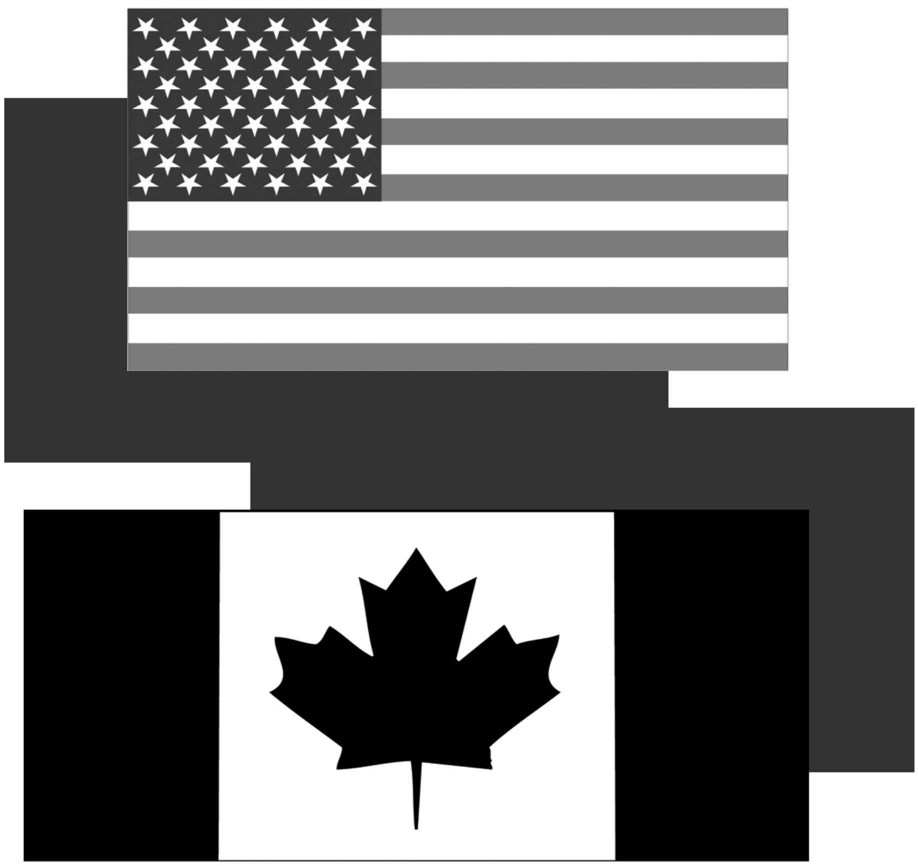
Report of the Technical Subcommittee of the Canada-United States Groundfish Committee

54th Annual Meeting of the TSC

April 30 – May 1, 2013
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
2009	May 5-6	Juneau, AK	Clausen	Clausen
2010	May 5-6	Nanaimo, BC	Stanley	Clausen
2011	May 3-4	Astoria, OR	Phillips	Clausen
2012	May 1-2	Newport Beach, CA	Larinto	Clausen
2013	April 30-May 1	Seattle, WA	Palsson	Larinto

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A. Overview and Terms of Reference

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

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

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

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

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

B. Executive Summary

The TSC met April 30-May 1, 2013 in Seattle, Washington. This year's meeting was hosted by the Alaska Fisheries Science Center (list of attendees is included in the minutes). The meeting was chaired by Traci Larinto, California Department of Fish and Wildlife. As is done each year at the meeting, participants review previous year (2012) research achievements and projected current year (2013) research for each agency. Each agency also submits a written report summarizing groundfish accomplishments for the previous year.

The TSC again noted the valuable ongoing work of the Committee of Age Reading Experts (CARE) (http://care.psmfc.org/), a long-standing TSC Working Group that was originally created by the TSC in 1982. The purpose of CARE is to facilitate among agencies the standardization of groundfish age determination criteria and techniques. Sandra Rosenfield (Washington Department of Fish and Wildlife, representing CARE) reported on CARE activities in 2012/13. CARE holds a biennial workshop involving all member agencies, the most recent of which was in April 2013.

The TSC recommended that the Parent Committee support the visual methods workshop and assists where possible and disseminates information from the NOAA NMFS strategic initiative on developing automated video review and the integration of visual biomass estimates with traditional area swept trawl biomass estimates. TSC also recommended that Agencies should investigate ergonomic remedies to minimize ergonomic injuries and the TSC suggests looking at ergonomic injuries and solutions in similar assembly type work (circuit boards) and medical pathology (microscope slide reading).

Other important topics discussed at the meeting included: 1) Ensuring that the results of 2011 Trawl and Longline Survey Workshop be sent out to those on the Western Groundfish Conference email list and a link to the document be posted on the WGC2014 website, 2) Catch reconstruction and adding this as an agenda item for the 2014 meeting, 3) Genetics and stock structure, and 4) marine reserves.

The 55th Annual Meeting of TSC is scheduled for **April 29 – April 30, 2014,** in Seattle WA, to be hosted by the IPHC.

C. Minutes of the Technical Subcommittee

Minutes
Fifty Fourth Annual Meeting of the
Technical Subcommittee (TSC) of the
Canada-U.S. Groundfish Committee
April 30-May 1, 2013
Alaska Fisheries Science Center
7600 Sand Point Way N.E., Building 4
Seattle, Washington 98115
(http://www.afsc.noaa.gov/GeneralInfo/directions.htm)
Host: Wayne Palsson, NMFS AFSC
Chair: Traci Larinto, CDFW

Tuesday, April 30

I. **Call to Order** – Traci Larinto, Chair, called the meeting to order at 9:06 am

II. **Appointment of Secretary** – Wayne Palsson, Tuesday am, Tom Wilderbuer, Tuesday pm, Kate Rutherford, Wednesday am.

III. **Introductions** – Reports that were made available online before the meeting, or provided at the meeting, including the 2012 TSC Report, and the 2013 reports from ODFW, WDFW, NWFSC, AKFSC, IPHC, DFO, AFSC, ADFG, AND CARE.

IV. List of Participants

- Traci Larinto, California Department of Fish and Wildlife, Los Alamitos, CA (Traci.Larinto@wildlife.ca.gov)
- Kate Rutherford, Science Branch, Pacific Biological Station, Department of Fisheries and Oceans Canada, Nanaimo, BC (Kate.Rutherford@dfo-mpo.gc.ca)
- Lynne Yamanaka, Science Branch, Pacific Biological Station, Department of Fisheries and Oceans Canada, Nanaimo, DFO (Lynne.Yamanaka@dfo-mpo.gc.ca)
- Dayv Lowry, Washington Department of Fish and Wildlife, Olympia, WA, (Dayv.Lowry@dfw.wa.gov)
- Theresa Tsou, Washington Department of Fish and Wildlife, Olympia, WA, (Tien-Shui.Tsou@dfw.wa.gov)
- Alison Dauble, Oregon Department of Fish and Wildlife, Newport, OR, (Alison.D.Dauble@state.or.us)
- Claude Dykstra, International Pacific Halibut Commission, Seattle, WA, (Claude@iphc.int)
- Kirsten MacTavish, International Pacific Halibut Commission, Seattle, WA, (Kristen@iphc.int)

- Jon Heifetz, Alaska Fisheries Science Center, NOAA, Auke Bay lab, Juneau, AK (Jon.Heifetz@noaa.gov)
- Wayne Palsson, Alaska Fisheries Science Center, NOAA, Seattle, WA, (Wayne.Palsson@noaa.gov)
- Tom Wilderbuer, Alaska Fisheries Science Center, NOAA, Seattle, WA, (Tom.Wilderbuer@noaa.gov)
- Peter Frey, Northwest Fisheries Science Center, Seattle, WA, (Peter.Frey@noaa.gov)
- Aimee Keller, Northwest Fisheries Science Center, Seattle, WA, (Aimee.Keller@noaa.gov)
- Sandra Rosenfield, CARE chair, Washington Department of Fish and Wildlife, Olympia, WA (Sandra.Rosenfield@dfw.wa.gov)
- Stephen Phillips, Pacific States Marine Fisheries Commission, Portland, OR, (SPhillips@psmfc.org)

V. Approval of 2012 Report

The report was approved, no one requested hard copies but a few may be bound for about $50. Past reports may be found at: www.psmfc.org/tsc2/.

VI. Approval of 2013 Agenda

The agenda was approved.

VII. Working Group Reports

A. Committee of Age Reading Experts (CARE) - Reported by Sandra Rosenfield, WDFW, CARE Chair.

The 2013 CARE workshop was held April 16-18 at AFSC, Seattle. There were 37 attendees with most agencies represented--CDFW and SWFSC were not. Main issues covered were otolith storage, the CARE charter, and a dogfish ageing mini-workshop. CARE to TSC and CARE to CARE recommendations were made.

- Several new sections were added to the CARE manual including a QA/QC section and a section on Pacific Halibut Ageing. The Accuracy and Precision section was updated. Additionally, work progresses on a Lingcod Otolith Ageing section and Thin Sectioning Method.
- The Sablefish working group discussed results from an ageing structure exchange and recommending revising the Sablefish Ageing Procedures section.
- Age structure exchanges included skates, sablefish and Pacific sardines.
- Four scientific presentations were made including dogfish ageing, otolith microchemistry, bomb calorimetry, and long-term glycerin storage.
- It was noted that long-term storage of otoliths in glycerin leads to cloudy edges, and it's best to store them in an ethanol/water mixture. What is the recommended storage? Sandy: dry. Seems to be no impact.

- There was a dogfish mini-workshop that looked at ageing with spines and vertebrae. There was concern that spines may not be good for ageing, vertebrae appear to be better.
- Some problems with sardine ageing in California and Canada. An exchange was done, not pretty. It may be a magnification issue, also need to clarify acronyms used by both agencies.

CARE to CARE Recommendations

- CARE recommends posting archived editions of the CARE manual online along with the year of publication.
- CARE recommends expanding the manual by finalizing the draft Lingcod Otolith Ageing, Thin Sectioning Method, Rockfish Ageing Thin Section Method sections. Adding an Ergonomics and Walleye Pollock Ageing Procedures sections. Revise the Sablefish Ageing Procedures section.
- CARE recommends looking at long-term storage from IPHC and AFSC with the plan to update the manual in 2015 based on the results.

TSC to CARE Recommendations

- TSC thanks CARE for its efforts to standardize and advance ageing techniques and for their report. TSC supports CARE's concerns about ergonomics and will put forth TSC to TSC recommendation and a TSC to Agency recommendation on the ergonomic issue (See Section XI A 1).

B. Yelloweye Rockfish Working Group.

This working group has been established since 2008 and is still on the books. Its formation was based on Pacific Fishery Management Council need. The only recent activity has been some back and forth conversations between Ian Stewart and Lynne. The last meeting was in Portland in 2008. **TSC members agreed to drop the working group for now, and reestablish it as needed.**

VIII. Other Topics

A. Marine Reserves

AFSC – There are Habitat Areas of Particular Concern (HAPC) including coral and deepwater protection areas. HAPCs are being considered for skate nursery areas and for Bering Sea Canyons.

DFO Canada – Rockfish Conservation Areas (RCAs) have been instituted for some time. There are other areas established by Industry/NGOs. Trawl footprints have been frozen to satisfy certification and coral/sponge habitats are being considered including Endeavor Sea Mount, Bowie Sea Mount, Race Rocks, and a sponge reef reserve in the Strait of Georgia. There are two reserve processes in Canada, the Oceans Act creates marine protected areas (MPA) for conservation and the Fisheries Act creates reserves for fisheries goals. RCAs are a spatial management tool under the Fisheries Act to control recreational fishery, sponge reef coral reserves are for conservation under the Oceans Act.

WDFW – A variety of MPA-focused research is ongoing. There have been some proposals, but nothing specifically worked on. The public and other agencies want to know what WDFW is doing. There is a move to update the 2009 MPA report. Will be pulling together dive survey data. There has been a working group on benthic terrain mapping and biological resources and a desire to move forward with science based network of marine reserves. There is 0.25 FTE dedicated to work on reserves. Puget Sound Partnership identified a 2014 deadline to recommendation on recommendations to move marine reserves forward. WDFW needs explicit goals to compare the effectiveness of marine reserves.

ODFW – Harvest prohibitions went into effect on January 1, 2012 for Oregon's first two reserves at Redfish Rocks and Otter Rocks. There will be three more new marine reserves (MR): Cape Perpetua, Cascade Head, Cape Falcon based on bills that have been passed by Oregon's Legislature after a long scoping process. Pre-closure monitoring is now being conducted. Lots of field work is funded and some new positions. See ODFW's website.

CDFW – There are some offshore reserves for bottom species (RCAs) but many state mandated reserves. No-take reserves cover 9.4 percent of state waters and MPAs 16 percent of state waters. MPAs are a mix of restrictions, some allowing no take, others recreational only harvest or rules for specific species. There was a long process to establish this system with the third try being successful. In February, there was a symposium of central coast MPA system discussing the first five years post-implementation.

Aimee Keller brought up an issue regarding NMFS surveys that need to enter the reserves. By closing areas to the surveys, it is eroding the survey time series for Oregon. She has applied for Oregon scientific permits but has been denied fishing at three stations in the reserves. She has lost hundreds of stations over time and the prospect is that the new reserve sites are larger, and will further impact the trawl survey. Ali responded that now there is time to talk before restrictions go into force. **Ali volunteered to look at policy issue of take in OR reserves.** There is a combination of MPA and MRs (closer to shore) with a combination of restrictions. The same issue is occurring in California, where MPAs are limiting access to historic trawl survey stations. Recently there has been more oversight for scientific collecting permits (SCP) in California. CDFW found one reserve with 28 SCPs—and is starting to prioritize take.

Claude noted that surveys and their results may be the only long-term data for reserves. Claude asked about enforcement in reserves? Oregon has very little. Police are aware, and port samplers monitor where people fish. There is a substantial educational outreach. DFO-educational, groundfish fisheries are all monitored. Fisheries officers do monitor reserves and have conducted some sting operations but there are no dedicated patrols. DFO reserve enforcement is integrated in regular patrols. California does not have dedicated enforcement, but officers do enforce them, especially when reserves are newly created. There is massive public education including nice booklets showing all MPAs and a website that's kind of like an app on your phone, especially GPS enabled phones, showing the MPAs and their restrictions.

B. Genetics and Stock Structure

AFSC – Rockfish studies are going on at ABL. Sablefish samples have been taken. Mike Canino, AFSC Seattle, is working on Pacific Cod. There is a sleeper shark study underway. Tony Gharrett has developed an assay for rougheye and blackspotted rockfishes and some species off Alaska. Systematics Lab in Seattle is working on identifying species clusters in sandlances, snailfishes, etc. There was a NPFC stock structure workshop that identified genetic study needs and funds. For AFSC, need to find outside funds or collaborators.

DFO Canada – Robin Forest is working on Pacific cod. Rick Stanley is looking for yellowtail rockfish in the Strait of Georgia. (*Rick is retiring August 28, 2013*). Rougheye and blackspotted rockfish trawl and trap surveys are being sampled. There are problems with identification and hybrids. Jon, AFSC, has been doing the same. Canada may declare rougheye and blackspotted rockfishes to be listed as “at risk”. Once they identify them by spatial separation, they can be listed.

WDFW – There is no genetics work being done along the coast; but they are collaborating with Canino. Interestingly, there was a Pacific herring spawning event in Elliott Bay totaling 200 tons. They have never been observed spawning there, and at such a weird time in the spring. Herring returned last Friday (4/26/13) to spawn again. WDFW Trawl survey is starting tomorrow (5/1/13).

ODFW – Has no current genetics studies.

CDFW – is not doing any genetics studies either. SWFSC may be working on larval fish genetics, but not sure who is doing the work. There is work on vermilion/sunset rockfish and the two blue rockfish species at SWFSC. *Is there a need for a centralized place to process groundfish samples?*

NWFSC – is working along the coast at species level, not population level. Researchers are looking at genetic differences between sunset and vermilion rockfish, two cryptic species. They are also proceeding with age and growth studies and are stockpiling genetic samples for later processing. Coral DNA samples now being worked on by a Post doc. DNA fin clips degrade overtime. Paul Chitaro, is publishing a paper on Puget Sound/Strait of Georgia hake microchemistry studies.

IPHC – Port samplers don’t know sex of the Pacific halibut because they are landed dressed. They are working with Lorenz Hauser, UW, using microsatellites to predict sex as a cheaper, faster method.

C. Western Groundfish Conference

Lynne and Scott Buchanan are co-chairs. Sponsor request letters will be coming to the agencies. There will be a photo contest for logo design. They are getting concerned about participation due to location (Victoria, British Columbia) and U.S. federal travel restrictions. The conference will be held at the Harbor Towers Hotel. Stephen suggested an email quick poll to get an estimate of attendance and to under bid numbers and have another hotel available in case more come. ODFW will likely be more restricted, 3 people to go, compared to 15 in past. WDFW maybe 2 people attending. CDFW no one will attend due to international travel restrictions.

D. Catch Reconstruction Workshop

The Catch Reconstruction Workshop occurred on the 2nd day of TSC 2012 meeting. The group determined that they were not ready to develop best business practices or recommendations, but wanted each agency to report. Call-ins occurred and TSC members stayed for the workshop. The notes have not been finalized but will be coming. There is a vast disparity in agency progress. California had SWFSC help with the process, including recovering old data. Meisha

Key, CDFW, was on the call as she was involved with California's catch reconstruction. Lynne worked on catch reconstruction for Canada. Vladina Gertseva, NMFS, helped with Oregon's catch reconstruction efforts. She couldn't call in but Ali provided an update on their progress.

WDFW – is having staffing issues, but was able to make some progress entering historical fish tickets that should be completed by June 2013.

ADFG – *is* not working on this as the NPFMC doesn't go back prior to Magnuson-Stevens Act. There is some work being done on the Federal side. Catches back to 1977 NPFMC are limited. But stock assessment models do start earlier—in the 1960s for POP, pollock and yellowfin sole. One CIE review found inconsistent methods used for catch reconstruction. A length-based model for dogfish has been used to go backwards in time.

CDFW – is trying to get a standardized approach; there is some information being added on the recreational side. Cindy Tribuzio has a tech memo on bycatch in halibut fishery for all species but there are lots of caveats.

ODFW – commercial reconstruction document still in a draft stage. NOAA wants more review. Catch reconstruction has become a low priority with staffing issues on the recreational side.

DFO – rockfish catch reconstruction is done. All groundfish catch is desired, but has fallen off the table. There are some data in pdf form that is now keypunched, but needs to be verified and published. Right now, they are documenting which fisheries occurred in Canada by foreign and domestic fishers. Palsson suggested contracting Greg Lippert, WDFW, for historical documents that include Canadian catches.

NWFSC – is doing some catch reconstruction work, but specifics not given.

IPHC – has some folks looking at IPHC data for sharks and redfish, but not that helpful. Some work using survey data as proxy. Redfish, shark, other flatfish.

Brad Stenberg, PSMFC, PACFIN data manager, wants to put historical data into PACFIN. Catch Reconstruction will be kept on the agenda for next year.

The TSC agreed to add an agenda item on Catch Reconstruction Efforts for the 2014 meeting.

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

A. Agency Overviews

AFSC – *A*uke Bay staff is down by 3 people of which one may be rehired. Assessment work is on biennial cycles which coincide with surveys. The incorporation of grenadiers into the FMP has been delayed for now. RACE –a very diverse division with scientific activity plans to identify core areas. Chukchi sea research is now ongoing. Laboratory research work is done in Newport, Oregon and Kodiak, Alaska. REFM division is initiating the hiring of a flatfish stock assessment scientist.

DFO Canada – *T*here have been a few recent retirements of which one is a section head. Funding for research cruises has been cancelled by Ottawa, however, the agency can now sell fish to pay for surveys. Trawl surveys and sablefish surveys will be paid for by industry (not from sold fish). Want to pay for survey with halibut caught during the survey. A budget shortfall exists.

WDFW – Groundfish research is organized as an outer coastal unit and Puget Sound unit. Personnel have decreased from 10 people down to 7 (permanent) and some temporary employees. They are currently doing some work for the Navy allowing a saving from the general budget. A ROV survey of Puget Sound has recently been completed but not analyzed yet. Agency still needs to decide who will be their Council representatives on the Plan Teams and SSC.

ODFW – No staffing changes at this time. Budgets are running on status quo with no large cuts planned. There is uncertainty in the status of federal grants which account for 1/3 of the current operating budget.

CDFW – Big change is that the Department has a new name, we are now the California Department of Fish and Wildlife. The Marine Regional Manager retired last June, but is still working on Council issues until December 2013. No rehire yet, but the acting regional manager is going to retire in June 2013. Otherwise, the groundfish staff is stable. Funding is an issue as federal contributions have dwindled but the state money has been stable. Furloughs are ending in June as the state funding has stabilized. Little money is allocated for research as most is used for salaries.

NWFSC – Contractors are dwindling (retiring and transferring elsewhere) and not being replaced. The survey group (FRAM) has gained 4 people. Surveys are being funded.

IPHC – Staffing turnover, Drs. Hare and Valero are gone, Drs. Stewart and Martell hired. There is a new survey team member and there has been some administrative department turnover. A position is currently open for an age reader. Funding from appropriations for staff is stable and the catch from the surveys is sold to cover the cost.

B. Multispecies Studies

AFSC – RACE Division annually performs multispecies surveys, 4 were completed in 2012 including the Chukchi Sea, Aleutian Islands, Eastern Bering Sea, and Bering Sea Slope. There were also sponge and coral habitat studies, and a new bathymetry of the Aleutian Islands has been developed. There is an NPRB study of GOA involving 6 species –upper trophic study looks at recruitment. Coral studies have been conducted using scuba observations.

NWFSC – 2 multispecies surveys completed. The ecosystem group is working on an integrated study of the California current. Catchability study recently completed indicates herding for flatfish. Current surveys have extended the collection of oceanographic variables for each haul. Video cameras are being used to try to identify (to species) inside the trawl but has not received time and money to develop further.

CDFW – Recently took over the recreational fishery sampling program. Now we’ve taken on commercial passenger fishing vessel (aka party boats or charters) logbook data entry and sample data entry formerly done by PSMFC. Additionally, CDFW is now producing effort estimates, previously done by PSMFC. *Note: This was due, in part, to state contracting issues which prevented CDFW from contracting out this work.*

ODFW – Federal funding has been made available to conduct year-round port sampling in some of the smaller ports to ground truth the expansion estimates in years that do not have any winter sampling. Funding has been made available to conduct port sampling in Port Orford year-round. The agency is developing a HD camera for surveying and making progress. Video analysis from ROV studies is continuing. Hypoxia study from ROV transects is coming to completion.

DFO Canada – Two multispecies surveys are performed each year (one on government vessel and other on charter, alternating areas). Multispecies small mesh surveys were also done. Using a prioritization scheme for stock assessments, species which do not get an assessment very often were tracked and updated (species usually not in the top 15 by biomass).

WDFW – The Neah Bay recreational rockfish fishery was mimicked by biologists during the summer to obtain proxy catch information. It was concluded that species ID was a big problem, especially for misidentifying of canary rockfish. A trawl survey was conducted in Puget Sound in May 2012 but it was different from past surveys because they had to abandon shallow sampling due to salmon bycatch concerns. A ROV study covered 197 transects from the San Juan Islands to the south of Puget Sound. The video is now being analyzed with a goal to produce abundance estimates, habitat characterizations and associations, and ground-truthing maps. The survey is planned to be repeated in 2015.

C. By Species

1) <u>Pacific cod</u>

DFO Canada – Agency has delivered a stock assessment this year, now using fin rays to improve ageing. Efforts are also being made to examine anatomical data to improve maturity estimates.

WDFW – Efforts have been made to catch brood stock from the coast and Puget Sound to look at the tolerance of P. Cod to warming (assumption is that the Puget Sound fish are more tolerant to warm conditions than the coastal stock).

AFSC – The stock is in good condition in both the Bering Sea and the Gulf of Alaska, recent recruitment is good. Ageing and catchability are still issues.

2) <u>Nearshore rockfish</u>

ODFW – A maturity study is now complete and results indicate a prolonged maturation period from April to August. A decade of tagging black rockfish has resulted in over 32,000 tagged fish and exploitation from tagging is estimated for, 2010-2011 4.4 percent. Recompression devices are encouraged in the recreational fisheries.

AFSC – Rougheye rockfish recompression studies indicate that small fish have better survival than larger fish. If recompressed over a longer period, the large fish survived better.

DFO Canada – Quillback rockfish are being considered to be listed as threatened. If listed then management measures come into force.

3) <u>Shelf rockfish</u>

NWFSC and SWFSC – data moderate assessments use only limited data. Vermillion, bocaccio and canary rockfish are being analyzed for maturity schedules.

WDFW – Bocaccio rockfish are very rare and have only been found in one location just west of San Juan Island on two occasions.

DFO Canada – Bocaccio rockfish are estimated at only 7 percent of their unfished biomass and will be assessed this year as well as silvergrey rockfish.

4) Slope rockfish

NWFSC – 3 species to be assessed this year.

AFSC – GAM modeling of the occurrence of Pacific ocean perch in the Aleutians indicate that longitude and depth are the greatest explainer of their presence/absence. Maturity studies for rougheye rockfish has indicated some skip-year spawning for this species. Dusky rockfish and Pacific ocean perch are being examined for maturity by habitat type.

Dave Somerton has been given $600,000 per year for 3 years for video assessment (strategic initiative) to turn video transects into absolute biomass estimates.

5) Thornyheads

NWFSC – Shortspine thornyheads have new maturity schedules developed from shallow and deep water fish.

6) Sablefish

AFSC – Low biomass results from the last survey in 2012 may indicate a decreasing trend. A new ovary collection is now being histologically examined.

Wednesday, May 1

7) Halibut and INPFC activities

2012 ongoing projects – The Commission is putting samplers onboard NMFS trawl survey vessels, conducting more oceanographic casts (Seabird-CTD) on survey vessels, and reconciling macroscopic and histological ovary samples for maturity determination. Mercury monitoring continues in conjunction with the Alaska Department of Conservation. Results indicate low levels so far in Alaska, but higher in halibut sampled from Washington, and Oregon. Four different tagging projects are still ongoing (archival tags, tag attachment study, recovery hotspots study, geomagnetic tag study with a UAF student). A whisker hook bycatch study is also ongoing with the goal to catch less rockfish.

The *Ichthyophonus* (internal parasite) study has continued with 12 coastwide collection sites in 2012 and indicates, coastwide, a 47 percent infection rate, mostly in adult fish. Prince William Sound (inside and outside) had high infection rates. Trout and herring have growth and survival problems when infected but, unsure what the effect is on halibut, if any. Three sites are scheduled to be tested in 2013, the last year of the project. A bait comparison study between pollock, chum salmon and pink salmon (chum is the standard bait) was conducted in 2012. The study may be repeated in 2015 since the results are not consistent spatially and may have temporal trends as well. Pollock seemed to have less bycatch of rockfish and dogfish.

2013 projects – New length-weight relationships are being explored. The summer setline survey is being expanded (15 stations) into northern California because of the increasing sport harvest. The Commission is setting aside money to increase survey stations by 25-30 percent (for one year, 2014) into depths not currently sampled and in areas with no stations. Commercial catch show significant catch in some of these depths during the time the survey is conducted. Most of the 2012 projects are also continuing in 2013.

8) Flatfish

NWFSC – No flatfish assessments in 2012.

AFSC – Greenland turbot study of spawning, advection pathways and settlement was conducted. Northern rock sole settlement patterns were examined using beam trawls in the Bering Sea. A Kodiak study was conducted using cameras in nearshore areas to study the relationship of northern rock sole settlement relative to worm tubes. NPRB maturity study for Bering Sea flatfish is ongoing.

DFO Canada – Northern rock sole, southern rock sole and arrowtooth flounder assessments later this year.

9) Lingcod

DFO Canada – Inside waters stock assessment next year, Strait of Georgia sampling this year.

10) Pacific Whiting (hake)

CDFW – Fishing in California for hake is mostly finished due to trading shares as part of the IQ program to the Oregon fleet (bycatch only) for sablefish.

ODFW – Oregon has had record landings the past year. It is speculated that the 2010 year class is very large.

11) Walleye Pollock

AFSC – Studies by the MACE group continue and Stan Kotwicki dissertation (UW).

12) Dogfish and other sharks

AFSC – Dogfish have been tagged with satellite tags, 40 each in Yakutat and SE Alaska. One tag return was from southern California. Study objectives are to look at behavior on bottom and discern the availability to the bottom trawl, temperature, location and movement. Age studies are also conducted for dogfish and also the taxonomy of sleeper sharks (several species) are being studied.

IPHC – Collecting length, sex for first five fish on each station coastwide and provides the data to Auke Bay laboratory researchers.

13) Skates

AFSC – Proposed habitat areas of particular concern for skate eggs in Alaska.

DFO Canada – New stock assessment on the big skate was completed as a result of a working group.

14) Grenadiers

AFSC – Working with regional office to get giant grenadier listed as a FMP species. Currently there is a large bycatch of this species in deep water fishing. Ageing studies underway, they may live to 80-90 years.

15) Other Species

ODFW – Data compilation on kelp greenlings (maturity).

IPHC – Working with Liz Conners on octopus (3 species caught?). Maturity study of several slope rockfishes in the Gulf of Alaska was completed by Christina Conrath.

DFO Canada – Hagfish permit has been provided for a commercial fishery using 3 experiments.

AFSC – Some prowfish research beginning.

D. Other Related Studies

1) Ecosystem studies

CDFW – MPA monitoring enterprise has been established, a partnership between different groups. A 5 year review of the central coast MPAs has recently been completed and is available on the CDFW website.

AFSC – The REEM subtask of the REFM division is at the forefront in ecosystem modeling efforts as part of the BSEIRP and GOAEIRP research. An annual report card for the Bering Sea, Gulf of Alaska and Aleutian Islands ecosystems based on a variety of ecosystem indicators is now a prominent part of the annual SAFE report.

E. Other Items

Marine mammal predation on groundfish

The TSC participants recommended that this item be dropped for next year.

AFSC – Gear studies are being conducted to deal with for salmon bycatch in the Pollock fishery.

X. Progress on 2012 Recommendations

A. From TSC to itself

Develop a workshop on using visual surveys in rockfish stock assessments.

Progress has been made in organizing the workshop. Organizers are thinking about holding the workshop before the groundfish conference if there is interest, or in spring 2013.

B. TSC to Parent Committee

Support work on the visual workshop.

C. TSC to CARE

Thank you to CARE and encourage them to continue with online otolith archive.

XI. 2013 Recommendations

A. From TSC to Itself

1) TSC recommends examining long-term health exposures and issues resulting from evaluating fish age structures. These exposures include but are not limited to repetitive stress; poor body position; positions of tables, chairs, and microscopes; eye fatigue, long and durations at scopes. Agencies should investigate ergonomic remedies to minimize ergonomic injuries and the TSC suggests looking at ergonomic injuries and solutions in similar assembly type work (circuit boards) and medical pathology (microscope slide reading). The TSC acknowledges this request made by CARE.

2) The TSC recognizes that organization of a TSC workshop on developing ROV surveys for use in rockfish stock assessments, recommended in 2012, has been initiated with a general plan to have a two day workshop in Seattle in the Spring of 2014 on visual survey methods. Following along the success of the trawl and fixed gear survey workshop held in 2011, participants will be asked to submit a short summary of their visual survey and methods together with challenges they have encountered. The visual survey summaries will be compiled into a document and widely distributed and the challenges explored and discussed during the workshop.

   During the TSC meeting, Dave Somerton announced that there is a new strategic initiative ($1.2 m) that will be led by Mary Yoklavich and Liz Clarke on two aspects of visual surveys; the software engineering of automated video analysis and the analytical methods for combining trawlable (traditional surveys) and untrawlable (visual surveys) area estimates of absolute biomass. A meeting is planned soon in D.C. to start this work.

   TSC recommends that the TSC visual survey workshop organizers contact Dave, Mary and Liz to see if there could be any collaboration with their strategic initiative.

3) TSC recommends that all TSC attendees notify relevant contacts within their parent organizations that the IPHC has gender and length frequency data for dogfish shark (*Squalus suckleyi*). This data has been collected since 2011 on a coastwide basis, and is available from the IPHC.

4) The TSC recognizes the accomplishments of the TSC over the last 20 years and would like to have the Overview document on the TSC website updated to reflect the TSC's accomplishments and also updating the Terms of Reference. Stephen Philips has agreed to contact Mark Wilkins, former TSC member, about updating the document.

   The TSC also recommends reformatting the TSC webpage, adding in historical documents such as older reports and the results of the many TSC workshops to showcase the work done by the TSC.

5) TSC recognizes the importance of the TSC annual reports and requests that each Agency make them and the TSC website more visible, adding it to their website. The TSC would also like to inform the Western Groundfish Conference organizers about it and asking them to acknowledge the TSC website in conference materials.

6) TSC has received the summary document from the 2011 Trawl and Longline Survey Workshop. The document is comprehensive and covers all trawl and longline survey activity from NOAA NMFS Regions of Alaska, Northwest, Southwest and Northeast, State agencies of Alaska, Washington and Maine, the Atlantic States Marine Fisheries Commission, the International Pacific Halibut Commission, and the Department of Fisheries and Oceans in Canada. TSC views this document as a valuable compendium of survey work and would like to see this document posted on the TSC website and widely distributed to all groundfish researchers, industry members and university students in the fisheries field. TSC suggests that the document be sent out to those on the Western Groundfish Conference email list and a link to the document be posted on the WGC2014 website.

B. TSC to Parent Committee

1) TSC recommends that the Parent Committee supports the visual methods workshop and assists where possible and disseminates information from the NOAA NMFS strategic initiative on developing automated video review and the integration of visual biomass estimates with traditional area swept trawl biomass estimates.

2) TSC recommends that the Parent Committee support CARE by acknowledging the TSC's request to Agencies to investigate ergonomic remedies to minimize ergonomic injuries and the TSC suggests looking at ergonomic injuries and solutions in similar assembly type work (circuit boards) and medical pathology (microscope slide reading).

3) TSC recommends that the Parent Committee remind the Agencies about the valuable information available on the TSC website, including the annual TSC reports and Workshop summaries.

C. TSC to CARE

1) TSC acknowledges CARE's concerns regarding ergonomic injuries caused by extended periods ageing fish and has recommended that the Parent Committee request Agencies to investigate ergonomic remedies to minimize ergonomic injuries and the TSC suggests looking at ergonomic injuries and solutions in similar assembly type work (circuit boards) and medical pathology (microscope slide reading).

XII. Schedule and location of 2014 meeting

April 29 and 30, 2014 at Seattle, Washington, with the IPHC as the host agency**.**

XIII. Adjourn

D. Parent Committee Minutes

Minutes of the 54th Annual Meeting
of the
Canada-U.S. Groundfish Committee
(a.k.a. "Parent Committee")

I. Call to Order

Mr. Stephen Phillips, PSMFC, represented the United States and Ms. Lynne Yamanaka, DFO, represented Canada. The meeting was called to order at 10:00 am, Wednesday, May 1, 2013.

II. The Agenda

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

III. The 2012 Parent Committee meeting minutes

The Parent Committee minutes were adopted as presented

IV. Progress on 2012 Parent Committee recommendations

Visual Survey Workshop: Parent Committee agrees with the 2012 TSC recommendation to support hosting a workshop on using visual survey data in stock assessments.

Action: This was deferred to 2013.

V. 2013 Parent Committee Recommendations

Parent Committee agrees with the 2012 TSC recommendation to support hosting a workshop on using visual survey data in stock assessments.

VI. 2014 Meeting Location

Parent Committee agrees with the proposed location and schedule for the 2014 TSC and Parent Committee Meeting: Seattle, WA, April 29 and 30, 2014. The IPHC will be the host agency.

VII. Other Business

a. The Parent Committee thanked Traci Larinto for taking over as chair of t the TSC meetings.
b. The Parent Committee thanks PSMFC for its ongoing support for the Annual TSC meetings.

c. The Parent Committee thanks the Alaska Fisheries Science Center and Wayne Palsson for setting up and hosting the meeting.

VIII. The Parent Committee meeting was adjourned at 10:45 am, Wednesday May 1, 2013.

E. Agency Reports

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

AGENCY REPORTS

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1. ALASKA FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERES SERVICE

2. CANADA, BRITISH COLUMBIA GROUNDFISH FISHERIES

3. INTERNATIONAL PACIFIC HALIBUT COMMISSION (IPHC)

4. NORTHWEST FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE

5. SOUTHWEST FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE

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

8. STATE OF CALIFORNIA – DEPARTMENT OF FISH AND GAME

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

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

Alaska Fisheries Science Center
of the National Marine Fisheries Service

2012 Agency Report

to the

Technical Subcommittee of the

Canada-US Groundfish Committee

April 2013

Compiled by Wayne Palsson, Tom Wilderbuer, and Jon Heifetz

VIII. REVIEW OF AGENCY GROUNDFISH RESEARCH, ASSESSMENTS, AND MANAGEMENT IN 2012

A. Agency Overview

Essentially all groundfish research at the Alaska Fisheries Science Center (AFSC) is conducted within the Resource Assessment and Conservation Engineering (RACE) Division, the Resource Ecology and Fisheries Management (REFM) Division, the Fisheries Monitoring and Analysis (FMA) Division, and the Auke Bay Laboratories (ABL). The RACE and REFM Divisions are divided along regional or disciplinary lines into a number of programs and tasks. The FMA Division performs all aspects of observer monitoring of the groundfish fleets operating in the North Pacific. The ABL conducts research and stock assessments for Gulf of Alaska groundfish. All Divisions work together closely to accomplish the missions of the Alaska Fisheries Science Center. A review of pertinent work by these groups during the past year is presented below. A list of publications pertinent to groundfish and groundfish issues is included in Appendix I. Yearly lists of publications and reports produced by AFSC scientists are also available on the AFSC website at http://www.afsc.noaa.gov/Publications/yearlylists.htm , where you will also find a link to the searchable AFSC Publications Database.

Lists or organization charts of groundfish staff of these four Center divisions are included as Appendices II - V.

RACE DIVISION

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

In 2012, one of the primary activities of the RACE Division continued to be fishery-independent stock assessment surveys of important groundfish species of the northeast Pacific Ocean and Bering Sea. Regularly scheduled bottom trawl surveys in Alaskan waters include an annual survey of the crab and groundfish resources of the eastern Bering Sea shelf and biennial surveys of the Gulf of Alaska (odd years) and the Aleutian Islands and the upper continental slope of the eastern Bering Sea (even years). Three Alaskan Biennial Bottom Trawl Surveys of groundfish and invertebrate resources were conducted during the summer of 2012 by RACE Groundfish Assessment Program (GAP) scientists: the annual eastern Bering Sea shelf survey, the biennial eastern Bering Sea Continental Slope survey, and the biennial survey of the continental shelf of the Aleutian Islands. GAP scientists also partnered with University of Alaska researchers to conduct a bottom trawl survey of the Chukchi Sea.

RACE scientists of the Habitat Research Team (HRT) continue research on essential habitats of groundfish including identifying suitable predictor variables for building quantitative habitat models, developing tools to map these variables over large areas, investigating activities with potentially adverse effects on EFH, such as bottom trawling, and benthic community ecology work to characterize groundfish habitat requirements and assess fishing gear disturbances.

The Midwater Assessment and Conservation Engineering (MACE) Program conducted echo integration-trawl (EIT) surveys of midwater pollock abundance during the summer of the eastern Bering Sea as well as winter acoustic surveys in the Gulf of Alaska. Research cruises investigating bycatch issues also continued.

For more information on overall RACE Division programs, contact acting Division Director Guy Fleischer at (206)526-4103.

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, Economics and Social Sciences Research, Resource Ecology and Ecosystem Modeling, and Status of Stocks and Multispecies Assessment. REFM scientists prepare stock assessment documents for groundfish and crab stocks 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 on regional fishery management teams.

For more information on overall REFM Division programs, contact Division Director . Patricia Livingston at (206) 526-4172.

AUKE BAY LABORATORIES

The Auke Bay Laboratories (ABL), located in Juneau, Alaska, is a division of the NMFS Alaska Fisheries Science Center (AFSC). ABL’s Marine Ecology and Stock Assessment Program (MESA) is the primary group at ABL involved with groundfish activities. Major focus of the MESA Program is on research and assessment of sablefish, rockfish, sharks, and grenadiers in

Alaska and with the studies on benthic habitat. Presently, the program is staffed by 14 scientists, including 13 permanent employees and 1 term employee. ABL's Ecosystem Monitoring and Assessment Program (EMA) has also been conducting groundfish-related research for the past few years.

In 2012, field research, ABL's MESA Program, in cooperation with the AFSC's RACE Division, conducted the AFSC's annual 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 sablefish maturity study conducted jointly with the AFSC RACE Division; 3) satellite tagging studies of spiny dogfish and sablefish; 4) recompression experiments on rougheye and blackspotted rockfish; 5) a large-scale, epipelagic trawl survey of the eastern Bering Sea shelf conducted by ABL's EMA Program that provides annual data on abundance of age-0 walleye pollock; and 6) an upper trophic level fisheries oceanography survey of the Gulf of Alaska.

Ongoing analytic activities in 2012 involved management of ABL's sablefish tag database, analysis of sablefish logbook and observer data to determine fishery catch rates, and preparation of nine status of stocks documents for Alaska groundfish: Alaska sablefish and Gulf of Alaska Pacific ocean perch, northern rockfish, dusky rockfish, rougheye/blackspotted rockfish, shortraker rockfish, "Other Rockfish", thornyheads, sharks, and grenadiers. Other analytic activities in 2012 included analysis of sablefish archival tag data, an updated analysis of conventional sablefish tag data, and recalculation of geographic area sizes used for computing abundance indices from the longline survey.

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

B. Multispecies Studies

1. Stock Assessment and Surveys

2012 Eastern Bering Sea Continental Shelf Bottom Trawl Survey – RACE GAP

The thirty-first in a series of standardized annual bottom trawl surveys of the eastern Bering Sea (EBS) continental shelf was completed on 6 August 2012 aboard the AFSC chartered fishing vessels *Arcturus* and *Alaska Knight*, which bottom trawled at 376 stations over a survey area of 144,600 square nautical miles. Researchers processed and recorded the data from each trawl catch by identifying, sorting, and weighing all the different crab and groundfish species and then measuring samples of each species. Supplementary biological and oceanographic data collected on the bottom trawl survey was also collected to improve understanding of life history of the groundfish and crab species and the ecological and physical factors affecting their distribution and abundance.

Survey estimates of total biomass on the eastern Bering Sea shelf for 2012 were 3.49 million metric tons (t) for walleye pollock, 896 thousand t for Pacific cod, 1.95 million t for yellowfin sole, 1.92 million t for rock sole, 21.8 thousand t for Greenland turbot, and 189 thousand t for Pacific halibut. There were slight increases in estimated total biomass compared to 2011 levels for walleye pollock and Greenland turbot, and slight decreases for Pacific cod, yellowfin sole, rock sole, and Pacific halibut.

Average surface (5.1°C) temperatures were the same as in 2011, but average bottom temperatures decreased from 2.33°C in 2011 to 0.9°C in 2012 reflecting the long extension of the cold pool. Both average surface and bottom temperatures were well below the 1982-2012 long-term averages (6.5°C and 2.3°C, respectively).

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

Bottom Trawl Survey of the Eastern Chukchi Sea – RACE GAP

The 2012 eastern Chukchi Sea bottom trawl survey was funded by the Bureau of Ocean Energy Management (BOEM) as part of a larger, integrated, and comprehensive fishery and oceanographic survey effort called the Arctic Ecosystem Integrated Survey (Arctic Eis) Project. Arctic Eis involved a collaboration of more than 40 investigators from the AFSC, the Pacific Marine Environmental Laboratory, the University of Alaska Fairbanks (UAF), the U.S. Fish & Wildlife Service, and the Alaska Department of Fish & Game. The primary motivation for this multidisciplinary effort was to gather baseline data as a scientific foundation to determine how climate change is affecting the Arctic marine ecosystem and for responsibly guiding or mitigating future economic development activities in the Arctic region. Rapidly changing climate and developing economic activities in the Arctic have created an urgent need for comprehensive broad-scale scientific baseline data for long-term monitoring and environmental assessment. Past surveys in the Chukchi Sea have been spatially and temporally fractured or have not followed standard sampling practices, and have therefore been difficult to assemble into the spatially and temporally coherent picture necessary to enhance our understanding of long-term climatic influences over such a large area. This survey was based on a sampling design incorporating well-established standardized quantitative sampling techniques with surface, midwater, and bottom trawls, oblique plankton tows, midwater acoustics, and oceanographic sampling of the water column. The bottom trawl survey gear and methods were identical to those used in the northern Bering Sea in 2010, the Beaufort Sea in 2008, and for annual standardized bottom trawl surveys on the eastern Bering Sea shelf conducted since 1982. Using the same primary sampling tool in all of these areas will provide a valuable comparison of the distribution and abundance of fishes and invertebrates over a large contiguous area ranging from the Alaska Peninsula to the Arctic ice edge. Biological and physical data collected on the survey will be used to improve our understanding of the population structure and life history of the biota of the Chukchi Sea, as well as the environmental factors affecting their distribution and abundance. Scientists from the collaborating organizations did an exceptional job coordinating research projects to ensure the best use of biological samples for studies on age and population stock structure, trophic interactions, bioenergetics, trawl gear selectivity, and fish and invertebrate systematics.

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

2012 Biennial Bottom Trawl Survey of Groundfish and Invertebrate Resources of the Aleutian Islands– RACE GAP

The twelfth in a series of comprehensive bottom trawl surveys of groundfish resources in the Aleutian Islands (AI) region was conducted from June 4 through August 14, 2012 with actual trawling occurring from June 8nd to August 11th. This regional survey began in 1980 and was conducted triennially until 2000 and was then conducted biennially thereafter. The AI survey was not conducted in 2008. The standard AI survey area, established in 2000, begins at the at Islands of the Four Mountains at the base of the Aleutian Islands (170° W longitude) and extends west to Stalemate Bank (170° E longitude) in the eastern hemisphere. Sampling depths range from approximately 15 to 500 m during a typical survey. Commercially and ecologically valuable species of flatfish, roundfish, rockfish, and invertebrates inhabit the area. In many areas rocky bottom conditions provide abundant substrate for many species of bottom-oriented including bryozoans, hydroids, sponges and corals, and these invertebrate communities, in turn, provide essential habitat for juveniles and adults of many groundfish species. The major survey objective is to continue the time series to monitor trends in distribution, abundance, and population biology of important groundfish species and to describe and measure various biological and environmental parameters. Secondary objectives include investigating fish and invertebrate life histories (trophic relationships, reproductive biology, groundfish systematics, etc) and improving survey methodology.

Survey fishing was conducted aboard two chartered commercial trawlers, the F/V *Ocean Explorer* and the F/V *Sea Storm*, during the 72 day period. The survey design is a stratified-random sampling scheme based 39 strata of depth and region and applied to a grid of 5x5 km^2 cells. These cells of past successfully trawled stations are the sampling frame of possible trawl stations. Stations are allocated amongst the strata using a Neyman scheme weighted by stratum areas, cost of conducting a tow, past years' data, and the ex-vessel values of key species. Four hundred twenty stations were originally planned. Occupied stations were sampled with 15-minute tows using standardized RACE Poly Nor'Eastern four-seam bottom trawls rigged with roller gear. Catches were brought aboard and sorted, counted, and weighed by species. Individual length measurements, age structures, and other biological data and specimens are collected from samples of important species in each catch.

Successful hauls were made at all 420 stations at original or nearby alternate sites, ranging in depth from 32 to 465 m. Just over 453 mt fish of fish and 21 mt of invertebrates were captured during the survey, and the catch consisted of 153 fish taxa and 524 invertebrate taxa. Pacific ocean perch was the most abundant fish species found in the survey, followed by, Atka mackerel, northern rockfish, walleye pollock, and Pacific cod. Catch rates were low for many important species, possibly as a result of the coldest water temperatures found during any AI survey.

For further information contact Wayne Palsson (206) 526-4104, Wayne.Palsson@noaa.gov .

MACE Program

GULF OF ALASKA

Winter acoustic-trawl surveys in the Gulf of Alaska
The MACE Program conducted winter acoustic-trawl (AT) surveys in 2012 aboard the NOAA ship *Oscar Dyson*, targeting walleye pollock (*Theragra chalcogramma*) in Sanak Trough, the Shumagin Islands, along the shelf break southeast of Chirikof Island, and in the Shelikof Strait area.

The Sanak Trough survey was conducted 15 February 2012 along transects spaced 2-nmi apart. The Shumagin Islands portion of the survey was conducted 16-19 February 2012 along parallel transects. Transects were spaced 5-nmi apart within Shumagin Trough, 1-nmi apart east of Renshaw Point, and 2.5-nmi apart elsewhere.

The densest pollock aggregations in Sanak Trough, which consisted primarily of adult pollock 41-73 cm fork length (mode of 48 cm), were located over the northeast portion of the trough. The unweighted maturity composition for males longer than 40 cm was 0% immature, 3% developing, 6% pre-spawning, 78% spawning, and 14% spent. The unweighted maturity composition for females longer than 40 cm FL was 0% immature, 3% developing, 84% pre-spawning, 6% spawning, and 6% spent. The combined percentage of spawning and spent female fish this year was much lower than in previous years and together with the high percentage of pre-spawning females indicates that survey timing was closer to peak spawning than in previous years. The average gonadosomatic index (GSI: ovary weight/body weight) for pre-spawning females was 0.15. The abundance estimate for Sanak Trough was 24,300 t, based on catch data from 2 trawl hauls and acoustic data from 181 nmi of survey transects.

Very little walleye pollock were observed in the Shumagin Islands, and what was observed was very diffuse and sparse. The densest walleye pollock aggregations in the Shumagin Islands area were located off Renshaw Point. The unweighted maturity composition for males longer than 40 cm FL was 0% immature, 5% developing, 16% pre-spawning, 68% spawning, and 10% spent. The maturity composition of females longer than 40 cm FL was 0% immature, 9% developing, 82% pre-spawning, 2% spawning, and 7% spent. The mean GSI for mature pre-spawning females was 0.13. The pollock AT survey abundance estimate in the Shumagin Islands area was 15,500 t, based on catch data from 3 trawl hauls and acoustic data from 368 nmi of survey transects. The 2012 estimate was the lowest in the time series.

The MACE Program also conducted winter AT surveys along the shelfbreak southeast of Chirikof Island and in the Shelikof Strait area. Chirikof shelf break was surveyed during 17-19 March 2012 along parallel transects spaced 6-nmi apart. The Shelikof Strait sea valley was surveyed from south of Chirikof Island to Paramanof Bay on Afognak Island during 20-26 March 2012 along parallel transects spaced 7.5-nmi apart.

Most walleye pollock backscatter in the Chirikof shelfbreak survey was detected on two transects just west of the mouth of Barnabas Trough. The walleye pollock caught were adults ranging in length from 40- 71cm FL. The unweighted maturity composition for males longer than 40 cm FL was 11% immature, 0% developing, 67% pre-spawning, 22% spawning, and 0% spent. The unweighted maturity composition for females longer than 40 cm FL was 18% immature, 0% developing, 80% pre-spawning, 2% spawning, and 0% spent. The average GSI for pre-spawning females was 0.15. The abundance estimate was 21,200 t, based on catch data from 2 trawl hauls and acoustic data from 155 nmi of survey.

Walleye pollock aggregations in the Shelikof Strait survey northeast of the Semidi Islands formed a continuous dense near-bottom layer within 80 m of the seafloor and consisted of a mixture of sizes primarily in the 9-29 cm FL range, with major modes at 13 and 22, representing age-1 and age-2 fish, respectively. Some larger fish, up to 70 cm FL, were also present but in much smaller numbers. Similar aggregations were also located farther north, into the Strait proper, and along the Kodiak side of the Strait, and contained more large adults in the 30-70 cm FL range. Within the deepest section of the Strait along the Alaska Peninsula dense aggregations of pre-spawning adult fish in the 40-65 cm FL range were detected. These pre-spawning adult fish were predominantly between the ages of 4 and 7 years old. Several dense schools were also present in midwater in the north central portion of the Strait proper and consisted mostly of age-4 and -5-year-old non-spawning pollock in the 30-60 cm FL range.

In Shelikof Strait, the unweighted maturity composition for males longer than 40 cm FL was 37% immature, 20% developing, 38% mature pre-spawning, 4% spawning, and 1% spent. The maturity composition of females longer than 40 cm FL was 4% immature, 47% developing, 49% pre-spawning, <1% spawning, and <1% spent. The small fraction of spawning and spent females relative to pre-spawning females suggests that the survey timing was appropriate. The average GSI for mature pre-spawning females was 0.12. The pollock abundance estimate for Shelikof Strait was 335,800 t, 22% lower than in 2010 (429,700 t) which was the largest seen in the region since 2001. The 2012 estimate was based on catch data from 11 trawl hauls and acoustic data from 759 nmi of survey transects.

BERING SEA

Winter acoustic-trawl survey in the southeast Aleutian Basin near Bogoslof Island

The MACE Program conducted an acoustic-trawl (AT) survey of walleye pollock in the southeastern Aleutian Basin near Bogoslof Island aboard the NOAA ship *Oscar Dyson* during 7-15 March, 2012. The survey was designed with two survey tracks, which covered 3,656 nmi^2 of the CBS Convention Specific Area. The primary survey track was nearest to the Aleutian Islands and consisted of 35 north-south parallel transects spaced 3 nmi apart and the second survey track was located just north of the primary survey track, and consisted of 12 north-south parallel transects space 9 nmi apart. This second survey track was essentially northern extensions of the primary survey track, designed to observe whether walleye pollock were present in deeper water.

