 lbs.) from each of three regions (Fairweather, Trinity, and Attu) during the setline survey. An additional 97 samples where collected from two Attu stations that produced what appears to be anomalously high readings in 2005. Results will be published as they become available. ADEC has expressed interest in further assessments of contaminant occurrence in halibut in 2008.

Project 650.00: Archival tagging – pilot studies

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

PAT tags represent a powerful tool for studying the movement and behavior of adult halibut, but their relatively large size has so far prevented us from extrapolating the results across population components. PAT tags have only been deployed on fish larger than 105 cm fork length (FL) and most halibut of this size are female. It is reasonable to examine whether males and non-reproductive individuals behave differently than large females. Sex-specific migratory behavior is common in many species because males and females typically do not possess the same annual energy budgets and potential for long-distance dispersal. This study represents a controlled test of the relative utility of three different models of internal archival tag that can be used on relatively small (60-99 cm FL) halibut. In August 2006, halibut ranging from 65-90 cm FL were transported to the Oregon Coast Aquarium in Newport, and fifteen were surgically implanted with archival tags in October. Five fish were tagged with each of 3 different tag varieties: 1) Lotek LTD 1110, an 11 mm by 32mm resin-body tag, 2) Lotek LTD 2310, a 16 mm by 76 mm silicon-coated stainless steel tag with a 24 cm external light stalk, 3) Wildlife Computer MK9, a 17 mm by 67 mm resin-body tag with a 19 cm external light stalk. All tag varieties record temperature and depth, and the tags with light stalks are capable of recording ambient light for the purpose of estimating fish location. All fish survived the implantation process, although one died in July due to a large temperature fluctuation at the holding facility. The one-year holding period has just concluded and fish will be sacrificed during the first week of December. They will be examined internally to assess any potential reactions to the internal tag, and we will also use this opportunity to determine the feasibility of non-invasive sex determination via veterinary ultrasound, so that future tagging can be conducted in a sex-specific manner.

Project 652.11: Verification of hooking success using Didson sonar

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

The purpose of the study is to verify, by direct observation, the halibut hooking success curve for halibut on setlines. This curve has been estimated from tag release/recovery data and from a small set of direct observation data collected with an underwater video camera in shallow waters. This project would generate a larger set of observations and operate in more appropriate depths. During 2005 and 2007, the IPHC conducted gear studies aimed at estimating the effects of hook size and hook spacing on setline catches. The 2007 Hooking success (#652.00) study developed a gear selectivity curve for large circle hooks based on direct observation of hook attacks and hooking success. This continuation will expand the current study to include observations on smaller hook sizes. The conclusions of this continuation study will be valuable in interpreting the results of the 2007 hook size and spacing study, giving direct observations on hook attacks and more importantly hooking success as a function of halibut length.

Project 653.00: Species identification of amphipods frequenting Pacific halibut

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

The project intends to document the occurrence and virulence of attacks by predatory amphipods on halibut caught on IPHC surveys and, by inference, the commercial fishery. The commercial industry suffers annual losses of product due to amphipod predation and must adjust its fishing locations and practices in response to predation. Harvester discussions indicate that predation sites are both known and ephemeral, and the virulence may vary interannually at a given site. The specific identity of the amphipods has not been established and it is probable that more than one species is involved. Harvesters are interested in both documentation of predation areas for avoidance, as well as gaining an understanding of the dynamics of the species at given sites, i.e., are there cycles of abundance that respond to other factors. Data were collected on all stations during the 2004, 2005, and 2006 stock assessment surveys as part of standard protocol, recording incidence of sand flea predation, and the extent and virulence of the predation. The 2006 was the last year of data collection for this stage of the project. The 2007 summer intern performed initial analysis of interannual occurrence and virulence. Additional work will be directed at correlated variables.

Proposed New Research in 2008

1. Comparison of halibut catch rates in swivel gear

Start Date: 2008
Anticipated ending: 2008
Personnel: S. Kaimmer, K. Gravel, Survey team

IPHC has been collecting information on the incidence and use of swivels in the halibut fishery since 2001. In 2001, 34% of the trips used swivel snap gear in Area 2B. This number rose to 46% in 2002, to 62% in 2003, and dropped slightly to 58% in 2004. This study will determine the effect of using swivels on the catch rates of species subject to longline gear.

We are still in the design stage at this point. Some issues being examined include the area in which the study will operate, the number of comparison sets and subsequent fishing trips, specific gear configurations to test, and potential amount of rockfish bycatch.

2. PAT tags: summer releases in Area 4

Start Date: 2008
Anticipated ending: 2009
Personnel: T. Loher, B. Clark, sea samplers

The staff is proposing to release PAT tags in Area 4 in 2008 in an effort to determine the reasons why so few PIT tags were recovered in the Bering Sea halibut fisheries. Recoveries to date of PIT tags are far below what was expected. The releases would be made in batches of 20 tags in each of the Area 4 survey regions during the summer assessment surveys, for a total of 100. The large number of releases is expected to provide sufficient recoveries to enable estimation of fish movements.

3. Archival tags: pilot releases in Area 2B

Start Date: 2008
Anticipated ending: 2009
Personnel: T. Loher

This study will investigate 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 will be used in this project. The tags would be applied to all females above 90 cm and all fish above 100 cm, late in the season. Attachment protocols will be determined over the spring and summer of 2008.

The depth data from the tags will be used to quantify: 1) mean timing and duration of fall departure to deep water, 2) mean deep-water residence period, 3) mean active spawning date, 4) mean active spawning depth, 4) mean timing and duration and the spring return to shallow water, 6) proportion of the tagged population failing to make a fall migration, 7) proportion of the tagged population failing to display spawning rises, 8) differences between male and female fish, and eventually 9) regional variance in all the above parameters (presuming sample sizes allow meaningful comparisons). Along with means, of particular interest will be fitting descriptive functions to the range of data (such as described earlier for the rise initiation date data).

4. Coastwide water column profilers for IPHC survey vessels

Start Date: 2008
Anticipated ending: Continuing
Personnel: L. Sadorus, S. Hare, P. Stabeno (NMFS PMEL)

The goal of this project is to implement a program to measure oceanic properties in the waters over the Alaskan, B.C., and the U.S. West Coast continental shelf that can be correlated to catch per unit effort (CPUE) of halibut as well as incidence of other groundfish species. The IPHC operates a survey that covers the area, and water column profilers that measure temperature, salinity, dissolved oxygen, pH, and florescence will be deployed at each station. These data will provide an annual snapshot of near shore oceanic conditions as well as valuable observational data for modeling and biological studies on recruitment and growth variability.

To better understand the factors driving fluctuations in growth and recruitment of fish populations, increasing attention is being paid to climatic and oceanic conditions. Primary and secondary productivity are directly driven by variations in water temperature, salinity, oxygen, mixing, and light penetration, among other factors. Most of this production takes place in the mixed layer, between 20 and 100 meters depth. Spring and early summer are peak periods of production. Waters over the continental shelf are, naturally, most important to the groundfish species that constitute much of the fish production of the northeast Pacific. Observations of ocean conditions are important both to understand variability in time and space as well as to provide necessary data for modeling productivity. Satellites sample the ocean surface and free drifting arrays of mid-ocean profilers (Davis 1991, Feder 2000) provide data on mid-latitude ocean conditions. Moorings provide continuous hydrographic and current data but at fixed points. More recently, gliders have been employed to survey cross-shelf transects, but these units are very expensive. Generally, there is a great lack of observational data for most of the near shore northeast Pacific.

Capital expenditures for this project consist of the acquisition of 14 profilers from Sea-Bird Electronics (Bellevue, WA) and 14 laptop computers to accompany each profiler at sea. The amount budgeted for these expenditures is based on a quote provided by Sea-Bird in February 2007 and is good for one year. The quote includes a quantity discount and an additional discount due to IPHC's non-profit status.

5. Removal fishing – pilot study

Start Date: 2008
Anticipated ending: 2009
Personnel: R. Webster

Our proposal is to trial removal sampling as a technique for directly estimating catch probability at a sample of setline survey stations in one regulatory area in 2008. For the selected stations, a sequence of five sets will be made on consecutive days. The first set will be the standard survey set. Subsequent sets will use the same methods and collect the same data on halibut and station conditions as standard survey sets. These data will allow us to model catch probability as a function of station and individual fish covariates, and compute a population index for the area that accounts for catch probability. Some design and analysis issues remain to be worked out, in particular, whether migration of fish during the sampling at each station can be accounted for in the modeling.

6. Alaska fishery electronic monitoring – pilot study

Start Date: 2008
Anticipated ending: 2009
Personnel: G. Williams, B. Leaman, B. Karp and J. Cahalan (NMFS Observer Program)

Bycatch rates in the Pacific halibut fishery are not well estimated. The majority of vessels operating in this fishery are not required to have NMFS/NPGOP monitoring; hence estimates of bycatch are not based on direct observation of the fishery. The long term focus of this research is to improve our 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. We will be comparing and evaluating the effectiveness of electronic monitoring (EM) and the currently utilized National Marine Fisheries Service (NMFS), North Pacific Groundfish Observer Program (NPGOP) monitoring methods to operate effectively in a commercial longline (hook-and-line) setting in Alaskan waters. This is a cooperative study with the commercial fishing industry and relies on our ability to sample on various vessel configurations.

Previous research by one of the partners in this proposal documented successful EM of Pacific halibut longline fishing from chartered research vessels (Ames, 2005; Ames et al., 2007). While this work supported the use of EM to monitor bycatch, the research was not conducted under commercial fishing conditions. In the commercial fishery a much broader range of environmental and physical factors affect the vessel operations. As a result, these methods are not yet proven under commercial fishing conditions off Alaska. Partial funding for this project has already been secured through the North Pacific Research Board.

7. False annuli identification in juvenile halibut ages one to four

Start Date: 2008
Anticipated ending: 2009
Personnel: S. Wischniowski

The purpose of the study is to address the question of otolith annuli and check interpretation. Is the age and growth lab correctly assigning ages based on its definition of a translucent growth zone compared to a check? The Bering Sea has demonstrated to produce growth patterns in which this interpretation may be in question. To address this issue selected samples of both "typical" and "atypical" growth zones will be analyzed both chemically and morphometrically. First, LA-ICP-MS will be utilized to determine if the elemental constituency of an otolith changes between growth zones. LA-ICP-MS will be utilized to raster selected areas of summer growth, winter growth, and suspected checks of thin-sectioned otoliths to determine if chemical signatures differ between these rastered areas. Specifically, we wish to determine if a check has a different chemical signature when compared to its neighboring translucent zone(s). Second, MIA will be used to quantify the percent occurrence of juvenile halibut that demonstrate similar occurring check patterns. All translucent and check zones will be measured from the focus to quantitatively characterize each otolith's microstructure. Results will then be compared among geographic regions to test for statistically significant check (microstructural) patterns that may be associated to location of capture.

Other 2008 Research – Contracts and Grants

Project 375.00: Alaska port sampling

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

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

Project 628.00: Alaska catcher vessel logbook and sablefish data collection

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

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

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

Research Conducted Without Direct Funding

1. The 2007 stock assessment

Personnel: B. Clark, S. Hare

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

2. Development of IPHC harvest policy

Personnel: S. Hare, B. Clark

Staff quota recommendations are calculated by applying a judiciously chosen harvest rate to an estimate of present exploitable biomass. The constant harvest rate policy was developed on the basis of its performance over a long time horizon and with the explicit goal of avoiding reaching the minimum stock sizes seen in the 1930s and 1970s. In 2003 the staff proposed a conditional constant catch policy under which total removals would be capped at a chosen ceiling level at high biomass levels, while a constant harvest rate policy would continue to be employed at low and intermediate stock levels. The Commission did not adopt the proposed policy at the 2004 annual meeting, and a staff/industry workshop on harvest policy alternatives in September 2004 showed general satisfaction with the present policy, as mediated in practice by the judgment exercised by the Director in developing staff recommendations and by the Commission in finally setting catch limits. In 2004, an explicit lower limit on spawning biomass and a threshold below which the harvest rate will be reduced—were added to the constant harvest rate policy. As a result the target constant harvest rate for the core IPHC areas (2B, 2C, and 3A) was lowered to 22.5% from 25%. The staff will continue to evaluate the constant harvest rate policy. In particular, we will recalculate the optimum harvest rate itself in light of our present understanding of stock dynamics and new information on commercial length-specific selectivity coming from the PIT tag experiment.

3. Development of a robust management procedure

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

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

4. Estimation of halibut abundance from mark-recapture data

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

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

The staff marked the catch of three skates at each survey station coastwide in 2003 and in Areas 2B and 3A in 2004. Preliminary analysis of the 2004 recoveries showed good agreement with the stock assessment in Areas 2B and 2C, but farther west the mark-recapture estimates were much higher than the assessment estimates. Recoveries in 2005-2006 followed a similar pattern. The 2007 recoveries will be added to the analysis this year.

5. Seabird occurrence project

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

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

6. Seabird data repository (Project 643)

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

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

7. Estimates of bycatch on the setline surveys

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

Area 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 marked with an external Floy tag and the tag number is recorded with the set (and recently the skate number) information. All marked fish were retained for sale. At the offload, a state biologist meets the vessel and samples the rockfish for length, weight and maturity, takes a genetic sample and otolith. The IPHC then provides each agency with the effort information collected as part of the normal survey data collection.

In 2007, IPHC and Washington Department of Fisheries received funding from Pacific States Marine Fish Commission (PSMFC) for the second year of a join project with industry. The Washington survey region was expanded to include 18 special stations (ten of which where fished in 2006, and eight were new locations for 2007) to look at rockfish populations. Stations were selected by WDFW with the hope of targeting rockier bottom than traditionally fished by the standard survey stations in the Washington region, so as to better characterize rockfish abundance. Three skates of gear where fished at each station as a precautionary approach due to the exploratory nature of these stations and concerns for over fishing yelloweye rockfish. Activities at each station were identical to those on standard IPHC stations, and rockfish were handled as described above. A summary of this project will be submitted to PSMFC by the end of November 2007. Depending on those results, there may be a third season of sampling under this funding opportunity.

Area 2B

In 2007, IPHC worked with DFO to provide a third biologist on IPHC survey vessels to sample rockfish. While this is the fifth year of the extensive bycatch sampling program in Canada, it is the first year that the IPHC trained and deployed the third biologist (previous years the third was provided by Archipelago Marine Research Ltd.). The program was funded by industry (Pacific Halibut Management Authority). Data collected included hook by hook occupancy information for all species, and otoliths, maturities, and lengths for rockfish. Continued collaboration is anticipated.

Area 2C and eastern 3A

In 2007, IPHC worked cooperatively with Alaska Department of Fish and Game (ADFG) to collect rockfish bycatch data. Rockfish caught in the Ketchikan, Ommaney, Sitka, Fairweather and Yakutat charter regions were marked with an external Floy tag and the tag number was recorded with the set and skate capture information. All marked fish were retained for sale. At the offload, state biologists (contract biologist for BC landings) would meet the vessel and sample the rockfish for length, weight, maturity, and the otolith. The IPHC then provides each agency with effort information collected as part of the normal survey data collection. This was a developmental year for this sampling effort and it evolved somewhat over the course of the season. As not all offloads were met by biologists, the IPHC samplers assisted with the data collection where possible. Additionally the work focused on demersal shelf rockfish (DSR), with the subsampling being constrained to those species. The IPHC did collect piece count observations for all rockfish involved despite the focus on DSR specimens.

Area 4

The IPHC collected retention/non-retention information on Pacific cod for landings coming into Dutch Harbor and St. Paul. Survey vessels recorded the number and pounds of Pacific cod retained and discarded by survey station. This information was collected when the vessel initiated retention of Pacific cod which usually started four days from the expected landing date. Additional subsamples from the retained Pacific cod were obtained opportunistically from the survey offloads by IPHC port sampling staff. This included piece count information and length data. This was part of a developing effort to collect bycatch information on Pacific cod in the western regions of our survey, where it makes up the largest component of our survey bycatch.

8. Sleeper shark investigations: Ageing study (Project 630)

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

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

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

9. Review of port sampling, 1994 to present

Start Date: 2002 (Deferred in 2004)
Anticipated ending: 2008
Personnel: L. Hutton, T. Kong

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

10. Electronic reporting project for commercial landings in Alaska

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

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

Northwest Fisheries Science Center

National Marine Fisheries Service

NOAA Fisheries

2008 Agency Report to the Technical Subcommittee

of the Canada-U.S. Groundfish Committee

April 2008

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

During 2007, 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 ecosystem research. Significant progress continues in all programs.

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

Other Divisions at the NWFSC are:

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

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

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

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

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

B. Multi-species Studies

1. Research

a) Demersal fish abundance in relation to an offshore hypoxic zone along the U.S. West Coast

In August 2007, as part of the West Coast Groundfish 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 the West Coast Groundfish Trawl 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 2007, FRAMD dedicated 2-days of the groundfish survey to examining the abundance of demersal fish and invertebrates within the hypoxic zone in greater detail. Working collaboratively with colleagues from Oregon State University, we identified the geographic extent of the 2007 hypoxic zone. We sampled 17 stations along 2 depth contours (50 and 70 m) within the area. A Seabird SBE19-plus was attached to the trawl gear to monitor oxygen concentration during each tow. 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 2-day survey, bottom oxygen concentrations at all stations were hypoxic with means along the tow tract ranging from 0.43 to 1.27 ml l^{-1}. Total CPUE (ln, kg $hectare^{-1}$) was significantly ($F = 6.56$, $P = 0.02$, $n = 17$) and positively related to oxygen concentration along the hypoxic gradient (Figure 1). In addition, CPUE (ln transformed) for 11 individual demersal fish species and 5 benthic invertebrate species were significantly ($P < 0.10$) and positively related to bottom oxygen concentration within the hypoxic region. Condition factors for 6 fish species, as well as Dungeness crab increased with increased bottom oxygen levels along the hypoxic gradient and preliminary results suggest the average weight of stomach contents for 4 fish species were lower at the lowest oxygen concentrations encountered.

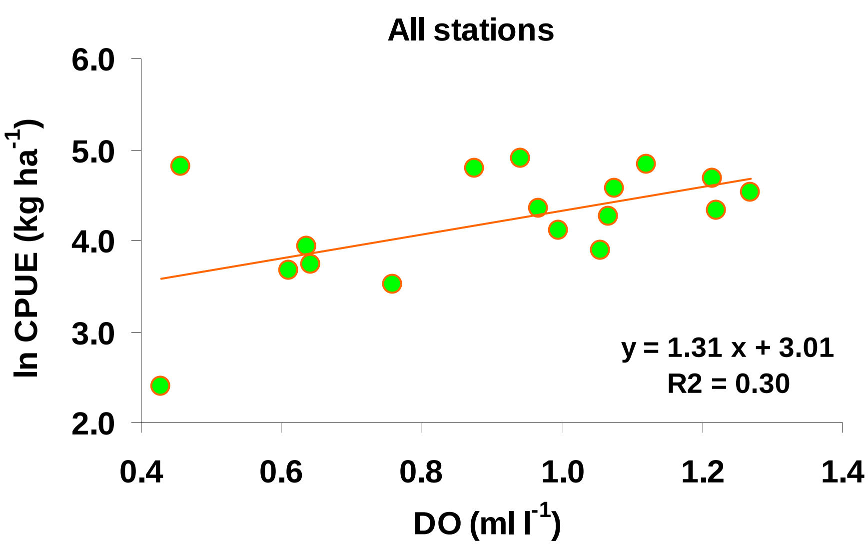

Figure 1. Relationship between catch per unit effort (CPUE, ln kg $hectare^{-1}$) and mean bottom oxygen concentration (ml l^{-1}) along the tow track within the hypoxic zone.

b) The effects of temporal variation in fishing effort in the U.S. West Coast At-Sea hake fishery

In 2007, FRAMD examined the effects of temporal variation in fishing effort on bycatch rate in the U.S. West Coast at-sea hake (*Merluccius productus*) fishery. Recent regulations limiting the bycatch of particular rockfish species in the at-sea Pacific hake fishery have resulted in several changes in the fishery, including documented changes in fishing depths. Concerns about rockfish bycatch have led to speculation that tows made during daytime hours have lower rockfish bycatch rates in comparison to nighttime tows. For the 2006 and 2007 seasons, a voluntary agreement between the vessels was proposed to focus fishing primarily during daylight hours and minimize nighttime fishing when possible, in an effort to reduce widow rockfish (*Sebastes entomelas*) bycatch. Fishing during nighttime hours was still conducted, but the data indicate a distinct shift towards increased fishing effort during daylight hours. Bycatch in the hake fishery is highly variable, and rare tows with very high rates of bycatch can skew the data, but overall averages indicate the total bycatch rate increases around dawn and are slightly higher during daytime hours. However, the rate of hake catch drops off during the night and thus the perception of higher bycatch – in relation to hake caught – has led to the idea of limiting nighttime fishing to reduce bycatch. It does appear that the hours surrounding dawn might be a beneficial time to reduce effort in an attempt to lower bycatch overall.

Due to the sporadic nature of large widow rockfish catches, reduced nighttime fishing has not had a large impact on the total amount caught. Other means of bycatch reduction should be explored. Avoidance of the 1.5% of tows which have very high widow bycatch should be made the priority. If this could be done the widow bycatch rate could be cut in half. Bycatch is influenced by multiple variables and time of day is just one those. Further investigations are needed to determine the extent of these influences.

For more information, please contact Vanessa Tuttle at Vanessa.Tuttle@noaa.gov

c) Evaluating biomass reference points in a variable environment

A simulation analysis was completed by Melissa Haltuch, FRAMD, as part of her Ph.D. thesis, to evaluate biomass reference points in a variable environment based on life-histories of three U.S. west coast groundfish species. There is strong evidence that low frequency inter-annual environmental variability, in addition to fishing, is able to impact fish population abundance via recruitment. However, scientific advice regarding harvest strategies is often based on control rules which depend upon the estimation of biomass reference points. These control rules typically do not explicitly consider the impact of trends in reference points that are caused by environmental variability. Sustainable harvest rates based on commonly-used biological reference points such as the level of unfished spawning biomass (B_0), and the current size of the stock in relation to B_0 under current environmental conditions may be unsustainable under different environmental conditions. Although several methods exist for estimating biomass reference points, it is unclear which methods are most robust to the impact of long term, low frequency, environmental variability. Therefore, simulation is used to evaluate alternative estimators, which differ in terms of whether a stock-recruitment relationship is estimated, for B_0, the steepness of the stock-recruitment relationship, and current spawning biomass relative to B_0. The simulations consider life histories of three U.S. west coast groundfish species: a long-lived unproductive rockfish, a moderately long-lived and productive flatfish, and a moderately long-lived and productive semi-pelagic gadid with highly variable recruitment.

For more information, please contact Melissa Haltuch at Melissa.Haltuch@noaa.gov

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

In 2007, FRAMD, working with collaborators, examined the feeding ecology of juvenile rockfish off Oregon and Washington based on diet and stable isotope analysis. Early life history stages of marine fish suffer high mortality rates making this period a critical determinant of year-class strength. Despite this importance, few studies have looked at the feeding habits of co-occurring pelagic young-of-the-year rockfish (*Sebastes* spp.) off the west coast—information crucial to understanding how these fish may be influenced by bottom-up processes. We undertook a study of the feeding habits of juvenile rockfish 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 (% number) from 2002 and 2006 revealed that darkblotched rockfish had a high degree of variation in their diets, consisting of gelatinous zooplankton (2002) several life-history stages of euphausiids (2006), as well as hyperiid amphipods and copepods (2002 and 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 isotopes confirmed tahat all fish from the same year were feeding at nearly the same trophic level while in both years darkblotched had enriched carbon values relative to all other species. Taken together, the stomach content and stable isotope data will advance our understanding of some of the important environmental factors that effect young-of-the-year rockfish during their pelagic phase.

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

e) Using bioenergetics models to estimate responsiveness of California Current groundfish to temperature anomalies

In 2007, FRAMD used bioenergetics models to estimate responsiveness of California Current groundfish to temperature anomalies. Temperature is known to affect fish feeding, growth, and reproductive rates, which in turn are related to numerous demographic and ecological variables. Bioenergetics models were developed for three groundfish (yelloweye rockfish *Sebastes ruberrimus*, sablefish *Anoploma fimbria*, and spiny dogfish *Squalus acanthias*) and used to estimate how each species responded to both long-term temperature change and temperature variability. Response variables were mass at age 1, maturation rate, maximum size, lifetime consumption and lifetime fecundity, all standardized relative to baseline scenarios at a fixed temperature of 8º C. As lifetime rearing temperature increased, most response variables increased non-linearly, peaked, and then declined precipitously. The most responsive species were yelloweye rockfish (age-1 mass, maturation rate) and spiny dogfish (maturation rate, maximum size, lifetime consumption, lifetime fecundity). When mean temperature was fixed at 8º C but allowed to vary (CV range = 5% to 20%), mean values of most response variables remained stable, with variability increasing in proportion to temperature CV.

The exception was maturation rate: increasing temperature variability slightly accelerated maturation for yelloweye rockfish and spiny dogfish. Of the remaining response variables, yelloweye rockfish were most responsive in terms of age-1 mass, and least responsive in all others. The chosen response variables are assumed proxies for key demographic and ecological properties, including first-year survival, reproductive potential and trophic impact, and may offer insight as to how these species population biology, distribution, and trophic ecology will be affected by climate anomalies and climate change.

For more information, Dr. Chris Harvey at Chris.Harvey@noaa.gov

2. Stock Assessment

a) SS2 stock assessment model development

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

SS2 was first used for operational assessments in 2005. In 2007, SS2 was updated to version 2.00, which incorporated several enhancements including algorithms to define movement between assessment sub-areas and enhanced controls over processes for growth, selectivity, and recruitment. Its usage has expanded beyond west coast groundfish to include several groundfish stocks in Alaska and southeast Australia, west coast sardine and mackerel, and some tuna and billfish assessments. Further enhancements under development in 2008 include the capability to analyze tag-recapture data and weight frequency data.

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

b) Spatial stock structure and the performance of stock assessments: the revenge of SLOSS?

The traditional approach to stock assessments on the U.S. west coast is to assume a unified population stock. This assumption is either based on direct evidence of perceived structure or, more commonly, the default assumption that there is no structure until proven otherwise. Given increasing evidence of population structuring mechanisms in nearshore species and the potential structure-inducing effects of environmental change and fishing on metapopulations, the main question becomes: when does the assumption of stock unity break down? When assessing a population, is it better to assume more structure or less? This work explores the performance of stock assessments under varying assumptions of stock connectivity, life histories, and removal pressures. An operating model is used to simulate population dynamics under varying scenarios of stock connectivity and in turn sample data (i.e. indices of abundance and age compositions) commonly used to assess stocks. Each population is then assessed under varying stock structure hypotheses using Stock Synthesis 2, the primary assessment framework used for west coast groundfish assessments. Under an experimental simulation testing framework, absolute and relative errors between the true population model values and the derived assessment estimates of recruitment, biomass, spawning biomass, and stock depletion are compared to evaluate the performance of stock assessments under varying stock assumptions. As dry as this approach sounds, the results provide important insights into how assumptions of stock structure may or may not bias assessment outcomes and potential management advice. The above research was conducted by J. Cope as part of his Ph.D. thesis.

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

c) Summary of the status of Pacific coast groundfish stocks

Recent stock assessments for many Pacific coast groundfish species have shown substantial increases in biomass and rebuilding progress over the past few years. Today, the status of the stocks is a sharp contrast to where we were in 2000. FRAMD summarized the improvements in the status of Pacific coast groundfish from 2000 to 2007 for presentation at the 2008 Western Groundfish Conference in Santa Cruz, CA. Nine groundfish stocks were declared overfished along the West coast between 1999 and 2002, with spawning biomasses below 25% of unfished levels. Rebuilding plans were implemented that reduced fishing mortality for the overfished species as well as associated species throughout nearly all sectors of the groundfish fishery resulting in historically low allowable harvests and landings.

The reduction in fishing mortality combined with a stronger than average 1999 year class for many west coast groundfish species has resulted in increasing trends in biomass for the overfished species and the rebuilding of two stocks, Pacific hake (whiting) and lingcod, to target levels (40% of unfished spawning biomass). Rebuilding for some of the overfished rockfish stocks is expected to occur over a longer period of time, however, recent stock assessments and rebuilding analyses suggest four stocks, Pacific ocean perch, canary rockfish, bocaccio, and widow rockfish are rebuilding more quickly than previously estimated.

For more information, please contact Stacey Miller at Stacey.Miller@noaa.goov

d) 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.

For more information, please contact Ian Stewart at Ian.Stewart@noaa.gov

C. By Species, by Agency

The PFMC currently operates under a biennial schedule for the development of stock assessments and management guidance. For all groundfish species except Pacific hake, stock assessments are scheduled for review only during odd-numbered years. A schedule for Stock Assessment Review (STAR) panels for full assessments of species other than Pacific hake, conducted in 2007, is shown in Table 1.

Table 1. 2007 Review Schedule for Full Groundfish Assessments other than hake.

STAR PANEL	STOCK	AUTHOR(S)	STAR PANEL DATES	STAR PANEL LOCATION
1	Longnose skate Sablefish	Vladlena Gertseva Michael Schirripa	May 7-11	Hatfield Marine Science Center Barry Fisher Bldg., Room 101, 2032 SE Oregon State University Drive, Newport, OR 97365
2	Black rockfish (N&S) Blue rockfish (Calif)	David Sampson & Farron Wallace Meish Key	May 21-25	Pacific States Marine Fisheries Commission 205 SE Spokane Street, Portland, OR 97202
3	Bocaccio Chilipepper rockfish	Alec MacCall & Steve Ralston John Field	June 25-29	Southwest Fisheries Science Center 110 Shaffer Road Santa Cruz, CA 95060
4	Darkblotched rockfish	Owen Hamel	July 16-20	NOAA Western Regional Center Bldg 9. Conference Room, 7600 Sand Point Way NE, Seattle, WA 98115
5	Canary rockfish Arrowtooth flounder	Ian Stewart Isaac Kaplan & Tom Helser	July 30- Aug. 3	NOAA Western Regional Center Bldg 9. Conference Room, 7600 Sand Point Way NE, Seattle, WA 98115

1. Shelf Rockfish - West Coast

b) Stock Assessments

Shelf rockfish assessments conducted during 2007 included a full assessment of canary rockfish and an update of the 2006 yelloweye rockfish assessment.

Canary rockfish: This 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 2006. The resource is modeled as a single stock. 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 that there are distinct biological stocks of canary rockfish off the U.S. coast and very limited tagging data to describe adult movement, which may be significant across depth and latitude. Future efforts to specifically address regional management concerns will require a more spatially explicit model that likely includes the portion of the canary rockfish stock residing in Canadian waters off Vancouver Island. Since 1916 annual catch has ranged from 46.5 mt in 2004 to 5,544 in 1982. Canary rockfish have been primarily caught by trawl fleets, on average comprising ~85% of the annual catches, with the Oregon fleet removing as much as 3,941 mt in 1982. Historically, just 10% of the catches have come from non-trawl commercial fisheries, although this proportion reached 24% and 358 mt in 1997. Recreational removals have averaged just 6% of the total catch, historically, but have become relatively more important as commercial landings have been substantially reduced in recent years. Recreation catches reached 59% of the total with 30 mt caught in 2003. Total catches after 1999 have been reduced by an order of magnitude in an attempt to rebuild a stock determined to be overfished on the basis of the 1999 assessment.

Canary rockfish spawning stock biomass, as estimated in 2007, has grown steadily since the mid-1990s in response to reductions in overall harvest and above-average recruitment in the preceding decade. The best estimate is that spawning biomass has doubled since 1997; however, the magnitude of this increase is subject to considerable uncertainty. The size of the current spawning stock is estimated roughly 32% of the unfished level. Recent year-class strength has generally been low. As the larger recruitments from the late 1980s and early 1990s move through the population in future projections, the effects of recent poor recruitment will tend to slow the rate of recovery. Canary rockfish is currently managed under a rebuilding plan. Recent recruitment and levels of depletion are presented in Figure 2.

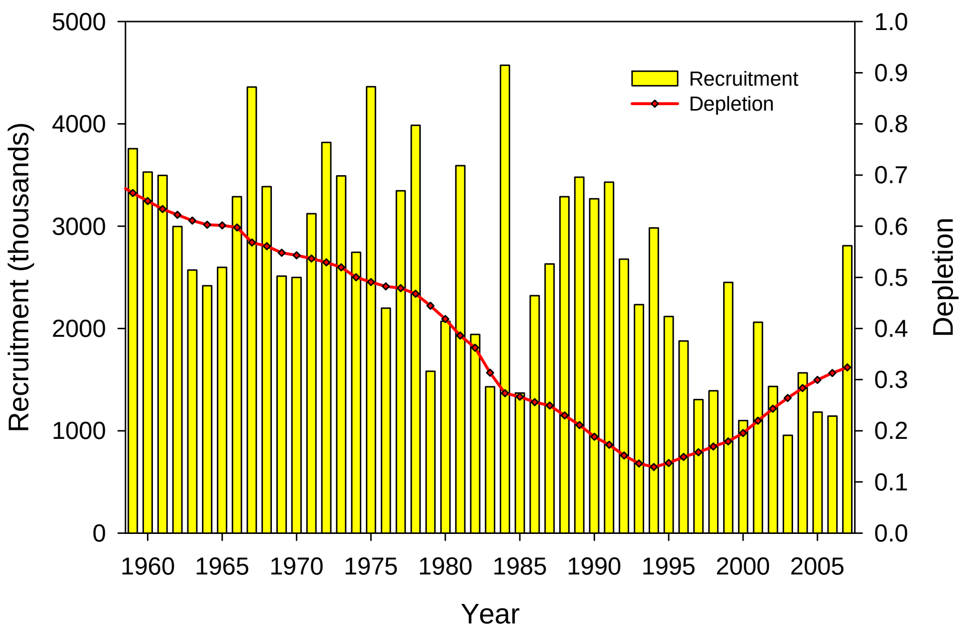

Figure 2. Level of depletion and recruitment for canary rockfish, 1966-2008.

Canary rockfish: The complete version of: Status of the U.S. canary rockfish resource in 2007 can be viewed online at: http://www.pcouncil.org/groundfish/gfstocks.html

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

Yelloweye rockfish: The last full assessment of the yelloweye rockfish (*Sebastes ruberrimus*) resource off the west coast of the United States was conducted was conducted in 2006 (Wallace, et al.). That assessment included both a coast-wide model, from the Mexican border to the Canadian border, and area models for Washington, Oregon, and California. The 2007 assessment represents an update of the coast-wide model, upon which management in 2007-08 was based. Catch data were updated for the period 1983-2006, with catches prior to 1983 taken from Wallace, et al. (2006). Annual total catch of yelloweye rockfish peaked around 1980, and remained above 200 mt throughout the mid-1990s. Catch declined sharply between 1997 and 2001.

The most recent assessment for yelloweye rockfish was conducted using SS2, version 1.21 in 2006 by Wallace, et al. Fishery-independent data used in that assessment included a CPUE index and size-compositions from the longline survey conducted by the International Pacific Halibut Commission. Catch data, as well as age and size compositions, were included for commercial and recreational fisheries off Washington, Oregon, and California. CPUE indices were also constructed from recreational data from each state. In the process of refreshing data for use in this updated assessment, several problems were corrected in developing the 2007 base model. Since the corrected bin values were lower than those used in the previous assessment and the Washington trawl data contained a higher proportion of old fish, these corrections led to downward revisions in the amount of spawning biomass and the level of depletion, relative to the 2006 assessment. In converting the model to SS2c, the prior assessment's old SS1 "super-year" approach for dealing with small sample sizes for age and size compositions in some years was updated using the recommended SS2 method. This change had little effect on model results.

Additionally, during the 2006 STAR Panel review, a representative from the Canadian Department of Fisheries and Oceans, who was present, reported that the estimated value for yelloweye natural mortality (M) off British Columbia was 0.033. This information led the Panel to recommend lowering the value of M in the U.S. model from 0.045 (as used in 2005) to 0.036. Subsequently, it has been discovered that the actual estimated value of M for the B.C. stock is 0.043 (for females). The Chair of the STAR Panel has conveyed that if the correct value had been available during the review, it would likely have recommended for use, rather than the 0.036 value (Owen Hamel, personal communication). Additionally, sensitivity analysis conducted across a range of M values, as part of the current assessment, indicates a substantial degradation in model fit with M=0.036, relative to values of M in the 0.043-0.046 range. As a result, current and projected biomass and depletion levels for an alternative base case (with M=0.043) are also reported in this document.

The long-term biomass trajectory in this assessment is very similar to that in the 2006 assessment. Spawning biomass declined steadily and rather rapidly, beginning in the early-1970s, with no indication of increase until roughly 2001. The amount of spawning biomass in all years is lower in the current base model than in the previous assessment, due to the correction of data/input errors previously discussed. The current spawning biomass is estimated to be 422 mt with the base model and 485 mt with the alternative model, resulting in depletion estimates of 14.5% and 16.4%, respectively. Recent recruitment and levels of depletion are presented in Figure 3.

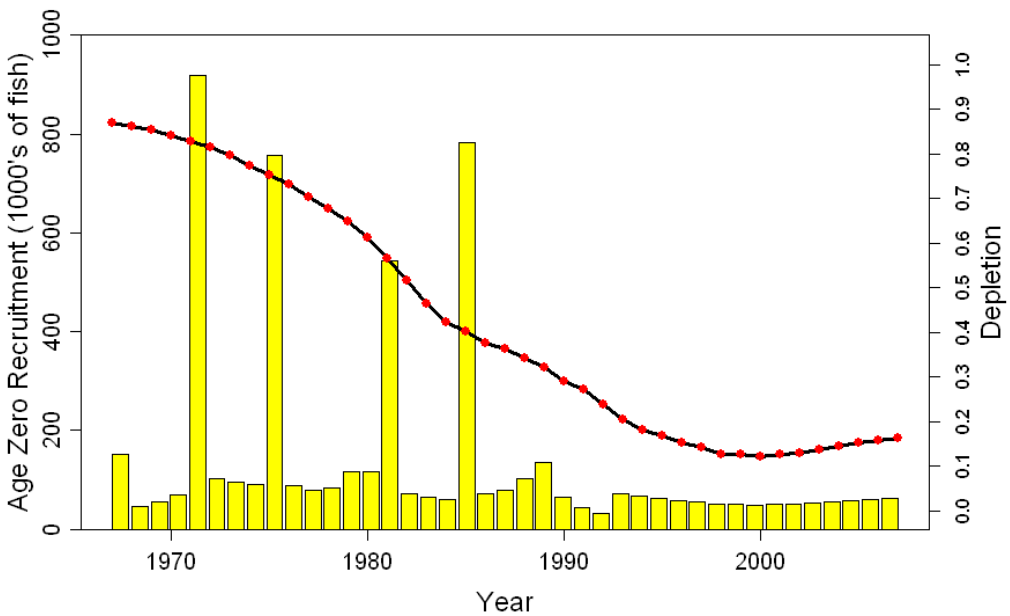

Figure 3. Level of depletion and recruitment for yelloweye rockfish, 1967-2007.

Yelloweye rockfish: The complete version of: Update to the status of yelloweye rockfish (*Sebastes ruberrimus*) off the U.S. West Coast in 2007 can be viewed online at: http://www.pcouncil.org/bb/2007/0607/Groundfish_Assessments_E6/Yelloweye_Update_2007_Final.pdf

For more information on the yelloweye rockfish assessment, contact John Wallace at John.Wallace@noaa.govv

2. Slope Rockfish

b) Stock assessment

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

Darkblotched rockfish: This assessment applies to the darkblotched rockfish (*Sebastes crameri*) for the combined US Vancouver, Columbia, Eureka and Monterey INPFC areas. The largest landings (removals between 2,300 and 4,200 metric tons (mt)) 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 1000 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 assessment used the SS2 model, version 2.00f and data through 2006. 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 5 or 6 years. Since 2001, overfishing occurred only once, with estimated catch exceeding the ABC by 14 mt (5.8%) in 2004. This assessment used the SS2 model, version 2.00f and data through 2006.

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.

Based on this assessment, darkblotched rockfish on the West Coast remain below the overfished threshold, but the spawning biomass appears to have increased steadily (and roughly doubled) over the past 6 or 7 years to 22% of the unfished level. 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. Since 2001, overfishing occurred only once, with estimated catch exceeding the allowable catch by 14 mt (5.8%) in 2004. 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 4.

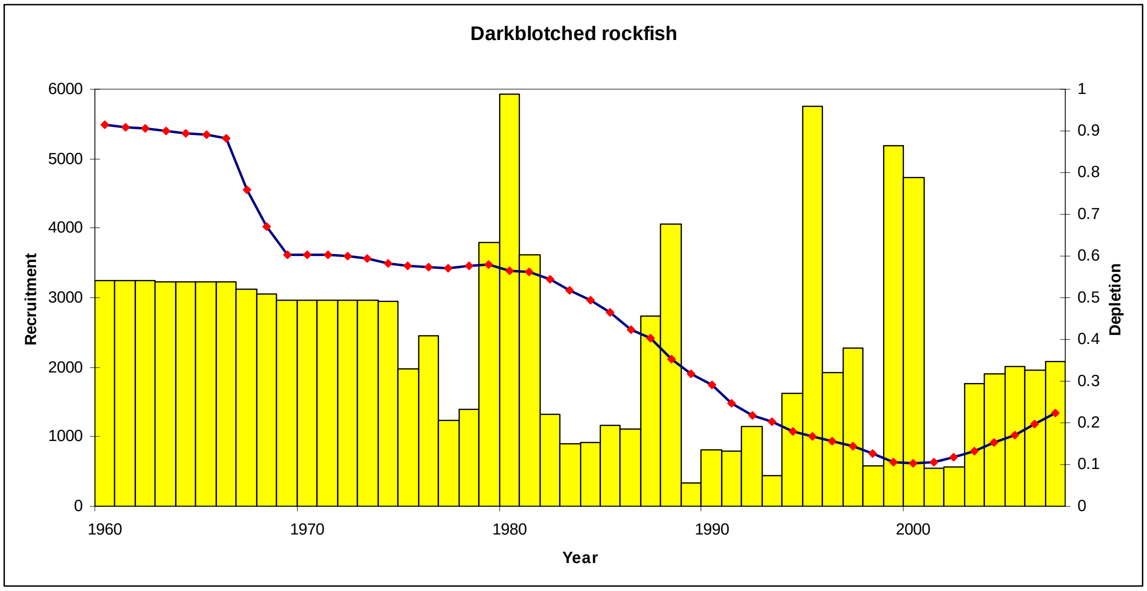

Figure 4. Level of depletion and recruitment for darkblotched rockfish, 1960-2007.