The abundance estimate for walleye pollock in the primary survey area was 48.6 million fish weighing 67.1 thousand metric tons (t). Walleye pollock biomass wase concentrated north of Samalga Pass (59%; Samalga region), and northeast of Umnak Island (41%; Umnak region). Based on catch data from four trawl hauls, the pollock size composition in both regions ranged between 41 cm and 67 cm FL, and was characterized by a dominant mode of about 60 cm FL in the Samalga region and about 50 cm FL in the Umnak region. Most of the female pollock observed in both regions were in the mature pre-spawning condition. Male pollock however, were mostly in the mature pre-spawning condition in the Samalga region and in the mature-spawning condition in the Umnak region. The average GSI for mature pre-spawning females was 0.18.

Minor acoustic backscatter was observed along the second survey track, north of Samalga region and was attributed to walleye pollock. Although no trawl sample was collected, these fish were assumed to be similar to those in the Samalga region. Thus, the backscatter amounted to another 20 metric tons.

The estimated age composition for 2012 was bimodal, where 51% of the abundance was represented by 6 and 7 year old fish (2006 and 2005 year classes) and 30% was represented by 11 and 12 year old fish (2001 and 2000 year classes). Most of the younger fish (6 and 7 year olds) were observed in the Umnak region, whereas most of the older fish were observed in the Samalga region.

<u>Summer acoustic-trawl survey on the eastern Bering Sea shelf</u>
The MACE Program conducted an acoustic-trawl (AT) survey of midwater walleye pollock (*Theragra chalcogramma*) between 7 June and 10 August 2012 aboard the NOAA ship *Oscar Dyson*. The survey design consisted of 29 north-south transects spaced 20 nautical miles (nmi) apart from 162° W (west of Port Moller, Alaska) across the U.S.-Russia Convention Line to about 178° 20 E, including the Cape Navarin area of Russia. The survey's primary objective was to collect 38 kHz echo integration and trawl information to estimate daytime midwater walleye pollock abundance and distribution. Additional survey sampling included conductivity-temperature-depth (CTD) and expendable bathythermograph (XBT) casts to characterize the Bering Sea shelf physical oceanographic environment, and supplemental trawls to improve species identification and to obtain an index of euphausiid abundance using multiple frequency techniques. A number of specialized sampling devices were used during or after the survey, including light level sensors, a Simrad ME70 multibeam sonar to image fish schools, an 83-112 net modified to sample fish in midwater, and a trawl-mounted, stereo camera ("Cam-Trawl") designed to determine the species identification, density, and size of animals as they pass the camera.

Survey results showed that ocean conditions remained even colder in 2012 than in the recent cold period (2006-2011), which had been substantially colder than 2000-2005. About 61% of the summed acoustic backscatter at 38 kHz observed during the 2012 survey was attributed to adult or juvenile walleye pollock, compared with over 80% in 2010. The remaining 38 kHz backscatter was attributed to an undifferentiated plankton-fish mixture, or in a few isolated areas, to Pacific herring, rockfish species, or unidentified fish. The majority of the 2012 biomass in the U.S. EEZ spanned a region from west of the Pribilof Islands to Pervenets Canyon, between the ~80 m and 200 m isobaths. Estimated pollock abundance in midwater (between 16 m from the surface and 3 m off bottom) in the U.S. EEZ portion of the Bering Sea shelf was 6.67 billion fish weighing 1.843 million metric tons; in the Russian EEZ, there were 2.53 billion fish weighing 0.550 million metric tons (23% of the total midwater biomass). The pollock observed in the region east of 170°W (11.7% of total biomass) were distributed evenly inside and outside of the

Steller Sea Lion Conservation Area (SCA), and the predominant length mode was 47-48 cm with a lesser mode at 41 cm. In the U.S. west of 170° W (65.4% of total biomass) modal lengths were 23, 38 and 30 cm, in decreasing order of importance. The percentage of walleye pollock biomass found to the west of 170° W declined relative to the other areas for the first time since 2002. In Russia, modal pollock lengths were 32 and 23 cm.

Preliminary age results using a NMFS bottom trawl survey age-length key indicated that inside the U.S. EEZ, ages-4, -2 and -3 fish were dominant numerically and together represented 90% of the total numbers and 76 % of total biomass. Walleye pollock age 6 (the 2006 year class) totaled only 3.5% of the population numerically and made up 9% of the total biomass, compared with having represented 40% of total biomass at age 4 in 2010. Ages 7+ accounted for only 2% of the population numbers and only 7% of the total biomass. Analyses of walleye pollock vertical distribution indicated that among adults (≥34 cm) shelf-wide, 80-90% were found within 50 m of the bottom, whereas for juveniles west of 170° W, only 60% were found in that near-bottom region (very few juveniles occurred east of 170° W).

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

Gulf of Alaska Project: Fisheries Oceanographic Surveys - ABL

The Gulf of Alaska Project in 2011 conducted the first Upper Trophic Level (UTL) fisheries oceanographic survey as part of the North Pacific Research Board's (NPRB) Gulf of Alaska Integrated Ecosystem Research Program (GOA Project) which focuses on comparing and contrasting ecological function in the southeast and central regions of the Gulf of Alaska (GOA). This fisheries oceanographic study is investigating how environmental and anthropogenic processes affect trophic levels and dynamic linkages among trophic levels, with emphasis on fish and fisheries, marine mammals, and seabirds. It is interdisciplinary in nature and consists of four components that link together to form a fully integrated ecosystem study of the GOA. These components are the Upper Trophic Level (UTL), Middle Trophic Level (MTL), the Lower Trophic Level (LTL), and Ecosystem modeling.

The primary goal of the UTL component focuses on identifying and quantifying the major ecosystem processes that regulate recruitment strength of commercially and ecologically important groundfish species in the first year of life. Distribution, energetic condition, and transport during the early life history over the broad shelf of the central GOA are being contrasted with the narrower shelf adjacent to southeast Alaska (SEAK). Spatial and temporal overlap with seabirds, marine mammals, and piscivorous fish that prey upon the five focal species (arrowtooth flounder, Pacific ocean perch, sablefish, Pacific cod, and walleye pollock) during the age-0 life stage and upon other forage fishes are also being quantified. The MTL focuses on piscine competitors and early life history processes occurring in bays and fjords which influence productivity, abundance, and survival of the five focal species. The LTL focuses on physical and biological oceanographic properties, zooplankton, and ichthyoplankton that may influence the recruitment of the five species. Ecosystem Modeling links the dynamic processes being observed in the field with historical data in order to describe and predict the ecosystem responses (and variability therein) within the southeast and central GOA. In addition to these four main components, there is also a Retrospective component that is tasked with collecting all historical information relevant to this ecosystem synthesis and with exploring spatiotemporal patterns within the time series collected.

The 2012 survey season of this integrated project was an additional survey year conducted by the UTL and some sampling was not conducted as in 2011. Two fisheries oceanographic surveys were conducted off southeast Alaska and Kodiak Island during summer by the F/V Northwest Explorer, a chartered commercial trawler. Fish samples were collected using a midwater rope trawl (Cantrawl model 400). During the 2012 survey, the trawl was not fished at depth to verify acoustic targets or modified to fish at the water surface by stringing buoys along the headrope as it was in 2011. Surface tows were made at predetermined grid stations and were 30 minutes in duration, while midwater trawls targeting specific layers varied in duration. Immediately after the trawl was retrieved, catches were sorted by species and standard biological measurements (length, weight, and maturity) were recorded. Whole age-0 marine fish, juvenile salmon, and forage fish were collected and frozen for transportation to the laboratory for food habits, energetic, and genetic analyses. A "live box" was attached to the codend of the survey trawl at predetermined grid stations to collect live age-0 rockfish in the southeast GOA region. Once the "live box" was retrieved, live *Sebastes* specimens were immediately transferred to an aerated live well on deck and transported to ABL for feeding and growth rate studies.

Acoustic data was not collected by a Simrad ES-60 echosounder and a hull-mounted 38 kHz splitbeam transducer in 2012 as it had previously been collected in 2011. Thus, acoustic transects, orthogonal to shore, were not run between all rope trawling stations. Nor were constituent species observed in the acoustic record verified, or opportunistic trawls made to target midwater aggregations that the surface trawl would not sample. In years where acoustics are part of the survey, the acoustic echogram is monitored in real time for unusual or interesting aggregations along transects. And catches from midwater trawls were sorted by species and length and weight samples were measured whenever sufficient (>30) numbers were caught.

Physical oceanographic data were collected at gridded survey stations by deploying a conductivity, temperature, and depth meter (CTD) with ancillary sensors. These provided vertical profiles of salinity, temperature, fluorescence, photosynthetic available radiation (PAR), and dissolved oxygen. Water samples for nutrients (N, P, Si), chlorophyll a, phytoplankton, and microzooplankton were also collected (surface 10m, 20m, 30m, 40m, and 50m depth). Zooplankton and ichthyoplankton samples were collected at gridded stations using double oblique bongo tows from the surface to within 5 meters of bottom, with a maximum depth of 200 m.

The habitat research project of the UTL continues to digitize available bathymetry and sediment data for later use in habitat suitability models specific to the five focal species. Additionally, a new post-doc was accepted for developing the base suitability models and associated maps. Once these models/maps are completed they will be provided to the modeling component for use in the species specific individual based models.

We intend to again sample the eastern and central regions of the GOA during summer and fall 2013, when field work for this project terminates. For more information, contact Jamal Moss at (907)-789-6609 or jamal.moss@noaa.gov

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 and submitted for review to the Gulf of Alaska and Bering Sea/Aleutian Islands Groundfish Plan Teams of the North Pacific Fishery Management Council.

Assessment scientists provided analytic assistance on many current fisheries management issues. These included: 1) identification and prioritization of research activities intended to improve groundfish stock assessments; 2) continued refinement and review of Bering Sea crab stock assessments 3) research activities associated with the impacts of climate change 4) research activities associated with the incorporation of ecosystem variables in stock assessments 5) significant contribution and development of the analysis for the Chinook salmon bycatch Environmental Impact Statement 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/FIT.htm

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

Gulf of Alaska Project: Fisheries Oceanographic Surveys - ABL

The Gulf of Alaska Project in 2011 conducted the first Upper Trophic Level (UTL) fisheries oceanographic survey as part of the North Pacific Research Board's (NPRB) Gulf of Alaska Integrated Ecosystem Research Program (GOA Project) which focuses on comparing and contrasting ecological function in the southeast and central regions of the Gulf of Alaska (GOA). This fisheries oceanographic study is investigating how environmental and anthropogenic processes affect trophic levels and dynamic linkages among trophic levels, with emphasis on fish and fisheries, marine mammals, and seabirds. It is interdisciplinary in nature and consists of four components that link together to form a fully integrated ecosystem study of the GOA, which are the Upper Trophic Level (UTL), Middle Trophic Level (MTL), the Lower Trophic Level (LTL), and Ecosystem modeling.

The primary goal of the UTL component focuses on identifying and quantifying the major ecosystem processes that regulate recruitment strength of commercially and ecologically important groundfish species in the first year of life. Distribution, energetic condition, and transport during the early life history over the broad shelf of the central GOA are being contrasted with the narrower shelf adjacent to southeast Alaska (SEAK). Spatial and temporal overlap with seabirds, marine mammals, and piscivorous fish that prey upon the five focal species (arrowtooth flounder, Pacific ocean perch, sablefish, Pacific cod, and walleye pollock) during the age-0 life stage and upon other forage fishes are also being quantified. The MTL focuses on piscine competitors and early life history processes occurring in bays and fjords which influence productivity, abundance, and survival. The LTL focuses on physical and biological oceanographic properties, zooplankton, and ichthyoplankton. Ecosystem Modeling links the dynamic processes being observed in the field with historical data in order to describe and predict the ecosystem responses (and variability therein) within the southeast and central GOA.

Four fisheries oceanographic surveys were conducted off southeast Alaska and Kodiak Island during summer and fall by the F/V *Northwest Explorer*, a chartered commercial trawler. Fish samples were collected using a midwater rope trawl (Cantrawl model 400). During the survey, the trawl was either fished at depth to verify acoustic targets or modified to fish at the water surface by stringing buoys along the headrope. Surface tows were made at predetermined grid stations and were 30 minutes in duration, while midwater trawls targeting specific layers varied in duration. Immediately after the trawl was retrieved, catches were sorted by species and standard biological measurements (length, weight, and maturity) were recorded. Whole age-0 marine fish, juvenile salmon, and forage fish were collected and frozen for transportation to the laboratory for food habits, energetic, and genetic analyses. A "live box" was attached to the codend of the survey trawl at predetermined grid stations to collect live age-0 rockfish in the southeast GOA region. Once the "live box" was retrieved, live *Sebastes* specimens were immediately transferred to an aerated live well on deck and transported to ABL for feeding and growth rate studies.

Acoustic data were collected by a Simrad ES-60 echosounder and a hull-mounted 38 kHz splitbeam transducer. Acoustic transects, orthogonal to shore, were run between all rope trawling stations. To verify constituent species observed in the acoustic record, opportunistic trawls targeted midwater aggregations that the surface trawl would not sample. As the survey progressed, the acoustic echogram was monitored in real time for unusual or interesting aggregations along transects. Catches from midwater trawls were sorted by species and length and weight samples were measured whenever sufficient (>30) numbers were caught.

Physical oceanographic data were collected at gridded survey stations by deploying a conductivity, temperature, and depth meter (CTD) with ancillary sensors. These provided vertical profiles of salinity, temperature, fluorescence, photosynthetic available radiation (PAR), and dissolved oxygen. Water samples for nutrients (N, P, Si), chlorophyll *a*, phytoplankton, and microzooplankton were also collected (surface 10m, 20m, 30m, 40m, and 50m depth).

Zooplankton and ichthyoplankton samples were collected at gridded stations using double oblique bongo tows from the surface to within 5 meters of bottom, with a maximum depth of 200 m. Neuston tows were also made at the surface with a Sameoto sampler.

We intend to again sample the eastern and central regions of the GOA during summer 2012, although fall sampling will not occur. In 2013, when field work for this project terminates, we are planning both summer and fall surveys. For more information, contact Jamal Moss at (907)-789-6609 or jamal.moss@noaa.gov

2. Research

Correcting density dependent effects in abundance estimates from bottom trawl surveys.

Indices of abundance are important for estimating population trends in stock assessment and ideally should be based on fishery-independent surveys to avoid problems associated with the hyperstability of the commercial catch per unit effort data (CPUE) data. However, recent studies indicate that the efficiency of the survey bottom trawl for some species can be density dependent, which could potentially affect reliability of survey derived indices of abundance. A function $q_e \sim f(u)$, where q_e is bottom trawl efficiency and u is a catch rate, was derived using experimentally-derived acoustic dead zone correction and bottom trawl efficiency parameters obtained from combining a subset of bottom trawl catch data with synchronously collected acoustic data from walleye pollock in the eastern Bering sea (EBS). We found that q_e decreased with increasing bottom trawl catches resulting in hyperstability of the index of abundance derived from bottom trawl survey. Density-dependent q_e resulted in spatially and temporarily variable bias in survey CPUE and biased age structure derived from survey data.

We used $q_e \sim f(u)$ relationship to obtain new, corrected for density dependence, index of abundance. We also obtained variance-covariance matrix for a new index that accounted for sampling variability and the uncertainty associated with the q_e. We found that incorporating estimates of the new index of abundance changed outputs from stock assessment model. Although changes were minor, we advocate incorporating estimates of density dependent q_e into stock assessment as a precautionary measure that should be undertaken to avoid negative consequences of the density-dependent q_e. Stan Kotwicki, James N. Ianelli, André E. Punt

The Alaska Coral and Sponge Initiative (AKCSI): a NOAA Deep Sea Coral Research and Technology Program regional fieldwork initiative in Alaska--RACE GAP

Deep-sea coral and sponge ecosystems are widespread throughout most of Alaska's marine waters. In some places, such as the western Aleutian Islands, these may be the most diverse and abundant deep-sea coral and sponge communities in the world. Deep-sea coral and sponge communities are associated with many different species of fishes and invertebrates in Alaska. Because of their biology, these benthic invertebrates are potentially vulnerable to the effects of commercial fishing, climate change and ocean acidification. Since little is known of the biology and distribution of these communities, it is difficult to manage human activities and climate impacts that may affect deep-sea coral and sponge ecosystems.

Beginning in FY2012, the NOAA Deep Sea Coral Research and Technology Program (DSCRTP) initiated a field research program in the Alaska region for three years (FY2012-2014) to better understand the location, distribution, ecosystem role, and status of deep-sea coral and sponge habitats. The research priorities of this initiative include:

- Determine the distribution, abundance and diversity of sponge and deep-sea coral in Alaska;
- Compile and interpret habitat and substrate maps for the Alaska region;
- Determine deep-sea coral and sponge associations with FMP species and their contribution to fisheries production;
- Determine impacts of fishing by gear type and testing gear modifications to reduce any impacts;
- Determine recovery rates of deep-sea coral and sponge communities from disturbance; and,
- Establish a monitoring program for the impacts of climate change and ocean acidification on deep-coral and sponge ecosystems.

FY12 Research Activities

In FY12, three cruises were conducted in by AKCSI researchers in Alaska. In June 2012, a multibeam mapping cruise was conducted to collect bathymetry and backscatter information for three study sites in the southeast and one site in the central Gulf of Alaska. This mapping was conducted to support FY13-14 research activities that will explore the distribution and ecology of Primnoa thickets. A second research cruise in early August was conducted aboard a chartered fishing vessel out of Kodiak to look at the ecology and production of commercial fishes from coral and non-coral habitats. Researchers collected underwater video at 18 transects inside and outside coral habitat. They also collected rockfish from coral and sponge habitat in four bottom trawl hauls. Oceanographic information and zooplankton samples were also collected. The research found that dusky rockfish (*Sebastes variabilis*) and northern rockfish (*Sebastes polyspinis*) were the most commonly identified species of commercial fish in the area.

The third research cruise was conducted in mid-August aboard a chartered fishing vessel to groundtruth a coral and sponge distribution model. This research cruise conducted underwater camera drops at 106 locations in the central and eastern Aleutian Islands from Unimak Pass to Petrel spur. In addition, a region north of the Aleutian chain, Bowers ridge and Bowers bank was also explored. Corals were observed at 53 of the 106 sites and sponges were observed at 69 of 106 sites.

In addition to these three cruises funded by AKCSI, there were also a number of field data collections carried out in partnership with other research activities in Alaska. In FY12, with partners in the AFSC RACE division (funded by the North Pacific Research Board) we purchased two sensors to collect O2, salinity, turbidity and pH measurements on the headrope of bottom trawls used to conduct annual stock assessment surveys. A deployment mechanism was constructed and tested during the 2012 eastern Bering Sea slope bottom trawl survey. Oceanographic data were collected on 168 tows along the Bering Sea slope from Bering Canyon to the U.S.-Russia border at depths to 1100 m. Oceanographic equipment to measure O2, pH, salinity and temperature was also purchased to set up long-term monitoring stations in southeast Alaska and was deployed into Tracy Arm in January 2013. In FY12, a pilot project was conducted to construct a camera system that could be attached to longline and pot fishing gear in Alaska to collect information on the impacts of these gears on benthic habitats. A prototype camera system was constructed by research partners in the RACE division and was deployed off a vessel of opportunity in July 2012. Although the test revealed the difficulty of designing a deployment platform for the camera, the design is sound and testing will continue on this project deploying the instrument again in FY13. Field activities also included the collection of 120 sponge specimens for morphological taxonomic study and coral and sponge tissue samples for genetic analysis through collaboration with the Aleutian Islands bottom trawl survey. In anticipation of deploying settlement plates to serve as substrate for new Primnoa coral recruits, a number of naturally occurring rocks were collected in southeast Alaska. These rocks were cut into regular squares and attachment points were inserted. The plates will be “cured” by holding them in flowing seawater tanks at the Auke Bay Labs wet laboratory during the winter. The arrays will then be deployed in Primnoa thickets at two sites in summer FY13. Laboratory studies were also conducted to support the AKCSI program in FY12. Work on genetic markers for Primnoa corals was performed in our partner laboratory at the U.S. Geological Survey (Leetown Science Center, West Virginia). This work will support the analysis of genetic population connectivity among Alaska and West Coast populations of Primnoa scheduled for FY13 and FY14. Additional work was conducted at the AFSC and U.S. Geological Survey to compile bathymetry and sediment maps for the Aleutian Islands and Gulf of Alaska in anticipation of completing a geologically interpreted substrate map for these regions in FY14. Some of the work on this project was funded through a small research grant from DSCRTP in FY11. Thus, the continuation of this work resulted in the completion of the Aleutian Islands region this year.

Recruitment and Response to Damage of an Alaskan Gorgonian Coral -ABL

Benthic habitats in deep-water environments experience low levels of natural disturbance and recover slower than shallow-water habitats. Deep-water corals are particularly sensitive to disturbance from fishing gear, in part because they are long-lived, grow slowly, and are believed to have low rates of reproduction. Limited data describes recruitment and recovery of deep-water corals. This information is critical to understanding long-term effects of anthropogenic disturbances, such as commercial fishing, on the population dynamics of living benthic habitat.

In 2009, scientists from the Auke Bay Laboratories initiated a multi-year study to examine recruitment and recovery of the gorgonian coral *Calcigorgia spiculifera*, a species broadly distributed in the Gulf of Alaska and along the Aleutian Islands. *Calcigorgia spiculifera*, as well as many other gorgonian corals, is found in areas and depths that coincide with trawl and longline fisheries and is often damaged by these fisheries. The body plan of *C. spiculifera* is similar to many other gorgonian corals commonly found throughout the North Pacific Ocean. Therefore, sensitivity to disturbance, rate of recovery, and recruitment of *C. spiculifera* is likely to be similar to other coral species, and thus results from this research may be applied broadly. Recovery rate and recruitment data are necessary for modeling habitat impacts and forecasting recovery and will ultimately guide fisheries managers in making decisions regarding benthic habitat conservation measures. In this study, recruitment is being investigated by observing settlement of coral planulae onto rings equipped with natural stone tiles, and coral recovery is being examined by observing the response of colonies to damage treatments.

The study site, Kelp Bay, Southeast Alaska, offers hundreds of *C. spiculifera* colonies concentrated at depths easily accessible to scuba divers. Field operations in Kelp Bay began in August 2009 when a team of four divers located and tagged 48 *C. spiculifera* colonies. Of that total, 9 colonies were fitted with settlement rings equipped with removable tiles. The remaining 39 tagged colonies were ascribed to three damage treatment groups and a control group. The damage treatments were designed to mimic actual damage that can occur from a passing trawl. These treatments were performed *in situ* and included deflection, soft tissue excision, and branch severance. Video of each colony was recorded before and after the treatments were performed to establish baseline coral characteristics and to identify immediate treatment effects. Since the initial site visit, the dive team has returned to observe the tagged corals on three additional occasions (June 2010, September 2010, and August 2011). On each visit, subsamples of the stone tiles were collected and preserved in solution for subsequent inspection in the laboratory for adhesion of coral recruits. Damaged and control colonies were also videoed so that comparisons can be made to pretreatment images. At least one subsequent site visit is planned for 2014 to allow additional tile collections and to capture long-term effects of disturbance. For more information, contact Patrick Malecha at (907) 789-6415 or pat.malecha@noaa.gov

Habitat use and productivity of commercially important rockfish species in the Gulf of Alaska

The contribution of specific habitat types to the productivity of many rockfish species within the Gulf of Alaska remains poorly understood. It is generally accepted that rockfish species in this large marine ecosystem tend to have patchy distributions that frequently occur in rocky, hard, or high relief substrate. The presence of biotic cover (coral and/or sponge) may enhance the value of this habitat and may be particularly vulnerable to fishing gear. Previous rockfish habitat research in the Gulf of Alaska has occurred predominantly within the summer months. This project will examine the productivity of the three most commercially important rockfish in the Gulf of Alaska (Pacific ocean perch, *Sebastes alutus*, northern rockfish, *S. polyspinis*, and dusky rockfish, *S. variabilis*) in three different habitat types during three seasons. Low relief, high relief rocky/boulder, and high relief sponge/coral habitats in the Albatross Bank region of the Gulf of Alaska will be sampled using both drop camera image analysis and modified bottom trawls. We will sample these habitats examining differences in density, community structure, prey availability, diet diversity, condition, growth, and reproductive success within the different habitat types. This research will enable us to examine the importance of different habitat types for these rockfish species providing data critical for both protecting essential habitat as well as effective management of these species. In the summer of 2012, two research cruises were conducted in May and August. During these cruise,s 34 camera drops and 11 trawl tows were conducted. In the upcoming year(s), research cruises will take place in August 2013, winter 2013/14, spring 2014, and August 2014.

For further information contact Christina Conrath, (907) 481-1732

Mapping Untrawlable Habitats in the Gulf of Alaska-RACE GAP

Rockfish are difficult to assess using standard bottom trawl surveys due to their propensity to aggregate in rocky high relief (untrawlable) areas. The amount of untrawlable seafloor within the Gulf of Alaska bottom trawl survey area is unknown and has a negative impact on the accuracy of trawl survey biomass estimates for rockfish. The purpose of this study is to find low-cost methods to map trawlability of the seafloor using acoustics. Fieldwork for this project was carried out in a small area in 2009 and on a wider scale in 2011 with scientists from the UNH-Center for Coastal and Ocean Mapping and AFSC participating aboard the GOA-wide biennial acoustic-trawl survey aboard the NOAA ship *Oscar Dyson*. In the 2009 pilot project, an important offshore bank called the “Snakehead” was mapped using a Simrad ME70 multibeam as well as EK60 echosounders. During the 2011 survey, Simrad echosounder data were also collected along the regularly spaced survey transects from the Islands of Four Mountains in the Aleutian Islands (169°59'0"W 52°43'11"N) to East Kodiak Island (151°5'25"W 57°20'46"N) in continuation of the Snakehead seafloor mapping project.

In addition to ME70 data collected along the 2011 survey trackline, several fine-scale mapping surveys were conducted over localized areas where previously collected seafloor information (with cameras or submersibles) provided groundtruthing observations. A total of 37 of these previously sampled camera locations were targeted. Fine-scale ME70 surveys also targeted localized areas having no ground truth seafloor data, but which were suspected of being untrawlable based on historical information from AFSC bottom trawl surveys (see next paragraph). Single or stereo camera deployments were conducted at these stations to groundtruth the ME70 data.

In many areas, the oblique (45 degrees) incidence seafloor backscatter data collected with the ME70 during the summer 2011 survey were matched with the spatial location of previously conducted AFSC bottom trawl survey tows from 1996-2011. Backscatter values were extracted for the area that the net contacted the seafloor, taking into account the length of the wire out from the ship, and the width of the net. Tows had been previously classified as good, failed, or marginally successful by AFSC groundfish researchers based on the level of gear damage sustained from contact with the seafloor. The ME70 mapping data from the ship trackline and fine-scale surveys corresponded with the location of 351 total tows (325 classified as good, 12 marginally successful, 14 failed). Preliminary analyses also underway show separation in the distribution of backscatter values and seafloor types that correspond to the tow performance categories. A draft report is available, which details the model predicting trawlable and untrawlable grounds, as well as data collection protocols.

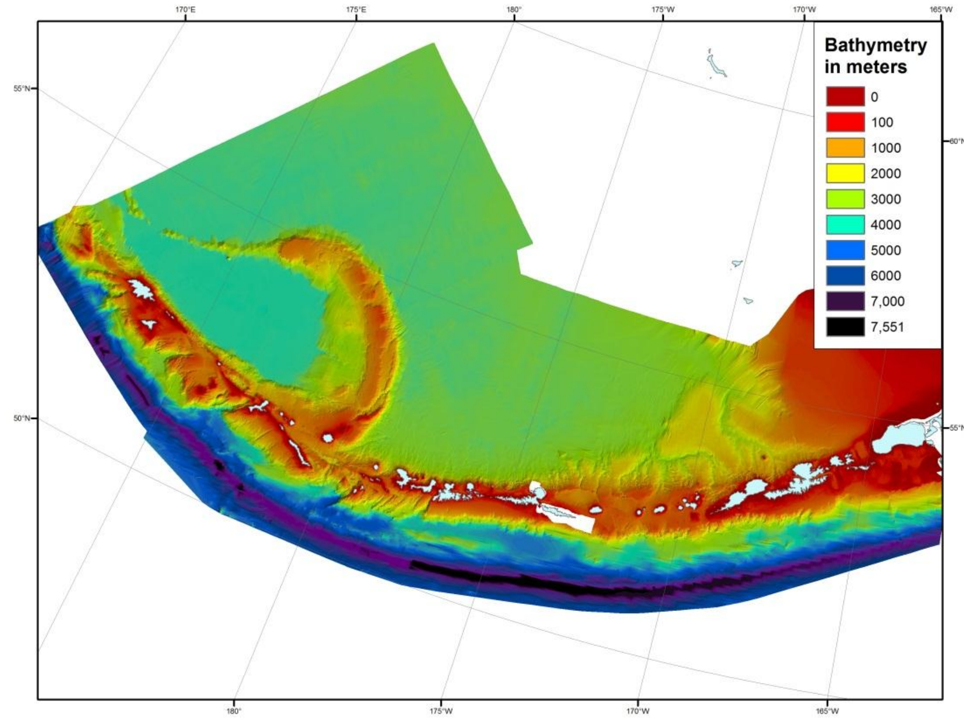
Tentative ancillary research plans during the GOA summer 2013 acoustic-trawl survey include ancillary mapping activities to improve the methods used to characterize trawlable habitats and potentially improve station selection during demersal surveys. This ancillary research will also begin collection of data that will ultimately be used to estimate the proportion of shelf rockfish species in trawlable and untrawlable areas, and thus available to the bottom trawl survey. The work will use acoustic-optical survey methods by combining shipboard echosounders and stereo drop cameras to determine rockfish abundance in the two habitat types. The acoustic dead zone and interactions with fish behavior may also be investigated using motion triggered cameras deployed in untrawlable areas, if time is available.

For more information, contact Chris Wilson (chris.wilson@noaa.gov) and Chris Rooper (chris.rooper@noaa.gov).

Bathymetric Analysis of the Gulf of Alaska and Aleutian Islands-RACE GAP

Several ongoing projects are aimed at improving the understanding of seafloor habitats in the Gulf of Alaska and Aleutian Islands by assembling multi-beam data sets and extracting observations of bathymetry and seafloor substrates from "smooth sheets" generated by original NOAA hydrographic and charting surveys that contain much more depth and sediment information than the resulting navigation charts. These improved datasets have immediate application to the GOA-IERP study of the central and eastern GOA and to prediction of deepwater coral and sponge habitats in the upcoming Alaska Coral and Sponge Initiative (see above). The analysis has already identified details of relic glacial moraines, earthquake faults, slumps, and other features which have a significant impact on seafloor currents and bottom trawlability.

A first draft bathymetry of the Aleutian Islands, assembled from 2.1 million corrected soundings from 290 different smooth sheet surveys, was completed. A manuscript describing the methods and the data sets utilized is in progress. This effort included digitizing thousands of previously unavailable soundings and proofing available soundings both for horizontal displacement errors (datum-shifts) and vertical displacement errors (incorrect digitization). Despite this exhaustive, multi-year effort to compile all available bathymetry, significant gaps remain in the bathymetric coverage of the central Aleutians, around Atka, Amlia and Seguam Islands. Over 25,000 verbal sediment descriptions were also digitized from the smooth sheets, making this the largest sediment data set available for the Aleutians, and probably for the entire state of Alaska.



Analysis of smooth sheet data has continued in support of the GOA IERP project. A manuscript is in progress which describes the GIS techniques which have been applied to smooth sheet data and resulted in groundfish habitat descriptors including: shore measures such as length of mainland and island shore, and proximity of any location to land; water measures such as surface area and volume of any depth interval, tidal prism, and vertical cross-sections; seafloor measures such as areal exposure at low tide, bathymetry and bathymetric derivatives such as slope, rugosity, and aspect; sediment measures such as gravel, sand and mud on a 0 to 100% scale; the areal extent of kelp patches and rocky outcrops; and shoreline exposure. Additionally, freshwater input from rivers and streams draining watersheds depicted on USGS topographic sheets and orthographic aerial or satellite imagery can be used to estimate areas of low and high salinity.

These GIS techniques were applied to the smooth sheets for 5 central GOA sites chosen for intensive study by the Mid-Trophic Level (MTL) of the GOA-IERP. Thus, Kiliuda Bay, Izhut Bay, the Barrren Islands, Port Dick and Aialik Bay have all been compared on the basis of quantifiable variables. A manuscript describing the similarities and differences between these sites in is progress. Below are draft figures for (A) bathymetry for Kiliuda Bay, (B) sediments for Port Dick, (C) exposure of shoreline to the Gulf of Alaska for Izhut Bay, (D) watershed, streams and integration of bathymetry with USGS topographic map for Aialik Bay, and (E) predicted (Norcross et al. (2007)) essential fish habitat for juvenile Pacific halibut (*Hippoglossus stenolepis*) and juvenile flathead sole (none) (*Hippoglossoides elassodon*) at the Barren Islands.

Contact Mark Zimmermann@noaa.gov

Norcross, B., F. -J. Muter, and B. A. Holladay. 1997. Habitat models for juvenile pleuronectids around Kodiak Island, Alaska. Fish. Bull. 95:504-520.

RACE Recruitment Processes

The Recruitment Processes Program's overall goal is to understand the mechanisms that determine whether or not marine organisms survive to the age of "recruitment." Recruitment for commercially fished species occurs when they grow to the size captured or retained by the nets or gear used in the fishery. For each species or ecosystem component that we study, we attempt to learn what biotic and abiotic factors cause or contribute to the observed population fluctuations. These population fluctuations occur on many different time scales (for example, between years, between decades). The mechanistic understanding that results from our research is applied by us and by others at the Alaska Fisheries Science Center to better manage and conserve the living marine resources for which NOAA is the steward. Below are research activities focusing on multiple species and ecosystem effects and research on individual species are found in Section C By Species.

Bering Sea (EBS)

Walleye Pollock Ichthyoplankton Dynamics in the Bering Sea:
The Eco-FOCI program conducts ongoing work to examine seasonal linkages between spring spawning areas, early summer distribution patterns, and late summer/early fall occurrences of walleye pollock (*Theragra chalcogramma*) in the EBS. We conduct alternate year surveys in spring to assess abundance of eggs and larvae over the EBS shelf, and to describe larval fish assemblages after the late winter spawning season. Data are used to determine how physical and biological factors affect the transport, distribution, recruitment and survival of fish larvae. Analyses to date indicate that spatial distributions of walleye pollock early life stages are influenced by broad-scale (temperature, spawning stock biomass, and wind) and fine-scale (zooplankton biomass) variables, though it appears that temperature explains more of the variation in abundance of early life stages than any other covariate. Results also suggest that hatching can be delayed by several weeks during cold periods, and there are delays in timing of peak abundance when thermal conditions over the EBS shelf are colder-than-average.

	Cold Peak DOY	Warm Peak DOY	Difference
Egg	75	75	0
Yolksac	150	130	20 d
Preflexion	155	130	25 d
Late Larvae	175	150	25 d
Juvenile	225	225	0

Table 1. Shifts in timing of peak abundance of walleye pollock early life stages in the eastern Bering Sea. DOY = day of year (Julian days).

Recently, we documented spatial shifts in the distribution of early life stages to the east (middle domain) under warmer-than-average conditions over the EBS shelf, which appear to be related to predominant wind patterns.

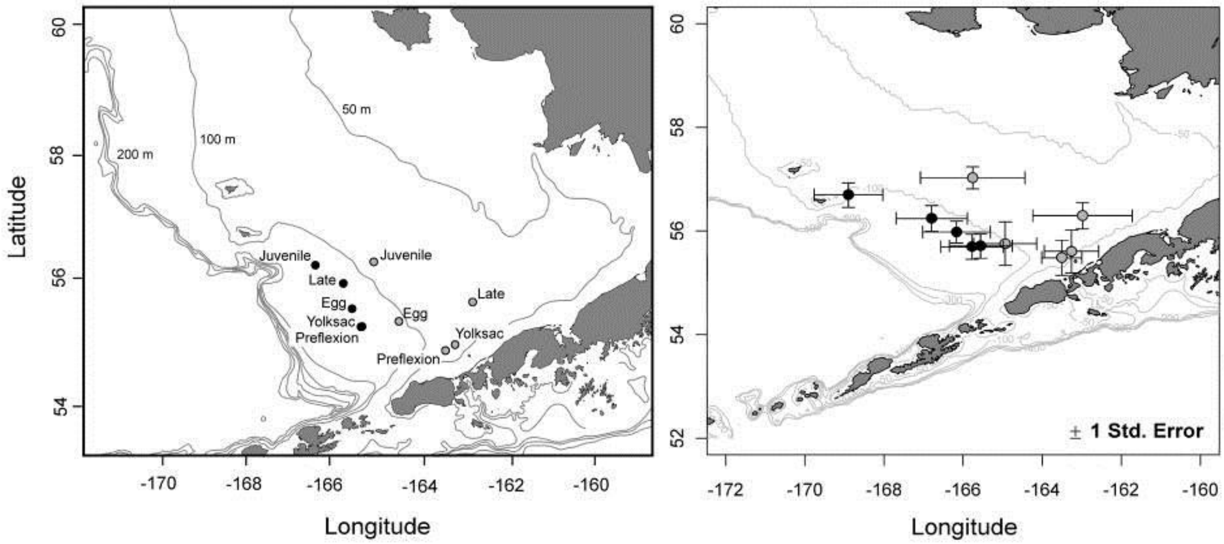


Figure 1. Early life stages of walleye pollock are distributed over the outer shelf during cold periods (filled circles) and over the middle shelf during warm years (open circles). Error bars denote 1 STD.

We are presently developing a biophysical model (ROMS-TRACMASS) to examine how variable atmospheric forcing, and the ocean's response to this forcing, affects the distribution of walleye pollock ichthyoplankton. Implementation of the model will assist us in determining primary forcing factors for observed spatial shifts. It will allow us to examine historical dispersal pathways of walleye pollock eggs and larvae and to forecast how these might change in the future under changing climate and ocean conditions.

Work from seasonal surveys described above is also being utilized to examine variations in ichthyoplankton assemblages and relationships of larval fish communities with climate and oceanographic variables. Data show strong cross-shelf gradients delineating slope and shelf assemblages, an influence of water masses from the Gulf of Alaska on species composition, as well as differences in relative abundances between warm and cold periods. Understanding these variables can elucidate ecosystem-level responses to climate variability, and we are working toward understanding how community-level changes in ichthyoplankton composition reflect species-specific responses to climate change.

<u>Shelf-associated flatfish juveniles in the Bering Sea:</u>
Eco-FOCI studies on early life history stages of flatfishes help to understand mechanisms controlling recruitment variation. We continue to conduct field studies of juvenile distributions, habitat, and diet in the EBS of northern rock sole (*Lepidopsetta polyxystra*), flathead sole (*Hippoglossoides elassodon*), arrowtooth flounder (*Atheresthes stomias*), Pacific halibut (*Hippoglossus stenolepis*), and yellowfin sole (*Limanda aspera*).

Northern rock sole juvenile spatial distribution and abundance are correlated in RACE groundfish survey data. Large abundances of age-2 fish have more northwards distributions, suggesting density dependent spatial patterns or spatially dependent production. To date, age-0 distribution is reflected 2 years later in the groundfish survey of age-2 fish. A large area of the EBS between Cape Newenham and Nunivak Island served as age-0 northern rock sole habitat in 2003 (a warm year survey conducted by B. Norcross University Alaska, Fairbanks), but not in 2008 or 2010 (cold years), and in 2012 (another cold year) densities were low and age-0 northern rock sole were small.

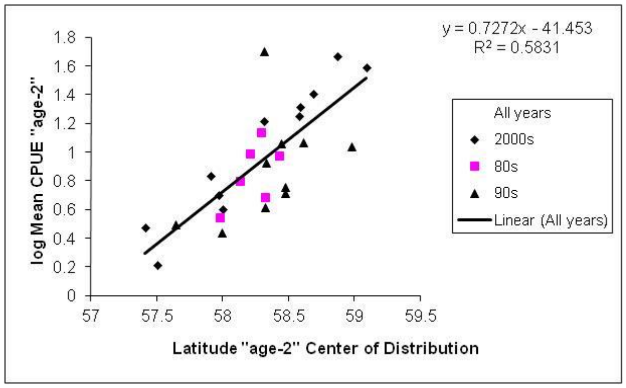


Figure 2. Relationship between annual mean catch per unit effort and the latitude of the catch-weighted center of age-2 sized northern rock sole in the EBS groundfish survey from 1982 through 2010.

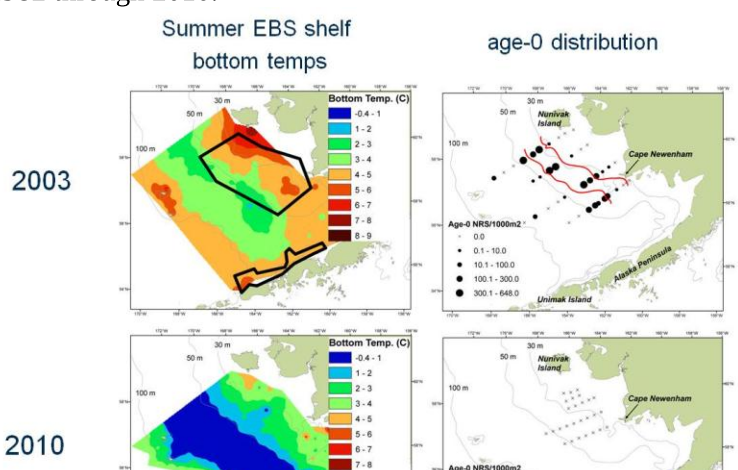


Figure 3. EBS Summer bottom temperatures in 2003 (upper left) and 2010 (lower left) and autumn age-0 northern rock sole distributions in 2003 (upper right) and 2010 (lower right).

Age-0 northern rock sole mean length is higher in warm, nearshore areas than in cold, offshore areas, suggesting temperature dependent growth and/or shoreward movement after settlement. In 2012, the AFSC Fisheries Behavioral Ecology (FBE) Program surveyed juvenile flatfish and Pacific cod densities inshore of the Eco-

FOCI offshore survey area (Port Moller and Herendeen Bays) for comparison. This study confirmed that age-0 northern rock sole settle offshore and not in bays. Follow-up work in conjunction with the FBE program will include growth and diet of northern rock sole and Pacific cod fish in nursery habitat.

To better understand factors influencing recruitment success, the feeding habits of two commonly occurring and commercially important flatfishes are being studied. Age-0 northern rock sole and age-1 yellowfin sole from the EBS are being examined for diet overlap, prey resource partitioning, and habitat preference. Juvenile northern rock sole and yellowfin sole spatially co-occur in shallow, nearshore waters in the EBS during fall. Collections were made during September 2008 and 2010 using a 3-m modified plumb-staff beam trawl. In both years, the principal prey were gammarid amphipods and annelids for northern rock sole. In 2010, northern rock sole diets were more diverse and included bivalves and harpacticoid copepods; diets were spatially structured in both 2008 and 2010. Diets of both species appear to be age-structured, but structuring was not related to geography in yellowfin sole. In 2008, yellowfin sole diets were diverse and showed no spatial structuring; however, 2010 diets indicate limited spatial structuring within the inner shelf. Investigations continue with additional statistical analyses on age structure, length, and prey field. Diet studies in the EBS are being extended to flathead sole, arrowtooth flounder, and Pacific halibut.

Modeling studies are complementing the field studies. One study modeled northern rock sole connectivity between spawning and nursery areas in the EBS. Starting points for larvae were determined by historical ichthyoplankton data and were located to the north and south of Unimak Island, along the north side of the Alaska Peninsula, and north from Unimak Pass to the Pribilof Islands. The model indicates larvae are transported along the Alaska Peninsula by the Bering Coastal Current, or to the north towards the Pribilof Islands and farther north by baroclinic flow. The model also predicts that larvae from the Gulf of Alaska south of Unimak Island are transported into the Bering Sea through Unimak Pass. The model provided another line of evidence that northern rock sole settle and then move shoreward to nursery habitat in EBS.

Deep-sea spawning flatfishes in the Bering Sea:
Eco-FOCI has been examining canyon and slope habitat utilization, and spawning to nursery area connectivity for Greenland halibut (*Reinhardtius hippoglossoides*) and Pacific halibut, two deep-sea spawning flatfish in the EBS. Distribution and abundance of adults, larvae and juveniles are seasonally assessed using field surveys. Results indicate that, during non-spawning periods, Greenland halibut adults tend to be more abundant along the continental slope, though during the spawning season no differences in habitat use were found. Larvae and juveniles of both species recruit to the middle and outer domains of the continental shelf. Pelagic juveniles are collected in collaboration with the Ecosystem Monitoring and Assessment Program and settled juveniles are collected in collaborations with the Groundfish Assessment Program. Greenland halibut larvae and juveniles tend to be distributed over the middle and outer continental shelves farther to the north of Pacific halibut young. Ongoing research using biophysical models indicates that connectivity between spawning and nursery areas is less dependent on current flow and more a function of availability of nursery habitat over the continental shelf. Finally, statistical models are being used to evaluate the impact of climate variability on transport and settlement success.

Gulf of Alaska (GOA)

Walleye Pollock Age-0 Ecology in the Gulf of Alaska:

Eco-FOCI conducts small-mesh midwater trawling cruises, mostly in alternate years, primarily to study the biology and ecology of small neritic forage fishes in the GOA. Due to their commercial importance, research focuses on juvenile walleye pollock. However, capelin and eulachon are studied because these species are poorly covered by groundfish assessments and because their importance in the GOA food web has been underscored by food web modeling.

Eco-FOCI research on these fishes focuses on the western GOA where walleye pollock are prevalent and during late summer and early autumn when age-0 fish are abundant. Our findings indicate that age-0 walleye pollock and capelin are broadly distributed across the shelf during late summer while older walleye pollock (age1+) and eulachon occur in association with elevated current velocity and krill population density. At this time of year, age-0 walleye pollock and capelin exhibit opposite cross-shelf gradients in body size: age-0 walleye pollock are largest near shore and capelin are largest offshore. Considerable overlap in food habits exists, with all species consuming copepods and krill, but capelin and age-0 walleye pollock respond differently to low krill availability. Eulachon are almost singularly dependent on krill, while walleye pollock are flexible zooplanktivores. For age-0 walleye pollock, the area off east Kodiak Island provides greater food-related benefits than the more heavily populated area downstream of Shelikof Strait due to higher krill abundance that is associated with greater oceanic influence. We are investigating spatial and temporal variation in the size of prey consumed by these species to assess whether predator-prey size ratios govern energy flux through marine food webs (including commercially important fishes, protected marine mammals and seabirds).

Eco-FOCI has leveraged opportunities to collaborate with other programs that conduct studies that put our late-summer studies into a seasonal context to better understand the spatial-temporal interactions that determine year-class strength. Overwinter samples collected by other programs showed that the benefit to juvenile walleye pollock of rearing off Kodiak Island was restricted seasonally to late summer and only when fish are age-0 juveniles. For age-1 walleye pollock, otolith-based growth trajectories indicate that the growing season lasts almost 7 months with a 0.6 mm/day peak in growth during early July. Onset of the growing season corresponds with vernal lengthening of the photoperiod while autumnal slowing may reflect increased thermal stress. We are investigating the use of otolith chemistry as a natural tag to identify GOA pollock nurseries, which are areas that contribute substantially to the adult population. This will provide geographic focus to subsequent research and management efforts to understand recruitment and protect essential nursery habitat. Recently, Eco-FOCI researchers have been tasked with examining the suitability of surface and midwater trawls to conduct assessment surveys of age-0 walleye pollock. Goals are threefold: to compare catch per unit effort of YOY among the gear types, to compare the size ranges of walleye pollock collected, and to compare the community assemblage of fishes collected across gear types.

Shelf-associated flatfishes in the Gulf of Alaska:

Stations across the western GOA shelf were sampled in late summer 2011 for settled juvenile flatfish species, including age-0 arrowtooth flounder. These data are being used to test the predictive ability of habitat models developed in GOA bays for application over the continental shelf. This study is increasing our knowledge of juvenile flatfish habitat in the GOA, including improving estimates of juvenile flatfish habitat for GOAIERP models.

Synthesis of Gulf of Alaska ichthyoplankton data illuminates the recruitment process among species with variable life history and ecological patterns.

Data are from historical and ongoing collections of ichthyoplankton samples and associated oceanographic and climate measurements in the GOA. Ichthyoplankton surveys that sample the early ontogeny pelagic phase (eggs/larvae) of fish integrate information on a diverse range of species with variable adult habitats and ecologies. Synthesis of these ichthyoplankton and associated environmental data are being carried out in order to evaluate species pelagic exposure patterns and response outcome during early ontogeny. The research is contributing to a mechanistic understanding of environmental forcing on early life history aspects of recruitment processes among GOA fish species. Multivariate analysis of the historical GOA ichthyoplankton has revealed synchronicities and similarities among species early life history patterns and their links to the environment. This research has yielded an effective conceptual framework for evaluating the exposure and response of fish species to the pelagic environment during early life. The working hypothesis for this ongoing research is that we can utilize similarities in reproductive and early life history characteristics among species to identify: 1) ecologically-determined species groups that are pre-disposed to respond to environmental forcing during early life in similar ways, and 2) plausible environmental predictors of early life history aspects of recruitment variation. Evaluation of the effectiveness of this conceptual framework will continue as the ichthyoplankton time-series (1981-2011) continues to be investigated in relation to interannual variation in the oceanographic environment. Application of this research to stock assessments is being explored. The objective is to determine which species-specific larval abundance data and environmental drivers should be incorporated into groundfish stock assessment models to best account for environmental forcing of recruitment

Other Activities:

Multi-species approaches – Development of DNA-based methods for identification of fish eggs, larvae and prey remains.

We developed a mitochondrial DNA (mtDNA) sequence database and restriction fragment length polymorphism protocols to accurately identify any life history stage of commercially important marine fish species, with special emphasis on select species that have been difficult or impossible to identify by conventional taxonomic means. Seven PCR-based restriction fragment length polymorphism (PCR-RFLP) protocols screening portions of the mitochondrial cytochrome *c* oxidase (COI) and cytochrome *b* (cyt *b*) genes were diagnostic for 19 species in five families Results from this study demonstrated the potential to fill important knowledge gaps for commercially and ecologically important species routinely studied at AFSC, with particular regard to species composition in fish diets and ichthyoplankton. The database provided the foundation for development of rapid, cost-effective, and accurate molecular protocols to identify species under circumstances where traditional taxonomic approaches founder or fail.

Recruitment Processes Contribution to the GOAIERP project

Synthesis of historical GOA ichthyoplankton data is included in the Retrospective component of the NPRB-sponsored GOAIERP program. Spatial, seasonal, and interannual patterns of variation in abundance and lengths of the early ontogeny stages of the five focal species (Pacific cod, walleye pollock, Pacific Ocean perch [represented by *Sebastes* spp. larvae], sablefish, and arrowtooth flounder) have been integrated into the construction of individual pelagic exposure profiles for each. Observed similarities and synchronies with other species, as well as evaluation of links between larval abundance patterns and the physical environment are also included in the exposure profiles. The early life history parameters have been incorporated into the development of Individual Based Models for each species by the Modeling component of GOAIERP. The comprehensive early life history reviews of these species are being developed into a manuscript for publication. This historical synthesis provides a comparative framework for interpreting the results of the 2010-2013 GOAIERP surveys from the eastern and western GOA with respect to identification of early life history habitat, connectivity between spawning and nursery grounds, and early ontogeny response to the pelagic environment.

As part of the Lower Trophic Level Component of the GOAIERP program, the Recruitment Processes Program has been involved in the planning and carrying out of ichthyoplankton, and oceanographic sampling in the eastern and western GOA for the 2011 and upcoming 2013 field years. Results from the 2010 pilot study, and the 2011 surveys have been analyzed. New information has emerged regarding differences in spawning and early life history patterns between the eastern and western GOA for the focal species. In addition, genetic analysis of *Sebastes* spp. specimens in conjunction with larval length distributions indicates separate spring and summer cohorts of rockfish larvae with Pacific Ocean Perch likely being the dominant species in the spring group.

Scientific Exchange

The National Oceanic and Atmospheric Administration's Alaska Fisheries Science Center and the International Pacific Halibut Commission will co-host the 9th International Flatfish Ecology Symposium at Suncadia Lodge in Cle Elum, WA, from November 9-14, 2014. The Symposium is organized every three years and provides the international platform for flatfish scientists and managers to meet, share their research, and discuss management applications. There are six themes planned for the 9th IFS: *Flatfish and the Pelagic Realm: New Perspectives*, *The Influences of Flatfish on Trophic Interactions and Community Structure*, *Flatfishes and Climate Variability*, *Disentangling Multivariate Effects*, *Stock Assessment and Fisheries Management*, and *Physiology, Development, and Aquaculture*. The 9th IFS is generously supported by academic, state, federal, and industry representatives. For more information, please visit: www.flatfishsymposium.com or contact Janet Duffy-Anderson (NOAA) at Janet.Duffy-Anderson@noaa.gov or Tim Loher (IPHC) at Tim@iphc.int.