Darkblotched rockfish: The complete version of: Status and Future Prospects for the Darkblotched Rockfish Resource in Waters off Washington, Oregon, and California as Assessed in 2007 can be viewed online at:
http://www.pcouncil.org/groundfish/gfstocks.html

Pacific ocean perch: This assessment update applies to the Pacific ocean perch (*Sebastes alutus*) (POP) species of rockfish for the combined US 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 mt 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 mt per year from 2002 through 2006. This assessment is an update and uses the same model as in the 2003 and 2005 assessments, a forward projection age-structured model (Hamel 2005, Hamel et al. 2003). New data and changes to the data used in the previous assessment are as follows. Catch data for 2003 and 2004 were updated, and new catch data were added for 2005 and 2006. Fishery age compositions from 1999-2004 were updated, with new 2005 and 2006 age compositions added. The 1999-2004 NWFSC slope survey biomass indices and age compositions were recalculated based upon changes in stratum area estimates and any updates in the database, with the 2005 and 2006 NWFSC slope survey biomass indices and age compositions added.

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 5 years, as the 1999 and 2000 year classes (two of the largest since the early 1960s) reach full maturity. 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 recruitment and levels of depletion are presented in Figure 5.

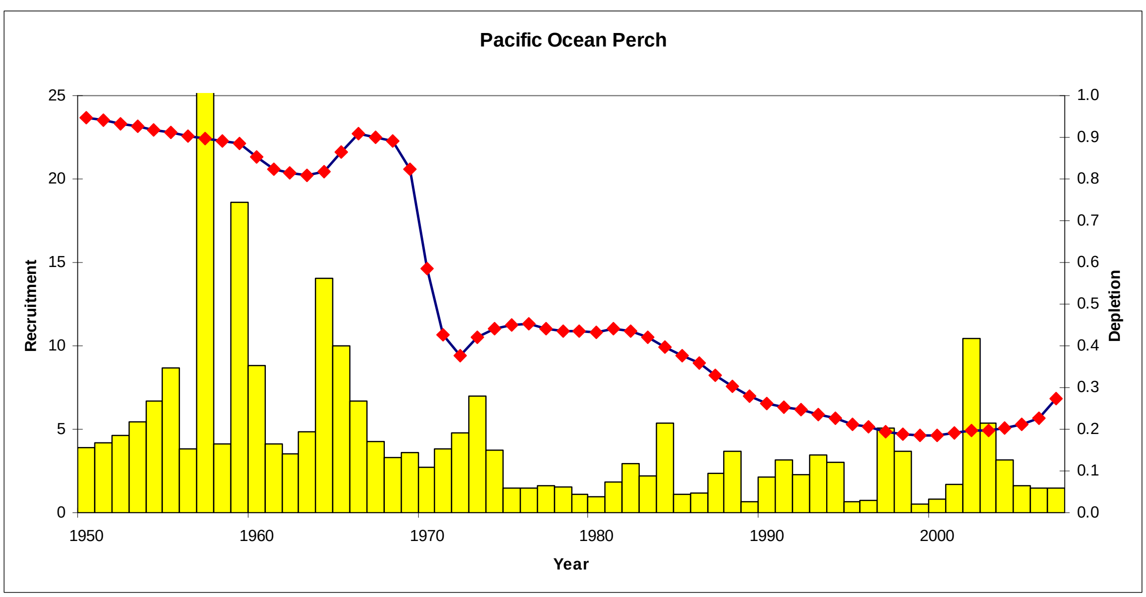

Figure 5. Level of depletion and recruitment for Pacific ocean perch, 1950-2007.

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 2007can be viewed online at: http://www.pcouncil.org/groundfish/gfstocks.html

For more information on both of these assessments contact Dr. Owen Hamel at: Owen.Hamel@noaa.gov

3. Thornyheads

b) Stock Assessment

No thornyhead assessments were conducted during 2007, and none are scheduled for 2008.

4. Sablefish

b) Stock Assessment

A full sablefish assessment was conducted in 2007.

In this assessment, the West Coast sablefish population was modeled as single stock extending from the southern border of the Conception INPFC area through the northern border of the U.S. Vancouver INPFC area. Prior to 1967, catches varied between 1,000 and 3,600 mt. From that point, catches rose to over 24,000 mt in both 1976 and 1979. Catches have declined gradually since then to the 5,500-6,500 range in recent years. Data from several trawl surveys, along with landings, length and age data, and environmental indices were combined in a maximum likelihood statistical framework using Stock Synthesis 2 (SS2, version 2.00b, March 22, 2007). The major sources of uncertainty in this stock assessment were (1) survey catchability (*Q*), and (2) discard quantity and length composition, and 3) the mortality rate of discarded fish.

The West Coast sablefish spawning stock is estimated to be at roughly 38% of the unfished level. Improvements in the level of depletion and stock size since the 2005 assessment can be attributed primarily to the continued progression of the strong 1999 and 2000 year-classes into the population (Figure 6). However, erratic recruitment levels since 2001, combined with several poor year-classes prior to 1999, dampen expectations of stock increase over the next several years. Evidence continues to suggest that larval survival is modulated in part by annual fluctuations in the California Current System. A significant relation was observed between second quarter (April, May, and June) sea surface height in the northern coast (44-48 degrees latitude) and age-0 sablefish survivorship. A weaker, yet still significant, relationship was found between recruitment deviations and zooplankton species composition. Recent recruitment and levels of depletion are presented in Figure 6.

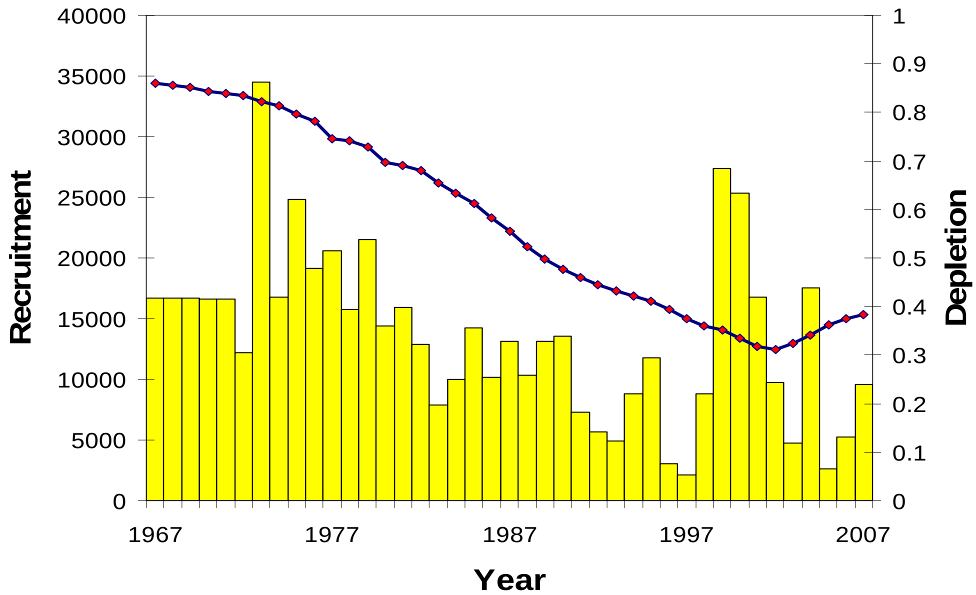

Figure 6. Level of depletion and recruitment for west coast sablefish, 1967-2007.

Sablefish: The complete version of: Status of the Sablefish Resource off the Continental U.S. Pacific Coasts in 2007 can be viewed online at: http://www.pcouncil.org/groundfish/gfstocks.html

For more information, please contact Dr. Michael Schirripa at Michael.Schirripa@noaa.gov

5. Flatfish

b) Stock Assessment

An update of the 2005 English sole assessment and a full assessment for arrowtooth flounder were conducted 2007.

English sole: The English sole (*Parophrys vetulus*) assessment updated the status of the resource off the coast of the United States from the Mexican Border to the Canadian border. As in the 2005 assessment, data sources are treated separately for a southern (INPFC Conception and Monterey) and a northern (INPFC Eureka, Columbia and U.S. Vancouver) area, however the English sole population is modeled as a single stock. The biggest obstacle to modeling the English sole population in the southern and northern areas separately is a lack of data; specifically the length frequency of discarded fish (to reliably estimate selectivity separately for each fleet), current maturity observations and sufficient age data (mainly from the south) to allow estimation of the growth curve for each area as well as model changes in growth over time. Without these data and more spatially complex models, it is difficult to speculate on whether regional management is appropriate for English sole, as relatively large historical catches of similar magnitude have been removed from both areas, albeit over different portions of the historical record.

The updated assessment uses historical landings reconstructed from a variety of sources for the 2005 assessment, to describe fishery removals over the period 1876 to 1980. Landings from 1981 to 2006 have been updated to reflect the best available estimates as of May, 2007. Peak landings from the southern area occurred in the 1920s with a maximum of 3,976 metric tons (mt) of English sole landed in 1929. Peak landings from the northern area occurred from the 1940s to the 1960s with a maximum of 4,008 mt landed in 1948. Landings in both areas have generally declined since the mid-1960s and have been at historical lows in recent years. Model estimates of discarding average 24% by weight over the time-series since 1940, with higher discards corresponding to periods of large recruitment and due to the associated increase in catch of smaller unmarketable English sole and modeled changes in selectivity and growth.

The most recent assessment for English sole was performed in 2005. The 2005 assessment used an early version (1.19) of the Stock Synthesis 2 modeling framework to estimate model parameters and management quantities. That assessment modeled the coast-wide English sole population (U.S. only), including both males and females. Fishery independent data included the NMFS triennial groundfish survey index of abundance (1980-2004), maturity observations, length-weight relationships as well as survey length-frequency and age-frequency data. Length and age data from commercial fishery landings are included from 1948-2004, as well as fishery discard information from three separate observer programs, 1950-1961, 1985-1987 and 2001-2004. This document updates the 2005 assessment using the newest version of SS2 available, 2.00e (Methot 2007). The methods for summarizing the raw data and the modeling approach are maintained. The recent landings series have been updated for 1981-2006, and a large quantity of fishery length and age data (primarily from Washington) that was previously unavailable is now included. These new data provide substantially improved information regarding recent year class strengths and current stock status.

As in 2005, English sole spawning biomass was found to be increasing rapidly over the last 15 years after a period of poor recruitments from the mid-1970s to the early 1990s, which left the stock at nearly historically low levels. The spawning biomass at the beginning of 2007 was estimated to be 41,906 mt (~ 95% confidence interval: 31,046-52,766), which corresponds to 116% (83-149%) of the unexploited equilibrium level. This value reflects the accelerated maturity schedule estimated from the 1990's relative to historical conditions and therefore does not necessarily correspond to the same age structure in the population as implied by unexploited conditions. Historical depletion levels were estimated to have reached minima as low as 20% in 1953 and, more recently, 23% in 1992. Current (2006) total catches were estimated to be 1,078 mt, of which 886 mt were landed. These results are very similar to the 2005 assessment, although the recent trend shows a slightly larger increase in stock size.

Following two decades of low recruitments, strong year classes were estimated for 1995, 1998-2000, and 2002. The data indicate that the 1999 year class is the largest in the time-series, and the magnitude of this event is now much more certain than in the 2005 assessment; the coefficient of variation (CV) of this estimate has dropped from 25% (in 2005) to 19%. This change is mainly due to the large quantity of age data now available through 2006. These large recent recruitment estimates are larger than those from the 2005 assessment, resulting in the estimate of relatively higher current stock size. The recruitment deviations for 2004 and later years are informed primarily by the stock recruitment function and this is reflected in the increased relative uncertainty of these estimates.

The estimated spawning potential ratio (SPR) for English sole fluctuated above and below the proxy target of 40% for flatfish from the late 1940s to the early 1990s. Since 1992 the intensity of exploitation has been less than that of the target, resulting in higher SPR levels. This corresponds to a relative exploitation rate (catch/biomass of age 3 and older fish) history that is high from the late 1940s to the early 1990s, and steadily declining to very low levels over the last 15 years. The stock appears to have never been exploited at the rate (0.27) that would reduce the stock to SPR levels estimated to produce *MSY*, 0.259, during the time-series. The fishery has exceeded the relative exploitation rate that results in fishing at the SPR target of 40% of 0.17 in only a few years of the historical series. Recent English sole landings and estimated discards have been below both the coast-wide ABC of 3,100 mt and the estimated *MSY* harvest level of 4,080 mt. Recent recruitment and levels of depletion are presented in Figure 7.

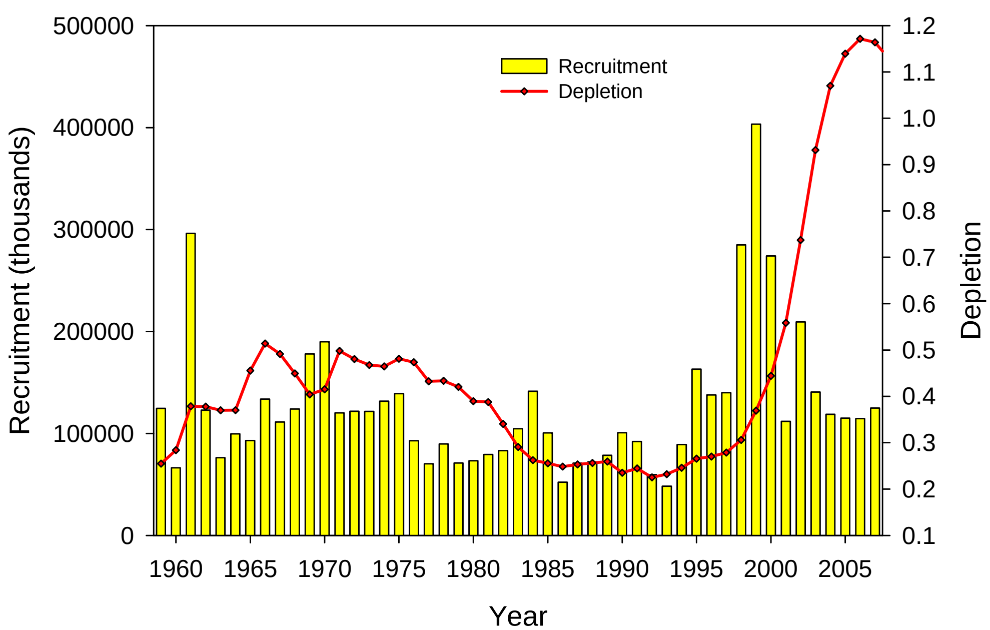

Figure 7. Level of depletion and recruitment for English sole, 1959-2008

English sole: The complete version of: Updated U.S. English sole stock assessment: Status of the Resource in 2007 can be viewed online at:
http://www.pcouncil.org/groundfish/gfstocks.html

For more information on the English sole assessment, please contact Dr. Ian Stewart at Ian.Stewart@noaa.gov

Arrowtooth flounder: This assessment reports the status of arrowtooth flounder (*Atheresthes stomias*) off the U.S. West Coast. Arrowtooth flounder are primarily found off Washington, Oregon, northern California, and north of the U.S.-Canada border. We assume a single mixed stock, using a model with one area. Arrowtooth are commonly caught by trawl fleets off Washington and Oregon, but they are frequently discarded due to low flesh quality. This is the first assessment of arrowtooth flounder off the U.S. West Coast since 1993, and the first to use a modern age-structured estimation framework (Stock Synthesis 2). We modeled both males and females, allowing for different growth between the sexes. We included catch data from 1928-2006. We obtained and incorporated ages (from otolith readings) for a subset of fish from the NWFSC Shelf-Slope Survey and commercial landings from 1986-1991, 1998, and 2003-2005. The model shows a period of moderate depletion through the 1950s and 1960s, followed by a rebuilding of the stock beginning in the late 1970's. Recent strong year classes, in particular the 1999 year class, have led to an increase in the stock since the late 1990s. We estimated unexploited equilibrium spawning biomass to be 80,313 mt (95% CI: 68,228-92,398). We estimate that the stock has never fallen below the overfished threshold. Since this stock is not overfished we have not reported any rebuilding parameters. Recent recruitment and levels of depletion are presented in Figure 8.

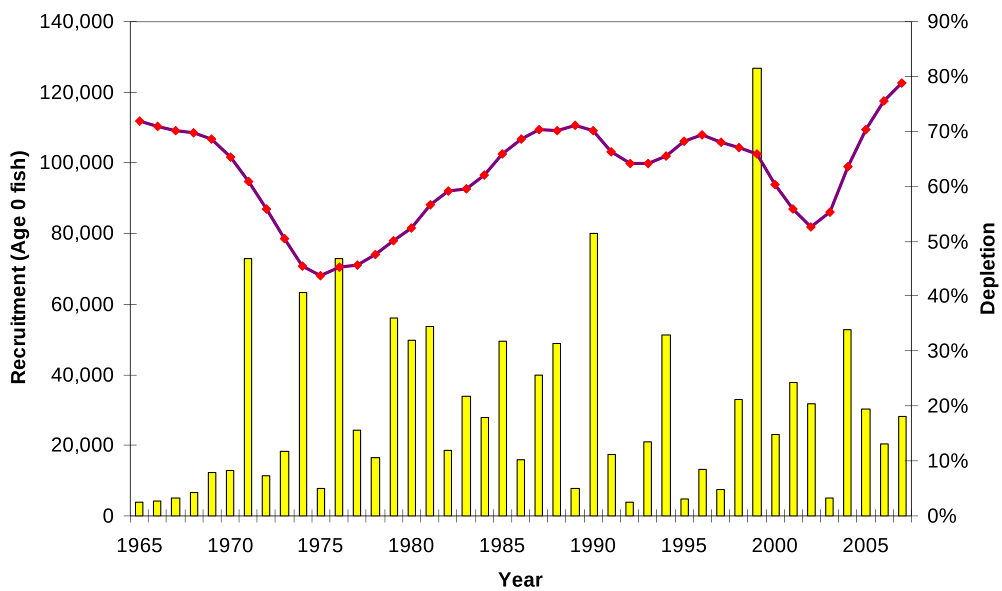

Figure 8. Level of depletion and recruitment for arrowtooth flounder, 1965-2007.

Arrowtooth flounder: The complete version of: Stock Assessment of the Arrowtooth flounder (*Atheresthes stomias*) Population off the West Coast of the United States in 2007 can be viewed online at: http://www.pcouncil.org/groundfish/gfstocks.html.

For more information on the arrowtooth flounder assessment, please contact Isaac Kaplan at Isaac.Kaplan@noaa.gov

6. Pacific Hake

b) Stock Assessment

The status of Pacific hake was assessed in early 2007 and 2008. In both years, the assessments and reviews were conducted with representation from the U.S. and Canada. The coastal stock of Pacific hake is currently the most abundant groundfish population in the California Current system. Smaller populations of hake occur in the major inlets of the north Pacific Ocean, including the Strait of Georgia, Puget Sound, and the Gulf of California. However, the coastal stock is distinguished from the inshore populations by larger body size, seasonal migratory behavior, and a pattern of low median recruitment punctuated by extremely large year classes. The population is modeled as a single stock throughout U.S. and Canadian coastal waters, however fishing fleets from each country are treated separately in order to capture some of the spatial variability in Pacific hake distribution.

Coastwide fishery landings from 1966 to 2007 have averaged 219,000 mt, with a low of 90,000 mt in 1980 and a peak harvest of 364,000 mt in 2006. Catches in 2006 and 2007 (276,000 mt) were above the long term average. Catches in both of these years were predominately comprised by fish from the large 1999 year class. The United States has averaged 163,000 mt, or 74.6% of the total landings over the time series, with Canadian catch averaging 56,000 mt. The 2006 and 2007 landings had similar distributions, with 74% and 72%, respectively, harvested by the United States fishery. The current model assumes no discarding mortality of Pacific hake.

The acoustic survey catchability coefficient (q) has been, and continues to be, one of the major sources of uncertainty in the model. From 2003 to 2007, assessments have presented two models (which have been assumed to be equally likely) in an attempt to bracket the range of uncertainty in the acoustic survey q. In the 2008 assessment, also conducted in SS2 (version 2.00n), an effort was made to include the uncertainty in q, as well as additional uncertainty regarding the acoustic survey selectivity and the natural mortality rate of older fish within a single model. As a result, a broader range of uncertainty is presented via probability distributions and risk profiles using Markov Chain Monte Carlo simulation. Further refinements include, for the first time, incorporation of an age-reading error matrix.

Pacific hake spawning biomass declined rapidly after 1984 (6,450,000 mt) to the lowest point in the time series in 2000 (880,000 mt). This long period of decline was followed by a brief increase to 1,890,000 mt in 2003 as the 1999 year class matured. In 2008 (beginning of year), spawning biomass is estimated to be 1.10 million mt and approximately 42.9% of the unfished spawning biomass (SB_{zero}). Estimates of uncertainty in relative depletion range from 21.9%-53.9% of unfished biomass, based on asymptotic confidence intervals. It should be pointed out that the 2008 estimates of spawning biomass are lower and depletion level higher compared to last year's assessment result for 2007. The reason is that survey *q* was freely estimated and the assessment incorporated an age-reading error matrix that lowered estimates of SB_{zero} (through a reduction in mean log recruitment) and increased the size of the 1999 year class. As such, spawning biomass for the most recent years, while generally lower than predicted in the 2007 assessment, is greater relative to the estimate of SB_{zero}. Recent spawning biomass levels and depletion relative to B_{zero} are presented in Figure 9.

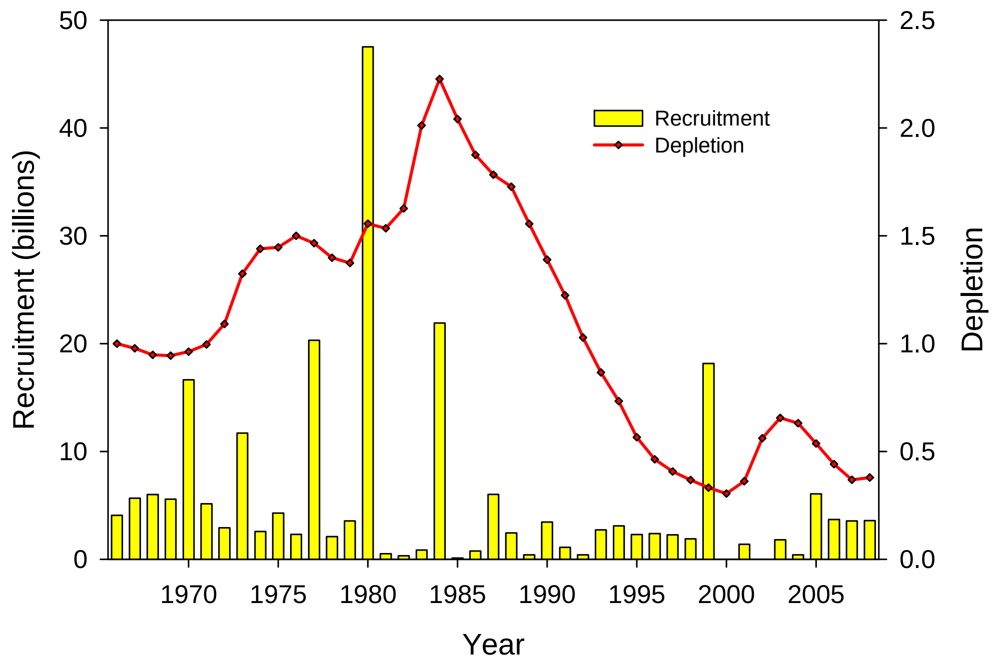

Figure 9. Level of depletion and recruitment for Pacific hake, 1966-2008.

The 2007 assessment for Pacific hake is available online at:
ftp://ftp.pcouncil.org/pub/Hake07. The 2008 assessment is available online at:
http://www.pcouncil.org/groundfish/gfstocks.html.

For more information, please contact Dr. Thomas Helser at Thomas.Helser@noaa.gov

7. Other species

b) Stock Assessment

An assessment of longnose skate was conducted during 2007.

Longnose skate: Longnose skates (*Raja rhina*) are found from Navarin Canyon in the Bering Sea and Unalaska Island in Alaska to Cedros Island, Baja California in Mexico. This assessment is for the population occupying the waters off California, Oregon and Washington, bounded by Canada in the north and Mexico in the south. Within this study area, the longnose skate population is treated as one fishery stock, due to the lack of biological and genetic data supporting the presence of multiple stocks.

The longnose skate is not a commercially important target species. It is caught primarily as bycatch in trawl fisheries, where most are discarded. Although the landed catch of skates is documented through fish tickets, most records are for a combined-skate category. There are also apparent reporting inconsistencies with regard to the condition of landed skates (e.g., as whole fish or as wings). The extent to which landings in the combined-skate category were comprised by longnose skate is informed by limited periods of species-composition sampling in Oregon and Washington. Historical landed catch was reconstructed from variety of sources. Over the last 57 years, longnose skate landings ranged between 35 and 1,721 mt. Landings peaked in the mid-1990s, due to increased demand from Asian markets. Discards rates were estimated at 93% prior to 1995 and 53% after 1995, which corresponds to changes in skate markets in the mid-1990s. This is the first assessment for longnose skate on the U.S. West Coast. The Stock Synthesis 2 (version 2.00e) modeling program was used to conduct the analysis and to estimate model parameters and management quantities. Since there are no apparent differences in biological and life history parameters as well as length and age frequencies between females and males, the assessment uses a single-sex model. The model starts in 1916, assuming an unfished equilibrium state of the stock in 1915. The assessment model includes one fishery that operates within the entire area of assessment. Fishery dependent data used in the assessment include combined-skate landings (1950-2006), fishery length compositions (1995-2006) and limited age data (2003-2004). Fishery independent data include biomass estimates (1980-2006) and length compositions (1997-2006) from four NMFS surveys conducted on the continental shelf and slope, as well as age data from one of the surveys (2003). The model uses discard data from Rogers and Pikitch's study (1986-1987), the Enhanced Data Collection Project (1996-1998), and the NMFS West Coast Groundfish Observer Program (2004-2005).

This assessment uses a single-sex model; therefore, spawning biomass is the sum of the mature biomasses of both sexes. Using the base model, the unexploited level of spawning stock biomass for longnose skate is estimated to be 14,069 mt. At the beginning of 2007, the spawning stock biomass is estimated to be 9,268 mt, which represents 66% of the unfished stock level. The assessment shows that the stock of the longnose skate in the US West Coast is not overfished. Currently, the stock is at 66% of its unfished level. Historically, the exploitation rate for the longnose skate has been low. It reached its maximum level of 4.02 % in 1981. Currently, it is at the level of 1.25 %.

Longnose skate: The Status of the Longnose Skate (*Raja rhina*) off the continental US Pacific Coast in 2007 can be viewed online at:
http://www.pcouncil.org/bb/2007/0607/Groundfish_Assessments_E6/LongnoseSkate_AssessmentReport.pdf

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

D. Other Related Studies

1. The PaCOOS, West Coast habitat data portal

The PaCOOS Marine Habitat Data Portal was conceived in 2005 as a Local Data Access Center (LDAC) of the Integrated Ocean Observing System (IOOS). Funding for its development was provided by the NOAA IOOS Program through the FRAM Division of the Northwest Fisheries Science Center. The database and GIS system had its origin the data collected together for the West Coast Essential Fish Habitat Environmental Impact Statement, which was completed in 2005/2006. Maintained jointly by FRAM and COAS' Seafloor Mapping Laboratory and in collaboration with PSMFC, the portal provides access to data (search, connection, and download), a visualization environment, and integrated navigation tools. Currently, this portal houses geological and geophysical data including benthic habitat maps, fisheries survey datasets, and ocean climatologies. Data access, which includes data searching and metadata harvesting, is provided through IOOS Data Management and Communications (DMAC) compliant pathways such as OPeNDAP, OGC WMS, and ESRI ArcIMS map services. The portal's centerpiece is its unique map viewer environment (http://nwioos.coas.oregonstate.edu/), an online application that provides a map interface to data holdings with custom tools for data downloads and queries. There is a growing user base that includes local, state, and federal agencies within the California Current Large Marine Ecosystem.

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2. West Coast bycatch reduction research: fish behavior during interactions with bottom trawls

Since 2004, the NWFSC has collaborated with the Oregon Department of Fish and Wildlife (ODFW) on a bycatch reduction research project to obtain baseline information on the behavior of demersal fishes when overtaken by a bottom trawl. *In situ* information of this nature is critical to the future development of species-selective trawls and bycatch reduction devices for West Coast groundfish fisheries. In this project, a conventional low-light video was used in conjunction with a DIDSON ultrasonic imaging sonar (Dual-frequency IDentification SONar) to document and categorize fish behavior in response to interaction with a selective flatfish bottom trawl (Figure 10). A complementary project seeks to build a catalog of enzyme activities as an indicator of species-specific, burst-swimming abilities for many groundfish species.

The summer of 2007 marked the third field season for this research project. This project represents the first successful application of a DIDSON sonar in bottom-tending mobile fishing gear, which produced dual observations of fish-trawl interaction vis-à-vis video and DIDSON imaging. A novel set of mounting frames provided a stable platform for sonically imaging all areas in front and in the mouth of the trawl (e.g., footrope, headrope, wings, and footropes mud cloud form). DIDSON imaging of Pacific halibut, lingcod, Pacific hake, skates, and flatfish will help assess methods to reduce bycatch. Information was gathered on trawl performance, in the form of observational data on the speed and direction of fish movement, herding behavior, wing interactions, and footrope and headrope effects.

The 2007 field season focused on deploying the DIDSON sonar system to obtain information on diel differences in response to contact with the trawl foot rope in the absence of artificial light. The use of lights may confound observations of fish behavior in the proximity of fishing gear, submersibles, or ROVs. DIDSON imaging sonar uses only ultrasound to form images of fish, as well as the gear, surrounding structures and the seafloor. We used DIDSON to examine diel behavior differences in roundfish along a 12-meter section of the footrope on a starboard wing of a selective flatfish trawl. The DIDSON was mounted looking forward along the starboard wing of the net, giving a view of the footrope and the seafloor ahead of it. We used a lightmeter on the net to measure light levels at the trawl mouth. As the DIDSON image does not allow species identification where the seafloor is also in view, all fish captured in the trawl were counted and weighed: roundfish and halibut were measured for length. We tracked the movements of individual fish, continuously measuring the 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 direction and velocity. These behavioral differences suggest that herding efficiency and gear selectivity is different in darkness. They emphasize the importance of monitoring environmental factors during surveys where constant selectivity is applied. . Data from both the 2006 and 2007 field seasons are currently being analyzed. Preliminary results were presented at the 2007 American Fisheries Society Annual Meeting symposium entitled: “Developing Tools for Ecosystem-Based Fishery Management: Incentive Programs, Bycatch Quantification, and Gear Technology” and the 2008 Western Groundfish Conference.

Figure 10. DIDSON ultrasonic imaging sonar system.

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Keith Matteson at keith.m.matteson@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 2007, CAP aged the following species: canary rockfish, Pacific ocean perch, darkblotched rockfish, Pacific hake, sablefish, arrowtooth flounder, and English sole.

For more information, please contact Dr. Jim Hastie at Jim.Hastie@noaa.gov

4. Cooperative Resource Surveys

a) West Coast Slope and Shelf Groundfish Survey

The NWFSC conducted its tenth annual bottom trawl resource survey for groundfish off the coasts of Washington, Oregon, and California. The objective of the 2007 survey was to provide information on the distribution and relative abundance of demersal species within this region at depths from 30 to 700 fathoms. Other biological information necessary to assess the status of groundfish stocks (e.g. length, weight, sex and age structures) was collected throughout the survey period.

The NWFSC chartered commercial fishing vessels to conduct independent, replicate surveys using standardized trawl gear. Fishing vessels *Ms. Julie, Excalibur, Noah's Ark* and *Raven* were contracted to survey the area from Cape Flattery, WA to the Mexican border in Southern California, beginning in the later part of May and continuing through the third week of October. Each vessel was chartered for eight weeks with the *Ms Julie* and *Noah's Ark* surveying the coast during the initial pass from May to July. The *Excalibur,* and *Raven* operating in tandem, surveyed the coast during the second pass from mid-August to late October. The survey 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 2007, we also continued to utilize the FSCS data collection system with updated software applications, and wireless networking. Established NOAA national bottom trawl protocols were used throughout the survey. As in prior years, a series of special research projects were undertaken in cooperation with other NOAA groups and various Universities.

Additional data were collected during the trawl survey for collaborative research projects with several NMFS/academic colleagues: 1) Maternal effects on larval quality in rockfishes - Southwest Fisheries Science Center; 2) Establishing a DNA sequence database for the marine fish fauna of California- Scripps Institution of Oceanography; 3) Life history of the white-spotted ratfish, *Hydrolagus colliei* - Moss Landing Marine Laboratories; 4) Feeding ecology of the roughtail skate, *Bathyraja trachura*.; 5) Collection of all unusual or unidentifiable skates, sharks, or chimaeras - Moss Landing Marine Laboratories; 6) Collection of biological data and specimens of the deepsea skates, *Bathyraja abyssicola*, and broad skates, *Amblyraja badia* - Moss Landing Marine Laboratories; 7) Collection of *Raja stellulata* - 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) collection of samples from spiny dogfish to aid stock assessment and demographic analysis; 3) fin clip collection for various shelf rockfish species; 4) collection of stomachs for selected species including: Pacific hake, bocaccio and chilipepper; 5) identification and density-estimation of seabirds along the U.S. West Coast; 6) collection and identification of cold water corals; 7) Food habits studies of jumbo squid, *Dosidicus gigas*, in the California Current; 8) Comparison of skate total length with disc width for California Skate *Raja inornata*, Starry Skate *Raja stellulata*. Longnose Skate *Raja rhina*, and Big Skate *Raja binoculata*; and 9) a preliminary determination of sexual parasitism of crabs (carcinophily) in the northeast Pacific Ocean.

The Northwest Fisheries Science Center's Fishery Resource Analysis and Monitoring Division (FRAMD) also investigated the composition and abundance of benthic marine debris collected during the 2007 West Coast Groundfish Trawl Survey from May 14 to October 23, 2007. Marine debris was recorded in 198 tows; 86 tows during pass 1 and 112 tows during pass 2. Total debris recorded from all tows weighed 3,574 kg (range 0.01–2,200 kg tow^{-1}). The largest item taken during the survey was a fishing net (2,200 kg) retrieved by the F/V Ms. Julie off CA. Debris was subdivided into 6 categories (plastic, metal, clothing, glass, toxic and other). Plastic and metal debris were encountered most frequently with 502 kg of plastic taken in 108 tows and 406 kg of metal taken in 94 tows. Clothing (134 kg) was present in 54 tows while glass debris (47 kg) was present in 56 tows. Preliminary results indicate that marine benthic debris is more frequently encountered in the southern portion of the survey, occurring in 65% of the southernmost tows versus 25% overall.

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b) Research Related to Improving Bottom Trawl Surveys

1) Methods for standardizing the U.S. West Coast Groundfish Trawl Survey

The Northwest Fisheries Science Center presented information on the gear and methods used to standardize the annual West Coast Groundfish Trawl Survey at the 16th annual PICES (North Pacific Marine Science Organization) meeting in October 2007. PICES is an intergovernmental scientific organization, established in 1992 to promote and coordinate marine research in the northern North Pacific and adjacent seas. Its present members are Canada, Japan, People's Republic of China, Republic of Korea, the Russian Federation, and the United States of America. The 16th annual meeting focused on the changing North Pacific: previous patterns, future projections, and ecosystem impacts with a workshop devoted to trawl standardization. Standardization of both gear and methods for bottom trawl surveys is essential to correctly interpret catch per unit effort as a measure of relative abundance. In the United States, standardization problems stemming from inaccurate measurement of the towing warps on a NOAA survey vessel resulted in a thorough review of standardization methodology and the development of the National Bottom Trawl Survey Protocols governing the operation of all NOAA-sponsored surveys. The PICES workshop attended by FRAM reviewed the various pelagic and bottom trawl surveys conducted by PICES member countries, with a focus on the operational protocols used to ensure that survey catchability remains constant over time. The history, design, and trawl standardization protocols for the West Coast Groundfish Trawl Survey were described at the meeting. Operation protocols include: net diagrams, construction, repair methodology and certification procedures; warp standardization and measurement; tow duration, distance-fished and speed over ground; and use of trawl mensuration instrumentation. On each haul wingspread, headrope height, trawl depth, temperature and bottom contact are measured using trawl-mounted sensors. Trawl operations are mediated and reviewed by field staff via a series of custom software applications. The applications display real-time sensor data and include trawl annotations and environmental conditions. Additional applications provide graphical displays of all sensor time series for evaluation and review; require entry of a tow quality judgment at the conclusion of each trawl operation and allow at sea data checking and verification. Software applications promote data quality by guiding field staff workflow, minimizing data entry errors and providing for as much immediacy in operation evaluation and corrective action as possible during and following trawling. Variation in net mensuration data for acceptable tows was also described and discussed.

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2) When Do Adverse Conditions Dictate a Weather Day?

As weather conditions deteriorate, the effectiveness of trawl survey gear may be reduced well before safety considerations force the cessation of sampling activity.

Through comparison of 1,754 hauls completed as part of the West Coast Groundfish Trawl Survey between 2003 and 2005 on the shelf and slope using chartered fishing vessels, we show a significant reduction in catch rates of bottom dwelling fish and invertebrates as a function of visually-estimated wave height. Comparing randomly located trawl sets that occurred fortuitously close to one another, we conclude that to reduce the estimated impact of elevated wave height on catch of benthic species (and potentially relative biomass estimates) survey trawl activities on these vessels should be halted when wave heights reach six feet. Only 41 hauls from the 2003-2005 data were conducted when wave heights exceeded six feet, however their exclusion reduces the maximum expected bias in any single tow due to wave height by ~31%. Selecting a lower maximum wave height for routine sampling would begin to exclude geographic areas of the survey and introduce new bias to the randomized sampling design.

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c) Development of Survey Techniques for Use in Untrawlable Habitats

The Northwest Fisheries Science Center (NWFSC), in collaboration with researchers at Woods Hole Oceanographic Institution (WHOI), is developing the SeaBED AUV to overcome the difficulty of monitoring fish populations in rocky areas. Rocky, untrawlable areas are not well surveyed by traditional trawl gear, yet these areas are important habitat for a variety of commercially important fish stocks including rockfish.

Traditional fish monitoring techniques, such as trawl surveys and ship borne acoustics, are of limited applicability in these areas due to the rugged nature of the terrain. Thus, to enhance our ability to adequately assess fishery species that use these habitats alternate technologies must be identified and evaluated for augmenting current fishery-independent assessment techniques. Hover-capable AUVs offer a unique tool that is appropriate for work in these types of habitat. In addition, AUVs allow other simultaneous shipboard data collections that will greatly enhance the data available for integrated ecosystem assessments.

The Seabed AUV is a multi-hull, hover capable vehicle, which unlike traditional torpedo shaped AUVs, is capable of working extremely close to the seafloor while maintaining very precise altitude (3m +/- 0.05m) and navigation control. Its small footprint coupled with its 2000m working depth makes it an ideal platform for conducting surveys off the continental shelf on ships ranging from standard NOAA oceanographic vessels to smaller fishing vessels of opportunity.

Figure 11. The Seabed - a hover capable AUV developed by Hanu Singh at WHOI.

The suite of sensors onboard the AUV include 12 bit 1.2 Megapixel high dynamic range camera and associated strobe, a 230kHz Delta-T multibeam imaging system, a 1.2 MHz RDI Acoustic Doppler Current Profiler, fluorometers and a pumped CTD. Typical mission durations for the current vehicle allow it to run with its suite of sensors for 6-8 hours covering distances of up to 10-15 km on a single dive.

The sensors, the AUV, and its associated systems are all vertically integrated. Thus the imagery can be easily color corrected, merged with the navigation and attitude data, photo-mosaiked and then analyzed for species counts, sizes and distributions with easy to use, web accessible GUIs. Example mosaics of photos taken using the downward-looking camera during the 2006 cruise are shown in Figure 12.

Enhancements of the Seabed AUV are being developed to improve our ability to identify rockfish. These will include addition of higher resolution forward-looking as well as downward-looking camera configurations. In Spring 2007 in collaboration with DFO Canada mapping of rockfish and their habitat off Vancouver Island, B. C. was conducted off CCGS Vector using both the DFO Canada ROV and the Seabed AUV. A comparison of the results is underway.