RACE Habitat Research Team (HRT)

Scientists with the RACE Habitat Research Team (HRT) continue research on essential habitats of groundfish including identifying suitable predictor variables for building quantitative habitat models, developing tools to map these variables over large areas, investigating activities with potentially adverse effects on EFH, such as bottom trawling, and benthic community ecology work to characterize groundfish habitat requirements and assess the ecological consequences of fishing gear disturbances. Research in 2012 was primarily focused on evaluating acoustic backscatter and infaunal prey as predictors of groundfish distributions in the eastern Bering Sea (EBS). An analysis of short-term bottom trawl effects was also completed.

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

Habitat Modeling

The HRT is building numerical models to explain the distribution and abundance of groundfish and benthic invertebrates in the eastern Bering Sea (EBS). Abundance estimates from annual bottom trawl surveys are being combined with synoptic environmental data to produce basin-scale continuous-value habitat models that are objective and have quantifiable uncertainty. The resulting quantitative relationships not only satisfy the Congressional mandate to identify and describe essential fish habitat (EFH), they may also be used to gauge the effects of anthropogenic disturbances on EFH, to elevate stock assessments to SAIP tier 3, and to predict the redistribution of species as a result of environmental change. In practice, we use systematic trawl-survey data to identify EFH as those areas supporting the highest relative abundance. This approach assumes that density data reflect habitat utilization, and the degree to which a habitat is utilized is considered to be indicative of habitat quality. The models are developed with an iterative process that assembles existing data to build 1st generation expressions. Promising new predictors are then evaluated in limited-scale pilot studies, followed by a direct comparison of alternative sampling tools. Finally, the most cost-effective tool is used to map the new variable over the continental shelf and the existing model for each species is updated to complete the iteration.

Our current research (the “FISHPAC” project) is investigating whether quantitative information about seafloor characteristics can be used to improve existing habitat models for EBS species. Preliminary work[1] demonstrated that surficial sediments affect the distribution and abundance of groundfish, however direct sampling with grabs or cores is impractical over large areas. Subsequent pilot studies[2,3] showed that acoustic systems were suitable for broad-scale seafloor surveys and that processed acoustic data can be used to improve the numerical habitat models. A major field experiment was conducted in 2012 aboard NOAA Ship *Fairweather* to investigate whether seafloor backscatter data can be used to improve EFH descriptions. Although largely a scientific study, the FISHPAC project also collected hydrographic-quality bathymetric data to update nautical charts of areas with outdated or non-existent information. The study area consisted of five 115-145 nautical mile tracklines across the EBS shelf over depths ranging from

[1] McConnaughey, R.A. and K.R. Smith. 2000. Associations between flatfish abundance and surficial sediments in the eastern Bering Sea. Can. J. Fish. Aquat. Sci. 57: 2410-2419.
[2] McConnaughey, R.A. and S.E. Syrjala. 2009. Statistical relationships between the distributions of groundfish and crabs in the eastern Bering Sea and processed returns from a single-beam echosounder. ICES J. Mar. Sci. 66: 1425-1432.
[3] Yeung, C. and R.A. McConnaughey. 2008. Using acoustic backscatter from a sidescan sonar to explain fish and invertebrate distributions: a case study in Bristol Bay, Alaska. ICES J. Mar. Sci. 65: 242–254.

37 to 126 meters (Fig. 1). These survey lines were chosen to pass directly over 26 RACE bottom-trawl-survey stations at which a wide range of fish and invertebrate abundances has been observed. Over the period 12-28 July, each line was navigated three times with continuous shipboard operations. On every pass, backscatter and bathymetry were collected using the ship's two multibeam sonars (Reson models 7111 operating at 100 kHz and 8160 at 50 kHz). Three other sonars were utilized on the first and third passes over each of the lines, including a conventional side scan sonar (Klein 5410, 455 kHz) and a prototype long-range side scan sonar (Klein 7180, 180 kHz) with an independent single-beam echosounder mounted on the towfish (Elac Nautik, 38 kHz). Following a review of side scan imagery, geological and biological sampling was conducted on the second passes over the lines and constituted groundtruthing of the sonar data. Two sediment grabs and digital still photos were collected at 4-6 points on each trackline. One of these grabs will be used for a laboratory analysis of sediment properties, and the other will be processed to characterize invertebrate organisms living in the substrate. Video data were also collected and will be converted to still-image mosaics of the seafloor. Geophysical properties of the seabed as well as sound velocities in the water column were measured at each groundtruthing location, and elsewhere as needed, using a free-fall cone penetrometer (FFCPT). Occasional conductivity-temperature-depth (CTD) casts provided additional sound-velocity data to ensure high quality hydrographic products. Subsea positions for all instruments were determined with an ultra-short baseline positioning system that interfaced with the ship's navigational system. After nearly 3,800 GB (3.7 terabytes) of data are processed, statistical analyses will identify the most cost-effective sonar system. The best performing system will then be used to map and characterize the seabed of the EBS shelf and to update EFH descriptions for all FMP-managed species. These same acoustic data may also be useful for stock assessment purposes, if survey-trawl performance (catchability) is related to seafloor characteristics.

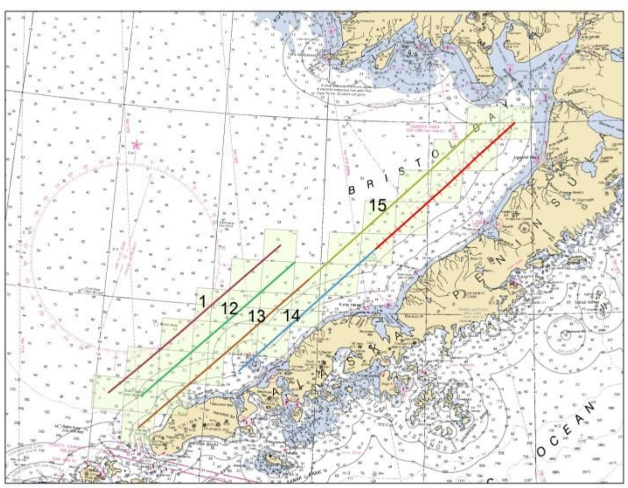


Figure 1. Survey tracklines completed during the 2012 FISHPAC cruise. Shaded boxes represent 20 by 20 nautical mile squares centered on RACE bottom trawl survey stations for the Bering Sea shelf. The northeast section of line 14 in red with cross hashes was navigated once with MBES acquisition only.

Following completion of the 2012 FISHPAC cruise, *Fairweather* embarked with HRT scientists on a northerly transit across the Bering Sea, through the Bering Strait, and into Kotzebue Sound (Fig. 2). The scientific objective was to investigate latitudinal trends in seabed characteristics (backscatter and bathymetry) and to continuously measure turbidity, colored dissolved organic matter, and chlorophyll-a by towing the Klein 7180 LRSSS. These data will provide a first look at seafloor and water-column habitats in the area. The cruise also provided an opportunity for NOAA to consider utility of the towed LRSSS for reconnaissance surveying, as compared to more conventional ship-mounted hydrographic systems.

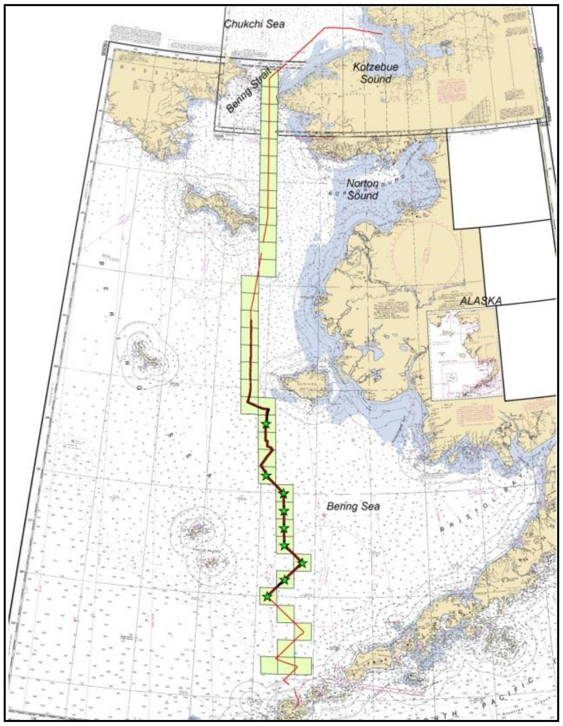


Figure 2. Completed South Arctic Reconnaissance survey trackline with black and red lines representing Klein 7180 and Reson MBES coverage, respectively. Shaded boxes represent 20 by 20 nautical mile squares centered on RACE bottom-trawl-survey stations and green stars represent FFCPT sample sites.

The Effects of Fishing

Research to understand and quantify the effects of bottom trawls has occurred throughout the world in a variety of benthic marine habitats. Most of these studies have used methods based on one of two experimental approaches. Short-term (acute) effects are studied by comparing conditions in experimental corridors before and after a single pass or repeated passes of the gear. Occasionally, the recovery process is examined by resampling at a later date; these studies incorporate untrawled control corridors into the sampling program in order to account for natural variability during the study period (a before–after, control–impact, or BACI, experimental design). This approach provides insights about the process of trawl disturbance and is the basis for most knowledge about trawling effects. Longer-term (chronic) effects are studied by comparing conditions in heavily fished and lightly fished or unfished areas and, as such, measure the cumulative effects of fishing. These experiments are relatively uncommon because high-quality historical fishing-effort data are frequently unavailable, and their designs are often flawed because the (unfished) "control" areas have previously been fished or they are fundamentally different than the corresponding experimental units. Although generalizations about the effects of fishing are possible, site-specific responses are likely and local studies are advisable because of variation in the composition of the benthos and differences in the intensity, severity and frequency of both natural and anthropogenic disturbances.

The HRT has been investigating potential adverse effects of bottom trawls at soft-bottom sites in the Bristol Bay region of the eastern Bering Sea (the "TRAWLEX" project). These sites are relatively shallow (44-57 m), have sandy substrates, show a high level of natural disturbance, and support a rich invertebrate assemblage. Both chronic and short-term effects on the benthos have been studied. This research addresses Congressional mandates to investigate potential adverse impacts of fishing gear on essential fish habitats.

The well-documented development of commercial trawl fisheries in the EBS since 1954 presented a unique opportunity to investigate the chronic effects of bottom trawling on soft-bottom benthos.[4,5] Using detailed accounts of closures and fishing activity, it was possible to reconstruct historical effort and identify untrawled (UT) areas immediately adjacent to areas that had been heavily trawled (HT) over many years. For most of the benthic invertebrate species examined, it was determined that biomass and mean body size were reduced as a result of heavy trawling, suggesting a general population decline. In a few cases, greater overall biomass accompanied the observed body-size reduction, suggesting a proliferation of relatively small individuals in the HT area. The only exception to the pattern of smaller individuals in the HT area was red king crab. In this case, mean body size was greater in the HT area, due to substantially fewer small crabs in the HT area than in the UT area. Since biomass in the HT area was lower than that in the UT area, the red king crab response to chronic bottom trawling was

[4] McConnaughey, R.A., K. Mier and C.B. Dew. 2000. An examination of chronic trawling effects on soft-bottom benthos of the eastern Bering Sea. ICES J. Mar. Sci. 57: 1377-1388.
[5] McConnaughey, R.A., S.E. Syrjala and C.B. Dew. 2005. Effects of chronic bottom trawling on the size structure of soft-bottom benthic invertebrates. Pages 425-437 *in* P. W. Barnes and J. P. Thomas, editors. Benthic habitats and the effects of fishing. American Fisheries Society, Symposium 41, Bethesda, Maryland.

fewer individuals of greater mean size. Overall, these effects on body size were relatively small when compared with natural variability in a large, adjacent area closed to commercial trawling. From a community perspective, the HT benthos was less diverse, was dominated by the purple-orange seastar (*Asterias amurensis*), had less emergent epifauna and less biogenic substrate (shell) resulting in reduced structural complexity, and was more patchy overall.

Another study investigated short-term effects of bottom trawling and recovery using a BACI experimental design. This work occurred inside the same closure area used for the chronic effects study. Six pairs of experimental and control trawl corridors (statistical blocks) were established adjacent to one another in a previously untrawled area. Each corridor was 19.4 km long, based on the average length of commercial bottom-trawl hauls in the area and was 100 m wide to contain all components of the commercial gear. Potential impacts were investigated with biological and geological sampling before and after four passes with a commercial bottom trawl (Nor'eastern Trawl System Inc. 91/140 two-seam Aleutian combination otter trawl with a 0.46 m footrope diameter). Invertebrates that live on the seafloor (epifauna) were sampled with 15 min tows at a speed of 3 kts, using a standard AFSC 83/112 bottom trawl that was modified to improve capture and retention of small organisms. At each of these locations, the invertebrates that live in the seafloor (infauna) and the physical-chemical properties of the surficial sediments were characterized with two pairs of grab samples collected prior to trawling for epifauna. Changes in seafloor morphology were assessed with side scan sonar surveys that were conducted prior to any sampling or commercial trawling disturbance and again after the commercial-trawl disturbance.

Catch per unit effort (CPUE) data were analyzed for 24 taxonomic groups (ranging from species to order) before and after trawling. In addition to the BACI design, covariates (depth, water temperature, and various sediment measurements) were included in the analyses to minimize effects of random variations in the habitat. Species composition changed very little over the course of the study; *Asterias amurensis* and *Paralithodes camtschaticus* comprised over 80% of the sampled invertebrate biomass (kg ha^{-1}) during both years of the study. In general, the commercial trawl did not significantly affect the abundances of benthic invertebrates. The immediate (4-14 days) trawling effect was statistically significant in only three of the 24 taxa that were analyzed, as expected for $\alpha = 0.10$. Biomass immediately after the trawling disturbance was lower for 15 of the taxa and higher for the other nine, with a median change of -14.5%. Similarly, the effect of trawling on invertebrate biomass after one year was not statistically significant for any of the taxonomic groups ($p \geq 0.23$). Further analysis of the BACI model indicated that major storms, such as a 5-6 d event during this experiment, have an overall greater effect on the benthos than do bottom trawls at this location. The effects of trawling observed in the side scan imagery also were negligible, probably due to the naturally disturbed condition of the seabed. However, some degree of physical disturbance did occur based on distinctive patterns in the post-trawl imagery that were not present in the imagery acquired prior to the commercial trawling. Details of the analyses and results of this study are currently being written up for publication.

Benthic Invertebrate Ecology

The HRT is studying the life history and ecology of benthic invertebrates in the eastern Bering Sea in order to better understand their role as habitat for commercially important species and to improve interpretation of population- and community-level changes due to fishing gear disturbances. The community of clams, crabs, sponges, corals, snails, marine worms, and similar organisms constitutes a living component of habitat. As a group, benthic invertebrates function as predators, prey, competitors, and provide shelter for other species. They are also useful indicators of the health and integrity of the ecosystem, and are known to be an important factor affecting the distribution of managed species. Unfortunately, relatively little is known about their life histories and ecologies let alone the complex linkages and dependencies that exist at the community and ecosystem levels.

In general, the available information on ecologically important marine invertebrates is sparse and frequently exists in unpublished reports. To address this need, the HRT is assembling the existing information for individual EBS species and summarizing it in a standard format that includes topics such as growth and development, sexual maturity, reproductive cycles, feeding and diet, mortality rates and causes, distribution and abundance, and anthropogenic interactions. The first in a series of reports focused on the four major species of snails in the genus *Neptunea.*[6]. These snails are a major component of the benthic invertebrate community on the EBS continental shelf and our research has demonstrated they are sensitive to bottom trawling. This synopsis summarizes studies of local populations as well as somewhat more extensive findings for *Neptunea* species in other geographic regions. Geographic distribution and abundance of the four species on the EBS shelf are represented with maps based on RACE bottom-trawl survey data for selected years from 1983 to 2010. Work is underway on a synopsis for the purple orange sea star (*Asterias amurensis*), an extremely abundant species in inshore areas that is also affected by bottom trawling.

Miscellaneous Projects

The HRT contributed to several strategic efforts with habitat themes, including a North Pacific Fishery Management Council request for background information on the Northern Bering Sea (NBS) ecosystem. The Council had previously closed the area to non-pelagic trawling, established the NBS Research Area, and requested a Research Plan to investigate the effects of non-pelagic trawls. The area had no history of industrial-scale fishing because of historical ice cover, and relatively little was known about the fisheries potential, the nature of benthic habitats, and the potential impacts of trawling in this near-pristine ecosystem. The Council ultimately decided to suspend development of the Research Plan and instead requested a compilation of the best available information on the NBS ecosystem that is relevant to planning research on nonpelagic trawl impacts in the NBSRA. Members of the HRT contributed to the document and were responsible for coordinating the multi-agency effort.

[6] Smith, K. R., R. A. McConnaughey, and C. E. Armistead. 2011. Benthic invertebrates of the eastern Bering Sea: a synopsis of the life history and ecology of snails of the genus Neptunea. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-231. 59 p.

The HRT also contributed to development of a plan for Essential Fish Habitat research by the AFSC and the Alaska Regional Office.[7] This document identified the following habitat-research priorities for the next five years:

(1) Characterize habitat utilization and productivity; increase the level of information available to describe and identify EFH; apply information from EFH studies at regional scales.
(2) Assess sensitivity, impact, and recovery of disturbed benthic habitat.
(3) Validate and improve the current habitat impacts model
(4) Begin to develop a geographic-based database for offshore habitat data.
(5) Map the seafloor to provide information for characterizing fish habitat and utilization.
(6) Assess coastal and marine habitats facing development.

The HRT also participated in a synthesis of scientific information about Bering Sea canyons, in response to a request by the Council. In this case, the Council motion was based on numerous proposals designed to preserve representative portions of the highly productive shelf break zone in the Bering Sea, specifically the Pribilof and Zhemchug canyons, as candidates for management measures to provide EFH protection for deep-sea corals, sponges, and other benthic habitat important to FMP-managed species. This was a follow-up to a previous request by the Council to support consideration of Habitat Areas of Particular Concern (HAPC) designations for Pribilof, Pervenets, and Zhemchug canyons. The Council postponed taking action at that time because scientific information was not available to establish the dependence of managed species on habitat features of the canyons, per the EFH mandate. The current effort is using new information to support a re-examination of possible habitat protection and management measures for the Pribilof and Zhemchug canyons. The draft discussion paper includes consideration of the following issues:

(1) How do the canyons' substrate and habitat characteristics compare to the rest of the Bering Sea slope and shelf?
(2) To what extent is habitat homogeneous within individual canyons?
(3) Where can fish associations with particular habitat features be established or suggested, and how do these relationships compare to those for the entire Bering Sea shelf?
(4) What is the expected vulnerability of the canyons to anthropogenic activity (including fishing)?
(5) Are adverse impacts likely to primarily affect benthic habitat?

Finally, two electronic databases are maintained to support the design and interpretation of HRT experiments. One of these includes peer-reviewed papers and reports concerned with Mobile Fishing Gear Effects (http://access.afsc.noaa.gov/mfge/search.htm). Similarly, a database is maintained for literature on the life histories and ecology of important benthic invertebrates. New references are continually added to the databases.

[7] Sigler, M. F., M. F. Cameron, M. P. Eagleton,C. H. Faunce, J. Heifetz, T. E. Helser, B. J. Laurel, M. R. Lindeberg, R. A. McConnaughey, C. H. Ryer, and T. K. Wilderbuer. 2012. Alaska Essential Fish Habitat Research Plan: A research plan for the National Marine Fisheries Service's Alaska Fisheries Science Center and Alaska Regional Office. AFSC Processed Rep. 2012-06, 21 p.

Bering Sea infauna communities and flatfish habitats

Benthic infauna constitute the primary prey of the complex of small-mouthed Bering Sea flatfish, which includes yellowfin sole (*Limanda aspera*), Alaska plaice (*Pleuronectes quadrituberculatus*), and rock sole (*Lepidopsetta* spp.). Polychaetes, clams, and amphipods are the dominant taxonomic groups in the infauna and the principal prey of these flatfish. Yellowfin sole are generally known to prefer amphipods, Alaska plaice prefer polychaetes, and rock soles have a more diverse and flexible diet mainly consisting of polychaetes and amphipods.

The last regional survey of Bering Sea infauna occurred in the late 1970s. Effort was renewed in 2006 to survey Bering Sea infauna communities and build a current database for fisheries and ecosystem research. Benthic samples were collected with 0.1 m^2-van-Veen-type grabs during the Bering Sea shelf bottom-trawl surveys and acoustic bottom mapping surveys in 2006-2012. The samples were collected at standard bottom-trawl stations that are surveyed annually. Sediment characteristics and infauna composition were analyzed from the samples. To date, some 70 stations have been sampled in the southeastern Bering Sea north of the Alaska peninsula and spanning across the shelf from nearshore to shelf edge. Twelve stations have been sampled in the northern Bering Sea, along a latitudinal transect east of St. Lawrence Island that extended from 60^oN to 63^oN, in depths of 20 to 50 m.

Infauna communities in the southeastern Bering Sea were organized along the distinctive cross-shelf environmental gradients of sediment grainsize, depth, and hydrographic domain. Clams and amphipods were the dominant groups on the inner shelf in depths down to about 50 m. Polychaetes were dominant on the middle shelf from 50 to 100 m. From 2009 samples, prey composition in the stomachs of yellowfin sole, Alaska plaice, and rock sole, respectively, corresponded spatially with infauna compositions. For example, Alaska plaice, which usually eat mostly polychaetes, consumed predominantly clams and amphipods on the inner shelf. The correspondence may reflect limited prey availability and not preference. “Cold” conditions in the Bering Sea - when extremely cold bottom water pervades the middle shelf, as occurred in 2009, may limit access to the polychaete-rich habitat there, thus shaping Alaska plaice diet to resemble the infauna composition on the inner shelf (Yeung et al. 2013).

The northern Bering Sea benthic habitats, as the data so far indicated, harbored infauna biomass at least comparable to the southeastern Bering Sea. Amphipods were relatively more abundant than other infauna groups, especially further north along the transect. Here in this environment of apparently plentiful prey and lower predator populations, the diets of the flatfish species reflected their respective dietary preference, not the infauna composition. In terms of prey availability, the northern Bering Sea could be prime flatfish habitat.

Effort continues to extend benthic sampling coverage to the entire Bering Sea shelf, compile spatial maps of infauna communities, explore linkages between infauna and flatfish diets and condition, and ultimately devise measures of infauna communities as indices of flatfish habitat quality.

Reference

Yeung, C., Yang, M.-S., Jewett, S.C., Naidu, A.S. 2013. Polychaete assemblage as surrogate for prey availability in assessing southeastern Bering Sea flatfish habitat. J Sea Res 76:211-221

2012 Resource Ecology and Ecosystem Modeling Program (REFM/REEM)

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

Groundfish Stomach Sample Collection and Analysis

The Resource Ecology and Ecosystem Modeling (REEM) Program continued regular collection of food habits information on key fish predators in the North Pacific. During 2012, AFSC personnel analyzed the stomach contents of a wide variety of species from the eastern Bering Sea, the Aleutian Islands, and the Gulf of Alaska regions. The contents of 14,715 stomach samples were analyzed in the laboratory and 4,018 stomach were analyzed at sea during the Aleutian Islands groundfish survey. Support of seasonal energy flow modeling in Alaska's marine ecosystems was also provided through preparation of about 800 tissue samples for stable isotope analysis. Over 55,000 records were added to AFSC's Groundfish Food Habits Database in 2012.

Collection of additional stomach samples was accomplished through resource survey and Fishery Observer sampling. Large and abundant predators were the focus of this year's stomach sample collection from the eastern Bering Sea bottom trawl surveys of the continental shelf and slope. In total, 1,498 stomach samples were collected during the survey of the eastern Bering Sea slope, and 5,260 stomach samples were collected during the survey of the eastern Bering Sea shelf. These samples were supplemented by the collection of about 2,600 stomach samples from Alaskan fishing grounds by Fishery Observers. Fish stomach samples were also collected during scientific trawling operations in the eastern Chukchi Sea. The sampling strategy targeted more abundant or larger-mouthed species, but other species were opportunistically sampled, resulting in 1,930 stomachs collected from 38 species of fish.

Predator-Prey Interactions and Fish Ecology:

Accessibility and visualization of the predator-prey data through the web can be found at http://www.afsc.noaa.gov/REFM/REEM/data/default.htm. The predator fish species for which we have available stomach contents data can be found at http://access.afsc.noaa.gov/REEM/WebDietData/Table1.php. Diet composition tables have been compiled for many predators and can be accessed, along with sampling location maps at http://access.afsc.noaa.gov/REEM/WebDietData/DietTableIntro.php. The geographic distribution and relative consumption of major prey types for Pacific cod, walleye pollock, and arrowtooth flounder sampled during summer resource surveys can be found at http://www.afsc.noaa.gov/REFM/REEM/DietData/DietMap.html. REEM also compiles life history information for many species of fish in Alaskan waters, and this information can be located at http://access.afsc.noaa.gov/reem/lhweb/index.cfm.

Diet Composition of Walleye Pollock in the Eastern Bering Sea, 1987-2011, and Predator-prey Relationships with Copepods and Euphausiids

Walleye pollock (*Theragra chalcogramma*) has a central role in the eastern Bering Sea (EBS) food web. It is a key forage species for many intermediate and upper trophic level predators and is the dominant consumer within the EBS food web. Pollock diet composition is known to differ with pollock size and location in the EBS, the geographic distribution and size composition of the EBS pollock stock changes over time, and the sampling of pollock stomachs varies among years in intensity and geographic distribution. Weighting diet information by stomach fullness and biomass for six size-categories (0-19, 20-29, 30-39, 40-49, 50-59, and ≥60 cm fork length, FL) was used to provide a consistent average diet description of walleye pollock in the bottom trawl survey from 1987 through 2011. An index of partial fullness was also calculated for major prey over this time-period.

Partial fullness is an indicator of the average relative consumption of each prey type in each year (Figure 1). The average index was calculated and plotted for euphausiids and copepods for three time periods – 1987-1992, 1993-2004 and 2005-2011, with the middle period being 12 years of continuous below average (0.22) partial fullness values for copepods. Partial fullness values for euphausiids were found to be serially random ($P > 0.5$), the probability that the partial fullness values for copepods were serially random was lower ($P = 0.10$), and the difference between the partial fullness values of euphausiids and copepods were found to be serially non-random ($P = 0.02$).

Hyperiid amphipods were not important in the diet of EBS pollock in most years, but in 2010 they were the dominant prey type (Figure 1). The majority of these amphipods were likely *Themisto libellula* based on the locations and water temperatures where they were consumed. *Themisto libellula* is associated with Arctic water masses and in the Barents Sea, the highest concentrations are found near the Polar Front where the majority of reproduction and production of this species likely occurs due to the greater amount of food available to them compared to the Arctic Ocean. We speculate that recent conditions of cold water temperatures over the EBS shelf coupled with early ice-melt in the Arctic and/or more extensive ice-free zones in the Arctic may contribute to conditions that have favored the reproduction and survival of *T. libellula*. This may provide a vector for the enhanced retention of primary production in the pelagic zone in the northern Bering Sea, and could have an effect on benthic-feeding invertebrates, fishes and marine mammals.

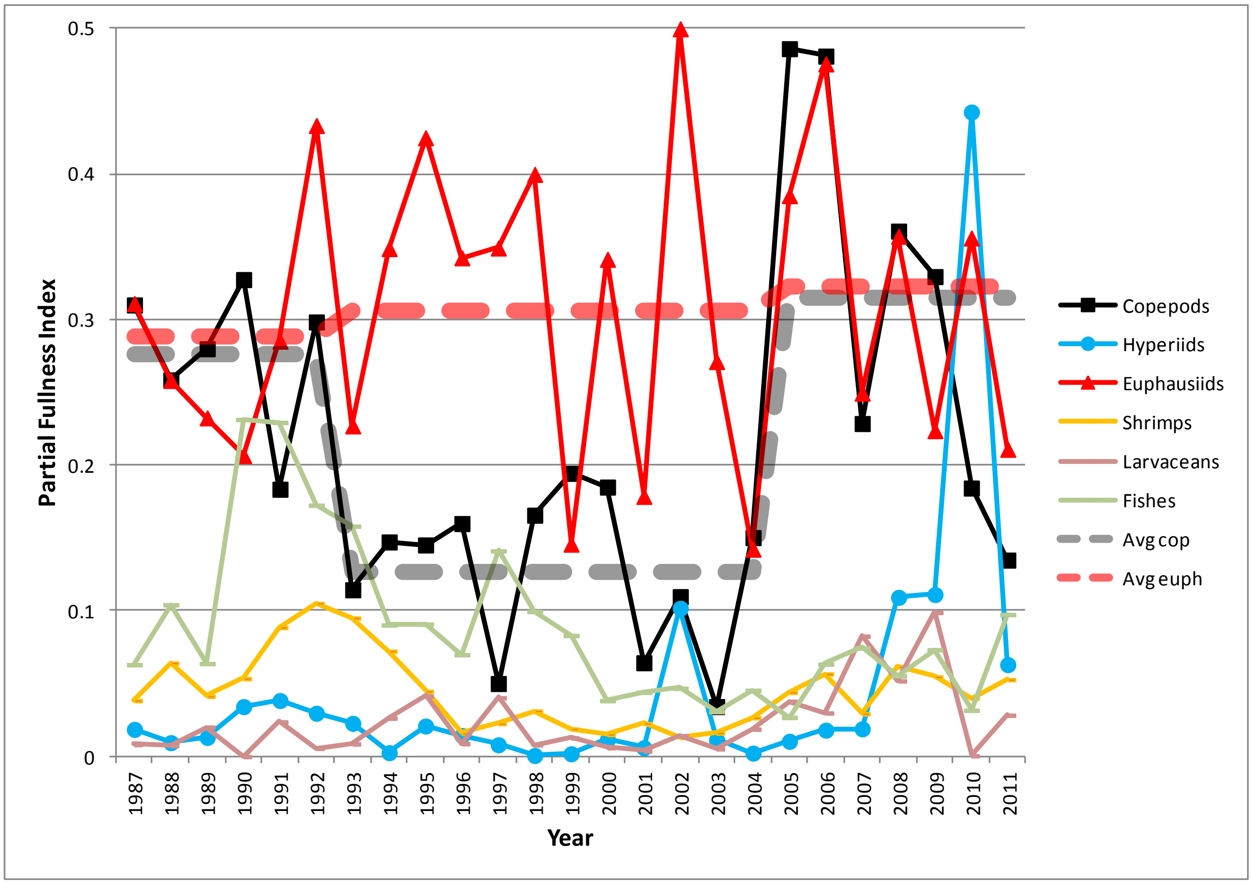


Figure 1. An index of partial fullness of major components in the diet of EBS pollock from 1987 through 2011. The average index for copepods (Avg cop) and euphausiids (Avg euph) are indicated for 3 periods; 1987-1992, 1993-2004 and 2005-2011.

The relationship between average annual weight composition (%W) of copepods and euphausiids to the average annual stomach fullness (%bw) varies by pollock size (Figure 2). Each trend-line extends over the range of %bw values observed over the 25 years for each size category. The correlation between %bw and (arcsin transformed) %W of copepods in the diet was generally positive, especially for 30-39 cm pollock (r^2 = 0.20, P < 0.05) and 40-49 cm pollock (r^2 = 0.15, 0.10 > P > 0.05). The correlation between %bw and %W of euphausiids in the diet was positive for the largest and smallest size groups of pollock (r^2 = 0.05, 0.20 > P > 0.10; r^2 = 0.01, P > 0.50; respectively), but negative for other size groups, especially 40-49 cm pollock (r^2 = 0.20, P < 0.05). For 40-49 cm pollock, euphausiids became more important in the annual average diet when the annual average stomach fullness was lowest. Euphausiids may provide a more consistent food source from year to year than other potential prey of intermediate sizes of pollock. This may be similar to the role of euphausiids as a more consistent, baseline food source in seasons when other prey becomes less available.

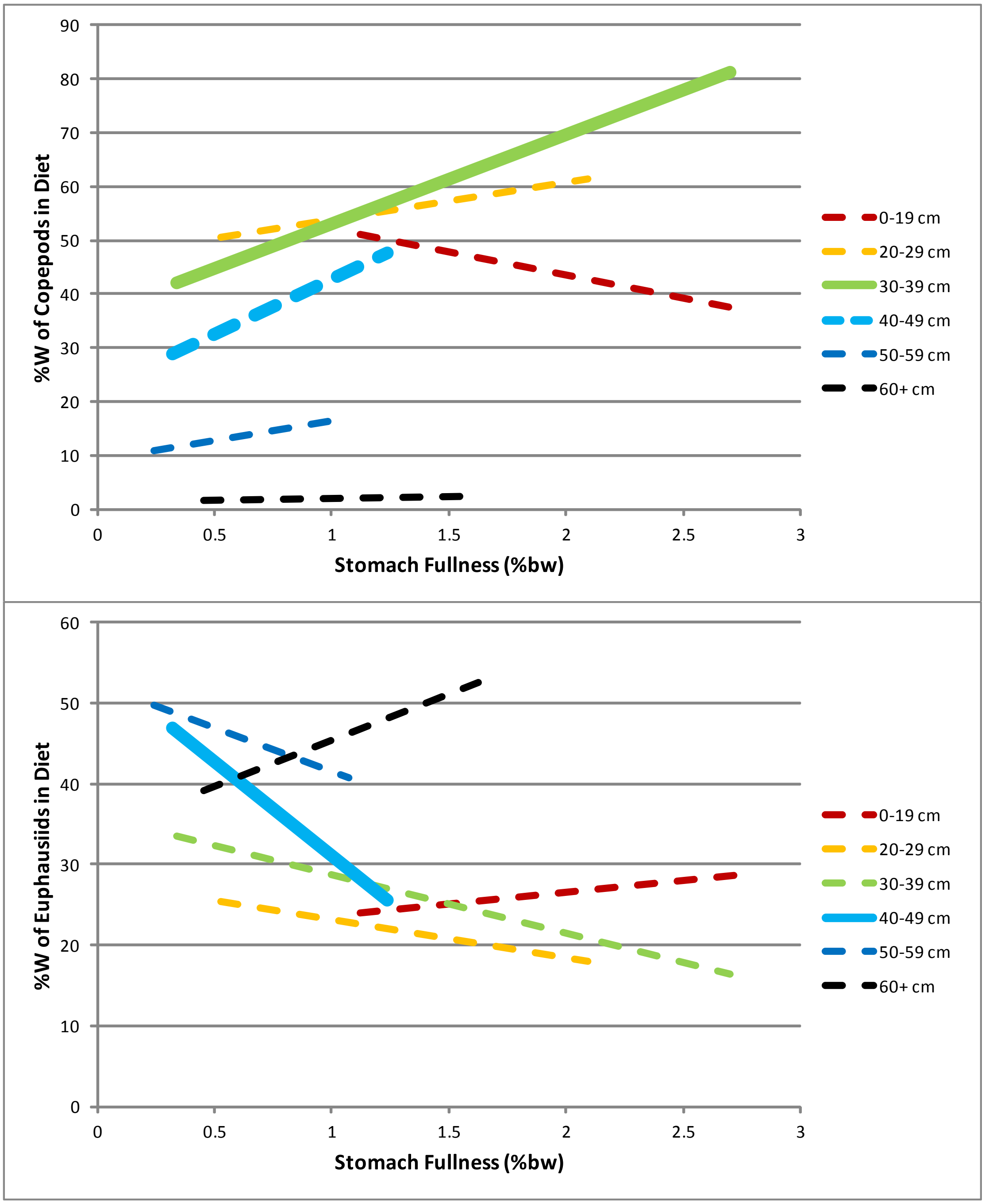


Figure 2. The trend in the average annual weight composition (%W) of copepods (upper panel) and euphausiids (lower panel) relative to the average annual stomach fullness (%bw) of each size category of pollock sampled by AFSC's EBS bottom trawl survey, 1987-2011. Correlations are significantly ($P < 0.05$, thick solid line), almost significantly ($0.10 > P > 0.05$, thick dashed line), or not significantly ($P > 0.10$, thin dashed line) different from zero.

Euphausiid biomass estimates have recently become available for 2004 and 2006-2010 in the EBS (and include some hyperiid amphipod biomass, P.H. Ressler, pers. comm.). The increase in euphausiid biomass over this period was reflected in the %W of euphausiids in the diets of pollock ≥ 60 cm FL and possibly pollock < 20 cm FL (Figure 3). Although correlations were not significant, the positive correlation between euphausiid biomass and %W of euphausiids in the diets of the smallest and largest size groups in the EBS, had r^2 values of 0.41 and 0.61, respectively.

The strongest trophic link between pollock and euphausiids appears to be limited to the smallest and largest pollock while intermediate sizes of pollock appear to have a closer link to copepods in the summer. Size-specific relationships between pollock and specific subsets of the zooplankton community should improve the interpretation of patterns in pollock abundance and distribution whether due to interannual changes in physical conditions or longer term climate change.

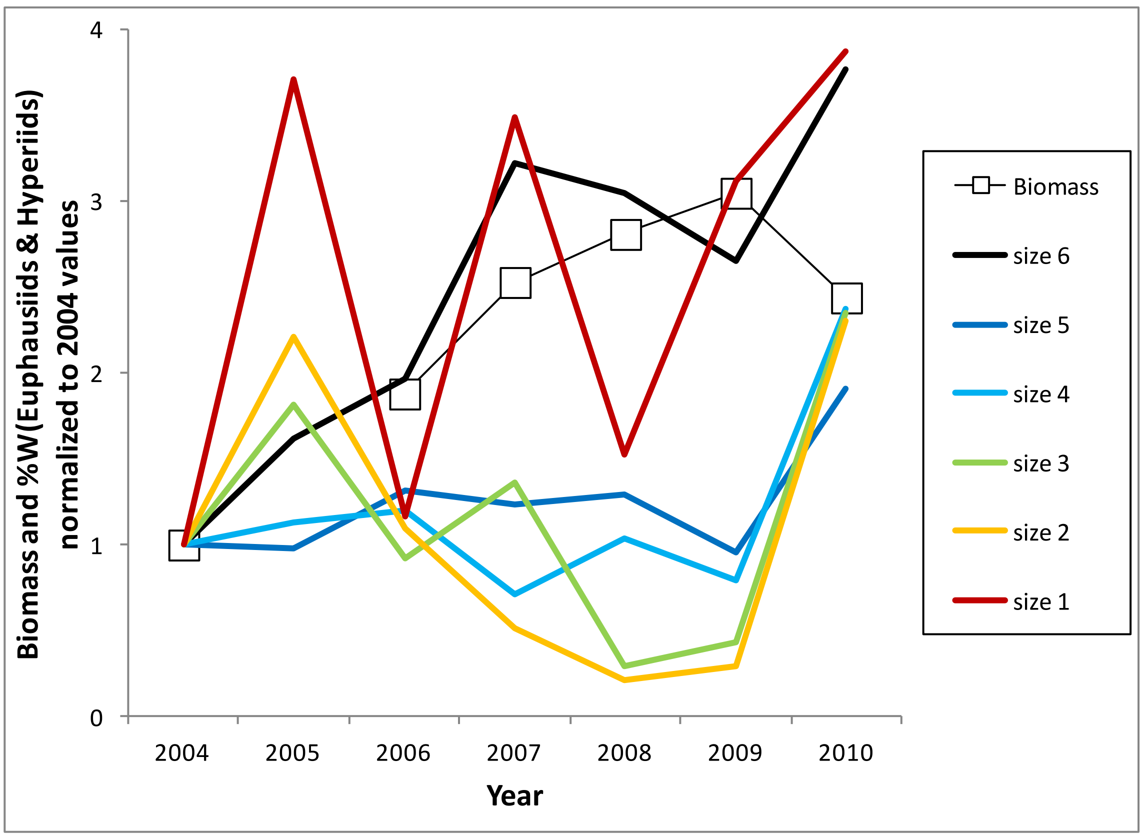


Figure 3. Time series of euphausiid biomass from the hydroacoustic survey and the combined %W of euphausiids and hyperiid amphipods in the diets of 6 sizes of pollock from the Bottom Trawl Survey. The 7 time series are normalized to their 2004 value to indicate the relative change over time.

Pacific Seabird Research

A project on seabird bycatch in Alaska trawl fisheries, comparing observer sampling protocols, examined additional sources of mortality to seabirds that standard observer sampling cannot account for. The study focused on 9,000 trawl hauls that were observed using both standard and supplemental sampling in the years 2004-2006 and 2009 (Figure 4).

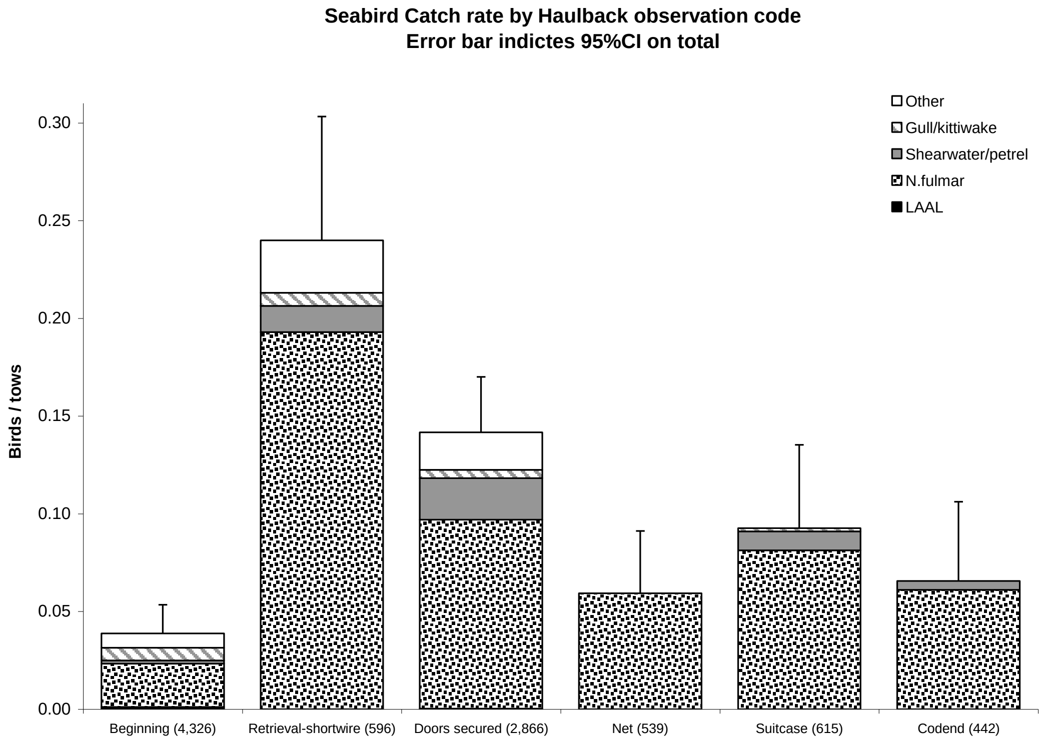


Figure 4. Comparison of seabird catch rates (birds/tow) at trawl haulback stages for Alaskan groundfish trawl vessels during an observer special project, 2004-2006 and 2009. The category "codend" represents standard observer sampling. Other categories represent the special project supplemental sampling completed by observers.

Another project using combined seabird indices to show lagged effects of bottom temperature and food supply on reproduction in the eastern Bering Sea. This project involved creating simplified indices that represent common trends among multiple seabird species and colonies (Figure 5). These indices were found to be related to ecosystem processes at lagged time scales. The new indices have been incorporated into the Ecosystem Considerations report produced annually by AFSC as part to the Groundfish Stock Assessment and Fishery Evaluation report.

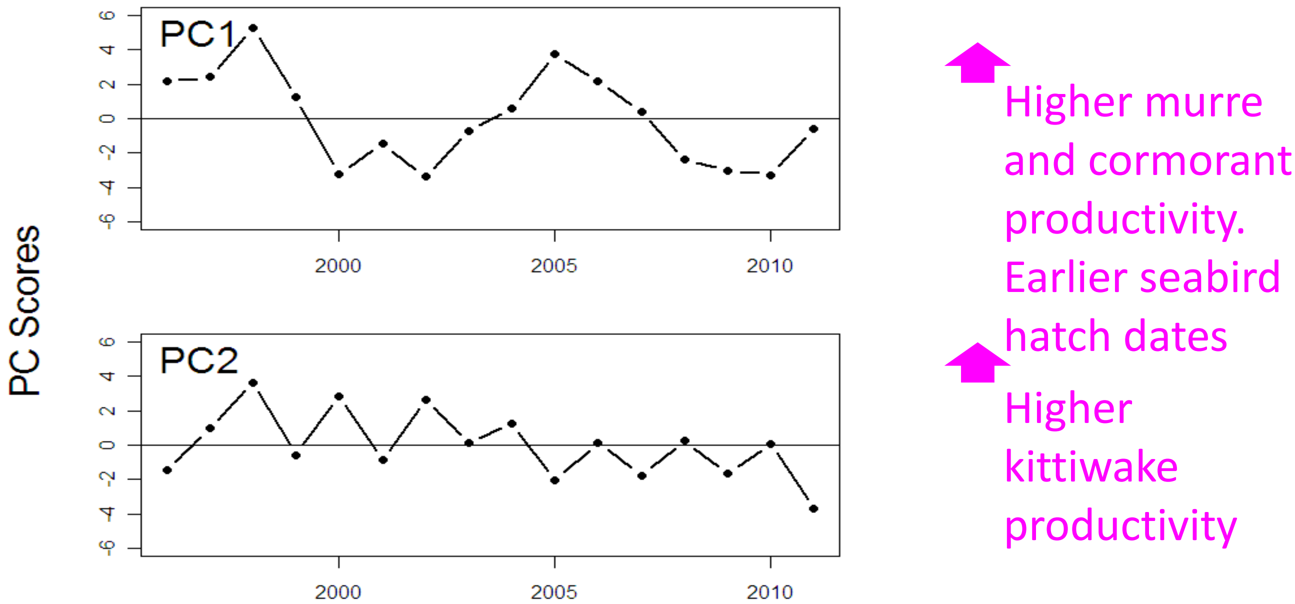


Figure 5. Eastern Bering Sea combined seabird index temporal trends. Seabird reproductive data are from the Pribilof Islands. Higher values of PC1 indicate earlier seabird hatch dates and higher cormorant and murre productivity (except for St. George Island thick-billed murres). Higher values of PC2 indicate higher kittiwake and St. George Island thick-billed murre productivity.

Seabird Bycatch Estimates for Alaskan Federal Groundfish Fisheries

The AFSC released the most recent estimates of seabirds caught as bycatch in commercial groundfish fisheries in Alaska operating in federal waters of the U.S. Exclusive Economic Zone for the years 2007 – 2011. The report can be found in the 2012 Ecosystem Considerations report, available at: http://access.afsc.noaa.gov/reem/ecoweb/index.cfm. The gear types represented are demersal longline, pot, pelagic trawl, and non-pelagic trawl. The bycatch estimates do not apply to gillnet, seine, troll, or halibut longline fisheries. Seabird bycatch in pot fisheries is minimal.

The estimates are based on two sources of information: (1) data provided by NMFS-certified Fishery Observers deployed to vessels and floating or shoreside processing plants, and (2) catch estimates provided by the NMFS Alaska Regional Office Catch Accounting System.

Total estimated seabird bycatch in all Alaskan groundfish fisheries is shown in Table 1. Northern fulmars (*Fulmaris glacialis*) are the most commonly caught seabird in each year. Gulls and shearwaters, both of which are combined species groups, were typically the second and third most commonly caught, although shearwater bycatch was much reduced in 2011.

Albatross bycatch varied annually. The greatest numbers of albatross were caught in 2008. In 2011, 87.0% of albatross bycatch occurred in the GOA which accounts for only 18.5% of overall seabird bycatch. Of special interest is the endangered short-tailed albatross. Since 2003, bycatch estimates were above zero only in 2010 and 2011, when 2 birds and 1 bird were incidentally hooked respectively. This incidental take occurred in the Bering Sea area.

Table 1. Total estimated seabird bycatch in Alaskan groundfish fisheries, all gear types and Fishery Management Plan areas combined, 2007 through 2011. **Note:** estimations extrapolate observed bycatch to unobserved portions of the fisheries fleets and thus are greater than actually observed bycatch.

Species/Species Group	2007	2008	2009	2010	2011
Unidentified Albatross	16	0	0	0	0
Short-tailed Albatross	0	0	0	15	5
Laysan Albatross	17	420	114	267	189
Black-footed Albatross	176	290	52	44	206
Northern Fulmar	4,581	3,426	7,921	2,357	6,214
Shearwater	3,602	1,214	622	647	199
Storm Petrel	1	44	0	0	0
Gull	1,309	1,472	1,296	1,141	2,208
Kittiwake	10	0	16	0	6
Murre	7	5	13	102	14
Puffin	0	0	0	5	0
Auklet	0	3	0	0	0
Other Alcid	0	0	105	0	0
Other Bird	0	0	136	0	0
Unidentified	509	40	166	18	259
Total	10,228	6,914	10,441	4,596	9,298

In the longline fishery, the 2011 numbers are 30.5% above the 2007-2010 average of 7,249. Bycatch in the longline fishery showed a marked decline beginning in 2002 due to the deployment of streamer lines as bird deterrents. Since then, annual bycatch has remained below 10,000 birds. The 2010 bycatch (3,704 birds) was the lowest estimated in this fishery overall, but the numbers increased to 8,914 in 2011, the second highest in the streamer line era. The increased numbers in 2011 are due to a doubling of the gull numbers (1,084 to 2,206) and a 3-fold increase in northern fulmar bycatch from 1,782 to 5,848.

There are many factors that may influence annual variation in bycatch rates, including seabird distribution, population trends, prey supply, and fisheries activities. The longline fleet has traditionally been responsible for about 91% of the overall seabird bycatch in Alaska, as determined from the data sources noted above. However, standard observer sampling methods on trawl vessels do not account for additional mortalities from net entanglements, cable strikes, and other sources. Thus, the trawl estimates are biased low. A project is underway that addresses this issue.

Seabird mitigation gear used on longline vessels can substantially reduce bycatch. Individual vessel performance varies, and further reduction of overall fleet averages may depend on targeted improved performance for a handful of vessels within the fleet. Additional methods, such as integrated weight longline gear, have been researched and shown to be effective (Washington Sea Grant Program). Continued collaboration with the longline industry will be important. Albatross bycatch in the Gulf of Alaska is generally higher than in other regions. With observer program restructuring and the deployment plan recommended by NMFS and approved by the North Pacific Fisheries Management Council, we will have a better sense of albatross bycatch issues within GOA-fisheries.

BSIERP Collaboration and FEAST Modeling

The Bering Sea Integrated Ecosystem Research Program (BSIERP) is part of The Bering Sea Project, a multi-year partnership between the National Science Foundation and the North Pacific Research Board. The Bering Sea Project is a collection of 35 distinct but linked proposals that study climate, oceanography, zooplankton, fish, seabirds, marine mammals, fisheries, Native Alaskan communities and management.

As part of the modeling effort, a vertically integrated model couples five distinct modules: climate, oceanography, nutrient-zooplankton, fish, and fisheries. The fish module called FEAST (Forage / Euphausiid Abundance in Space and Time) is fully coupled with the nutrient-zooplankton and fisheries components, and will be run both in hindcast and forecast mode. FEAST is a bioenergetics model that includes 12 fish species linked to 5 zooplankton groups and 20 fisheries specified by sector, gear and target species. Species include walleye pollock, Pacific cod, arrowtooth flounder, salmon, capelin, herring, eulachon, sandlance and myctophids, squids, shrimp and epifauna; these have a two-way interaction with five groups from the NPZ module: small/large copepods, oceanic/shelf euphausiids and benthos. Temperature and advection estimates from the physical oceanography portion (ROMS) are used in the fish bioenergetics, movement and reproduction components. The hindcast is compared both to timeseries and spatial patterns obtained from historical field data, stock assessments and fishing effort data.

Comparisons of data versus model outputs were performed, highlighting the model’s ability to capture prey switching, species distribution based on temperature and prey availability, interannual differences between cold and warm years, and preferred temperature ranges for walleye pollock, Pacific cod and Arrowtooth flounder. A large part of the parameter estimation for FEAST was based on the extensive food habits database supported by the program since 1982. Figure 6 shows diets for pollock at different lengths, which are at the core of the FEAST model. Figure 7 shows model distributions for pollock, cod and arrowtooth for July, 2008. Fish movement and growth is estimated the same way for all three species, with species specific bioenergetics and prey preferences dictating the movement and growth of each species. FEAST will be used as the model representing the real world in the Management Strategy Evaluation project part of BSIERP.

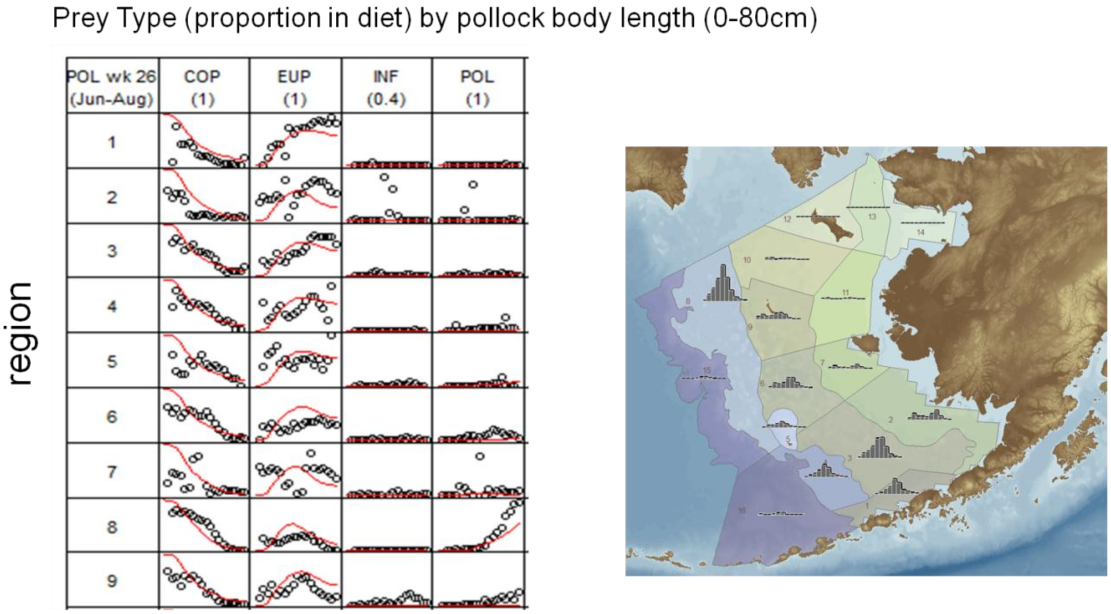


Figure 6. Pollock diets at different lengths, in nine different regions of the eastern Bering Sea. The marine regions shown in the right panel were drawn using GIS layers for multiple data seabirds, zooplankton, currents, etc.). Column plots in each region show the number of stomachs available for different lengths of pollock. The panel on the left show the proportion in diet of a given prey for pollock at different lengths. Data is represented by circles, red lines represent model estimates.

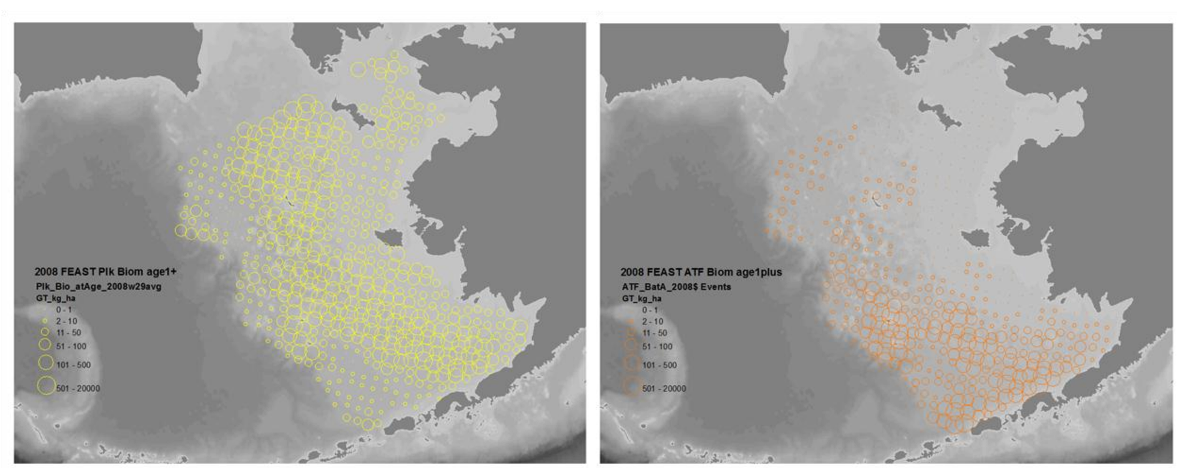


Figure 7. Fish distribution as predicted by FEAST for July 2008. Left panel shows total age 1+ biomass of pollock estimated at RACE survey stations, right panel shows total age 1+ Arrowtooth flounder biomass.

Forage Euphausiids Abundance in Space and Time (FEAST):

More and more, high resolution end-to-end models have started incorporating fish as one of their components. Such exercises are usually restricted to a few years, and do not include fisheries removals. FEAST is a length based, spatially explicit bioenergetics model that comprises the fish portion of the vertically integrated model of the Bering Sea Integrated Ecosystem Program (BSIERP). The vertical model itself contains 5 modules: climate, oceanography (ROMS), lower trophic levels (NPZ), fish, and fisheries (FAMINE). FEAST models 14 fish species linked to 5 zooplankton groups (Figure 8) and 20 fisheries specified by sector, gear and target species. Species include walleye pollock, Pacific cod, arrowtooth flounder, salmon, capelin, herring, eulachon, sandlance, myctophids, squids, shrimp, crab, epifauna, and amphipods; these have a two-way interaction with six groups from the Nutrient - Phytoplankton - Zooplankton (NPZ) module: small copepods, oceanic/shelf copepods, oceanic/shelf euphausiids, and benthos. Temperature and advection estimates from the physical oceanography portion (ROMS) are used in the fish bioenergetics and movement components. The model has a spatial resolution of approximately 10 Km and will be run both with past climate (1970-2010 hindcast) and three different climate projections stemming from three different climate models. In addition, FEAST is the "real world" model to be used in a Management Strategy Evaluation for walleye pollock and Pacific cod, two of the main commercial groundfish in the Bering Sea.

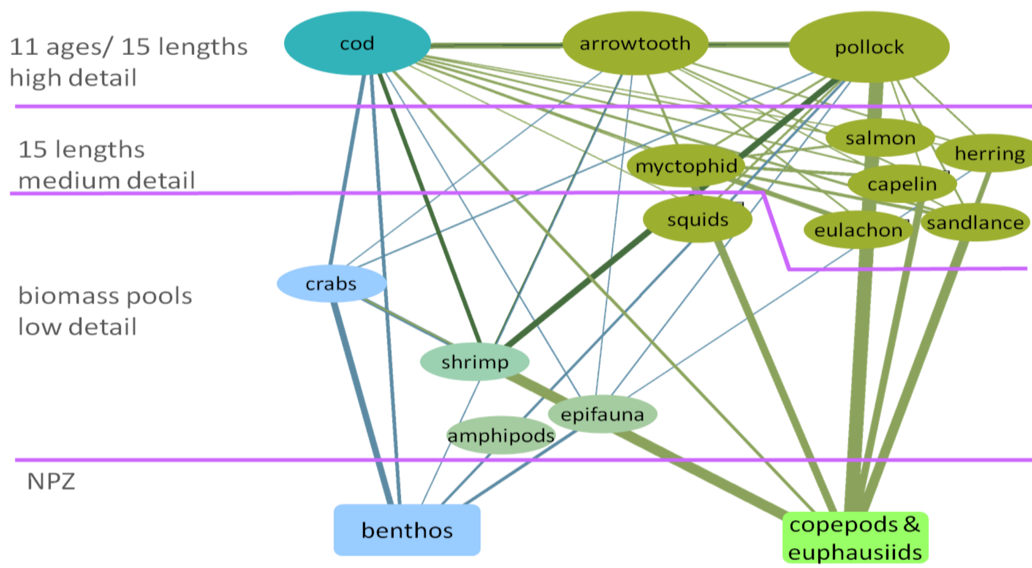


Figure 8. Food-web underlying FEAST, showing level of detail for the groups modeled. Lines depict trophic flows, line thickness is proportional to magnitude of flow and color represents pelagic (green) or benthic (blue) routes.

Multispecies Stock-Assessment (MSM) and Bioenergetic Modeling:

MSM is a three-species model of some of the most productive stocks and key predators in the Bering Sea – walleye pollock, Pacific cod, and arrowtooth flounder. Their biological interactions may influence natural mortality estimates and subsequent harvest recommendations. Thus MSM is a first cut approach for implementing ecosystem-based management of fisheries resources in the Bering Sea. MSM combines traditional catch-at-age stock assessment models with multispecies virtual population analysis models (MSVPA) in a statistical framework and uses abundance and diet data to estimate fishing mortality, recruitment, stock size, and predation mortality. MSM typically models the latter as a series of functional bioenergetics responses to derive temperature dependent predator rations. Since MSM can capture critical threshold effects that characterize many ecological interactions, such an approach also provides a statistical framework to evaluate and manage both the direct and indirect effects of fisheries harvest on multiple species.

We conducted comparative analyses of annual predator rations estimated from (i) digestive corrections applied to the data, (ii) von Bertalanffy derived estimates of consumption, and (iii) estimates from Wisconsin bioenergetic models for the three species (Figure 9). Various ration estimates are compared to data from the food habits database and provide indices of predation pressure over time.

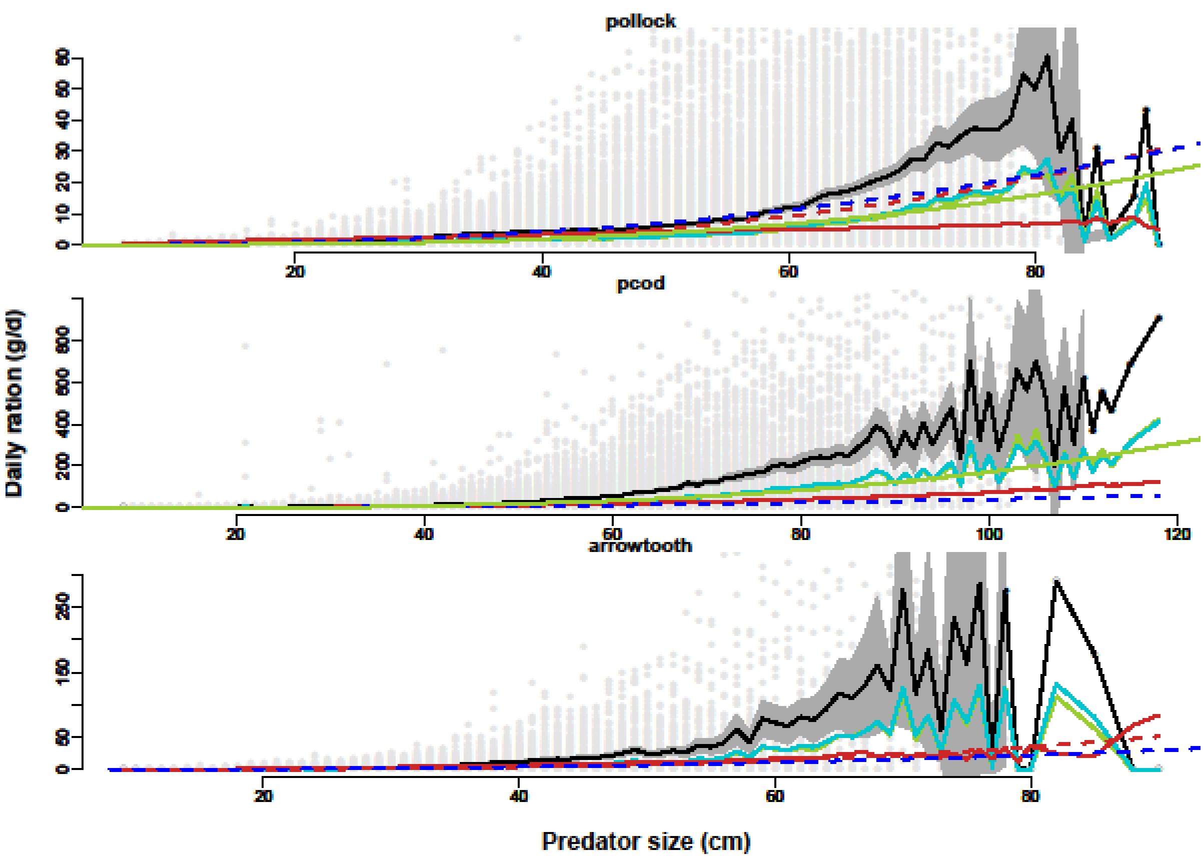


Figure 9. Daily size-dependent ration estimates for walleye pollock, Pacific cod, and arrowtooth flounder from the Eastern Bering Sea. Shaded gray polygons represent the mean proportional weight of stomachs (gray dots; g stomach / g body weight), as compared to digestion corrected

values (green lines; “livingston”), von Bertalanffy consumption estimates from two different fitting methods (blue and red lines), and Wisconsin bioenergetic model estimates (solid red lines).

We completed a comparative analysis of field-based daily ration values (corrected for digestion) to bioenergetic-based ration estimates for the EBS, GOA, and AI regions for walleye pollock, Pacific cod, and arrowtooth flounder. For this, we refit Wisconsin bioenergetic parameters to published consumption data for the three (or similar) species and compared bioenergetic rations to digestion corrected field-based ration estimates (using two different methods) and von Bertalanffy derived estimates of consumption (Figure 10). This allowed us to derive consumption parameters that can now be used to update regional MSM models.

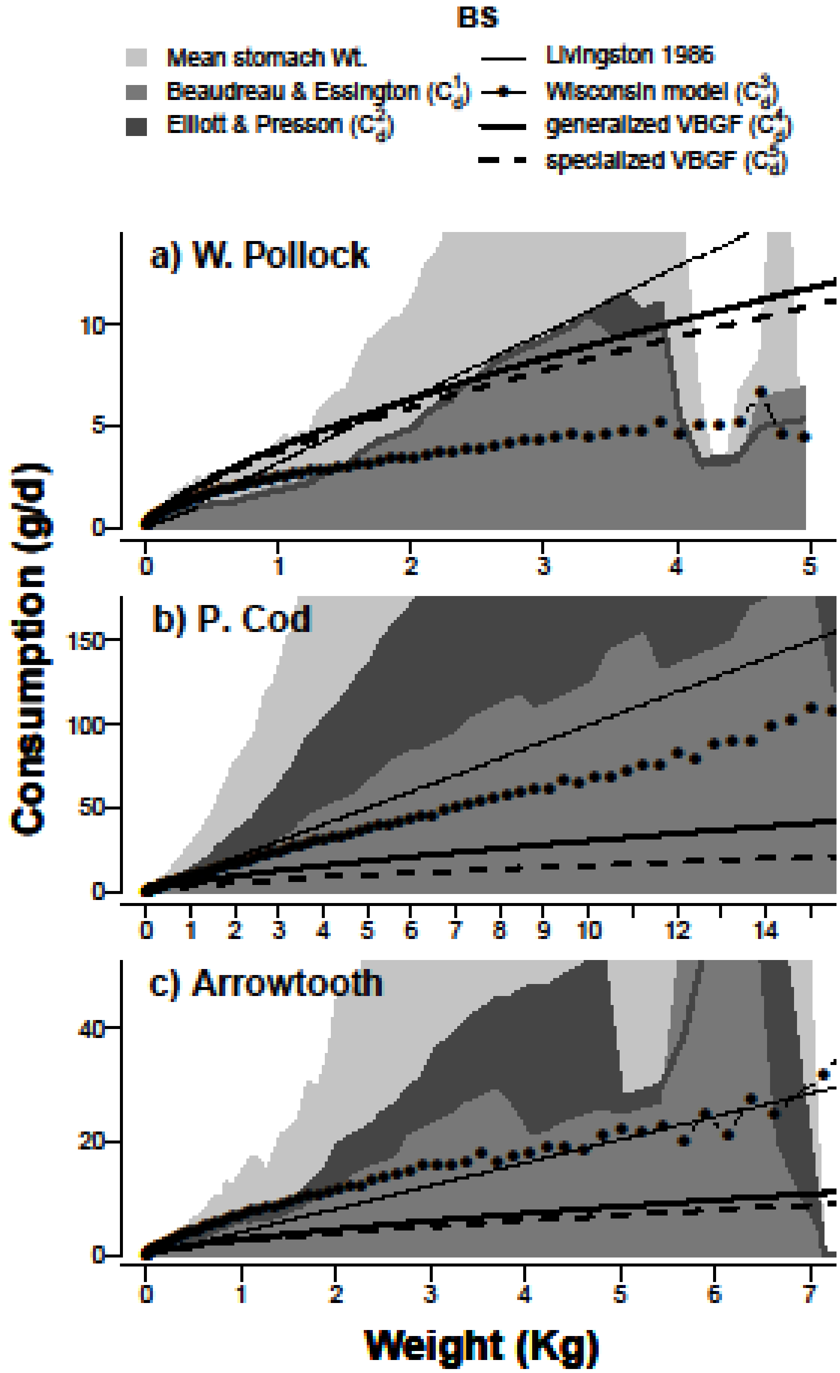


Figure 10. Weight-dependent annual ration estimates for walleye pollock, Pacific cod, and arrowtooth flounder from the Eastern Bering Sea. Shaded polygons represent field-based rations estimated from three different methods: Mean Stomach Wt. (i.e., no correction; light gray), Beaudreau & Essington (digestion correction using prey condition; medium gray); Elliott & Presson (digestion correction using mean stomach weights; dark gray). The thin line shows values reported in Livingston et al. 1986. The remaining lines represent bioenergetic based estimates of consumption from the Wisconsin model (dot line), the

generalized von Bertalanffy growth equation (solid thick line) and the specialized von Bertalanffy (dashed line).

Additionally, we have conducted a detailed analysis of allometric patterns in predation risk and prey selectivity (Figure 11). These analyses have allowed us to parameterize the size-based foraging model used in MSM. We have applied the updated bioenergetic and foraging model parameters to the MSM model for EBS. In particular, we have generated projections for the three species under various target harvest rates including (i) no fishing, and (ii) fishing to 40% of the un-fished spawning biomass. Model predictions were compared to single species assessments from 2011 as well as Ecosim predictions for the Bering Sea (Figure 12).

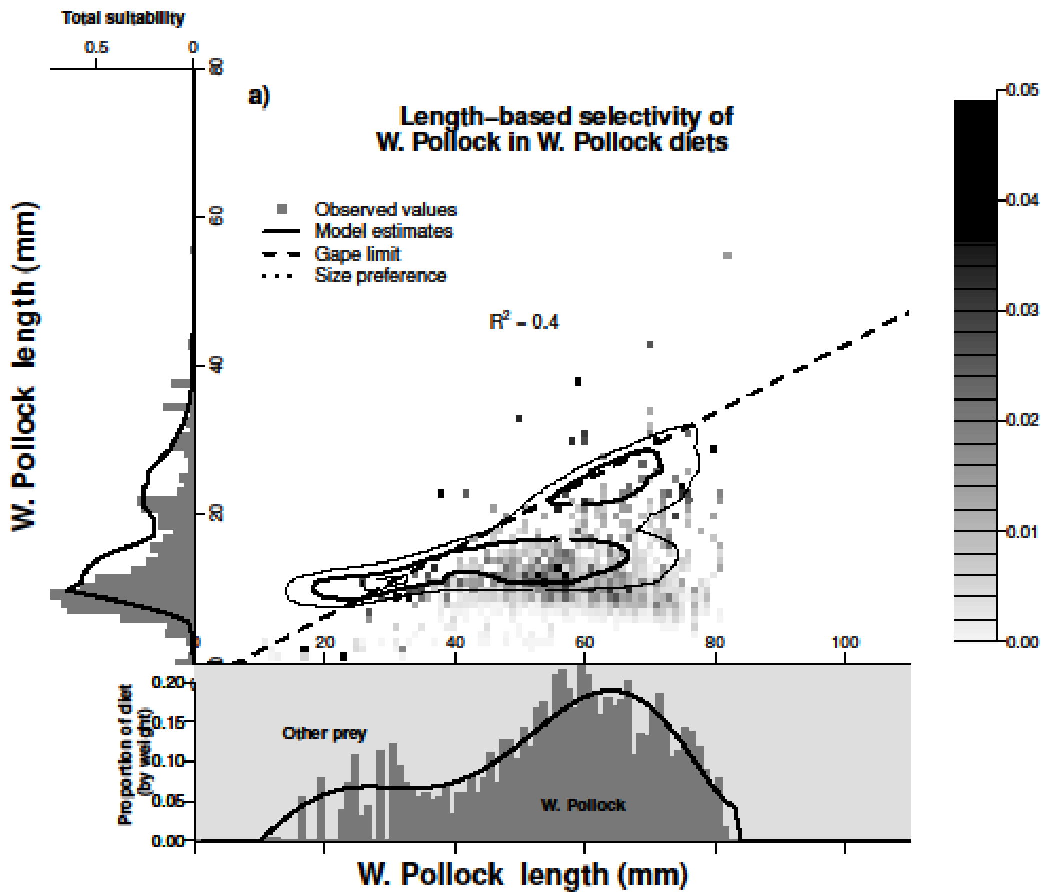


Figure 11. Length-based prey selectivity for cannibalistic walleye pollock predators consuming walleye pollock prey of various sizes (shaded squares), and model estimates of selectivity (contour lines). The horizontal and vertical bar graphs represent the row (i.e., suitability) or column (i.e., proportion of diet by weight) totals, respectively; solid lines represented foraging model estimates.

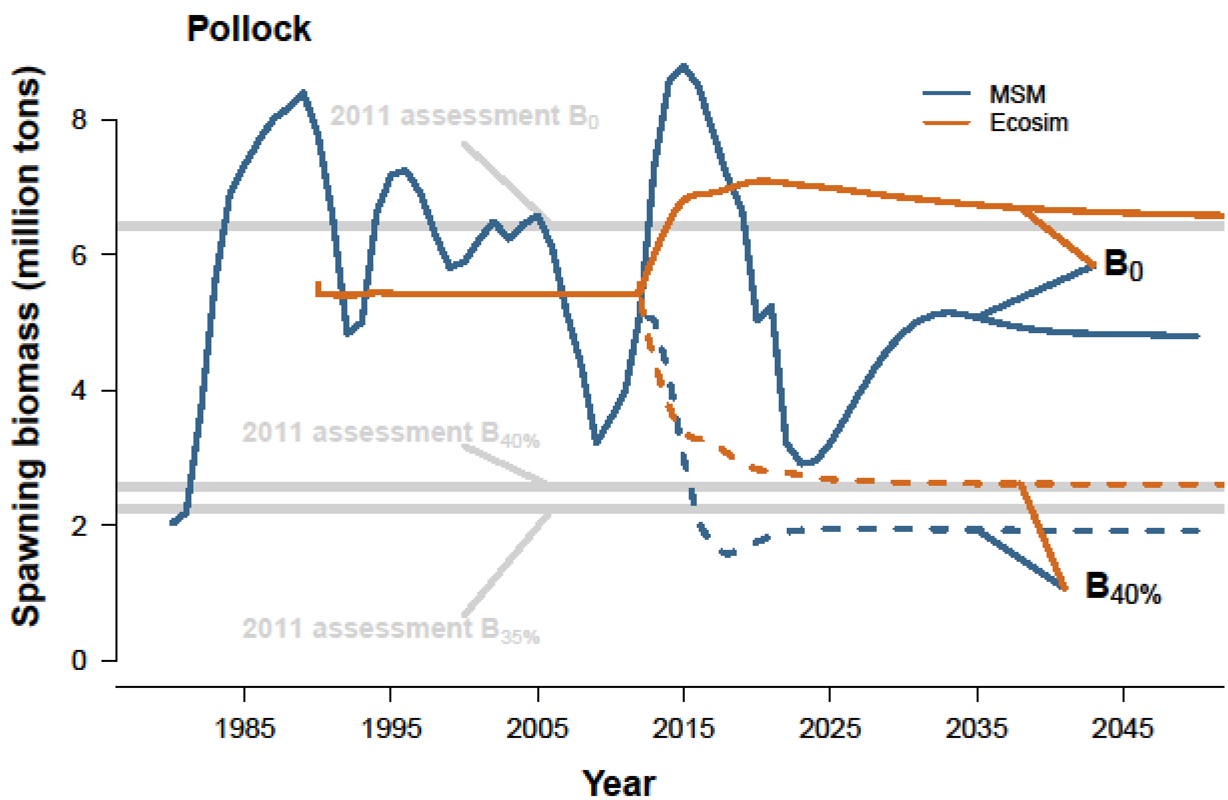


Figure 12. MSM estimates of spawning biomass of walleye pollock from the Eastern Bering Sea (blue line) and projections of unfished and 40% unfished biomass from MSM (solid and dashed blue lines, respectively), Ecosim (orange lines), and the 2011 stock assessment (horizontal gray bar).

<u>Alaska Marine Ecosystem Considerations</u>

The Ecosystem Considerations report is produced annually for the North Pacific Fishery Management Council as part of the Stock Assessment and Fishery Evaluation (SAFE) report. The goal of the Ecosystem Considerations report is to provide the Council and other readers with an overview of marine ecosystems in Alaska through ecosystem assessments and by tracking time series of ecosystem indicators. The ecosystems under consideration include the eastern Bering Sea, the Aleutian Islands, and the Gulf of Alaska. New this year, the report includes a preliminary Arctic ecosystem assessment.

The intent of adding the Alaskan Arctic to the Ecosystem Considerations report was to provide an overview of general ecosystem information that may form the basis for more comprehensive future Arctic assessments that would be useful for fishery managers making decisions on the authorization of new fisheries. Consistent with ecosystem assessments of the eastern Bering Sea, Gulf of Alaska, and Aleutian Islands, we intend for the future Arctic assessments to include a list of indicators that directly address ecosystem-level processes and attributes that can inform fishery management advice by communicating indicator history, current status, and possible future directions.

The report includes additional new and updated sections, including the 2012 Eastern Bering Sea and Aleutian Islands Report Cards and ecosystem assessments. This year, the Hot Topics section includes topics from each ecosystem. For the Arctic, these include a description of the record sea ice minimum that was reached in mid-September and a review of the apparent waning of the Unusual Mortality Event for ice seals and walrus noted in 2011. The hot topic for the eastern Bering Sea was the fisheries failure that was declared for the commercial king salmon fisheries. The two leading hypotheses for the reduced runs are climate change and fishing. The hot topic for the Aleutian Islands focused on the recent spatial analysis of Blackspotted/Rougheye Rockfish that indicates that local exploitation rates may be higher than previously thought. The hot topic for the Gulf of Alaska includes a report on the apparent poor foraging conditions for upper trophic predators in 2011 that may indicate that this particular year-class of fishes may be poor. The section in the report that describes ecosystem and management indicators includes updates to 44 individual contributions and presents 5 new contributions. These include contributions on trends in surface carbon uptake by phytoplankton and forage fish catch rates during late summer to early fall in the eastern Bering Sea; Gulf of Alaska ichthyoplankton abundance indices and regional distribution of juvenile salmon and age-0 marine fish; and an analysis of spatial variability of catches in Bering Sea and Gulf of Alaska crab fisheries.

Additional regional 2012 ecosystem highlights include the extensive sea ice and cold pool in the eastern Bering Sea and record cold water temperatures during the summer in the Aleutian Islands, which may have influenced the observed decreases in pelagic foragers and apex fish predator biomass estimates relative to the last survey in 2010. NMFS surveys are conducted in the Aleutian Islands and Gulf of Alaska in alternate years, so no surveys were available in 2012.

The final draft was presented to the Council's Groundfish Plan Teams in November, and the final report was presented to the Science and Statistical Committee and Council Advisory Board in December when the 2013 groundfish quotas were set. The report is now available online at the Ecosystem Considerations website at: http://access.afsc.noaa.gov/reem/ecoweb/index.cfm

The Fishery Interaction Team (FIT)

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.

In late winter-early spring 2012, FIT staff conducted an Atka mackerel tag recovery cruise in the Aleutian Islands. Tagging experiments are being used to estimate abundance and movement of Atka mackerel between areas open and closed to the Atka mackerel fishery. In May to June of 2011, a cooperative venture between the North Pacific Fisheries Foundation and the AFSC released approximately 8,500 fish near the Seguam Pass area, 9,000 fish at Tanaga Pass, and 10,000 at Petrel Bank. In August 2011, FIT conducted a summer recovery cruise in the same areas. The winter-early spring recovery cruise was conducted from 27 March to 17 April. During the 2012 cruise 54 hauls were conducted and 1,529 metric tons (t) of Atka mackerel were examined for tags, equivalent to approximately 2.6 million individual fish. 49 tags were recovered: 13 at Seguam pass, 25 at Tanaga pass, and 11 at Petrel Bank, all of which were released during the 2011 tag release charter. All hauls were sampled for species composition and sexed length frequencies. In addition, 420 biological samples such as stomachs, gonads, and age structures were collected and sexed length frequencies from 4,697 individual fish were obtained. This recovery cruise also provided an opportunity to coordinate prey field sampling with Steller sea lion satellite tracking. During November 2011, the AFSC's National Marine Mammal Laboratory tagged a female adult Steller sea lion with a satellite tag. During the recovery cruise, she was located at Semisnopochnoi Island and travelled to the southern part of Petrel Bank at regular intervals, presumably to feed. FIT staff took the opportunity during the recovery cruise to run a hydroacoustic transect at the southern end of Petrel Bank. Five tows were conducted in areas where the sea lion was frequently observed and where fish signal was found along the transects.

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. In 2012, FIT staff conducted research designed to identify spatial and temporal patterns in Pacific cod spawning in the Bering Sea. Staff determined the location and timing of cod spawning by creating monthly maps of cod maturity stage, based on data collected by observers on commercial vessels. FIT staff collaborated with FMA to collect reproductive maturity data from commercial vessels. FIT staff collaborated with Oregon State University scientists to develop quantitative measures of cod spawning distribution and the relationships with environmental parameters.

FIT staff also contribute to SSMA research objectives. In 2012 FIT staff conducted a field study in support of stock assessment for the giant Pacific octopus. This project (funded by FY2012 Cooperative Research) was a direct field experiment to estimate the proportion of octopus that are alive at discard but later die due to being caught and handled. The plan of study was to use a commercial pot vessel fishing Pacific cod as a vessel of opportunity. Large, insulated, lidded totes were used as temporary holding containers for octopus captured during pot fishing. Each octopus was then be held in totes for a minimum of one week and checked daily. At the end of one week, surviving animals were again be classified for condition and activity.

Another key task of FIT staff is to provide analyses, advice and support to the Regional Office and the NPFMC in the preparation of Biological Opinions and Environmental Impact Statements. Libby Logerwell (FIT lead) is the Point of Contact, coordinating responses not only from FIT, but from other programs in REFM and RACE.

For more information on the FIT program, contact Libby Logerwell or access the following web link: http://www.afsc.noaa.gov/REFM/Stocks/fit/FIT.htm

C. By Species

1. Pacific Cod

a. Research

Juvenile Pacific cod seasonal habitat use and movement study
In 2012, researchers from the Kodiak Laboratory continued a project examining the seasonal habitat use and over wintering habits of juvenile Pacific cod, *Gadus macrocephalus*, within nearshore nursery areas of Kodiak Island, AK. Previous investigations have focused on the nursery requirements of age-0 and age-1+ juvenile Pacific cod mainly during the summer. The current project is an extension of this prior work and focuses on examining the habitat use patterns of older juvenile age classes (age 2+) still residing in the nursery areas. The project examines the hypotheses that older juvenile Pacific cod preferentially utilize bare substrate habitats and show strong site fidelity prior to the winter season and that juvenile cod winter migratory behavior will be variable among individuals.

In 2010, a laboratory study was completed that examined the effects of intra-peritoneal tag implantation on juvenile cod and the results indicated this is a valid technique. A combination of acoustic telemetry and a drop camera system was used to acquire habitat patch use of individual cod. In addition, a passive gate telemetry system was utilized to document the movement of individual cod transiting outside the nursery during the winter. In the fall of 2011 and 2012, 22 juvenile cod were captured in the field and fitted with acoustic transmitters. Preliminary results suggest the habitat use of juvenile cod during the fall months was highly variable. Depth range of re-located tagged cod ranged from 11.5 to 86.5 ft. At these depths, the bottom substrate varied from a bare sediment/shell mix in the deeper depths to a combination of the bare sediment/shell mix and kelp (*Agarum cribrosum* and *Laminaria* sp.) in the shallower depths. In 2011 and 2012, out migrations commenced during late August to early September and typically occurred prior to the water column becoming isothermal. The winter migratory movements were highly variable among the tagged individuals. Some individuals briefly transited the acoustic gate during the fall, while others resided in close proximity of the nursery area throughout the winter months. Results from this project will contribute significant knowledge about essential fish habitat requirements of juvenile cod.

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

Diel vertical migration of Pacific cod in Alaska-RACE GAP

Two analyses of depth, both derived from depth-recording archival tags attached to individual Pacific cod, are being used to describe how vertical movement varies between day and night in two different areas of Alaska: off Kodiak Island in the Gulf of Alaska and near Unimak Island in the eastern Bering Sea. A total of 286 adult Pacific cod (49 – 85 cm FL), externally tagged with depth and temperature archival tags (Lotek LTD 1100) were recovered from among 653 individuals released between November 2001 and May 2002. The analysis being done includes comparisons of vertical movement between day and night, during consecutive 24-hr periods, and site-specific and seasonal components to vertical movement. Contact Dan.Nichol@noaa.gov

Examining Genetic Stock Structure of Pacific Cod in the NE Pacific-RACE Recruitment Processes

A study of microsatellite DNA variation across the geographic range of Pacific cod in North America found a clear genetic isolation-by-distance pattern for coastal populations. Notable exceptions to this pattern were from the Georgia Basin (Puget Sound and the Strait of Georgia). Further screening of mitochondrial DNA variation revealed that the Georgia Basin group represented a distinct evolutionary lineage. The distinctness of this group from the coastal group, and to some degree between Puget Sound and the Strait of Georgia, provides the first evidence for estuarine stocks in this species. This may be of particular relevance for conservation and management of the transboundary Strait of Georgia population, one of four stocks recognized for management in Canada. Contact Mike Canino (Mike.Canino@noaa.gov) for more information.

Genomic Evidence for Localized Adaptation in Salish Sea Pacific Cod-RACE Recruitment Processes

M. Canino and L. Hauser (University of Washington) have received funding for a two-year project to assess the potential for adaptive differentiation in Puget Sound compared with coastal Pacific cod, two groups that have already been differentiated using neutral genetic markers. We will rear Puget Sound and coastal larvae in common garden experiments to determine the effects of temperature on family-specific survivorship. Next-generation sequencing techniques will be used to determine and annotate specific genes associated with survivorship at different temperatures. Results should provide insight into localized adaptation of Salish Sea (Straits of Georgia and Juan de Fuca, Puget Sound) Pacific cod and the potential for adaptation in response to projected future climate change. Contact Mike Canino (mike.canino@noaa.gov) for more information.

b. Stock Assessment

Bering Sea and Aleutian Islands

Considerable effort to respond to the public and the Council comments on the Pacific cod assessment continued in 2012. A number of alternative candidate models were considered at Team/SSC meetings in May/June and September/October, but in November, the winning candidate was the incumbent, namely last year's base model (Model 1). Thus, there were no changes in assessment methods. Survey data indicate that after all-time lows from 2006 through

2008, the Bering Sea survey biomass more than doubled between 2009 and 2010 and has remained approximately constant since. The 2006 and 2008 year classes were strong, and the 2010 and 2011 may be above average also. Thus, the stock abundance is expected to remain at a high level in the near future.

For 2012, all survey and commercial data series on CPUE, catch at age, and catch at length were updated. The 2012 Bering Sea trawl survey biomass estimate was almost the same as in 2011, while the estimate of abundance in number was up by 18%. The survey biomass estimate has increased by more than 100% since 2005.

The author has developed an exploratory model (Model 4) that has some attractive features (better modeling of weight at length, length- specific survey selectivity), but the author believes it needs more work. It will be brought forward again next year. At present, the assessment is done for the eastern Bering Sea (EBS) and the EBS abundance estimate is expanded to the entire Bering Sea/Aleutian Islands region (BSAI) according to a survey-based estimate of the proportion of the total located in the Aleutians (presently 7%). A single OFL, ABC, and TAC are then set for the entire region. The NPFMC plan team and the SSC have recommended developing a separate age-structured assessment for the AI. The assessment author presented preliminary versions this fall of an AI model, which tended to produce estimates of ABC substantially lower than recent catches. The SSC has given notice that it will adopt a separate AI model for setting OFL and ABC in the Aleutians when model development is complete, possibly as soon as next year for 2014 specifications.

B40% for this stock is estimated to be 358,000 t and projected spawning biomass in 2013 according to Model 1 is 422,000 t, thus the stock is assigned to Tier 3a management. There remains some concern about the fixed value of trawl survey catchability used in the assessment, and the retrospective behavior reported this year was not good, but neither the author nor the Team saw any compelling reason to recommend OFL or ABC values lower than prescribed by the standard control rule.

Pacific cod is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition. Recent catches have been well below OFL.

<u>Gulf of Alaska</u>
The 2011 NMFS bottom trawl survey estimate of 348 million fish is a 33 percent decrease in abundance over the 2009 survey estimate, which was a 199% increase from the 2007 estimate. The fishery data series was updated with catch for 2011, preliminary catch for 2012, catch-at-length for 2011, and seasonal and gear-specific catch for 1991-2012. The survey data series was updated with 2011 NMFS bottom trawl survey data for age composition and mean size-at-age.

The 2012 GOA Pacific cod assessment author evaluated ten models. The different model configurations focused on exploration of the effects of different combinations of the survey 27 cm – plus and sub 27 cm length groups on model fit. The sub-27 survey data are highly variable and there is considerable uncertainty with the probability and consistency of the capture of sub 27 cm fish in the trawl survey.

Model 2 was selected by the author as the preferred model because biomass estimates were similar to other model configurations, it had fewer parameters due to excluding the sub – 27 survey data, and it estimated the length of age-1 fish closer to the observed value than most other model configurations. Model 4 had much better fits to other data components and the author was encouraged to examine alternatives along these lines (e.g., down-weighting sensitivity to the mean-length at age data).

Estimated age-0 recruitment has been relatively strong since 2005 for this stock, and stock abundance is expected to be stable in the near term. The stock is not being subjected to overfishing and is neither overfished nor approaching an overfished condition. *B40%* for this stock is estimated to be 93,900 t and projected spawning biomass in 2013, according to Model 2, is 111,000 t, therefore the stock management for 2013 is in Tier 3a. Neither the author nor the Plan Team saw any compelling reason to recommend OFL or ABC values lower than prescribed by the standard control rule. The current values of *F35%* and *F40%* are 0.61 and 0.49. In the past the ABC of Pacific cod was apportioned among regulatory areas based on the three most recent trawl surveys. The apportionments based on the average area-specific biomass estimates from the 2007-2011 surveys were 32% in the Western GOA, 65% in the Central GOA, and 3% in the Eastern GOA. An alternative that is used in the Bering Sea - Aleutian Islands, based on a Kalman filter approach, would result in apportionments of 35% in the Western GOA, 61% in the Central GOA, and 4% in the Eastern GOA. The Team did not see any compelling biological reason to recommend one alternative over another.

For further information, contact Dr. Grant Thompson at (541) 737-9318 (BSAI assessment) or Dr. Teresa A'Mar (GOA assessment) (206) 526-4068.

2. Walleye Pollock

a. Research

Seasonal Fish and Oceanographic Surveys to Link Fitness and Abundance of larval and Age-0 Walleye Pollock to Climate Change and Variability on Bering Sea Ecosystems - ABL

The eastern Bering Sea (EBS) shelf is a highly productive ecosystem, where atmospheric forcing, duration and extent of sea ice cover, and transport through ocean passes in the Aleutian Islands dominate the physical processes on the shelf. Inter-annual variability in these processes is believed to influence the distribution, feeding, growth, and recruitment of important fisheries stocks. Physical oceanographic features (e.g. sea surface temperature (SST), fronts, mixed layer depth) and lower trophic level dynamics (e.g. primary production, zooplankton prey availability) also are critical to understanding migration, distribution, and survival of forage fish. Research on the interaction between physical oceanography, plankton, and forage fish such as age-0 walleye pollock (*Theragra chalcogramma*) and juvenile Pacific salmon (*Oncorhynchus spp.*) has been conducted annually by Auke Bay Laboratories Ecosystem Monitoring and Assessment Program researchers in 2000–2012, with biennial surveys planned for 2014 and onward. These surveys are part of a joint effort with other AFSC/NOAA programs, including the Ecosystems and Fisheries Oceanography Coordinated Investigations (EcoFOCI), the RACE Division's Midwater Assessment and Conservation Engineering (MACE) Program, REEM program within REFM Division and ABL's Recruitment Energetics Coastal Assessment (RECA) Program to examine recruitment processes of walleye pollock. Larval and juvenile fish and oceanographic information are collected during spring followed by epipelagic trawl and midwater acoustic surveys during late summer/early fall (August-October). The surveys provide information to assess the abundance and condition of these fish during the larval to juvenile stages and at the end of their early marine growth period, prior to their first winter.

The few large-scale studies of walleye pollock in the Bering Sea have mainly focused on their distribution in relation to sea-ice conditions (Wyllie-Echeverria 1995). In contrast, the seasonal time series on critical life stages of walleye pollock is presently the only shelf-wide data available to examine marine survival from spring to fall in the EBS. This time series provides integrated information on energy density, diet, abundance, and distribution in relation to changing ocean conditions. Such information coupled with an age-0 abundance index provides a unique opportunity to evaluate survival of juvenile walleye pollock relative to the reproductive output estimated from pollock stock assessments. For example, we have found a direct correlation ($r^2 = 0.73$) between the energy content of age-0 pollock (kJ/fish) and the number of age-1 recruits as predicted in the pollock stock assessment. These data are currently being considered by the North Pacific Fishery Management Council to help reduce the uncertainty in stock assessments for EBS walleye pollock.

Our survey results have been used to document the rapidly changing marine conditions in the EBS during the past ten years and provide baselines and analogues for different climate regimes. The EBS SST's underwent large-scale warming from 2002-2005 followed by substantial cooling in 2006-2012. These shifts altered fisheries distributions and have the potential to affect the overall ecology of this region. Coincident with changes in the SST we have observed changes in the energy density (kJ/g) of age-0 pollock. Currently, age-0 pollock appear to have maximized their energy content. The extent of winter sea ice and its rate of retreat influences spring bloom dynamics, secondary production, and the spatial extent of the cold-water pool during the summer. Because most fish growth occurs during the summer, the winter and spring climatic forcing along with summer atmospheric and oceanographic conditions will dramatically affect fish distribution and production. For more information, contact Ed Farley at (907) 789-6085 or ed.farley@noaa.gov.

Walleye Pollock in the Bering Sea- RACE Recruitment Processes

Water temperatures in the southeastern Bering Sea influence the density of walleye pollock *Theragra chalcogramma* early life stages, potentially influencing spatial distributions and the phenology of reproduction and development. Walleye pollock egg and yolk-sac larval spatial distributions are unaffected by temperature, suggesting that spawning locations are stable. Preflexion larvae, late larvae, and juveniles shift onto the shelf under warm conditions, similar to spatial shifts observed in distributions of sub-adults and adults. Temporal distributions were used to address the hypothesis that timing of the density peak at each stage is delayed under cold conditions. Differences in the timing of density peaks supported the hypothesis that the timing of spawning, hatching, larval development, and juvenile transition are temperature-dependent. The current analysis represents the best support available for the importance of temperature to walleye pollock in determining early life stage development and population trends in EBS. Data indicate that future changes in water temperatures could influence the early life stages of an ecologically dominant member of the EBS community by changing phenology and habitat use in the first several months of life.

Reference: Smart, T., Duffy-Anderson, J.T., Horne, J. In press. Alternating climate states influence walleye pollock life stages in the southeastern Bering Sea. *Mar. Ecol. Prog. Ser.*

Walleye Pollock Growth in the Gulf of Alaska- RACE Recruitment Processes

We quantified the growing season of yearling walleye pollock (*Theragra chalcogramma*) and related it to annual cycles of water temperature and day length. The study was restricted to members of the 2000 year class and thereby controlled for interannual variability. Fifty percent of juveniles exhibited an annulus on 16 March 2001 (± 11 days 95% confidence interval). No regional difference was detected in the timing of annulus formation or in post-annulus growth trajectories. A model, derived from growth trajectories, estimated that the growing season lasted 204 days (22 March to 13 October 2001) and that growth rate peaked at 0.59 mm day^{-1} on 2 July 2001. Growth rate increased with day length and water temperature during spring and decreased in late summer possibly due to thermal stress. Secondarily, we explored the utility of otolith size at the first annulus as a natural tag to identify nursery area, but this potential was curtailed by overlap in length among regions. Our results indicate that the first annulus can be used to advance our understanding of climate forcing on marine fish growth by providing fine temporal resolution of the growing season. See Wilson, et al. (2011b).

Examining Genetic Stock Structure of Walleye Pollock in the NE Pacific-RACE Recruitment Processes

A survey of amplified fragment length polymorphism (AFLP) was conducted o assess the extent of selective mortality during early larval stages. Comparing a cold year (1995) and a warm year (1993), we investigated changes in allele frequencies at 361 loci from two temporal samples collected from a single cohort in the EBS. Levels of genetic differentiation were relatively high, especially in 1995. Permutation tests indicated 24 loci with differentiation higher than expected by chance in 1993, and 125 loci in 1995. The study demonstrated the value of using genetic markers potentially influenced by natural selection (as opposed to neutral genetic markers) for identifying the extent of spatial and temporal variation in natural populations.

Reference: Hauser, L., Bailey, K.M., Canino, M.F., Jimenez-Hidalgo, I. 2009. Adaptation to a changing world: molecular evidence for selective mortality in walleye pollock. North Pacific Research Board Final Report 610.

Walleye Pollock Feeding Ecology- RACE Recruitment Processes

We examined stomach contents of juvenile walleye pollock (*Theragra chalcogramma*) to explain previously observed seasonal and regional variation in body condition. Mean stomach content weight (SCW, 0.72% somatic body weight) decreased with fish body length except from winter to summer 2001. Euphausiids composed 61% of SCW and were the main determinant of seasonal change in the diets of fish in the Kodiak and Semidi regions. Before and during winter, SCW and the euphausiid dietary component were highest in the Kodiak region. Bioenergetics modeling indicated a relatively high growth rate for Kodiak juveniles during winter (0.33 mm standard length/d). After winter, Shumagin juveniles had relatively high SCW and, unlike the Kodiak and Semidi juveniles, exhibited no reduction in the euphausiid dietary component. These patterns explain previous seasonal and regional differences in body condition. We hypothesize that high-quality feeding locations (and perhaps nursery areas) shift seasonally in response to the availability of euphausiids. See Wilson et al. (2011a).

b. Stock Assessment

GULF OF ALASKA

The 2012 Shelikof Strait acoustic survey biomass estimate declined 22% from the 2010 estimate (no survey was conducted in 2011). In contrast, the ADF&G crab/groundfish survey biomass estimate increased by 71% from the 2011 estimate. The NMFS multi-species groundfish survey was not conducted in 2012.

The age-structured model developed using AD Model Builder and used for GOA W/C/WYK pollock assessment remains similar to the model used for assessments in 1999-2011. A number of changes were considered based on recommendations of the July 2012 Center for Independent Experts (CIE) review. This assessment implemented CIE recommendations that could be easily accommodated within the existing model framework. Future assessments will explore CIE recommendations that require methodological development and substantial analysis. This year, the following changes were implemented: 1) the model includes ages 1-10 rather than ages 2-10 as in previous assessments; 2) a “plus-group” age was added to initial age composition and stronger equilibrium assumptions were used to initialize the model; 3) mean unbiased log-normal likelihoods are used for survey biomass indices; 4) the historical trawl data (pre-1984) was removed from the model; 5) six selectivity blocks were used for fishery selectivity rather than allowing selectivity parameters to vary annually with a random walk; 6) reduced weights (input sample sizes) were used for the fishery age composition data; and finally, 7) the model begins in 1964 rather than 1961. For comparison, two alternative models were also presented: 1) a model with the configuration from 2012, and 2) a model where NMFS trawl survey catchability was estimated using a prior. The performance of the new model was comparable to the model with the 2012 configuration. The Plan Team agreed with the authors that the new model was preferred since it performed well and incorporated a number of improvements over the 2012 configuration.

This year’s pollock chapter features the following new data: 1) 2011 total catch and catch at age from the fishery, 2) 2011 age composition from the NMFS bottom trawl survey, 3) 2012 biomass and length composition from the ADF&G crab/groundfish trawl survey. In addition to the historical trawl data (pre-1984), the egg production index from 1981 to 1992 was also removed. Model fits to fishery age composition data are adequate in most years. The largest residuals tended to be at ages 1-2 for the Shelikof Strait acoustic survey and the NMFS bottom trawl survey due to inconsistencies between the initial estimates of abundance and subsequent information about year class size. Model fits to survey time series are similar to previous assessments, and general trends are fit reasonably well. The discrepancy between the NMFS trawl survey and the Shelikof Strait acoustic survey biomass estimates in the 1980s accounts for the poor model fit to both time series during those years. All survey time series are consistent in showing an increase since 2007, but the magnitude is not the same for all time series. The ADF&G survey shows the strongest increase since 2007 and the Shelikof Strait acoustic survey shows the weakest increase. Therefore, the model fit represents a compromise between different survey trends.

The estimated abundance of mature fish in 2013 is projected to be nearly the same as in 2012, and is projected to decrease gradually over the next five years. The model estimate of spawning biomass in 2013 is 259,843 t, which is 35.1% of unfished spawning biomass (based on average post-1977 recruitment). The B40% estimate is 297,000 t. This represents a 9% increase from the 2011 assessment, which is due to an increase in mean recruitment, and an increase in mean weight at age. The Gulf of Alaska pollock is not being subjected to overfishing and is neither overfished nor approaching an overfished condition.

The Plan Team concurred with the author's recommendation to use the new model projection and the more conservative adjusted F40% harvest rate. Because model estimated 2012 female spawning biomass is below B40%, the W/C/WYK Gulf of Alaska pollock stock is in Tier 3b. The Plan Team accepted the author's recommendation to reduce F*ABC* from the maximum permissible using the "constant buffer" approach (first accepted in the 2001 GOA pollock assessment). The projected 2013 age-3+ biomass estimate is 981,791 t (for the W/C/WYK areas). Markov Chain Monte Carlo analysis indicated the probability of the stock being below B20% will be negligible in the next 5 years. An exempted fishing permit (EFP) has been proposed to evaluate the effect of salmon excluder devices in the pollock fishery. Based on the Plan Team recommendation, the assessment author provided the ABC and OFL values which accounted for estimated EFP catches by removing them from the population at the start of year in 2013 and 2014.

Therefore, the ABC for 2013 is based on the recommended model configuration, adjusted harvest control rule, and accounting for the EFP is 113,099 t (FABC = 0.15) for GOA waters west of 140°W longitude. **The ABC is 110,272 t for 2013** (reduced by 2,827 t which is 2.5% of the ABC to account for the Prince William Sound GHL). The 2013 OFL under Tier 3b is 150,817 t (*FOFL*= 0.20). In 2014, the recommended ABC and OFL values are 103,339 t (reduced by 2,583 t to account for the Prince William Sound GHL) and 138,610 t, respectively.

The Southeast Alaska pollock component (East Yakutat and Southeast areas) is in Tier 5 and the ABC and OFL recommendations are based on natural mortality (0.30) and the biomass from the 2011 NMFS bottom trawl survey (47,885 t). This results in a **2013 ABC of 10,774 t**, and a **2013 OFL of 14,366 t**. Recommendations for 2014 are the same as 2013.

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

EASTERN BERING SEA

There were no changes in the assessment model for the 2012 assessment. Spawning biomass in 2008 was at the lowest level since 1980, but has since increased by 44 percent, with a further increase projected for next year. The 2008 low was the result of extremely poor recruitments from the 2002-2005 year classes. Recent and projected increases are fueled by strong recruitments from the 2006 and 2008 year classes along with reductions in catch from 2008-2010 to well below the historical average. Spawning biomass is projected to be 22 percent and 19 percent above BMSY in 2013 and 2014, respectively.

The SSC determined that EBS pollock qualify for management under Tier 1 because there are reliable estimates of BMSY and the probability density function for FMSY. Both the Plan Team and the author conclude that the Tier 1 reference points are reliably estimated. The updated estimate of BMSY from the present assessment is 2.11 million t, up 4 percent from last year's estimate of 2.03 million t. Projected spawning biomass for 2013 is 2.58 million t, placing EBS walleye pollock in sub-tier "a" 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 0.491, down 8 percent from last year's value of 0.533. The harvest ratio of 0.491 is multiplied by the geometric mean of the projected fishable biomass for 2013 (4.69 million t) to obtain the maximum permissible ABC for 2013, which is 2.31 million t, up 5 percent and down 9 percent from the maximum permissible ABCs for 2012 and 2013 projected in last year's assessment.

However, as with other recent EBS pollock assessments, the authors recommend setting ABCs well below the maximum permissible levels. They list 10 reasons for doing so in the SAFE chapter.

To aid in identifying a set of recommended ABC values, the authors provided a "decision table" showing, in probabilistic terms, the outcomes of seven short-term harvest policies with respect to 12 decision metrics, including various measures related to spawning biomass, population age structure, fishing effort and mortality, and Chinook salmon bycatch.

After considering the results shown in the decision table, the authors recommend setting 2013 ABC at 1.2 million t and 2014 ABC at 1.547 million t. This recommendation results primarily from a harvest policy of achieving a 50% (approximate) probability that spawning biomass will return to the long-term average in five years. The authors' recommended 2013 ABC is almost identical to the 2012 ABC. The 2012 ABC was based on a policy of keeping fishing mortality constant at the most recent 5-year average.

The Team agreed that the authors had provided compelling reasons to set the 2013-2014 ABCs below the maximum permissible levels. In particular: 1) the decision table shows that catches even at a 2 million t level (well below the maximum permissible ABC) would result in a significant probability of exceeding FMSY; 2) the estimated strength of the 2006 year class is reduced in the current assessment (although it is still estimated to be well above average), thereby increasing the extent to which the stock and fishery are dependent on a single year class (2008); 3) the CV of the very strong 2008 year class is large relative to earlier year classes; and 4) past experience indicates that model estimates of recent year classes tend to decrease over time.