For more information, contact Dr. Elizabeth Clarke at Elizabeth.Clarke@noaa.gov

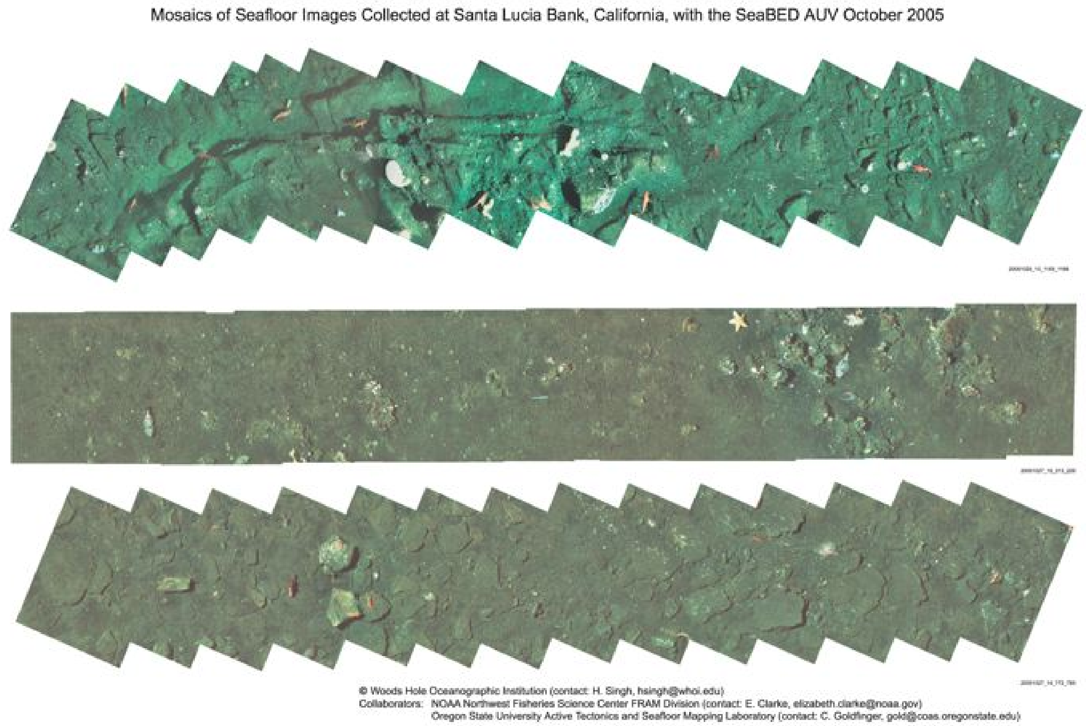

Figure 12. Photomosaics of some of the images collected with the AUV in a rocky untrawlable habitat.

d) Southern California hook-and-line survey

In early Fall 2007, FRAM personnel conducted the fourth hook and line survey for shelf rockfish in the Southern California Bight (SCB). This project is a cooperative effort with Pacific States Marine Fisheries Commission (PSMFC) aimed at developing an annual time series of catch rate data and other biological information for structure-associated species of rockfish (genus *Sebastes*) such as bocaccio (*S. paucispinis*) and vermilion rockfish (*S. miniatus*) within the SCB.

The F/V Aggressor (Newport Beach, CA) and F/V Mirage (Port Hueneme, CA) were each chartered for 11 days, with nine biologists participating throughout the course of the survey. The two vessels sampled a total of 101 sites ranging from Point Arguello in the north to 60 Mile Bank in the south. Approximately 2,500 lengths, weights, fin clips, and otolith pairs were taken representing 35 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. In 2007, 382 of these hooks were used during the course of the survey. An underwater video system was deployed at four sites to gather imagery of the seafloor for future analyses correlating catch rates of key species with specific habitat types. Other projects included the testing and networking of a data-logging anemometer 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, contact John Harms at John.Harms@noaa.gov

e) Joint U.S.-Canada acoustic survey

The Joint U.S./Canada Integrated acoustic and trawl survey was conducted from 20 June to 24 August 2007 to estimate 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 35º N to 55º N with acoustic transects spaced 10-20 nm apart. With the unexpected sidelining of the CCGS W.E. Ricker, the NOAA ship Miller Freeman completed the entire survey by combining survey time with inter-vessel (NOAA ship Oscar Dyson) calibration time. The survey resulted in 132 transects with over 12,000 miles of fishing and other operations. Pacific hake were observed from approximately 36.5º N (Pt. Sur) to 55º N (Dixon Entrance), the northern extent of the survey. Data were collected on 18-, 38-, 70-, 120-, and 200-kHz EK60 echo sounder. 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 92 successful trawls resulted in a total catch of 47,571.3 kg (90.3% hake by weight). Additionally 277 CTD casts were completed. The estimated total biomass of Pacific hake was 0.88 million metric tons. The stock was dominated by hake in the 45-50 cm length range. Additionally, there was a strong showing of one and two year old hake, which appeared further north relative to previous years.

Also on the joint US/Canadian survey, the NWFSC Digital Video Plankton Recorder (DVPR) 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 13. NWFSC Digital Video Plankton Recorder

For more information, contact Dr. Dezhang Chu at Dezhang.Chu@noaa.gov

f) Joint PWCC-NMFS hake pre-recruit survey

A joint Pacific Whiting Conservation Cooperative and FRAMD pre-recruit survey was conducted in 2007 to determine the spatial distribution and abundance of young-of-year (YOY) Pacific hake along the U.S. West Coast. The survey occurred in May-June 2007 and covered the area from 34º 30' N to 48º N 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 1200 m depth. 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.). Trawling was done at night at a speed of 2.7 kt for 15 minutes duration at target 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

g) 2008 Inter-vessel calibration (IVC) cruise

We are planning to conduct an Inter-Vessel Calibration cruise in August 2008. There will be three research vessels participating in the cruise including the NOAA ship FSV Miller

Freeman and Oscar Dyson, as well as the Canadian ship CCGS. W. E. Ricker. The purpose of the IVC cruise is to compare quantitatively the difference among the ship in terms of their acoustic estimates of Pacific hake (*Merluccius productus*) biomass, or more precisely, acoustic indexes. This is a crucial step towards a smooth transition from conducting hake surveys on the old generation of fisheries research vessels such as Miller Freeman to a new generation of fisheries research vessels such as Oscar Dyson.

For more information, contact Dr. Dezhang Chu at Dezhang.Chu@noaa.gov

5. NOAA Program: Fisheries And The Environment (FATE)

Project Title: Improving Stock Assessments by Explicitly Including Environmental Indicators and other FATE Products
Investigators: Michael J. Schirripa, Richard M. Methot, C. Phillip Goodyear

The goal of this investigation is to construct an environment of computer programs that will (1) enable the user to create a virtual fish population whose reproductive success is explicitly driven by a predetermined annual environmental and/or oceanographic event; (2) efficiently output a sample of data from this virtual population and create a file suitable for input into the stock assessment software program SS2; (3) evaluate the efficacy of the methods employed via the SS2 program to successfully capture and characterize the known environmental effect that emerges via the resulting observed and estimated population dynamics.

The FSIM program suite is a flexible software tool for simulating the response of fish populations to exploitation under many combinations of exploitation patterns and biological features of the species. It provides a convenient method to simulate many forms of fisheries data routinely collected from real fisheries. Analyses of these "known" simulated datasets facilitate studies of the robustness of alternative assessment methodologies. The model is also useful for exploring the implications of uncertainty about the dynamics of fish populations, forecasting consequences of management alternatives, and predicting future trends in population sizes and catches for a wide assortment of possible biological attributes under different management alternatives.
Annual stochastic variability can be added to the recruitment time series by specifying a value for the coefficient of variation of recruitment greater than zero. This is accomplished by multiplying the predicted (mean) recruitment from the stock-recruitment relationship by exp(R*CV – 0.5*CV 2), where R is a random normal deviate with mean of zero and a variance of 1.0; and CV is the coefficient of variation of the log of the random multiplier and is read from an input file. Longer term temporal trends may be incorporated in the simulations by reading a time series of deviations from mean survival. These are incorporated in the simulation by multiplying the predicted (mean) recruitment from the stock-recruitment relationship by exp(D), where D is an empirically derived, or assumed deviation from the expected recruitment in log units (i.e. D = log(O/E). where O ="observed" recruitment, and E = expected recruitment). The program assumes the cyclic pattern persists throughout the simulation, and accomplishes this by concatenating the pattern for the period of the simulation. The beginning point of the cycle may

be randomized. The annual stochastic and longer term cyclic survival patterns may be combined during a simulation by specifying non-zero values for both options.

The simulation tool set produced from this work was used to carry out investigations in conjunction with the Groundfish Harvest Policy Workshop held December 18-21, 2006 in La Jolla, California. A presentation was given entitled, "The potential effects of including/excluding environmental factors into stock assessments" A simulation-estimation framework was developed specifically for sablefish using FSIM, a population and fishery simulator. The estimation model used is the SS2 model used in the sablefish assessment. Environmental forcing on recruitment was modeled using an actual time series of sea surface height data to drive recruitment variability around the mean stock- recruitment relationship. A random component was also included to model residual variability not associated with sea surface height. A number of scenarios were considered, including those with and without environmental forcing on recruitment, and assessment models that attempted to estimate the environmental forcing and those that did not. All results are for scenarios in which the data using in the assessment is nearly perfect, i.e., there is minimal sampling error. To develop recommendations based on this work, the analyses need to be repeated for more realistic data-moderate and/or data-poor situation.

An alternative approach of using environmental data as a survey-like data input was discussed briefly at the workshop. We are currently comparing the two different approaches on parameter estimates and overall perception of stock status.

For more information, contact Dr. Michael Schirrpa at Michael.Schirripa@noaa.gov

6. Ecosystem Studies

a) Impact of fishing on marine community structure.

Using food web models, we are examining a range of marine communities, varying in species richness, productivity, and fishing intensity, to determine how fishing has affected community structure and some basic ecosystem parameters. Our initial work suggests that incompatibilities exist between managing for sustainable fisheries and managing for the health of coast ecosystems—two of NMFS' mission goals. We are developing indices of "ecologically sustainable yield" based, not on single-species fish population dynamics, but on systemic dynamics and NMFS ecosystem goals.

For more information Dr. Phil Levin at (206) 860-3473, Phil.Levin@noaa.gov

b) Groundfish bioenergetics.

Bioenergetics models have proven to be an excellent tool in estimating the energetic demands of fishes and, thereby, better understanding the amount of prey required by fish populations. Bioenergetics models are also useful for explaining fish growth trajectories as they relate to prey quality, temperature, fish size, and species- and sex-specific differences. We developed bioenergetics models for *Sebastes* species to examine various issues such as per capita prey demand of different species, the influence of temperature anomalies (e.g., PDO shifts, El Niño) on fish growth and reproductive potential, and habitat-specific prey allocation across different life history stages of rockfish (i.e., Do adult and juvenile rockfish share common habitats and common prey, and if so, do the predatory demands of one age group constrain the success of the other?).

For more information, Dr. Chris Harvey at (206)860-3228, Chris.Harvey@noaa.gov

c) Fish movement and MPA design.

Rational design of networks of MPAs requires an understanding of the relationship between the spatial extent of a reserve, home ranges of fish, and the distribution of resources. As a result, understanding movement patterns of fishes is of central importance to measuring MPA effectiveness. There are two potentially conflicting objectives of MPAs: (1) to conserve a breeding stock adult, movement out of MPAs should be minimal, but (2) to augment local fisheries, some flux outside the MPAs to harvested areas is desirable. However, very little is known about the short-term movement of most economically and ecologically important temperate fish species. Here, we propose (1) to determine the degree to which habitat structure and food resources affect movement by rockfishes, and (2) to apply these data to models that can ascertain effectiveness of existing MPAs and develop guidelines for designing future MPAs. Our approach involves first documenting the movement of rockfishes on rocky reefs using sonic telemetry. We will then use the information gathered during the empirical phase of our project to model MPA effectiveness as a function of fish motility and habitat-structure food availability.

For more information, contact Dr. Phil Levin at (206) 860-3473, Phil.Levin@noaa.gov

d) Development of a spatially explicit ecosystem model to examine effects of fisheries management alternatives in the Northern California Current

Decision analysis is intimately associated with the analysis of uncertainty: Given uncertainty about future behavior of a system, what policies are most robust over the full suite of alternative future conditions? Classic fisheries science, which relies on single-species population models, has been criticized by some as inadequate for fisheries decision analysis because it considers one possible effect of fisheries policy (i.e., fishing affects abundance and age structure which, in turn, affects yield). In contrast, ecosystem-based management recognizes a broader suite of system responses, and it explicitly recognizes that fish stocks respond to underlying yet unpredictable ecosystem dynamics (e.g., irreducible uncertainties) and that fishing itself can induce ecosystem changes. Thus, decision analysis frameworks ideally explore responses of populations to fishing under alternative scenarios of ecosystem forcing and fishing-mediated ecosystem change.

Do we presently have the tools to predict all elements of marine ecosystems? Absolutely not, and it is unlikely that such a case will ever arise. Do we presently have the tools to identify potential ecosystem responses and behaviors? Fortunately, we have considerable and expanding expertise. Our knowledge of food web processes in marine ecosystems continues to grow, building a strong conceptual framework of the types of food web relationships that are common, rare, and, most importantly, dangerous in the context of fisheries management. What is presently lacking, however, is an integrated modeling framework that can be used to 1) synthesize this information; 2) analyze possible ecosystem responses; and 3) identify key processes that govern ecosystem condition.

We are developing such a modeling framework for the Northern California Current Ecosystem (NCCE). Our approach explicitly estimates the ecosystem and population-level consequences of various fisheries management alternatives in the face of a varying environment. ATLANTIS, a modeling approach developed by CSIRO scientists in Australia, achieves the crucial goal of integrating physical, chemical, ecological, and fisheries dynamics in a three-dimensional, spatially explicit domain. In ATLANTIS, marine ecosystem dynamics are represented by spatially-explicit sub-models that simulate hydrographic processes (light- and temperature-driven fluxes of water and nutrients), biogeochemical factors driving primary production, and food web relations among functional groups. The ATLANTIS model represents key exploited species at the level of detail necessary to evaluate the direct effects of fishing. The model is thus ideally suited for ecosystem-based decision analysis.

The overarching goal of this project is to develop a model that allows users to examine the effects of large-scale management efforts against a backdrop of environmental variability resulting from climate events, seasonal changes, oceanographic dynamics, food web interactions, and fisheries. To achieve this goal, we are (1) collating data for the processes and functional groups included in the model; (2) defining the spatial structure of the NCCE; and (3) simulating behavior of the NCCE under alternate fisheries management policies and environmental regimes.

For more information, contact Dr. Phil Levin at (206) 860-3473, Phil.Levin@noaa.gov

e) Home range and patterns of space use for lingcod, copper rockfish and quillback rockfish in Puget Sound

For marine fishes the estimation of home range size has received attention recently because of its application to the design of marine reserves. How individuals use space may also be important to the management of the species or for understanding behavioral processes like optimal foraging or territoriality. We used an acoustic tracking system (VRAP) to examine patterns in home range size and movement behavior for three demersal fishes in Puget Sound: lingcod *Ophiodon elongatus*, copper rockfish *Sebastes caurinus* and quillback rockfish *S. maliger*. Data were collected over eight weeks in the summer of 2006.

Home ranges were relatively small (~1500 to 2500 m^2) and did not differ among species. However, lingcod had larger home ranges during the day than at night. Movement in all three species was in some way related to diel and tidal cycles, although individuals within species differed, and there was no general pattern. For example, about half of the lingcod used particular portions of their home ranges only during the day and on the flood tide. In contrast, other individuals used particular portions of their home ranges on the ebb tide. Some copper rockfish moved to specific areas of their home range on the day ebb tide, while others moved on the night flood tide and still others showed no movement pattern. Similar results were seen for quillback rockfish. The individual variation in movement behavior is the most interesting aspect of the results. Failure to incorporate this variation into ecological models ignores the individual level variability upon which natural selection operates.

For more information, contact Dr. Nick Tolimieri at Nick.Tolimieri@noaa.gov

f) Quillback otolith chemistry: life-history information obtained from opportunistic sampling

Ascertaining ecological information about species of concern is often difficult given their low abundance and conservation status. Using opportunistically collected quillback rockfish (*Sebastes maliger*) from sites throughout Puget Sound and the Strait of Juan de Fuca we investigated: a) the ability to differentiate fish based on the elemental concentrations found in their otoliths; and b) similarities in their life-histories as inferred from individual profiles of otolith chemistry. Our analyses indicate that the spatial patterns of otolith elemental concentrations were sufficiently unique to differentiate individuals among sites and to identify individuals that shared similar environments throughout their entire lives, compared with those that likely utilized different habitats at specific times in their lives. This study highlights the usefulness of opportunistically collected specimens and the application of techniques such as otolith chemistry to further our ecological understanding of species of concern.

For more information, contact Paul Chittaro at Paul.Chittaro@noaa.gov

g) Developing an *in situ* index of nutritional status in lingcod: implications for evaluating management strategies such as marine reserves

For most fish species, it is difficult to measure *in situ* growth or feeding rates non-lethally. In this project, we use the endocrine system, which plays an integral role in regulating cell division and growth in all vertebrates, to develop an index of nutritional status for lingcod *Ophiodon elongatus*. One of the principal hormones regulating growth is insulin-like growth factor-1 (IGF-I). Levels of blood plasma IGF-I are related to feeding and growth rates of Pacific salmon and several other marine teleosts. First, we characterize the relationship between levels of IGF-I and growth rates in a controlled laboratory experiment. Growth rates of lingcod in the laboratory varied from -0.96 – 1.56 g day^{-1} over two feeding periods lasting a total of 62 days. After characterizing the relationship between IGF and growth in the laboratory, we use this index to quantify relative differences in the nutritional status or growth of lingcod in the field by collecting blood samples at different fishing sites. The differences in this index among lingcod are compared with densities of lingcod and other groundfish species at each fishing site to investigate whether nutritional status (or growth) is density-dependent among sites. Understanding whether processes, such as density-dependent growth, occur will have considerable impacts on the overall success of specific management strategies.

For more information, contact Kelly Andrews at Kelly.Andrews@noaa.gov

h) Patterns of movement in sixgill sharks: does small scale behavior predict large scale patterns?

While patterns of density are ultimately produced by the interaction of births, deaths and movement, far more attention has been paid to the processes of births and deaths than to movement. The manner in which organisms move through their environment is crucial to the success of individuals and individual patterns of movement can generate observed spatial patterns of the population. We have been examining patterns of movement in sixgill sharks as a means to better predict the consequences of environmental change and/or human perturbation on this species. In 2005-2007, we acoustically tagged >40 sixgill sharks with pressure sensor transmitters and monitored their movement patterns. Acoustic monitoring suggests that sharks occupy core areas during late fall-early spring and move away from these core areas in warmer months. Active tracking revealed that sharks are responding to habitat attributes at the scale of 100's of meters. Analysis of 24h movement paths indicated that sharks tend to move much less than would be predicted by a random walk model on scales of days-weeks. The limited movement of these large predators suggests their local ecological impact may be substantial, and that they are at risk of local depletion if a fishery develops for them.

For more information, contact Dr. Phil Levin at (206) 860-3473, Phil.Levin@noaa.gov

7. Acoustic Modeling

a) Acoustic Scattering Modeling Workshop

From Jan. 14-Jan 18 2007, Drs. Rebecca Thomas and Dezhang Chu from the FRAM division attended the Acoustic Backscatter Modeling Workshop in Friday Harbor, WA. The workshop, funded by the NOAA/NMFS ASTWG for domestic participants and the NOPP for international participants, reviewed and compared the currently used fish/zooplankton scattering models that widely are used in the fisheries acoustics community. There were 16 participants, representing scattering modeling experts from six countries. The workshop was very successful in that it strengthened the collaborations and provided a direct and much more efficient communication channel among scientists from different organizations and countries. In addition, it established a convenient platform for future developments.

For more information, contact Dr. Dezhang Chu at Dezhang.Chu@noaa.gov

b) Fish Acoustics Science Review

A meeting of Fish Acoustic Science Review was held from 1 Nov. to 2 Nov in Plymouth, MA. It brought together approximately 25 scientists, along with ONR program managers from Biological Oceanography, Ocean Acoustics, and Signal Processing, spanning several disciplines. The review covered the areas of biology, acoustics, and signal processing. Each scientist gave a presentation of the state-of-the-art in their respective area. Dr. Dezhang Chu from FRAM division gave a presentation on acoustic modeling of scattering by swimbladder-bearing fish. After the plenary-style presentations were given, small focus groups were formed to identify issues. The initial outlines for an ONR

Departmental Research Initiatives (DRI) proposal entitle Multiscale Bioacoustics, which was a collaborative and multi-disciplinary research project, were presented by Dr. Jim Eckman (ONR program manager - Biological Oceanography) at the end of the review.

For more information, contact Dr. Dezhang Chu at Dezhang.Chu@noaa.gov

8. Economic Data Collection and Analysis

a) Commercial Fishing Economic Cost-Earnings Data

Development, implementation, and fielding of the West Coast open access groundfish and salmon economic cost earnings survey was completed during 2007. Economic cost earnings data was collected from the owners of over 300 fishing vessels through the use of in-person, telephone, and mail questionnaires. When combined with data from the limited entry cost earnings survey completed during 2006, this open access groundfish and salmon survey provides representative economic data on all vessel types which provide shoreside landings in the federally managed groundfish and salmon fisheries.

Cost earnings data collected from the limited entry trawl fleet (during 2006) was used during 2007 to model the impact of implementing an limited access privilege (LAP) regulatory regime on limited entry trawl fleet size and harvesting costs. This analysis indicates that fleet size is likely to be reduced by about 50% after implementation of a LAP regulatory regime, with a substantial reduction in annual harvesting costs.

The Center's first cost earnings survey of seafood processors was developed during 2007. Meetings were held with industry representatives to develop a survey questionnaire and OMB approval for survey fielding has been received. The survey will be fielded during 2008.

For more information, contact Dr. Carl Lian at Carl.Lian@noaa.gov

b) Survey of the Economic Value of Sport Fishing

An economic valuation survey was developed and implemented during several 2-month waves of recreational angling in Oregon and Washington during 2006. An original and innovative survey format was used to elicit the effect of regulations on angler valuations and participation rates. Extensive testing of the survey instrument and outside reviews were conducted to improve the quality for responses for use in future research.

For more information, contact Dr. Todd Lee at Todd.Lee@noaa.gov

c) Economic Survey of West Coast Charter Fishing Vessels

The economic survey of West Coast recreational Charter Boat operators has been developed over the past year and is currently being fielded in Oregon and Washington. The survey is designed to determine the state of the industry and to determine the regional economic impacts of the sector on the respective coastal communities. This survey will compliment the survey of the commercial fishing vessels which is also currently being fielded and the processor survey which has been developed and is under review of industry representatives. Upon completion we will be able to build a comprehensive regional economic model of the West Coast that incorporates commercial, recreational, and processors.

For more information, contact Dr. Todd Lee at Todd.Lee@noaa.gov

d) Regional Economic Impact Analysis

A three step research program has also initiated to investigate how coastal communities interface with marine resources. In Phase 1 a Social Accounting Matrix (SAM) will be developed for selected communities. This phase will utilize federal, state, and local secondary data sources and some limited "ground truthing". Presently, Westport, Washington and Newport, Oregon have been selected for inclusion in this project, and one or two communities in California may also be included. Significant progress was made during 2007 on Phase 1 of this project.

Phase 2 will involve surveying businesses and households in Westport, Newport, and at leaset six other communities. These interviews will be used to improve the data obtained from the secondary data sources and examine important issues such as location of expenditures by businesses and households, household income from marine related endeavors, extent of income from non-labor sources, and some more sociological questions about people's preferences and values for the marine resources. Phase 3 will focus on estimating visitor usage and visitor expenditure profiles. Completion of these two phases will rely upon future availability of funding. Survey design for phases 2 and 3 of this project has been completed, and fielding will begin after Paperwork Reduction Act clearance is received from OMB.

For more information, contact Dr. Carl Lian at Carl.Lian@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 2007 on groundfish fleets along the entire west coast.

a) At-Sea Hake Observer Program

The At-Sea Hake Observer Program deployed two fisheries observers on each of sixteen at-sea Pacific hake processing vessels for every fishing day during the 2007 season, exceeding 1,400 observer days at sea. Due to low total catch limits on some bycatch species in this fishery, observer data is crucial to the successful management of the fishery. Beginning in 2005, program staff has taken an active role in conducting pre-cruise meetings between vessel crew and the observers. These meetings provide an opportunity to outline observer duties, expectations, and identify solutions to meet both the needs of the observer program and the vessel through increased communication and cooperation. The observers sample nearly 100% of the hauls in this fishery. Through the hard work of the observers and vessel cooperation, the average sample size of each haul has increased from roughly 30% to around 50% during recent seasons.

b) West Coast Groundfish Observer Program

During 2007, the West Coast Groundfish Observer Program deployed observers on the bottom trawl and various fixed-gear fleets along the entire U.S. West Coast, exceeding 2,900 observer days at sea on over 300 vessels. The program also deployed electronic monitoring technology on the entire shore-based Pacific hake fleet and developed a cost sharing arrangement between the shore-based hake fleet and NOAA Fisheries for the 2007 season. 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. Due to its unique data collection circumstances, the program continues to stress safety and data quality. The program's safety focus and unique sampling methodology was exemplified by its high profile at the International Fisheries Observer Conference held in May in Victoria, British Columbia.

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 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 were completed during the fall and winter of 2007. The limited-entry trawl fleet report summarizes discarded catch data collected by the West Coast Groundfish Observer Program (WCGOP) from the limited-entry trawl fleet from January 1, 2006 through April 30, 2007. The non-sablefish report summarizes discarded catch data collected by the WCGOP from the limited-entry non-sablefish-endorsed fixed-gear fishery from January 1, 2006 through April 30, 2007. The sablefish report summarizes discarded catch data collected by the WCGOP from the limited-entry sablefish-endorsed fixed-gear fishery from January 1, 2006 through December 31, 2006. The nearshore report summarizes discarded catch data collected by the WCGOP from the open access fixed-gear fisheries in shallow water (average of start and end depths < 50 fathoms) from September 1, 2004 through April 30, 2006. FRAMD also prepares an evaluation of total annual fishing mortality. The most recent report is for the year 2006. All reports can be obtained at: http://www.nwfsc.noaa.gov/research/divisions-/fram/observer/datareport/index.cfm.

For more information, please contact Jonathan Cusick at Jonathan.Cusick@noaa.gov

d) Recent trends in bycatch and discard in the U.S. West Coast groundfish trawl fishery

The West Coast Groundfish Observer Program was initiated by NOAA Fisheries' Northwest Fisheries Science Center in the fall of 2001. Since that time, the Pacific Management Council has initiated numerous measures, such as closed areas, gear restrictions, and explicit modeling of bycatch, which have been intended to constrain the catch of species for which rebuilding plans have been developed. In 2007, FRAMD examined the trends in the trawl fleet's discard and overall bycatch of these rebuilding species since 2002, and related these changes to the evolution of groundfish management and its effect on the magnitude and distribution of fishing effort over this period. In addition to rebuilding species, FRAMD also reviewed changes in trawl discard species since 2002. Improved understanding of how bycatch and discard in this fishery have responded to recent management actions will enhance the ability to identify future groundfish management approaches that are effective with respect to achieving bycatch and economic objectives.

For more information, please contact Dr. Jim Hastie at Jim.Hastie@noaa.gov

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NMFS Southwest Fisheries Science Center

Agency Report to the Technical Subcommittee

of the Canada-U.S. Groundfish Committee

April 2008

Edited by John Field with contributions
from David Demer, John Hyde, and William Watson

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. Norman Bartoo, and the acting deputy director is Dr. Frank Schwing. 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) and other management teams and advisory bodies.

The Center is headquartered in La Jolla, which hosts three divisions that conduct research on a wide range of Pacific and Antarctic fish, marine mammals, sea turtles, and marine habitats; the Antarctic Ecosystem Research Division (led by Dr. Rennie Holt) , the Protected Resources Division (led by Dr. Lisa Ballance), and the Fisheries Resources Division (led by Dr. Roger Hewitt). The Fisheries Resources Division (FRD) conducts research on groundfish, large pelagic fishes (tunas, billfish and sharks), and small coastal pelagic fishes (anchovy, sardine and mackerel), and is the primary source of groundfish-related research in the La Jolla Laboratory. The La Jolla laboratory is also the primary source of federal support for the California Cooperative Oceanic Fisheries Investigations (CalCOFI) surveys that have taken place along most of the California coast since 1951. Researchers at the La Jolla lab have primary responsibility for ichthyoplankton collections, studies of species abundance and distribution (including responses to climate variability), systematics, and the application of early life history information to stock assessments.

The Fisheries Ecology Division (FED), located in Santa Cruz and directed by Dr. Churchill Grimes, comprises two research branches. The Fisheries Branch (led by Dr. Peter Adams) conducts research (and stock assessments) in salmon population analysis, economics, groundfish, and fishery oceanography. The Ecology branch (led by Dr. Susan Sogard) conducts research on the early life history of fishes, salmon ocean and estuarine ecology, habitat ecology, and molecular ecology of fishes. Specific objectives of FED groundfish programs include (1) collecting and developing information useful in assessing and managing groundfish stocks; (2) conducting stock assessments, and improving upon stock assessment methods, to provide a basis for harvest management decisions for the PFMC; (3) characterizing and mapping biotic and abiotic components of groundfish habitats, including structure-forming invertebrates; (4) disseminating information, research findings and advice to the fishery management and scientific communities; and (5) provide professional services (many of which fall in the above categories) at all levels, including inter-agency, state, national and international working groups.

The Environmental Research Division (ERD), directed by Dr. Franklin Schwing, is located at the Pacific Fisheries Environmental Laboratory (PFEL) in Pacific Grove. The ERD is a primary source of environmental information to fisheries researchers and managers along the west coast, and provides science-based analyses, products, and information on environmental variability to meet the agency's research and management needs. The objectives of ERD are to (1) provide appropriate science-based environmental analyses, products, and knowledge to the SWFSC and its fishery scientists and managers; (2) enhance the stewardship of marine populations in the California Current ecosystem, and other relevant marine ecosystems, by understanding and describing environmental variability, the processes driving this variability, and its effects on the production of living marine resources, ecosystem structure, and ecosystem function; and (3) provide science-based environmental data and products for fisheries research and management, to a diverse customer base of researchers, decision-makers, and the public. ERD also contributes oceanographic expertise to the groundfish programs within the SWFSC, including planning surveys and sampling strategies, conducting analyses of oceanographic data, and cooperating in the development and testing of environmental and biological indices that can be useful in preparing stock assessments.

B. MULTISPECIES STUDIES

1. Research

Ichthyoplankton Surveys
The CalCOFI ichthyoplankton time series, the longest such time series in existence, dates from 1951 to the present and has been used to study distribution and abundance changes of many fish species in relation to climate and ecosystem change in the California Current region. CalCOFI data have been used in recent assessments of bocaccio and shortbelly rockfishes, and may provide fishery-independent time series information for many other groundfish species. Since 2002 CalCOFI stations off central California, last routinely sampled in 1984, have been re-occupied during the winter and spring cruises in order to provide improved geographic coverage during the principal reproductive season for Pacific sardine and many of the groundfish species such as rockfishes, greenlings, cabezon, and various flatfishes whose spawning distributions are centered north of Point Conception.

Over the 57+ years of the CalCOFI time series substantial advances have been made in ichthyoplankton identifications and many species identifiable only to the level of genus or above in earlier years now are identified to species. To increase the consistency of identifications through the time series, a project to systematically work back through the archived CalCOFI ichthyoplankton samples to bring all identifications up to current standards has been completed for samples collected during the first nine months of 1969 and from 1972 to the present. In addition, we have begun re-identifying fish eggs collected in the CalCOFI bongo net samples, and are adding the count data for eggs of Pacific whiting (hake) and jack and Pacific mackerels to the database. Egg re-identifications have been completed for samples collected from 1992 to the present and we continue to work back through the time series for both eggs and larvae. A data report for the Southern California Nearshore Ichthyoplankton survey (2004-2005) was published in 2007 (Watson et al. 2007) and a study is currently underway to identify all the rockfish larvae collected during the CCA surveys. To date, visual and molecular identifications have been completed for about half the rockfish larvae collected during the 2002 CCA survey, representing 26 species.

Finally, larvae of most of the rockfish species cannot be reliably identified to species using standard visual techniques. However, one side of each bongo net sample collected during the

Cowcod Conservation Area (CCA) surveys was preserved in ethanol, thus these larvae can be identified using molecular techniques. Currently, about 60% of the “unidentified rockfish” larvae collected during the 2001 CCA survey have been identified, representing 27 species and dominated by squarespot and swordspine rockfishes. The results of this work will greatly enhance the number of species identified in such surveys and assist in the validation of pigment/morphology-based identifications.

Juvenile Surveys

Since 1983 the FED has conducted an annual survey of the distribution and abundance of pelagic juvenile rockfishes, with the goal of providing data for forecasting future recruitment to rockfish and other species, and to otherwise monitor the physical and biological environment. A number of west coast groundfish stock assessments have historically used this pelagic juvenile index to estimate impending recruitment. In 2004 the geographic coverage of the SWC pelagic juvenile rockfish mid-water trawl survey was expanded substantially, with the addition of new sample lines off of southern and northern California, from San Clemente Island to Point Delgada. As in 2005 and 2006, pelagic juvenile rockfish catches in the core part of the survey area were at very low levels in 2007, with some evidence of a redistribution of fish to the north and the south.

The Early Life History Team is continuing studies of essential fish habitat for newly settled rockfish in Monterey Bay. Using methods of trapping, otter trawling, drop camera surveys, scuba diving censuses and ROV censuses, we are examining a range of habitat types and depths from 20 to 100m. Ongoing poor recruitment trends have limited our attempts to use video methods of censuses, although trawling and trapping methods have revealed spatial patterns in settlement, with higher densities of YOY rockfish in southern Monterey Bay relative to the north, and higher densities in deeper regions relative to shallow. Low relief mud/sand substrates appear to have nursery value for newly settled rockfishes of several species, with later migration to the high relief rocky substrates typically recognized as adult habitat.

Adult Surveys

The Advanced Survey Technology (AST) and In-Situ Survey groups have made operational a Collaborative Optically-assisted Acoustic Survey Technique (COAST) to survey rockfish and evaluate their biotic and abiotic requirements for habitat. The COAST can provide estimates of biomass and dispersion by species, throughout the Southern California Bight (SCB), with practical sampling effort (Fig. 1). The techniques were developed in 2003/04 from the Commercial Passenger Fishing Vessel (CPFV) Outer Limits; applied throughout the Southern California Bight (SCB) in 2004/05 and 2007 (COAST07), largely from NOAA Ship David Starr Jordan. The COAST will provide a time-series of data for improving rockfish stock assessments. Efforts are underway to also apply the COAST to rockfish off central California.

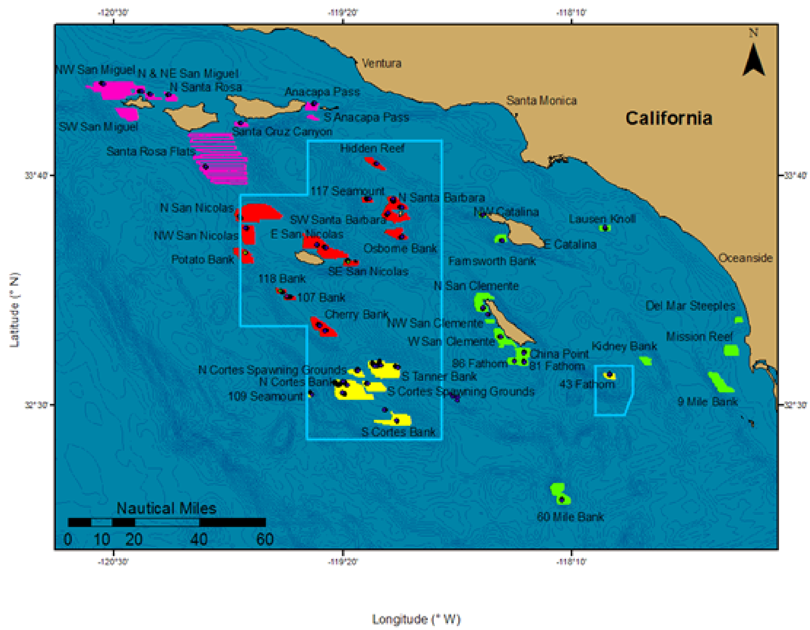

Figure 1. Sites for the COAST07 survey of rockfish in the SCB. COAST07 was conducted in four legs, each approximately 15 days in duration: Leg I, 8/26-9/9 (yellow); Leg II, 9/13-9/27 (red); Leg III, 10/1-10/15 (purple); and Leg IV, 10/19-10/31 (green). Most of the multi-frequency echosounder surveys (lines) and ROV transects (black dots) were conducted from the NOAA Ship David Starr Jordan. A few sights were completed with acoustic and optical observations from the CPFV Outer Limits. Indicated with light blue lines are the boundaries of the Cowcod Conservation Area.

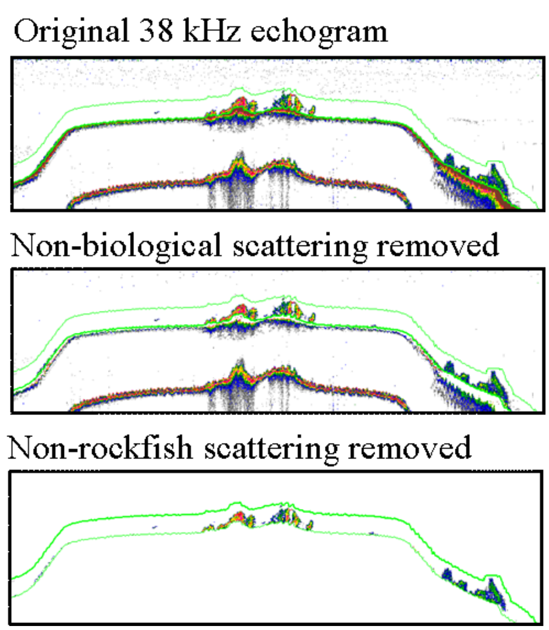

Figure 2. Volume backscattering strength data (Sv; dB) from multi-frequency echosounders is used to detect and classify rockfish near the seafloor.

Throughout COAST07, acoustical volume backscattering strengths (Sv; dB re 1 m) and in-situ target strengths (TS; dB 1 m2) were measured continuously by four Simrad EK60 echo sounders configured with 38, 70, 120, and 200 kHz hull-mounted transducers. Then, video and high-resolution still images of the rockfish were collected using cameras deployed on a remotely operated vehicle (ROV). In each of 42 sites surveyed, a three-dimensional seafloor was visualized by interpolating the bottom detections from the 38 kHz echo sounder to render a surface. Empirical relationships between the multi-frequency Sv were used to remotely identify and separate the scatterer taxa (i.e. large fish, small fish, and zooplankton; e.g. Fig. 2). Signals from the rockfish were thus extracted from the echograms and their distributions were overlaid on the rendering of the seafloor. Using these geographically-referenced files to navigate the ROV, optical images were obtained to characterize the fish species and their sizes, and also to validate acoustical seabed classifications. At the conclusion of each survey segment or day, a CTD was deployed in the area to profile the temperature, salinity, and sound speed within each survey location.

Additional optical surveys were conducted during December 2007 through April 2008, with the aid of partners in the sportfishing industry, to fill in missing data at a few sites. The goals were to examine the species compositions and length distributions of bocaccio (*Sebastes paucispinis*), cowcod (*S. levis*), vermilion (*S. miniatus*) and bank rockfish (*S. rufus*) at all sites. Results have been widely disseminated, and manuscripts detailing the methods and results of the COAST04/05 and COAST07 surveys are in preparation.

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 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 sample expansion efforts, the FED has also participated in the PFMC process since it's inception. Staff scientists have been represented on the Groundfish Management Team (GMT) in every year since it's establishment, and have also been active participants in the Scientific and Statistical Committee (SSC) for the PFMC.

C. BY SPECIES, BY AGENCY

2. Nearshore Rockfish

Research
The Early Life History Team continues to conduct research to evaluate sources of variability in the fitness characteristics of individual larval rockfish, such as the initial size of larvae at parturition, bioenergetic condition as indexed by oil reserves, initial swimming capabilities, growth rates and mortality. Maternal age appears to play an important role in larval success (growth and survival) for some species but not others. Age also appears to influence the timing of parturition, suggesting that older mothers fertilize their eggs earlier than younger mothers. The strength of some of these maternal effects appears to be related to seasonal patterns of parturition timing. We are currently expanding these studies to additional species common in deeper habitats. This issue is widely recognized by researchers and assessment scientists as important in evaluating the productivity and sustainability of West Coast groundfish fisheries, and insights gained from ongoing research will be incorporated into scientific assessments and management advice as it becomes available. In addition to research examining maternal effects, we have completed experiments testing for multiple paternity in kelp rockfish, with the finding that multiple paternity appears to be common.

Assessment
In 2007, FED biologists assisted in the development of a blue rockfish (*Sebastes mystinus*) stock assessment led by the California Department of Fish and Game (Key et al. 2008). The 2008 assessment indicated that increased catches in the 1970s resulted in a continuous decline in spawning biomass through the early 1990s. Spawning biomass was estimated to have reached a minimum (10% of unexploited) in 1994 and 1995; with a constant increase since that time, such that the current relative depletion level in 2007 is 30% of the unfished. The base model estimated that the stock could support an MSY of 275 metric tons. Although the assessment was fairly data poor and several key uncertainties were characterized in the assessment, including expected results from ongoing genetic studies that suggest that "blue rockfish" may in fact be represented by two closely-related species.

3. Shelf Rockfish

Research
Ongoing efforts are underway to develop a spawning biomass point estimate of bocaccio (*Sebastes paucispinis*) in the southern California Bight (SCB) using data collected during standard winter CalCOFI surveys and enhanced ichthyoplankton sampling surveys (Figure 3). Standard and enhanced ichthyoplankton sampling conducted during 2002 and 2003 were used to generate independent estimates of spawning biomass in those two years through the analysis of larval catch curves. Larval production was then linked to spawner biomass based on information obtained from adult fish recently collected in Ensenada, Mexico (i.e., maturity and fecundity data). The results will be evaluated in the next full bocaccio rockfish stock assessment

Assessments
In the 2007 stock assessment cycle, the FED conducted full stock assessments of cowcod and chilipepper rockfish, and updated assessments of bocaccio and widow rockfish. Updated rebuilding analyses were also developed for cowcod, bocaccio and widow rockfish. All assessments and rebuilding analyses are available on the Pacific Fishery Management Council website, at http://www.pcouncil.org/groundfish/gfstocks.html.

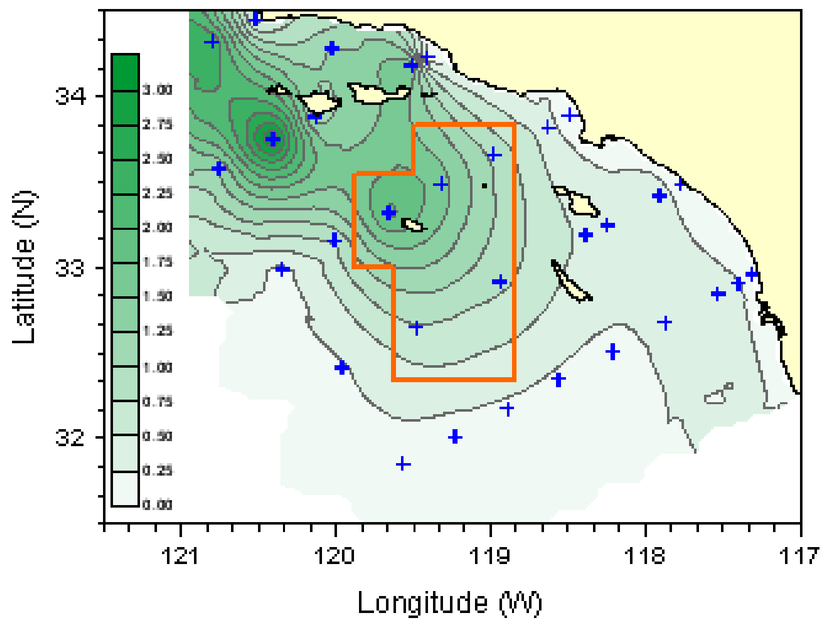

Figure 3: Historical distribution of bocaccio larval abundance (# ≅ 10 m^{-2}) from the CalCOFI database. Shown are contours of the estimated station effects from a Δ-lognormal GLM, with blue "+" symbols indicating actual station locations. The Cowcod Conservation Area is delimited by the orange polygon.

A full assessment of cowcod (*Sebastes levis*) rockfish was recommended by the PFMC SSC following the discussion of some corrections and refinements to the updated 2005 model. These corrections caused the estimate of the 2005 estimate of depletion to drop from 17.8% to 9.4%. A major effort was also initiated to refine the historical catch data and to improve on the means by which visual survey estimates of cowcod were incorporated into the model. The model was developed in Stock Synthesis II (SS2), the modeling platform used for most west coast groundfish assessments. The final model estimated the 2007 spawning biomass to be approximately 4.6% of the unfished level (Dick et al. 2008). 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 which are now truncated due to a ban on retention and the establishment of the Cowcod Conservation Areas (CCAs) to rebuild the stock.

Chilipepper rockfish (*S. goodei*) have been one of the most important commercial target species in California waters since the 1880s. Although the last stock assessment (in 1998) found that the stock was above target levels, landing have plummeted to a fraction of their former magnitude over the last ten years, due to management measures implemented to rebuild bocaccio and other rockfish of abundance. The 2007 assessment found that although the biomass through the early and mid 1990s was at low levels (close to, but above, the existing overfished threshold), the spawning biomass of chilipepper rockfish increased substantially in recent years, due to a strong 1999 year class as well as greatly reduced harvest rates in commercial and recreational fisheries (Field 2008). The base model result suggests a spawning biomass of 23,889 tons in 2006, corresponding to approximately 70% of the unfished spawning biomass and representing a near tripling of spawning biomass from the late 1990s.

The bocaccio (*S. paucispinis*) rockfish assessment was conducted primarily as an "update," which follows the methodology, assumptions and modeling platform (SS1) of the 2003 bocaccio assessment. The updated assessment estimated that the stock has continued to increase in abundance, due to both declining exploitation rates and a very strong 1999 year class, which appears to have been followed by a moderately strong 2003 year class. Recent management has been achieving total removals well below target levels, and far below maximum levels. A full assessment of bocaccio rockfish will be conducted in 2009.

The last full assessment of widow (*S. entomelas*) rockfish was conducted in 2005 using an age-based population model written in ADMB (He et al. 2006). The 2007 assessment applied the same assessment model and data compiling procedures, with new data from 2005 and 2006 including catches, age composition, and CPUE time series. The updated assessment results suggest that the stock may be approaching its rebuilding target (40% of the assumed unfished biomass level). The SSC of the PFMC recommended that the ability to classify this stock as "rebuilt" would be greatly enhanced if it was based on a full assessment, and the FED is currently undertaking this effort, including an exploration of the use of the Stock Synthesis 2 (SS2), which may be better able to handle the apparent area-specific growth rates.

7. Flatfish

Research

A manuscript on the age, growth, life history and fisheries for sand sole (*Psettichthys melanostictus*) was published (Pearson and McNally 2005), presenting a comprehensive evaluation of recently developed life history information for this species. From some 250 otoliths, the oldest fish was found to be age 8, with most fish found to be between 2 and 4 years old. Sand sole were thus found to be a relatively fast-growing, short lived species; available data also suggested a latitudinal gradient in growth rate. Although landings are relatively modest, the value of sand sole landings is high relative to most other West Coast flatfish. Maturity, growth, and life history studies of starry flounder, rex sole and sanddabs are also ongoing.

D. OTHER RELATED STUDIES

1. Western Groundfish Conference

The Fisheries Ecology Division co-hosted the Fifteenth Western Groundfish Conference, a meeting of over 200 participants representing state and federal fishery agencies, regional management councils, universities, conservation groups, and fishing and other marine industries. The meeting was held in Santa Cruz, CA in February of 2008, at the Coconut Grove Conference

Center. Other co-sponsors included the California Department of Fish and Game, the University of California Santa Cruz, and the Monterey Bay National Marine Sanctuary, and many others. The conference included oral and poster sessions on stock assessment, management targets and thresholds, advanced survey technology, ecosystem analysis, marine protected areas, habitat characterization, and general fishery biology. This conference is the only such meeting in the United States, and is the best venue for groundfish biologists to interact with colleagues from the fishing industry, the government, and universities. Dr. Alan Longhurst presented the keynote address entitled "The Sustainability Myth," challenging scientists and fishermen to reflect on the broad and cumulative impacts of fishing on marine ecosystems. The lecture was followed by an interactive panel of regional fishermen, scientists, and fisheries managers who discussed their perceptions of sustainability and the state of regional fisheries with conference participants.

2. Historical Catch Reconstruction

The Fisheries Ecology Division's Groundfish Analysis Team completed work on a California commercial landings database covering 1931 to 2007 based on California Department of Fish and Game (CDFG) records that had been available only in microfiche format. This spatially explicit landings information from 1931 through 1968 were recovered using funds and services provided by the NESDIS Climate Database Modernization Program (CDMP). The recovered data, when combined with more recent landings estimates from the California Cooperative Groundfish Survey from 1969-2007, forms one of the longest detailed catch records in the U.S. The 1931-68 period includes monthly summaries of catches by 10-minute geographic blocks. These data are now openly available to the public for use in stock assessments and monitoring of climate effects. This effort will provide historical catch information with a high degree of spatial resolution, which will be tremendously useful in both stock assessments and ecosystem models based on understanding past and future consequences of spatial exploitation patterns.

In addition to these data recovery efforts, FED staff have been involved in an ongoing effort to examine the reliability of more recent commercial groundfish landings estimates, together with staff from the Pacific States Marine Fisheries Commission and the California Department of Fish and Game. This effort represents a comprehensive examination of potential problems with species misidentification, landing receipt errors and unusual patterns in landings. Conclusions indicate that most landings estimates (by volume) have been at least somewhat reliable, although some problems are difficult to resolve. For example, catch histories for as many as 27 rarely or infrequently encountered Sebastes species in California waters are considered to be unreliable (Pearson et al., in prep), which will make meaningful assessments of vulnerability to overexploiation and the setting of appropriate total catch limits difficult.

The landings reliability assessment, as well as the historical catch reconstruction effort, are also critically important to the ongoing effort by the SSC of the PFMC to reconstruct consistent catch histories at the species level for west coast groundfish, particularly for rockfish (*Sebastes* species), which have typically been reported as a small number of market categories with a broad (and often time-varying) species composition.

3. Molecular Genetics in La Jolla

The La Jolla laboratory of the SWFSC houses a collection of over 20,000 groundfish tissue samples, which includes virtually all extant rockfish species. These samples have enabled the recent completion of a comprehensive and robust phylogenetic hypothesis for the genus (Hyde and Vetter 2007). Additionally, scientists in the genetics program have developed many genetic markers for groundfish, and have been working to determine stock structure and dispersal distances, examine mating systems, increase the species resolution of ichthyoplankton surveys, and are helping with the design of MPA networks.

The comprehensive phylogeny for Sebastes provided evidence for a cryptic species pair within the currently recognized vermilion rockfish (*S. miniatus*). The validity of this assertion was tested using a combined genetic and morphologic study (Hyde et al. 2008a). The results of this study strongly supported the existence of two species and a tentative name (*S. crocotulus*, "sunset rockfish") has been applied to the new species. A formal description of *S. crocotulus* is currently in preparation (Hyde in prep.) and will be submitted within the next few months. *S. crocotulus* and *S. miniatus* are separated primarily by depth and *S. miniatus* has a much broader geographic distribution. *S. miniatus* occurs from at least Vancouver Island, Canada to Punta Baja, Mexico and is found primarily shallower than 100 m. *S. crocotulus* is found from Monterey, CA to Punta Colnett, Mexico but is most abundant within the Southern California Bight, deeper than 100 m. The two species can be reliably separated by gill-raker counts and are significantly different at several morphometric characters.

Following the above study, a study of genetic connectivity between populations of *S. miniatus* was initiated (Hyde and Vetter in prep). A high-degree of genetic heterogeneity was observed among sample locations. Analyses supported a moderate genetic break across Point Conception with weaker breaks observed across Cape Blanco and possibly Cape Mendocino. There was a strong relationship between increasing genetic and geographic distance. The slope of this relationship was used to calculate larval dispersal values. The results suggest limited larval dispersal for vermilion rockfish, similar in magnitude to dispersal values obtained from our previous studies on brown, copper, and grass rockfish. These results are extremely valuable when designing MPA's to manage this and similar species.

Additionally important to the proper management of exploited species, particularly highly fecund, r-selected fishes, which often show strong discrepancies between census and effective population sizes, such as Sebastes spp., is the understanding of mating systems. Paternity analysis was performed on a phylogenetically and ecologically diverse sample of Sebastes species, with multiple paternity found in 14 of the 35 broods and 10 of the 17 examined species (Hyde et al. 2008b). This finding suggests that this polyandrous mating system is not a rare event within a single species and is likely common throughout the genus. Additionally we found that at least 3 sires can contribute paternity to a single brood. Hyde et al. (2008b) suggest that multiple paternity may be a form of bet hedging that serves to maximize genetic diversity within broods and that, regardless of the selective value at the level of individual fitness, the net effect at the population level may be a genetic buffer to the consequences of overexploitation.

4. SWFSC/Santa Cruz Lab Groundfish Habitat Ecology Program

The FED has an ongoing research program to implement legislative mandates with respect to Essential Fish Habitat (EFH) and Stock Assessment Improvement for West coast groundfish. This program uses a range of tools, including research submersibles, laser line scan system, and multibeam and side scan sonar. In addition to the Cowcod Conservation Area surveys and the gear intercalibration research described in the Assessments section for shelf rockfish, other ongoing projects include: 1) an evaluation of patterns in groundfish distribution and abundance and seafloor habitats at a range of spatial scales, being conducted in collaboration with USGS (Anderson and Yoklavich, in press.); 2) characterizing benthic invertebrates that form habitat on deep banks off southern and central California, with special reference to deep sea coral communities (Tissot et al. 2006); 3) an evaluation of the potential for laser line scan (LLS) systems to serve as a bridge between high resolution, limited coverage video survey tools (e.g., remotely-operated vehicle (ROV), occupied submersible, towed sled) and lower resolution, higher coverage acoustic technologies (e.g., multibeam and sidescan sonar) (Amend et al. in press). During a two week cruise along the Central California coast in November 2007, FED researchers spent time in Cordell Bank, Monterey Bay and off Point Sur, using the ROV to identify and map distribution of young-of-year rockfishes.

5. Economic Studies

The FED's Economics Team is developing a model of fishery dynamics using 1981-2005 vessel- and trip-specific data for all West coast commercial fisheries (including groundfish). This model is intended to: (1) analyze patterns of fishing behavior across space and time, (2) identify biological, economic, regulatory and environmental factors underlying these behavioral changes, and (3) evaluate the cumulative effects of these changes on fishing communities. The project is currently focused on the relationship between fishery behavior and port-level fishery infrastructure. Related efforts include the development of a Bayesian approach to estimating technical efficiency in the limited entry groundfish trawl fleet, in which an analysis is currently focused on the effects of the 2003 trawl vessel buyback program on technical efficiency in that fishery.

The Economics Team is also working in collaboration with the Environmental Research Division on an analysis of the economic effects of the Rockfish Conservation Areas on the groundfish trawl fleet. The ERD has expanded it's mapping of groundfish trawling to cover all of California's offshore waters out to 700 fathoms. Data consists of start and end locations of all tows from trawl logbooks from 1977 to 2005 linked to landings receipts for weight of market species. This year maps were created of the distribution and density of species from the trawl fishery for years before and during rockfish conservation area closures. Files of the 25 different RCA boundaries from 2002 to 2005 were created to overlay these maps. These data are being analyzed to quantify changes in fishing location and effort of the limited entry trawl fleet resulting from the RCA closures, including the spatial distribution of trawling by vessels from each port. This project will include analysis of (a) adaptations made by West coast groundfish trawlers in terms of movement between fisheries, and (b) adaptations by California groundfish trawlers in terms of spatial redistribution of effort and changes in fishing strategies.

6. MPA Center working groups

Currently a number of small working groups are being supported MPA Science Center Working Group on MPAs and Fisheries Science. One such group is the Density ratio working group. The premise of this collaboration is the recognition that marine reserves introduce several new sources of uncertainty to traditional fisheries stock assessment and management, requiring new tools for managers. For relatively data rich species, concerns have been raised regarding the impact of increasing spatial heterogeneity in population abundance and demographics. However for data poor stocks and assemblages (such as most California nearshore fisheries), it is possible that such heterogeneity could be used to provide guidance to management. For example, the relative abundance of target species in the fished area relative to the unfished area, and use a control rule analogous to the State of California's existing 60-20 rule to restrict catch or season when the density outside the MPA falls below ~60% of the density within MPAs. The rule could use the average densities of several representative species that could be adequately monitored (with separate OY's for assessed species). Cooperative surveys to develop relative abundance indices could improve industry acceptance as well as supplement survey funding. Although management system based on ratios of fished to unfished densities is appealingly simple in concept, a number of details need to be thoroughly evaluated before such an approach might be applied. The current working group is addressing several key questions regarding the feasibility of such an approach, based primarily on simulations of the effectiveness of such an approach using a simple management strategy evaluation (MSE).

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STATE OF ALASKA
GROUNDFISH FISHERIES

ASSOCIATED INVESTIGATIONS IN 2007

Prepared for the Forty Ninth Annual Meeting of the Technical Subcommittee
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With new contributions from:
Cleo Brylinsky, Mike Byerly, William Dunne, Kenneth J. Goldman, Lee Hulbert, Mike Jaenicke, Scott Meyer, Krista Milani, Kristen Munk, Nick Sagalkin, Gail Smith and Charlie Trowbridge

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ALASKA DEPARTMENT OF FISH AND GAME
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E. AGENCY REPORTS – STATE OF ALASKA

STATE OF ALASKA GROUNDFISH FISHERIES AND ASSOCIATED INVESTIGATIONS IN 2007

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. Other groundfish fisheries in Alaskan waters are managed by the federal government, or in conjunction with federal management of the adjacent Exclusive Economic Zone (EEZ). The information related in this report is from the state-managed groundfish fisheries only.

The State of Alaska is divided into three maritime regions for marine commercial fisheries management. The Southeast Region extends from the Exclusive Economic Zone (Equi-distant line) boundary in Dixon Entrance north and westward to 144^{o} W. longitude and includes all of Yakutat Bay (Appendix II). The Central Region includes the inside and outside Districts of Prince William Sound (PWS), Cook Inlet including the North Gulf District off Kenai Peninsula, and Bristol Bay. The Westward Region includes all territorial waters of the Gulf of Alaska south and west of Cape Douglas and includes North Pacific Ocean waters adjacent to Kodiak, and the Aleutian Islands as well as all U.S. territorial waters of the Bering, Beaufort, and Chukchi Seas.

a. Southeast Region

The **Southeast Region** Commercial Fisheries Groundfish Project is based in Sitka with the groundfish project leader, fisheries biologist, full-time fisheries technician, and seasonal research analyst located there. One full-time biologist and one full-time fisheries technician for this project are based in Douglas. Seasonal technicians and port samplers are employed in Petersburg, Ketchikan and Sitka. The project also received biometrics assistance from the regional office in Douglas 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 federal-managed fisheries; dockside sampling of sablefish, lingcod, Pacific cod, and rockfish landings; and skipper interview and logbook collection and data entry. Four resource assessment surveys were conducted during 2007. Funding for the Southeast Groundfish project comes from NOAA Grants NA06NMF4370212, NA04NMF4070165, and NA04NMF4370176.

b. Central Region

Central Region groundfish staff is headquartered in Homer and is comprised of a regional groundfish management biologist, a regional shellfish/groundfish research project leader, a groundfish sampling coordinator, a groundfish fish ticket entry position, three marine research biologists, and one seasonal commercial catch sampler. An area management biologist and a seasonal commercial catch sampler are also located in Cordova and regional support comes from Anchorage. The research project leader also functions as a member of the North Pacific Fishery Management Council's Gulf of Alaska Groundfish Plan Team. The R/V *Pandalus*, home ported in Homer, and the R/V *Solstice,* home ported in Cordova, conduct a variety of groundfish-related activities in Central Region waters.

Groundfish responsibilities include research and management of groundfish species harvested in territorial waters of Central Region. Within Central Region, groundfish species of primary interest include sablefish, rockfish, pollock, Pacific cod, lingcod, flatfishes, sharks, and skates. Stock assessment data are collected through port sampling, and through ADF&G trawl, longline, jig, scuba, and remotely operated vehicle (ROV) surveys. Commercial harvest data (fish tickets) are processed in Homer for state and federal fisheries landings in Central Region ports.

c. Westward Region

The **Westward Region** Groundfish management and research staff is located in Kodiak and Dutch Harbor. Kodiak staff is comprised of a regional groundfish management biologist, an area groundfish management biologist, an assistant area groundfish management biologist, a groundfish research project leader, a groundfish research project assistant biologist, a groundfish dockside sampling coordinator, a seasonal age-determination unit biologist, two seasonal fish ticket processing technicians, and a seasonal dockside sampler. A full-time assistant area groundfish management biologist and a seasonal fish ticket processing technician are located in the Dutch Harbor office. There is no longer a seasonal dockside sampler located in the Dutch Harbor office, this position was not filled in 2007. Seasonal dockside sampling also occurs in Chignik, Sand Point, and King Cove. No dockside sampling occurred in Adak 2006 or 2007. 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 (vacated January 1, 2008) 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 such 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) 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. 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 analysis 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.

Milestones for this ongoing ADF&G AKFIN program are primarily the annual production of catch records and biological samples. In calendar year 2007 ADF&G AKFIN staff processed

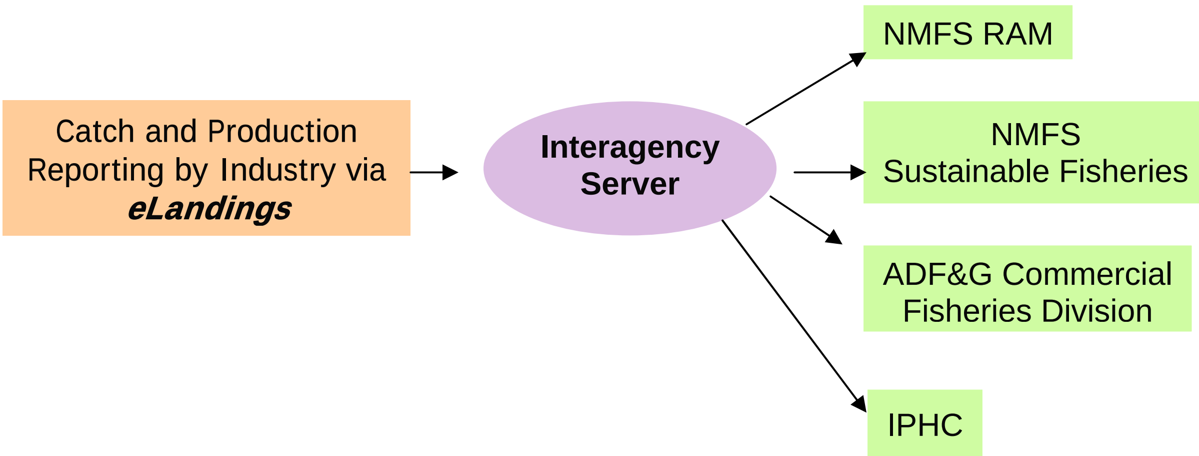
19,093 groundfish fish tickets and 9,252 shellfish fish tickets. Also, in state fiscal year 2007 ADF&G AKFIN staff processed approximately 37,000 shellfish and 24,000 groundfish biological samples and measured more than 11,000 age structures. These basic measures of ongoing production in support of marine 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)

Electronic Fish Ticket System (contact Gail Smith)
The Alaska Department of Fish and Game maintains a commercial harvest database, based on landing report receipts – fish tickets. These data are comprehensive for all commercial salmon, herring, shellfish, and groundfish from 1969 to present. Data is stored in an Oracle relational database and available to regional staff via the State of Alaska wide-area network.

The three resource management agencies tasked with commercial fisheries management in Alaska are the Alaska Department of Fish and Game (ADF&G), the International Pacific Halibut Commission (IPHC), and the National Marine Fisheries Service – Alaska Region (NMFS-AK). Since 2001, these agencies have been working to develop consolidated landing, production, and IFQ reporting from a sole source. This collaborative effort, the Interagency Electronic Reporting System (IERS), was developed with initial funding provided through the Pacific States Marine Fisheries Commission. The web-based reporting component of this system is ***eLandings***. An additional application was developed, designed to be installed on local computers for the at-sea, catcher processor fleet.

AKFIN funded ADF&G personnel participate in the IERS project on the development, implementation, and maintenance levels. The IERS provides processors with a web-based online electronic catch and production reporting program. The IERS features include electronic landing and production reports, real time quota monitoring, immediate data validation, and printable (.pdf) fish ticket reports. To date, IERS is required in all IFQ fisheries and extensively used in the Western Gulf and Bering Sea crab fisheries and groundfish fisheries – statewide. The ADF&G will be implementing the eLandings System in Southeast Alaska crab fisheries during 2008, as will as initiating a planning and requirements study to begin the implementation of this system in our salmon fisheries. Our approach, throughout this project has been staged implementation, which allows a small staff to successfully manage this ambitious project.
The web-based application provides the seafood industry with the ability to submit landing reports (fish tickets), IFQ fisher/processor quota harvest, and processor production information from a single location. The information submitted via the web application, ***eLandings***, is stored in a single repository database. The ADF&G, the IPHC, and the NMFS-AK copy data submitted by industry to their individual data systems.

DATA FLOW MODEL



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.
- 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.

Local ADF&G personnel in six locations throughout the state of Alaska (Petersburg, Sitka, Juneau, Homer, Kodiak and Dutch Harbor) maintain close contact with groundfish fishers, processors and state/federal enforcement to maintain a high quality of accuracy in the submitted fish ticket records. The Interagency Electronic Reporting System – eLandings applications, with immediate data validation and business rules, should continue to improve data quality and allow personnel to function at a higher level. 24/7 user support is being contracted 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 will continue to be submitted to local offices of ADF&G for additional review and comparison to other data collection documents. These documents include vessel/fisher logbooks, agency observer datasets, and dockside interviews with skippers.

Within the confines of confidentiality agreements, raw data is distributed to the State of Alaska Commercial Fisheries Entry Commission (CFEC) daily and to the National Marine Fishery Service NMFS-ARO and AKFIN Support Center on a monthly schedule. The CFEC merges the ADF&G fish ticket data with fisher permit and vessel permit data. This dataset is then provided to the AKFIN Support Center, which distributes the data to the professional staff of the North Pacific Fishery Management Council (NPFMC) and summarized data to the Pacific States Fisheries Information Network (PACFIN). Summary groundfish catch information is also posted on the ADF&G Commercial Fisheries website:
http://www.cf.adfg.state.ak.us/geninfo/finfish/grndfish/grndhome.php.
Summarized data is provided to the State of Alaska Board of Fisheries, the North Pacific Fisheries Management Council, and to the State of Alaska legislature as requested.

e. Gene Conservation Laboratory

In the past, the ADF&G Gene Conservation Laboratory collected genetic information on black rockfish, light and dark dusky rockfish, and pollock (a list of *Sebastes* tissue samples stored at ADF&G's Gene Conservation Laboratory can be found in Appendix III).

f. Age Determination Unit

The ADFG's centralized statewide age reading program at the Age Determination Unit (ADU) in Juneau continued to provide age data to ADFG regional managers in 2007. Age structures from approximately 8984 groundfish, representing 14 species, were received through statewide commercial and survey harvest sampling efforts. A total of 14,998 age data were released back to managers, which included data from samples received in previous years. Over 5,000 additional age data were produced through training and precision testing. A total of 23,151 otoliths (mostly otolith pairs from approximately 11,570 specimens) were measured. The majority (60%) of funding for this project is through the Alaska Fisheries Information Network (federal), approximately 23% from the Fisheries Management Plan Early Jurisdiction (Project 12; federal), and 17% is general funding (state). Seven people were employed for approximately 55 work months to age groundfish age structures (3 people) or conduct associated work (4 people), for example, sample preparation, data entry, archiving, otolith measurements, and project work. Only one employee was full-time and funded year round, and other individuals were seasonal, employed for 1-11 months duration.

Quality of age data is routinely assessed through second-reading of at least 15% of the sample, either by the initial-reader or by a reader with equal or greater experience. Species-specific control limits are imposed and further guide release of age data; transgression of control limits direct reviewing of some or the entire sample.

In 2007 the ADU was in production status for all species received except gadids (questions remain regarding contemporary aging practices of gadids). Due to substantial increases in sampling of sablefish and the need for these data in age structured models, all age readers were developed primarily and immediately for aging sablefish otoliths. This can depress production of age data in the short term due to the lengthy training of a difficult to age species. Sablefish otolith growth patterns are complex, and improvement in data quality generally occurs after several months of experience, as opposed to weeks for rockfish. Effort continues toward increasing objective information (age structure measurements, age validation) to strengthen foundation of pattern interpretation for all species.

The ADU continued work in validating age of species and therein age reading criteria. In 2006 we submitted otolith cores of thornyhead rockfish, and the resulting 14C data are supportive of age-reading criteria, with a submitted and validated high age of 46y old. These data have not yet been published. Bomb radiocarbon work was expanded in 2007, with species (and current highest age) in process for validation to include: Sablefish (48y), and dusky (44y), black (43y), tiger (46y), shortraker (41y), rougheye (46y), and redbanded (43y) rockfishes. Sample sizes have been met for only 3 species; however data for these and also submitted species with incomplete sample sizes, are all supportive of the applied age reading criteria. Samples to complete sample sizes will be submitted in 2008.These preliminary data are to be presented at the 2008 Western Groundfish Conference.

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. Commencement of Phase 3 development of AegIS continues to be postponed due to lack of availability of programmers. Limited refinements to the ADU website (http://tagotoweb.adfg.state.ak.us/ADU/) were made. (Contact Kristen Munk)

2. Description of the State of Alaska recreational groundfish fishery program (Sport Fish Division)

ADF&G has jurisdiction over all recreational groundfish fisheries within the internal waters of the state, in coastal waters out to three miles offshore, and throughout the EEZ. The Alaska Board of Fisheries extended existing state regulations governing the sport fishery for all marine species into the waters of the EEZ off Alaska in 1998. This was done under provisions of the Magnuson-Stevens Fishery Conservation and Management Act, which stipulate that states may regulate fisheries that are not regulated under a federal fishery management plan or other applicable federal regulations.

Most management and research efforts are directed at halibut, rockfish, and lingcod, the primary groundfish species targeted by the recreational fishery. Statewide data collection programs include an annual mail survey to estimate overall harvest (in number) of halibut, rockfish, lingcod, and sharks, and a mandatory logbook to assess harvest of the same species in the charterboat fishery. The Assistant to the Commissioner, Douglas Vincent-Lang, located in Anchorage, is the statewide lead in federal-state jurisdictional management issues. A new position of statewide bottomfish coordinator was created mid-season to coordinate federal data requests and develop scientifically-based advice for assessment and management of halibut and groundfish. This position is held by Scott Meyer.

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 the Federal Aid in Sport Fish Restoration program and through NOAA grant NA04NMF4370027 administered by NMFS. There are essentially two maritime regions for marine sport fishery management in Alaska. The Southeast Region extends from the Exclusive Economic Zone (Equi-distant line) boundary in Dixon Entrance north and westward to Cape Suckling, at approximately 144^o W. longitude. The Southcentral Region includes state and federal waters from Cape Suckling to Cape Newenham, including Prince William Sound (PWS), Cook Inlet, Kodiak, the Alaska Peninsula, the Aleutian Islands, and Bristol Bay.

a. Southeast Region Sport Fish

Regional staff in Douglas coordinate 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 while assistant project biologists were also located in Ketchikan (Kathleen Wendt), Juneau (Diana Tersteeg), and Sitka (Heather Riggs). The project biometrician (Steve Fleischman) is located in Anchorage. A total of 24 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, length and weight of rockfish species, length of 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.

Area management biologists in Yakutat, Haines, Sitka, Juneau, Petersburg, Klawock, 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. In general, sport fisheries for groundfish are managed preseason, rather than inseason.

b. Southcentral Region Sport Fish

The Southcentral Region groundfish staff consists of the area management biologists and assistants for the following areas: (1) PWS and the North Gulf areas (Daniel Bosch), (2) Lower Cook Inlet (Scott Meyer and Nicky Szarzi), and (3) Kodiak, Alaska Peninsula, and the Aleutian Islands (Len Schwartz). In addition, a region-wide harvest assessment project was based in the Homer office, consisting of a project leader (Scott Meyer and Charlie Stock), field supervisor, and six technicians. The research project biometrician (Steve Fleischman) 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 two of them read all rockfish and lingcod age structures. Halibut otoliths were collected from the harvest and will be forwarded to the International Pacific Halibut Commission for age reading.

Southcentral Region staff is responsible for management of groundfish fisheries in state and federal waters. For all species, the lack of stock assessment information has precluded development of abundance-based fishery objectives. As a result, management is based on building a conservative regulatory framework specifying bag and possession limits, seasons, and methods and means that provides for sustained yield over the long term. Inseason management action has generally been unnecessary, but increasing harvests of some species will eventually necessitate development of a well-defined harvest strategy.

Typical duties 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, working with Alaska Board of Fisheries, advisory committees, and local fishing groups to develop local area management plans (LAMPs), drafting and reviewing proposals for recreational groundfish regulations, and dissemination of information to the public.

B. By Species

1. Pacific cod

Catch rate and biological information is gathered from fish ticket records, port sampling programs, a tagging program, and during stock assessment surveys for other species. A mandatory logbook program was initiated in 1997 for the state waters of Southeast Alaska. Commercial landings in Southeast, Central Region and the Westward Region are sampled for length, weight, age, sex, and stage of maturity.

a. Research

The **Westward Region** has continued the cod-tagging program that was initiated in 1997 in the Central and Western Gulf of Alaska. Approximately 490 fish were tagged in 2007, bringing the total number of tags released to 14,470. By year's end, 26 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. Work has begun to integrate the Westward Region Pacific cod tagging results with those of the National Marine Fisheries Service.

b. Stock Assessment

No stock assessment programs were active for Pacific cod during 2007.

c. Management

Regulations adopted by the Alaska Board of Fisheries during November 1993 established a guideline harvest range (GHR) of 340 to 567 mt for Pacific cod in the internal waters of **Southeast Alaska**. The GHR was based on average historic harvest levels rather than on a biomass-based ABC estimate. Pacific cod 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. The guideline harvest levels (GHL) are allocated by gear type. The annual GHLs are based on the estimate of allowable biological catch (ABC) of Pacific cod as established by the NPFMC. Current GHLs are set at 25% of the Western Gulf ABC to be reserved for the South Alaska Peninsula Area, 25% of the Central Gulf ABC to be apportioned between the Kodiak, Chignik and Cook Inlet Areas and 25% of the Eastern Gulf ABC for the Prince William Sound Area. Action by the BOF in 2004 reduced the GHL in Prince William Sound to 10% of the Eastern Gulf ABC with a provision to increase subsequent GHLs to 25% if the GHL is achieved in a year.

Additional regulations include a 58’ vessel size limit in the Chignik and South Alaska Peninsula Areas and allocations between gear types in all five areas. 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 of restrictions on exclusive area registrations, vessel size and gear limits after October 31 to increase late season production to promote achievement of the GHL.

Efforts have increased to collect biological data through port sampling. In addition, observers are used on day-trips to document catches and at-sea discards in the nearshore pot fisheries.

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.

There is no bag, possession, or size limit for Pacific cod in the recreational fisheries in Alaska, and the season is open year-round. Recreational harvest of Pacific cod is estimated through the Statewide Harvest Survey (SWHS). Limited information is collected through the Sport Fish Division's Southcentral Region port sampling program. Specifically, numbers of cod kept and released by stat area is recorded by ADF&G groundfish stat area for each vessel-trip interview. No size or age data are collected. No information is collected in the Southeast Region creel survey program on the Pacific cod sport fishery.

d. Fisheries

Most of the Pacific cod harvested in **Southeast Alaska** are taken by longline gear in the Northern Southeast Inside (NSEI) area during the winter months. Pots have been the dominant gear in both the Cook Inlet and Prince William Sound areas. Overall Pacific cod harvest from the Cook Inlet and PWS areas during the parallel season has declined in recent years. In the Westward Region, trawl gear takes over 60% of the harvest, with the remainder split between longline, jig, and pot gear. 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. Pacific cod harvested since that time has been roughly evenly divided between bait use and human consumption. In other areas of the state, Pacific cod are harvested in both state and federal waters and utilized primarily as food fish. Harvests of Pacific cod in the Southeast state-managed (internal waters) fishery during 2007 totaled 288 mt. This is an increase over the 2006 catch of 139 mt. (It was stated IN ERROR last year that the 2006 harvest was 164 mt.).

The 2007 GHLs for the state-managed Pacific cod seasons in the Cook Inlet and Prince William Sound Areas of the **Central** Region were set at 1,420 mt and 413 mt, respectively. Harvest from the Cook Inlet Area state-managed Pacific cod fishery totaled 654 mt while the Prince William Sound Area harvest totaled 157 mt. Harvest from the 2007 state managed Aleutian Islands Pacific cod fishery totaled 5,280 mt, 1,260 mt more than 2006.   Harvest from the 2007 state managed fishery in the Kodiak Area totaled 2,904 mt, while 2,595 mt of cod were harvested in the Chignik Area, and the South Alaska Peninsula Area harvest totaled 5,750 mt. The Kodiak and South Alaska Peninsula Areas obtained their maximum GHL 'step up' provisions for 2000 and all subsequent years. The Kodiak Area will receive 12.5% of the Central Gulf ABC and the South Alaska Peninsula will receive 25% of the Western Gulf ABC in all future years. The Chignik Area achieved its maximum GHL 'step' up in 2003. The Chignik Area will receive 8.75% of the Central Gulf ABC in 2004 and all future years. Action by the Alaska Board of Fisheries during 2004 increased the Pacific cod allocation in the Cook Inlet Area 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 2007 recreational harvest of Pacific cod are not yet available from the statewide harvest survey, but the 2006 estimates were 9,165 fish in Southeast and 6,699 fish in **Southcentral Alaska**. The average estimated annual harvest for the most recent five-year period (2002-2006) was 7,209 fish in Southeast Alaska and 10,042 fish in Southcentral Alaska. There are no estimates of average weight in the sport harvest in either region.

2. Rockfishes

Rockfishes are managed under three assemblages: demersal shelf (DSR), pelagic shelf (PSR), and slope rockfish. Demersal Shelf Rockfish include the following species: yelloweye, quillback, china, copper, rosethorn, canary, and tiger. Pelagic shelf rockfish (PSR) include black, blue, dusky, dark, yellowtail, and widow. Black and blue rockfish were removed from the PSR assemblage in the federal fisheries management plan (FMP) and placed totally under state management in 1998. The North Pacific Fisheries Management Council (NPFMC) 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* and *Sebastolobus* species.

a. Research

In the **Southeast Region** port sampling and 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 2007 the directed fishery for demersal shelf rockfish (DSR) did not open in the Southeast Outside District (SEO) because the estimated bycatch mortality in the commercial halibut fishery combined with the estimated DSR harvest in the charter and sport fish fisheries was believed to leave insufficient TAC to support a commercial fishery. The directed fishery for DSR opened in internal waters but landings were minimal and no port sampling of those landings was possible. The Southeast Groundfish Project was able to sample yelloweye rockfish caught as bycatch during the IPHC Annual

Stock Assessment Survey during the summer of 2007. Age structures were obtained as well as biological data from these fish when they were landed in the ports of Sitka, Juneau, Ketchikan and Prince Rupert.

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. While work continued during 2007 at the Moss Landing Center for Habitat Studies to finish the interpretation of data collected in 2005, there were no new data sets collected in 2007 by the Department in the Southeast Region.

Skipper interviews and port sampling of commercial rockfish deliveries in **Central Region** during 2007 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 drastically reduced sampling opportunities during the second half of 2007. Additional sampling occurred during the Cook Inlet and PWS trawl surveys. Sample data collected included date and location of harvest, species, length, weight, sex, and gonad condition. Otoliths were collected from most sampled fish. Homer office staff determined ages of pelagic and demersal rockfish otoliths. Otoliths from all other rockfish species were sent to the Age Determination Unit (Contact Willy Dunne).

Work continued in 2007 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. A multibeam and side scan sonar habitat mapping survey was conducted in September, 2006 along the southern portion of the Chiswell Ridge to complete the mapping of that feature. The northern portion of the study area had been previously mapped using multibeam sonar by NOAA, NOS. Data were processed and incorporated into the GIS in 2007. A 125 sq km area was mapped and resulted in a 35% decrease in available rocky habitat. Yelloweye rockfish abundance estimates from a 2005 ROV survey were reassessed using the new habitat delineations and resulted in a 26% decrease.

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. The results from direct testing of these two assumptions of strip transect sampling will; 1) determine if the assumptions are likely to be violated, 2) determine possible biases – either positive or negative, 3) possibly quantify their effects, and 4) understand their effects to the extent that methods to overcome them may be incorporated in future surveys (Contact Mike Byerly or Ken Goldman.

The **Westward Region** continued its port sampling of the commercial rockfish and Pacific cod harvests in 2007. Rockfish sampling consisted mainly of black rockfish with opportunistic sampling of duskys, darks, and other miscellaneous *Sebastes* species. Skippers were interviewed for information on effort, location, and bycatch. Length, weight, gonadal maturity, and otolith samples were collected (contact Kally Spalinger). Staff from the Kodiak office have completed aging black rockfish otoliths through the 2006 season while a number of Pacific cod ototlihs remain to be read.

The **Westward Region** also continued several studies on Western Gulf of Alaska black and dark rockfish. Monthly gonad collections of dark rockfish continued throughout the year in an effort to determine reproductive seasonality and age and size of maturity. The acoustic tagging of black rockfish continued throughout 2007. An array of 16 moored receivers was put in position on the east side of Spruce Island, just north of the city of Kodiak. Seventy-five fish have had tags surgically implanted and all fish continue to be picked up by the receivers. In addition, hydroacoustic surveys of black and dark rockfish in the Northeast Section of the Kodiak Management Area were conducted in 2007 in an effort to generate biomass estimates and develop a management strategy for dark rockfish. (Contact Carrie Worton or Dan Urban).

The **Division of Sport Fish—Southeast Region** continued to collect catch and harvest data from rockfish as part of a marine harvest onsite survey program with rockfish harvests tabulated back to 1978 in some selected ports. Rockfish objectives included estimation of 1) species composition, 2) weight and length composition, and 3) the geographic distribution of harvest by the fleets by port. Primary species harvested in Southeast Alaska included yelloweye, black, and quillback rockfish. Approximately 2,900 rockfish were sampled at Ketchikan, Craig, Klawock, Wrangell, Petersburg, Juneau, Sitka, Gustavus, Elfin Cove, and Yakutat in 2007 (Contact Mike Jaenicke).

The **Division of Sport Fish—Southcentral Region** continued collection of harvest and fishery information on rockfish as part of the harvest assessment program. Rockfish objectives included estimation of 1) species composition, 2) age, sex, and length composition, and 3) the geographic distribution of harvest by the fleets by port. Approximately 2,500 rockfish were sampled at Seward, Valdez, Whittier, Kodiak, and Homer in 2007 (Contact Scott Meyer).

b. Stock Assessment

The **Southeast Region** uses line-transect methods, conducted from the submersible "Delta", to collect density estimates of yelloweye rockfish. Biomass is the product of density, average weight, and area of rock habitat. New density surveys were conducted during 2007 in CSEO. Yelloweye rockfish density for this stock assessment is based on the latest best estimate by management area. The EYKT and SSEO areas were last surveyed in 2003 and 2005 respectively, NSEO was surveyed in 2001. Density estimates by area range from 1,068 to 3,557 adult yelloweye per km^2.

The density estimate for CSEO in 2007 was 1,068 adult yelloweye/km^2 (CV=12.7%). This is significantly lower than the previous estimate obtained in 2003 of 1,865 adult yelloweye/km^2 (CV=11.22%). The model from which the 2007 estimate is derived is a half-normal model with 8 cutpoints truncated at 28 ft (Contact Cleo Brylinsky).