However, the Team was not prepared to adopt the authors' recommended policy of basing ABC on the probability of spawning biomass equaling the long-term average in five years. While such a policy would result in reasonable ABCs for 2013-2014, the Team was concerned that the policy might not be robust in the long term. Instead, the Team recommends retaining the current policy of keeping fishing mortality constant at the most recent 5-year average (0.38). This policy results in ABCs of 1.375 million t for 2013 and 1.430 million t for 2014. The OFL harvest ratio under Tier 1a is 0.543, the arithmetic mean of the ratio between MSY and the equilibrium fishable biomass corresponding to MSY. The product of this ratio and the geometric mean of the projected fishable biomass for 2013 gives the OFL for 2013, which is 2.55 million t. The current projection for OFL in 2014 given a 2013 catch equal to the Team's recommended ABC is 2.73 million t. The walleye pollock stock in the EBS is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

ALEUTIAN ISLANDS

The new data in the model consist of updated catch information from 1978 through 2012 and inclusion of the 2012 Aleutian Islands bottom trawl survey. There were no changes in the assessment methodology. This year's model estimate of natural mortality was 0.18, down from 0.19 last year.

The stock assessment model estimates that spawning biomass reached a minimum level of about B23% in 1999 and then has generally increased to about B34% at present. The increase in spawning biomass since 1999 has resulted more from a large decrease in harvest than from good recruitment, as there have been no above-average year classes spawned since 1989. Spawning biomass for 2013 is projected to be 85,200 t.

The SSC has determined that this stock qualifies for management under Tier 3. The model estimates B40% at a value of 99,800 t, placing the AI pollock stock in sub-tier "b" of Tier 3. The model estimates the values of F35% as 0.42 and F40% as 0.33. Under Tier 3b, with the adjusted value of F40%=0.27, the maximum permissible ABC is 37,300 t for 2013. The Plan Team recommends setting 2013 ABC at this level. Following the Tier 3b formula with the adjusted value of F35%=0.34, OFL for 2013 is 45,600 t. Given a 2013 catch of 19,000 t, the maximum permissible ABC would be 33,800 for 2014 and the projected OFL would be 41,400 t. If the 2013 catch is only 1,610 t (i.e., equal to the five year average), the 2014 maximum permissible ABC would be 39,800 t and the 2014 OFL would be 48,600 t. The walleye pollock stock in the Aleutian Islands is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

BOGOSLOF DISTRICT

The 2012 Bogoslof pollock acoustic-trawl survey resulted in the lowest estimate of biomass (67,100 t) in the region since the survey began in 1988. Survey biomass estimates since 2000 have all been lower than estimates prior to 2000, ranging from a low of 67,100 t in 2012 to a high of 301,000 t in 2000. The SSC has determined that this stock qualifies for management under Tier 5. The maximum permissible ABC value for 2013 would be 10,100 t (assuming M = 0.2 and FABC = 0.75 x M = 0.15): ABC = B2012 x M x 0.75 = 67,100 x 0.2 x 0.75 = 10,100 t. The projected ABC for 2014 is the same. Following the Tier 5 formula with M=0.20, OFL for 2013 is 13,400 t. The OFL for 2014 is the same.

The walleye pollock stock in the Bogoslof district is not being subjected to overfishing. It is not possible to determine whether this stock is overfished or whether it is approaching an overfished condition because it is managed under Tier 5.

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

3. Dusky Rockfish

a. Stock Assessment-Gulf of Alaska

Dusky rockfish, *Sebastes variabilis*, have one of the most northerly distributions of all rockfish species in the Pacific. They range from southern British Columbia north to the Bering Sea and west to Hokkaido Is., Japan, but appear to be abundant only in the Gulf of Alaska (GOA).

In 2012, dusky rockfish were assessed for the first time as a stand-alone species; widow and yellowtail rockfish are now included in the Other Rockfish stock assessment. This change in management is partially justified because dusky rockfish has a large biomass in the GOA and supports a valuable directed fishery, especially in the central GOA. In contrast, yellowtail and widow rockfish have a relatively low abundance in the GOA, are only taken commercially in very small amounts as bycatch, and do not commonly co-occur with dusky rockfish.

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 2012, an executive summary assessment was produced as there was no new trawl survey information available. For dusky rockfish, which are assessed using a single-species age-structured model, we run only the projection model with updated catch to determine ABC and the overfishing level (OFL).

For the 2013 GOA fishery, a maximum allowable ABC for dusky rockfish was set at 4,700 t. This ABC is a slight decrease of 62 t from the 2011 ABC. The stock is not overfished, nor is it approaching overfishing status. For more information, contact Chris Lunsford, ABL, at (907) 789-6008 or chris.lunsford@noaa.gov.

4. Slope Rockfish

a. Research

Recompression Experiments on Rougheye Rockfish with Barotrauma - ABL

Because rockfish (*Sebastes* spp.) are physoclystic, i.e. their gas bladders are closed off from the gut, they often suffer internal barotrauma injuries from rapid air expansion in their tissues when brought up from depth. Many rockfish released at the surface do not survive either because they cannot submerge due to excessive buoyancy or because of internal damage. There is some evidence that recompression may greatly increase the survival of barotrauma-injured rockfish. However, survival can be species specific therefore it is important to gauge the impacts on each species of interest. Research completed from 2010-2012 demonstrated that rougheye rockfish (*S. aleutianus*) and blackspotted rockfish (*S. melanostictus*), caught at depths from 500 to 900 feet and exhibiting barotrauma, can survive if recompressed after capture. This result is noteworthy because it is the deepest known successful capture and recompression of any rockfish species, which suggests there's potential to conduct scientific tagging studies to track movements and behavior of deepwater rockfish species.

All fish brought to the surface exhibited external some signs of barotrauma including exophthalmia ("pop-eye"), an everted esophagus, and ocular emphysema (air bubble under the cornea). In 2011 and 2012, we tagged and released 130 fish at ~200ft and 46 others were recompressed in portable pressure tanks and slowly brought back to surface pressure. All but one fish were brought to surface pressure over ~48 hours. Using a 48 hour schedule, no fish larger than 54 cm survived. One large fish was given ~96 hours in the tanks and survived with the longer depressurization schedule. After re-pressurization in the tanks, fish no longer had exophthalmia or an everted esophagus. In many cases, ocular emphysema also disappeared. Of the 46 fish, 23 survived long-term and were monitored in the laboratory through January 2013.

In January 2013, 21 of the 23 surviving fish were sacrificed. Eyes and internal organs were observed for signs of previous barotrauma. In addition, gonads were sampled for histological slide preparations to examine maturation. Slides are still being prepared, but to the naked eye gonads did not appear to be maturing, even though we would expect gonads to be maturing and enlarging in preparation for spawning in January. Many fish had repaired swim-bladders that were holding air (Figure 1). Two of the larger surviving fish (54 and 65 cm) were fitted with non-functional satellite tags and held in the laboratory to determine if larger rougheye rockfish could tolerate these tags. After a duration of two months, both fish survived and were negatively buoyant (Figure 2). One was sacrificed in March and the other is being displayed in an aquarium.

In 2013, no sampling will be done due to a lack of Auke Bay Laboratory funding. We had proposed to sample in the same area that was sampled in 2011 and 2012 to look for tagged fish and to deploy satellite tags. The goals of both objectives were to determine if released fish can survive being caught, tagged, and returned to depth. It may still be possible to capture rougheye rockfish locally with electric reels and deploy up to four satellite tags during the summer of 2013. For more information, contact Cara Rodgveller at (907) 789-6052 or cara.rodgveller@noaa.gov.

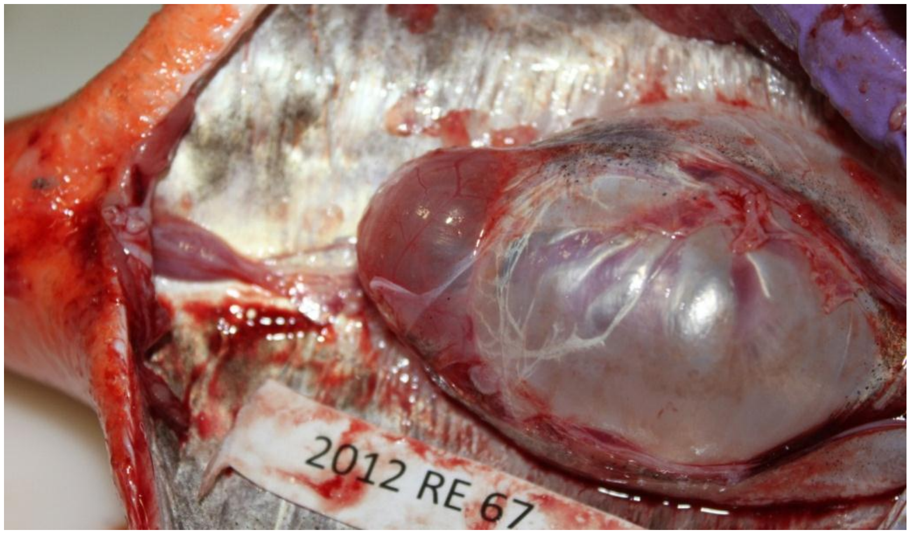


Figure 1. Photograph of an inflated rougheye rockfish swim bladder after capture, repressurization, and holding in the laboratory for 1.5 years. Note the herniated red area on the left side of the swim bladder, which is likely a healed barotrauma.

Figure 2. Rougheye rockfish that has been caught, repressurized, held in the laboratory for 1.5 years, and fitted with a satellite tag.

Predicting the Abundance and Distribution of Pacific Ocean Perch in the Aleutian Islands-RACE GAP

Work was continued examining which habitat characteristics best predict the abundance of POP in the Aleutian Islands. POP have been observed living in association with a variety of epibenthic invertebrates during juvenile and adult life stages, and adult POP have been observed schooling over sea whip forests, and juvenile abundance has been correlated to total sponge and coral biomass. We used generalized additive models (GAMs) to predict juvenile and adult *S. alutus* distribution and conditional abundance in Aleutian Islands bottom trawl surveys from both the occurrence of biogenic structures (i.e., sponges, corals, and bryozoans) and selected environmental parameters (e.g., depth, temperature, local slope, and tidal velocity). For our analyses, we separated sponges into distinct morphological groups using gross shapes like vase, fan, or ball.

Based on the six surveys conducted between 1997 and 2010, GAMs explained 25-28% of the observed deviance in juvenile and adult distribution and 40-44% of the deviance in conditional abundance. The GAMs predicted increased probability of encountering *S. alutus* as well as increasing abundance over the study period consistent with the increasing biomass trend observed for *S. alutus* in the Aleutian Islands since 1997; the greatest predicted increases were in the major Aleutian passes. Our results indicate that the probability of encountering both adult and juvenile *S. alutus* increased in the presence of fan and ball shaped sponges over moderate slopes within life-stage-specific depth ranges and decreased in the presence of strong currents. Longitude and depth had the greatest explanatory power in the GAMs, but combinations of epibenthic invertebrates, sponge morpho-groups, local slope, and tidal current also contributed significantly to predictions of *S. alutus* distribution and conditional abundance. Among other findings, this research suggests that some types of upright sponges and epibenthic invertebrates likely support higher abundances of *S. alutus* juveniles and adults, possibly indicating that these structures provide a form of refuge for this species. For further information contact Ned Laman (Ned.Laman@noaa.gov).

<u>Rockfish Reproductive Studies-RACE Kodiak Lab</u>

RACE groundfish scientists initiated a multi-species rockfish reproductive study in the Gulf of Alaska with the objective of providing more accurate life history parameters to be utilized in stock assessment models. There is a need for more detailed assessment of the reproductive biology of most commercially important rockfish species including: Pacific ocean perch, *Sebastes alutus,* the rougheye rockfish complex (rougheye and blackspotted rockfish, *S. aleutianus* and *S. melanostictus*), shortraker rockfish, *S. borealis* and other members of the slope complex. The analysis of maturity for the deeper water rockfish species has been complicated by the presence of a significant number of mature females that skip spawning. The results for Pacific ocean perch and preliminary results for rougheye rockfish are presented below. During the upcoming year, analyses of rougheye, blackspotted, and shortraker rockfish will be completed.

<u>Pacific ocean perch</u>

Despite the ecological and economic importance of rockfish fisheries in Alaska waters, little information is available concerning the reproductive biology of the majority of federally managed rockfish species in the Gulf of Alaska. This study re-examines the reproductive biology of Pacific ocean perch, *Sebastes alutus*, within the Gulf of Alaska utilizing histological techniques to microscopically examine ovarian tissue. Pacific ocean perch samples were obtained throughout the year during National Marine Fisheries Service and Alaska Department of Fish and Game scientific surveys, from the Fisheries Monitoring and Analysis Division, and from scientific charters. Pacific ocean perch ovaries began to ripen during the month of August with yolk increasing until February. Embryos appeared within the ovaries during February and continued to grow and develop until May when parturition occurred. Results from this study indicate the length at 50% maturity is 33.4 cm FL and age at 50% maturity is 8.4 years. Both of these values are smaller than those currently utilized in the stock assessment of Gulf of Alaska Pacific ocean perch. Results from this study will improve the stock assessment of this species by providing more accurate reproductive parameter estimates and reducing the uncertainty in length and age at maturity estimates.

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

<u>Rougheye rockfish</u>
The recent discovery that rougheye rockfish are two species, now distinguished as 'true' rougheye rockfish, *Sebastes aleutianus*, and blackspotted rockfish, *Sebastes melanostictus* further accents the need for updated reproductive parameter estimates for the members of this species complex. Current estimates for age and length at maturity for this complex in the GOA are derived from a study with small sample sizes, few samples from the GOA, and an unknown mixture of the two species in the complex. A critical step in improving the management of this complex is to understand the reproductive biology of the individual species that comprise it, as it is unknown if they have different life history parameters. This study re-examines the reproductive biology of one of these species, *S. aleutianus,* within the GOA utilizing histological techniques to microscopically examine ovarian tissue. Maturity analyses for this species and other deepwater rockfish species within this region are complicated by the presence of mature females that are skip spawning. Preliminary results from this study indicate age and length at 50% maturity for this species are 15.5 years and 43.9 cm FL with 36.6% of mature females not developing or skip spawning. These updated values for age and length at maturity have important implications for stock assessment in the GOA.

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

<u>Habitat Use and Productivity of Commercially Important Rockfish Species in the Gulf of Alaska-RACE Kodiak</u>
The contribution of specific habitat types to the productivity of many rockfish species within the Gulf of Alaska remains poorly understood. It is generally accepted that rockfish species in this large marine ecosystem tend to have patchy distributions that frequently occur in rocky, hard, or high relief substrate. The presence of biotic cover (coral and/or sponge) may enhance the value of this habitat and may be particularly vulnerable to fishing gear. Previous rockfish habitat research in the Gulf of Alaska has occurred predominantly within the summer months. We propose to examine the productivity of the three most commercially important rockfish in the Gulf of Alaska (Pacific ocean perch, *Sebastes alutus*, northern rockfish, *S. polyspinis*, and dusky rockfish, *S. variabilis*) in three different habitat types. Low relief, high relief rocky/boulder, and high relief sponge/coral habitats in the Albatross Bank region of the Gulf of Alaska will be sampled using both drop camera image analysis and modified bottom trawls. We will sample these habitats examining differences in density, community structure, prey availability, diet diversity, condition, growth, and reproductive success within the different habitat types. This research will enable us to examine the importance of different habitat types for these rockfish species providing data critical for both protecting essential habitat as well as effective management of these species. This research will commence during 2012 and will continue through 2014. For further information, contact Christina Conrath, (907) 481-1732

b. Stock Assessment

Pacific Ocean Perch (POP)

BERING SEA AND ALEUTIAN ISLANDS

Pacific ocean perch (POP) assessments are conducted on a two-year cycle to coincide with planned Aleutian Islands surveys. The 2012 assessment was a full assessment because the Aleutian Islands survey was conducted in 2012.

New data in the 2012 assessment included:

- The harvest time series was updated.
- The 2012 AI survey biomass estimate and length composition.
- The 2009 and 2011 fishery age compositions.
- The 2010 fishery length composition.
- The maturity curve was estimated based on recent data from the Aleutian Islands.
- The biased fishery ages from 1977-1980 were removed from the model and replaced with fishery lengths. The original age-reading data required to re-compute the biased age matrix with a different plus group was not readily available to the authors at the time of the assessment.

Several changes were made to the assessment methodology:

- A sensitivity analysis was conducted to evaluate how the age plus group affects the fit to various model components. Based on this analysis, the age plus group was increased from 25 years to 40 years
- The age error matrix was recomputed to better account for aging error within the plus group.

The survey biomass estimates in the Aleutian Islands and the Bering Sea Slope both were high in 2012. Estimated age 3+ biomass for 2013 was up substantially from the 2013 estimate projected a year ago. Spawning biomass is projected to be 274,000 t in 2013 and decline slightly to 258,000 t in 2014.

The SSC has determined that reliable estimates of *B40%*, *F40%*, and *F35%* exist for this stock, thereby qualifying Pacific ocean perch for management under Tier 3. The current estimates of *B40%*, *F40%*, and *F35%* are 184,000 t, 0.063, and 0.076 respectively. Spawning biomass for 2013 (274,000 t) is projected to exceed *B40%*, thereby placing POP in sub-tier “a” of Tier 3. The 2013 and 2014 catches associated with the *F40%* level of 0.063 are 35,100 t and 33,100 t, respectively. In 2010, the Plan Team recommended an adjusted ABC approach until the next Aleutian Islands survey. The 2012 AI survey was nearly as large as the 2010 survey so now the Plan Team endorses using maximum permissible ABC. The 2013 and 2014 OFLs are 41,900 t and 39,500 t.

The Team agrees with the author’s recommendation that ABCs be set regionally based on the proportions in combined survey biomass as follows (values are for 2013): BS = 8,130 t, Eastern Aleutians (Area 541) = 9,790 t, Central Aleutians (Area 542) = 6,980 t, and Western Aleutians (Area 543) = 10,200 t. The recommended OFL is not regionally apportioned. Pacific ocean perch is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

GULF OF ALASKA - REFM

Rockfish are assessed on a biennial stock assessment schedule to coincide with the availability of new survey data. For Gulf of Alaska rockfish in alternate (even) years, an executive summary is presented to recommend harvest levels for the next two years. Please refer to last year's full stock assessment report for further information regarding the assessment model which is summarized below from last year's assessment.

The trawl survey biomass estimate for 2011 was higher than the 2009 estimate (with much variability) but was at about the mean of the past decade. The 2012 assessment model estimate of female spawning biomass estimate (107,769 t) is above $B_{40\%}$ (93,876 t) and projected to be stable through 2013. Recruitment as measured by age 2 fish is highly variable and large recruitments comprise much of the biomass for future years. Recruitment appears to have increased since the early 1970s, with the 1986 year class remaining the highest in the time series.

Pacific ocean perch are determined to be in Tier 3a. The F_{OFL} is set at $F_{35\%}$ (0.138) and gives an OFL of 19,498 t. The Team accepted the author recommended model resulting in an estimated ABC of 16,918 t (with $F_{ABC}=F_{40\%}$ of 0.119). The stock is not overfished, nor is it approaching an overfished condition. The stock was not subjected to overfishing in 2010.

The four age-structured models for rockfish in the GOA rely on age compositions instead of bottom trawl survey length compositions. Based on Team comments at the August 2011 meeting, the authors presented an analysis that examined the effect of including length compositions for the current survey year, when age compositions are pending, then removing them when they become available. Model runs for the last four full assessment years (2005, 2007, 2009, and 2011) were compared for POP, dusky and northern rockfish. The results were inconclusive as to whether including length compositions increased or decreased variability in estimates of ABC and recruitment and varied by species.

Apportionment of the ABCs and OFLs is based on a weighted average of the percent distribution of biomass for each area using the three most recent trawl survey estimates (from 2007, 2009, and 2011). Each successive survey is given a progressively heavier weighting using factors of 4, 6, and 9, respectively. The revised apportionment values are: Western area, 12.4%; Central area, 66.6%; and Eastern area, 21.0%. Amendment 41 prohibited trawling in the Eastern area east of 140_{o} W longitude. Since Pacific ocean perch are caught exclusively with trawl gear, there is concern that the entire Eastern area TAC could be taken in the area that remains open to trawling (between 140_{o} and 147_{o} W longitude). Thus, as was done for the last four years, the Team recommends that a separate ABC be set for Pacific ocean perch in WYAK. The ratio of biomass still obtainable in the W. Yakutat area (between 140° W and 147° W) is lower than last year at 0.48. This corresponds to a 2012 ABC of 1,692 t for WYAK. Under this apportionment strategy, very little of the 1,861 t assigned to the remaining Eastern area (East Yakutat/Southeast Outside area) will be harvested.

GULF OF ALASKA - ABL

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 2012's assessment for the 2013 fishery) when there is only new catch information, we run only the projection model with updated catch data for single-species, age-structured assessments. For the 2013 fishery, we recommended the maximum allowable ABC of 16,500 t which was a slight decrease from last year's ABC of 16,918 t. The stock is not overfished, nor is it approaching overfishing status.

For more information, contact Dana Hanselman at (907) 789-6626 or dana.hanselman@noaa.gov.

Northern Rockfish (BSAI)-REFM

Northern rockfish assessments are conducted on a two-year cycle to coincide with planned Aleutian Islands surveys. The 2012 assessment was a full assessment because the Aleutian Islands survey was conducted in 2012.

New data included in the 2012 assessment included:

- Catch updated through October 6, 2012.
- The biomass estimate and length composition from the 2012 AI survey.
- The 2008, 2009, and 2011 fishery age compositions and the 2010 fishery length composition.
- The maturity curve was estimated based on recent data from the Aleutian Islands.

Several changes were made to the assessment methodology:

- A sensitivity analysis was conducted to evaluate how the age and length plus groups affect the fit to various model components. Based on this analysis, the age and length plus groups were increased to 40 years and 38 cm (previous values were 23 years and 34 cm).
- The age error matrix was recomputed to better account for aging error within the plus group.

Age 3+ biomass has been on an upward trend since 2002 for this stock. Spawning biomass has been increasing slowly and almost continuously since 1977. Female spawning biomass is projected to be 84,700 t in 2013. This value is well-above the Tier 3 B40% of 59,200 t. The SSC has determined that this stock qualifies for management under Tier 3 due to the availability of reliable estimates for *B40%* (59,200 t), *F40%* (0.063), and *F35%* (0.079). Because the female spawning biomass is greater than *B40%*, sub-tier "a" is applicable, with maximum permissible *FABC* = *F40%* and *FOFL* = *F35%*. Under Tier 3a, the maximum permissible ABC for 2013 is 9,850 t, which is the authors' recommendation for the 2013 ABC. Under Tier 3a, the 2013 OFL is 12,200 t for the Bering Sea/Aleutian Islands combined. The Plan Team continued to recommend setting a combined BSAI OFL and ABC. The Plan Team recommendation for 2014

ABC is 9,320 t and the 2014 OFL is 12,000 t. Northern rockfish is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

GULF OF ALASKA – ABL CONTRIBUTION

The northern rockfish, *Sebastes polyspinis*, is a locally abundant and commercially valuable member of its genus in Alaskan waters. As implied by its common name, northern rockfish has one of the most northerly distributions among the 60+ species of *Sebastes* in the North Pacific Ocean. Since 2005, Gulf of Alaska (GOA) rockfish have been moved to a biennial stock assessment schedule to coincide with the AFSC trawl survey. An age-structured assessment (ASA) model is used to assess northern rockfish in the GOA; the data used in the ASA model includes the trawl survey index of abundance, trawl survey age and length composition, fishery catch biomass, and fishery age and length composition. Updated catch data is the only data available in even years, while in odd years a full assessment is run that includes both updated survey and catch data since the last full assessment. In 2012 updated catch data was used in the projection model to determine ABC. The result was a recommended ABC for 2013 of 5,132 t; this ABC was 7% lower than the 2012 ABC of 5,509 t. The GOA northern rockfish stock is not subjected to overfishing, is not currently overfished, and is not approaching a condition of overfishing. For more information contact Pete Hulson, ABL, at (907) 789-6060 or pete.hulson@noaa.gov.

<u>Shortraker Rockfish (BSAI)-REFM</u>

Shortraker rockfish assessments are conducted on a two-year cycle to coincide with planned Aleutian Islands surveys. For 2012, the biomass estimate was updated with 2012 survey data. Estimated shortraker rockfish biomass is 16,400 t, which is a reduction of 1,100 t from the 2010 estimate. Overall, total biomass has trended slowly downward from 28,900 t in 1980.

The SSC has previously determined that reliable estimates only of biomass and natural mortality exist for shortraker rockfish, qualifying the species for management under Tier 5. The Tier 5 biomass estimate is based on a surplus production model . The assessment author recommendEd setting *FABC* at the maximum permissible level under Tier 5, which is 75 percent of *M*. The accepted value of *M* for this stock is 0.03 for shortraker rockfish, resulting in a *maxFABC* value of 0.025. The biomass estimate for 2013 is 16,400 t for shortraker rockfish, leading to 2013 and 2014 BSAI OFLs of 493 t and ABCs of 370 t. Shortraker rockfish is not being subjected to overfishing. It is not possible to determine whether this stock is overfished or whether it is approaching an overfished condition because it is managed under Tier 5.

<u>Shortraker Rockfish-Gulf of Alaska-ABL Contribution</u>

Rockfish in the Gulf of Alaska (GOA) are assessed on a biennial assessment schedule to coincide with new data from the AFSC biennial trawl surveys in the GOA. A straightforward update of the assessment was presented in an executive summary because the GOA survey was not conducted in 2012. Catch data were updated.

Shortraker rockfish has always been classified into “tier 5” in the North Pacific Fishery Management Council’s (NPFMC) definitions for ABC and overfishing level, in which the assessment is mostly based on averaging the exploitable biomass from the three most recent trawl surveys (presently the 2007, 2009, and 2011) to determine the recommended ABC. For an off-cycle year, there is no new survey information for shortraker rockfish; therefore, the 2011 estimates are rolled over. Estimated shortraker biomass is 48,048 mt, which is identical to the 2011 assessment biomass estimate. The NPFMC's "tier 5" ABC definitions state that F_{ABC} $\leq 0.75M$, where M is the natural mortality rate. Using an M of 0.03 and applying this definition to the exploitable biomass of shortraker rockfish results in a recommended ABC of 1,081 t for the 2013 fishery. Gulfwide catch of shortraker rockfish was 546 t in 2011 and estimated at 592 t in 2012. Shortraker rockfish in the GOA is not being subjected to overfishing, nor is it approaching overfishing status.

For more information, please contact Katy Echave at (907) 789-6006 or katy.echave@noaa.gov.

Blackspotted/rougheye rockfish complex- BSAI-REFM

Blackspotted and rougheye rockfish assessments are conducted on a two-year cycle to coincide with planned Aleutian Islands surveys, thus, a full-assessment update from 2010 was conducted utilizing the 2012 survey results.

The following input data were updated for this assessment:

- Catch updated through October 6, 2012.
- The biomass estimate from the 2012 AI survey.
- The 2009 and 2011 fishery age composition and 2010 fishery length composition.
- The 2010 survey age composition and 2012 survey length composition.

The age error matrix was also recomputed to better account for aging error within the plus group.

Model estimates of total biomass for 2013 were estimated at 28,000 t and the female spawning biomass in the AI has increased based on the survey data. For the Aleutian Islands, this stock qualifies for management under Tier 3 due to the availability of reliable estimates for *B40%*, *F40%*, and *F35%*. Because the projected female spawning biomass of 6,836 t is greater than *B40%*, (5,196 t), *F40%= FABC* = 0.035 and *F35% = FOFL* = 0.043. Under Tier 3a, the maximum permissible ABC is 569 t, which is the authors' and Plan Team's recommendation for the 2013 ABC. Under Tier 3a, the 2013 OFL is 691 t for the Bering Sea/Aleutian Islands combined. The apportionment of 2013 ABC to subareas is 328 t for the Western and Central Aleutian Islands and 241 t for the Eastern Aleutian Islands and Eastern Bering Sea. The harvest recommendations for 2014 ABC are 604 t and the 2014 OFL is 704 t. The blackspotted and rougheye rockfish complex is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

GULF OF ALASKA – ABL CONTRIBUTION
Rougheye (*Sebastes aleutianus*) and blackspotted rockfish (*S. melanostictus*) have been assessed as a stock complex since the formal verification of the two species (Orr and Hawkins 2008). We use a statistical age-structured model as the primary assessment tool for the Gulf of Alaska rougheye and blackspotted rockfish (RE/BS) stock complex which qualifies as a Tier 3 stock.

Rockfish are assessed on a biennial stock assessment schedule to coincide with the availability of new survey data. For Gulf of Alaska rockfish in even years, we present an executive summary to recommend harvest levels for the next two years. Additionally, for age-structured models in an off-cycle year, we do not re-run the assessment model, but do update the projection model with new catch information. This incorporates the most current catch information without re-estimating model parameters and biological reference points. For the 2013 fishery, we recommend the maximum allowable ABC of 1,232 t from the updated projection model. This ABC is slightly more than last year's ABC of 1,223 t and slightly less than last year's projected 2013 ABC of 1,240 t. The stock is not overfished, nor is it approaching overfishing status.

For more information, please contact Kalei Shotwell at (907) 789-6056 or kalei.shotwell@noaa.gov.

Other Rockfish Complex-BSAI-REFM

Other rockfish assessments are conducted on a two-year cycle to coincide with planned Aleutian Islands surveys. The 2012 assessment is a full assessment because the Aleutian Islands survey was conducted in year.

New data included in the 2012 assessment included:

- Updated catch and fishery lengths.
- Biomass estimates from the 2012 AI trawl survey, the 2012 EBS slope survey, as well as CPUE and lengths from the 2012 AI trawl survey. Assessment of these species relies on survey biomass alone as information is unavailable to construct a stock assessment model.

There were no changes in the assessment methodology. Trends in spawning biomass are unknown. Stock biomass, as measured by trawl surveys of the Aleutian Islands and the EBS slope are similar to the 2010 assessment.

The author recommended an approach of setting *FABC* at the maximum allowable under Tier 5 (*FABC* = 0.75*M*). Multiplying these rates by the best biomass estimates of shortspine thornyhead and other rockfish species in the "other rockfish" complex yields 2013 and 2014 ABCs of 686 t in the EBS and 473 t in the AI. The assessment uses a three survey weighted average to estimate biomass in similar fashion to the methodology used in the Gulf of Alaska rockfish assessments. The Plan Team recommends that OFL be set for the entire BSAI area, which under Tier 5 is calculated by multiplying the best estimates of total biomass for the area by the separate natural mortality values and adding the results, which yields an OFL of 1,540 t for 2013 and 2014. The "other rockfish" complex is not being subjected to overfishing. It is not possible to determine whether this complex is overfished or whether it is approaching an overfished condition because it is managed under Tier 5.

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

GULF OF ALASKA – ABL CONTRIBUTION

"Other Rockfish" in the Gulf of Alaska (GOA) is a new management category that was implemented by the North Pacific Fishery Management Council (NPFMC) in 2012. The category is comprised of the 15 rockfish species that were previously in the "Other Slope Rockfish" category together with yellowtail and widow rockfish. The latter two species were formerly in the "Pelagic Slope Rockfish" category along with dusky rockfish, but dusky rockfish is now managed as a stand-alone species and the Pelagic Shelf rockfish group has been dissolved. The primary species of "Other Rockfish" in the GOA are sharpchin, harlequin, silvergray, and redstripe rockfish; most of the others are at the northern end of their ranges in Alaska and have a relatively low abundance here. Rockfish in the GOA have been moved to a biennial stock assessment schedule to coincide with data from the AFSC biennial trawl surveys in the GOA. Because these surveys occur in odd years, the last survey was conducted in 2011, and therefore a full assessment for "Other Rockfish" was completed in fall 2011. A survey is scheduled for this summer and a full assessment will be completed in the fall of 2013.

All species in the group have always been classified into "tier 5" or "tier 4" (only sharpchin rockfish is "tier 4") in the NPFMC definitions for ABC and overfishing level, in which the assessment is mostly based on biomass estimates from trawl surveys, instead of modeling. As in previous assessments since 1994, an average of the Gulf-wide biomass from the three most recent trawl surveys (presently the 2007, 2009, and 2011 surveys) is used to determine current exploitable biomass. This results in a current exploitable biomass of 85,774 mt for "Other Rockfish". Applying either an $F_{ABC} \leq F_{40\%}$ rate for sharpchin rockfish or an $F_{ABC} \leq 0.75M$ (M is the natural mortality rate) for the other species to the exploitable biomass for "Other Rockfish" results in a recommended ABC in the GOA of 4,045 mt for 2012. This is an increase of 8% compared to the 2010 and 2011 ABCs of 3,749 mt for "Other Slope Rockfish". The increase is mostly due to the addition of yellowtail rockfish to the group in 2012 and the large biomass of silvergray rockfish in the 2011 trawl survey. Gulfwide catch of "Other Slope Rockfish" was 874 mt in 2011, and estimated catch in 2012 was 1,039 mt. "Other Rockfish" is not considered overfished in the Gulf of Alaska, nor is it approaching overfishing status. However, in 2012, the apportioned ABC for the Central GOA was exceeded and the catch consisted of mostly harlequin rockfish, which is a relatively low abundance species in the area.

Two notable results were seen for "Other Rockfish" in the 2011 GOA trawl survey. First, compared to the 2009 survey, the biomass for silvergray rockfish increased ten-fold to over 100,000 mt. This is by far the largest biomass ever recorded for silvergray rockfish in the GOA, and is also the largest single biomass for any species of "Other Rockfish" in all the GOA trawl surveys. Second, for the third consecutive trawl survey, the biomass of harlequin rockfish was quite low at only ~4,000 mt. This could be a conservation concern because harlequin rockfish have comprised the majority of the commercial catch since 2003. \\

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

Thornyheads

GULF OF ALASKA - REFM

Thornyheads are assessed on a biennial schedule to coincide with the timing of survey data. The last complete assessment was presented in 2011. An executive summary is presented for 2012 with rollover values for 2013 and 2014. The latest full assessment from 2011 is summarized below.

New catch information includes updated 2011 and 2012 catch New assessment information includes updated biomass and length compositions from the 2011 NMFS trawl survey data, total catch for 2010 and partial 2011, and length composition from the 2009, 2010 and 2011 trawl and longline fisheries. Additionally, Relative Population Numbers (RPN's) and weight and size composition from the AFSC 2010 and 2011 longline surveys were included.

The 2011 GOA bottom trawl survey covered depths shallower than 701m (11% of the estimated biomass for thornyheads in 2009 trawl survey occurred in the 701-1000m stratum). The recommended alternative for this year's assessment inflated the 2011 survey estimate to account for the lack of sampling in the 701-1000m depth stratum. Area-specific mean percentages of biomass in the 701-1000 m stratum relative to the other depth strata for the Western, Central, and Eastern GOA from the 2005, 2007, and 2009 trawl surveys were calculated and the 2011 area-specific biomass estimates were increased by these percentages. This modification results in a total estimated biomass of 73,990 t, a 6% decrease from the 2009 total biomass estimate. Most of this decrease was observed in the Western Gulf where there was a 65% decrease, which was a concern highlighted by the plan team. The estimated biomass in the Central and Eastern Gulf were a 20% and 6% increase, respectively.

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

Estimates of spawning biomass are not available for thornyheads which are assessed under Tier 5. Age-structured assessments for this stock is currently hampered by insufficient age data for this species; two recent studies showed widely variable maximum ages of 115 and 150 years, highlighting the difficulty in ageing thornyheads. It is possible that production ageing could occur, but only for individuals younger than 10 years of age. An average natural mortality (M) of 0.03 is used in this assessment as it is currently considered the best estimate based on the age data available.

The authors' recommendation for OFL and ABC for 2012 from the current assessment (where *FABC* =0.0225) is 1,665 t and the OFL (*FOFL* =0.03) is 2,220 t.

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

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

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

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

GULF OF ALASKA – ABL CONTRIBUTION

Thornyheads (*Sebastolobus* species) are assessed as a stock complex under Tier 5 criteria using the assessment methodology introduced in 2003. We use the exploitable biomass from the most recent trawl survey to determine the recommended ABC for thornyheads. This complex is assessed on a biennial stock assessment schedule to coincide with the availability of new survey data. I n this off-cycle year, we present an executive summary to recommend harvest levels for the next two years. For an off-cycle year, there is no new survey information for thornyheads; therefore, the 2011 estimates are rolled over for the next two years. For the 2013 fishery, we recommend the maximum allowable ABC of 1,665 t. Catch levels remain below the TAC and the stock was not being subjected to overfishing last year.

For more information, contact Kalei Shotwell at (907) 789-6056 or kalei.shotwell@noaa.gov.

6. Sablefish

a. Research

The AFSC has conducted an annual longline survey of sablefish and other groundfish in Alaska from 1987 to 2012. The survey is a joint effort involving the AFSC's Auke Bay Laboratories and Resource Assessment and Conservation Engineering (RACE) Division. It replicates as closely as practical the Japan-U.S. cooperative longline survey conducted from 1978 to 1994 and also samples gullies not sampled during the cooperative longline survey. In 2012, the thirty-fourth annual longline survey of the upper continental slope of the Gulf of Alaska and eastern Aleutian Islands was conducted. One hundred-fifty-two longline hauls (sets) were completed during June 1 – August 26, 2012 by the chartered fishing vessel *Alaskan Leader*. Sixteen kilometers of groundline were set each day, containing 7,200 hooks baited with squid.

Sablefish (*Anoplopoma fimbria*) was the most frequently caught species, followed by giant grenadier (*Albatrossia pectoralis*), Pacific cod (*Gadus macrocephalus*), shortspine thornyhead (*Sebastolobus alascanus*), and Pacific halibut (*Hippoglossus stenolepis*). A total of 69,873 sablefish were caught in 2012, representing a substantial decrease of nearly 30,000 sablefish over the 2011 survey catch. Sablefish, shortspine thornyhead, and Greenland turbot (*Reinhardtius* *hippoglossoides*) were tagged with external floy tags and released during the survey. Pop-off satellite tags were externally attached to 45 spiny dogfish and 43 sablefish. Length-weight data and otoliths were collected from 1,992 sablefish. Killer whales *(Orcinus orca)* depredating on the catch occurred at five stations in the eastern Aleutian Islands, and five stations in the western Gulf of Alaska. This represents a slight increase in killer whale interactions in the Aleutian Islands compared to previous years. Sperm whales *(Physeter macrocephalus)* were observed at eighteen stations in 2012 and were reported depredating on the gear at eleven stations which is a decrease in comparison to previous years.

Several special projects were conducted during the 2012 longline survey. Sablefish and spiny dogfish were tagged with satellite pop-up tags throughout the Gulf of Alaska. Additionally, genetic tissue and otoliths of sablefish were sampled to collect a baseline genetic sample collection of sablefish in Alaska. Finally, opportunistic photo identification of both sperm and killer whales were collected for use in whale identification projects.

For more information, contact Chris Lunsford at (907) 789-6008 or chris.lunsford@noaa.gov.

Longline Survey Geographic Area Size Recalculations – Abl

Geographic area sizes (km^2) are used for computing abundance indices for sablefish and other groundfish species caught in the Alaska Fisheries Science Center's annual longline survey. These areas were devised before geographic information systems (GIS) and accurate bathymetric maps were available. In addition, there was poor documentation for how the currently used area measurements were determined. With new technology, area sizes can be defined using GIS to ground truth the area sizes currently being used for computing abundance indices. Additionally, because the survey was originally intended for sablefish, and their habitat is primarily in depths from 200-1,000 m, area sizes were not determined for areas shallower than 200 m. A substantial amount of survey effort is placed in the 151-200 m depth range and several species of interest are commonly caught in these depths. Using ArcView GIS 9.3 and GEBCO_08 bathymetry source, geographic area sizes were recalculated and compared with existing values. In addition, area sizes for shallow stratum, consisting of depths between 151 and 200 m, were created, and documentation was provided for how the currently used area measurements were determined.

Recalculated area sizes compared to those currently used (created by M. Sigler, Auke Bay Lab in 1989) are generally similar in size when looking at comparisons by entire management area, but there are exceptions for specific stratum in some geographic areas. The majority of the strata size estimates for the Shumagin Slope down to 800 m, the Kodiak Slope, the Southeast Outside Slope deeper than 400m, and Region I of the EBS were similar in size to the values currently used. Some substantial differences are in the Gulf of Alaska (GOA) gullies, as boundary lines were sometimes difficult to determine, and past documentation of the creation of gully areas was minimal. These discrepancies could be a result of different bathymetry data being used and differences in the delineation of gully boundary lines. Other large differences are in Region III of the EBS and in the western AI.

Direct comparisons of recalculated area sizes were made with the currently used RACE (Resource Assessment and Conservation Engineering Division) trawl survey area sizes. Differences between the recalculated values for the GOA from this document and the RACE trawl survey values are generally similar across the Western GOA (WGOA) and Central GOA (CGOA), with larger differences occurring in the Eastern GOA (EGOA). The largest differences are seen in the 201-300 m stratum, likely due to differences in gully measurements that would be included in this value. Recalculated area sizes are generally smaller in comparison to RACE trawl survey values.

For more information, contact Katy Echave at (907) 789-6006 or katy.echave@noaa.gov.

Sablefish Tag Program - Abl

The ABL MESA Program continued the processing of sablefish tag recoveries and administration of the tag reward program and Sablefish Tag Database during 2012. Total sablefish tag recoveries for the year were around 666. Twenty six percent of the recovered tags in 2012 were at liberty for over 10 years. About 33 percent of the total 2012 recoveries were recovered within 100 nautical miles (nm; great circle distance) from their release location, 35 percent within 100 – 500 nm, 21 percent within 500 – 1,000 nm, and 11 percent over 1,000 nm from their release location. The tag at liberty, the longest was for approximately 39 years, and the greatest distance traveled of a 2012 recovered sablefish tag was 2,061 nautical miles. Three adult sablefish and one juvenile sablefish tagged with archival tags were recovered in 2012. Data from these electronic archival tags, which will provide information on the depth and temperature experienced by the fish, are still being analyzed.

Tags from shortspine thornyheads, Greenland turbot, Pacific sleeper sharks, lingcod, and spiny dogfish are also maintained in the Sablefish Tag Database. Nine thornyhead and one archival spiny dogfish tag were recovered in 2012.

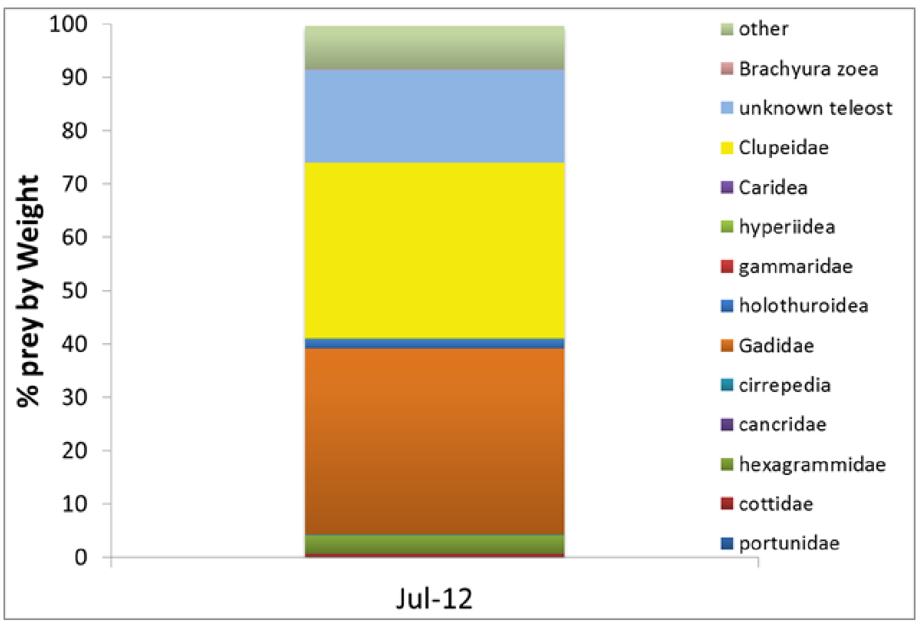
Releases in 2012 totaled 3,041 adult sablefish (including 48 with pop-up satellite tags), 497 juvenile sablefish, 748 shortspine thornyheads, 45 spiny dogfish with pop-up satellite tags, and 6 Greenland turbot. The first extensive tagging of sablefish with pop-up satellite tags was conducted on the AFSC annual longline survey in 2012. Pop-off satellite tags were deployed on 43 sablefish throughout the geographic range of the 2012 AFSC longline survey to study daily and large-scale movements. These tags were programmed to release from the fish 1 January 2013 and 1 February 2013, in hopes of determining spawning locations and ultimately areas which may be used to help assess recruitment. Data from these tags will also provide an improved picture of the daily movements and behavior patterns of sablefish. Approximately half of the tags were successful releasing from the fish on their respective dates, and have been successfully transmitting data via satellite. With just one year of data acquired and still in the early stages of analysis of the data that has been received, it is still too early to determine if there is a directed movement by sablefish for spawning purposes. However, having the release location of the tag and the pop up location (location of the fish when the tag released) has provided great insight into (relatively) short term and winter behavior of sablefish. Movement has ranged from <5 km in the approximate 6 month period to a Gulf crossing from the WGOA to the EGOA. For more information, contact Katy Echave at (907) 789-6006 or Katy.echave@noaa.gov.

Juvenile Sablefish Studies - Abl

Juvenile sablefish studies have been conducted by the Auke Bay Laboratories in Alaska since 1984 and were continued in 2012. A total of 334 juvenile sablefish were caught, and 331 tagged and released in St John Baptist Bay near Sitka, AK over five days (July 12th – July 16th) with 126 rod hrs. Researchers from University of Alaska participated to begin an ecological study of the bay. Gastric lavages were conducted on 302 juvenile sablefish. 58% of these samples had recoverable stomach contents. Total catch-per-unit-effort (CPUE) equaled 2.29 sablefish per rod hour fished. This was down significantly from 2011 (7.63) but higher than the 5-year average. Juvenile sablefish had a mean length of 33 cm fork length (95% CI, 29-36 cm), with one 46 cm fish (presumably a 2 year old). The St. John Baptist Bay juvenile sablefish tagging cruise will be conducted again in 2013 from July 8th-12th.

For more information, contact Dana Hanselman at dana.hanselman@noaa.gov.

Sablefish Maturity Study – Abl and Uaf



Sablefish Archival Tagging Study- Abl

During the 1998, 2000, 2001, and 2002 AFSC longline survey, 600 sablefish were implanted and released with electronic archival tags that recorded depth and temperature. These archival tags provide direct insight into the vertical movements and occupied thermal habitat of a fish. 127 of these tags have been recovered and reported from commercial fishing operations in Alaskan and Canadian waters. Analysis of these data began in 2011 continued in 2012 and 104 of these tags have been analyzed to date. Temporal resolution of depth and temperature data ranged from 15 minutes to one hour, and data streams for an individual fish ranged from less than a month to greater than five years. Sablefish exhibited a wide range of patterns in vertical movements and occurred mostly between 200 m – 800 m depth, though many fish often would spend shorter periods at depths >1000 m. Variability in vertical movement patterns were likely a function of individual variability and location of the fish (though horizontal locations were not recorded by the archival tags). Most fish regularly exhibited diel movement patterns and moved to deeper waters during the winter months, a pattern possibly related to spawning behavior. Sablefish typically occurred in waters between 3°-7° C with most occurring between 4°-6° C. Fish released along the slope of the eastern Bering Sea typically occurred in colder waters than those released along the slope of southeast Alaska. These results are preliminary and further analyses are planned.

For more information, contact Mike Sigler (907) 789-6037 or mike.sigler@noaa.gov.

Sablefish Movement Modeling – Abl

ABL researchers updated the Heifetz and Fujioka (1991) movement model with a data set that included over 300,000 tag releases in Alaska and over 27,000 tag recoveries from 1979-2009. The model included natural and fishing mortality, time-varying tag reporting, and shedding rates. The model was implemented in AD Model Builder and movement parameters were estimated with the negative-binomial likelihood. Parameter uncertainty was estimated with both a normal approximation and Bayesian methods. We estimated total mortality from time at liberty with several traditional methods and a new method. Movement rates were high, with annual movement rates ranging from 3-80% depending on area and size group.

We compared our movement estimates to a previous analysis of data from 1979-1987 (i.e., Heifetz and Fujioka). Unlike the previous study, this study also incorporated tag releases from Southeast Alaska inside waters. Overall, movement rates were still very different between areas and sizes, but were estimated to be higher than the previous study. Most of the change in movement rates was due to using the much larger time series of data and changing to a negative binomial likelihood. The largest relative changes in movement rate were in the Aleutian Islands where the increase in annual movement probability ranged from 48-79%. Large fish showed large increases in annual probability of movement out of the Eastern Gulf of Alaska and Western Gulf of Alaska. Small fish movement out of the Bering Sea increased, while medium and large fish were more likely to stay there. The estimates of directionality of movement have changed since the previous study for small sablefish. In our results, estimated annual movement of small sablefish from the Central Gulf of Alaska had the reverse pattern of the previous study, with 29% moving westward and 39% moving eastward. Most estimates of annual movement rates were reasonably precise, with CVs usually less than 25%. The largest differences in movement rates were caused by the origin of the tag release, not fish size. Our total mortality estimates from time at liberty are similar to the stock assessment.

The results confirm the one-stock hypothesis used in management of the Alaska federal sablefish fishery in the Gulf of Alaska, Aleutian Islands and Bering Sea. The results indicate that sablefish in the state-managed Chatham Strait are part of the greater North Pacific sablefish population, while there is no conclusive evidence that state-managed Clarence Strait is part of the greater North Pacific sablefish population. A Ph.D. student at University of Alaska is completing work previously started at ABL to estimate age-and-sex-based movement with similar models. These results will inform apportionment strategies to maximize spawning biomass and future yields by incorporating these tag recovery and movement data into a fully age-structured spatial stock assessment model.

For more information, contact Dana Hanselman at (907) 789-6626 or at dana.hanselman@noaa.gov

b. Stock Assessment

Bering Sea, Aleutian Islands, and Gulf of Alaska

A full sablefish stock assessment was produced for the 2013 fishery. We added relative abundance and length data from the 2012 AFSC longline survey, relative abundance and length data from the 2011 longline and trawl fisheries, age data from the 2011 longline survey and 2011 longline fishery, updated 2011 catch, and estimated 2012 catch to the assessment model.

The fishery abundance index was flat from 2010 to 2011 (the 2012 data were not available yet). The longline survey abundance index decreased 21% from 2011 to 2012 following an 18% increase from 2008 to 2011. Spawning biomass is projected to decrease from 2013 to 2017, and then stabilize. Sablefish are currently slightly below the biomass target. We recommended the maximum permissible yield for 2012 from an adjusted F40% strategy is 16,230 t. The maximum permissible yield for 2013 is a 6% increase from the 2012 ABC of 17,240 t. This decrease was supported by a substantial decrease in the domestic longline survey index in 2012 that offset relatively high survey years in 2010 and 2011. The fishery abundance index was steady which moderated the decrease in ABC. The 2008 year class is appearing in the length and age compositions, but its size was constrained by this year's overall large decrease in the longline survey index. Spawning biomass is projected to decline through 2017, and then is expected to increase, assuming average recruitment is achieved. This year's survey turned the projection downward, predicting maximum permissible ABC to decrease in 2014 at 15,220 t and remain steady at 15,220 t in 2015

Projected 2013 spawning biomass is 37% of unfished spawning biomass. Spawning biomass has increased from a low of 30% of unfished biomass in 2002 to 37% projected for 2013. The 1997 year class has been an important contributor to the population but has been reduced and should comprise less than 10% of the 2013 spawning biomass. The 2000 year class is still the largest contributor, with 20% of the spawning biomass in 2013. The 2008 year class is beginning to show signs of strength and will comprise 5% of spawning biomass in 2013 even though it is only 40% mature

For more information, contact Dana Hanselman at (907) 789-6626 or dana.hanselman@noaa.gov

7. Yellowfin sole

a. Stock Assessment - Bering Sea

The 2012 EBS bottom trawl survey resulted in a biomass estimate of 1.95 million t, compared to the 2011 survey biomass of 2.4 million t (an decrease of 19 percent). The stock assessment model indicates that yellowfin sole have slowly declined over the past twenty years, although they are still at a fairly high level (53% above B_{MSY}), due to recruitment levels which are less than those which built the stock to high levels in the late 1960s and early 1970s. The time-series of survey age compositions indicate that only 5 of the past 20 year classes have been at or above the long term average. However, the 2003 year class appears to be as strong as any observed since 1983 and should now be a contributor to the reservoir of female spawners. The 2012 catch of 147,000 t represents the largest flatfish fishery in the U.S. and the five-year average exploitation rate has been 6% for this stock (consistently less than the ABC).

New data for this year's assessment include:

- 2011 fishery and survey age compositions
- 2012trawl survey biomass point estimate and standard error
- estimates of the discarded and retained portions of the 2011 catch
- estimate of total catch through the end of 2012.

The current assessment model allows for the input of sex-specific estimates of fishery and survey age composition and weight-at-age and provides sex-specific estimates of population numbers, fishing mortality, selectivity, fishery and survey age composition and allows for the estimation of sex-specific natural mortality and catchability. It also features the inclusion of estimates of time varying fishery selectivity, by sex.