In the **Southeast Region** no black rockfish surveys were conducted in 2007.

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 2007.

c. Management

Management of DSR is based upon a combination of guideline harvest ranges, seasons, gear restrictions, and trip limits. The state has management authority for demersal shelf rockfish in both state and federal waters of **Southeast Alaska**.

Directed harvest of demersal shelf rockfish is restricted to hook-and-line gear. Directed fishing quotas are set for the 4 outside water management areas (SEO) individually and are based on the poundage remaining after assigning a 2% harvest rate to the adult yelloweye biomass estimate and estimating bycatch (reported and nonreported) mortality. Directed fishery quotas for the two internal water management areas are set at 25 mt annually. Regulations adopted in 1994 include trip limits (within any 5 day period) of 6,000 pounds per vessel in all areas except for EYKT where the trip limit is 12,000 pounds, and added a requirement that logbook pages must be submitted with fish tickets for each fishing trip. At the Board of Fish meeting in early 2006 the season for the directed fishery of DSR in SEO was changed to occur in the winter only from January 5th until the day before the start of the commercial halibut IFQ season, or until the annual harvest limit is reached whichever occurs first. At this meeting the total allowable catch for DSR was allocated 84% to the commercial sector and 16% to the sport sector.

The 2007 TAC for DSR in SEO was 410 mt which resulted in an allocation of 344 mt to commercial fisheries and 66 mt to sport fisheries. A significant portion of the total commercial harvest is taken as bycatch mortality during the halibut fishery. In 2006 an alternate method to the one used in past years was implemented to try to be more precise in our estimation of bycatch of DSR in the halibut fishery. This new method recognizes the significance of depth as a component of the bycatch rate. Using the new method the estimate of DSR that was anticipated to be caught as bycatch by the halibut fleet in outside waters in 2007 ranged from 122-337 mt (95%CI) with the point estimate at 230 mt. The estimate using the old method would have been 354 mt. Full retention of DSR has been in regulation in state waters since 2002 and in Federal water since 2005. Landed catch of DSR in the halibut fishery in 2007 was 190 mt which was almost 20% under the estimation provided using the new method.

The commercial fishery for DSR in the management areas in SEO (EYKT, CSEO, NSEO, and SSEO) did not open in 2007. Management put off opening any part of the directed fishery in outside waters during 2007 to have one more year to track the actual bycatch landed in the halibut fishery as it compares with the new estimation technique. Prior to 2005, sport fish catch data was not available for DSR and had not been considered in estimating total mortality. Sportfish harvest estimates have been used in 2005, 2006 and 2007 to add to our knowledge of what we determine to be the total harvest of DSR in other fisheries. The sportfish preliminary estimate for 2007 was 69 mt. (Contact Cleo Brylinsky).

Management of black rockfish is based upon a combination of guideline harvest limits and gear restrictions. The state has management authority for black rockfish in both state and federal waters of Southeast Alaska. Directed fishery guideline harvest limits are set by management area, and range from 11.3 mt in IBS to 57 mt in SSEO, totaling 136 mt. A series of open and closed areas was also created so managers could better understand the effect a directed fishery has on black rockfish stocks. Halibut and groundfish fishermen are required to retain and report all black rockfish caught. The directed fishery for black rockfish had very little participation in 2007, with 1.4 mt landed in directed and bycatch fisheries combined. This is down almost 70% from 2006.

Shortspine thornyhead, shortraker rockfish, rougheye rockfish and redbanded rockfish may be taken as bycatch only (no directed fishing). A total of 117 mt of slope rockfish were landed in NSEI and SSEI during 2007.

Rockfish in **Central Region's** Cook Inlet and PWS Areas are managed under their respective Rockfish Management Plans. Plan elements include a fishery GHL of 68 mt for each area and 5-day trip limits of 0.5 mt in the Cook Inlet District, 1.8 mt in the North Gulf District, and 1.4 mt in PWS. Rockfish regulations underwent significant change beginning in 1996 when the Alaska Board of Fisheries formalized the GHL into a 68 mt harvest cap for all rockfish species in Cook Inlet and PWS and a 5% rockfish bycatch limit for jig gear during the state waters Pacific cod season. In 1998 the board adopted a directed rockfish season opening date of July 1 for the Cook Inlet Area and restricted legal gear to jigs, primarily because the fishery typically targets pelagic rockfish species. At the spring 2000 meeting, the board closed directed rockfish fishing in the PWS area and established a bycatch-only fishery with mandatory full retention of all incidentally harvested rockfish. In November 2004 the board also adopted a full retention requirement for rockfish in the Cook Inlet Area and restricted the directed harvest to pelagic shelf rockfish. Rockfish bycatch levels were also set at 20% during sablefish, 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 Charlie 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 2007, 71 mt of black rockfish were harvested from six sections in the Kodiak Area. Effort and harvest decreased in 2006 compared to 2005. Guideline harvest levels were attained in four sections. The 2007 black rockfish harvest in the Chignik and South Alaska Peninsula areas remains confidential because of minimum participation. Less than 3 mt were harvested in the South Alaska Peninsula Area. The 2007 black rockfish 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 are 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.

Prior to 1988, there were no bag or possession limits on rockfish in **Southeast Alaska's** sport fishery. In 1988, a bag and possession limit of 8 rockfish was applied to the waters near Sitka (Sitka Sound, Salisbury Sound, and Peril Strait). The remaining waters of Southeast Alaska had no bag or possession limit on rockfish species for 1988. During 1989 to 1993, for the majority of the marine waters of Southeast Alaska (except Yakutat) the bag and possession limit was 5 rockfish per day and 10 in possession, of which only 2 per day, 4 in possession could be yelloweye; however, for the Sitka area (Sitka Sound, Salisbury Sound, and Peril Strait) and the Ketchikan area (Behm Canal, Clarence Strait, Tongass Narrows, Nichols Passage, George Inlet, Carroll Inlet, Thorne Arm, Revillagigedo Channel) the bag and possession limit was three rockfish, of which only one could be a yelloweye.

Prior to 1994, the Yakutat area did not have any bag or possession limits on rockfish caught in the sport fisheries.

Since 1994, the **recreational rockfish regulations for Southeast Alaska** (including Yakutat) have been split into "pelagic" and "other" (other being non-pelagic), with a region wide bag and possession limit of pelagic rockfish of 5 per day, 10 in possession and a bag and possession limit of "other" rockfish of 5 per day, 10 in possession of which only 2 per day, 4 in possession could be yelloweye. However, the Sitka area (Sitka Sound, Salisbury Sound, and Peril Strait) and the Ketchikan area (Behm Canal, Clarence Strait, Tongass Narrows, Nichols Passage, George Inlet, Carroll Inlet, Thorne Arm, Revillagigedo Channel) the bag and possession limit was three rockfish, other than pelagic rockfish, of which only one could be a yelloweye.

For the 2007 season, the entire **Southeast Alaska** region's sport bag and possession limit for pelagic rockfish remained at 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).

In most of the recreational fisheries in **Southcentral Alaska**, bag limits in most areas have been designed to discourage targeting of rockfish yet allow for retention of incidental harvest. Bag limits in Prince William Sound, the North Gulf, and Cook Inlet are five rockfish daily, with no more than one or two being non-pelagic (DSR and slope) rockfish. The Alaska Board of Fisheries has allowed a 10-rockfish bag limit in the Kodiak and Alaska Peninsula areas because of lower levels of effort and predominance of pelagic species in the catch.

Given the lack of quantitative stock assessment information for much of Alaska, sport fish managers have established conservative harvest strategies for recreational rockfish fisheries. Recreational seasons and bag and possession limits for rockfish in Alaska are among the most restrictive on the West Coast.

d. Fisheries

The only directed rockfish fishery conducted in **Southeast** in 2007 was the directed black rockfish fishery. Effort was minimal and the harvest is confidential, but was down from

2006. There was no directed DSR fishery in 2007 in outside waters, the directed fishery did open in internal waters (SSEI and NSEI). The total amount of rockfish taken as bycatch in all southeast fisheries in 2007 in state and Federal water was 709 mt. DSR bycatch made in conjunction with the IFQ halibut fishery in outside as well as internal waters contributed 248 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 2007 **Cook Inlet Area** directed rockfish fishery opened July 1 and closed December 31 with harvest figures confidential. Total rockfish harvest including bycatch to longline, pot and trawl fisheries was 11.5 mt. Total rockfish harvest for the PWS Area rockfish bycatch-only fishery was 37 mt. This included a 4.3 mt incidental catch of slope rockfish from the walleye pollock trawl fishery and a 32.7 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 reports harvest for the general category of "rockfish", and the charter vessel logbook records rockfish harvest in two categories: "non-pelagic" and "pelagic". DSR are part of the "non-pelagic" category. Recreational rockfish harvest is typically estimated in numbers of fish. Estimates of the 2007 harvest are not yet available from the statewide harvest survey, but the 2006 estimates were 85,485 fish in Southeast and 87,674 fish in Southcentral Alaska. The average estimated annual harvest for the most recent five-year period (2002-2006) was 73,656 rockfish (all species) in Southeast Alaska and 81,507 fish in Southcentral Alaska.

Creel survey data for Sitka indicates that 8,081 individual yelloweye (approximately 32 mt) were retained by anglers in an area roughly equivalent to the CSEO in 2007. This is a 10% decrease in the harvest (by number of fish) of yelloweye in Sitka compared to the 2006 season, and is 9% 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) indicates that 3,800 yelloweye (approximately 14 mt) were retained in 2007 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 (~80%), based on the 2007 projections

3. Sablefish

a. Research

In 2007, 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 2007 overall CPUE (kg/hook) was 1.08, very much the same as 2006 (1.09) but down from 2005 (1.29). Thornyhead rockfish dominated the bycatch in all areas except the northern-most statistical area where skates were the dominant bycatch.

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) decreased very slightly again in 2007 to 0.22 round kg/hook compared to 0.23 round kg/hook in 2006. In the NSEI fishery, the overall CPUE adjusted for hook spacing expressed in round kg/hook for vessels was 0.34, up slightly from 2006.

In 2007, ADF&G continued a mark/recapture study in NSEI, tagging and releasing 6,158 sablefish. Pot gear was used to capture the fish from June 1st to 25th one and a half months prior to the start of the fishery which commenced on August 15, 2007. 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 use to catch fish for tagging.

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. (Contact Ken Goldman).

Skipper interviews and port sampling occurred in Whittier, Cordova and Seward for the PWS Area fishery and in Seward and Homer for the Cook Inlet Area fishery. Data obtained included date and location of harvest, length, weight, sex, and gonad condition. Otoliths were removed and sent to the Age Determination Unit (Contact Willy Dunne).

b. Stock Assessment

In **Southeast**, the department is using mark-recapture methods with tags and fin clips to estimate abundance and exploitation rates for sablefish in the NSEI Subdistrict. Sablefish are captured with pot gear in 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. Based on Chapman's modification of the Petersen estimator (Chapman 1948), there were an estimated 2,427,828 sablefish in NSEI at the time of the 2006 fishery. The 90% confidence interval for the 2006 sablefish abundance estimate was 2,259,843 – 2,620,065 sablefish. The forecast for 2007 was made by decrementing the 2006 estimate to account for natural mortality, and adding a number of age-4 recruits equal to that of 2006. The forecast for 2007 was 2,203,396 sablefish and 16,750,915 round pounds of sablefish. An $F_{40\%}$ (=0.116) harvest rate was applied to the lower confidence interval of the forecasted biomass to give a preliminary ABC of 1,623,219 round pounds. In addition to the mark-recapture work, an annual longline survey is conducted in NSEI to provide biological data as well as relative abundance information (Contact Sherri Dressel). In SSEI only an annual longline survey is conducted to provide biological data as well as relative abundance information.

A longline survey, using ADF&G vessels, has been conducted in **Prince William Sound** annually since 1996. Mean CPUE between 1996 and 2002 ranged from 0.08 to 0.17 sablefish/hook, with an overall mean CPUE of 0.12 (all years combined). Longline survey effort was extended into the North Gulf District in 1999, 2000 and 2002. The 2005 and 2006 PWS survey covered all of PWS, and data will be analyzed during the winter of 2008-2009 to determine the veracity of the data for setting harvest limits on the PWS fishery. Survey costs are partially offset by the sale of fishes caught in the survey, however, Central Region staff is considering a switch to a pre-fishery pot survey that would use tag and recapture methods to set harvest limits, which would not sell the fishes caught (Contact Ken Goldman).

c. Management

There are three separate internal water areas in Alaska which have state-managed sablefish fisheries. The Northern Southeast Inside Subdistrict (NSEI), the Southern Southeast Inside Subdistrict (SSEI), and the Prince William Sound District each have separate seasons and guideline harvest ranges.

In the **Southeast Region** both the SSEI and NSEI sablefish fisheries have been managed under a license limitation program since 1984. In 1994 the BOF adopted regulations implementing an equal share quota system where the annual guideline harvest level was divided equally between permit holders and the season was extended to allow for a more orderly fishery. In 1997 the BOF adopted this equal share system as a permanent management measure for both the NSEI and SSEI sablefish fisheries.

Due to declines in fishery CPUE and preliminary results from our mark-recapture work, ADF&G reduced the NSEI quota 35% in 1999 to 1,415 mt where it remained through 2000. Beginning in 2001 a biomass estimate was available and the NSEI area total allowable catch (TAC) 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 as referenced in the "stock assessment" section in this report. 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.

The SSEI quota was set at 316 mt in 2000, and has remained the same thru 2007. 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.

During the January 2006 Alaska Board of Fisheries (BOF) meeting, the BOF made only one change in regulations affecting the NSEI and SSEI sablefish fisheries. While permit holders are still allowed to carry-over up to 5% of their annual equal quota share as an overage or underage the BOF removed the allowance for transfers of quota share among permit holders. The provision for the allowance of fishing outside the regular season remains but no off season fishing trips were conducted in 2006 or 2007 due to staff constraints.

Sablefish fisheries in outer coastal state waters (0-3 miles) have been managed in conjunction with the federal-managed fishery in the EEZ. There is no open-access sablefish fishery in the Southeast Outside District as there are limited areas that are deep enough to support sablefish populations inside state waters. In some areas of the Gulf, the state opens the fishery concurrent with the EEZ opening. These fisheries, which occur in 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 quotas are based on historic catch averages and closed once these have been reached.

The 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 2007 fishery GHL was 33.6 mt. In 2004 the BOF adopted sablefish fishery-specific registration and logbook requirements and a 48-hours trip limit of 1.3 mt. For PWS, a limited entry program that included gear restrictions and established vessel size classes was adopted in 1996. Additionally a commissioner's permit, which stipulates logbook and catch reporting requirements, must be obtained prior to participation in the fishery. The fishery GHL is set at 110 mt, which is the midpoint of the harvest range set by a habitat-based estimate. Fishery management continued to develop through access limitation and 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.

There are no bag, possession, or size limits for sablefish in the recreational fisheries in Alaska. Sablefish harvest is not explicitly estimated by the SWHS and no information is collected in the creel surveys and port sampling of the recreational fisheries in Southcentral or Southeast Alaska. Sablefish are caught incidentally to other species and the total harvest is believed to be quite small.

d. Fisheries

In the **Southeast Region** the 2007 NSEI sablefish fishery opened August 15 and closed November 15. The 103 permit holders landed a total of 681 mt of sablefish. The fishery is managed by equal quota share; each permit holder was allowed 6.5 mt. The 2006 SSEI sablefish fishery opened June 1 and closed November 15. Twenty-nine permit holders landed a total of 281 mt of sablefish, each with an equal quota share of 9.8 mt. In SSEI 28 permits were designated to be fished with longline gear and the remaining four fished with pot gear. Three of the longline permits did not fish in 2007. (Contact Cleo Brylinsky)

In the **Central Region** the 2007 open access sablefish fishery in the Cook Inlet North Gulf District opened at noon July 15 and closed at noon on August 1. Ten vessels harvested 34.9 mt. In 2007, PWS season dates were modified by emergency order because of orca depredation of an unknown extent during the spring season which resulted in reduced effort. The result was that the spring opening remained from March 15 - May 15 but the second opening (August 1 – 21) was increased to July 25- August 31. The 2007 PWS harvest totaled 90.4 mt. Biological sampling was conducted in-season which gathered age, length, weight, sex and gonad condition data. Effort, location and CPUE information was gathered via mandatory logbooks. (Contact Charlie Trowbridge).

Within the **Westward Region**, only the Aleutian Islands have sufficient habitat to support mature sablefish populations of sufficient magnitude to permit commercial fishing. All other sections within the region are closed by regulation to avoid the potential for localized depletion from the small amounts of habitat within the jurisdiction of the state. Bycatch from the areas closed to directed fishing is limited to 1%. The 2007 Aleutian Island fishery opened on May 15, 2007. Additional requirements for the fishery include registration and logbook requirements. The GHL was set at 289 mt for the state managed fishery. The preliminary harvest from the 2007 Aleutian Islands sablefish fishery was 136 mt. The season remained open until the November 15 closure date.

4. Flatfish

a. Research

There was no research on flatfish during 2006.

b. Stock Assessment

There are no stock assessments for flatfish.

c. Management

Trawl fisheries for flatfish are allowed in three small areas in the internal waters of **Southeast Alaska** under a special permit issued by the department. The permits are generally issued for no more than a month at a time and specify the area fished and other requirements. Trawl gear is limited to beam trawls, and mandatory logbooks are required, observers can be required, and there is a 20,000 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 six years, with no harvest reported for the 2006-2007 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 2007.

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. Due to uncertainty about the appropriate harvest level for the PWS pollock fishery, assessment in 2007 included commercial fishery catch sampling and a bottom trawl survey of the summer (post-spawning) population. Skipper interviews and port sampling of **Central**

Region commercial pollock deliveries during 2007 occurred in Kodiak and Seward. Additional sampling occurred during the Cook Inlet and PWS trawl and sablefish longline surveys. Sample data collected included date and location of harvest, species, length, weight, sex, and gonad condition. Otoliths were collected from most sampled fish. Homer office staff determined ages of pollock otoliths (Contact Willy Dunne).

In 1996, interactions between pollock, herring, and juvenile salmon were also examined as part of Sound Ecosystem Assessment (SEA) funded by the *EXXON Valdez* Oil Spill Restoration.

In pollock we are testing for spatial patterns of genetic variation in six population samples from three regions: North America – Gulf of Alaska; North America – Bering Sea; Asia – East Kamchatka. We tested for annual stability of the genetic signal in replicate samples from three of the North American populations. These studies, begun in 1998 and 1999, continued into 2000. A manuscript documenting the findings is under internal review. Allozyme and mtDNA markers provide concordant estimates of spatial and temporal genetic variation. These data show significant genetic variation between North American and Asian pollock as well as evidence that spawning aggregations in the Gulf of Alaska, such as Prince William Sound, are genetically distinct and may merit management as distinct stocks. These data also provide evidence of inter-annual genetic variation in two of three North American populations. Gene diversity values show this inter-annual variation is of similar magnitude to the spatial variation among North American populations, suggesting the rate and direction of gene flow among some spawning aggregations is highly variable (Contact Bill Templin).

b. Stock Assessment

Hydroacoustic surveys, with sample collection by mid-water trawl, were conducted in PWS in the winters of 1995, 1997, 1998, 2000, 2001, and 2002 by the Prince William Sound Science Center in cooperation with ADF&G. Biomass estimates of prespawning pollock aggregations have been relatively stable, except for 1998, with a slight decline indicated in more recent years. The department also conducts a biennial bottom trawl survey during the summer in PWS, and develops a pollock biomass estimate used to establish the harvest guideline for the winter commercial fishery. This approach is justified, despite the belief that a significant portion of the spawning population targeted by the winter fishery immigrated from federal waters, because the summer population is not assessed by the NMFS summer survey. Survey biomass estimates from the biennial bottom trawl survey have declined in recent years, and the fishery harvest level has been reduced accordingly (Contact Ken Goldman).

c. Management

Prince William Sound pollock fishery regulations include a commissioner's permit and a registration deadline of January 13. The permit stipulates logbooks, catch reporting, 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. (Contact Bob Berceli).
In October of 2006 the Board of Fish adopted regulation for a state-waters Aleutian Islands pollock fishery between 174° W long. and 178° W long. Regulation stated that the GHL would be set at 3,000 mt, reduced by the amount of walleye pollock authorized to be taken by the federal exempted fisheries permit fishery inside critical habitat areas. Participating vessels are restricted to pelagic trawl gear and may not be more than 58 feet in overall length. Daily reporting is required throughout the fishery. In addition all state waters within 20 miles around a Steller sea lion rookery and all waters within three miles around a Steller sea lion haulout are closed. This fishery was repealed by the Board of Fish in October 2007 due to low abundance of pollock in the registration area.

d. Fisheries

The 2007 fishery opened on January 20 with a GHL of 1,651 mt. Catch and effort remained low until early March. The Hinchinbrook section closed by emergency order on March 30, while the Knight Island and Bainbridge sections closed by regulation on March 31. Total pollock harvest for all sections combined was 1,179 mt. As in past years, fishery bycatch was dominated by squid (5.1 mt), rockfish (4.3 mt), and sharks (1.2 mt).

The Aleutian Islands pollock fishery did not open in 2007 as NMFS authorized the entire 3,000 mt to be taken by the federal exempted fisheries permit fishery inside critical habitat. ADG&G issued several commissioner permits to allow pollock fishers participating under the federal exempted fishery permit to harvest inside of state waters.

6. Sharks

a. Research

In the **Central Region** Spiny dogfish and Pacific sleeper sharks have been tagged annually since 1997 as part of the PWS longline survey for sablefish, and since 2000 during bottom trawl surveys in Cook Inlet and PWS. Through 2003, over 400 each of spiny dogfish and Pacific sleeper sharks have been tagged. To date, 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 2003, 340 spiny dogfish were sacrificed and the posterior dorsal spine removed for age determination. In addition, 10-15 sleeper sharks have been sacrificed annually during 2000 to 2003 for parasite and contaminant analysis. In 2005 muscle tissue samples from 49 spiny dogfish caught in the PWS longline survey were sent to Alaska Department of Environmental Conservation for analysis of mercury levels. Results were received in 2006 and incorporated into DEC's Fish Monitoring Program. Total mercury concentrations ranged from 0.1 to 1.3 ppm with a mean concentration of 0.8 ppm. (Contact Ken Goldman)

There was a modest **recreational** fishery targeting salmon sharks in Prince William Sound. Little information is available to assess the status or structures of targeted stocks. The Division of Sport Fish initiated a cooperative tagging program with a few charterboat operators in 1998 and continues to collect biological data on all sharks harvested in the sport fishery through the port-sampling program.

b. Stock Assessment

Among **Central** Region assessment projects sharks are caught in trawl surveys and the PWS longline survey. Catch per unit effort for Pacific sleeper shark ranged from 1.1 fish/set in 1996 to 4.3 fish/set in 1999. Spiny dogfish CPUE has ranged from 0.9 to 9.2 fish/set except for a dramatic increase to 51.3 fish per set in 1998. The high catch rates of spiny dogfish in 1998 appear to have been an anomaly (Contact 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. Shark harvest is still at a relatively low level, but it is hoped that size and age composition of the harvest of some species can be estimated using multiple years of data. In 2006, 55 salmon sharks and 3 spiny dogfish were sampled for length, sex, and age structures from the sport harvest throughout the region. Interviews also provided estimates of the numbers of salmon sharks and spiny dogfish kept and released by ADF&G statistical area (Contact Scott Meyer).

c. Management

The Alaska Board of Fisheries prohibited all directed commercial fisheries for sharks in 1998. In 2000 the BOF increased the bycatch allowance in **Southeast Region** for dogfish taken while longlining for other species to 35% round weight of the target species and also allowed full retention of dogfish bycatch in the salmon setnet fishery in Yakutat. This action was an effort to minimize waste of dogfish in these two fisheries and to encourage sale of bycatch. In **Central Region**, bycatch is set by regulation at 20% of the round weight of the directed species on board. However in 2004 the BOF amended 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.

Recreational fishing for sharks is allowed under the statewide Sport Shark Fishery Management Plan adopted by the BOF in 1998. The plan recognizes the lack of stock assessment information, the potential for rapid growth of the fishery, and the potential for over harvest, and sets a statewide daily bag limit of one shark and a season limit of two sharks of any species. Recreational demand for spiny dogfish remains low and they are widely considered a nuisance species. There is, however, a small directed charter boat fishery for salmon sharks in Southcentral Alaska, primarily at Seward and in Prince William Sound. Pacific sleeper sharks are occasionally caught but rarely retained.

In 2000 the BOF prohibited the practice of “finning”, requiring that all shark retained must be sold or utilized and have fins, head, and tail attached at the time of landing. “Utilize” means use of the flesh of the shark for human consumption, for reduction to meal for production of food for animals or fish, for bait, or for scientific, display, or educational purposes.

d. Fisheries

The Department received no requests for permits to target spiny dogfish in Cook Inlet during 2007.

Estimates of **recreational shark harvest** in 2007 are not yet available from the Statewide Harvest Survey, but in 2006 an estimated 149 sharks of all species were harvested in Southeast Alaska and 718 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 2006, charter operators reported harvesting 49 salmon sharks in Southeast Alaska and 224 salmon sharks in Southcentral Alaska.

7. Lingcod

a. Research

Over the past twelve years in the Southeast Region 9,008 lingcod have been tagged and 399 fish recovered. Opportunistic tagging of 111 lingcod in Sitka Sound occurred during 2007. Length, sex and tagging location are recorded for all tagged fish. Dockside sampling of lingcod caught in the commercial fishery continued in 2007 in Sitka and Yakutat with over 700 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 already gutted (Contact Willy Dunne). The lingcod research conducted in 2007 was concurrent with and had the same goals as those identified above in rockfish research (section 2a). These included continued development of the marine habitat GIS, habitat mapping, reevaluation of 2005 Chiswell Ridge population abundance estimates, and evaluation of ROV strip transect sampling methods. Lingcod abundance estimates for the Chiswell Ridge study area decreased by 34% with the new habitat delineations based on multibeam and side scan sonar.

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 2007 included Juneau, Sitka, Craig/Klawock, Wrangell, Petersburg, Gustavus, Elfin Cove, Yakutat, and Ketchikan. Length and sex data were collected from 977 lingcod in 2007, 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 621 lingcod were sampled from sport harvest at Seward, Valdez, Whittier, Kodiak, and Homer in 2007. These ports accounted for the majority of recreational lingcod harvest in Southcentral Alaska (Contact Scott Meyer).

b. Stock Assessment

The **Southeast Region** is not currently able to reliably estimate lingcod biomass or abundance. Lacking abundance estimates, and given the complex life history and behavior of lingcod, impacts to lingcod populations from fishing are difficult to assess. Analysis of catch per unit effort data (CPUE), in terms of fish per hook-hour for 1988–1998, showed that CPUE had declined between 21 to 62% in areas where a directed fishery and increased recreational catch had developed. Consequently the quota for lingcod was reduced in all areas in 1999. Commercial logbook data for the period 2002-2007 reveals a changing picture in some areas for directed lingcod fishing in **Southeast**. In CSEO effort is down by 50% since 2002 and CPUE is trending up; in EYKT effort has been steady since 2002 and CPUE is trending up slightly and SSEOC has only had sporadic participation in the last 4 years. The IBS super-exclusive registration area had no one directed fishing for lingcod from 2000-2002 and now there are 12 vessels participating and CPUE is constant.

The Sport Fish Division, **Southcentral Region**, is continuing efforts toward a lingcod stock assessment. Initial work focused on compiling data from sport and commercial fisheries, mining existing survey data from other agencies, estimating natural mortality from age data, and estimating length-weight and growth parameters. Some of the next steps include standardization and comparison of CPUE indices and compilation of spatial data.

c. Management

Management of lingcod in **Southeast Alaska** is based upon a combination of guideline harvest ranges, season and gear restrictions. The state has management authority for lingcod in both state and federal waters. Regulations include a winter closure for all users except longliners between December 1 and May 15 to protect nest-guarding males. Guideline harvest limits were greatly reduced in 2000 in all areas and allocations made between directed commercial fishery, sport fishery, longline fisheries, and salmon troll fisheries. This was the first time sport catch was included in a quota allocation. The 27” minimum commercial size limit remains in effect and fishermen must keep their lingcod with the head on, and proof of gender to facilitate biological sampling of the commercial catch. Vessel registration and trip limits are allowed when needed to stay within allocations. The directed fishery is limited to jig or dinglebar troll gear. In 2003 the

Board of Fish established a super-exclusive directed fishery for lingcod in the IBS Subdistrict.

Regulations for the **Central Region 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 **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 2007, lingcod bag limits were reduced from 2 to 1 fish per day region wide for all anglers, lingcod possession limits were set at 2 fish for nonguided residents and 1 fish for nonresidents and guided anglers, slot limits were imposed for guided and nonresident anglers in all management areas, and the season was closed in northern Southeast management areas (NSI, CSO, and NSO) from June 16 through August 15. In addition, in all management areas in Southeast Alaska (except the Yakutat area) there were the following restrictions: a nonresident annual limit of 1 lingcod with harvest record required, and captain and crew on charter vessels with clients could not harvest any fish species (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), as bycatch in the halibut fishery (5% limit everywhere except IBS where the bycatch is 10%), and as bycatch in the salmon troll fishery. The directed fishery landed 106 mt of lingcod in 2007 and an additional 62 mt was landed as bycatch in other fisheries. The halibut longline fishery accounted for roughly 76% of lingcod bycatch in the Southeast Region and the salmon troll fishery accounted for 23%.

Central Region commercial lingcod harvests have primarily occurred in the North Gulf District of Cook Inlet and the Outside District of PWS. In 2007, the Cook Inlet GHL was 24 mt and the PWS GHL was 11 mt. Lingcod harvests in 2007 totaled 21.4 mt in Cook Inlet and 13.9 mt in PWS. The majority of both the Cook Inlet Area and the PWS Area lingcod harvest was from longline bycatch to other (primarily halibut) fisheries. Directed jig fishing accounted for 47.9% of the Cook Inlet harvest and 18.9% of the PWS harvest.

No directed effort occurred for lingcod in the **Westward Region** during 2007. Incidental harvest in other fisheries totaled 23 mt for the year. The majority of the harvest occurred in the Kodiak Area with a minor amount occurring in the Chignik Area.

Recreational lingcod harvest is estimated in numbers of fish. Estimates of the 2007 harvest are not yet available from the statewide mail survey, but in 2006 an estimated 18,497 lingcod were harvested in Southeast Alaska while 16,627 lingcod were taken in Southcentral Alaska. The average estimated annual harvest for the most recent five-year period (2002-2006) was 15,380 fish in Southeast Alaska and 13,688 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. In 2007, interest continued for a skate fishery in the Cook Inlet and Kodiak Areas; However no skate fishing permits were issued in 2007 due to the closure of directed skate fishing in adjacent federal waters 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. Using annual survey CPUE estimates to monitor population trends may be possible, but a more rigorous assessment is needed to determine if the existing sampling designs and variance estimators are appropriate. 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. Valuable biological data was collected that will advance the understanding of life history parameters so that managers can have a better understanding of the risk involved in exploiting these species.

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 governing the sport charter fishery.

The BOF took action in 2000 prohibiting the development of a live fish fishery for groundfish in the Southeast District.

C. Other Related Studies

Staff in the **Central Region** 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 Department of Fish and Game manages state groundfish fisheries under regulations set triennially by the Board of Fisheries. The department announces the open and closed fishing periods consistent with the established regulations, and has authority to close fisheries at any time for justifiable conservation reasons. The department also cooperates with NMFS in regulating fisheries in the offshore waters.

By regulation, fish tickets are required for all shore-based landings in Alaskan ports and for all landings from state-managed fisheries. The catch data from the fish tickets is used as the primary means of tracking the in-season harvest levels. Groundfish fish tickets are collected from as many as 184 processors within the state. The fish tickets are edited for accuracy and the data is entered on microcomputers in Petersburg, Douglas, Sitka, Homer, Kodiak, and Dutch Harbor. Because of the intensity of many of the groundfish fisheries, a "soft data" accounting system using processor contacts is also utilized, when necessary, to track landings during a fishery.

In 1997 at the Southeast Groundfish meeting, the Board of Fisheries adopted a regulation that requires all groundfish fishermen to complete mandatory logbook pages while fishing. These logbook pages must be submitted as part of their landing record and attached to their fish ticket at delivery. The Board also requires that fishermen obtain a conditional use permit when fishing for any species for which specific regulatory language is not in effect. This will allow ADF&G to deny permits for some species and allow exploratory or controlled fishing for others.

1. Dixon Entrance Area

Total removals from the Dixon Entrance area (Alaska statistical areas 325431, 315431, 325401, and 315401) have not risen by much since last year. The table below lists the catch by species group from 1988 through 2007 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

2. Marine Reserves

In September of 1997 the ADF&G submitted proposals to both the BOF and the NPFMC requesting that they implement a small no-take marine reserve in **Southeast**. The purpose of these proposals was to permanently close a 3.2 sq. mile area off Cape Edgecumbe to all bottomfish and halibut fishing (including commercial, sport, charter, bycatch and subsistence) and anchoring to prevent over-fishing and to create a groundfish refuge. Two large volcanic pinnacles that have a diversity and density of fishes not seen in surrounding areas dominate the Edgecumbe Pinnacles Marine Reserve. The pinnacles rise abruptly from the seafloor and sit at the mouth of Sitka Sound where ocean currents and tidal rips create massive water flows over this habitat. These two pinnacles provide a very unique habitat of rock boulders, encrusted with *Metridium*, bryazoans and other fragile invertebrate communities, which attracts and shelters an extremely high density of juvenile rockfishes. The area is used seasonally by lingcod for spawning, nest-guarding, and post-nesting feeding. Yelloweye rockfish and pelagic rockfish species as well as large numbers of prowfish and Puget Sound rockfish also densely inhabit the pinnacles. This closure protects the fragile nature of this rare habitat, and prevents the harvest or bycatch of these species during critical portions of their life history. In February 1998 the BOF approved of the reserve and the NPFMC approved of the reserve at their June 1998 meeting. The NPFMC recommended to the BOF that they consider closure of the area to salmon trolling which would make the area a complete-no take zone. In February 2000 the BOF rejected closing the area to salmon trolling. The area is an important "turn-around" area for commercial trollers and the BOF did not believe there was sufficient conservation benefit to warrant closing the area to salmon fishing.

In 2004 a short movie of the Edgecumbe Pinnacles Marine Reserve was created because of increased public interest in our work, and to give others an opportunity to learn about, and view the pinnacles from below the waters surface. This movie is available in either VHS or DVD format for schools or non-profit organizations through the Sitka office of the Alaska Department of Fish and Game.

3. User Pay/ Test Fish Programs

The state of Alaska Department of Fish and Game receives receipt authority from the state legislature that allows us to conduct stock assessment surveys by recovering costs through sale of fish taken during the surveys. Receipt authority varies by region. In **Southeast Alaska** we have several projects that are funded through test fish funds (total 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 maps requests are made in NAD83 (the State of Alaska standard) or will be converted into NAD83, if possible. Final output and all metadata will be in NAD83. Users in other divisional and area offices use ArcGIS 8, ArcView 3.x, and Mapinfo 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 2007 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

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. Catch and harvest are reported for each individual angler, along with their 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. Numerous small changes were made to the 2007 logbook, including dropping reporting of the number of rods fished, and collecting information from anglers who ride along for free. The numbers of salmon sharks released was also dropped because operators were reporting spiny dogfish released in that column. The Sport Fish Division is cleaning up the logbook database and evaluating the accuracy of logbook entries by comparing the data to observed data and surveying individual anglers.

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Web Pages

ADF&G Home Page: http://www.adfg.state.ak.us/

Commercial Fishery Division Home Page: http://www.cf.adfg.state.ak.us/

News Releases: http://www.adfg.state.ak.us/news/dept_news.php

Sport Fish Division Home Page: http://www.sf.adfg.state.ak.us/statewide/sf_home.cfm

Sport Fish Division Southcentral Region Halibut and Groundfish Program:
http://www.sf.adfg.state.ak.us/region2/groundfish/gfhome.cfm

Age Determination Unit Home Page: http://tagotoweb.adfg.state.ak.us/ADU/default.asp

Region 1 Groundfish Home Page:
http://www.cf.adfg.state.ak.us/region1/finfish/grndfish/grndhom1.php

Region II Groundfish Home Page:
http://www.cf.adfg.state.ak.us/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/2007/GOAdsr.pdf

Adobe PDF versions of groundfish charts can be viewed or downloaded at
http://www.cf.adfg.state.ak.us/geninfo/statmaps/charts.php

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Sagalkin, N.H.. 2007. Annual management report for the groundfish fisheries in the Kodiak, Chignik, and South Alaska Peninsula management areas, 2006. Alaska Department of Fish and Game, Division of Commercial Fisheries, Fishery Management Report No 07-48, Kodiak.

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APPENDIX I.

ALASKA DEPARTMENT OF FISH AND GAME
PERMANENT FULL-TIME GROUNDFISH STAFF DURING 2006.

COMMERCIAL FISHERIES DIVISION

HEADQUARTERS, P.O. Box 25526, Juneau, Alaska 99802-5526

Fish Ticket Programmer/Analyst Phil Witt (907) 465-4753	GIS Programmer/Analyst Evelyn Russell (907) 465-6147	Fish Ticket Research/Analyst Gail Smith (907) 465-6157
AKFIN Program Coordinator Lee Hulbert (907) 465-6109	Age Determination Unit Kristen Munk Box 25526 Juneau, AK 99802 (907) 465-3054	

SOUTHEASTERN REGION

Groundfish Project Leader Cleo Brylinsky 304 Lake St. Rm. 103 Sitka, AK 99835 (907) 747-2683	Fishery Biologist Jennifer Stahl Box 240020 Douglas, AK 99824-0020 (907) 465-4071	Survey and Port Sampling Coordinator Mike Vaughn 304 Lake St. Rm. 103 Sitka, AK 99835 (907) 747-6688
Project Biometrician Sherri Dressel Box 240020 Douglas, AK 99824-0020 (907) 465-4216	Fishery Technician IV Deidra Holum Box 240020 Douglas, AK 99824-0020 (907) 465-4218	Fishery Technician IV Kamala Carroll 304 Lake St. Rm. 103 Sitka, AK 99835 (907) 747-6688

CENTRAL REGION

CI/PWS Groundfish & Shellfish Research Project Leader Dr. Kenneth J. Goldman 3298 Douglas Place Homer, AK 99603-7942 (907) 235-8191	CI/PWS Management Biologist Charlie Trowbridge 3298 Douglas Place Homer, AK 99603-7942 (907) 235-8191	Groundfish Sampling Coordinator William Dunne 3298 Douglas Place, Homer AK 99603-7942 (907) 235-8191
Fish Ticket Entry Technician Morris Lambdin 3298 Douglas Place, Homer, AK 99603-7942 (907) 235-8191	Fishery Biologist Mike Byerly 3298 Douglas Place Homer, AK 99603-7942 (907) 235-8191	PWS Management Biologist Robert Berceli PO Box 669 Cordova, AK 99574-0669 (907) 424-3212

Fishery Biologist Margaret Spahn 3298 Douglas Place Homer, AK 99603-7942 (907) 235-8191	Fishery Biologist Richard Gustafson 3298 Douglas Place Homer, AK 99603 (907) 235-8191	

WESTWARD REGION

Shellfish/Groundfish Biologist Wayne Donaldson 211 Mission Rd. Kodiak, AK 99615-6399 (907) 486-1840	Area Management Biologist Nick Sagalkin 211 Mission Rd. Kodiak, AK 99615-6399 (907) 486-1840	Groundfish Research Biologist Dan Urban 211 Mission Rd. Kodiak, AK 99615-6399 (907) 486-1849
Groundfish Sampling Coordinator Kally Spalinger 211 Mission Road Kodiak, AK 99615 (907) 486-1840	Assistant Area Management Biologist Lynn Mattess 211 Mission Road Kodiak, AK 99615 (907) 486-1840	Assistant Area Management Biologist Krista Milani P.O. Box 920587 Dutch Harbor, AK 99692 (907) 581-1239
Assistant Groundfish Research Biologist Carrie Worton 211 Mission Rd. Kodiak, AK 99615-6399 (907) 486-1871		

SPORT FISH DIVISION

HEADQUARTERS, P.O. Box 25526, Juneau, Alaska 99802-5526

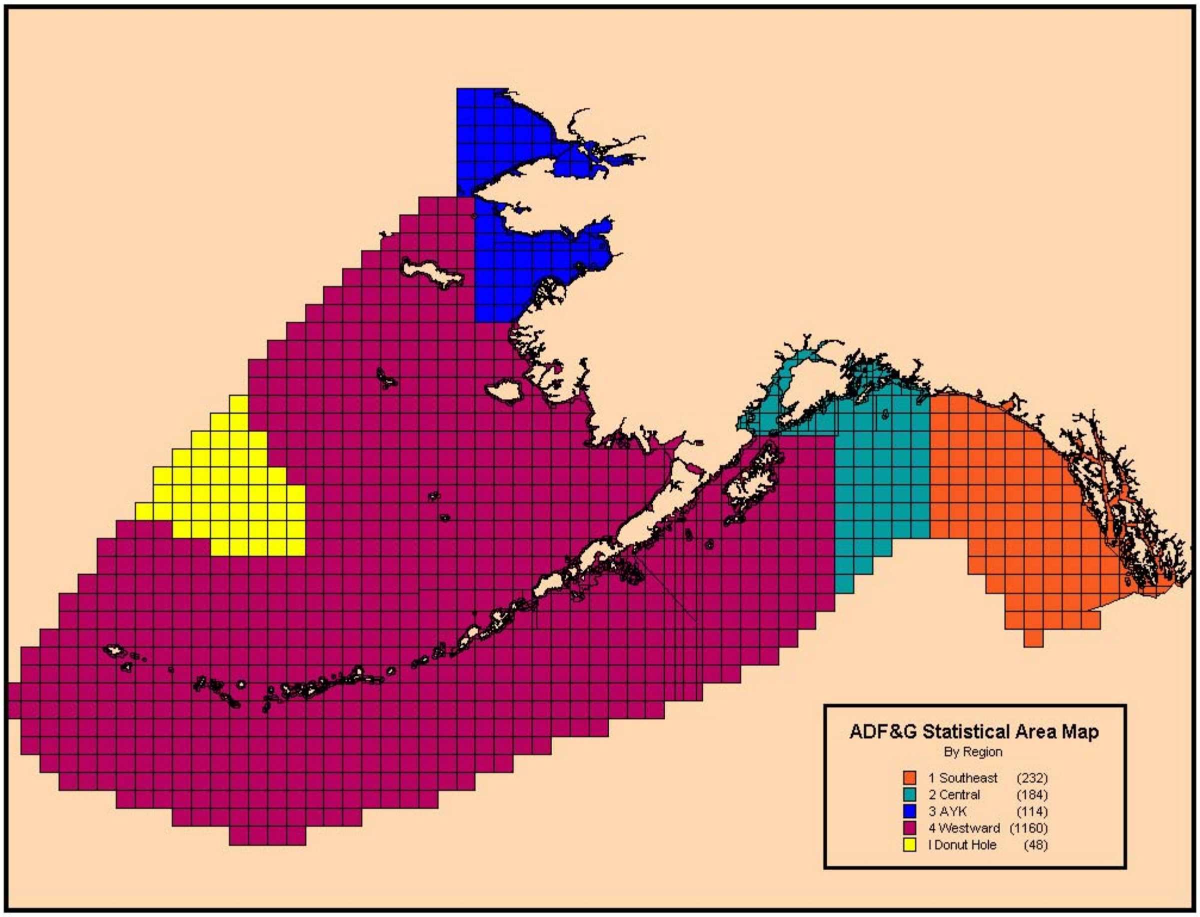
Deputy Director Rob Bentz PO Box 115526 Juneau, AK 99811-5526 (907) 465-6187	Assistant to the Commissioner Doug Vincent-Lang 333 Raspberry Road Anchorage, AK 99518-1565 (907) 267-2339	Statewide Bottomfish Coordinator Scott Meyer 3298 Douglas Place Homer, AK 99603-8027 (907) 235-1742

SOUTHEAST REGION

Project Leader, Marine Harvest Studies Michael Jaenicke PO Box 110024 Juneau, AK 99811-0024 (907) 465-4301	Regional Management Biologist Robert Chadwick 304 Lake St., Room 103 Sitka, AK 99835-7563 (907) 747-5551	Regional Research Biologist John Derhovanisian P.O. Box 110024 Juneau, AK 99811-0024 (907) 465-4398
Yakutat Area Management Biologist Robert Johnson P.O. Box 49 Yakutat, AK 99689-0049 (907) 784-3222	Haines/Skagway Area Mgmt. Biol. Richard Chapell P.O. Box 330 Haines, AK 99827-0330 (907) 766-3638	Juneau Area Management Biologist Brian Glynn PO Box 110024 Juneau, AK 99811-0024 (907) 465-4320
Sitka Area Management Biologist Troy Tydingco 304 Lake St., Room 103 Sitka, AK 99835-7563 (907) 747-5355	Petersburg/Wrangell Area Mgmt. Biologist Douglas Fleming P.O. Box 667 Petersburg, AK 99833-0667 (907) 772-9336	Prince of Wales Area Management Biologist Steve McCurdy P.O. Box 682 Craig, AK 99921 (907) 826-2498
Ketchikan Area Mgmt. Biologist -------------------- 2030 Sea Level Drive, Suite 205 Ketchikan, AK 99901 (907) 225-2859		

SOUTHCENTRAL REGION

Halibut/Groundfish Project Leader Scott Meyer/Charles Stock 3298 Douglas Place Homer, AK 99603 (907) 235-8191	Regional Management Biologists Thomas Vania, Matthew Miller 333 Raspberry Road Anchorage, AK 99518-1565 (907) 267-2218	Regional Research Biologist Jack Erickson 333 Raspberry Road Anchorage, AK 99518-1565 (907) 267-2218
Lower Cook Inlet Mgmt. Biol. Nicole Szarzi 3298 Douglas Place Homer, Alaska 99603-8027 (907) 235-8191	PWS and North Gulf Mgmt. Biol. Daniel Bosch 333 Raspberry Road Anchorage, AK 99518-1599 (907) 267-2153	Kodiak, Alaska Pen., and Aleutian Islands Management Biologist Len Schwarz 211 Mission Road Kodiak, AK 99615-6399 (907) 486-1880
Biometrician Steve Fleischman Division of Sport Fish-RTS 333 Raspberry Road Anchorage, AK 99518-1599 (907) 267-2388		



Appendix II.

Map Depicting State of Alaska Commercial Fishery Management Regions.

Appendix III.

Tissue samples of *Sebastes* species collected for genetic analyses and stored at Alaska Department Fish and Game, Gene Conservation Laboratory, Anchorage. Species, sampling location and collection ID, year collected, sample size, and tissue type are given.

Species	Silly Name - Location	Year	Size	Tissue Type
Yelloweye Rockfish *S. ruberrimus*	YERFLAM98 - Flamingo, British Columbia.	1998	46	fin clips; larvae
	YERTASU98 - Tasu, British Columbia.	1998	50	fin clips
	YERTOPK98 - Topknot, British Columbia.	1998	49	fin clips
	YERTRI98 - Triangle, British Columbia.	1998	63	fin clips; larvae
	YERSE298 - Sitka	1998	49	fin clips
	YRSE99 - Stat areas 355601, 365701	1999	100	fin clips
	YERYAK99 - Fairweather grounds	1999	100	fin clips
	YEPW91 – Prince William Sound; Gravina, Danger, Herring	1991	27	muscle, liver, eye
	YERGA98 – Prince William Sound, Knight Is./Naked Islands area	1998	100	fin clips
	YERPWS100 - Whittier	2000	97	fin clips
	YERPWS200 - Whittier	2000	50	fin clips
	YERRES99 – Resurrection Bay	1999	100	fin clips
	YERKACH99 - Kachemak Bay	1999	58	fin clips
	YERKOD99 – Kodiak Island	1999	115	fin clips
Black Rockfish	BRORE99 – Pacific Northwest; Oregon	1999	50	muscle, liver, heart
S. melanops	BRWASH98 - 47°08' / 124°37'; Washington	1998	20	fin clips
	BRSIT98 - Sitka	1998	50	fin clips
	BRSIT99T - Sitka Sound	1999	200	fin clips
	BRSIT99 – Sitka	1999	83	fin clips

BRPWS100 - Valdez	2000	13	fin clips
BRPWS200 - Whittier	2000	16	fin clips
BRRESB97 - Resurrection Bay	1997	82	muscle,liver,heart,eye,fin
BRRESB98 – Resurrection, North Fox Island	1998	24	fin clips
BRKOD96 - Kodiak Island	1996	2	muscle, liver, heart, eye
BRKOD197 - Ugak Bay	1997	100	muscle,liver,heart,eye,fin
BRKOD398 - Westside Kodiak Island	1998	114	fin clips
BRKOD198 - Eastside Kodiak Island	1998	100	fin clips
BRKOD298 - Southwest side Kodiak Island	1998	86	fin clips
BRSAND98 - Carpa Island near Sand Point	1998	40	fin clips
BRSAND99 - Castle Rock near Sand Point	1999	60	fin clips
BRKOD00 - Chignik	2000	100	fin clips
BRBERS99- Akutan	1999	100	fin clips
BRDUTS00 - Dutch Harbor	2000	6	fin clips
BRYAKU03- Yakutat	2003	130	fin clips

OREGON'S GROUNDFISH FISHERIES AND INVESTIGATIONS IN 2007

OREGON DEPARTMENT OF FISH AND WILDLIFE

2008 AGENCY REPORT
PREPARED FOR THE May 6-7, 2008 MEETING OF THE TECHNICAL SUB-COMMITTEE OF THE CANADA-UNITED STATES GROUNDFISH COMMITTEE

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Oregon Department of Fish and Wildlife
Marine Resources Program
2040 SE Marine Science Drive
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April 2008

A. AGENCY OVERVIEW - MARINE RESOURCES PROGRAM

MRP Program Manager	Dr. Patricia M. Burke
Resource Assessment and Analysis	Dave Fox
Management and Monitoring	Gway Kirchner
Data Services	Bill Herber

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 55 permanent and more than 70 seasonal or temporary positions. The program budget is approximately $6 million yearly, with about 40% of funding from federal sources and the remainder from various state sources.

B. MULTISPECIES STUDIES

1. Sport Fisheries Project:

Sampling of the ocean boat sport fishery by MRP's Ocean Recreational Boat Survey (ORBS) continued in 2007. Starting in November 2005 major ports were sampled year round. We continue to estimate catch during unsampled periods in minor ports. The estimates are based on the relationship of effort and catch in minor ports relative to major ports observed during summer-fall periods when all ports are sampled.

Black rockfish remains the dominant species caught in the ocean boat fishery. Lingcod, several other rockfish species (blue rockfish, china rockfish and other nearshore species), cabezon and greenling are also commonly landed. Oregon's fishery for Pacific halibut continues to be a very popular, high profile fishery requiring International Pacific Halibut Commission (IPHC), federal, and state technical and management consideration and management.

The ORBS program continued species composition and biological sampling of groundfish species at Oregon coastal ports during 2007. As in prior years, black rockfish and blue rockfish otoliths were gathered, in addition to lingcod fin rays, for ageing studies. Age structure sampling was expanded in 2005 to include many additional nearshore species. ORBS continued collecting length and weight data from all groundfish species.

Starting in 2001, from April through October, a portion of sport charter vessels were sampled at sea for species composition, discard rates and sizes, location, depth and catch per angler (CPUE) using ride-along samplers.

Starting in 2003, the harvest of several groundfish species was monitored inseason for catch limit tracking purposes. Inseason action was taken in 2007 to prohibit retention of cabezon. The shore fishery remained open. As in recent years the retention of canary rockfish and yelloweye rockfish was prohibited year round.

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. In 2007, staff participated in a number of stock assessments. Black rockfish was re-assessed and is considered to be in a healthy status. The allowable catch starting in 2009 is expected to be increased.

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.

Landings in the sport and commercial halibut fisheries were monitored weekly for tracking the status of catch limits. The majority of halibut continue to be landed in the central coast sub-area and Newport was the top port for landings.

Contact: Don Bodenmiller (541) 867-0300 ext. 223 (Don.G.Bodenmiller@state.or.us)

2. Maturity Studies

We continued research begun several years ago to produce histologically verified female maturity data for a variety of species for which maturity data is unavailable or outdated. This work continued in 2007, with a focus on nearshore rockfish, and poorly known slope rockfish species (aurora, redbanded). We are currently working on analysis and drafting of a paper describing these data for aurora, china, quillback and copper rockfish. Additional sampling of Pacific ocean perch was also conducted to examine interannual variation in abortive maturation as a function of maternal age.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

3. Discard mortality and movement of rockfishes using acoustic telemetry

We used acoustic telemetry to monitor the vertical and horizontal movement patterns of rockfishes captured by hook and line and released using recompression techniques at Siletz Reef. In 2007, we tagged 24 canary rockfish, 2 yelloweye rockfish , 3 quillback rockfish and 1 tiger rockfish. We also were able to track the movements of several yelloweye, quillback and 1 copper rockfish tagged in 2006 and still alive in our receiver grid in late 2007, confirming longer term survival of at least some rockfish with barotrauma. Results to date show very low site fidelity and large vertical movements for canary rockfish and high site fidelity and very modest vertical movements for copper, tiger, quillback and yelloweye rockfish. Monitoring of the grid is scheduled to continue through October 2008.

Contact: Bob Hannah, (bob.w.hannah@state.or.us), or Polly Rankin (polly.s.rankin@state.or.us)

4. Effects of catastrophic decompression on rockfish physiology and survival in the laboratory

Alena Pribyl of Oregon State University continued her dissertation research on the physiological effects of barotrauma in Pacific rockfish. In 2007, she completed her experiments using the pressurized aquaria and is now focused on finalizing the histology results and comparing, through gene expression analysis, the physiological processes in rockfish recovering from barotrauma with control fish.

Contact: Alena Pribyl (OSU) or Bob Hannah (bob.w.hannah@state.or.us)

5. Evaluating selective flatfish trawls

The selective flatfish trawl became required fishing gear for all U.S. groundfish vessels trawling shoreward of the Rockfish Conservation Area on January 1, 2005. Work in 2006 with the selective flatfish trawl focused on using a DIDSON imaging sonar to study fish behavior inside and ahead of the trawl to try and understand the factors that result in either capture or escapement. This work continued in 2007 with an in situ comparison of fish behavior at night and during daylight hours, again using a DIDSON imaging sonar. Preliminary results showed that fish behavior in response to the trawl changed in the absence of light, from a typical optimotor response to more of a "startle" response, characterized by reduced minimum distances between the fish and the trawl footrope and a change in average trajectory shape. This was a cooperative project with Waldo Wakefield of NMFS Northwest Fishery Science Center.

In 2007, we also conducted an evaluation of the effectiveness of the selective flatfish trawl at reducing canary rockfish bycatch in the 2005 nearshore bottom trawl fishery based on observer data. This was a cooperative project with Nancy Gove of NMFS Northwest Fishery Science Center. A report is available summarizing this evaluation.

Contact: Bob Hannah (bob.w.hannah@state.or.us) or Keith Matteson (keith.m.matteson@state.or.us)

7. Barotrauma in rockfishes

We continued to work with three pressurized aquaria that can hold up to 6 rockfish each and simulate depths of up to 30 m. In a cooperative project with Richard Brill and Christopher Magel of the Virginia Institute of Marine Science and Michael Davis of the Alaska Fisheries Science Center, we tested the effect of barotrauma on vision in black rockfish using electro-retinograms and the effect of bright light on vision in Pacific halibut. We found no effect on vision in black rockfish despite moderate to severe exophthalmia during the surface interval, but there was an effect of bright light on vision in Pacific halibut. Brief lab studies examining the travel of swimbladder gas through the body of rockfish with catastrophic decompression were also conducted.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

8. Developmental Fisheries Project

The ODFW Developmental Fisheries Program was created in 1993 to allow for controlled development of new species and fisheries. Each year, the Developmental Fishery Board recommends to the Oregon Fish and Wildlife Commission a list of food fish species that are considered to be developmental and a harvest program that includes a limited entry system. The Developmental Fishery Board is made up of members from a broad range of fishing interests (harvesters, processors, and state agencies).

Recently, the developmental fisheries program moved two of its largest fisheries, sardines and bay clams, into their own limited entry systems. From 1999 to 2005 the Oregon sardine fishery was managed under the Developmental Fishery Program. By mid-2004 ODFW began discussions with the Developmental Fisheries Board and the sardine industry to move Pacific sardine into a limited entry program. By December 2005 the Oregon Fish and Wildlife Commission established a limited entry program with 20 available permits. Then in April and August of 2006, the Commission adopted rules establishing renewal requirements and amended existing rules that established eligibility requirements for limited entry sardine permits. The amended eligibility rules added 6 new permits and the 2006 fishery operated under the new limited entry system with 26 permits issued by the Department.

In 2004, members of the bay clam dive fishery requested bay clams be moved off the developmental species list and placed into its own limited entry system. Throughout 2004 and most of 2005 the Developmental Fisheries Board held six public meetings to discuss limited entry proposals. In November of 2005 bay clams (cockle clams, butter, gaper, native littleneck and softshell clams) were removed from the developmental fisheries species list and a limited entry system was created with ten permits available coast wide and five permits for the south coast of Oregon.

After creating limited entry systems for these two fisheries the developmental fisheries program began in early 2007, an evaluation of the Developmental Fisheries Program, which will continue through June 2009. In this evaluation, staff, with guidance from the Developmental Fisheries Board, will examine how the program and the board operate, where to improve efficiencies, and how to manage the program on an extremely limited budget. As initial steps of the program evaluation, staff has initiated re-forming a diverse and productive Developmental Fisheries Board to assist with the evaluation, and began review and assessment of the main two permitted developmental fisheries, the hagfish and spot prawn fisheries. At-sea observing and market sampling for both fisheries began in March, 2008, and will continue for the duration of the evaluation.

As of April, 2008, a total of 53 developmental fisheries permits were issued. All of the hagfish (25) and spot prawn (10) permits were issued, as well as 8 out of 10 available coonstripe/sidestripe shrimp permits. The remaining permits were issued for anchovy/herring (2), box crab (3), Tanner crab (2), giant octopus (2) and flat abalone (1) fisheries.

Contact: Gway Kirchner for more information (541-867-4741) or email Gway.R.Kirchner@state.or.us

9. Marine Finfish Ageing Unit:

In 2007, our ageing unit worked on three primary tasks: production ageing of sport and commercial black rockfish samples, aging of otoliths from rockfishes collected as part of the maturity study and an age validation research project. 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 growth increments in aurora rockfish and the Norther Oscillation Index and a strong negative correlation with the Pacific Decadal Oscillation and a 1 year index of sea level.

Contact: Josie Thompson (541) 867-0300, ext. 292. (josie.e.thompson@state.or.us)

10. Angling Selectivity Studies

We continued our study of how increasing the height of angled baits above the bottom using long leaders (3.0 and 4.6 m) inserted between the lowermost bait and the terminal weight (long leader gear) altered the species and size composition of the catch off the Oregon coast. In 2007, we conducted additional trials examining how the use of whole bait changed the 2006 results obtained mostly with artificial lures. We found that although side-by-side fishing tests suggested that the catch of yelloweye rockfish could be reduced in a bait fishery to a large degree by the use of long leaders, this effect was largely due to bait selection: in the presence of both gears, yelloweye chose the closer bait (standard gear) at much higher levels, but when only long-leader gear was presented, yelloweye rockfish were still caught. This did not happen when the same two experiments were conducted using only small shrimp flies and plastic worms, suggesting yelloweye rockfish will come quite a ways off the bottom to strike at bait, if the bait is large enough (and looks like a fish!). The net result of these studies is that long leader gear may be effective at reducing yelloweye rockfish bycatch (and the bycatch of other demersal rockfish) in the nearshore fishery for black rockfish, if the types and size of baits is also restricted, but won't be helpful in reducing bycatch in the bait-based fishery for Pacific halibut.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

11. Shrimp trawl impacts on mud seafloor macroinvertebrate populations

We began a study in 2007 using our ROV to examine impacts of shrimp trawls on macroinvertebrate populations in mud habitats typically trawled by ocean shrimp fishers. 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. The initial field surveys were competed in 2007 and analysis of the video generated is under way. We sampled four 1 mile square areas, two with minimal trawl history and enclosed within the newly closed area and two with a much more intensive trawling history that are located in areas that will continue to be trawled. We will compare the four areas to determine the between-area level of variability in macroinvertebrate populations around Nehalem Bank and to see if differences in these populations suggest a relationship to the amount of historical trawling activity. It is our hope that a follow-up study can be completed after a period of 5-10 years to see if the closed

areas show evidence of recovery of large macroinvertebrates such as sea pens and whether the areas that remain open show negative changes in macroinvertebrate populations.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

12. Tests of a shrimp selective grate.

We conducted a brief field study in 2007 testing a rigid-grate bycatch reduction device with a section designed to size-sort ocean shrimp, allowing the very smallest shrimp to escape the trawl. The tests showed that such a device has some potential to work, but requires a different design than the one we tested and may decrease shrimp catch volume too much to be useful to shrimp fishers.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

13. Hypoxia Effects on Seafloor Communities

In 2007, personnel from ODFW's Marine Habitat Project partnered with the Partnership for Interdisciplinary Study of Coastal Oceans (PISCO) to document the ecological effects of recently discovered hypoxia events on seafloor communities. We conducted Remotely Operated Vehicle (ROV) work on the R/V Elakha offshore of Cape Perpetua (south of Newport) for a total of 7 days at sea spread throughout May – August. 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 collect ROV video data along the transect line before, during, and after hypoxia events. We were able to document pre-hypoxic conditions and *in situ* conditions during ongoing hypoxic events, but we were unable to collect post-hypoxia footage as planned due to scheduling constraints. Qualitative observations suggested that mobile fish species (e.g., black rockfish, blue rockfish) left the area upon onset of hypoxic waters, while more sedentary species (e.g., quillback rockfish, sculpins) remained and were more sluggish than normal during the hypoxic period. Once oxygen levels returned to normal after a hypoxic event, the full complement of fish species were again observed along the transect. We have monitored the Cape Perpetua transect each year since 2002 (except one), and we plan to continue this valuable time series in the future to monitor the ongoing hypoxia-related disturbance and recovery to the seafloor community.

Contact: Mike Donnellan (Michael.D.Donnellan@state.or.us)

C. BY SPECIES

1. Black rockfish PIT tagging

Oregon's primary recreational groundfish fishery targets the nearshore species, black rockfish. 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. We tagged 2,550 fish in 2002, 3,000 fish in 2003, 3,013 in 2004, 2,882 in 2005, and 2,989 in 2006 with PIT tags (12mm x 2mm) during 20-24 days of fishing each year near Newport, Oregon. In 2007, we tagged an additional 3,056 black rockfish. In 2008, if catch rates allow, the number of tagged fish will be increased in order to increase tag recoveries and decrease variation in parameter estimates. 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. Carcasses of black rockfish are counted and electronically scanned for tags year-round upon being landed by recreational fishers. In 2007, 86% of the black rockfish landed in Newport and 30% of those landed in Depoe Bay were scanned for tags. We recovered 325 tags in 2007 with recoveries from all six tag cohorts in Newport and no tags recovered in Depoe Bay. 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. Black rockfish populations off Oregon and California underwent a full assessment in 2007. Due to the inability of the assessment software to directly incorporate estimates of exploitation rate as a model input, we estimated an annual series of population abundances using exploitation rates from the PIT tag study and estimates of total landings from MRP's ORBS program. This series was included in the 2007 assessment as an index of abundance for the assessed population.

Contact: Troy Buell (troy.v.buell@state.or.us)

2. Pacific hake

The Shoreside Hake Observation Program (SHOP) was established in 1992 to provide information for evaluating bycatch in the directed Pacific hake (*Merluccius productus*) fishery, and for evaluating conservation measures adopted to limit the catch of salmon, other groundfish and prohibited species. The 2007 coastwide optimum yield (OY) was set 10% lower than the 2005 and 2006 level, resulting in a U.S. OY of 242,591 mt. The 2007 assessment indicated uncertainty in the harvestable biomass of incoming year classes. The uncertainty in these estimates along with concerns regarding bycatch of overfished rockfish species, resulted in the decision to decrease the 2007 harvest.

An estimated 2,000 mt was identified for research and bycatch in other fisheries. The tribal fishery was allocated 13% of the U.S. OY (32,500 mt). Commercial fisheries received the remaining 86.3% (208,091 mt) of the U.S. OY. Long standing sector allocations were used to divide the commercial OY into allocations for the shoreside, 42% (87,398 mt); catcher/processors, 34% (70,751 mt); and catcher vessels delivering to motherships, 24% (49,942 mt). On November 28, 2007, 6,000 mt of the shore-based whiting allocation was reapportioned to the catcher/processor sector (72 FR 72630, December 21, 2007), resulting in revised allocations of the shore-based and catcher/processor sectors.

The directed season for mothership and catcher/processor at-sea processing (north of 42^{o} N) began on the 15th of May 2007. The directed shoreside hake fishery began on April 1, 2007 off California (south of 42^{o} N), and on June 15, 2007 off Oregon and Washington (north of 42^{o} N). To avoid pre-empting more northerly segments of the fishery, the California component of the hake fishery is limited to 5% of the total shoreside allocation until the northern component of the shoreside fishery begins. No landings were made in California after May 29th.

The season started slowly, with small fish, scattered schools, and high bycatch. The at-sea sectors instituted voluntary operational measures in an attempt to reduce bycatch (e.g., no night fishing, short tows, area closures). The shoreside sector organized a voluntary stand-down that lasted approximately 6 days. Fishing resumed in mid-July and lasted a total of 42 calendar days before the widow bycatch cap for all sectors was exceeded and the fishery closed on July 26 at 6:00 p.m. During the September PFMC meeting, the widow cap was increased to 275 mt and the hake fishery was reopened on October 7, 2007 (72 FR 56664, October 4, 2007). While shoreside interest was limited during the late season opener, several vessels did participate. The last shoreside landing was on December 13th. About 6-7 catcher-processors were active during the fall season. By mid November, effort ebbed to 2 or 3 vessels and after the re-apportionment on November 28^{th,} only one catcher-processor was active; they finished December 12th. Total impacts (coastwide; all sectors) of overfished rockfish species are as follows: canary rockfish catch was 3.98 mt; darkblotched rockfish, 12.96 mt, Pacific Ocean perch, 26.79 mt; widow rockfish, 234.73; and yelloweye rockfish, 0.05 mt.

The tribal fishery harvested 30,177 mt (92.9%) of their set-aside. The shoreside directed fishery closed on December 31, 2007 and harvested 73,280 mt (83.8% of the allocated amount). The catcher/processor fishery closed on December 31, 2007 and harvested 73,263 mt (95.5% of the revised allocation). The mothership fishery closed December 31, 2007 and harvested 47,809 mt (95.7%).

In the shoreside fishery, samplers measured 5,857 Pacific hake for length-frequency information, and collected 1,398 Pacific hake otolith samples, along with length and weight information. Biological samples acquired by SHOP during the fishing season were sent to the following locations:

- Pacific hake—Omar Rodriguez, NOAA Fisheries, Fishery Resource Analysis and Monitoring Division (Newport, Oregon)

- Yellowtail rockfish—Sandra Rosenfeld, WDFW, Marine Fish & Shellfish Division (Olympia, Washington)

- Widow rockfish—Don Pearson, NOAA Fisheries, NMFS (Santa Cruz, California)

- Other species—Sablefish, jack and Pacific chub mackerel, darkblotched, bocaccio, canary rockfish, and other bycatch species data have been retained by respective state agencies where specimens were landed for analysis (WDFW, ODFW, CDFG).

Current and former shoreside hake observation reports are available on the internet at www.dfw.state.or.us/mrp/hake.

Contact: Kelly Ames at 541-867-0300 ext 271 (Kelly.L.Ames@state.or.us)

3. Pacific Sardine

Pacific sardines (Sardinops sagax) are managed under the Pacific Fishery Management Council's Coastal Pelagic Species Fishery Management Plan (CPS FMP). Under the FMP, the biomass of sardines is estimated each year and a coast-wide harvest guideline is established. In 2002, the Council adopted an interim allocation system for the 2003-2005 seasons. Discussions to design a new allocation system began in 2004 and in June 2005 the Council approved a new long-term allocation formula for Pacific sardine. The new allocation framework, which releases allocations of fish coast wide by date rather than area, was implemented for the 2007 Pacific sardine fishery under Amendment 11 to the Coastal Pelagic Species Fishery Management Plan. The 2007 coastwide harvest guideline (HG) for Pacific sardines was established at 152,564 metric tons (mt).

The 2007 Oregon sardine fishery saw the second highest harvest on record since the current Oregon fishery began in 1999. Vessels landed a total of 42,151 mt (92,927,053 lbs) of sardines in 2007; this a 16% increase from the 35,648 mt landed in 2006. As in the past, spotter planes, hired by the industry, were used to locate fish and the first landing of the year into Oregon was made on June 7th but major harvest activities did not start in earnest until mid July. Approximately 4,700 mt per week were landed during August, the peak of the fishery, and 3,909 mt per week in September, with an overall fishery average of 48mt (105,960 lbs) of sardine per landing. Individual landings ranged from 1,756 lbs (0.79 mt) to over 252,661 lb (114.6 mt) and the last directed landing occurred on October 13, 2007. A total of 877 landings were made at eight different processors throughout Warrenton and Astoria.

Contact: Gway Kirschner for more information (Gway.R.Kirschner@state.or.us)

D. PUBLICATIONS

Brill, R., C. Magel, M. W. Davis, R. W. Hannah and P. S. Rankin. In review (Fishery Bulletin). Effects of rapid decompression and exposure to bright light (simulated capture) on the visual function of black rockfish (*Sebastes melanops*) and Pacific halibut *(Hippoglossus stenolepis*).

Chan, F., J. A. Barth, J. Lubchenco, A. Kirincich, H. Weeks, W. T. Peterson, B. A. Menge. 2008. Emergence of Anoxia in the California Current Large Marine Ecosystem. Science. V 319 (5865), p. 920.

Hannah, R. W., N. Gove and S. J. Parker. Effectiveness of selective flatfish trawls in the U.S. west coast groundfish trawl fishery. Oregon Dept. Fish Wildl., Information Rept. Ser., Fish. No. 2007-05. 22p.

Hannah, R. W., and S. A. Jones. 2007. Effectiveness of bycatch reduction devices (BRDs) in the ocean shrimp (*Pandalus jordani*) trawl fishery. Fish. Res. 85:217-225.

Hannah, R. W. and S. J. Parker. 2007. Age-modulated variation in reproductive development of female Pacific ocean perch (*Sebastes alutus*) in waters off Oregon. Proceedings, Lowell Wakefield Symposium on Biology, Assessment and Management of North Pacific Rockfishes. Alaska Sea Grant, Anchorage.

Hannah, R. W., and K. M. Matteson. 2007. Behavior of nine species of Pacific rockfish after hook-and-line capture, recompression, and release. Trans. Amer. Fish. Soc. 136:24-33.

Hannah, R. W., S. J. Parker, and K. M. Matteson. In Press. Escaping the surface: the effect of depth of capture and size on submergence success of surface-released Pacific rockfishes. North American Journal of Fisheries Management.

Parker, S. J., H. I. McElderry, P. S. Rankin, and R. W. Hannah. 2006. Buoyancy regulation and barotrauma in two species of nearshore rockfish. Transactions of the American Fisheries Society. 135:1213-1223.

Parker, S. J., P. S. Rankin, J. M. Olson, and R. W. Hannah. 2007. Movement patterns of black rockfish in coastal Oregon waters. Pages 397-415 *In* (Keller et al. Eds.) 23rd Lowell-Wakefield Symposium, Biology, Assessment, and Management of North Pacific Rockfishes, Alaska Sea Grant, Anchorage.

Stoner, A. W., C. H. Ryer, S. J. Parker, P. J. Auster, and W. W. Wakefield. In Review. Potential bias in fish surveys conducted with underwater vehicles: evaluating the role of fish behavior. Canadian Journal of Fisheries and Aquatic Sciences.

E. PROJECTS PLANNED FOR YEAR 2008:

1. Barotrauma and movement in rockfishes: We plan to continue the telemetry work described above with black rockfish and other species, but we also hope to work on developing cage holding protocols to begin to measure discard survival as a function of depth of capture.

Contact: Bob Hannah (bob.w.hannah@state.or.us)

2. Yelloweye Rockfish Survey: In 2008, ODFW plans to expand the International Pacific Halibut Commission's standard stock assessment survey, concentrating on rockfish habitat, to obtain data necessary for the yelloweye rockfish stock assessment. We propose to sample some additional longline sampling stations focused on rocky habitat to 1) initiate an additional yelloweye rockfish abundance index based on longline CPUE in rocky shelf habitat, 2) investigate the evidence for localized depletion bias at the 5 IPHC standard grid longline stations that regularly produce yelloweye rockfish, and 3) increase biological data collection for the yelloweye rockfish stock assessment.

Contact: Kelly Ames at 541-867-0300 ext 271 (Kelly.L.Ames@state.or.us)

3. ROV Survey of Habitat and Fish Communities at Redfish Rocks: We plan to survey benthic habitat and fish communities at Redfish Rocks Reef, a ~9 km^2 area of high-relief rocky reef just south of Port Orford on Oregon's south coast. We are coordinating our study with the Port Orford Ocean Resource Team (POORT), a community-based fishing interest group actively exploring innovative community-based fisheries management approaches. POORT has secured funding for a multibeam bathymetry survey of the study area and the survey is planned for early 2008. Our survey will build upon past work that our project has conducted at Redfish Rocks, which has included a sidescan sonar survey and diver surveys of habitat and the fish community.

Contact: Mike Donnellan (Michael.D.Donnellan@state.or.us)

4. Resolving Spatial Scales of Nearshore Groundfish-Habitat Relationships: To work towards our ultimate goal of habitat-based stock assessments for nearshore fish species, we plan to further develop our understanding of fish-habitat relationships at Siletz Reef offshore of Lincoln City. High-resolution multibeam bathymetry data exist for Siletz Reef, and we will assess differences in fish densities relative to different multibeam-derived landscape measures calculated using an automated (read: non-subjective) GIS-based tool called a Bathymetric Position Index (BPI). The BPI identifies landscape features such as ridges and valleys, and is a further refinement to typical bathymetry-derived measures of seafloor topography such as slope, rugosity, and aspect. We will test whether this new tool has potential for increasing precision of fish density estimates on Oregon's Nearshore reefs.

Contact: Mike Donnellan (Michael.D.Donnellan@state.or.us)

Washington Contribution to the 2008 Meeting of the Technical Sub-Committee (TSC) of the Canada-US Groundfish Committee

Compiled by:

Theresa Tsou
Senior Research Scientist

Washington Department of Fish and Wildlife

May 6th - 7th, 2008

Seattle, Washington

Review of Agency Groundfish Research, Assessment, and Management

A. Puget Sound Area Activities

1. Puget Sound Groundfish Monitoring, Research, and Assessment *(Contact: Theresa Tsou 360-902-2855, tsoutt@dfw.wa.gov; Wayne Palsson 425-379-2313, palsswap@dfw.wa.gov) Marine Fish Science Unit*

Staff of the Puget Sound Marine Fish Science Unit includes Wayne Palsson, Robert Pacunski, Tony Parra, Jim Beam, and Ocean Eveningsong. Their tasks are primarily supported by supplemental funds from the Washington State Legislature for the recovery of Puget Sound bottomfish populations. Most of the work of the staff is associated with the Puget Sound Assessment and Monitoring Program (PSAMP) and is tasked by the newly formed Puget Sound Partnership. 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-seven 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 have been developing a technical review on the Biology and Status of Rockfishes in Puget Sound that will serve as a source document for the development of a Conservation Plan for Rockfishes in Puget Sound. 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 in 2008.

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.

Preliminary results indicate that the patterns of stocks status were generally similar between North and South among the 17 species of rockfish that were examined. Six populations (19%) of the 32 populations present in either North or South Sound were in Healthy Status. Twelve populations (38%) were in Precautionary status. Only one population in North Sound was in Vulnerable status, and seven populations (22%) were in Depleted status. Six populations (34%) were in Unknown status with five of these in North Sound. Copper and quillback rockfishes have been the two most important species in the recreational fishery, and both were both in depleted or vulnerable status in both North and South Puget Sound. Yelloweye and canary rockfishes are also depleted but were always uncommon in Puget Sound catches but have been overfished in coastal waters. Five species in North Sound and six species in South Sound were in precautionary status, and these species such as black, yellowtail, and bocaccio have been secondary species of importance in recreational and commercial fisheries. Black rockfish in the western portion of the Strait of Juan de Fuca are a special exception to the overall precautionary status, perhaps because this area is fed directly by spillover from coastal areas. Populations of brown rockfish in South Sound are another exception: This population is healthy but generally not present in the recreational catches. Other healthy populations include the deepwater redstripe, greenstriped, and shortspine thornyheads, all species that appear to be uncommon or rare in inspected catches. The status of six populations was unknown with most of these in North Sound. These species are rare in catches and include tiger, China, Blue, brown, and splitnose rockfishes in North Sound and tiger rockfish in South Sound. Several species are generally not detected in South Sound including China and blue rockfishes in South Sound. Vermilion rockfish appear to be invading Puget Sound from coastal waters but their status is Precautionary until more assessment information is developed.

b. Puget Sound Marine Habitat Studies

Wayne Palsson and Robert Pacunski continue to collaborate with Professors Don Gunderson of the University of Washington and Gary Greene of Moss Landing Marine Labs in developing habitat use models for groundfish in Puget Sound. A Washington Sea Grant study was conducted in 2004 and 2005 to examine the distribution of marine fishes in relation to seafloor habitats in the San Juan Archipelago. Seafloor maps developed from high-resolution multibeam bathymetric and backscatter data was used to design the two surveys. In 2004 we used a Phantom 2+2HD ROV to visually survey the diversity of rocky, coarse, and fine sediment habitats in San Juan Channel. As expected, rockfish and lingcod were almost exclusively associated with rocky habitats, and we found strong community associations with the major substrate types surveyed. In 2005, we used the same ROV, focusing solely on rocky habitats to better examine the factors controlling the habitat relationships of rockfish and lingcod in San Juan Channel. Data from the 2004 have been analyzed and a preliminary manuscript developed for publication in a peer-reviewed publications. Wayne Palsson and Gary Greene organized and led a session on seafloor mapping at the 2007 Georgia Basin/Puget Sound (GBPS) Research, and Robert Pacunski presented the results of the 2004 survey in that session. In April 2007, Robert Pacunski gave a presentation at the Habitat Mapping Technology Workshop for Alaska, resulting in a peer-reviewed paper, “Conducting Visual Surveys with a Small ROV in Shallow Water”, that will be published in the workshop proceedings. Videotape data from the 2005 survey have been reviewed and are in the preliminary stages of analysis. A draft document for peer-review is expected to be ready by Fall 2008.

In an effort to adapt a quantitative 3-beam laser scaling system for use on a small ROV, Marine Fish Science staff conducted a weeklong survey in Hood Canal. Based on habitat maps developed from previous WDFW scuba and drop-camera surveys, the 2007 ROV survey was designed to sample many of the rocky habitats within the canal to evaluate the efficacy of the technique. A total of 57 transects were completed, although several technical difficulties were encountered that limited our ability to complete all of the planned transects. The collected video data have been reviewed and are awaiting analysis.

c. Continued investigation of the 2006 Recruitment Event of Young-of-the-Year Rockfishes in Puget Sound and the Strait of Juan de Fuca

During 2007, Marine Fish Science staff reoccupied dive sites surveyed in 2006 that documented remarkable settlement of post-larval rockfishes in the inland waters of Washington. In contrast to the previous year, no YOY rockfish were observed at any site in 2007, although large numbers of now 1+ year-old copper and quillback rockfish were observed on adult habitats adjacent to the nearshore YOY sites. Larry LeClair presented the results of the 2006 scuba surveys at the 2007 Georgia Basis/Puget Sound Research Conference.

d. Low Dissolved Oxygen Conditions at Sund Rocks Marine Reserve

Hood Canal is a fjord connected to Puget Sound in the north and extending 100 km to the south. The steep sides of the canal extend to depths of 180 m in the north and range to depths of over 125 m for most of the water body. Hood Canal is one of the water bodies identified in the Pew Ocean Commission report as a hypoxic dead zone. Dissolved oxygen (DO) concentrations of less than 2 mg/l have been observed for decades in deep and shallow waters in the southern portion of the canal, and these low concentrations have been attributed to naturally poor circulation resulting from low estuarine flow and bottom water replacement. In recent years, low DO concentrations have become chronic, extending into nearshore waters and possibly becoming worse due to eutrophication (J. Newton, Hood Canal Dissolved Oxygen Program). Mass mortality events of fishes and invertebrates (Fish Kills) in 1926 and 1963 likely have resulted from poor water quality.

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. MFS staff continued monitoring at this site in 2007 to detect potential impacts to fish populations inhabiting the local area. Unlike the previous year, 2007 can be classified as a low-impact year, with no extreme hypoxic events or fish kills reported. MFS staff continued their participation in the Hood Canal Dissolved Oxygen Program as partners and scientists. Wayne Palsson and MFS staff authored a peer-reviewed paper, "The Effects of Hypoxia on Marine Fish Populations in Southern Hood Canal", based on the results of scuba surveys conducted at Sund Rocks MR since 2002. The paper was presented by Wayne Palsson at the 2007 American Fisheries Society Symposium on Mitigating Impacts of Natural Hazards on Fishery Ecosystems and is in press in the American Fisheries Society Symposium series.

e. Second Tacoma Narrows Bridge Mitigation Study

In March 2003, the Washington Department of Transportation (WSDOT) and the Washington Department of Fish and Wildlife (WDFW) established a contract to fulfill part of the terms of the mitigation agreement for the construction of a second bridge at Tacoma Narrows, connecting Tacoma with the Kitsap Peninsula across Puget Sound. The contract establishes that staff from WDFW will conduct sampling to examine the impacts bridge construction activities of the bridge on marine fish communities at the bridge site. Primary areas of interest include the two caisson and pier sites, the proposed anchor sites, and riprap fields placed at the footings of the existing and new tower piers. As part of the mitigation requirements associated with the Second Narrows Bridge, a new artificial reef was created at Toliva Shoal in spring 2005 that was designed to test the efficacy of attracting young-of-the-year and juvenile rockfish to the offshore location of the shoal. The new reef consisted of strips of small, quarried rock placed on or near existing artificial habitat composed of large boulders and concrete deployed for attracting adult rockfish. The Tacoma Narrows Mitigation Project final report is in preparation, with an expected completion date of April 1, 2008.

Monitoring at the bridge site included scuba surveys in the shallow waters (<100 ft) at planned anchor sites and matched control sites, and a towed video survey at the planned anchor and matched control stations, as well as the riprap fields surrounding the new bridge towers. Pre-construction surveys revealed that most rockfish and lingcod were distributed along old bridge rubble and natural hardpan habitats on the eastern side of the Narrows. Post-construction data were collected in 2006 and analyzed by finfish taxa to examine changes that may have occurred as a result of bridge construction activities. Densities of rockfishes, lingcod, sculpins, and surfperches generally declined at control and caisson anchor sites after bridge construction. In contrast, these taxa remained constant or increased at the east and west caisson sites after construction. Increased rocky habitats resulting from the placement of riprap fields around the caissons are likely to have influenced these results. We did not observe any effects of a novel anchoring system to hold the caissons in place during deployment. In contrast to large concrete anchors used for the original bridge construction, the new anchors were steel, locking anchors that were injected in the seafloor with minimal exposure above the seafloor itself.