The projected female spawning biomass estimate for 2013 is 582,000 t. Projected spawning biomass for 2013 and beyond suggests a leveling off of the generally monotonic decline in spawning biomass that has prevailed since 1994. An upward trend in the population may be expected due to high recruitment from the 2003 year class.

The SSC has determined that reliable estimates of B_{MSY} and the probability density function for F_{MSY} exist for this stock. Accordingly, yellowfin sole qualify for management under Tier 1. The estimate of B_{MSY} from the present assessment is 353,000 t. Similar to the approach used in recent years, the 1978-2006 stock-recruitment data were used this year to determine the Tier 1 harvest recommendation. This provided a maximum permissible ABC fishing mortality rate (the harmonic mean of the F_{MSY} harvest ratio) of 0.11. The current value of the OFL fishing mortality rate (the arithmetic mean of the F_{MSY} ratio) is 0.12. The product of the maximum permissible ABC fishing mortality rate and the geometric mean of the 2013 biomass estimate produces the author- and Plan Team-recommended 2013 ABC of 206,000 t, and the corresponding product using the OFL harvest ratio produces the 2013 OFL of 220,000 t. For 2014, the corresponding quantities are 206,000 t and 219,000 t, respectively.

Yellowfin sole is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition. As in previous years, this assessment contains an ecosystem feature that represents catchability of the EBS shelf trawl survey as an exponential function of average annual bottom temperature.

8. Northern Rock Sole

a. Research

The influence of polychaete tube habitat on the prey availability, feeding habits, and condition of juvenile rock sole. – Collaboration with the Fish Behavioral Ecology Program:

Ampharetid polychaete worm tubes (*Sabellides sibirica*) are prevalent, small-scale habitat features in flatfish nurseries around Kodiak, Alaska, USA. Juvenile northern rock sole (*Lepidopsetta polyxystra*), associate with worm tubes in summer months but the functional role of this habitat remains uncertain. In this study, we investigated whether worm tubes contribute to increased benthic infauna and result in associated changes in diet composition, size, and body condition of age-0 rock sole. We conducted benthos sampling and beam trawl surveys at a Kodiak flatfish nursery during the summers of 2008 and 2009. Results indicated the abundance, biomass, and number of benthic fauna (potential prey) increased with depth, most significantly in regions with sparse to moderate worm-tube density. Juvenile rock sole diets reflected the spatial availability of prey, including the ingestion of ampharetid worms, which formed a significant component of the diet where available. However, despite increased feeding opportunities associated with worm tubes, rock sole body condition was only highest in these regions during August. In July, rock sole in the bare substrates had higher body condition compared to rock sole in worm-tube habitat, and in September, body condition was similar across the entire nursery region. These patterns require further investigation but may reflect ontogenetic changes in feeding constraints. Alternatively, spatial-temporal interactions in prey quality, predator interactions, or water temperatures within the nursery may be important components of habitat quality during this period. Collectively, these data suggest that worm-tube habitat serves an important trophic role in flatfish nurseries during discrete time periods, and should be considered alongside other mediating factors that affect food availability (e.g. temperature, predators, and prey quality). The manuscript for this project is completed and in NMFS internal review.

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

b. Stock Assessment

The northern rock sole stock is currently at a high level due to strong recruitment from the 2001, 2002 and 2003 year classes which are now contributing to the mature population biomass. The 2012 bottom trawl survey resulted in a biomass estimate of 2.15 million t, 3% lower than the 2011 point estimate. The northern rock sole harvest primarily comes from a high value roe fishery conducted in February and March which usually takes only a small portion of the ABC because it is constrained by prohibited species catch limits and market conditions.

The stock assessment model indicates that the stock declined in the late 1990s and early 2000s due to poor recruitment during the 1990s but is now projected to increase in the near future due to the recently observed strong recruitment. It is currently estimated at over twice the B_{MSY} level.

New information for the 2012 analysis include:

- 2011 fishery age composition;

- 2011 survey age composition
- 2012 trawl survey biomass point estimate and standard error
- updated fishery discards through 2011
- fishery catch and discards projected through the end of 2012.

The current assessment model allows for the input of sex-specific estimates of fishery and survey age composition and weight-at-age and provides sex-specific estimates of population numbers, fishing mortality, selectivity, fishery and survey age composition and allows for the estimation of sex-specific natural mortality and catchability. It also features the inclusion of estimates of time varying fishery selectivity, by sex.

The stock assessment model estimates a 2013 age 6+ biomass estimate of 1,470,000 t. This is 20% less than the 2013 value projected in last year's assessment. Spawning biomass has been increasing since 2009. If harvest rates remain close to the recent average, northern rock sole stock is expected to continue increasing for the next few years because of recruitment from the 2000-2005 year classes, all of which were stronger than any year class spawned between 1991 and 1999.

The SSC has determined that northern rock sole qualifies for management under Tier 1. Spawning biomass for 2013 is projected to be 264% of B_{MSY}, placing northern rock sole in sub-tier "a" of Tier 1. In some past years, one difficulty with applying the Tier 1 formulae to rock sole was that the harmonic and arithmetic means of the F_{MSY} distribution were extremely close, resulting in little buffer between recommendations of ABC and OFL. This closeness resulted from estimates of F_{MSY} that were highly certain. The use of time-varying fishery selectivity, first instituted in the 2010 assessment, increased the buffer between ABC and OFL from a little over 1 percent in the 2009 assessment to >10 percent in this year's assessment.

The Tier 1 2013 ABC harvest recommendation is 214,400 t (FABC = 0.15) and the 2013 OFL is 240,600 t (FOFL = 0.16). The 2014 ABC and OFL values are 203,800 t and 240,600 t, respectively. This is a stable fishery that lightly exploits the stock because it is constrained by PSC limits and the BSAI optimum yield limit. Usually the fishery only takes a small portion of the northern rock sole ABC (the average catch/biomass ratio is about 4 percent). Northern rock sole is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

9. Flathead Sole

a. Research

<u>Contrasting the Maturation, Growth, Spatial Distribution and Vulnerability to Environmental Warming of *Hippoglossoides robustus* (Bering flounder) with *H. elassodon* (flathead sole) in the Eastern Bering Sea</u>

Two similar appearing congeners, *Hippoglossoides robustus* (Bering flounder) and *H. elassodon* (flathead sole), inhabit the Bering Sea and are harvested together during the commercial fishery. In order to establish more precise overfishing limits, the annual spawning biomass must be estimated. Spawning biomass is modeled using the best estimate of the age and length at which 50% of the stock is expected to reach maturity (A_{50}, L_{50}). The major objective of this study was to establish the first maturity estimates for Bering flounder. Females matured at a similar age for Bering flounder (A_{50}, 9 years) and flathead sole (A_{50}, 10 years). However, the body length at which females matured was significantly smaller for Bering flounder (L_{50}, 238 mm) compared to flathead sole (L_{50}, 320 mm). The difference in the length-at-maturity was probably caused by growth differences, which significantly differed between species. The distribution and spawning locations of both species in the eastern Bering Sea survey area was related to the prevailing seawater temperatures and Bering flounder occurred in significantly colder water than flathead sole. The association between cold and the distribution of Bering flounder suggests that this species may be particularly vulnerable to periods of extended sea warming. See Stark (2011a) or contact Jim Stark for further information (jim.stark@noaa.gov).

b. Stock Assessment

Bering Sea

The flathead sole assessment also includes Bering flounder, a smaller, less abundant species with a more northern distribution relative to flathead sole. The 2012 shelf trawl biomass estimate decrease 35% from 2011 to 2012. Areas of high abundance for both stocks are very similar for the past 30 years. The 2007 year class is estimated to be above average, but it follows three years of poor recruitment. The assessment employs an age-structured stock assessment model.

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

- The 2011 fishery catch was updated and preliminary 2012 catch was included.
- Sex-specific size compositions from the 2012 fishery and EBS shelf survey were included, and fishery size compositions from 2011were updated.
- Sex-specific age compositions from the 2010 and 2011 fisheries and the 2011 EBS shelf survey were included.
- The biomass estimate from the 2012 EBS shelf survey was included.
- The mean bottom temperature from the 2012 EBS shelf survey was included.

The preferred model is identical to that selected in last year's assessment. Model estimated age 3+ biomass increased from a low of 119,000 t in 1977 to a peak of 958,000 t in 1994, then declined to 780,000 t in 2003, rose briefly to 804,000 t in 2006, and subsequently declined again to 727,000 t in 2012. This was the lowest total biomass since 1987. Estimated female spawning biomass followed a similar trend, although the peak value (318,000 t) occurred in 1997 rather than 1994. Spawning biomass in 2009 (233,000 t) was the lowest since 1991, but has since rebounded somewhat (243,000 t in 2012). These changes in stock biomass are primarily a function of recruitment, as fishing pressure has been relatively light. The 2004-2008 have all been weak, but the 2009 year class may be strong.

The SSC has determined that reliable estimates of *B40%*, *F40%*, and *F35%* exist for this stock, thereby qualifying flathead sole for management under Tier 3. The current values of these reference points are *B40%*=128,000 t, *F40%*=0.29, and *F35%*=0.35. Because projected spawning biomass for 2013 (245,000 t) is above *B40%*, flathead sole is in sub-tier "a" of Tier 3. The author recommend setting ABCs for 2013 and 2014 at the maximum permissible values under Tier 3a, which are 67,900 t and 66,700 t, respectively. The 2013 and 2014 OFLs under Tier 3a are 81,500 t and 80,100 t, respectively. Flathead sole is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

Gulf Of Alaska

Flathead sole are assessed on a biennial schedule to coincide with the timing of survey data. The last complete assessment was presented in 2011. An executive summary is presented for 2012 with rollover values for 2013 and 2014. The latest full assessment from 2011 is summarized below.

Flathead sole survey biomass increased from 225,377 t in 2009 to 235,639 t in 2011. Catch levels for this stock remain well-below the TAC and below levels where overfishing would be a concern. Stock assessment model estimates of projected female spawning biomass is estimated at 104,301 t for 2012, which is less than the projected 2010 model estimate for 2012 (115,427 t).

The assessment was updated as follows:

1. The fishery catch and length compositions for 2010 and 2011 (through Sept. 24, 2011) were incorporated in the model.
2. The 2009 fishery catch and length compositions were updated.
3. Age compositions from the 2001 and 2009 groundfish surveys were added to the model.
4. The 2011 GOA groundfish survey biomass estimate and length composition data were added to the model.

Flathead sole are determined to be in Tier 3a based on the age-structured model. The preferred model gives a 2012 ABC using $F_{40\%}$ (0.450) of 47,407 t. This ABC is 1,726 t lower than the 2011 ABC. The 2012 OFL using $F_{35\%}$ (0.593) is 59,380 t. The Plan Team noted the model's starting point is 1984 and encouraged the author to investigate starting the model in 1977 since catches from 1977-1984 are presented in the assessment. In addition, the Team recommended the author work to incorporate an ageing error matrix for flathead sole and to configure the model to accept fishery ages and evaluate the available sample sizes.

The stock is not overfished nor approaching an overfished condition.

For further information, contact Jack Turnock (206) 526-6549, Teresa A'Mar (206) 526-4068 or William Stockhausen (206) 526-4241

10. Alaska Plaice

a. Stock Assessment

The Alaska plaice resource continues to be estimated at a high and stable level with very light exploitation. The 2012 survey biomass was 581,900 t is a 19% increase over 2011 and is largely consistent with estimates from resource assessment surveys conducted since 1985. Of interest in 2010 is that the combined results of the eastern Bering Sea shelf survey and the northern Bering Sea survey indicate that 38% of the Alaska plaice biomass was found in the northern Bering Sea in 2010. The stock is expected to remain at a high level in the near future due to the presence of a strong year class estimated from 2002. Exploitation occurs primarily as bycatch in the yellowfin sole fishery and has averaged only 1% from 1975-2012.

The assessment methodology uses an age-structured model and was unchanged from the previous assessment. Female spawning biomass decreased from 1985 to 1998, and has been relatively stable since then. The shelf survey biomass has been fairly steady since the mid-1980s. The 2001-2002 year classes appear very strong, and the 2004-2005 year classes are estimated to be slightly above average. If recent average fishing mortality rates continue into the future, spawning biomass is projected to be fairly stable for the next few years.

Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, therefore qualifying it for management under Tier 3a. The updated point estimates are $B_{40\%}$= 152,000 t, $F_{40\%}$ = 0.16, and $F_{35\%}$ = 0.19. Given that the projected 2012 spawning biomass of 261,000 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2013 were calculated under sub-tier “a” of Tier 3. Projected harvesting at the $F_{40\%}$ level gives a 2013 ABC of 55,200 t and a 2014 ABC of 55,800 t. The OFL was determined from the Tier 3a formula, which gives a 2013 value of 67,000 t and a 2014 value of 60,200 t.

Model projections indicate that this species is neither overfished nor approaching an overfished condition. There is not a targeted fishery for this species as there is presently no market. The total exploitation rate is quite low for Alaska plaice as it is caught principally in pursuit of yellowfin sole.

11. Greenland Halibut (Turbot)

a. Research

Greenland Halibut- RACE Recruitment Processes

Spawning in Greenland halibut (*Reinhardtius hippoglossoides*) occurs along the continental slope and in submarine canyons in the EBS. Eggs were found in Bering and Pribilof Canyons and over the adjacent slope during February and March, confirming that spawning occurs in these regions. Larvae were present over the slope, outer shelf and middle shelf in winter and spring, and settled juveniles were collected over the shelf in September. Oceanographic modeling approaches that simulate larval advection from spawning to nursery habitats indicate depth-discrete variations in transport pathways from submarine canyons to the adjacent shelf contribute to interannual variability in transport trajectories. Overall, data highlight specific physical mechanisms of delivery that are modulated by large-scale atmospheric and oceanographic forcing, potentially varying the degree of slope-shelf connectivity for Greenland halibut and other slope-spawning species.

Reference: Duffy-Anderson, J.T., Blood, D.M., Cheng, W., Ciannelli, L., Matarese, A., Sohn, D., Stabeno, P., Vance, T., and Vestfals, C. Combining field observations and modeling

approaches to examine Greenland halibut (*Reinhardtius hippoglossoides*) early life ecology in the southeastern Bering Sea. In review: *J. Sea Research*.

Greenland Halibut and Pacific Halibut- RACE Recruitment Processes

Greenland halibut (GH, *Reinhardtius hippoglossoides*) and Pacific halibut (PH, *Hippoglossus stenolepis*) are key commercial fish species in the EBS that share several critical life history attributes. Both species are thought to spawn eggs in batches offshore over the continental slope, deep in the water column during winter months, and have extended pelagic larval durations, moving to shallow, and nearshore areas on the EBS shelf to settle as juveniles. Despite similarities in their spawning times, locations and depths, GH and PH exhibit distinct differences in the distribution and abundance of their egg, larval, juvenile and adult stages, as well as their overall population dynamics. An examination of the affects of ocean currents on the transport of these two flatfish species during their early life history stages is being undertaken to explain these differences and understand how slope-shelf connectivity, and thus recruitment, may be influenced by changing environmental conditions. Ten years of data (1995-2004) from the Regional Ocean Modeling System (ROMS) ocean circulation model were examined for differences in along-shelf and cross-shelf transport. Strong seasonal and interannual variation in flow was observed, with along-shelf transport generally highest during fall and winter months, coinciding with spawning activity in both species. Preliminary analysis suggests that connectivity between spawning and settlement locations may be connected to the thermal regime of the EBS shelf, with slope-shelf connectivity being enhanced in 'warm' years and reduced in 'cold' years.

Reference: Vestfals, C.D., Ciannelli, L., Duffy-Anderson, J.T., Spitz, Y., and Dever, E.D. Influence of ocean circulation on Greenland halibut and Pacific halibut early life history in the eastern Bering Sea. 8th International Flatfish Symposium, Ijmuiden, The Netherlands. November 5-10, 2011.

A second project hypothesized that the settlement success in Pacific and Greenland halibut is related to variations in ocean circulation and atmospheric forcing during ontogeny. To test the hypothesis, we quantified inter-annual variability of settlement success for both species through their dispersal pathways. The dispersal pathways from spawning to settling locations were simulated using the Dispersal Model for Early Life Stages (DisMELS). Based on historical observations from the EBS groundfish surveys, we created a probability map using presence/absence data of newly settled juveniles of both species. We estimated successful settlers for each species by overlaying the probability map with path and end-point results from the dispersal simulations. Results indicate differences of successful settlement among years and between species, which are currently being examined in relation to ocean circulation and atmospheric forcing. The knowledge from this study could shed light on the difference in recruitment of these two species over time in the EBS.

Reference: Sohn, D., Ciannelli, L., Duffy-Anderson, J.T., Batchelder, H., Stockhausen, W., and Vestfals, C. Characterizing the interannual variability of settlement success in slope spawning flatfishes. In prep.

b. Stock Assessment

Changes to the input data for this year's assessment include:

- The pre-2002 slope survey biomass estimates were removed from the data file.
- Abundance estimates from the 2012 slope, shelf, and longline surveys were included.
- Length composition data from the 2012 slope and shelf surveys and the 2009-2012 longline surveys were included.
- Fishery catch and length composition data were updated through 2012.
- Haul-by-haul fishery length composition data were weighted proportionally to catch.

Several changes were made to the assessment model which has had a substantial impact on the assessment.

- The weight-at-length relationship was re-estimated.
- A new method was used to weight annual fishery length compositions.
- Several changes were made in the method for estimating recruitment in the early part of the time series.
- A new method for parameterizing sex-specific selectivity curves was used.
- The prior distributions for survey catchability were changed to be as diffuse as possible.

The projected 2013 female spawning biomass is 23,500 t from the assessment model. This is a marked (51percent) decrease from the 2012 spawning biomass of 47,700 t due to major revisions in the stock assessment model. Spawning biomass is projected to increase slightly in 2014 to 26,500 t. A strong 2008 year class and an especially strong 2009 year class were observed in both the survey and fisheries size composition data. These two year classes are expected to be larger than any other recruitment event since the 1970s and will begin to have an increasing influence on spawning stock biomass starting in 2014.

12. Arrowtooth Flounder

a. Research

Female Maturity, Reproductive Potential, Relative Distribution, and Growth compared Between Arrowtooth Flounder (*Atheresthes stomias*) and Kamchatka Flounder (*A. evermanni*) Indicating Concerns for Management-RACE GAP

Arrowtooth flounder (*Atheresthes stomias*) and Kamchatka flounder (*A. evermanni*), major piscivorous predators in the eastern Bering Sea and Aleutian Islands, are morphologically similar. Consequently, the two species have been managed together as a species complex using the length- and age-at-maturity derived from Gulf of Alaska arrowtooth flounder, which had been the only available maturity estimates. However, there could be serious management consequences if the two species matured at significantly different ages and fork lengths. Therefore, this study was conducted during 2007 and 2008 to determine if there were significant differences in maturation between the two species. Significant differences in size and age of female maturation and growth were found. The age and length of 50% maturity ($A_{50,}L_{50,}$ respectively) for arrowtooth flounder females is 7.6 years of age and 480 mm in body length. In comparison, $A_{50,}L_{50}$ of Kamchatka flounder females is 10.1 years of age and 550 mm, meaning that Kamchatka flounder has a significantly lower reproductive potential than arrowtooth flounder. The large difference in reproductive potential indicates that managing the two species together as a species complex using the reproductive characteristics of arrowtooth flounder, was not conservative for Kamchatka flounder. This study also determined that arrowtooth flounder maturation was consistent between the Gulf of Alaska and eastern Bering Sea populations. See Stark (2011b) or contact Jim Stark (Jim.Stark@noaa.gov).

b. Stock Assessment

Bering Sea

The annual Bering Sea shelf survey conducted in 2012, combined with the 2010 slope and Aleutian Islands surveys, indicates that the arrowtooth flounder population continues at a high level. The stock is at a high level and the stock assessment model indicates that the resource has steadily increased from a low biomass in the late 1970s to its current high biomass. Good recruitment from seven of the ten years from 1998-2007 combined with light exploitation should keep the abundance level high.

Beginning in 2011, Kamchatka flounder were removed from the combined *Atheresthes* stock assessment and are assessed separately from arrowtooth flounder and receive an individual ABC and TAC.

New input data include:

- Biomass estimates and size compositions from the 2012 EBS shelf and slope surveys and the 2012 AI survey.
- Fishery size composition for 2010 and 2011.
- Updated 2011 catch and preliminary 2012.

The assessment model changed from last year due to the use of a new maturity schedule. However, the Plan Team opted not to accept the new model due to technical issues regarding the way that the new maturity parameters were estimated. The 2011 stock assessment model resulted in a 2013 age 1+ biomass projection of 1,130,000 t, compared to 1,020,000 t from this year's assessment. The corresponding values for 2013 spawning biomass are 812,000 t (last year's assessment) and 638,000 t (this year's assessment). Although the scales differ between the two assessments, they both show a long-term increasing trend in spawning biomass that is expected to peak in 2013. The 1997-2006 year classes are all above average in both last year's and this year's assessments.

Because the SSC has determined that reliable estimates of B40%, F40%, and F35% exist for this stock, arrowtooth flounder was assessed for management under Tier 3. The point estimates of B40%, F40%, and F35%from last year's assessment were 281,000 t, 0.22, and 0.27, respectively; from this year's assessment, they are 246,000 t, 0.17, and 0.21, respectively. The projected 2013 spawning biomass is far above B40% in both last year's and this year's assessments, so ABC and OFL recommendations for 2013 were calculated under sub-tier "a" of Tier 3. It was recommended to set FABC at the F40% level, which is the maximum permissible level under Tier 3a. Projected harvesting at the F40% level in this year's assessment gives 2013 and 2014

ABCs of 111,000 t and 112,000 t, respectively. However, because the Plan Team did not accept the new maturity schedule in this year's assessment, the Team recommends rolling over the current 2013 ABC of 152,000 t (set last year) for 2013 and 2014. Similarly, the 2013 and 2014 OFLs from this year's assessment are 132,000 t and 134,000 t, respectively, but the Team recommends rolling over the current 2013 OFL of 186,000 t (set last year) for 2013 and 2014.

Arrowtooth flounder is a lightly exploited stock in the BSAI. Arrowtooth flounder was managed separately from Kamchatka flounder for the first time in 2011. Under either last year's or this year's assessment, arrowtooth flounder is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

In contrast to the Gulf of Alaska, arrowtooth flounder is not at the top of the food chain on the EBS shelf. Arrowtooth flounder in the EBS is an occasional prey in the diets of groundfish, being eaten by Pacific cod, walleye pollock, Alaska skates, and sleeper sharks. However, given the large biomass of these species in the EBS overall, these occasionally recorded events do not translate into considerable total mortality for the arrowtooth flounder population in the EBS ecosystem.

Gulf of Alaska

Arrowtooth flounder are assessed on a biennial schedule to coincide with the timing of survey data. The last complete assessment was presented in 2011. An executive summary is presented for 2012 with rollover values for 2013 and 2014. The latest full assessment from 2011 is summarized below.

Survey abundance estimates were low in the 1960's and 1970's, increasing from about 146,000 t in the early 1970's to about 2,822,830 t in 2003. Survey biomass declined to 1,899,778 t in 2005 and in 2009 declined to 1,772,029 t from the 2007 estimate of 1,939,055 t. The 2011 survey indicates the stock remains at a high level.

New data include updated 2009, 2010, and 2011 catch (through September 17, 2011). The 2011 survey biomass and length data were added to the model. Fishery length data for 2009 was updated and 2010 and 2011 were added to the model. Survey age data were added for 2007 and 2009. The same model configuration was used as in 2009, but the added constraint on the last three estimated recruitments was removed. The stock is not overfished nor approaching an overfished condition. Catch levels for this stock remain below the TAC level.

The estimated age 3+ biomass from the model has increased by an order of magnitude since 1961 and peaked at about 2.2 million t in 2006. Since then, the stock has stabilized. The age 3+ biomass estimates are slightly higher in the current assessment than the projected 2009 assessment estimates. Female spawning biomass in 2011 is estimated to be 1,238,210 t, a <1% decrease from the projected 2011 biomass from the 2009 assessment.

Arrowtooth flounder has been determined to fall under Tier 3a. The 2012 ABC using *F40%*=0.174 is 212,882 t, a slight decrease from the 2011 ABC of 213,150 t. The 2012 OFL using *F35%*=0.207 is 250,100 t. The 2013 ABC (212,033 t) and OFL (249,066 t) were estimated using the projection model and catch in 2012 estimated using the recent 5-year average (F=0.020).

The ABC set for arrowtooth flounder is equivalent to the maximum permissible ABC. Area apportionments of arrowtooth flounder ABCs for 2010 and 2011 are apportioned based on the fraction of the 2011 survey biomass in each area.

13. Other Flatfish

a. Stock Assessment

Bering Sea

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 2012. Because of insufficient information about these species, no model analyses are possible and trawl survey estimates are used to determine stock biomass. The latest assessment incorporates 2012 total catch and discard and 2012 trawl survey information. The 2012 EBS bottom trawl survey resulted in biomass estimates of 98,500 t, 5% higher than the 2012 estimate. The biomass of these species in the Aleutian Islands is 15,700 t from the 2012 survey.

Because this complex is managed under Tier 5, no models are available from which to predict future trends. Starry flounder, rex sole, and butter sole comprise the majority of the fishery catch with a negligible amount of other species caught in recent years. Starry flounder continues to dominate the shelf survey biomass in the EBS and rex sole is the most abundant "other" flatfish in the AI. There is no consistent trend in the survey biomass of EBS butter sole over time. The 1982 butter sole estimate for the Eastern Bering Sea was 182 t compared to the 2012 estimate of 619 t, with values as high as 6,340 t in 1986 and as low as 37 t in 1983 (the median of the absolute value of the relative change from year to year is 59 percent). EBS starry flounder biomass increased from 7,780 t in 1982 to 98,600 t in 2007 and remains at a high level (62,800 t) in 2012. This estimate has fluctuated over time, though there has been an upward trend. Conversely, EBS longhead dab decreased from a one-time high of 104,000 t in 1982 to 9,000 t in 2012. This estimate has fluctuated over time, though less dramatically from 1985 through the present. Habitat and depth preference may affect the apparent changes in abundance. For example, longhead dab are found in inshore waters that are not normally sampled by the bottom trawl survey. Sakhalin sole biomass, which has no pattern in fluctuation, had a high of 1,410 t in 1997 and a low of 30 t in 2007. However, the northern BS survey in 2010 indicated that the primary distribution of this species is north of the standard survey area. Thus, distributional changes (e.g., onshore-offshore or north-south), might affect the survey biomass estimates of "other" flatfish.

The SSC has classified "other flatfish" as a Tier 5 stock complex with harvest recommendations calculated from estimates of biomass and natural mortality. Natural mortality rates for rex sole

(0.17) and Dover sole (0.085) in the GOA SAFE document are used, along with a value of 0.15 for all other species in the complex. Projected harvesting at the 0.75 M level (average *FABC* = 0.11), gives a 2013-2014 ABC of 13,300 t for the "other flatfish" complex. The corresponding 2013-2014 OFL (average FOFL = 0.15) is 17,800 t. This assemblage is not being subjected to overfishing. It is not possible to determine whether this assemblage is overfished or whether it is approaching an overfished condition because it is managed under Tier 5.

<u>Gulf of Alaska</u>

Shallow-water and deep-water flatfish are assessed on a biennial schedule to coincide with the timing of survey data. The last complete assessment was presented in 2011. An executive summary is presented for 2012 with rollover values for 2013 and 2014. The latest full assessment from 2011 is summarized below.

The shallow water flatfish complex is made up of northern rock sole, southern rock sole, yellowfin sole, butter sole, starry flounder, English sole, sand sole, Alaska plaice and other minor species. Stock status for shallow water flatfish is based on the NMFS bottom trawl survey (triennial from 1984 to 1999 and biennial from 1999 to 2011). Survey abundance estimates for the entire shallow-water complex were lower in 2011 compared to 2009; decreasing by 37,629 t. By species, southern rock sole has a generally increasing trend in abundance, although biomass decreased between 2009 and 2011. Northern rock sole has general increasing trend through 2007 and then has been decreasing since. The remainder of the species in the shallow water flatfish complex exhibit varying trends, although most species increased in abundance between 2009 and 2011 with the exception of sand sole and English sole.

There were no changes in the assessment methodology for Tier 5 (non-rock sole species) but a Tier 3 assessment methodology was adopted for northern and southern rock sole. This catch-at-age model was updated with fishery catch data, fishery catch-at-length data, NMFS bottom trawl survey age composition and size-at-age data from 1984, 1987, 1990, 2001, 2003, 2005, 2007, and 2009 and bottom trawl survey biomass and size compositions from the 2011 survey. For the remainder of the flatfish complex, the 2011 survey biomass was the only new input data. Relative the 2009 survey biomass (436, 590 t), total shallow water flatfish biomass decreased 9% in 2011.

The *FABC* and *FOFL* values for southern rock sole were estimated as: *F40%*=0.16 and *F35%* = 0.19, respectively. For northern rock sole, the values are: *F40%*=0.18 and *F35%* =0.214. Other flatfish ABCs were estimated with *FABC*=0.75 M and *FOFL*=M. For the shallow water flatfish complex, ABC and OFL for southern and northern rock sole are combined with the ABC and OFL for the rest of the shallow water flatfish complex. This yields a combined ABC of 50,683 t and OFL of 61,681 t for 2012. For 2013, the combined ABC of 46,483 t and the OFL is 56,781 t. The ABC and OFL for 2012 and 2013 shallow-water flatfish are lower than the 2010 and 2011 due to a decline in survey biomass. The ABC for the shallow water flatfish complex was set at the maximum permissible amount and was apportioned relative to the survey biomass estimated for each area.

The deep water flatfish complex is comprised of Dover sole, Greenland turbot, and deepsea sole. Catch and trawl survey biomass data for Dover sole, Greenland turbot and deepsea sole are updated to 2011. For Dover sole, an updated age-structured assessment model was presented.

The sex and age-structured model for Dover sole is similar to what was presented in 2009. The model fit the survey biomass relatively well, but underestimated large catches in the early 1990s. The model resulted in unrealistically high biomass values and was substantially different than the previous model estimates. The author and Team were concerned with this and concluded that further evaluation was needed and was inappropriate to apply for management recommendations. Some parameters converged at their bounds and the selectivity estimates seemed questionable.

The Team agrees with the author's recommendation to move Dover sole into Tier 5 until the model can be more fully evaluated. The Plan Team requested a review of the revised model in September 2012.

Information is insufficient to determine stock status relative to overfished criteria for Tier 5 and 6 species such as Dover sole, Greenland turbot and deepsea sole. Catch levels for this complex remain below the TAC and below levels where overfishing would be a concern.

Dover Sole were previously in Tier 3a but due to the aforementioned concerns about the validity of the model the Plan Team recommended that it be moved to Tier 5. Both Greenland turbot and deepsea sole are in Tier 6. The Tier 6 calculation (based on average catch from 1978-1995) for the remaining species in the deep water flatfish complex ABC is 183 t and the OFL is 244 t. These values apply for 2012 and 2013 ABC and OFLs. For the Dover sole Tier 5 assessment, the 2012 and 2013 ABC using $FABC=0.75*M = 0.064$ results in 4,943 t. The 2012 and 2013 OFL using $FOFL=M = 0.085$ results in 6,590 t. The combined ABC (5,126 t) and OFL (6,834 t) for the deep water flatfish complex are used for management of the deep water complex. The ABC is equivalent to the maximum permissible ABC.

Area apportionments of deep water flatfish (excluding Dover sole) are based on proportions of historical catch. Area apportionments of Dover sole are based on the fraction of the 2011 survey biomass in each area.

14. Dogfish and Other Sharks

a. Research

Salmon shark life history - collaboration with Auke Bay Laboratory and the Alaska Department of Fish and Game

Sharks in Alaska waters are currently managed as a part of the 'Other Species' group by the North Pacific Fishery Management Council. Shark catches within the Gulf of Alaska (GOA) are dominated by three species, the spiny dogfish, *Squalus acanthias*, the Pacific sleeper shark, *Somniosus pacificus*, and the salmon shark, *Lamna ditropis*. While not the target of commercial fisheries, salmon sharks are captured by recreational fishers and as bycatch in several fisheries within the GOA. The stock assessment and management of this species is hindered by a lack of life history data to input into models. Parameters needed to support stock assessment include reproductive timing and periodicity, fecundity, and improved age and length at maturity estimates. The life history of this species is being examined by researchers at the Kodiak Laboratory. Salmon sharks captured incidentally in other fisheries are being collected and dissected to examine: length at maturity, fecundity, reproductive periodicity, and age and growth. To date, 19 female salmon sharks have been obtained at the Kodiak Laboratory during the fall months with additional specimens collected by researchers at the Alaska Department of Fish and Game and researchers at Auke Bay Laboratories. The manuscript for this project is completed and in NMFS internal review.

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

Spiny Dogfish Ecology and Migration - ABL

Scientists at the Auke Bay Laboratories are continuing an annual tagging program for spiny dogfish using electronic archival tags. Thirty-five pop-off and >300 numeric tags were deployed in Yakutat Bay in the summers of 2009 and 2010, 45 pop-off tags were deployed during the annual AFSC longline survey in 2011. In 2012, an additional 45 pop up tags were deployed on the longline survey, as well as 44 more tags deployed in inside waters of SEAK, British Columbia and Puget Sound (WA). Six spiny dogfish tagged in Puget Sound were tagged with acoustic tags in addition to the pop-off tags, to attempt to compare the light based geolocation with known positions from the acoustic receivers. To date, data from 112 pop up tags have been recovered and there are 47 tags still at liberty (7 total tags have failed to report). There are 20 tags planned for deployment in 2013, which will be the final year of tag deployments. Recovered data from the pop-off tags, which includes temperature, depth, and geographic location, are still being analyzed. For more information, contact Cindy Tribuzio at (907) 789-6007 or cindy.tribuzio@noaa.gov.

Spiny Dogfish Improved Aging Methods - ABL

Staff from ABL, AFSC REFM Division, and the University of Alaska Fairbanks are participating in a North Pacific Research Board funded project to investigate alternative aging methods for spiny dogfish. This project aims to compare the previous method of aging the dorsal fin spines with a new technique developed that uses the vertebrae. Much of the laboratory work has been completed and readers are finishing up reading the structures. Preliminary results were presented at the Alaska Marine Science Symposium in January 2013. Project leaders are also hosting a session at the 2013 CARE (Center for Age Reading Excellence) meeting to discuss methods and compare reader interpretations. Once all reads are completed, the project leaders will begin an inter-lab exchange of specimens.

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

Skate Nursery Sites as Habitat Areas of Particular Concern (HAPC)-RACE GAP

Six skate nursery sites in the eastern Bering Sea have been proposed to the North Pacific Management Council for designation as HAPC sites. The sites are important for the successful reproduction and well being of three skate species that dominate the eastern Bering Sea shelf and upper continental slope areas. Because of protracted embryo development time and the fragile nature of skate eggs, the sites are vulnerable to disturbances which may reduce hatching success.

The HAPC proposal has been reviewed by all council committees and continues to be of consideration for adoption for future conservation measures.

Contact Jerry Hoff, jerry.hoff@noaa.gov.

b. Stock Assessment

The shark assessments in the Bering Sea/Aleutian Islands (BSAI) and the Gulf of Alaska (GOA) were moved to biennial cycles. The GOA assessment coincides with the biennial trawl survey in odd years and the BSAI assessment is in the even years. In 2012, a full assessment was presented for the BSAI to the North Pacific Fishery Management Council's Groundfish Plan Teams in November.

There are currently no directed commercial fisheries for shark species in federally or state managed waters of the BSAI or GOA, and most incidentally captured sharks are not retained. Catch estimates from 2003-2012 were updated from the NMFS Alaska Regional Office's Catch Accounting System. The GOA assessment was in an "off year", thus only catch was updated. Catch estimates from the Catch Accounting System was 521 t for 2011 catch for the assessment in 2012 was 636 t. The primary species caught in the GOA is the spiny dogfish.

In the BSAI, catch estimates of shark catch from the Catch Accounting System from 2011 were 105 mt and the estimated catch for the assessment in 2012 was 96 mt. Pacific sleeper shark are the primary species caught. Survey biomass estimates were updated for the assessment. Pacific sleeper shark biomass from the surveys was 1,359 t (CV=28%) and 22 t (CV=100%) for the slope and Aleutian Islands surveys, respectively (no biomass was estimated from the shelf survey because only one shark was caught). The biomass estimates on the BSAI are highly uncertain and not informative for management purposes.

In the BSAI, all shark species are considered "Tier 6" with the 2013 ABC = 1,020 t and OFL = 1,360 t. In the GOA, spiny dogfish are considered a "Tier 5" assessment species and all other sharks a "Tier 6" species. The GOA-wide ABC and overfishing level (OFL) for the entire complex is based on the sum of the ABC/OFLs for the individual species, which resulted in ABC=6,028 t and OFL= 8,037 t for 2013. For more information, contact Cindy Tribuzio at (907) 789-6007 or cindy.tribuzio@noaa.gov.

15. Other Species

Assessment of Grenadiers in Alaska - ABL

Giant grenadier (*Albatrossia pectoralis*) are by far the most abundant grenadier in Alaska at depths <1,000 m. They are the major bycatch species in directed fisheries for sablefish and Greenland turbot. Assessments have been based on giant grenadier serving as a proxy for entire grenadier group. Besides being the most abundant grenadier, they also have the highest CPUE of all species caught during the trawl survey in depths >400 m.

In 2012, a full assessment was done for grenadiers in Alaska and incorporated as an appendix to the North Pacific Fishery Management Council's (NPFMC) annual Stock Assessment and Fishery Evaluation Report. Dave Clausen, the previous primary author of the assessment, retired in December of 2012 and so Cara Rodgveller took over as the primary author in 2012 with Dave assisting as the co-author. ABC recommendations remained the same in the GOA since there has not been a trawl survey that has sampled deep enough to be used in calculations of giant grenadier Allowable Biological Catches (ABCs). The ABC in the Bering Sea and Aleutian Islands decreased in 2012 because 1) the trawl survey biomass estimate from the 2012 Bering Sea slope survey was lower than previous surveys and 2) due to a change in the methodology used for calculating biomass in the Aleutian Islands (Rodgveller and Clausen 2012). A new method was used because trawl surveys only extend to 500 m in the Aleutian Islands and the great majority of giant grenadier biomass is deeper than 500 m. In previous grenadier assessments, an indirect method was used to determine a more up-to-date biomass in this region. In 2012, we used a new method to estimate giant grenadier biomass that utilizes trawl survey biomass estimates from waters < 500 m as well as shallow (<500 m) and deep (501-1000 m) relative abundance data from the longline survey to estimate total AI biomass (1-1000 m) (Rodgveller and Clausen 2012).

Current biomass estimates for giant grenadier are: eastern Bering Sea (EBS), 553,557 mt; Aleutian Islands (AI), 598,727 mt; and Gulf of Alaska (GOA), 597,884 mt. Based on the NPFMC's "tier 5" definition for ABC, we applied an $F=M=0.078$ approach (M is the natural mortality rate) 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, 32,383 mt; AI, 35,026 mt, and GOA, 34,976 mt. When these values are compared with the estimated catches of giant grenadier, it appears giant grenadier are not being overfished at this time.

All species of grenadier in Alaska are presently considered "nonspecified species" by the North Pacific Fishery Management Council (NPFMC), which means they are not part of the NPFMC management process. Therefore, there are no limitations on catch or retention, no reporting requirements, and no official tracking of grenadier catch by management. In June 2009, work started on a new amendment package by the NPFMC. The new amendments were in response to guidelines on "Annual Catch Limits" (ACLs) developed by NMFS to comply with the reauthorized version of the Magnuson-Stevens Fishery Conservation and Management Act. Alternatives considered in the new amendments included listing grenadiers in the FMPs as either "in the fishery" or as members of an "ecosystem component" category. At the June 2012 meeting of the NPFMC, a discussion paper was reviewed that described four alternatives for moving grenadiers into the FMPs (Pearson et al. 2012). The Council motion at this meeting included a purpose and need statement for moving grenadiers into the FMPs and the four alternatives. One of the alternatives is status quo while the other three would put grenadier into at least one FMP as "in the fishery" or as an "ecosystem component".

If grenadiers are categorized as "in the fishery" in future FMP amendments, the NPFMC would then need to establish overfishing levels (OFL), acceptable biological catch (ABC), and total allowable catch (TAC) for grenadiers in Federal waters of Alaska. If grenadier became an "ecosystem component" catch would be required to be tracked, but OFL, ABC, and TACs would not be required. An Environmental Assessment / Regulatory Impact Review/ Initial Regulatory Flexibility Analysis (EA/RIR/IRFA) is being prepared for discussion at the October, 2012 NPFMC meeting.

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

Otolith morphology and microchemistry of giant grenadier - ABL

Three different shapes of otoliths have been observed in giant grenadier (Rodgveller et. al. 2010). A review of the literature revealed that such variability in otolith shape is highly unusual for an individual fish species. Otolith morphology differences could be related to speciation or stock structure. Tagging studies are a traditional way to determine migration patterns and spatial stock structure for fish. However, these studies are not possible for giant grenadier because the fish do not survive the pressure difference when caught at depth and brought to the surface. Genetic and otolith microchemistry studies are an alternative means for determining stock structure and species determination, i.e., if giant grenadier are actually two or more species. In 2013, tissue and otoliths samples will be collected on the AFSC longline survey in the eastern and western Gulf of Alaska and the Bering Sea. Otoliths will be aged and measured for a quantitative comparison of otolith shape and for an examination of fish growth; microchemistry will be employed to examine movement and habitat use during the juvenile stages; microsatellites will be used to genetically determine if stock structure exists, and the genetic technique called the “bar code of life” will be used to examine speciation.

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

Giant Pacific Octopus

Octopus life history – collaboration with the Resource Ecology and Fisheries Management division

Initial stock assessments of octopus within the Gulf of Alaska have revealed that there is little life history information available for this group. RACE biologists at the Kodiak Laboratory in collaboration with REFM biologists in Seattle initiated a life history study of giant Pacific octopus during 2009. This study co-occurred with gear studies to examine the feasibility of an octopus fishery. The giant Pacific octopus, *Enteroctopus dofleini*, is the largest and most abundant octopus species found on the continental shelf of Alaska and it dominates the commercial bycatch of octopus within the Gulf of Alaska. Giant Pacific octopus specimens were obtained from charter operations, Pacific cod pot fishermen, and from scientific surveys within the Gulf of Alaska in order to examine the reproductive biology of this species. Giant Pacific octopus were found to have a protracted reproductive cycle with peak spawning occurring in the winter to early spring months. In the Gulf of Alaska, this species matures between 10-20 kg with 50% maturity values of 13.7 kg (95% CI 12.5-15.5 kg) for females and 14.2 kg (95% CI = 12.6-15.9 kg) for males. Fecundity for this species was found to range from 41,600 to 239,000 with an average fecundity of 106,800 eggs/female. Fecundity was significantly and positively related to the weight of the female. These data are a necessary first step in examining the life history of octopus within this region in order to determine their vulnerability to overfishing and establish appropriate management strategies for this species group within the Gulf of Alaska. The manuscript for this project is completed and in NMFS internal review.

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

D. Other Related Studies

Fisheries Resource Pathology Program – RACE

During the 2012 survey season, the Fisheries Resource Pathobiology sub-task continued its monitoring effort of potentially important diseases of a number of species found in the Bering Sea shelf region. As part of an ongoing study, non-lethal hemolymph withdrawals were collected from *Chionoecetes opilio*, *Chionoecetes bairdi*, *Paralithodes camtschaticus*, and *Paralithodes platypus* to determine the prevalence and distribution of bitter crab syndrome caused by *Hematodinium sp*., a parasitic dinoflagellate.

As a disease program, we frequently get inquiries regarding the nature of encountered anomalies. It is our goal to develop a web-based reference site or information center. Therefore, we inspected numerous fish and shellfish for assorted visual anomalies during the 2012 EBS RACE survey. Abnormalities were photographed, excised, and placed in fixative for subsequent microscopic diagnosis and for genetic characterization of the respective etiological agent. Species analyzed included Alaska plaice, yellowfin sole, northern rock sole, Pacific cod, flathead sole, and walleye Pollock.

For further information, contact Dr. Frank Morado, (206) 526-6572.

Systematics Program-RACE GAP

Several projects on the systematics of fishes of the North Pacific have been completed or were underway during 2012. A partial revision of the fish family Caristiidae (manefishes and veilfins), describing six additional new species, is in press (Stevenson and Kenaley, in press), and a revision of the sandlance genus *Ammodytes* of the North Pacific based on molecular and morphological data, with a description of a new species and the recognition of two species in the eastern North Pacific, is nearing completion (Wildes et al). In addition to revisions and descriptions of new taxa, a thorough description of the osteology of the prowfish (*Zaprora silenus*) is in press (Hilton and Stevenson, in press). Additional projects documenting the genetic diversity of lumpsuckers (Cyclopteridae) across the North Pacific and Bering Sea (Kai and Stevenson), and testing the hypothesis of cryptic speciation in northern populations of the eelpout genus *Lycodes* (Stevenson) have recently been initiated. In addition to systematic publications and projects, RACE systematists have been involved in works on the zoogeography of North Pacific fishes, including collaborations with the University of Washington reporting range extensions of 82 species of fishes into or in new regions of Alaska (Maslenikov et al., 2013), a checklist of the fishes of the Salish Sea (Pietsch and Orr, in review), a field guide to the gadiform fishes of the eastern North Pacific (Hoff et al., in prep), and notes on new records of other fishes (Kai et al., in review; Paquin et al., in review).

With the support of NPRB and JISAO, an annotated checklist of the marine macroinvertebrates of Alaska was completed (Drumm et al., in review). The list comprises over 3,500 species, an increase of more than 70% over that presented in the most recent inventories. Several range extensions and a new species have been discovered as a result of this work (Drumm and Bamber, in review; Drumm et al., in review).

Salmon Excluders-RACE MACE

AFSC Conservation Engineering (CE) scientists participated in tests and refinement of the salmon excluder designs in February and March 2011. CE scientists provided and operated underwater video and sonar equipment to directly observe gear, assuring effective tuning of devices. Chinook salmon escape rates were between 25 and 40%, while chum salmon escape rates remained in the 10 – 15% range. Pollock escape was insignificant at less than 1%. The North Pacific Fisheries Research Foundation placed a technician aboard Gulf of Alaska vessels to demonstrate correct tuning and operation of the new excluder design to promote transfer of this technology to that fleet. The AFSC provided the camera systems used by this technician from our CE "loaner pool." BREP funding was also used for travel to a Fall 2011 workshop at the fishing gear testing facility in St. Johns, Newfoundland to develop new designs to improve escape rates for both salmon species.

Development and Evaluation of Trawl Ground Gears that Produce Less Damage to Crabs in Soft Bottom Areas-RACE MACE

In June, CE scientists conducted two weeks of tests of alternative footrope designs for flatfish capture efficiency and crab bycatch rates aboard the catcher/processor *Cape Horn*. The vessel's twin trawling and catch handling systems allowed direct comparisons of catch rates on each tow. Preliminary results indicate that a conventional disk footrope had much lower crab bycatch rates than a comparable roller gear footrope (a result expected by fishermen), but very similar flatfish catch rates (an unexpected result). In a second test, we found that widening disk spacing, and hence reducing ground contact and potential for crab damage, had little effect on flatfish catch rates.

In August, the same footrope designs were used in tests to determine the mortality rate of crabs passing under each of these footropes. Reflex scans were conducted on recaptured crabs and converted to mortality rates with a relationship between reflex loss and delayed mortality (RAMP) developed in prior years. Analysis of those results is not yet complete. During that cruise, we also conducted experiments to address concerns raised by fishermen regarding the experimental methods for estimating escape mortality rates of crabs. They were concerned that exposure to suspended sediment during recapture behind the footropes could be causing additional mortality. We developed a way to expose crabs to the sediment and recapture process, without having to also contact a footrope. This provides a better control condition for the mortality estimates, improving their scientific validity, as well as understanding and acceptance by affected fishermen.

Mortality Rates for Crab Bycatch in Gulf of Alaska Trawls and Applicability of Sweep Modifications to Reduce Crab Morality-RACE MACE

CE scientists also evaluated Tanner crabs caught by commercial trawl vessels in the Gulf of Alaska to estimate crab bycatch mortality rates and applicability of mortality estimation methods from previous studies. A sample of the assessed crabs were held in both onboard and laboratory tanks to test how the RAMP relationship for bycatch crabs compared to the RAMP developed for escaping crabs after encountering trawls on the seafloor. In combination with similar observations for Tanner and snow crabs during the Bering Sea cruise on the *Cape Horn*, described above, this provided the observations and validation tests to generate estimates of trawl bycatch mortality rates. Preliminary analyses confirm how such mortalities are related to handling time aboard the capture vessel. We also worked with captains to assess the implementation of trawl sweep modifications to the Gulf fleet for reducing crab mortality on the seafloor. These improved estimates of crab bycatch mortality rates and information on applicability of sweep modifications will inform considerations of crab protection actions by the North Pacific Fisheries Management Council.

APPENDIX I - AFSC GROUNDFISH-RELATED PUBLICATIONS AND DOCUMENTS

Published January 2012 through December 2012 (AFSC authors in bold text)

Title: External review of IATTC bigeye tuna assessment.
Year: 2012
Document Type: Other Documents
Division: REFM
Citation: SIBERT, J. R., S. J. HARLEY, J. N. IANELLI, and A. E. PUNT. 2012. External review of IATTC bigeye tuna assessment. IATTC Special Report 19, 31 p.
Date Entered: 2013-02-27

Title: Attributes of the Eastern Chukchi Sea Food Web With Comparisons to Three Northern Marine Ecosystems.
Year: 2012
Document Type: Quarterly Feature Article
Division: REFM
Citation: WHITEHOUSE, A. 2012. Attributes of the Eastern Chukchi Sea Food Web With Comparisons to Three Northern Marine Ecosystems. AFSC Quarterly Report Feature (October-November-December 2012) 7 p. (.pdf, 1.06 MB).
Date Entered: 2013-02-11
URL: http://www.afsc.noaa.gov/Quarterly/OND2012/OND2012-Feature.pdf

Title: Red king crab, Paralithodes camtschaticus, size-fecundity relationship, and interannual and seasonal variability in fecundity.
Year: 2012
Document Type: Journal Article
Division: RACE
Citation: SWINEY, K. M., W. C. LONG, G. L. ECKERT, and G. H. KRUSE. 2012. Red king crab, Paralithodes camtschaticus, size-fecundity relationship, and interannual and seasonal variability in fecundity. J. Shellfish Res. 31:925-933.
Date Entered: 2013-01-31

Title: Results of the acoustic-trawl surveys of walleye pollock (Theragra chalcogramma) in the Gulf of Alaska, February-March 2012 (DY2012-01 and DY2012-03).
Year: 2012
Document Type: Processed Report
Division: RACE
Citation: JONES, D., and M. GUTTORMSEN. 2012. Results of the acoustic-trawl surveys of walleye pollock (Theragra chalcogramma) in the Gulf of Alaska, February-March 2012 (DY2012-01 and DY2012-03). AFSC Processed Rep. 2012-09, 62 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115. (.pdf, 3.42 MB).
Date Entered: 2013-01-28
URL: http://www.afsc.noaa.gov/Publications/ProcRpt/PR2012-09.pdf

Title: Atlas of nearshore fishes of Alaska: a synthesis of marine surveys from 1998 to 2011.
Year: 2012
Document Type: AFSC Technical Memorandum
Division: ABL
Citation: JOHNSON, S. W., A. D. NEFF, J. F. THEDINGA, M. R. LINDEBERG, and J. M. MASELKO. 2012. Atlas of nearshore fishes of Alaska: a synthesis of marine surveys from 1998 to 2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-239, 261 p. (.pdf, 60 MB).
Date Entered: 2013-01-28
URL: http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-239.pdf

Title: Landscape genetics reveals population subdivision in Bering Sea and Aleutian Islands Pacific cod.
Year: 2012
Document Type: Journal Article
Division: RACE
Citation: SPIES, I. 2012. Landscape genetics reveals population subdivision in Bering Sea and Aleutian Islands Pacific cod. Trans. Am. Fish. Soc. 141:1557-1573.
Date Entered: 2013-01-28

Title: Simulation modeling of a trawl-acoustic survey for patchily distributed species.
Year: 2012
Document Type: Journal Article
Division: ABL, RACE, REFM
Citation: SPENCER, P. D., D. H. HANSELMAN, and D. R. McKELVEY. 2012. Simulation modeling of a trawl-acoustic survey for patchily distributed species. Fish. Res. 125-126:289-299.
Date Entered: 2013-01-28

Title: Food web and community dynamics of the northeast U.S. large marine ecosystem.