Total finfish abundance decreased throughout the Tacoma Narrows over the study period, with large declines observed at both control and anchor (i.e., impact) stations. These results indicate a general decline in finfish abundance in the Tacoma Narrows that cannot be attributed to bridge construction activities. Factors potentially influencing our results include the attraction and aggregation of fishes to the caisson sites after bridge construction, recreational harvest of fishes at these sites, and seasonal movements of fishes in the Narrows.

At the Toliva Shoal study site, scuba surveys conducted prior to the installation of the juvenile reef found that most rockfish and lingcod were sparsely distributed on previously existing artificial habitat composed of concrete and large (>1 m) quarried boulders. Scuba surveys following reef construction found sub-adult (<200 mm) rockfishes occurring in greater densities on the small (<20 cm) quarry rock comprising the new reef than on the existing adult reef. Overall abundance of rockfish at Toliva Shoal increased significantly at almost all impact and control treatments. These increases are potentially the result of aggregation as well as recovery of rockfishes resulting from increased protective measures in Puget Sound and the MPA status enacted at Toliva Shoal in 2005.

During 2006, an unprecedented recruitment of young-of-the-year rockfish was observed in the nearshore vegetated habitats of central and southern Puget Sound. However, no young-of-the year rockfish were observed at the artificial habitats at Toliva Shoal during the initial surveys at this site, although a total of 31 YOY rockfish were later observed in Fall 2006. Hundreds of YOY copper and quillback rockfish were observed at inshore habitats in close proximity (<2 km) to the newly created juvenile reef at Toliva Shoal, suggesting that offshore habitats are not as important as nearshore habitats for the settlement of larval rockfishes in Puget Sound. Compared to 2006, surveys conducted in 2007 showed little change in the overall abundance of juvenile and adult rockfish at the juvenile and adult reefs, while the presence of YOY rockfish at the site was rare. Due to the strong current patterns that occur at the Toliva Shoal site, portions of the juvenile reef are being inundated or buried by the coarse sands that are common in the area. This process is resulting in a loss of habitat at the juvenile reef due to the infilling of interstitial spaces utilized by the juvenile rockfishes inhabiting the reef.

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 since 1987, but more recently have focused on individual sub-basins to improve region specific confidence intervals. The goals and objectives of the current surveys are to estimate the abundance and describe the distribution of recreational and commercial groundfish and macro-invertebrate species, collect biological information from key species, and evaluate the relationship of abundance and distribution of key species to oceanographic features. The 2007 survey was divided into two sub-regions, East Strait of Juan de Fuca and West Strait of Juan de Fuca, and included a special study in Discovery Bay. The survey was conducted using the chartered vessel *F.V. Chasina* towing a 400 mesh Eastern net fitted with a 3 cm codend liner. Sampling stations were selected using a stratified random approach based upon four standardized depth zones within each of the sub-regions. The area sampled at each station was measured using differential GPS positions and known net width openings. The catch from each trawl station was identified, weighed, and enumerated. To estimate species densities, the weights and numbers of each species were divided by the area sampled. Species abundance was estimated multiplying the average station density within each stratum by the stratum area. A total of 98 trawl stations were occupied in the two sub-regions and special study. Pacific halibut and yearling lingcod were notably common during this survey.

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 (Figure 2), fourteen of which are significant for groundfish resources. As the system has expanded, MFSU staff monitored a core of the marine reserves on a frequent basis and visit other subtidal reserves on a periodic basis. This monitoring builds upon field research at many of these sites that was begun as early as 1986. The field work primarily consists of scuba divers conducting visual censuses along strip transects. Along with estimating fish density, divers measure individual fish, and in the case of lingcod, quantify nesting activity.

Specific monitoring activities in 2007 included surveying many of the Puget Sound reserves and comparable fished sites. Several reserves in central Puget Sound were visited six times during 2007 as an extension of a study initiated in 1995 that takes advantage of the previous information collected at Orchard Rocks. This site was declared as a fully-protected reserve in 1998 but was a fished site monitored in 1986, 1987, and from 1995-1997. With the addition of a new fished site treatment at Point Glover, the newly created refuge in a formerly monitored fished area is an excellent opportunity to evaluate the before and after impacts of refuge creation with a comparable fished site treatment. Monitoring was continued at the Zee's Reef and Colvos Passage in 2002 with six surveys conducted in 2007. MFS staff 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 over the past several years shows that lingcod at the marine reserve sites are larger, more abundant, and have higher nesting success than fish at non-reserve (i.e., fished) sites.

h. Other Activities

Wayne Palsson and Robert Pacunski participated in a 2-day Temperate Reef Symposium held at the University of Washington. The Symposium gathered many scientists and fishery managers involved with the research and management of fishery resources along the west coast of the United States.

At the invitation of University of Washington professors Dr. David Duggins and Dr. Ken Siebens, Wayne Palsson and Robert Pacunski assisted with the instruction of undergraduate and graduate students participating in a Subtidal Ecology Internship class at the Friday Harbor Laboratories. As part of the class field activities, we reoccupied a site at Pt. George in San Juan Channel that had previously been surveyed by Dr. Larry Moulton in the 1970's and sporadically thereafter by several graduate students at FHL, with the goal of developing a long-term database to be used by successive internship classes for assessing fishing, habitat, and climatic impacts on fishes within the region.

In response to an effort to examine the practicality of replenishing marine fish stocks, WDFW is entering a partnership with NOAA Fisheries to experimental releases of lingcod stocks in Puget Sound. Wayne Palsson has been examining the potential impacts to existing lingcod populations that may result from the introduction of hatchery-raised lingcod into Puget Sound. A joint proposal is in development to fund an intensive field and hatchery study.

Wayne Palsson has been actively involved with the newly created Puget Sound Partnership, working closely with scientists from NOAA and other State agencies to prioritize Partnership activities and establish baselines for conducting ecosystem risk assessments.

On April 10, 2007, NOAA Fisheries received a petition to list distinct population segments (DSP) of five rockfish species in Puget Sound (bocacio, greenstripe, yelloweye, canary, redstripe) as threatened or endangered under the provisions of the ESA. Citing a lack of sufficient commercial or scientific information, NOAA declined to initiate a review. On October 29, 2007, the petitioner submitted additional information not included in the original petition. In light of this new information, coupled with the previously supplied information and data within NOAA's files, NOAA determined that the new petition presented substantial scientific or commercial indicating that petition actions may be warranted. As a result of this determination, NOAA scientists have begun requesting relevant information from MFS staff to be incorporated into the Biological Review of the five petitioned species.

2. Herring Stock Assessment (*Contact: Kurt Stick 360 466-4345 ext. 243, stickkcs@dfw.wa.gov*)

Annual herring spawning biomass is estimated for known herring populations in Washington waters using spawn deposition and/or acoustic-trawl surveys. WDFW Region 4 staff based in the Mill Creek and La Conner offices attempts to conduct spawn deposition and/or acoustic-trawl surveys of all adult herring populations in Washington annually. Stock assessment activities for the 2008 spawning season are in progress.

The herring spawning biomass estimate for all Puget Sound stocks combined in 2007 is 12,274 tons (see table and figure below). The cumulative total is a considerable decrease from the 2006 total of 17,765 tons and less than the mean cumulative total for 1997-2006 of 14,067 tons. The combined biomass of south/central Puget Sound (including Hood Canal) stocks also decreased in 2007 compared to 2006, reflecting the total Puget Sound trend.

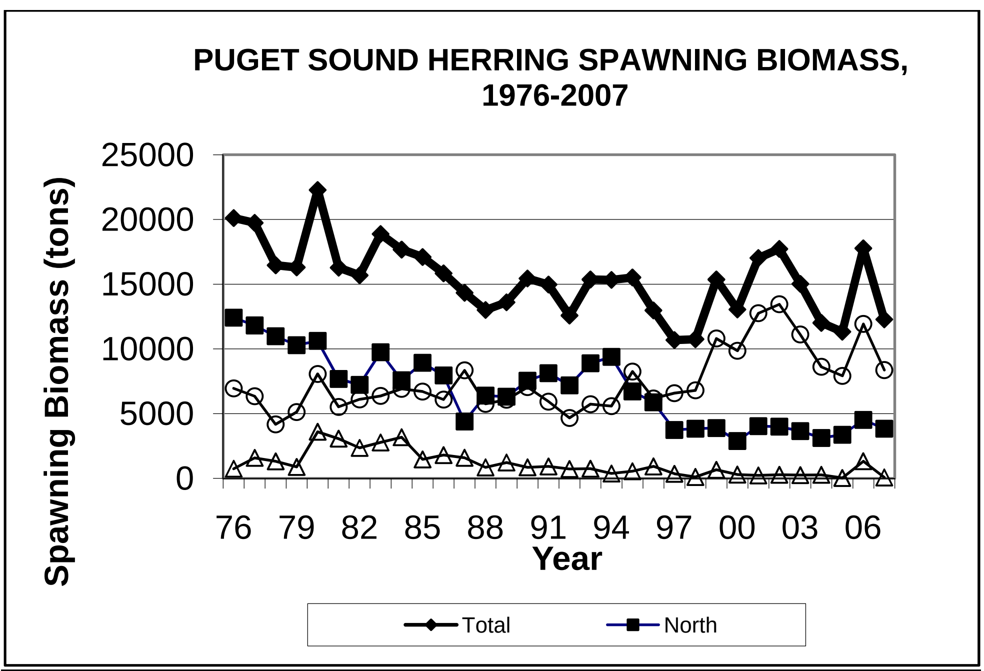
Cumulative biomass of North Puget Sound stocks has remained at a low level of abundance, primarily due to the continued critical status of the Cherry Point herring stock. The Cherry Point stock's spawning biomass in 2007 is 2,169 tons, a small decrease from 2,216 tons in 2006. This interrupted a gradual increase in this stock's abundance since a low of 808 tons in 2000. The Cherry Point stock ranged from 3,100 to nearly 15,000 tons between 1973 and 1995. The Fidalgo Bay herring stock continued a downward trend since 2001.

Herring spawning activity for the Strait of Juan de Fuca region was very reduced in 2007, with an estimated total of only 76 tons. This followed a relatively high estimate for the Discovery Bay stock in 2006 of 1,325 tons.

No spawning activity was observed in 2007 for coastal stocks (Willapa Bay and Grays Harbor). In general, herring spawning biomass for these areas is relatively small compared to Puget Sound.

HERRING SPAWNING BIOMASS ESTIMATES (SHORT TONS) BY STOCK AND REGION, 1998-2007.
(blanks indicate no surveys done that year)

	YEAR									
	2007	**2006**	**2005**	**2004**	**2003**	**2002**	**2001**	**2000**	**1999**	**1998**
Squaxin Pass	557	755	436	828	2201	3150	1597	371	474	68
Wollochet Bay	35	27	67	52	152	106	133	142		
Quartermaster Harbor	441	987	756	727	930	416	1320	743	1257	947
Port Orchard-Port Madison	1589	2112	1958	700	1085	878	2007	1756	2006	489
South Hood Canal	70	244	210	176	207	166	187	140	516	101
Quilcene Bay	2372	2530	1125	2342	916	2585	2091	2426	2464	1152
Port Gamble	826	774	1372	1257	1064	1812	1779	2459	1664	971
Kilisut Harbor	24	54	170	184	448	774	612	107	802	311
Port Susan	643	321	157	429	450	775	587	785	545	2084
Holmes Harbor	572	1297	498	673	678	573	275	281	175	464
Skagit Bay	1236	2826	1169	1245	2983	2215	2170	646	905	209
South-Central Puget Sound Total	8365	11927	7918	8613	11114	13450	12758	9856	10808	6796
Fidalgo Bay	159	323	231	339	569	865	944	737	1005	844
Samish/Portage Bay	348	412	218	351	299	496	470	196	555	643
Int. San Juan Is.	33	285	41	67	72	158	219	128	197	
N.W. San Juan Is.	0	0	0	0	13	131	62	90		107
Semiahmoo Bay	1124	1277	870	629	1087	1012	1098	926	868	919
Cherry Point	2169	2216	2010	1734	1611	1330	1241	808	1266	1322
North Puget Sound Total	3833	4513	3370	3120	3651	3992	4034	2885	3891	3835
Discovery Bay	42	1325	33	252	207	148	137	159	307	0
Dungeness/Sequim Bay	34	0	0	22	44	131	93	138	352	112
Strait of Juan de Fuca Total	76	1325	33	274	251	279	230	297	659	112
Puget Sound Total	12274	17765	11321	12007	15016	17721	17022	13038	15358	10743
Grays Harbor	0*	0*	15	33	129	87	77	166	297	77
Willapa Bay	0*	0*	145	0*	398	389	150	345	397	57
*partial survey coverage										
Coast Total	0	0	160	33	527	476	227	511	694	134



3. Puget Sound Ambient Monitoring Program (PSAMP) *(Contact: Sandie O'Neill 360-902-2843, ONEILSMO@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 its 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.

4. Puget Sound Ecosystem Investigation (Contact: Ray Buckley 360-902-2828, *BUCKLRMB@dfw.wa.gov*)

a. Trans-generation Marking of Viviparous Marine Fish Larvae in Puget Sound

Investigators at the Washington Department of Fish and Wildlife confirmed, through several years of experimentation and field trials, that an increased body-burden of elemental strontium in gestation rockfishes and surfperches will induce permanent marks the otoliths of viviparous marine fish larvae prior to birth. Laboratory trials developed the protocols for using intramuscular injection of strontium chloride to produce a mark that is detected as a narrow band of increased strontium/calcium in the otoliths of larvae. This is a unique method for directly estimating retention and dispersion rates of larval marine fishes from local populations.

Field trials were conducted in 2004-2006 at Point Heyer artificial reef, Vashon Island, Washington, with brown rockfish (*Sebastes auriculatus*). A total of 139 gestating females were injected and released *in situ*, and 671 otoliths from injection cohort juveniles have been recovered. A single marked otolith has thus far been found among the 242 juveniles assayed to date. The preliminary results of this work are published in:

Buckley, R.M., L.L. LeClair, E.C. Volk and S.L. Schroder. 2007. Preliminary results of trans-generational marking of larval marine fish otoliths. Pages 87-98, In J. Heifetz, J. DiCosimo, A.J. Gharrett, M.S. Love, V.M. O'Connell, and R.D. Stanley (eds.), Biology, assessment, and management of North Pacific rockfishes. Alaska sea Grant, University of Alaska, Fairbanks.

Funding for completing this research was eliminated in 2007.

b. Use of Microsatellite DNA and Pedigree Analysis to Test for Self-recruitment in an Isolated Population of Brown Rockfish in Puget Sound

This collaborative study between the Washington Department of Fish and Wildlife and the University of Washington used genetic markers to identify progeny of resident adult brown rockfish (*Sebastes auriculatus*) among juveniles sampled at Point Heyer artificial reef, Vashon Island, Washington, for the trans-generational marking field trials (see **Trans-generational Marking of Viviparous Marine Fish Larvae in Puget Sound, Washington**). Preliminary genetic results using a maximum likelihood estimation approach indicate self-recruitment to be about 15%. These genetic determinations verified that the juvenile brown rockfish with the strontium marked otolith was from a female injected with strontium chloride. The results of this work are reported in:

Hauser, L., L. Newton, L. LeClair and R. Buckley. 2007. Genetic identification of progeny of reef-resident brown rockfish (*Sebastes auriculatus*). Pages 99-120, In J. Heifetz, J. DiCosimo, A.J. Gharrett, M.S. Love, V.M. O'Connell, and R.D. Stanley (eds.), Biology, assessment, and management of North Pacific rockfishes. Alaska sea Grant, University of Alaska, Fairbanks.

c. A multidisciplinary approach to estimating larval dispersal rates and distances in Puget Sound brown rockfish (*Sebastes auriculatus*).

This is a collaborative Washington Sea Grant funded study between the Washington Department of Fish and Wildlife and the University of Washington to determine the dispersal patterns of larval brown rockfish (*Sebastes auriculatus*) produced by females resident on Point Heyer artificial reef, Vashon Island, Washington. The rockfish production at the reef at Pt Heyer is used to simulate rockfish produced in a Marine Protected Area (MPA) which are used in Puget Sound management to maintain rockfish populations and preserve biodiversity. However, nothing is known about the dispersal of larval rockfish to local and regional habitats. This study brings together the disciplines of oceanographic modeling, genetic determinations and otolith microstructure analyses to determine the dispersal patterns of the 2007 and 2008 cohorts of brown rockfish produced in the south-central Puget Sound basin.

During August and September 2007, the first phase of this research released three satellite-communicating drifter buoys at Pt Heyer to determine the movement of the top 60 ft. of water during the period when the larval brown rockfish were planktonic, The positions of these drifter buoys were reported every 30 minutes revealing the fine-scale patterns of movement of this water mass for in-put into oceanographic models.

B. Coastal Area Activities

1. Coastal Groundfish Management *(Contact: Heather Reed 360-249-1202, REEDHJR@dfw.wa.gov; and Corey Niles, 360-249-1223, nilescbn@dfw.wa.gov), Intergovernmental Resource Management*

a. Council Activities

The Department contributes technical support for coastal groundfish management issues via participation on the Groundfish Management Team (GMT), the Scientific and Statistical Committee (SSC), and the Habitat Steering Group (HSG) of the Pacific Fishery Management Council (PFMC). The Department is also represented on the Scientific and Statistical Committee and Groundfish Plan Teams of the North Pacific Fishery Management Council. Landings and fishery management descriptions for PFMC-managed groundfish are summarized annually by the GMT in the Stock Assessment and Fishery Evaluation (SAFE) document.

2. Coastal Groundfish Monitoring, Research, and Assessment (*Contact: Theresa Tsou 360-902-2855, TSOUTT@dfw.wa.gov; and Farron Wallace 360-586-6129, WALLAFRW@dfw.wa.gov) Marine Fish Science Unit*

a. Black Rockfish Stock Assessment

The Northern portion of the black rockfish (*Sebastes melanops*) stock found between Cape Falcon, Oregon and the U.S. border with Canada was assessed in 2007. This assessment treats these fish as a separate unit stock. The stock found South of Cape Falcon, Oregon is treated as another unit stock in a different assessment document.

This portion of the U.S. black rockfish stock was last assessed in 1999 (Wallace et al. 1999) with a population dynamics model constructed with AD model builder software (Fournier1997). The current assessment employed Stock synthesis 2 (SS2V2.00c, compiled 3/27/2006) to model the dynamics of this stock. The model was specified to begin in 1915 to ensure population equilibrium at the start of the modeling time period. Catch data were decayed from the last reliable catch estimates (1965) to 0 by 1940. Fisheries catch, size and age compositions were pooled into three fishery types including trawl, sport and non-trawl. The first size-age compositions were collected in the mid 1970's from the trawl fishery, but samples were not collected on a systematic basis until 1985. Growth (Lmin, Lmax and k) was estimated within the model to account for fishery selection of the larger individual fish at age. The population model was tuned to two fisheries-independent indices that include a tagging CPUE (1986-2007) and a tag abundance biomass index (2000-2007), both derived from WDFW black rockfish tagging information. Both STAT and STAR Panel members agreed that the available fishery dependent indices should not be incorporated due to potential bias resulting from bag limit changes and undocumented measures of fishing effort resulting from changes in search time across the time series.

The estimated current spawning biomass was 1,239 mt and unexploited spawning biomass at 2,321 mt, resulting in a current stock level that is 53.4% of the unfished. Several models were explored and all indicate that spawning biomass and age 3+ biomass reached the lowest levels in 1995, following poor recruitment and intense fishing in the late 1980's. Recent increases in biomass are the result of two prominent year classes in 1994 and in 1999. The 1999-year class is estimated to be the largest year class since the beginning of the estimation phase. Most current information suggests that there are no year classes above average since the 1999 recruitment event.

b. 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 2,622, 3,478, 2,779 and 3,200 black rockfish annually. Since 2002, commercial charter vessels have been used, including F/V Hula Girl, F/V Slammer and F/V Tequila Too. A total of 4,089 black rockfish were caught, tagged and released in 2002, 6,744 in 2003, 5,981 in 2004, 3,940 in 2005, 6289 in 2006 and 5780 in 2007. In 2004, passive integrated transponder (PIT) tags were used to reduce the labor needed to read and match recovered tags. In 2005, all tagged fish released were tagged with both CWTs and PIT tags, which will allow estimation of PIT tag loss rates (since CWT loss rates are already known). Tag detection experiments in 2006 indicated that detection of PIT tags during high volume recovery where fish are in the detectors range for less than a second was less than 60%. CWT tag detection was over 95%. Due to this, PIT tags have been excluded from tag releases in 2007.

Fish are released on pinnacles distributed throughout the area fished by the Westport charter fishing fleet. Each CWT tagged fish had two tags placed in the opercular musculature; one on each side of each fish's head. The tags were marked to allow for identification of specific individuals upon subsequent recapture. No tag shedding or tag related mortality was observed during holding experiments during 1998, 1999 and 2003.

On an annual basis, roughly 40% of the total Westport recreational black rockfish catch is sampled for CWT tags by passing fish carcasses through a metal detector tube (Northwest Marine Technologies R8000).

c. Cooperative Rockfish Sampling Survey Update

A join rockfish longline survey with the International Halibut Commission (IPHC) was conducted in 2006 and 2007. There were 25 and 18 rockfish stations added to the existing 27 IPHC survey stations off Washington coast in years 2006 and 2007, respectively. 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. The results from the 2-year experiment showed that the adaptive sampling protocols on average reduced 32% of coefficient of variation of the abundance index when compared with the same sampling survey efforts applied with a random sampling design. Results were presented at the 15th Groundfish conference, 4-8 Feb. Santa Cruz, California, entitled "Adaptive experimental design for rockfish survey along Washington State coast". This is collaboration among WDFW IRM, Marine Resource Unit, Science Division, and IPHC staff.

Table 1. Yelloweye catch summary from 2007 longline survey off Washington coast.

Station ID	Yelloweye caught	Skates	Fish/Skate
1061	1	5	**0.2**
1081	**18**	**5**	**3.6**
1082	**13**	**5**	**2.6**
1083	1	5	**0.2**
1514	18	3	**6.0**
1515	18	3	**6.0**
1516	6	3	**2.0**
1528	**42**	**3**	**14.0**
1529	**63**	**3**	**21.0**
1530	**5**	**3**	**1.7**
1531	**125**	**3**	**41.7**
1533	**33**	**3**	**11.0**
1534	**12**	**3**	**4.0**

d. Pilot Acoustic Tagging Yelloweye Rockfish Study

The current assessment (Wallace etal, 2006) treats the yelloweye stock as a single coastwide assemblage that is currently in a "Overfished Status". The affinity for hard bottom of this fish suggests that they may form stable local populations that, when recognized, could be treated as independent stocks, however, there is no current published information to verify this assumption. The overall goal of this project is to learn more about this species in its natural environment by identifying activity patterns and trends. Managers have little data with which to prioritize protection actions or for monitoring/assessment efforts information. Information gained from this and future projects be used to formulate conservation strategies that are most likely to be effective and efficient in reducing incidental mortalities of Yelloweye rockfish.

This study is designed to assess current technology and our capability to acoustic tag Yelloweye rockfish to quantify the residency and movements of Yelloweye rockfish (Sebastes ruberrimus).

Specifically, the objectives of this project are:

(1) Test current acoustic technology and assess our capability to tag and release Yelloweye rockfish.

(2)Quantify residence time of a small sample of Yelloweye rockfish;

(3) Describe their movement patterns among selected sites in rocky shelf zone;

(4) Test the application of recent advances in acoustic telemetry for the study of essential fish habitat;

(5) Incorporate information into a possibly larger study to better understand residency and movement in a larger geographic scale; and
(6) Provide recommendations to Management on the efficacy of current conservation strategies that will benefit Yelloweye rockfish.

The project relies on a combination of acoustic tagging of Yelloweye rockfish, deployment of acoustic receiving stations and tracking with mobile hydrophones. Study location is off the central Washington coast (15 miles due west of Westport, Washington) in area known by local fishers to have high abundance of Yelloweye rockfish in depths of 70-100 meters. We have focused our efforts on two locations approximately 4 square kilometers in diameter. Acoustic tags were surgically implanted following similar procedures to those successfully used by Starr et al. (2004, 2005) on lingcod in southeast Alaska. This pilot project was limited to our current inventory of 8 acoustic tags and 5 receivers. The receivers were deployed in an array and moored approximately 1-2 m above the seafloor. Fish were tagged and immediately lowered back to depth and released in the catch area located in the central part of the acoustic hydrophone array. Tags are designed for continuous operation over one year in which time the study will conclude and all moorings will be removed or additional specimens will be tagged and released.

Acoustic receiving station data has been recovered periodically over the last 6 months of deployment. Preliminary data analysis suggests that all of the fish tagged and released survived the tagging and decompression process. One fish has shown significant vertical migration over a relatively short time period (hours) before traveling outside receiver range and then returning 10 days later dropping in from the surface (Figure 1). This study will be expanded in summer 2008 to include an additional 30 fish and 14 receiving stations. We are also working with VEMCO Division AMIRIX Systems Inc personnel to test receiving stations that would provide telemetry information to track precise location and movement over time.

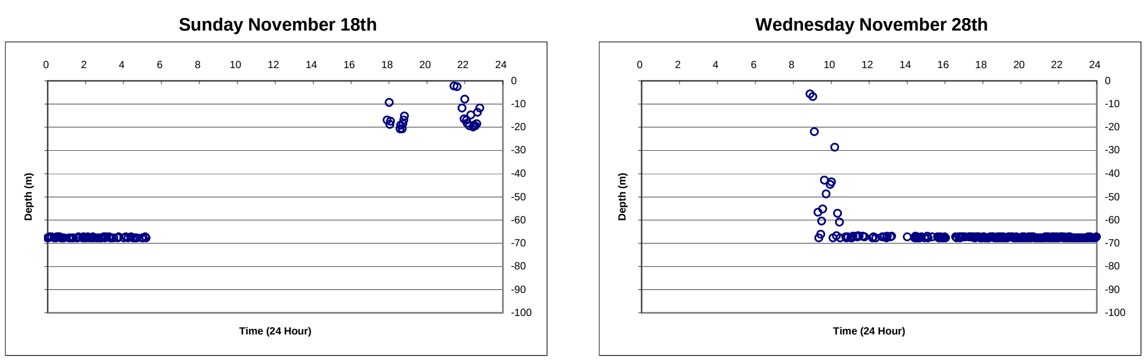


Figure 1. Diurnal patterns of movement from Yelloweye rockfish 950.

California Department of Fish and Game
Agency Report
to the
Technical Subcommittee
of the
Canada-United States Groundfish Committee

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A. AGENCY OVERVIEW

Within the California Department of Fish and Game (CDFG), the Marine Region is responsible for protecting and managing California's marine resources under the authority of laws and regulations created by the State Legislature, the California Fish and Game Commission (CFGC), and the Pacific Fishery Management Council (Council). The Marine Region is unique in the CDFG because of its dual responsibility for both policy and operational issues within the State's marine jurisdiction (0 – 3 miles). It was created to improve marine resources management by incorporating fisheries and habitat programs, environmental review, and water quality monitoring into a single organizational unit. In addition, it was specifically designed to be more effective, inclusive, comprehensive, and collaborative in marine management activities.

The Marine Region has adopted a management approach that takes a broad perspective relative to resource issues and problems. This ecosystem approach considers the values of entire biological communities and habitats, as well as the needs of the public, while ensuring a healthy marine environment. The Marine Region employs approximately 200 permanent and seasonal staff that provide technical expertise and policy recommendations to the CDFG, CFGC Council, and other agencies or entities involved with the management, protection, and utilization of finfish, shellfish, invertebrates, and plants in California's ocean waters.

B. MULTISPECIES STUDIES

1. Research and Monitoring

a. Commercial Fishery Monitoring

Statistical and biological data from landings are continually collected and routinely analyzed by CDFG to provide current information on groundfish fisheries and the status of the stocks. California's primary commercial landings database is housed in CDFG's Commercial Fisheries Information System. Outside funding also enables California fishery data to be routinely incorporated into regional databases such as Pacific Coast Fisheries Information Network (http://www.psmfc.org/pacfin).

Contributed by Bob Leos (831.649.2889)

b. Recreational Fishery Monitoring

The California Recreational Fisheries Survey (CRFS) began in January 2004 to provide catch and effort estimates for marine recreational finfish fisheries. The CRFS generates monthly estimates of total recreational catch for four modes of fishing (beach/bank and shore, piers and jetties, commercial passenger fishing vessels, and private vessels launched from public launch ramps) for six geographic districts along California's 1,000 plus miles of coast. The data are used by state and federal regulators to craft regulations to protect fish stocks and provide recreational fishing opportunities. The sampling data and estimates are available on the Recreational Fisheries Information Network (http://www.recfin.org).

The CRFS is a multi-part survey which uses field sampling and telephone surveys. In 2007, approximately 45 samplers worked to gather the field data. The CRFS samplers interviewed more than 98,000 anglers at 414 sites, and examined almost 194,000 fish. The licensed angler telephone survey completed almost 26,000 interviews in 2007 which is comparable to the number completed in 2006.

A review of the first three years of CRFS data was undertaken in 2007 to improve the analyses and estimation procedures. This resulted in changes to the number of trip types, the district boundaries, and effort estimation procedures. In 2008, the CRFS program will begin to conduct studies to verify the estimates of effort for night fishing and for boats that depart from and return to private marinas. For more information, go the CDFG's Marine Region website: http://www.dfg.ca.gov/marine/crfs.asp.

As a condition of their fishing permit, operators of commercial passenger fishing vessels are required to submit a record of their fishing activities on a log provided by the CDFG. The operators must complete and submit a log of each fishing trip. Each log documents the target species, the fishing method, the type of bait, the number and type of fish landed or released, the number of anglers and hours fished, and the location where most of the fish were caught. In 2007, more than 29,000 logs were received by CDFG and processed. The database is maintained in CDFG's Commercial Fisheries Information System.

Contributed by Connie Ryan (650.631.2536)

c. In-season Monitoring

The CFGC has authority under state law to manage nearshore species (as defined by the state's Marine Life Management Act and the Nearshore Fisheries Management Act). The CFGC has given CDFG the authority to take action as a routine management measure to close the recreational and/or commercial sectors of the cabezon, California sheephead, and greenling fisheries upon projected attainment of their respective established optimum yields and fishery allocations. The CDFG also has authority to make in-season trip limit adjustments to the commercial fisheries for cabezon, California sheephead, and greenlings. In 2006 and 2007, the CDFG made in-season adjustments to the commercial cabezon fishery. The September-October cumulative two-month trip limit was reduced from 900 pounds to 200 pounds per nearshore permit holder, allowing the fishery to remain open for the year rather than closing early, which had occurred in the two previous years. Currently, in-season monitoring is used to track landings against statewide total allowable catches, statewide and/or regional allocations, and trip limits.

The CDFG has additional authority to take in-season action to modify management measures or close the recreational fishery for groundfish if harvests are projected to exceed or be well below federally-established harvest guidelines. This authority was exercised in September 2007 to conform to the federal action that closed the recreational fishery in the Northern (Oregon border to the 40°10' North latitude line located just below Cape Mendocino) and North-Central Groundfish Management (40°10' line to Pigeon Point at 37°11' North latitude) areas effective October 1, 2007 due to unanticipated high catches of yelloweye rockfish, a federally-designated “overfished” species.

In-season monitoring of California commercial nearshore species landings is now conducted by CDFG biologists in the areas north and south of the 40°10’ line. South of Pigeon Point, monitoring is further delineated at Lopez Point (36°00’ North latitude) and Point Conception (34°27’ North latitude). This work is done in conjunction with in-season monitoring, management, and regulatory tasks conducted by the Council. CDFG biologists are currently analyzing landings data and evaluating alternative two-month trip limits for the nearshore fisheries, north and south of the 40°10’ line, in preparation for the 2009-2010 regulatory management cycle. The take of minor nearshore rockfishes between the Oregon border and the 40°10’ line may also be specifically addressed. Since 2005, the fishery has exceeded the federal harvest guideline limits in this area primarily due to the take of blue rockfish. Various options are being explored regarding the black and blue rockfish trip limit structure for the Northern management area. Additionally, work has begun on more in-depth monitoring and analyses of the associated bycatch of yelloweye rockfish. This is a stock of special concern for both the commercial and recreational sectors since it is a key constraining species in the take of other rockfish species.

Contributed by Bob Leos (831.649.2889)

d. Study on the Effects of Allowing Limited Entry Trawl Permit Holders to Fish Fixed Gear

Exempted fishing permits issued by the federal National Marine Fisheries Service (NMFS) allow the permit holders to conduct experimental fisheries that are exempt from annual fishing regulations. The Nature Conservancy and Environmental Defense Fund (co-sponsored by CDFG) submitted an application for an exempted fishing permit to allow a harvesting cooperative (using limited entry trawl permits) to test hook-and-line and trap gears in central California to target groundfish, primarily sablefish. This exempted fishing permit was recommended by the Council.

Contributed by Joanna Grebel (831.649.2804)

e. Cooperative Research and Assessment of Nearshore Ecosystems (CRANE)

In 2004, The CDFG and nine partners (including universities and other government agencies) completed a cooperative sampling effort to provide information for managing California’s nearshore rocky reef fish and invertebrate populations. This information was gathered for fishery management purposes as well as to evaluate rocky reef ecosystems as a whole. Specifically, the objectives of CRANE were to 1) estimate the density of nearshore fish and invertebrates that are subject to fisheries, 2) measure the size structure of these populations, and 3) measure habitat and ecosystem components that can be associated with changes in density and size distributions over space and time.

Divers surveyed depths from 6 to 20 meters. A subset of the sites was surveyed to a depth of 100 meters using remotely operated vehicles (ROVs). The report documenting the snapshot scuba effort and the results from sampling 88 sites in 2004 was released in 2006. The same report also reviews historical abundance and size information from select sites.

With funding from the Coastal Impact Assistance Program, the 2004 CRANE study provided a unique opportunity for several groups of researchers to survey a broad segment of the California coastline over a relatively short period of time. The CRANE sampling protocol has been integrated into the monitoring program for Marine Protected Areas (MPAs) in the northern Channel Islands. In addition, data collected by CRANE was used in the Marine Life Protection Act (MLPA) process in central California (see sections D.1. and D.2. of this report).

From 2005 through 2007, sampling activities by a subset of the original collaborators focused on density measurements and size frequency of nearshore fish and invertebrate populations at select locations. These locations were primarily inside and outside of established MPAs at the Channel Islands and in areas of the central coast where MPAs are being considered. In 2008, the State's Ocean Protection Council in coordination with CDFG, is providing funding for a study similar in scope , but smaller in size than the original 2004 CRANE effort.

Contributed by Dave Osorio (831.649.7195)

2. Management

a. 2007 State Management Measures Affecting Groundfish

The following management measures were continued as *status quo*. These management measures are designed to limit catches of "overfished" cowcod, bocaccio, canary, darkblotched, widow, and yelloweye rockfishes.

- Commercial *status quo* measures:
  - The boundaries of the trawl rockfish conservation area (RCA) closure north of the 40°10' line remained at 75 – 250 fathoms for two-month management periods 1, 2 and 6; 75 – 200 fathoms for periods 3 and 4; and, 100 – 200 fathoms during period 5.
  - The boundaries of the trawl RCA closure south of the 40°10' line remained at 100 – 150 fathoms year-round, except between the 40°10' line and Pt. Reyes (38°00' North latitude) for periods 1 and 6 where a modified boundary of 100 – 200 fathoms continued.
  - The boundaries of the non-trawl RCA closure north of the 40°10' line remained at 30 – 100 fathoms year-round.
  - The boundaries of the non-trawl RCA closure south of the 40°10' line remained at 30 – 150 fathoms between the 40°10' line and Pt. Conception, and 60 – 150 fathoms south of Pt. Conception year-round.

- The season lengths for groundfish in waters off California remained the same as for 2006[5].

- Recreational *status quo* measures for groundfish including rockfish, lingcod, cabezon, greenlings, and associated state-managed species (rock greenlings, California sheephead, and ocean whitefish) included season length and depth/area closures with exceptions for fishing for sanddabs and “other flatfish”:
  - Northern Groundfish Management Area (Oregon border to the 40°10’ line):
    - Season length[2]: Open May through December; open May through November for lingcod.
    - Depth restrictions: Fishing allowed shoreward of the 30 fathom contour line May through December.
  - North-Central Groundfish Management Area (40°10’ line to Pigeon Pt.):
    - Season length[6]: Open June 1 through November 30
    - Depth restrictions: Fishing allowed shoreward of the 30 fathom contour line June through November.
  - South-Central Groundfish Management Area (Pigeon Pt. to Pt. Conception):
    - Season length: Open May 1 through November 30
    - Depth restrictions: Fishing allowed shoreward of the 40 fathom contour line May through November.
  - South Groundfish Management Area (Pt. Conception to U.S./Mexico border):
    - Season length: Open March through December for rockfish, cabezon and greenling. Open April through November for lingcod. Open year-round for California scorpionfish.
    - Depth restrictions: Fishing allowed shoreward of the 60 fathom contour line March through December.
  - Cowcod Conservation Areas (in federal waters near San Diego):
    - Season length: Open March through December for nearshore rockfish, cabezon, greenling, ocean whitefish, and California sheephead. Open April through November for lingcod. Open year-round for California scorpionfish.
    - Depth restrictions: Fishing allowed in waters less than the 20 fathom contour line.

Contributed by Joann Graebel (831.649.2804)

[5] The commercial fishery for greenling closed August 1, 2007 for the remainder of the year, and the commercial fishery for California sheephead closed October 1, 2007 for the remainder of the year due to exceeded allocations.

[6] The recreational fishery for federally managed groundfish was closed to boat-based anglers as of October 1, 2007 north of 37°11’North latitude due to exceeding the harvest guidelines of canary and yelloweye rockfish.

b. Nearshore Management

In 2002, the CFGC adopted the State's Nearshore Fishery Management Plan (FMP) for 19 species (black, black-and-yellow, blue, brown, calico, China, copper, gopher, grass, kelp, olive, quillback, and treefish rockfishes; cabezon; kelp and rock greenlings; California scorpionfish; California sheephead; and monkeyface prickleback). All but California sheephead, rock greenling and monkeyface prickleback are also included in the Council's federal Groundfish FMP. The Nearshore FMP is based on a framework management approach that gives the CFGC a comprehensive management strategy to prevent overfishing, rebuild depressed stocks, ensure conservation, promote habitat protection and provide for non-consumptive uses.

The CFGC adopted seasonal closures, total allowable catch, and trip limits for cabezon, kelp greenling, and California sheephead. Additionally, the CFGC provided CDFG with authority to close any of these fisheries upon attainment of the total allowable catch. Seasonal closures coincide with federal groundfish closures in waters off the state of California.

Contributed by Traci Larinto (562.342.7111)

c. Restricted Access for Nearshore Fisheries

The State of California began a restricted access program for the commercial nearshore fishery in 2003. The Nearshore Fishery Permit is required to take 10 shallow nearshore species: black-and-yellow, gopher, kelp, China, and grass rockfishes, kelp and rock greenlings, California scorpionfish, California sheephead, and cabezon. The Nearshore Fishery Permit program was set up on a regional basis with four regions: North Coast Region (Oregon border to the 40°10' line), North-Central Coast Region (40°10' line to Point Año Nuevo at 37°06' North latitude), South-Central Coast Region (Point Año Nuevo to Point Conception), and South Coast Region (Point Conception to the U.S./Mexico border). Nearshore Fishery Permit holders may only take these nearshore species within the region for which the permit is issued. Both transferable and non-transferable Nearshore Fishery Permits are issued.

A permit capacity goal was set for each nearshore region: 14 for the North Coast Region, 9 for the North-Central Coast Region, 20 for the South-Central Coast Region, and 18 for the South Coast Region. Until a region reaches its capacity goal, transferability is on a two-for-one basis, whereby two permits are purchased, one is retired and the other is used to fish. When the program began in 2003, a total of 224 permits were issued. In 2007, the number of permit decreased to 195; however the number of permits in each region remains above its respective capacity goal.

The Nearshore Fishery Bycatch Permit program, which was started in 2003, authorized the take, possession, and landing of shallow nearshore species by vessels using only trawl or entangling nets (gill and trammel nets). Twenty-one Nearshore Fishery Bycatch Permits were issued in 2007.

A Deeper Nearshore Species Fishery Permit program was also implemented in 2003. This permit allows the take of the following eight species of deeper nearshore rockfishes: black, blue, brown, calico, copper, olive, quillback, and treefish. The permit is non-transferable, because there is no capacity goal for the fishery. Permit holders may catch and land these species anywhere in the state where fishing is allowed. A total of 294 permits were issued in 2003; the number of permits issued decreased to 240 in 2007.

Contributed by Traci Larinto (562.324.7111)

C. By Species

1. Pacific Whiting

a. Primary Whiting Season

California shore-based landings of trawl-caught Pacific whiting (*Merluccius productus*) totaled 2,967 metric tons in 2007, 3.4 percent of the 87,398 metric ton optimum yield for the United States shore-based sector. Landings in 2007 represented a 45 percent decrease from the 5,428 metric tons landed in 2006.

Seven vessels targeted whiting with trawl gear during the 2007 primary season. The primary whiting season in California waters north of Cape Mendocino (40°30' North latitude) commenced April 1, 2007. The area south of Cape Mendocino opened April 15, 2007. The last California landings occurred on May 29, 2007. On July 26, 2007, NMFS closed the primary season when an estimated 220.7 metric tons of widow rockfish were taken. The season reopened October 7 after NMFS adjusted the widow rockfish optimum yield to 275 metric tons, and the season concluded on December 31, 2007.