Year: 2012
Document Type: Book
Division: REFM
Citation: LINK J. S., R. J. BELL, P. J. AUSTER, B. E. SMITH, W. J. OVERHOLTZ, A. E. METHRATTRA, F. PRANOVI, and W. J. STOCKHAUSEN. 2012. Food web and community dynamics of the northeast U.S. large marine ecosystem. U.S. Dep. Commer., Northeast Fish Sci. Cent. Ref. Doc. 12-15; 96 p.
Date Entered: 2013-01-28
URL: http://www.nefsc.noaa.gov/publications/crd/crd1215/

Title: Development of a real-time PCR assay for detection of planktonic red king crab (Paralithodes camtschaticus (Tilesius 1815)) larvae.
Year: 2012
Document Type: Journal Article
Division: RACE
Citation: JENSEN, P. C., M. K. PURCELL, J. F. MORADO, and G. L. ECKERT. 2012. Development of a real-time PCR assay for detection of planktonic red king crab (Paralithodes camtschaticus (Tilesius 1815)) larvae. J. Shellfish Res. 31:917-924.
Date Entered: 2013-01-28

Title: Comparative analysis of cod and herring production dynamics across 13 northern hemisphere marine ecosystems.
Year: 2012
Document Type: Journal Article
Division: REFM
Citation: HOLSMAN, K. K., T. ESSINGTON, T. J. MILLER, M. KOEN-ALONSO, and W. J. STOCKHAUSEN. 2012. Comparative analysis of cod and herring production dynamics across 13 northern hemisphere marine ecosystems. Mar. Ecol. Prog. Ser. 459:231-246.
Date Entered: 2013-01-28

Title: Genetic structure of northern rockfish along the shelf break of the Gulf of Alaska and Aleutian Islands.
Year: 2012
Document Type: Journal Article
Division: REFM
Citation: GHARRETT, A. J, R. J. RILEY, and P. SPENCER. 2012. Genetic structure of northern rockfish along the shelf break of the Gulf of Alaska and Aleutian Islands. Trans. Am. Fish. Soc. 141:370-382.
Date Entered: 2013-01-28

Title: AD Model Builder: Using automatic differentiation for statistical inference of highly parameterized complex nonlinear models.
Year: 2012
Document Type: Journal Article
Division: REFM
Citation: FOURNIER, D. A., H. J. SKAUG, J. ANCHETA, J. IANELLI, A. MAGNUSSON, M. N. MAUNDER, A. NIELSEN, and J. SIBERT. 2012. AD Model Builder: Using automatic differentiation for statistical inference of highly parameterized complex nonlinear models. Optim. Methods Softw. 27:233-249.
Date Entered: 2013-01-28

Title: Winter observations of a group of female and immature sperm whales in the high-latitude waters near the Aleutian Islands, Alaska.
Year: 2012
Document Type: Book
Division: NMML, REFM
Citation: FEARNBACH, H., J. W. DURBAN, S. A. MIZROCH, S. BARBEAUX, and P. R. WADE. 2012. Winter observations of a group of female and immature sperm whales in the high-latitude waters near the Aleutian Islands, Alaska. Mar. Biodiversity Rec. Vol. 5, e13, 4 p.
Date Entered: 2013-01-28

Title: A new conceptual framework for evaluating the early ontogeny phase of recruitment processes among marine fish species.
Year: 2012
Document Type: Journal Article
Division: RACE
Citation: DOYLE, M. J., and K. L. MIER. 2012. A new conceptual framework for evaluating the early ontogeny phase of recruitment processes among marine fish species. Can. J. Fish. Aquat. Sci. 69:2112-2129.
Date Entered: 2013-01-28

Title: Scale-dependent depletion of natural populations.
Year: 2012
Document Type: Journal Article
Division: REFM
Citation: BARTOLINO, V., L. CIANNELLI, P. SPENCER, T. K. WILDERBUER, and K-S. CHAN. 2012. Scale-dependent depletion of natural populations. Mar. Ecol. Prog. Ser. 444:251-261.
Date Entered: 2013-01-28

Title: Results of the March 2012 acoustic-trawl survey of walleye pollock (Theragra chalcogramma) conducted in the southeastern Aleutian Basin near Bogoslof Island, Cruise DY2012-02.
Year: 2012
Document Type: Processed Report
Division: RACE
Citation: McKELVEY, D., and S. STEINESSEN. 2012. Results of the March 2012 acoustic-trawl survey of walleye pollock (Theragra chalcogramma) conducted in the southeastern Aleutian Basin near Bogoslof Island, Cruise DY2012-02. AFSC Processed Rep. 2012-08, 36 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115. (.pdf, 1.84 MB).
Date Entered: 2013-01-22
URL: http://www.afsc.noaa.gov/Publications/ProcRpt/PR2012-08.pdf
Title: Pacific cod (Gadus macrocephalus) as a paleothermometer: Otolith oxygen isotope reconstruction.
Year: 2012
Document Type: Journal Article
Division: REFM
Citation: WEST, C. F., S. WISCHNIOWSKI, and C. JOHNSTON. 2012. Pacific cod (Gadus macrocephalus) as a paleothermometer: Otolith oxygen isotope reconstruction. J. Archaeol. Sci. 39:3277-3283.
Date Entered: 2013-01-09
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Citation: WEBER, T. C., A. De ROBERTIS, S. F. GREENAWAY, S. SMITH, L. MAYER, and G. RICE. 2012. Estimating oil concentration and flow rate with calibrated vessel-mounted acoustic echo sounders. PNAS 109:20240-20245.
Date Entered: 2013-01-09
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Year: 2012
Document Type: Document Chapter
Division: NMML
Citation: Ver HOEF, J. 2012. Biodiversity, p. 216-220. In A.-H. El-Shaarawi, and W. Piegorsch (editors), Encyclopedia of Environmetrics, Second Edition. John Wiley & Sons Ltd, Chichester, UK.
Date Entered: 2013-01-09
Title: Efficiency of the Korean bottom survey trawl for snow crab Chionoecetes opilio
Year: 2012
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Division: RACE
Citation: CHOI, J. H., and D. A. SOMERTON. 2012. Efficiency of the Korean bottom survey trawl for snow crab Chionoecetes opilio. Fish. Aquat. Sci. 15(4):1-7.
Date Entered: 2013-01-08
Title: Changes in eelgrass habitat and faunal assemblages associated with coastal development in Juneau, Alaska
Year: 2012
Document Type: AFSC Technical Memorandum
Division: ABL
Citation: HARRIS, P. M., A. D. NEFF, and S. W. JOHNSON. 2012. Changes in eelgrass habitat and faunal assemblages associated with coastal development in Juneau, Alaska, 47 p. U.S. Dep. Commer., NOAA Tech. Mmeo. NMFS-AFSC-240, 47 p. (.pdf, 4.17 MB).
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Title: Evaluating the quality of bycatch data and bycatch estimates among disparate fisheries.
Year: 2012
Document Type: Journal Article
Division: OCD
Citation: DESFOSSE, L. L., W. A. KARP, and S. G. BROOKE. 2012. Evaluating the quality of bycatch data and bycatch estimates among disparate fisheries. Mar. Fish. Rev. 74(3):6-13. (.pdf, 979 KB).
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Title: Estimating overall fish bycatch in U.S. commercial fisheries.
Year: 2012
Document Type: Journal Article
Division: OCD
Citation: BROOKE, S. G., L. L. DESFOSSE, and W. A. KARP. 2012. Estimating overall fish bycatch in U.S. commercial fisheries. Mar. Fish. Rev. 74(3):1-5. (.pdf, 720 KB).
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Title: Beyond the defaults: Functional response parameter space and ecosystem-level fishing thresholds in dynamic food web model simulations.
Year: 2012
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Date Entered: 2012-12-26
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Year: 2012
Document Type: Other Documents
Division: REFM
Citation: MATTA, M. E., and D. K. KIMURA. 2012. Age determination manual of the Alaska Fisheries Science Center Age and Growth Program. NOAA Professional Paper NMFS 13, 97 p. (.pdf, 14.4 MB).
Date Entered: 2012-12-19
URL: http://spo.nwr.noaa.gov/pp13.pdf
Title: Size of juvenile salmon prey from southeastern Alaska and northern British Columbia.
Year: 2012
Document Type: Processed Report
Division: ABL
Citation: LANDINGHAM, J., P. D. MOTHERSHEAD, and M. V. STURDEVANT. 2012. Size of juvenile salmon prey from southeastern Alaska and northern British Columbia. AFSC Processed Rep. 2012-07, 19 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., Auke Bay Laboratories, 17109 Point Lena Loop Rd., Juneau, AK. (.pdf, 664 KB).
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Title: Public willingness to pay for recovering and downlisting threatened and endangered marine species.
Year: 2012
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Year: 2012
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Citation: LEW, D. K., and D. M. LARSON. 2012. Economic values for saltwater sport fishing in Alaska: a stated preference analysis. N. Am. J. Fish. Manage. 32:745-759.
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Title: Food habits of Pacific cod and walleye pollock in the northern Gulf of Alaska.
Year: 2012
Document Type: Journal Article
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Date Entered: 2012-12-04
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Year: 2012
Document Type: Other Technical Memorandum
Division: RACE
Citation: WILLIAMS, K., C. ROOPER, and J. HARMS (editors). 2012. Report of the National Marine Fisheries Service Automated Image Processing Workshop. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-121, 48 p.
Date Entered: 2012-10-25
Title: Effects of environmental temperature on the dynamics of ichthyophoniasis in juvenile Pacific herring (Clupea pallasii).
Year: 2012
Document Type: Journal Article
Division: ABL
Citation: GREGG, J. L., J. J. VOLLENWEIDER, C. A. GRADY, R. A. HEINTZ, and P. K. HERSHBERGER. 2012. Effects of environmental temperature on the dynamics of ichthyophoniasis in juvenile Pacific herring (Clupea pallasii). J. Parasitol. Res. Vol. 2011, Article ID 563412, 9 p. (.pdf, 1.05 MB).
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Title: DNA extraction from archived Giemsa-stained blood smears using polymerase chain reaction to detect host and parasitic DNA.
Year: 2012
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Date Entered: 2012-10-15
Title: Airborne remote sensing of a biological hot spot in the southeastern Bering Sea.
Year: 2012
Document Type: Journal Article
Division: ABL, HEPR
Citation: CHURNSIDE, J. H., E. D. BROWN, S. PARKER-STETTER, J. K. HORNE, G. L. HUNT, Jr., N. HILLGRUBER, M. F. SIGLER, and J. J. VOLLENWEIDER. 2012. Airborne remote sensing of a biological hot spot in the southeastern Bering Sea. Remote Sens. 3:621-637.
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Title: Alaska Essential Fish Habitat Research Plan: a research plan for the National Marine Fisheries Service's Alaska Fisheries Science Center and Alaska Regional Office.
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Division: HEPR, NMML, RACE, REFM, ABL, FMA
Citation: SIGLER, M. F., M. F. CAMERON, M. P. EAGLETON, C. H. FAUNCE, J. HEIFETZ, T. E. HELSER, B. J. LAUREL, M. R. LINDEBERG, R. A. McCONNAUGHEY, C. H. RYER, and T. K. WILDERBUER. 2012. Alaska Essential Fish Habitat Research Plan: a research plan for the National Marine Fisheries Service's Alaska Fisheries Science Center and Alaska Regional Office. AFSC Processed Rep. 2012-06, 21 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 17109 Pt. Lena Loop Road, Juneau, AK 99801. (.pdf, 704 KB).
Date Entered: 2012-10-09
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Title: Growth and production of Pacific ocean perch (Sebastes alutus) in nursery habitats of the Gulf of Alaska.
Year: 2012
Document Type: Journal Article
Division: RACE, REFM
Citation: ROOPER, C. N., J. L. BOLDT, S. BATTEN, and C. GBURSKI. 2012. Growth and production of Pacific ocean perch (Sebastes alutus) in nursery habitats of the Gulf of Alaska. Fish. Oceanogr. 21:415–429.
Date Entered: 2012-10-04
Title: Habitat structure influences survival and predator-prey interactions of early juvenile red king crab Paralithodes camtschaticus.
Year: 2012
Document Type: Journal Article
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Citation: PIRTLE, J. L., G. L. ECKERT, and A. W. STONER. 2012. Habitat structure influences survival and predator-prey interactions of early juvenile red king crab Paralithodes camtschaticus. Mar. Ecol. Prog. Ser. 159:2025-2034.
Date Entered: 2012-10-04
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Year: 2012
Document Type: Journal Article
Division: RACE
Citation: LAUREL, B. J., L. A. COPEMAN, and C. C. PARRISH. 2012. Role of temperature on lipid/fatty acid composition in Pacific cod (Gadus macrocephalus) eggs and unfed larvae. Mar. Biol. 159:2025-2034.
Date Entered: 2012-10-04
Title: Application of an acoustic-trawl survey design to improve estimates of rockfish biomass.
Year: 2012
Document Type: Journal Article
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Date Entered: 2012-10-04
Title: Bayesian hierarchical modeling of Pacific geoduck growth increment data and climate indices.
Year: 2012
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Date Entered: 2012-10-04
Title: An atlas of reproductive development in rockfishes, genus Sebastes.
Year: 2012
Document Type: Other Documents
Division: RACE, REFM
Citation: SHAW, F. R., J. F. MORADO, V. C. LOWE, and S. F. McDERMOTT. 2012. An atlas of reproductive development in rockfishes, genus Sebastes. NOAA Professional Paper NMFS 14, 77 p. (.pdf, 35.1 MB).
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Title: Ocean Acidification: Monitoring and Measuring the Physiological and Population Response of Living Marine Resources in Alaska.
Year: 2012
Document Type: Quarterly Feature Article
Division: ABL, HEPR, RACE, REFM
Citation: ROBERT J. FOY, MARK CARLS, MICHAEL DALTON, TOM HURST, W. CHRISTOPHER LONG, MICHAEL F. SIGLER, ROBERT P. STONE, and KATHERINE M. SWINEY. 2012. Ocean Acidification: Monitoring and Measuring the Physiological and Population Response of Living Marine Resources in Alaska. AFSC Quarterly Report Feature (July-August-September 2012) 8 p. (.pdf, 4.38 MB).
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Title: Resource partitioning among Myoxocephalus sculpins, and their predator–prey relationships with Chionoecetes crabs in the eastern Bering Sea.
Year: 2012
Document Type: Journal Article
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Citation: TENBRINK, T. T., and T. W. BUCKLEY. 2012. Resource partitioning among Myoxocephalus sculpins, and their predator–prey relationships with Chionoecetes crabs in the eastern Bering Sea. Mar. Ecol. Prog. Ser. 464:221–235.
Date Entered: 2012-09-19
Title: Diets and trophic linkages of epipelagic fish predators in coastal Southeast Alaska during a period of warm and cold climate years, 1997–2011.
Year: 2012
Document Type: Journal Article
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Citation: STURDEVANT, M. V., J. A. ORSI, and E. A. FERGUSSON. 2012. Diets and trophic linkages of epipelagic fish predators in coastal Southeast Alaska during a period of warm and cold climate years, 1997–2011. Mar. Coast. Fish.: Dynam. Manag. Ecosys. Sci. 4:526-545.
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Title: Two new species of snailfishes of the genus Careproctus (Scorpaeniformes: Liparidae) from the Bering Sea and eastern North Pacific Ocean, with a redescription of Careproctus ovigerus.
Year: 2012
Document Type: Journal Article
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Date Entered: 2012-08-20
Title: Statistical distribution of age readings of known-age sablefish (Anoplopoma fimbria).
Year: 2012
Document Type: Journal Article
Division: ABL, REFM
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Date Entered: 2012-08-20
Title: Results of cooperative research acoustic surveys of walleye pollock (Theragra chalcogramma) in the western Gulf of Alaska from September 2007 to September 2011.
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Citation: ROMAIN, S., M. DORN, and V. WESPESTAD. 2012. Results of cooperative research acoustic surveys of walleye pollock (Theragra chalcogramma) in the western Gulf of Alaska from September 2007 to September 2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-238, 35 p. (.pdf, 1.7 MB).
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Title: Underlying causes of habitat-associated differences in size of age-0 walleye pollock (Theragra chalcogramma) in the Gulf of Alaska.
Year: 2012
Document Type: Journal Article
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Citation: DOUGHERTY, A., K. BAILEY, T. VANCE, and W. CHENG. 2012. Underlying causes of habitat-associated differences in size of age-0 walleye pollock (Theragra chalcogramma) in the Gulf of Alaska. Mar. Biol. 159:1733-1744.
Date Entered: 2012-07-30
Title: Multispecies age-structured assessment for groundfish and sea lions in Alaska
Year: 2012
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Citation: Van KIRK, K. F., T. J. QUINN II, J. S. COLLIE, and Z. T. A'MAR. 2012. Multispecies age-structured assessment for groundfish and sea lions in Alaska, p. 147-168. In G. H. Kruse, H. I. Browman, K. L. Cochrane, D. Evans, G. S. Jamieson, P. A. Livingston, D. Woodby, and C. I. Zhang (editors), Global Progress in Ecosystem-Based Fisheries Management. Alaska Sea Grant, University of Alaska Fairbanks, AK.
Date Entered: 2012-07-18
Title: Estimating species and size composition of rockfishes to verify targets in acoustic surveys of untrawlable areas.
Year: 2012
Document Type: Journal Article
Division: RACE
Citation: ROOPER, C. N., M. H. MARTIN, J. L. BUTLER, D. T. JONES, and M. ZIMMERMANN. 2012. Estimating species and size composition of rockfishes to verify targets in acoustic surveys of untrawlable areas. Fish. Bull., U.S. 110:317-331. (.pdf, 1.18 MB).
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Year: 2012
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Division: REFM
Citation: KRUSE, G. H., H. I. BROWMAN, K. L. COCHRANE, D. EVANS, G. S. JAMIESON, P. A. LIVINGSTON, D. WOODBY, and C. I. ZHANG. 2012. Steps for future progress in ecosystem-based fisheries management: What's next? Pages 375-380. In Kruse, G. H., H. I. Browman, K. L. Cochrane, D. Evans, G. S. Jamieson, P. A. Livingston, D. Woodby, and C. I. Zhang (editors), Global progress in ecosystem-based fisheries management. Alaska Sea Grant, University of Alaska Fairbanks, AK.
Date Entered: 2012-07-18
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Year: 2012
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Year: 2012
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Year: 2012
Document Type: Journal Article
Division: RACE
Citation: GUSTAFSON, R. G., M. J. FORD, P. B. ADAMS, J. S. DRAKE, R. L. EMMETT, K. L. FRESH, M. ROWSE, E. A. K. SPANGLER, R. E. SPANGLER, D. J. TEEL, and M. T. WILSON. 2012. Conservation status of eulachon in the California Current. Fish Fish. 13:121-138.
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Title: Interdecadal change in growth of sablefish (Anoplopoma fimbria) in the northeast Pacific Ocean.
Year: 2012
Document Type: Journal Article
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Year: 2012
Document Type: AFSC Technical Memorandum
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Title: The 2011 Eastern Bering Sea continental shelf bottom trawl survey: Results for commercial crab species
Year: 2012
Document Type: AFSC Technical Memorandum

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Title: Disease will limit future food supply from the global crustacean fishery and aquaculture sectors.
Year: 2012
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Title: Developing an acoustic survey of euphausiids to understand trophic interactions in the Bering Sea ecosystem.
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Title: Life history characteristics of a lightly exploited stock of Squalus suckleyi.
Year: 2012
Document Type: Journal Article
Division: ABL
Citation: TRIBUZIO, C. A., and G. H. KRUSE. 2012. Life history characteristics of a lightly exploited stock of Squalus suckleyi. J. Fish Biol. 80:1159-1180.
Date Entered: 2012-04-23
Title: Lack of trophic competition among wild and hatchery juvenile chum salmon during early marine residence in Taku Inlet, Southeast Alaska.
Year: 2012
Document Type: Journal Article
Division: ABL
Citation: STURDEVANT, M., E. FERGUSSON, N. HILLGRUBER, C. REESE, J. ORSI, R. FOCHT, A. WERTHEIMER, and W. SMOKER. 2012. Lack of trophic competition among wild and hatchery juvenile chum salmon during early marine residence in Taku Inlet, Southeast Alaska. Environ. Biol. Fishes 94:101-116.
Date Entered: 2012-04-23
Title: Determining effective sample size in integrating age-structured assessment models.
Year: 2012
Document Type: Journal Article
Division: ABL
Citation: HULSON, P-J., D. H. HANSELMAN, and T. J. QUINN II. 2012. Determining effective sample size in integrating age-structured assessment models. ICES J. Mar. Sci. 69:281-292.
Date Entered: 2012-04-23

Title: Overview of salmon stock enhancement in southeast Alaska and compatibility with maintenance of hatchery and wild stocks.
Year: 2012
Document Type: Journal Article
Division: ABL
Citation: HEARD, W. R. 2012. Overview of salmon stock enhancement in southeast Alaska and compatibility with maintenance of hatchery and wild stocks. Environ. Biol. Fishes 94:273-283.
Date Entered: 2012-04-23
Title: Acoustic Vessel-of-Opportunity (AVO) index for midwater Bering Sea walleye pollock.
Year: 2012
Document Type: Processed Report
Division: RACE
Citation: RESSLER, P. H., T. HONKALEHTO, R. H. TOWLER, S. C. STEINESSEN, D. R. McKELVEY, and A. L. McCARTHY. 2012. Acoustic Vessel-of-Opportunity (AVO) index for midwater Bering Sea walleye pollock. AFSC Processed Rep. 2012-04, 13 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115. View Online (.pdf, 896 KB).
Date Entered: 2012-04-16
URL: http://www.afsc.noaa.gov/Publications/ProcRpt/PR2012-04.pdf
Title: Estimation of discard mortality of sablefish (Anoplopoma fimbria) in Alaska longline fisheries.
Year: 2012
Document Type: Journal Article

Division: ABL
Citation: STACHURA, M. M., C. R. LUNSFORD, C. J. RODGVELLER, and J. HEIFETZ. 2012. Estimation of discard mortality of sablefish (Anoplopoma fimbria) in Alaska longline fisheries. Fish. Bull., U.S. 110:271-279. (.pdf, 564 KB).
Date Entered: 2012-03-28
URL: http://fishbull.noaa.gov/1102/stachura.pdf
Title: Structure-forming corals and sponges and their use as fish habitat in Bering Sea submarine canyons.
Year: 2012
Document Type: Journal Article
Division: ABL
Citation: MILLER R. J., J. HOCEVAR, R. P. STONE, and D. V. FEDOROV. 2012. Structure-forming corals and sponges and their use as fish habitat in Bering Sea submarine canyons. PLoS ONE 7(3):e33885. Available online: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0033885. (.pdf, 602 KB).
Date Entered: 2012-03-28
URL: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0033885
Title: A retrospective of the hake stocks off the Atlantic and Pacific coasts of the United States: Uncertainties and challenges facing assessment and management in a complex environment.
Year: 2012
Document Type: Journal Article
Division: REFM
Citation: HELSER, T. E., and L. ALADE. 2012. A retrospective of the hake stocks off the Atlantic and Pacific coasts of the United States: Uncertainties and challenges facing assessment and management in a complex environment. Fish. Res. 114:2-18.
Date Entered: 2012-03-28
Title: Female maturity, reproductive potential, relative distribution, and growth compared between arrowtooth flounder (Atheresthes stomias) and Kamchatka flounder (A. evermanni) indicating concerns for management.
Year: 2012
Document Type: Journal Article
Division: RACE
Citation: STARK, J. W. 2012. Female maturity, reproductive potential, relative distribution, and growth compared between arrowtooth flounder (Atheresthes stomias) and Kamchatka flounder (A. evermanni) indicating concerns for management. J. Appl. Ichthyol. 28: 226–230.
Date Entered: 2012-03-21
Title: Investigation of fishing and climate effects on the community size spectra of eastern Bering Sea fish.
Year: 2012
Document Type: Journal Article
Division: RACE, REFM
Citation: BOLDT, J. L., S. C. BARTKIW, P. A. LIVINGSTON, G. R. HOFF, and G. E. WALTERS. 2012. Investigation of fishing and climate effects on the community size spectra of eastern Bering Sea fish. Trans. Am. Fish. Soc. 141:327-342.
Date Entered: 2012-03-21
Title: Contrasting maturation and growth of northern rock sole in the eastern Bering Sea and Gulf of Alaska for the purpose of stock management.
Year: 2012
Document Type: Journal Article
Division: RACE
Citation: STARK, J. W. 2012. Contrasting maturation and growth of northern rock sole in the eastern Bering Sea and Gulf of Alaska for the purpose of stock management. N. Am. J. Fish. Manag. 32:93-99.
Date Entered: 2012-03-06

Title: Genetic stock composition analysis of chum salmon bycatch samples from the 2010 Bering Sea groundfish fisheries.
Year: 2012
Document Type: AFSC Technical Memorandum
Division: ABL
Citation: KONDZELA, C. M., W. T. McCRANEY, H. T. NGUYEN, and J. R. GUYON. 2012. Genetic stock composition analysis of chum salmon bycatch samples from the 2010 Bering Sea groundfish fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-233, 29 p. Online (.pdf, 1 MB).
Date Entered: 2012-03-05
URL: http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-233.pdf
Title: National Marine Fisheries Service Workgroup Report on Encounter Protocol on Vulnerable Marine Ecosystems in the North Pacific Fisheries Commission Area.
Year: 2012
Document Type: Processed Report
Division: REFM
Citation: LOW, L-L. 2012. National Marine Fisheries Service Workgroup Report on Encounter Protocol on Vulnerable Marine Ecosystems

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Date Entered: 2012-03-05
URL: http://www.afsc.noaa.gov/Publications/ProcRpt/PR2012-02.pdf
Title: Evaluating vitality and predicting mortality in spot prawn, Pandalus platyceros, using reflex behaviors.
Year: 2012
Document Type: Journal Article
Division: RACE
Citation: STONER, A. W. 2012. Evaluating vitality and predicting mortality in spot prawn, Pandalus platyceros, using reflex behaviors. Fish. Res. 119/120:108–114.
Date Entered: 2012-02-27
Title: Short-term effects of commercial fishing on the distribution and abundance of walleye pollock (Theragra chalcogramma).
Year: 2012
Document Type: Journal Article
Division: RACE, REFM
Citation: WALLINE, P. D., C. D. WILSON, A. B. HOLLOWED, and S. C. STIENESSEN. 2012. Short-term effects of commercial fishing on the distribution and abundance of walleye pollock (Theragra chalcogramma). Can. J. Fish. Aquat. Sci. 69:354–368.
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Title: Results of the acoustic-trawl survey of walleye pollock (Theragra chalcogramma) on the U.S. and Russian Bering Sea shelf in June - August 2010 (DY1006).
Year: 2012
Document Type: Processed Report
Division: RACE
Citation: HONKALEHTO, T., A. McCARTHY, P. RESSLER, K. WILLIAMS, and D. JONES. 2012. Results of the acoustic-trawl survey of walleye pollock (Theragra chalcogramma) on the U.S. and Russian Bering Sea shelf in June - August 2010 (DY1006). AFSC Processed Rep. 2012-01, 57 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115. (.pdf, 2.14)
Date Entered: 2012-02-09
URL: http://www.afsc.noaa.gov/Publications/ProcRpt/PR2012-01.pdf
Title: Multifrequency species classification of acoustic-trawl survey data using semi-supervised learning with class discovery.
Year: 2012
Document Type: Journal Article
Division: RACE
Citation: WOILLEZ, M., P. H. RESSLER, C. D. WILSON, and J. K. HORNE. 2012. Multifrequency species classification of acoustic-trawl survey data using semi-supervised learning with class discovery. J. Acoust. Soc. Am. 131(2):EL184-EL190.
Date Entered: 2012-01-30
Title: Do silent ships see more fish? Comparison of a noise-reduced and a conventional research vessel in Alaska
Year: 2012
Document Type: Document Chapter
Division: RACE
Citation: De ROBERTIS, A., C. WILSON, and N. J. WILLAMSON. 2012. Do silent ships see more fish? Comparison of a noise-reduced and a conventional research vessel in Alaska, p. 331-334. In A. N. Popper, and A. Hawkins (editors), The Effects of Noise on Aquatic Life, Advances in Experimental Medicine and Biology Vol. 730.
Date Entered: 2012-01-11
Title: Scale and the guild functional response: Density-dependent predation varies with plot size.
Year: 2012
Document Type: Journal Article
Division: RACE
Citation: LONG, W. C., and A. H. HINES. 2012. Scale and the guild functional response: Density-dependent predation varies with plot size. J. Exp. Mar. Biol. Ecol. 413:50–55.
Date Entered: 2012-01-10
Title: Comparison of habitat-based indices of abundance with fishery-independent biomass estimates from bottom trawl surveys.
Year: 2012
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Division: RACE
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Date Entered: 2012-01-10
URL: http://fishbull.noaa.gov/1101/rooper.pdf
Title: Effects of maternal age and size on embryonic energy reserves, developmental timing, and fecundity in quillback rockfish (Sebastes maliger).
Year: 2012
Document Type: Journal Article

Division: ABL
Citation: RODGVELLER, C. J., C. R. LUNSFORD, and J. T. FUJIOKA. 2012. Effects of maternal age and size on embryonic energy reserves, developmental timing, and fecundity in quillback rockfish (Sebastes maliger). Fish. Bull. 110:36-45. (.pdf, 1.86 MB).
Date Entered: 2012-01-09
URL: http://fishbull.noaa.gov/1101/rodgveller.pdf
Title: Habitats and demersal fish communities in the vicinity of Albatross Bank, Gulf of Alaska
Year: 2012
Document Type: Document Chapter
Division: ABL
Citation: REYNOLDS, J. R., S. C. ROONEY, J. HEIFETZ, H. G. GREENE, B. L. NORCROSS, and S. K. SHOTWELL. 2012. Habitats and demersal fish communities in the vicinity of Albatross Bank, Gulf of Alaska, p. 539-553. In P. T. Harris and E. K. Baker (editors), Seafloor Geomorphology as Benthic Habitat. Elsevier.
Date Entered: 2012-01-09
Title: Climate change impacts on marine ecosystems.
Year: 2012
Document Type: Journal Article
Division: REFM
Citation: DONEY, S. C., M. RUCKELSHAUS, J. E. DUFFY, J. P. BARRY, F. CHAN, C. A. ENGLISH, H. M.GALINDO, J. M. GREBMEIER, A. B. HOLLOWED, N. KNOWLTON, J. POLOVINA, N. N. RABALAIS, W. J. SYDEMAN, and L. D. TALLEY. 2012. Climate change impacts on marine ecosystems. Annu. Rev. Mar. Sci. 4:11-37.
Date Entered: 2012-01-09
Title: Prey selection of subadult male northern fur seals (Callorhinus ursinus) and evidence of dietary niche overlap with adult females during the breeding season.
Year: 2012
Document Type: Journal Article
Division: NMML
Citation: CALL, K. A., and R. R. REAM. 2012. Prey selection of subadult male northern fur seals (Callorhinus ursinus) and evidence of dietary niche overlap with adult females during the breeding season. Marine Mammal Sci. 28(1):1-15.
Date Entered: 2012-01-09
Title: Social network correlates of food availability in an endangered population of killer whales, Orcinus orca.
Year: 2012
Document Type: Journal Article
Division: NMML
Citation: FOSTER, E. A., D. W. FRANKS, L. J. MORRELL, K. C. BALCOMB, K. M. PARSONS, A. van GINNEKEN, and D. P. CROFT. 2012. Social network correlates of food availability in an endangered population of killer whales, Orcinus orca. Anim. Behav. 83(3):731-736.
Date Entered: 2012-05-01
Title: Genetic stock composition analysis of Chinook salmon bycatch samples from the 2010 Bering Sea trawl fisheries.
Year: 2012
Document Type: AFSC Technical Memorandum
Division: ABL
Citation: GUTHRIE, C. M. III, H. T. NGUYEN, and J. R. GUYON. 2012. Genetic stock composition analysis of Chinook salmon bycatch samples from the 2010 Bering Sea trawl fisheries. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-232, 22 p. (.pdf, 673 KB).
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Title: Connecting Independent Research Surveys of Bering Sea Salmon Populations to Chum Salmon Bycatch in Bering Sea Groundfish Fisheries.
Year: 2012
Document Type: Quarterly Feature Article
Division: ABL
Citation: MURPHY, J., and E. FARLEY. 2012. Connecting Independent Research Surveys of Bering Sea Salmon Populations to Chum Salmon Bycatch in Bering Sea Groundfish Fisheries. AFSC Quarterly Report Feature (January-February-March 2012) 7 p. (.pdf, 1.3 mb).
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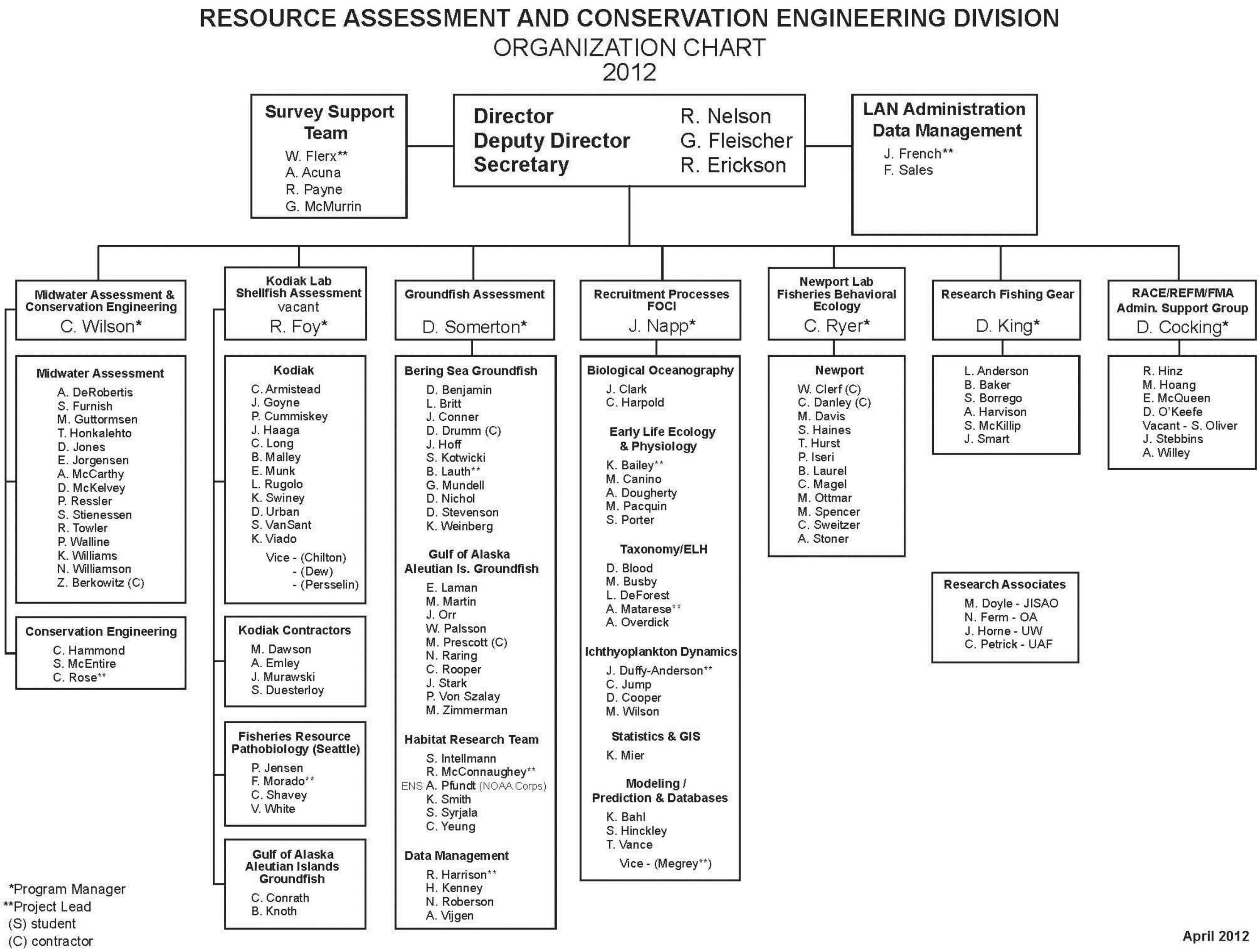
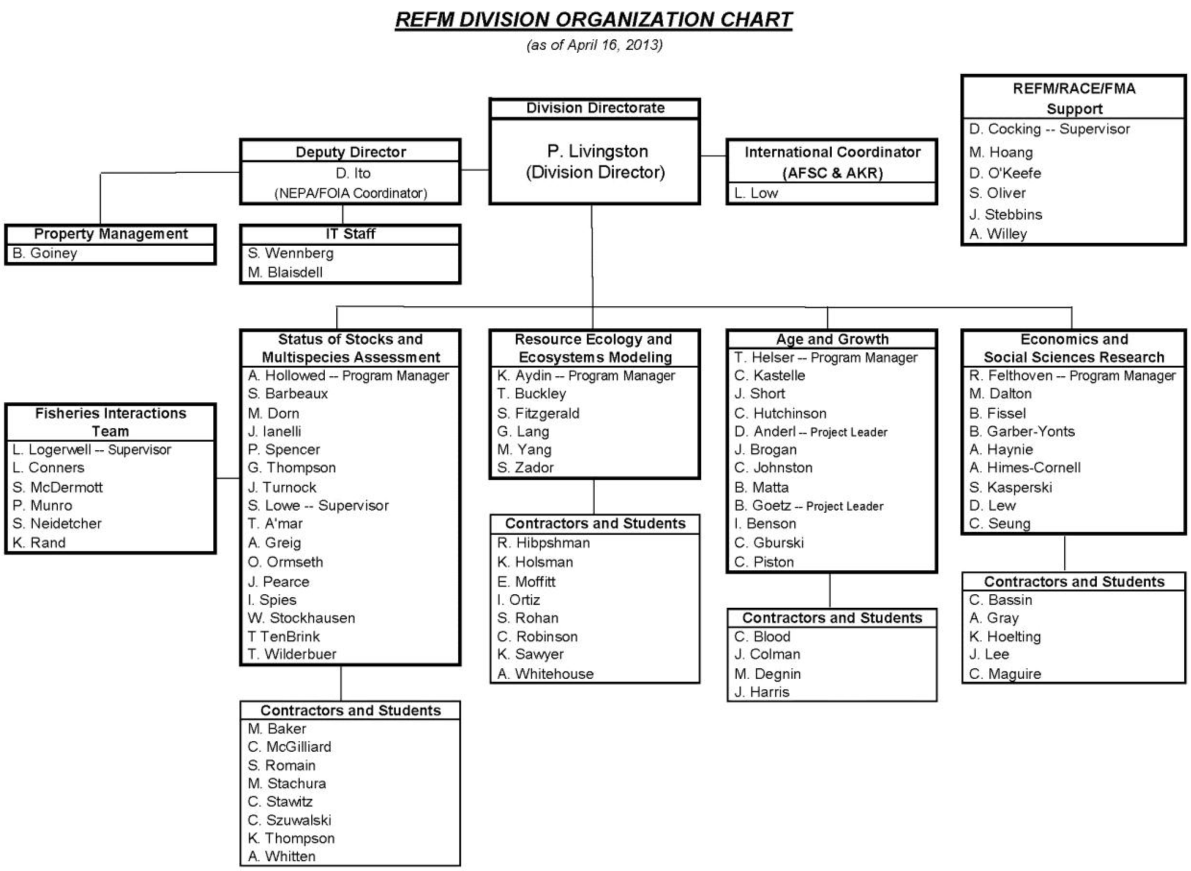
Tribuzio, C. A. and G. H. Kruse (2012). "Life history characteristics of a lightly exploited stock of *Squalus suckleyi*." Journal of Fish Biology 80(5): 1159-1180.

APPENDIX II. RACE ORGANIZATION CHART



APPENDIX III. REFM ORGANIZATION CHART



APPENDIX IV – AUKE BAY LABORATORY ORGANIZATIONAL CHART

Name	Duties
Phil Rigby	Program Manager
Dave Csepp	Forage Fish, Hydroacoustics
Katy Echave	Sablefish Tag Database, Stock assessment
Dana Hanselman	Sablefish, Rockfish, Stock Assessment
Pete Hulson	Rockfish and Shark Assessment
Jon Heifetz	Rockfish, Sablefish, Stock Assessment, Effects of Fishing
John Karinen	Gulf of Alaska Groundfish
Chris Lunsford	Rockfish, Sablefish, Stock Assessment, Longline Survey
Pat Malecha	Groundfish Ecology, Effects of Fishing
Cara Rodgveller	Sablefish, Rockfish, Longline Survey, Grenadiers
Tom Rutecki	Sablefish, Webmaster, Outreach
Kalei Shotwell	Groundfish Habitat, Rockfish, Stock Assessment
Robert Stone	Seafloor Ecology, Effects of Fishing, Coral and Sponge Life History
Cindy Tribuzio	Sharks, Rockfish, Stock Assessment

Other ABL Staff Working on Groundfish-related Research

Darcie Neff	Essential Fish Habitat, Forage Fish
Christine Kondzela	Rockfish Genetics
Sharon Wildes	Forage Fish Genetics
Ed Farley	Epipelagic Trawl Survey in Bering Sea, Age-0 Walleye Pollock
Jamal Moss	Gulf of Alaska Fisheries Oceanography Project

CANADA

British Columbia Groundfish Fisheries and Their Investigations in 2012

May 2013

Prepared for the 54th Annual Meeting of the
Technical Sub-Committee of the Canada-United States Groundfish Committee
April 30-May 1, 2013, NWAFSC, Seattle, Washington, USA.

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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, British Columbia (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	Mr. David Prince (Acting)
Ocean Science	Mr. Robin Brown
Salmon & Freshwater Ecosystems	Mr. Mark Saunders
Marine Ecosystems & Aquaculture	Dr. Laura Brown

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

Groundfish	Mr. Greg Workman
Invertebrates	Mr. Graham Gillespie
Pelagic Fish Research & Conservation Biology	Mr. Jacob Schweigert
Applied Technologies	Mr. Henrik Krieberg
Aquaculture and Environmental Research	Dr. Steven MacDonald

Groundfish research and stock assessments are conducted in the Groundfish Section. Groundfish specimen ageing and hydroacoustic work are conducted in the Applied Technologies Section. The Canadian Coast Guard operates DFO research vessels. These research vessels include the *W.E. Ricker, J.P. Tully*, *Vector*, and *Neocaligus*. A replacement vessel for the *W.E. Ricker* has been delayed until 2014 or beyond.

The Pacific Region Headquarters (RHQ) of Fisheries and Oceans Canada is located at 401 Burrard Street, in Vancouver, BC, V6C 3S4. Management of groundfish resources is the responsibility of the Pacific Region Groundfish Regional Manager (Mr. Neil Davis, Acting) within the Fisheries and Aquaculture Management Branch (FAM). Fishery Managers receive assessment advice from MEAD through the Canadian Centre for Scientific Advice Pacific (CSAP) review committee which is headed by Mrs. Marilyn Hargreaves. The Groundfish Section has at least two review meetings per year, in which stock assessments or other documents undergo scientific peer review (including external reviewers who are often from NOAA). The resulting Science Advisory Report summarises the advice to Fishery Managers, with the full stock assessment becoming a Research Document. Both documents can be viewed on the Canadian Stock Assessment Secretariat website: http://www.dfo-mpo.gc.ca/science/advice-avis/index-eng.html.

The Trawl, Sablefish, Rockfish, Lingcod, North Pacific Spiny Dogfish, and Halibut fishery sectors 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. Details for the February 2013 Groundfish Integrated Fisheries Management Plan can be viewed at [http://www.pac.dfo-mpo.gc.ca/fm-gp/ifmp-eng.htm#Groundfish.](http://www.pac.dfo-mpo.gc.ca/fm-gp/ifmp-eng.htm#Groundfish)

A shift in the funding of industry collaborations, particularly in conducting cooperative surveys, was required after the *Larocque* court decision of June 23, 2006. Prior to the *Larocque* decision, compensation provided to fishers for their data collection services took the form of the proceeds of the unavoidable fish kills in the research surveys, less any samples retained for detailed scientific analysis. In instances where these proceeds did not cover the cost of the research survey, the department allowed fishers to catch additional fish for payment purposes. Post-*Larocque* these "top up" payments for fishing activities were no longer possible. Larocque Relief Funding, to replace fish allocations, was provided in 2007 and continued to fund surveys through March 2013. Recent legislative changes grant the Minister of Fisheries and Oceans the authority to allocate fish or fishing gear for the purpose of financing scientific and fisheries management activities that are described in a joint project agreement entered into with any person or body, or any federal or provincial minister, department, or agency. Larocque Relief funded projects are targeted for transitioning to the new Fisheries Act provisions for the 2013-14 fiscal year, where feasible and where the current stakeholders are willing.

Allocations of fish for financing scientific and management activities are identified in the Groundfish Integrated Fisheries Management Plan. Joint project agreements outlining how industry and DFO will collaborate to support science and management activities through an allocation of fish are currently being developed for the 2013-14 fiscal year.

B. Multispecies or ecosystem models and research

1. Stock Assessment Prioritization

A Groundfish Section stock assessment prioritization and scheduling plan was developed in 2011 and early 2012. This first plan covers 10 years (2012-2021) but the process calls for it to be reviewed and updated every five years, rolling forward over time. The current schedule focuses on 39 "Type A" species which includes species identified as being conservation concerns (i.e., Bocaccio, Basking Shark, etc.) and species which are important to the First Nations, commercial and recreational fisheries. The frequency of assessment for Type A species ranges from 1 year (i.e., Pacific Hake), to 2 years (Sablefish and Pacific Cod), to 5 or 10 years for the remaining Type A species depending upon biological characteristics, stock status, and FAM priorities.

The timing of assessment for species that have been flagged as conservation issues by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is synchronized with the timing of COSEWIC re-assessments.

The remaining 200+ non-commercial fish species that can be considered to lie within the Groundfish research mandate are classified as Type B species. The current process calls for a fast screening of the relative abundance trends in surveys and commercial CPUE for each of these species every five years. The fast screening is designed to provide a short-list of the 20-30 Type B species that should receive more detailed consideration in order for them to be scheduled into the coming 10 year workplan.

2. NSERC Canadian Capture Fisheries Research Network (CCFRN)

Starting in 2010, Groundfish staff have been participating in the National Sciences and Engineering Research Council of Canada's (NSERC) *Canadian Capture Fisheries Research Network*. The CCFRN is a collaboration of academic researchers, the fishing industry, and government researchers and managers from across Canada. The Network includes 33 academics from 13 universities, working with collaborators in the Canadian fishing industry, DFO, and provincial governments. The Network is industry-driven and focussed on projects that have the active collaboration of each sector. The Network will link with other strategic networks and coordinate with DFO programs, where appropriate.

The vision of the Network is to re-shape fisheries research in Canada, bringing together industry, academia and government on priority research questions and linking existing research so that it is useful to industry and management. The research of the Network is aimed at increasing knowledge that will enhance the ecological sustainability, socio-economic viability and management of Canadian fisheries. Specifically, the research objectives are to:

- overcome information gaps for important commercial fisheries and improve the use of industry information in assessment and management;
- enhance ecological sustainability while achieving operational efficiency; and improve the basis for the ecosystem approach to fisheries management.

The Network will provide a forum for sharing research objectives and results that will build capacity in each sector; as well as establish a tradition of collaborative, strategic fisheries research in Canada that is expected to extend beyond its timeline. In addition, the Network will train a cohort of new researchers that will be equipped to meet the research challenges of a new fisheries management regime.

The information and technological advances gained through the research of the Network will have a significant impact on the sustainability, viability and competitiveness of Canada's capture fisheries industry, and will provide environmental and socio-economic benefits. The research will build upon and inform the development of policies and strategies for the management of capture fisheries in Canada and internationally. Details can be found at: http://www.nsercpartnerships.ca/How-Comment/Networks-Reseaux/CCFRN-CCRRN-eng.asp

3. Summary of research surveys in 2012

A number of multi-species trawl surveys are conducted by the Groundfish Section and Groundfish staff participate in trawl surveys conducted by other groups. For a summary of research trawl survey activity in 2012, please see Appendix 2. Other research surveys conducted in 2012 include longline and trap surveys. These surveys are described under their respective species programs below.

C. By species

1. Pacific Cod

a. Research program

1355 dorsal fin rays from the 2010 and 2011 groundfish surveys, covering all four major survey areas (West Coast Vancouver Island, West Coast Haida Gwaii, Hecate Strait and Queen Charlotte Sound) were analysed for ageing in 2012. Age and length data are now available in the groundfish database, GFBio. In addition, fins and otoliths from specimens less than 35 cm in length were collected during the 2012 shrimp and synoptic surveys. These samples will be analysed with the intention of developing improved techniques for ageing young Pacific Cod. A genetics expert was contracted to review literature and identify gaps in current understanding of the stock structure of Pacific Cod throughout the northeastern Pacific Ocean. Based on the recommendations of this review, genetic samples will be collected during the 2013 and 2014 synoptic surveys. Fishery observers will also be asked to collect genetic samples from spawning fish in the spring 2014 fishery. These samples will be analysed and used to address the question of whether or not Pacific Cod in Canada's waters are part of a larger population centred in Alaska. The genetic analyses will also be used to address the question of whether there are sub-populations within Canada's waters, as is currently assumed by management.

b. Stock Assessments

No new stock assessments for Pacific Cod were conducted in 2012. Dr. Robyn Forrest and Mr. Rob Kronlund have made significant progress for an assessment in 2012, due for review in November 2013. This work will include feedback simulation studies to explore the performance of alternative management procedures for this species.

2. Rockfish – inshore

a. Research programs in 2012 and planned for 2013

1. Surveys on the Inside (PMFC Area 4B)

A research longline survey designed for the Inside waters east of Vancouver Island and initiated in 2003, surveyed the northern half of the study area in 2012. Hard bottom areas were identified through bathymetric analyses, inshore rockfish fishing records and fishermen consultations. The hard bottom survey areas were then overlain with a 2 km by 2 km grid and survey blocks were stratified by area and depth (41 – 70 m and 71 – 100 m) and selected for sampling at random. Twenty-one days of DFO ship time are allocated in August for this survey in 2013 which will cover the southern half of the study area.

Visual surveys are not planned for 2013.

2. Surveys on the Outside (PMFC Areas 3CD, 5ABCDE)

Since 2003, a third technician has been deployed on the annual International Pacific Halibut Commission (IPHC) Area 2B setline survey to collect hook-by-hook catch data and conduct biological sampling of non-Halibut catch (Yamanaka et al. 2011; Flemming et al. 2011). The third technician was supported by Larocque funds between 2007 and 2012. A transition to other funding mechanisms has not been completed in time for this survey program in 2013.

In collaboration with the halibut industry, a research longline survey was designed and conducted in the outside BC coastal waters in 2006. Hard bottom areas were identified through bathymetric analyses, inshore rockfish fishing records and fishermen consultations. The hard bottom survey areas were then overlain with a 2 km by 2 km grid (matched with the adjacent trawl survey grid) and survey blocks were stratified by area and depth and chosen at random. Approximately 200 survey sets are targeted annually. The survey covers the coastwide Outside waters over two years, alternating annually between the north and the south. Three chartered fishing vessels conduct this survey between August 15 and September 15. The northern portion of BC was surveyed in 2012. Similar to the IPHC survey, alternative funding has not been secured for this program in 2013.

b. Stock assessment

There were no stock assessments prepared in 2012 and no plans for 2013.

c. Management

Public consultations on the potential Quillback Rockfish listing under SARA were conducted in 2012. Subsequent to the consultations, the Minister of Environment will make a decision on whether to list Quillback Rockfish as *threatened*.

3. Rockfish – shelf

a. Research Programs in 2012

There was no directed biological research work on shelf rockfish in 2012.

b. Stock assessments in 2012

Work on the synchronous assessment of five rockfish (Splitnose, Sharpchin, Harlequin, Redstripe, and Greenstriped) was reviewed in the fall of 2012. Due to the paucity of historical information and unreliable stock reconstructions, the assessment of all five rockfish was inconclusive. A Bocaccio assessment was reviewed in May 2012; the assessment showed that the median estimate of the ratio of current stock size to that at maximum sustainable yield was 7.0%, with 90% confidence limits of 2.9-18.2%.

c. Research activities planned for 2013

Completion of a Yellowtail Rockfish genetics paper is planned but requires a sample from the Strait of Georgia, which is proving difficult to obtain.

DFO staff continues to collaborate with NMFS-AFSC staff on the study of Blackspotted and Rougheye Rockfish. Genetics samples from all major surveys are now being collected and analysed with the results shared with U.S. counterparts. Preliminary results were presented in a poster at the 2012 Western Groundfish Conference.

d. Stock assessments planned for 2013

A coastwide Silvergray Rockfish assessment is planned for 2013, to be reviewed in November 2013.

4. Rockfish – slope

a. Research programs

The Slope Rockfish Program remains responsible for the assessment of rockfish species living on the marine continental slope of British Columbia (BC). The program also tackles a variety of other issues: COSEWIC (Committee on the Status of Endangered Wildlife in Canada) listing requirements, oceanographic exploration, software development for the R statistical platform, and scientific research in marine ecological modelling.

The Groundfish Section at the Pacific Biological Station (PBS, Nanaimo BC) conducts a suite of synoptic surveys that covers most of BC's ocean bottom ecosystems, including those on the continental shelf and slope. The survey team gathers information on abundance and biology (lengths, weights, maturity, otoliths, etc.). The Slope Rockfish Program, headed by Andrew M. Edwards (PBS research scientist) and including Rowan Haigh (PBS research biologist), focuses on the development of models and software tools for the analysis of data pertaining to groundfish and other species. The program retains the interest of two scientists – Jon T. Schnute (PBS scientist emeritus) who contributes time and expertise; and Paul J. Starr who works for the Canadian Groundfish Research and Conservation Society and plays an integral role in the stock assessments assigned to our program.