Contributed by Mike Fukushima (707.441.5797)

b. Shoreside Whiting Exempted Fishing Permit Fishery

Six midwater trawlers participated in the 2007 exempted fishing permit fishery, and landed 2,959 metric tons of unsorted whiting at two designated processing plants. The trawlers fished under the provisions of an exempted fishing permit, which required maximized retention of total catch, and allowed them to land unsorted whiting catches at designated processing plants without penalty for taking prohibited species or exceeding federal groundfish trip limits.

Fishery technicians observed 10 of 53 exempted fishing permit deliveries in California (18.9 percent observation rate). The observed landings included 547.6 metric tons of whiting, 643 kilograms of rockfish, 82 kilograms of other groundfish, and 10 Chinook salmon (54 kilograms total weight). The bycatch rates for the observed exempted fishing permit deliveries were 0.02 salmon per metric ton of whiting and 1.3 kilograms groundfish per metric ton of whiting.

The total bycatch for all exempted fishing permit whiting vessels weighed 22.4 metric tons. The bycatch included 567 Chinook salmon (1.4 metric tons total) for a harvest rate of 0.19 salmon per metric ton of whiting. Rockfish bycatch amounted to 22.3 metric tons with a harvest rate of 7.5 kilograms rockfish per metric ton of whiting.

The 2007 exempted fishing permit fishery included bycatch caps for widow, canary, and darkblotched rockfishes. The bycatch caps were: 275 metric tons for widow rockfish, 4.7 metric tons for canary rockfish, and 25 metric tons for darkblotched rockfish. The bycatch of these species by the California whiting fishery was far below each cap. The catches were 1.0 metric ton of widow rockfish, 1.3 kilograms of canary rockfish, and 0.8 metric tons darkblotched rockfish.

Contributed by Mike Fukushima (707.441.5797)

2. Chilipepper Rockfish

Three exempted fishing permit applications were submitted to the Council at its November 2007 meeting. Two proposals were designed to test different hook-and-line gear configurations and strategies to selectively target chilipepper rockfish in federal waters. Another proposal was designed to test the use of recreational hook-and-line gear to catch chilipepper and slope rockfish in commercial passenger fishing vessels. Two of the applications were approved by the Council.

Contributed by Joanna Grebel (831.649.2804)

3. Kelp Greenling

The kelp greenling (*Hexagrammos decagrammus*) is one of the19 nearshore finfish species in California's Nearshore FMP. It inhabits nearshore kelp beds and rocky reefs to a depth of 150 feet, and is harvested by recreational and commercial fisheries from Point Conception to the Oregon border. Little is currently known about kelp greenling population dynamics, and kelp greenling was listed as having a "data-poor" status in a 2005 stock assessment review. Specifically, there is lack of sound scientific data pertaining to age and growth, maturity, abundance, distribution, and size class structure. The CDFG's Fisheries Independent Scuba Assessment Project initiated an age, growth, and maturity study in November 2007. The specific objectives of the study are to: 1) determine age and growth parameters of kelp greenling using otoliths from all size classes and sexes; 2) verify periodicity of growth band formation by otolith edge analysis, and marking captive fish with oxytetracycline; 3) estimate length/age at maturity by visual and histological inspection of reproductive tracts; and 4) determine spawning season by comparing monthly gonadosomatic and hepatosomatic indices.

The results of this study will greatly increase our knowledge of kelp greenling population dynamics. Data collected for this study will enhance future stock assessments of kelp greenling by providing validated age, growth, and length and age at maturity estimates, as well as details on duration of spawning season. Information from this study will enhance CDFG's ability to make better informed management decisions for kelp greenling.

Contributed by Sean Hoobler (831.649.2847)

4. Cabezon

The cabezon (*Scorpaenichthys marmoratus*) is one of the 19 nearshore finfish species in California's Nearshore FMP. There is limited information available on population abundance, natural mortality, and changes in biomass. In addition, previous age estimates for cabezon have not been validated. The CDFG's Fisheries Independent Scuba Assessment Project has initiated two studies. The first study is a multiple mark-recapture survey to estimate population abundance, survival and mortality rates of cabezon in Carmel Bay, from Cypress Point to Yankee Point. The study area encompasses three MPAs, allowing reserve affects to be investigated. Cabezon will be captured across a wide size distribution, preferred depths, and habitats. The second study is for age validation. Chemical age validation techniques will be used, because otolith edge analysis methods were unsuccessful in validating cabezon ages in previous studies. Cabezon held in local aquariums will be injected with oxytetracycline or calcein, marked externally for individual identification, and then sacrificed after one year. Periodicity of growth band formation can then be validated. The results of these studies as well as a similar study underway in Morro Bay will provide more information on abundance and mortality for use in future stock assessments and management decisions.

Contributed by Diane Haas (831.649.2994)

5. Blue rockfish

In 2007, a stock assessment for blue rockfish (*Sebastes mystinus*) was conducted to determine the stock's status in California waters from the Oregon border to Point Conception, where blue rockfish are most commonly found. The variability in growth over time and between areas along the coast of California were evident while assessing this stock, but the lack of sufficient data did not allow for the complex modeling needed to appropriately assess blue rockfish. Genetic evidence also suggested two species of blue rockfish in California, so the status report is considered an assessment of a blue rockfish "complex" instead of a single species. Items of major uncertainty in the assessment included emerging evidence of two separate species, infrequent encounters with males, evidence for variable growth rates over space and time, accuracy of reconstructed historical catches back to 1916, and uncertainties regarding natural mortality.

The stock assessment team felt strongly that the decision table represented an asymmetrical picture of uncertainty; the higher likelihood scenarios representing the base case and higher natural mortality resulted in outcomes that placed the status of the stock between 30 to 50 percent of unfished biomass, which is within the "precautionary" zone. In California's Nearshore FMP, the "overfished" threshold for blue rockfish is 30 percent of the unfished biomass. However, fishing mortality rates have been above both state and federal target levels in recent years, suggesting that overfishing has been occurring. The assessment team advised that this assessment be used with caution for management purposes. In November 2007, the Council adopted the assessment for use in management in spite of uncertainties and concerns regarding the data quality and identification of two species of blue rockfish. These results are now being used to develop nearshore fishery regulations for the 2009-2010 management season.

Contributed by Meisha Key (831.420.3973)

D. OTHER RELATED ACTIVITIES AND STUDIES

1. Marine Life Protection Act (MLPA) Process

The MLPA, passed by California State Legislature in 1999, requires CDFG to develop a network of MPAs to protect species abundance and diversity, and preserve ecosystem integrity. Over the past year, significant advances have been made towards the successful implementation of the MLPA and the development of a cohesive statewide network of MPAs. Previous attempts at MLPA implementation on a statewide level through a single action were unsuccessful. As a result, the state was split into five separate study regions and is now a public-private partnership commonly referred to as the Marine Life Protection Act Initiative. The first (Central Coast) of five study regions was completed, and the second study region (North Central Coast) is nearing completion. The order for completion of the remaining three study regions is as follows: South Coast, North Coast, and San Francisco Bay. The expected completion date for all five study regions is around 2011.

The MPAs fall into five categories:

- State Marine Reserve – Area that protects rare or endangered plants, animals, habitats, communities or ecosystems. Access is limited to research, while non-consumptive use may be allowed.
- State Marine Park – Area that protects rare or endangered plants, animals, habitats, communities or ecosystems; or contributes to our understanding of marine ecosystems; or preserves cultural objects or geologic features. Access for research and non-consumptive use is encouraged, while recreational harvest may be allowed.
- State Marine Conservation Area – Area that protects rare or endangered plants, animals, habitats, communities or ecosystems; or contributes to our understanding of marine ecosystems, preserves geologic features or provides for sustainable harvest. Access for research and non-consumptive use is encouraged, while recreational and commercial harvest may be allowed.

- State Marine Cultural Preservation Area – Area that protects cultural objects of historical, archeological or scientific interests. The only restrictions are regarding the cultural object, no other uses are restricted.
- State Marine Recreational Management Area – Area that limits or restricts recreational activity. No other uses are restricted.

Central Coast Study Region: The Central Coast Study Region extends from Pigeon Point south to Point Conception. After multiple public meetings and hundreds of public comments, the CFGC voted unanimously on April 13, 2007 to establish a network of 29 MPAs covering approximately 204 square miles of state waters or about 18 percent of the study region (Table 1). The new MPAs went into effect in September 2007, and include about 85 square miles (7.5 percent) of "no-take" state marine reserves.

Table 1. Central Coast Region MPAs.

Type of MPA (number)	Area (square miles) of MPAs in Central Coast	Percent of Central Coast State Waters
State Marine Reserve (13)	85.34	7.42
State Marine Park (1)	6.35	0.55
State Marine Conservation Area (5)	112.19	9.76
Total (29)	**203.88**	**17.73**

North Central Coast Study Region: The North Central Study Region extends from Alder Creek near Point Arena (38° 55' North latitude) south to Pigeon Point. Three proposals for a network of MPAs in the North Central Coast Study Region (Table 2) will be formally presented to the Blue Ribbon Task Force on April 22, 2008. The proposals are the result of eight public workshops, eight formal meetings and three work sessions of the Regional Stakeholder Group, seven meetings of the Blue Ribbon Task Force, eight meetings of the Science Advisory Team, and four telephone meetings of the Statewide Interests Group. The three proposals will undergo scientific and feasibility evaluations by CDFG, and the Blue Ribbon Task Force will forward their recommended preferred alternative to the CFGC. The CFGC is the ultimate decision-making body in the MLPA process and has the sole authority to adopt proposed MPAs after their own public process.

Table 2. North Central Coast Region MPA proposals.

Proposal	Total Area (square miles) of all proposed MPAs	Proposed percentage of state waters in Study Region in no-take State Marine Reserves	Proposed percentage of state waters in Study Region in State Marine Conservation Areas	Proposed percentage of state waters in Study Region in State Marine Parks
Proposal 1-3	164.62	11.43	10.13	0.01
Proposal 2-XA	137.51	8.91	9.03	0.09
Proposal 4	204.89	13.76	12.72	0.37

South Coast Study Region: Initial preparations in the South Coast Study Region, which extends from Point Conception to the U.S./Mexico border, will begin early summer 2008. The overall planning process will be similar to those of the Central Coast and the North Central Coast Study Regions. Initial public informational workshops will be held, and a South Coast Regional Stakeholder Group, Blue Ribbon Task Force, and Science Advisory Team will be announced. The MPA proposals will continue to largely be the creation of the South Coast Regional Stakeholder Group, based upon scientific guidance from the Science Advisory Team, policy guidance from the Blue Ribbon Task Force, feasibility guidance from CDFG, and overall support from Marine Life Protection Act Initiative staff.

Further information can be found at: http://www.dfg.ca.gov/mlpa.

Contributed by Elizabeth Pope-Smith (707.445.5301)

2. Research on and Monitoring of Marine Protected Areas (MPAs)

a. Overview of MPA Monitoring

One of the primary requirements of the MLPA is adaptive management. To facilitate this requires a comprehensive monitoring program to measure performance of MPAs relative to stated goals and regional objectives. This comprehensive monitoring program is being developed through collaboration between CDFG and the MPA Monitoring Enterprise. The MPA Monitoring Enterprise was created through the State's Ocean Protection Council and the Ocean Sciences Trust to coordinate the development of the MPA monitoring program, to house and analyze monitoring data, and synthesize results in a manner that assists managers and policy makers in adaptive management decisions. The MPA Monitoring Enterprise is currently in the process of developing monitoring priorities and a monitoring framework for the regional and the statewide networks of MPAs.

- *Central Coast MPA Monitoring Program (Pigeon Point to Point Conception, CA):* In April 2007, the CFGC adopted 29 MPAs along the central coast of California. This represents the first of five regional networks of MPAs (as discussed above). The large scale of the system of MPAs in California inhibits the ability of any single entity to effectively monitor and evaluate the MPA network. Therefore the monitoring program must be based on collaboration with other agencies, academic institutions, nongovernmental organizations, and existing monitoring programs.

  The first step in developing a monitoring program and evaluating the network of MPAs was to create a baseline from which to measure change. The Central Coast MPA Baseline Data Collection Project was a collaborative effort between the State Coastal Conservancy, the State's Ocean Protection Council, CDFG, and California Sea Grant Program. Approximately $2.2 million was available as a competitive grant for projects to collect baseline performance indicator data for biophysical and socioeconomic systems that could be used to compare MPAs to fished reference areas and establish trends and track changes to measure the effectiveness of the MPAs relative to regional and individual MPA goals and objectives. A total of five projects to gather baseline information were funded in June 2007. These included investigations of rocky shore intertidal communities, underwater diver surveys of kelp communities, deep water and submarine canyon habitats using a manned submersible, a collaborative fishing study using recreational charter boats and volunteer anglers to collect species composition, life history, and catch rate information, and, lastly, a socioeconomic study of human use patterns. These projects completed field work in March 2008 with the results and final reports expected in early summer 2008.

One critical component that was not funded through the Central Coast MPA Baseline Data Collection Project was surveys of deepwater habitats beyond the range of scuba divers, which can be accomplished using ROVs. The CDFG has an ROV project (see section D.2.(b), below) that will monitor MPAs throughout California within the depth range typically between 20 – 200 meters or more. The ROV project will conduct baseline data collection in the Central Coast Region in 2008.

- *North Central Coast MPA Monitoring Program:* The MPA Monitoring Enterprise is currently developing a monitoring framework and monitoring priorities for the North Central Coast Region and baseline data collection priorities will be determined. The North Central Coast Regional Stakeholders Group has submitted final draft MPA proposals to the Science Advisory Team for evaluation and to the Blue Ribbon Task Force for consideration. The Blue Ribbon Task Force is expected to recommend a preferred alternative to the CFGC in late spring of 2008. Following adoption of a regional network of MPAs and pending funding for baseline data collection, a North Central Coast MPA Baseline Data Collection Project will be developed similar to that of the Central Coast Region.

- *Channel Islands MPA Monitoring Program:* In 1998, prior to enactment of the MLPA, a group of concerned citizens requested the CFGC establish a series of MPAs in the northern Channel Islands. Following a long process, the Channel Islands MPAs were implemented in 2003. Though not created under the MLPA, the Channel Islands MPAs will be considered in the MLPA process in the South Coast Region. Monitoring of the Channel Islands MPAs has reached its five year comprehensive evaluation. A special session dedicated to the five year evaluation was held at the California Islands Symposium on February 7 – 8, 2008. Monitoring projects included biophysical and socioeconomic-human use investigations. Please see http://www.dfg.ca.gov/marine/channel percent5Fislands/ for more information on the Channel Islands MPA monitoring.

Contributed by Jason Vasques (831.649.7113)

b. Remotely Operated Vehicle (ROV) Research

Since 2003, the CDFG has used a ROV to survey fish populations and habitat in the Channel Islands MPAs. This effort was expanded in 2007 when CDFG conducted the first annual quantitative surveys in MPAs in the Central Coast Region from Monterey Peninsula to Point Lobos. The primary objective of the ongoing research is to evaluate MPA effectiveness by monitoring changes in finfish density within areas of predominantly rocky habitat that are beyond the depth limit of scuba based sampling. The CDFG and its partners are committed to developing a statewide nearshore monitoring program that provides data for both fisheries management and MPA assessment.

During August 2007, surveys were conducted at the Channel Island MPAs aboard the Channel Islands National Marine Sanctuary's R/V *Shearwater*. Substrate and finfish abundance was quantitatively sampled within the 10 priority sampling sites in nine days. Five of the sampling sites were located within marine reserves near San Miguel, Santa Rosa, Santa Cruz, and Anacapa islands, and the other five reference sites were outside and adjacent to the reserve sites. All reference sites were selected for comparable habitat in nearby areas open to some level of fishing. These 10 permanent sampling sites are composed of 500 meter wide rectangles that span a depth range from 20 to 70 meters. At each of the 10 sites, randomly selected 500 meter track lines are surveyed annually and are subsequently broken into finfish density transects.

In September and October 2007, survey efforts focused on completing two experiments to validate the fish measurement method. The objective of these experiments was to quantify the accuracy of sizing fish using paired lasers set 11 cm apart by "painting" fish or adjacent substrate. The accuracy of this method was tested using varying sized models of commonly observed finfish species that were deployed by scuba divers.

The survey along the central coast was conducted aboard CDFG's patrol vessel *Steelhead* in August 2007. Selected MPAs were quantitatively sampled for substrate and finfish abundance. A total of nine survey sites were located within the four selected MPAs from the Monterey Peninsula at Pacific Grove to Point Lobos. The 2008 surveys will include sites adjacent to MPAs with similar habitat in areas open to fishing. In addition, in 2008 surveying will occur within and adjacent to additional MPAs.

Refinements to the field protocols over the last four years have increased data collection efficiency and allowed for real-time determination of the amount of predominantly rocky habitat sampled. During the 2007 Channel Islands MPA surveys, 70 kilometers of seafloor were covered in nine days, averaging 8.9 kilometers of track line completed per day, an increase compared to 6.4 kilometers in 2006, 5.6 kilometers in 2005, and 5.4 kilometers in 2004.

The location of derelict fishing gear is noted when encountered during the surveys. One such piece of gear located in 2005 was a large 2 metric ton purse seine net which was later removed off the eastern end of Santa Rosa Island from a depth of 4 – 5 fathoms.

For more information on ROV sampling protocols and research cruises, see the CDFG web site at www.dfg.ca.gov/marine.

Contributed by Kon Karpov (707.964.7298)

c. Baseline abundance estimates of nearshore species in Carmel Pinnacles State Marine Reserve, Carmel Bay

Carmel Pinnacles State Marine Reserve was established in September 2007 as one of 29 newly designated MPAs along the central coast of California. To date, there are no abundance estimates for the fish community at the high-relief rocky reef habitat of the Carmel Pinnacles State Marine Reserve. Staff from CDFG's Fisheries Independent Scuba Assessment Project will collect baseline data in 2008, and will monitor changes over time in the fish population at the Carmel Pinnacles State Marine Reserve. The study will estimate: 1) abundance of fishes in a state marine reserve at inception of protected status using CPUE, mark-recapture, and ROV survey data; 2) size frequency and sex distribution of several fish species; and 3) movement of individual fishes in and out of the reserve.

Staff will conduct a mark-recapture study to generate CPUE and abundance estimates for the area. Hook-and-line and possibly trap fishing gear will be used to catch and subsequently recapture groundfish species. Lingcod, cabezon, kelp greenling, and some rockfishes will be tagged with small T-bar anchor tags.

Data collected will enhance management of nearshore species by increasing knowledge of abundances relative to MPA design and placement. Collecting baseline data on the fish population at the Carmel Pinnacles State Marine Reserve is valuable for future monitoring efforts of MPA effectiveness. This type of fishery-independent study has not been undertaken for this site and data collected may provide useful information for stock assessments for some "data-poor" species. This project will be an ongoing study, using multiple sampling events to capture year-to-year variation in the fish population. This work will complement a similar study being undertaken at the south end of Carmel Bay by California State University students from Moss Landing Marine Laboratories.

Contributed by Scot Lucas (831.649.7101)

3. Evaluation of State-managed Trawl Fisheries

In response to the new and amended state laws, CDFG created a new project, State Fisheries Evaluation Project, with six full time positions to evaluate the state-managed trawl fisheries for California halibut, Pacific ocean shrimp (pink shrimp), sea cucumber, and ridgeback prawn. In January of 2007, these new staff began addressing the specific habitat requirements prescribed in the Halibut Trawl Bill that pertain to California halibut and pink shrimp trawl fisheries operating in state waters. The statutory time line required the CFGC to make a determination about whether or not to allow bottom trawling for pink shrimp in state waters, also known as the Pink Shrimp Trawl Grounds, by January 1, 2008, and a determination about whether or not to close 42 percent of the California Halibut Trawl Grounds by April 1, 2008. Reports with comprehensive description of both the pink shrimp and California halibut trawl fisheries within state waters were prepared and submitted to the CFGC in 2007 and 2008, respectively. A report on bycatch reduction devices used in the pink shrimp trawl fishery was also prepared for the CFGC in 2008. The following specific activities were carried out by the project in 2007:

- Produced spatial description of the Pink Shrimp Trawl Grounds and California Halibut Trawl Grounds. Spatial polygon map layers are available from the State Fisheries Evaluation project.
- Compiled data on benthic substrate and structure forming benthic organisms present in Pink Shrimp Trawl Grounds and California Halibut Trawl Grounds. Draft hydrographic survey data provided by United States Geological Survey and California State University Monterey Bay Seafloor Mapping Lab were used to identify areas of rocky habitat within the proposed closures within the California Halibut Trawl Grounds.
- Created a spatial representation of trawl effort from logbook data. Maps of trawling effort were produced for the Pink Shrimp Trawl Grounds (Figure 1). A spatial index of trawling intensity was created for the California Halibut Trawl Grounds (Figure 2).
- Summarized trawl catch and economic value for pink shrimp and California halibut inside and outside of the state trawl grounds and proposed closures.
- Identified known and unknown impacts of trawl gear on bottom habitat, kelp restoration, ecosystem and other biogenic habitats in state waters.
- Collaborated with CDFG's ROV project to investigate an area of uncharacterized rocky seafloor within the California Halibut Trawl Grounds off of Carpenteria, California.
- Project staff captured *in situ* video of a trawl net and trawl doors aboard a vessel that actively fishes within the California Halibut Trawl Grounds.
- Collaborated with the Southern California Trawlers Association and California Sea Grant to conduct a bycatch study within the California Halibut Trawl Grounds.

Project Reports

CDFG. 2007. Information regarding the pink shrimp trawl fishery off northern California. California Department of Fish and Game, Marine Region, State Fisheries Evaluation Project. 25p. www.dfg.ca.gov/marine/pdfs/pinkshrimp.pdf.

CDFG. 2008. Information concerning the California halibut trawl fishery off southern California. Draft report to the California Fish and Game Commission, California Department of Fish and Game, Marine Region, State Fisheries Evaluation Project. 34 p.

CDFG. 2008. Review of California halibut trawl fishery in the California Halibut Trawl Grounds. Draft supplemental report to the California Fish and Game Commission, California Department of Fish and Game, Marine Region, State Fisheries Evaluation Project. 10 p.

CDFG. 2008. Information on the bycatch reduction devices used in the pink shrimp trawl fishery. Draft report to the California Fish and Game Commission, California Department of Fish and Game, Marine Region, State Fisheries Evaluation Project. 10 p.

Contributed by Mike Prall (707.441.5754)

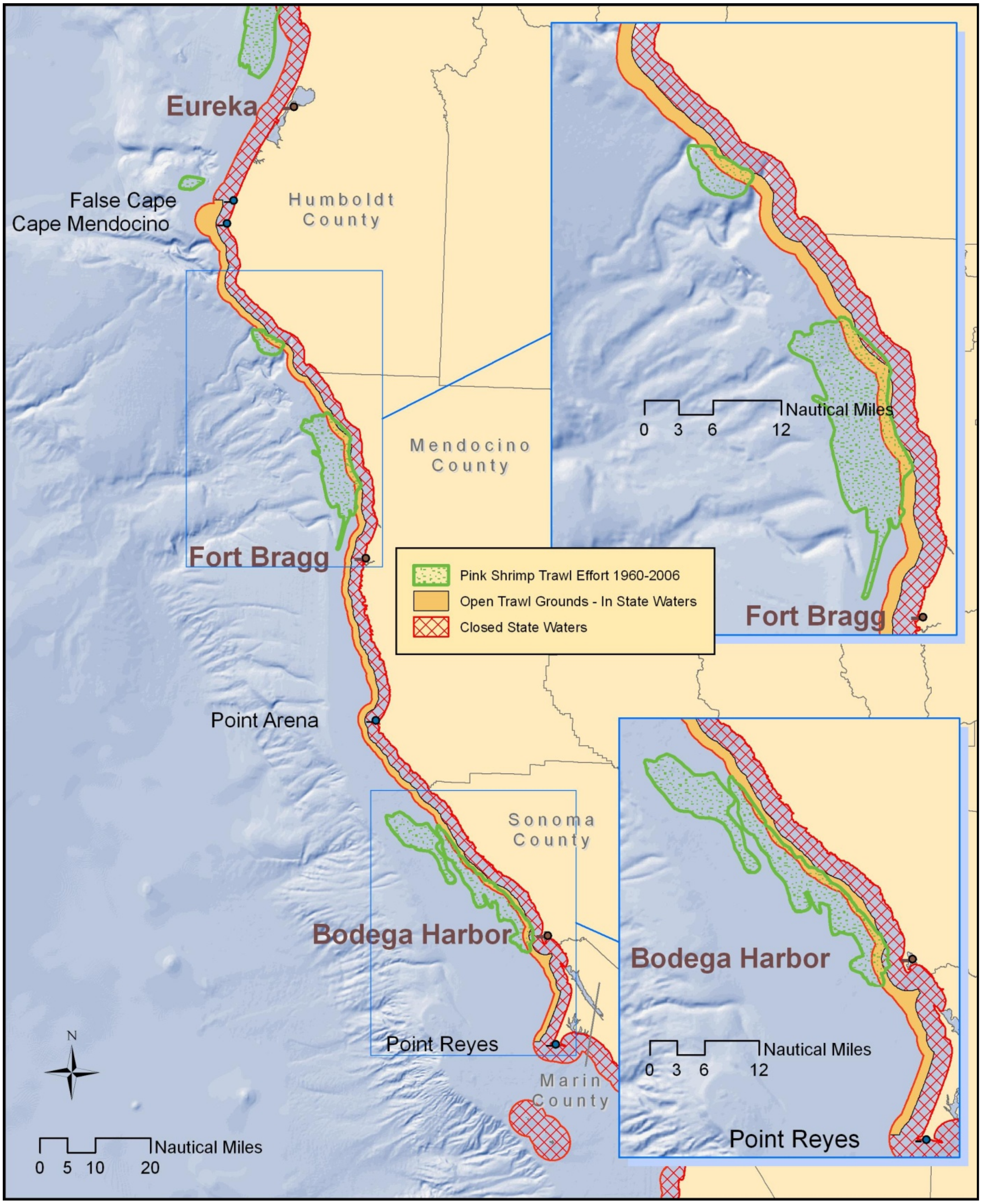


Figure 1. Historical pink shrimp trawl effort from 1960 to 2006 showing the main shrimp beds off the coast of northern California. Inset maps show the trawl effort from 1960 to 2006 in the three beds within the pink shrimp trawl grounds. Data source: CDFG historical Annual Ocean Shrimp Reports (i.e., Administrative Reports) and pink shrimp logbooks.

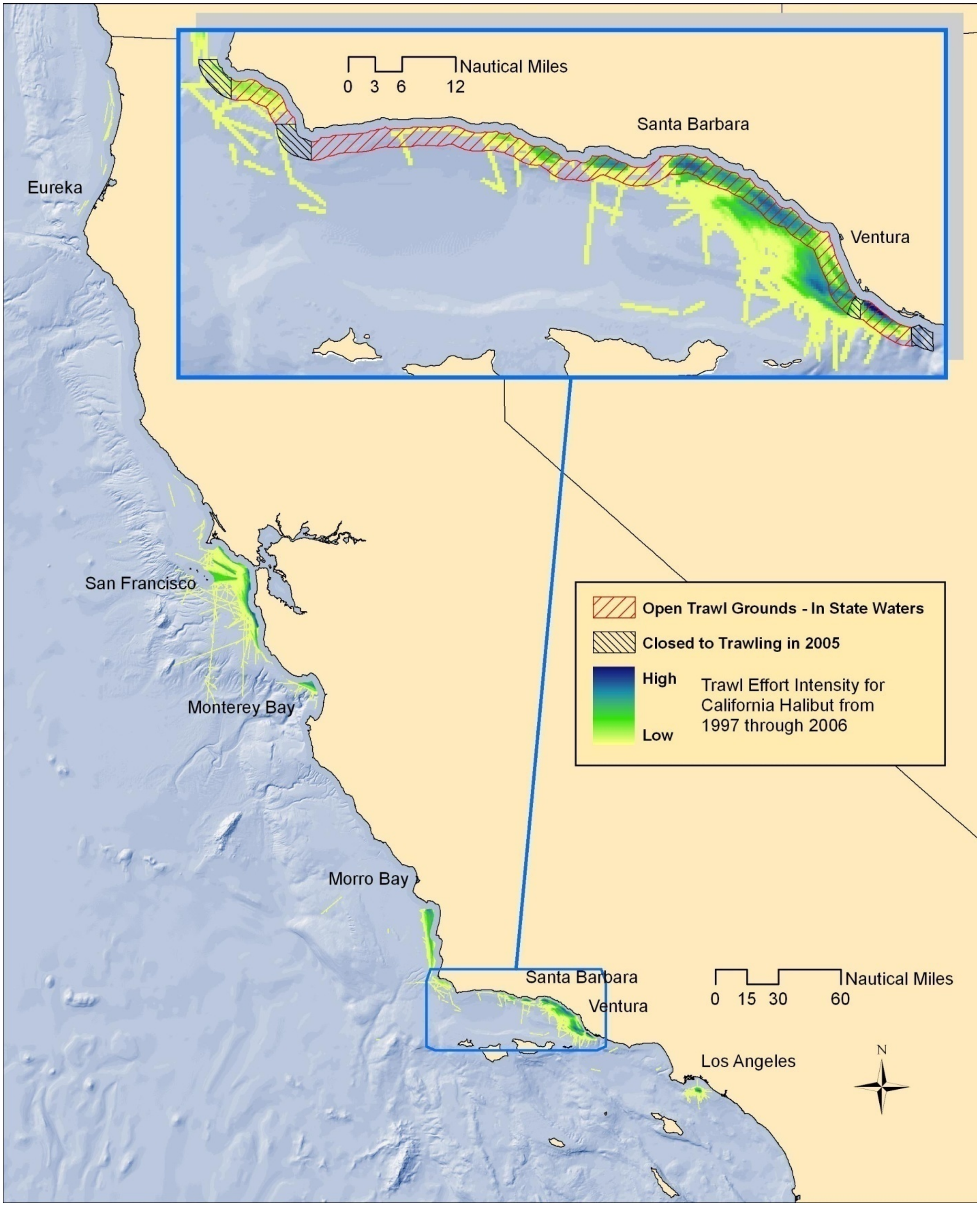


Figure 2. Historical California halibut bottom trawl effort throughout California from 1997 to 2006, including the California halibut trawl grounds which comprise state waters not less than one nautical mile from shore between Point Arguello (34° 33’ North latitude) and Point Mugu (34° 04’ North latitude).

E. OTHER ITEMS

1. Geographic Information System (GIS) Applications

The CDFG's Marine Region maintains a large geospatial data library with a spatial extent ranging from Coastal British Columbia, Canada to Baja California, Mexico including out to 200 nautical miles offshore. The Marine Region Geographic Information Systems (GIS) Lab serves many types of data including aerial imagery, base maps (e.g., NOAA charts) bathymetric, biological, cultural, hydrological, oceanographic, topological, consumptive and non-consumptive uses and administrative boundary features. Resolutions of all data are variable, but in many cases they are very precise, including sub-meter imagery. The following are examples of categorical data holdings; they are not comprehensive lists.

Bathymetric: High resolution (less than 5 meter) multibeam bathymetry and or backscatter data are available for select portions of the coastal, Channel Islands and Farallon Islands waters. Our most recent addition (2007) includes 2 meter bathymetric soundings and imagery for the entire extent of state waters from Pigeon Point to Point Arena. Currently there are existing contracts funded by the State's Ocean Protection Council to complete high resolution bathymetric mapping for all California State waters (0 – 3 miles). It is expected that early (southern) phases of this effort will be available by summer 2008. Additional derivate data products have been generated from backscatter and multibeam collections such as hillshades, contours, slopes, rugosity, BPI (bathymetric position indices), and benthic habitat classification maps.

Biological: Data are varied but include kelp canopies (1989, 1999, and annual surveys from 2002 to 2007), eelgrass, surfgrass, birds, mammals and natural history, observation and harvest records of many fishes and invertebrates.

Consumptive and non-consumptive use: Data for commercial and recreational activities are available. These include all recorded fisheries and some more common aquatic activities (e.g., scuba diving, kayaking, etc.) In many cases these data have been summarized by standard methods of aggregation (e.g. summarizing fisheries data by CPUE on a 1' grid scale). Additionally, CDFG commissioned the data collection of high resolution recreational fishing, commercial fishing, and non-consumptive use activities in areas of importance for the MLPA North Central Coast Region. Similar commercial fishing areas of importance were previously collected for the Central Coast Region.

Cultural: Data provide information related to communities such as coastal access points, parks, shipwrecks, sewage outfalls, research institutions, cities, roads (and other transportation layers), ports and census information.

Physical and oceanographic: Data include rivers, lakes, watersheds, submarine features, coastal upwelling zones, coastal rocks, coastal points, islands, sea surface chlorophyll and temperature.

Spatial Management: Data showing existing MPAs, Rockfish Conservation Area closures, Cowcod Conservation Areas, military safety zone areas, administrative fishing blocks, districts, counties, state lands, state jurisdictions and kelp administrative boundaries.

Services: With widely available public spatial data to compliment our existing in-house data, the Marine Region GIS Lab analyzes trends and produces general references, such as maps, graphs and presentations to aid CDFG in planning and management decisions. Some of the higher profile projects conducted by the lab include the correlation of nearshore fish market catch to fishing block location and time, which has shown resource managers single species "hot-spots", support of CRFS and MPA planning and monitoring with traditional and real-time GIS support. Some of the lower profile services provided by the lab are real-time simple spatial data queries and map production for all Marine Region projects.

The most current software and hardware platforms are available to support the Marine Region's spatial analysis needs. A modern five-seat GIS lab running ESRI ArcGIS 9.2 is the primary analytical tool for spatial analysis and map production. Specific technologies within this architecture include: ArcGIS, ArcSDE, ArcIMS, ArcGIS Server, ArcInfo SQL Server 2000, Network Analyst, 3D Analyst, ArcScan, Spatial Analyst, Geostatistical Analyst, and ArcPublisher. A large format 42 inch plotter is available for printing large maps or posters for Marine Region staff.

Contributed by Paulo Serpa (831.649.7143)

APPENDIX 1:

2007 CALIFORNIA GROUNDFISH COMMERCIAL FISHERY REVIEW

The 2007 California commercial groundfish harvest (Table 3) was approximately 10.4 thousand metric tons (23.0 million pounds), with an ex-vessel value of $15.9 million. Total harvest was lower by 12.9 percent and revenue was slightly higher by 3.95 percent than comparable values in 2006, which continued a steady trend in harvest beginning in 2001. Even though the 2006 ex-vessel value was up by about 11 percent compared to 2005, it still is about 20 percent lower than the total in 2000, when approximately $20 million was generated. Total groundfish landings were nearly 25 thousand metric tons (55 million pounds) worth approximately $25 million as late as 1994.

In 2007, 87 percent of the groundfish landed was taken by bottom and mid-water trawl gear, a slight decrease from the 88 percent observed in 2006. Line gear accounted for the second largest amount at 9 percent, a very slight increase from 8.6 percent observed in 2006. The line gear contribution was at a recent peak in 1992 at 18 percent. Trap gear was 3 percent in both 2007 and 2006. Gill and trammel net landings have dropped to less than 0.5 percent because of increasingly restrictive State and Federal regulations. The major reduction in the use of gill and trammel net gear to harvest groundfish occurred in the mid-1990s; their contributions dropped from 5 percent in 1993 to 1 percent by 1996 and down to 0.4 percent in 2007.

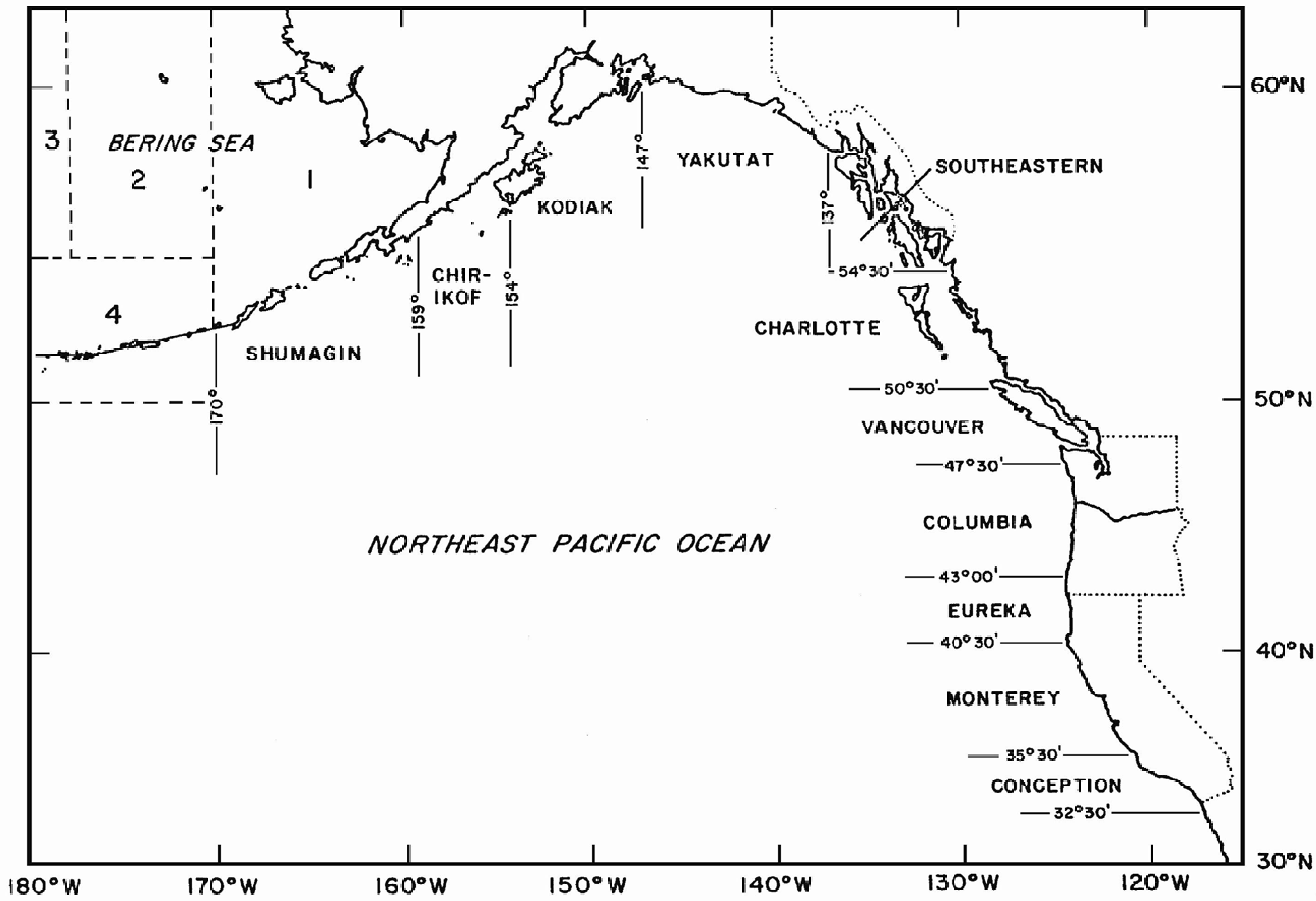
Pacific whiting, Dover sole, sablefish and petrale sole dominated California's 2007 groundfish harvest, making up approximately 77 percent of the state's landings. Pacific whiting experienced a 45 percent decrease in 2007 compared to 2006, with landings of 2,968 and 5,430 metric tons, respectively. Landings of Dover sole in 2007, however, experienced a 56 percent increase from 2006. Sablefish landings decreased by 10 percent and petrale sole increased by 20 percent compared to 2006. Thornyheads and rockfishes experienced slight decreases relative to 2006.

Contributed by Bob Leos and Caroline Mcknight (831.649.2889)

Table 3. California commercial groundfish landings (metric tons) for 2007.

	2007	2006	2007 percent change from 2006	1997	2007 percent change from 1997
FLATFISH	4,271	3,169	+ 34.8	8,352	- 48.9
Dover sole	2,759	1,760	+ 56.8	5,304	- 48
English sole	178	299	- 40.5	649	- 72.6
Petrale sole	900	753	+ 19.5	833	+ 8
Rex sole	171	149	+ 14.8	454	- 62.3
Sanddabs	157	115	+ 36.5	928	- 83.1
Other flatfish	106	93	+ 14	184	- 42.4
ROCKFISH	1,427	1,482	- 3.7	10,193	- 86
Thornyheads	845	890	- 5.1	2,810	- 69.9
Bocaccio	6	5	+ 20	272	- 97.8
Canary	1	2	- 50	217	- 99.5
Chilipepper	55	43	+ 27.9	1,271	- 95.7
Darkblotched	41	21	+ 95.2	12	+ 241.7
Splitnose	81	8	+ 912.5	0	-
Widow	8	8	0	1,401	- 99.4
Black (north of 40°10')	77	59	+ 30.5	93	- 17.2
Minor nearshore (north of 40°10')	21	17	+ 23.5	37	- 43.2
Shallow nearshore rockfish (South of 40°10')	53	47	+ 12.8	131	- 59.5
Deeper nearshore (south)	36	37	- 2.7	127	- 71.7
Black (south)	4	3	+ 33.3	29	- 86.2
Ca. scorpionfish	4	3	+ 33.3	38	- 89.5
Other rockfish	195	339	- 42.5	3,755	- 94.8
ROUNDFISH	4,520	7,137	- 36.7	9,945	- 54.6
Lingcod	78	64	+ 21.9	514	- 84.8
Sablefish	1,448	1,613	- 10.2	2,940	- 50.7
Pacific whiting	2,968	5,430	- 45.3	6,363	- 53.4
Cabezon	25	28	- 10.7	120	- 79.2
Kelp greenling	1	2	- 50	8	- 87.5
OTHER	252	244	+ 3.3	2,037	- 87.6
TOTAL	10,470	12,032	- 13	30,527	- 65.7

Source: California Fisheries Information System.



International North Pacific Fisheries Commission (INPFC) statistical areas in the North Pacific Ocean.
Source: http://www.npafc.org/new/publications/Statistical%20Yearbook/Data/1993/1993page.htm