Work started on an International Governance Strategy (IGS) project entitled *Ocean Acidification and Impacts on Marine Ecosystems* headed by Debby Ianson at the Institute of Ocean Sciences (IOS, Sidney BC). Participants include Andrew Edwards (PBS), Rowan Haigh (PBS), Carrie Holt (PBS), and Holly Neate, a co-op student from the University of Victoria who worked at PBS for eight months. The first phase of the study involves a literature review and paper outlining the direct and indirect effects of ocean acidification on marine organisms and habitats along the Canadian west coast. The report will concentrate on the effects to BC fisheries.

In 2012, work continued on maintaining and upgrading the suite of PBS packages for the R statistical platform:

PBSmodelling	http://cran.r-project.org/web/packages/PBSmodelling/index.html
PBSmapping	http://cran.r-project.org/web/packages/PBSmapping/index.html
PBSadmb	http://cran.r-project.org/web/packages/PBSadmb/index.html
PBSddesolve	http://cran.r-project.org/web/packages/PBSddesolve/index.html
PBStools	http://code.google.com/p/pbs-tools/
PBSmapx	http://code.google.com/p/pbs-mapx/
PBSdata	http://code.google.com/p/pbs-data/
PBSawatea	http://code.google.com/p/pbs-awatea/

In particular, Nicholas Boers (Computer Science, Grant MacEwan University, Edmonton AB) worked on issues identified by developers and users of PBSmapping and PBSmodelling. Nick is the original computer programmer for the mapping package and remains the primary source for the C-code therein. Additionally, he has quickly learnt the programming behind PBSmodelling, which greatly simplifies the cumbersome mechanism of tcl/Tk (tool command language/ toolkit) for building graphical user interfaces (GUIs) in R.

Research continued in the wider area of marine ecological modelling, including a publication (Edwards *et al.*, 2012) that demonstrated methodological issues in recent *Nature* and *Science* papers concerning movements of marine animals (including Atlantic cod, basking sharks, bigeye tuna and mussels). Correcting the methodological issues (by using valid likelihood methods) led to opposite biological conclusions to those originally found.

We hosted a *Fisheries Applications of Remote Observations* workshop at PBS, 20-22nd March. Instructors came from Bedford Institute of Oceanography and Plymouth Marine Laboratory, UK. Participants came from government, academia, industry and First Nations. The workshop fostered many potential collaborations, and may lead to Remote Sensing (of ocean colour) being used in future Fisheries Applications, such as for albacore tuna.

b. Stock assessment

In 2012, our group presented the first BC stock assessments for populations of Pacific Ocean Perch (POP, *Sebastes alutus*) along the West coast of Vancouver Island (Pacific Marine Fisheries Commission area (PMFC) 3CD) and the West coast of Haida Gwaii and Dixon Entrance (PMFC 5DE). These Bayesian models complete the coastwide assessment of POP started in 2010, when the Queen Charlotte Sound (PMFC 5ABC) stock was assessed for the first time since 2001.

For area 3CD, the spawning biomass (mature females only) at the beginning of 2013 (B_{2013}) was estimated to be 0.41 (0.19-0.68) of unfished spawning biomass (B_0); numbers in brackets denote median and 5th and 95th quantiles of the Bayesian posterior distribution. Also, B_{2013} was estimated to be 1.53 (0.55-3.32) of the equilibrium biomass at maximum sustainable yield, B_{MSY} (Figure 3).

For area 5DE, B_{2013} was estimated to be 0.37 (0.16-0.67) of $B_{0,}$ and 1.61 (0.57-3.57) of B_{MSY} (Figure 3).

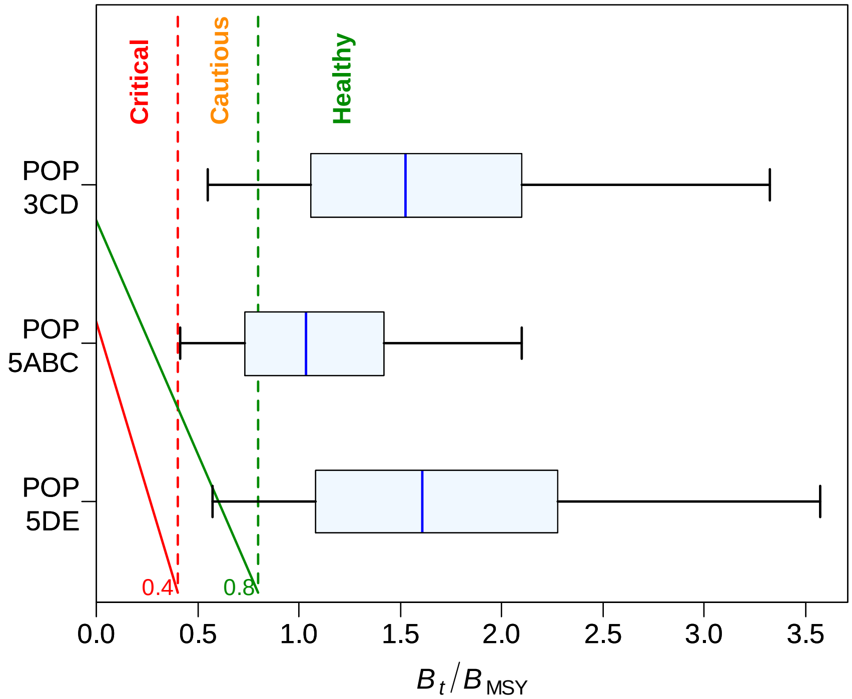

Figure 3. Current status of the three Canadian POP stocks relative to the DFO Precautionary Approach provisional reference points of $0.4B_{MSY}$ and $0.8B_{MSY}$. The value of B_t/B_{MSY} is for t = 2013 for 3CD and 5DE, and for t = 2011 for area 5ABC. Boxplots show the 5, 25, 50, 75 and 95 percentiles from the Bayes posterior distribution of B_t/B_{MSY}.

An exceptionally strong recruitment of age-1 fish in 1977 was estimated for the stock in area 5DE, though not for area 3CD.

Decision tables were presented using the provisional reference points from the DFO *Sustainable Fisheries Framework* Precautionary Approach, namely a limit reference point of $0.4B_{MSY}$ and upper reference point of $0.8B_{MSY}$. For area 3CD, B_{2013} is estimated to have a 0.99 probability of being $>0.4B_{MSY}$, and a 0.87 probability of being $>0.8B_{MSY}$ (i.e., of being in the healthy zone). The probability that the exploitation rate in 2012 is below that associated with MSY is 0.89.

For area 5DE, B_{2013} was estimated to have a 0.98 probability of being $>0.4B_{MSY}$, and a 0.88 probability of being $>0.8B_{MSY}$. The probability that the exploitation rate in 2012 was below that associated with MSY is 0.84.

Advice to management was presented in the form of decision tables using ten-year projections for a range of fixed harvest levels. For both stocks, removals slightly above the recent mean catches in each of the next ten years indicate essentially no change in the aforementioned probabilities of the spawning biomass being above the reference points.

c. Research activities for 2013

Preparatory work will start for a stock assessment on Redbanded Rockfish (*S. babcocki*) for 2014, and possibly for a future assessment of Shortraker Rockfish (*S. borealis*). Some of us will also be assisting in the Rock Sole (*Lepidopsetta bilineatus*) assessment scheduled for review in November.

The collaborative project on ocean acidification will continue until 2014/15, including completion of the literature review and meshing biological responses to model predictions of pCO_2 and pH off the west coast of Vancouver Island.

If funding becomes available, we will collaborate with Jackie King (PBS) on a project called "Implementing Ecosystem-based Fisheries Management in the Groundfish Stock Assessment Process" funded by the Strategic Program for Ecosystem-Based Research and Advice (SPERA). The objectives are (i) to identify mechanisms linking climate-ocean variability to groundfish recruitment, and (ii) to construct and test the decision-based framework for commercially important groundfish species.

5. Sablefish

a. Research activities in 2012 and planned for 2013

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

1. A Traditional Standardized Program (1990-2010)

This program was not conducted in 2011-2012 and is unlikely to be resumed. This program included standardized sets at nine (9) offshore fishing localities and biological sampling. Starting in 1990, one set was made in each of five (5) depth intervals in each locality. Since 1999, additional shallower and deeper depth intervals have been added, removed and changed. However, the 5 core intervals have remained the same over time. Catch rates from these core sets extend a stock abundance index series and Sablefish are sampled for data on size and growth.

2. A Traditional Tagging Program (1991-2007, hiatus in 2008-2012)

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

3) A Randomized Tagging Program (2003-2012)

This program captures Sablefish for tagging and release following a depth and area stratified random survey design. The catch rate data can be used to derive an index of stock abundance. Tag-recoveries can be used for deriving estimates of gear selectivity, studying movement, and deriving an index of tagging-based abundance. The survey also provides biological samples.

4) An Inlets Program (1995-2012)

This program includes standardized sets at four (4) mainland inlet localities. Sablefish are tagged and released from inlet sets and are sampled for biological data.

The annual Research and Stock Assessment Survey Program will be conducted in the fall of 2013 contingent on adequate resources from DFO and the Sablefish industry, but will include only the randomized program (c) and the inlets program (d).

b. Stock assessment activities in 2012 and planned for 2013

A full assessment of Sablefish was conducted in 2010 (Cox et al. 2011). The next scheduled re-examination of the management strategy evaluation simulations is planned for late 2013, the results of which will provide advice for the 2014/15 fishing year and subsequent 2 fishing years. The coast-wide quota for the 2013/14 fishing year was set at approximately 1,900 t based on the catch recommendation from the preferred management procedure.

Sablefish stock assessment and management in British Columbia is conducted collaboratively by DFO and the Canadian Sablefish Association. The collaboration is formalized as a Joint Project Agreement that identifies the respective responsibilities of the two parties and provides a mechanism for joint contributions to fishery management and science activities for Sablefish. Annual survey activities are conducted using fishing vessels chartered from the Sablefish longline trap fleet.

Fishery reference points are based on a target spawning biomass at maximum sustained yield, B_{MSY}, with limit and upper stock reference points at $0.4B_{\mathrm{MSY}}$ and $0.8B_{\mathrm{MSY}}$, respectively. Conservation objectives relate to (*i*) maintaining the spawning biomass above the limit reference point of $0.4B_{\mathrm{MSY}}$ in 95% of years projected over two Sablefish generations (~36 years), and (*ii*) implementing an acceptable probability of stock decline over 10 years that scaled from 0.5 at the target biomass to 0.05 at the limit reference point. A multi-gear, age-structured, catch-at-age model was fitted to historical data to create stock scenarios that captured uncertainty in natural mortality, growth, and future recruitment variability. Stock reconstructions suggest stock status is currently below B_{MSY} for all scenarios. A closed-loop feedback simulation approach was used to evaluate the relative performance of candidate management procedures that are distinguished by the choice of survey data, assessment model assumptions, harvest control rule specifications, and future regulations related to at-sea release of sub-legal Sablefish. Candidate management procedures were robust to the uncertainties considered as indicated by a consistently low probability ($p < 5\%$) of breaching the limit reference point over two Sablefish generations (~36 years) regardless of the management procedure or stock scenario. Expectations for stock growth toward the target reference point over two Sablefish generations range from B_{MSY} or greater to levels near, but not above B_{MSY} under the more pessimistic scenarios.

Performance of management procedures based on the stratified random trap survey alone suggested the legacy standardized trap survey could be discontinued without creating a conservation concern, and could also achieve reduced catch variability relative to the use of both surveys. Increases in expected conservation and catch performance due to adopting an avoidance option for sub-legal Sablefish, or a full retention option, were small relative to the performance attained by the existing size limit tactic, but these effects are likely underestimated due to suspected violations of assumptions related to trawl gear selectivity.

Development of the management strategy evaluation for BC Sablefish in 2010 added modeling of retained and released catches to the age-structured operating model. A 55 cm fork length minimum legal size limit in British Columbia means that sub-legal fish are released by regulation. Work in 2013 will focus on improvements to the modeling of releases by gear sector and simulation evaluation of the B_{MSY}-based reference points. The longline trap and longline hook sectors of the Sablefish fishery in BC received Marine Stewardship Council certification on July 29, 2010. Certification was awarded with conditions related to (*i*) assessment of stock status relative to fishery reference points and in particular whether the stock is fluctuating around the target reference point, (*ii*) evaluation of the impacts of bycatch of the rougheye/blackspotted rockfish complex, (*iii*) evaluation of existing sea-bird bycatch data and improvement of seabird bycatch monitoring data collection.

New research planned for the annual survey and commercial fishing trips to the northern seamount fishery in 2013 focuses on (1) quantifying bottom contact by fixed longline trap gear; (2) biological sampling and tagging of Sablefish at seamounts, and (3) continuing biological data collection for the Blackspotted/Rougheye Rockfish sibling species complex:

1. Quantifying bottom contact is a first step toward evaluating and (possibly) mitigating effects of fishing on benthic habitat, as per requirements under the DFO Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas. This activity is also consistent with Marine Stewardship Council Condition 5 on the Sablefish fishery, which requires that the management system demonstrate "… *sufficient data are available to allow the nature of the interaction of the fishery on habitat types to be identified and that there is reliable information on the spatial extent of the interaction, and timing and location of use of the fishing gear*".

2. Biological sampling includes measurements of individual sablefish length, sex, maturity, and extraction of ageing structures (i.e., otoliths). The tagging activity includes the first attempts to release tagged sablefish at seamounts since a small release was conducted in 1987. Tag releases-recoveries obtained from this research work will be analyzed along with coastal tag releases-recoveries to determine the possible extent of sablefish movement between seamounts and coastal areas.

3. Sampling of Blackspotted and Rougheye Rockfish will be undertaken as opportunities arise to fulfill biological and genetic data needs in support of the *Management Plan for the Rougheye Rockfish Complex (Sebastes aleutianus and S. melanostictus) and Longspine Thornyhead (Sebastolobus altivelis) in Canada*.

Electronic equipment will be deployed affixed to Sablefish traps during permitted fishing operations. The following devices will be attached within traps:

1. Tri-axial accelerometers that produce measurements of quasi-continuous 3-axis motion and orientation of fishing traps;

2. Deep-water autonomous cameras affixed to traps that produces motion-activated and fixed-interval high definition video of benthic substrate type, gear interaction with the substrate, and biological communities);

3. Standard oceanographic temperature-depth recorders (Seabird SBE39's) that measure *in situ* depth and temperature data needed for gear mobility (depth) and habitat suitability modeling (both).

Successful development of the methodology for quantifying the nature of interaction between fishing gear and benthic habitat at seamounts will encourage application to continue similar activities during permitted commercial fishing operations in the future at seamounts, and for research on fishing gear interactions with benthic habitat during coastal commercial fishing.

6. Flatfish

a. Research program in 2012

Ongoing data collection in support of the flatfish research program continued in 2012 with samples being collected during two Groundfish synoptic bottom trawl surveys, the first off the west coast of Vancouver Island and the second off the west coast of Haida Gwaii. Additional samples were collected by port samplers in Vancouver as well as by at-sea observers deployed on bottom trawl vessels. During surveys biological data were collected from all flatfish species encountered.

b. Research activities planned for 2013

Biological data collection for all flatfish species will continue in 2013 with fishery independent samples coming from Hecate Strait/Dixon Entrance and Queen Charlotte Sound synoptic surveys.

c. Stock assessments planned for 2013

A coast wide assessment of Rock Sole is planned for 2013. The required aging is complete, a project charter has been drafted, a working group formed and the assessment is scheduled to be reviewed in November of 2013.

7. Lingcod

a. Research programs in 2012

A Lingcod (*Ophidodon elongatus*) egg mass survey was conducted by DFO SCUBA divers at Snake Island Reef and Entrance Island Reef in the Strait of Georgia in February 2013. This survey was undertaken to add to the existing time series from Snake Island Reef, one of the primary index sites, and to provide an ongoing source of biological and relative abundance information for Strait of Georgia Lingcod.

b. Research activities planned for 2013

Starting in 2012, Dr. Murdoch McAllistair from the University of British Columbia will be leading a multi-year research project aimed at using management strategy evaluation to identify economically viable harvesting options for the BC small boat groundfish fleet. This project is funded by the National Sciences and Engineering Research Council of Canada's (NSERC) *Canadian Capture Fisheries Research Network.* The outside Lingcod fishery will be used as an initial case study for this research, with the Lingcod portion of the research focusing on the question of how seasonal differences in habitat use and vulnerability to capture between male and female Lingcod affect management performance for different harvest options. DFO staff will be collaborating on this project.

c. Stock assessments planned for 2013

A stock assessment of the inside (Strait of Georgia) Lingcod stock is planned for May 2014. As part of the assessment, a management strategy evaluation (MSE) approach will be used to provide harvest advice. MSE will be used to compare performance measures based on stock status and yield for alternative harvest strategies identified by groundfish managers and a multi-stakeholder working group. This comparison will enable managers to identify which harvest strategy provides the most acceptable trade-off between performance measures, while ensuring that the objectives and risk tolerances identified by both the DFO Precautionary Approach Framework and stakeholders are met.

8. Pacific Hake

a. Research programs in 2012

Triennial (until 2001), then biennial acoustic surveys, covering the known extent of the Pacific Hake stock have been done since 1995. Though it was unscheduled, a full survey, ranging from California to northern British Columbia was done in 2012: this survey was done in response to concern about the status of the stock due to the 2012 survey biomass estimate of 521,000 metric tonnes, which was the lowest estimate since the beginning of the time series in 1995; the 2012 survey biomass estimate was 1,380,724 metric tonnes. The abundance was dominated by two and four-year old fish from the 2008 and 2010 year classes. Following the 2010 assessment, nearly all of the data sources available for Pacific Hake were reconstructed and thoroughly re-evaluated by US scientists, with input from Canadian scientists. These improved data streams were updated for 2013 with the addition of new age distributions from the 2012 fishery and acoustic survey, as well as the 2012 acoustic survey biomass index.

b. Stock assessments planned for 2013

Coastwide landing for Pacific hake in 2012 were 204,040 mt. In Canada, the assessment-based allocation for 2012 was 50,345 mt; with the additional overage carried forward from 2011 this became 65,772 mt. The fishery caught 46,776 mt, 92.9% of the 2012 allocation or 71.1% of the total allocation including the overages from 2011. Since the catch was only 71.1% of the total, the fishery will again be allowed the maximum 15% overage for the 2013 season. The 2012 catch was taken solely by the shore-based fishery; the JV fishery was not opened. The 2012 fishery followed the same spatial pattern as in the last several years with older, larger fish caught in Queen Charlotte Sound later in the year and a large portion of the total caught in the vicinity of La Perouse Bank throughout the summer and fall months. Quatsino Sound and Brooks Peninsula have also become hotspots for the fishery in the last two years.

Management of Pacific Hake is now under treaty between Canada and the United States. The Joint US-Canada Agreement for Pacific Hake (called the Agreement) was formally ratified in 2006 (signed in 2007) by the United States as part of the reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act. Although the Agreement has been considered to be in force by Canada since June 25, 2008, an error in the original U.S. text required that the Agreement be ratified again before it could be implemented. This second ratification occurred in 2010. Under The Agreement, Pacific Hake stock assessments are to be prepared by the Joint Technical Committee (JTC) comprised of both U.S. and Canadian scientists and reviewed by the Scientific Review Group (SRG), with national representatives to both groups appointed by their respective governments.

In contrast to previous years, the 2013 assessment for Pacific Hake used a single assessment model. The JTC used the Stock Synthesis platform, with the same base-case parameterization that was used in the 2012 assessment. The assessment depends primarily upon the acoustic survey biomass index (1995, 1998, 2001, 2003, 2005, 2007, 2009, 2011 and 2012) for information on the scale of the current hake stock. The 2011 index was the lowest in the time-series but the 2012 index was much greater. The aggregate fishery age-composition data (1975–2012) and the age-composition data from the acoustic survey contribute to the model's ability to resolve strong and weak cohorts. Both sources show a somewhat strong 2008 cohort and a strong 2010 cohort, but the 2011 and 2012 age compositions differ slightly regarding the relative magnitude of the weaker 2005 and 2006 cohorts. Applying the default F40% target harvest rate with a 40:10 adjustment, led to a median predicted catch of 626,364 mt but the TAC was set to be much lower.

The key uncertainty in the 2013 assessment was the strength of the 2010 year class. The 2013 assessment showed that until cohorts are five or six years old, the model's ability to resolve cohort strength is poor. For many of the recent above-average cohorts (2005, 2006, and 2008), the size of the year class was overestimated when it was age 2, compared to updated estimates as the cohort aged and more observations were available from the fishery and survey. Accordingly, the 2013 TAC was set with some caution.

The final decision on catch advice for the 2013 fishing season was made at the meeting of the International Pacific Hake Joint Management Committee in Lynnwood, WA on March 18-19, 2013. The final, coast-wide, unadjusted quota was 336,200 mt with an adjusted quota (including carry overs) of 365,112 mt. All Pacific Hake Agreement documents are posted at: http://www.nwr.noaa.gov/fisheries/management/whiting/pacific_whiting_treaty.html

9. Elasmobranchs

a. Research programs in 2012

Ongoing collaboration with the Alaska Fisheries Science Center and Moss Landing Marine Labs, on a collaborative project on bomb dating for age validation of Big Skate (*Raja binoculata*) and Longnose Skate (*R. rhina*). A population genetics study for Salmon Shark in the North Pacific began with collaborators from Alaska, California and Mexico. Age determination studies on Spotted Ratfish will be completed in 2012. A population genetics study for blue shark in the North Pacific was completed with collaborators from California, Alaska, Hawaii and Japan. Age determination studies on Spotted Ratfish was completed in 2012 using volmerine tooth plate ridge counts.

b. Stock assessment in 2012

There were no elasmobranch assessments in 2012.

c. Management

There were no new elasmobranch management iniatives in 2012.

d. Research activities for 2013.

A stock assessment for Big Skate (*Raja binoculata*) and Longnose Skate (*R. rhina*) will be completed in May 2013.

D. Other related studies

1. Statistics and Sampling

a. Biological sampling and database work in 2012

Principal Statistics and Sampling activities in 2012 included the ongoing population of the groundfish biological database (GFBio). This database now includes almost 9,100,000 specimens. Data entry activities continue to concentrate on the input of current port sampling and observer biological data and recent research cruises. The groundfish trawl fishery continues to be covered by 100% dockside and virtually 100% observer coverage. These observers also provided 297 length/sex/age samples and 189 length samples in 2012. Port samplers provided an additional 29 samples, all except one sample with ageing structures (length/sex/age/weight). The focus of their sampling efforts was from those fisheries not covered by at-sea observers.

Statistics and Sampling staff also took the lead DFO role in assisting Industry and ENGO personnel in data analysis to support development of a plan to freeze and shrink the extent of bottom trawling on the BC coast. It is expected that the plan will be implemented in early 2012.

b. Catch monitoring in 2012

Staff continued to play a key role in development of a new Regional Catch Monitoring information system as well being actively involved in the Groundfish Hook and Line Catch Monitoring Program and a Recreational Catch Monitoring Working Group.

c. Field work in 2012

Staff participated on various bottom trawl surveys (see Summary of Groundfish Surveys below) including the west coast of Vancouver Island and west coast of Haida Gwaii (formerly called Queen Charlotte Island) groundfish trawl surveys, a new Strait of Georgia survey, the West Coast Vancouver Island, and Queen Charlotte Sound shrimp trawl surveys, as well as the Pacific Hake hydroacoustic survey and Sablefish survey. This group also included the port sampling activity (1 person-year) in the Vancouver area. Staff continued to enhance GFBioField, the integrated (paper-less) data capture system for surveys.

d. Proposed field and database work for 2013

Port sampling in the Vancouver area will continue in 2013, and will include the addition of sampling sablefish tag recoveries and frozen samples from seamount trips.

Staff will participate in bottom trawl surveys to Hecate Strait and Queen Charlotte Sound, the shrimp trawl surveys off the west coast of Vancouver Island and in Queen Charlotte Sound, the Pacific Hake hydroacoustic survey and the Sablefish survey.

Development of "GFCatchAll" as a comprehensive database that will include all known sources of groundfish catch (1900-present) was to have been started in 2012. This focus of this project is currently being reexamined.

APPENDIX 1. REVIEW OF CANADIAN GROUNDFISH FISHERIES

1. Commercial fisheries

All catch figures for the 2012 calendar year are preliminary. Canadian domestic trawl landings of groundfish (excluding halibut) in 2012 were 80,310 t, a decrease of 1% from the 2011 catch. The major species in the trawl landings were Pacific Hake (58%), Arrowtooth Flounder (6%), Walleye Pollock (6%), Pacific Ocean Perch (5%), Yellowtail Rockfish (5%), and Dover Sole (3%). Trawl production was distributed amongst areas 3C (36%), 3D (27%), 5B (10%), 5A (10%), 4B (5%), 5D (5%), 5E (3%), and 5C (2%).

Canadian landings of groundfish caught by gear other than trawl in 2012 totalled 7,175 t. Landings of Sablefish by trap and longline gear accounted for 2,562 t, approximately 32% by trap gear, 62% by longline gear and 6% by unspecified. Landings of species other than Sablefish by trap, longline, handline and troll gear accounted for 4,250 t (46% rockfish, 22% Lingcod, 20% North Pacific Spiny Dogfish, and 11% skates).

2. Recreational fisheries

Each year, Fisheries Management Branch of DFO conducts creel surveys and collects fishing lodge logbooks for the recreational angling fishery in the four south coast regions.

For the Strait of Georgia, in 2012, the estimates were generated from a combination of creel surveys and fishing lodge reports and covered the months of January to September. Provisional estimates of 2012 catches, landings and releases, for this 9-month period were 23,150 fish for Lingcod, 27,356 fish for all rockfish species, 614 fish for Pacific Halibut, 7,109 fish for Rock Sole, 5,701 fish for Starry Flounder, 11,138 fish for North Pacific Spiny Dogfish, 5,117 fish for greenlings, 2,848 fish for Pacific Cod and 1,868 fish for other groundfish species.

For the Strait of Juan de Fuca catch estimates have been generated from creel surveys and fishing lodge reports for the months of January to September. Provisional estimates for this 9-month period are 6,447 fish for Lingcod, 15,992 for all rockfish species, 4,538 fish for Pacific Halibut, 1,137 fish for rock sole, 1,389 fish for other flatfish species, 9,966 fish for North Pacific Spiny Dogfish, 7,937 fish for greenlings, and 2,736 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 2012 catches were 32,376 fish for Lingcod, 40,374 fish for all rockfish species, 36,755 fish for Pacific Halibut, 1,244 fish for North Pacific Spiny Dogfish, 3,239 fish for greenlings, and 1,174 fish for other groundfish species.

In Johnstone Strait catch estimates have been generated from creel surveys and fishing lodge reports for June to August. Provisional estimates of 2012 catches were 4,292 fish for Lingcod, 10,547 fish for all rockfish species, 6,415 fish for Pacific Halibut, 1,434 fish for Pacific cod, 1,061 fish for greenlings, 614 fish for North Pacific Spiny Dogfish and 1,276 fish for other groundfish species.

3. Joint-venture fisheries

There were no joint-venture fisheries conducted off British Columbia in 2012.

4. Foreign fisheries

There were no national or supplemental fisheries for Pacific Hake off British Columbia in 2012.

APPENDIX 2. SUMMARY OF BOTTOM TRAWL SURVEYS IN 2012

1. Multi-Species Small mesh (SHRIMP) bottom trawl Survey

An annual fixed-station survey of commercially important shrimp grounds off the West Coast of Vancouver Island was initiated in 1973. In 1998, areas in Eastern Queen Charlotte Sound were added to the survey. The survey is conducted using a shrimp bottom trawl without an excluder device. As a result, groundfish can make up a significant portion of the catch in many of the tows. Catch rate indices generated by the survey have been used to track the abundances of several groundfish stocks. Catch per unit effort is a useful indicator of stock status but additional information such as the size and age composition of the catch improves the usefulness of the index. Consequently, a program was initiated in 2003 to collect biological samples from all groundfish species caught during the survey.

The groundfish section routinely places two staff on board for the duration of the survey. Four different groundfish staff participated in the shrimp survey in 2012. Groundfish staff provide assistance in catch sorting and species identification and also collect biological samples from selected species. Since 2010 the goal has been to collect a small subset of information from as many different species in each tow as possible, as opposed to detailed information from only a few species. As such, most of the biological sampling effort has been focused on length by sex data as opposed to collecting ageing structures. Ageing structures were collected from Rougheye/ Blackspotted Rockfish, Bocaccio Rockfish, and Pacific Cod.

The 2012 survey was conducted onboard the W.E. Ricker and ran from April 26 to May 22. A total of 179 tows were conducted. The total catch weight of all species was 73,426 kg. The mean catch per tow was 410 kg, averaging 26 different species of fish and invertebrates in each. The most abundant fish species encountered was Arrowtooth Flounder (*Atheresthes stomias*) followed by Pink Shrimp (*Pandalus jordani*) and Eulachon (*Thaleichthys pacificus*). Biological data were collected from a total of 32,436 individual fish from 44 different groundfish species.

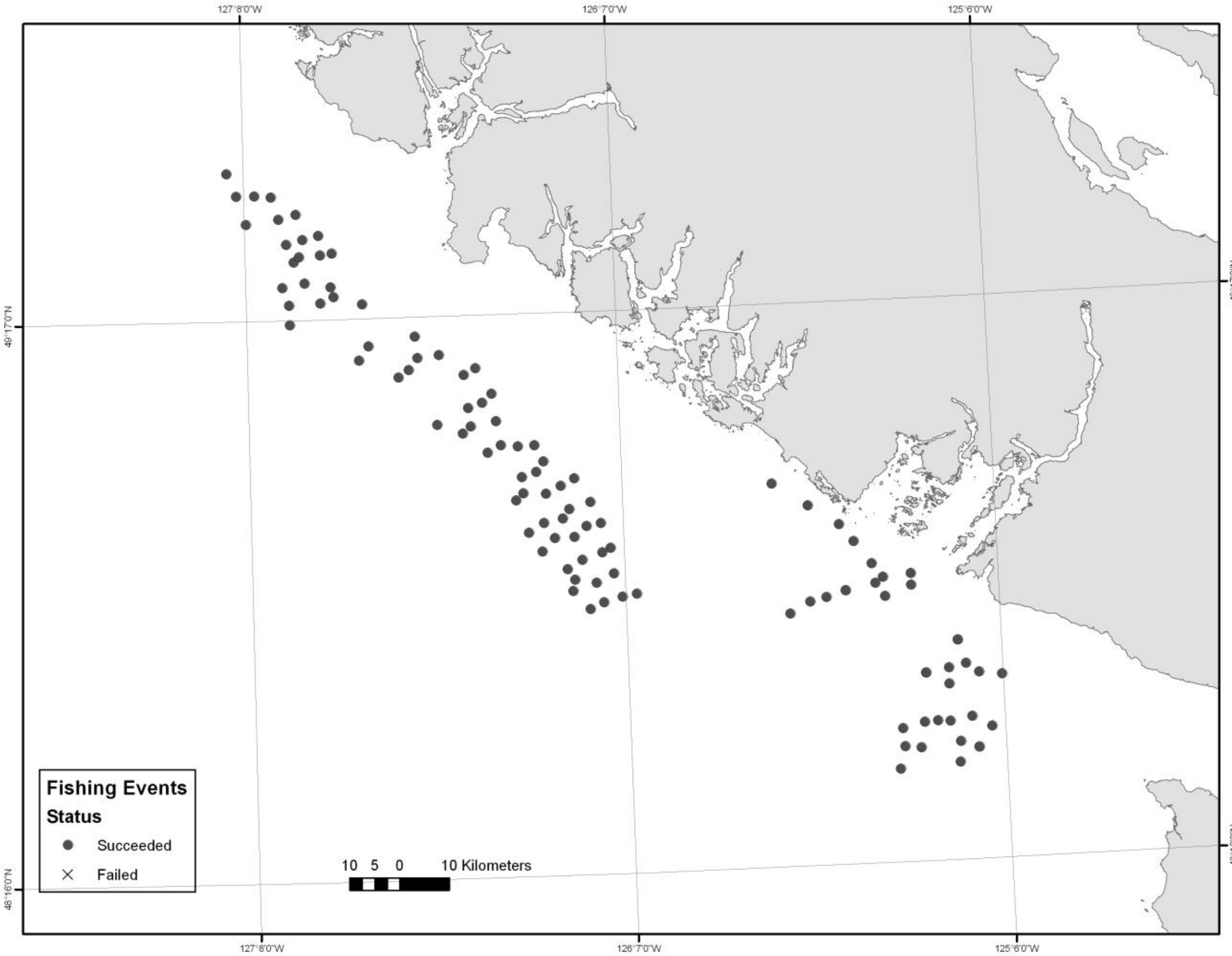

Figure 4. West Coast Vancouver Island set locations of the 2012 Multi-species Small Mesh Bottom Trawl Survey.

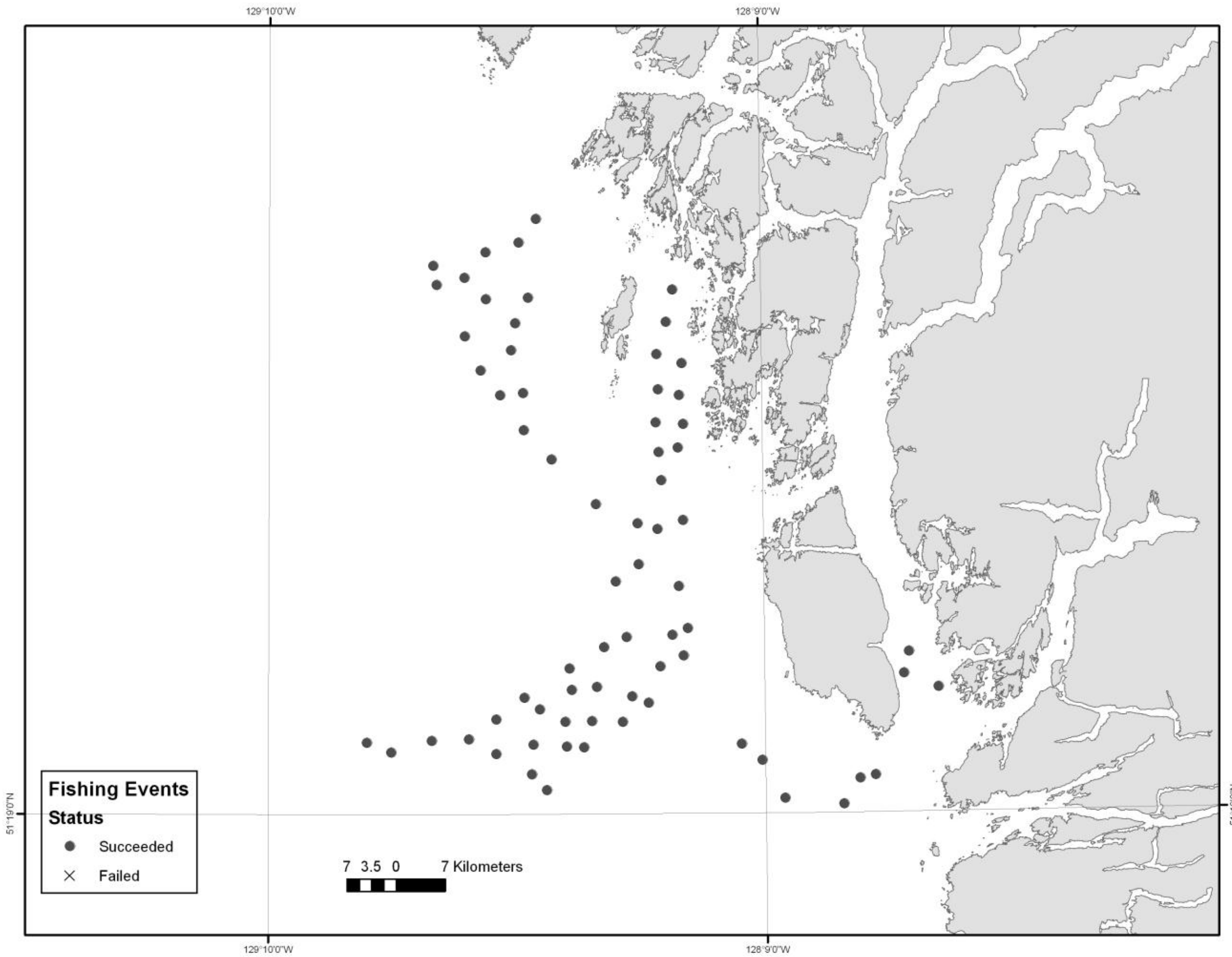

Figure 5. Eastern Queen Charlotte Sound set locations of the 2012 Multi-species Small Mesh Bottom Trawl Survey

Table 1. Number of tows, catch weight, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the West Coast Vancouver Island set locations of the 2012 Multi-species Small Mesh Bottom Trawl Survey.

Species	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
Eulachon	67	2222	2559	0.18
Arrowtooth Flounder	71	1747	1917	0.18
Pacific Herring	59	1394	1795	0.37
Pacific Cod	55	1356	1388	0.34
Rex Sole	71	1070	1251	0.09
Walleye Pollock	42	791	911	0.43
Spotted Ratfish	70	694	767	0.09
Dover Sole	69	478	498	0.17
Yellowtail Rockfish	30	455	509	0.41
Pacific Sanddab	33	427	407	0.28
Slender Sole	71	329	372	0.11
Flathead Sole	61	290	291	0.15
Lingcod	36	234	283	0.20
English Sole	44	227	273	0.26
Pacific Halibut	32	204	243	0.18
Greenstriped Rockfish	22	200	293	0.61
Silvergray Rockfish	2	190	289	0.80
Blackbelly Eelpout	47	176	165	0.32
Canary Rockfish	10	114	168	0.55
Longnose Skate	42	110	122	0.18
Petrale Sole	44	107	119	0.18
Sablefish	29	89	84	0.32
North Pacific Spiny Dogfish	15	72	78	0.35
Pacific Ocean Perch	38	53	48	0.78
Redstripe Rockfish	3	25	37	0.92

Table 2. Number of tows, catch weight, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the eastern Queen Charlotte Sound set locations of the 2012 Multi-species Small Mesh Bottom Trawl Survey.

Species	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
Arrowtooth Flounder	67	9928	8663	0.13
Eulachon	55	1792	1511	0.29
North Pacific Spiny Dogfish	34	1605	1349	0.49
Spotted Ratfish	64	1194	965	0.13
Blackbelly Eelpout	60	1121	934	0.25
Flathead Sole	59	1069	886	0.16
Dover Sole	67	873	768	0.16
Pacific Ocean Perch	43	661	593	0.53
Rex Sole	67	409	349	0.19
Walleye Pollock	36	354	268	0.26
Longnose Skate	35	311	267	0.20
Yellowtail Rockfish	29	265	228	0.39
Slender Sole	58	230	191	0.15
Big Skate	10	130	108	0.37
English Sole	19	106	86	0.28
Silvergray Rockfish	14	104	91	0.57
Pacific Halibut	18	104	89	0.28
Pacific Cod	19	86	66	0.29
Pacific Sanddab	4	78	66	0.64
Sablefish	34	61	50	0.16
Bocaccio	3	44	28	0.75
Petrale Sole	24	34	29	0.20
Lingcod	7	32	27	0.43
Sandpaper Skate	18	29	25	0.26
Redbanded Rockfish	17	28	25	0.29

2. Multi-species Synoptic bottom trawl surveys

Fisheries and Oceans, Canada (DFO) together with the Canadian Groundfish Research and Conservation Society (CGRCS) have implemented a comprehensive multi-species bottom trawl survey strategy that covers most of the BC Coast. The objectives of these surveys are to provide fishery independent abundance indices of as many benthic and near benthic fish species available to bottom trawling as is reasonable while obtaining supporting biological samples from selected species. The abundance indices and biological information are incorporated into stock assessments, status reports, and research publications.

The surveys follow a random depth stratified design. Fishing sites are predetermined by randomly selecting survey blocks (2 km x 2 km) within each depth strata. If a survey block is not fishable for any reason it will be abandoned and the vessel will proceed to the next block.

There are four surveys, two of which are conducted each year. The Hecate Strait survey and the Queen Charlotte Sound survey are conducted in odd-numbered years while the West Coast Vancouver Island survey and the West Coast Haida Gwaii (formerly Queen Charlotte Islands) survey are conducted on even-numbered years. Surveys are conducted on both chartered commercial vessels and government research vessels. The Hecate Strait survey and the West Coast Vancouver Island survey are conducted on a Canadian Coastguard research trawler while the Queen Charlotte Sound survey and the West Coast Haida Gwaii are conducted on chartered commercial fishing vessels.

In 2012, the West Coast Vancouver Island and West Coast Haida Gwaii surveys were conducted. In addition, a Strait of Georgia Multi-species Synoptic Bottom Trawl Survey was conducted in March. The Strait of Georgia survey follows all the same protocols as the other multi-species synoptic bottom trawl surveys. A smaller bottom trawl net (Yankee 36) is used but otherwise all fishing and sampling protocols are the same. The Strait of Georgia survey is planned to be repeated every three to five years.

2.1 West Coast Vancouver Island Multi-species Synoptic Bottom Trawl Survey

The West Coast Vancouver Island Multi-Species Synoptic Bottom Trawl Survey was conducted on the Canadian Coast Guard Ship W. E. Ricker between May 22 and June 16. We conducted a total of 157 tows; 150 were successful and 7 were failures due to hang ups or insufficient bottom time. We assessed a total of 200 blocks (Table 3).

A total of 12 different DFO staff, one summer co-op student and two contractors participated in the survey.

The total catch weight of all species was 109,192 kg. The mean catch per tow was 700 kg, averaging 25 different species of fish and invertebrates in each. The most abundant fish species encountered were North Pacific Spiny Dogfish (*Squalus suckleyi*), Redstripe Rockfish (*Sebastes proriger*), Pacific Ocean Perch (*Sebastes alutus*), and Arrowtooth Flounder (R*einhardtius stomias*). Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 31,913 individual fish of 73 different species. Oceanographic data, including water temperature, depth, salinity, and dissolve oxygen were also recorded for most tows.

Table 3. 2012 West Coast Vancouver Island Multi-Species Synoptic Bottom Trawl Survey final block summary showing the number of blocks rejected based on fishing master's knowledge or by on-ground inspection, number of failed blocks (due to hang-ups or insufficient bottom time), number of successful tows, and number of un-fished blocks (due to other reasons such as tide, weather, or other vessels) per survey stratum.

Depth Stratum (m)	Rejected Prior	Rejected Inspected	Failed	Success	Not Fished	Total
50 - 125	4	17	2	59	0	82
125 - 200	7	7	0	46	0	60
200 - 330	2	4	1	25	0	32
330 - 500	2	3	0	20	1	26
Total	**15**	**31**	**3**	**150**	**1**	**200**

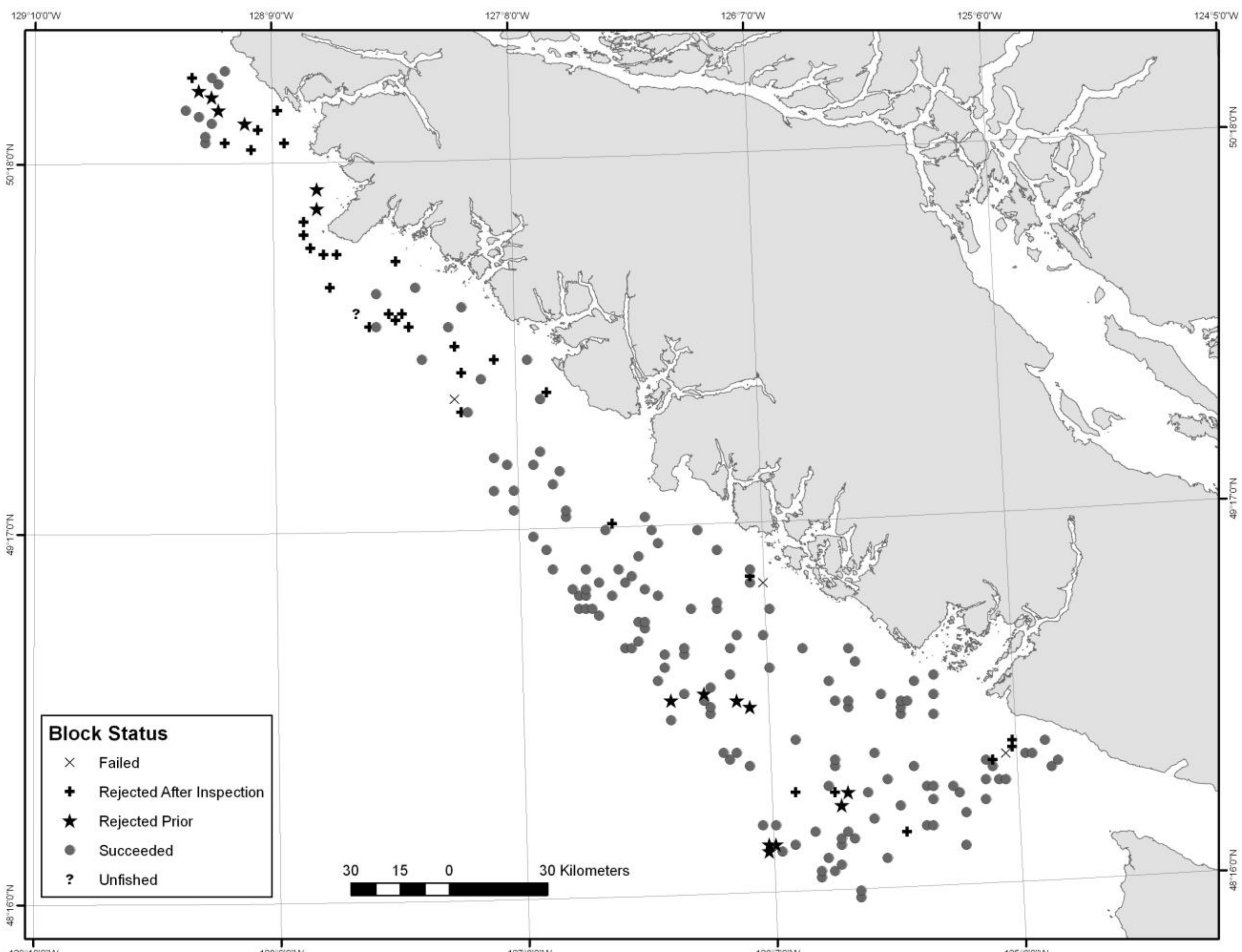

Figure 6. Final status of the allocated blocks for the 2012 West Coast Vancouver Island Multi-Species Synoptic Bottom Trawl Survey.

Table 4. Number of tows, catch weight, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the 2012 West Coast Vancouver Island Multi-Species Synoptic Bottom Trawl Survey.

Species	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
North Pacific Spiny Dogfish	92	15812	11128	0.44
Redstripe Rockfish	44	12067	7722	0.66
Arrowtooth Flounder	136	10723	5807	0.14
Pacific Ocean Perch	62	10519	2998	0.26
Sharpchin Rockfish	58	9240	3267	0.40
Splitnose Rockfish	37	6227	1716	0.34
Silvergray Rockfish	46	4883	2927	0.76
Sablefish	70	4740	1553	0.34
Spotted Ratfish	136	4533	3343	0.26
Canary Rockfish	49	3105	2090	0.61
Dover Sole	132	3016	1515	0.11
Rex Sole	137	2456	1532	0.08
Yellowtail Rockfish	41	1794	1161	0.30
English Sole	91	1484	1211	0.23
Pacific Hake	52	1411	708	0.59
Greenstriped Rockfish	67	1376	837	0.17
Pacific Cod	95	1295	974	0.18
Pacific Sanddab	48	1006	834	0.31
Flathead Sole	55	964	760	0.28
Lingcod	88	882	640	0.16
Shortspine Thornyhead	42	866	252	0.12
Petrale Sole	90	815	676	0.22
Pacific Halibut	61	774	587	0.21
Redbanded Rockfish	46	745	280	0.31
Longnose Skate	62	649	358	0.22

2.2 West Coast Haida Gwaii Multi-species Synoptic Bottom Trawl Survey

The West Coast Haida Gwaii Multi-Species Synoptic Bottom Trawl Survey was conducted on the F/V Nordic Pearl between August 24 and September 19. We conducted a total of 141 tows; 130 were successful and 11 were failures due to hang ups or insufficient bottom time. We assessed a total of 141 blocks (Table 5). Note that some blocks may have multiple failed tows and a successful tow.

A total of 5 different DFO staff and three contractors participated in the survey.

The total catch weight of all species was 148,939 kg. The mean catch per tow was 1063 kg, averaging 19 different species of fish and invertebrates in each. The most abundant fish species encountered were Pacific Ocean Perch (*Sebastes alutus*), Rougheye/ Blackspotted Rockfish (*Sebastes aleutianus/ melanostictus*), Sharpchin Rockfish (*Sebastes zacentrus*), and Silvergray Rockfish (*Sebastes brevispinis*). Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 17,137 individual fish of 53 different species. Oceanographic data, including water temperature, depth, salinity, and dissolve oxygen were also recorded for most tows.

Table 5. 2012 West Coast Haida Gwaii Multi-Species Synoptic Bottom Trawl Survey final block summary showing the number of blocks rejected based on fishing master's knowledge or by on-ground inspection, number of failed blocks (due to hang-ups or insufficient bottom time), number of successful tows, and number of un-fished blocks (due to other reasons such as tide, weather, or other vessels) per survey stratum.

Depth Stratum (m)	Rejected Prior	Rejected Inspected	Failed	Success	Not Fished	Total
180 - 330	0	5	1	75	0	81
330 - 500	0	3	1	29	0	33
500 - 800	0	1	0	10	0	11
800 - 1300	0	0	0	16	0	16
Total	**0**	**9**	**2**	**130**	**0**	**141**

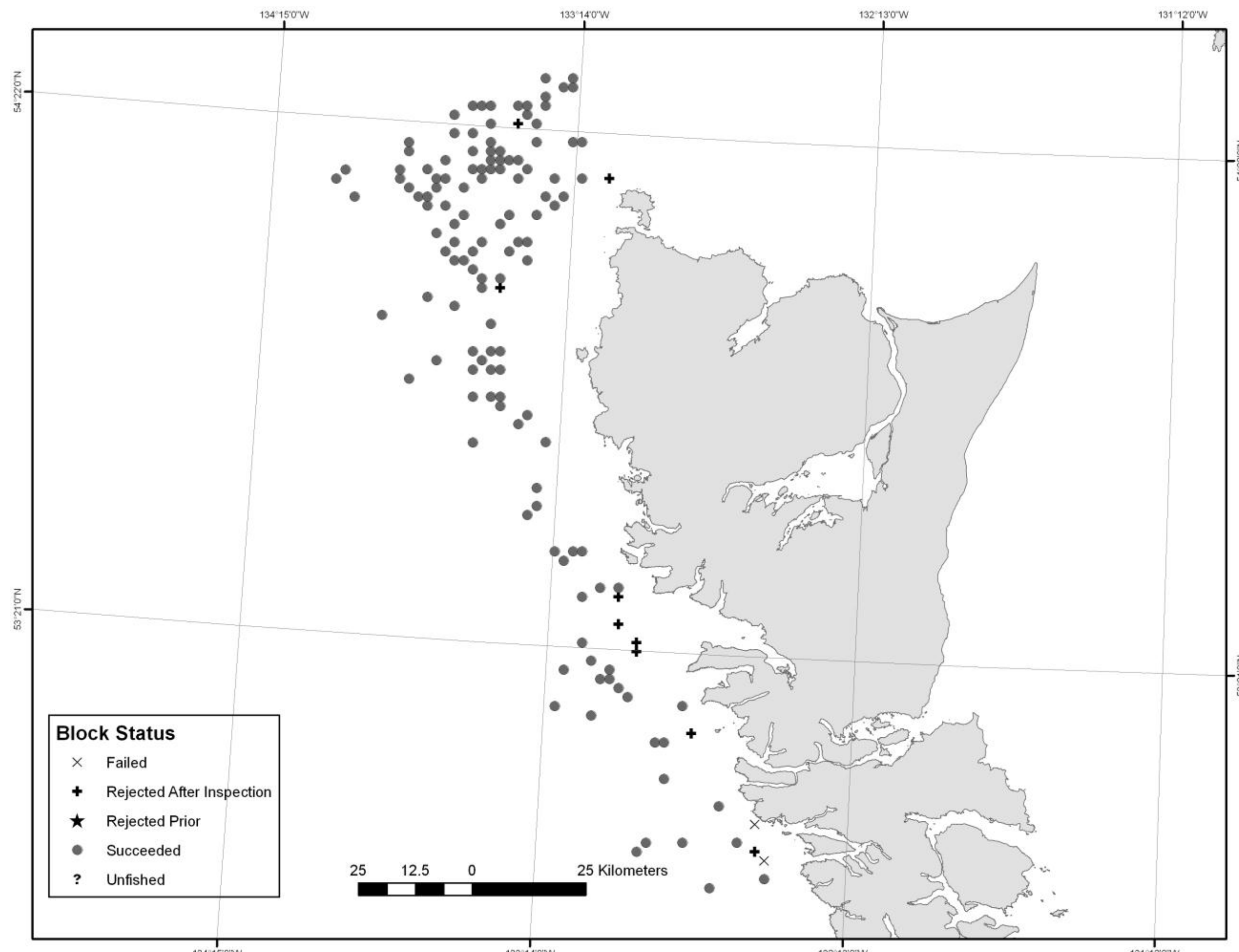

Figure 7. Final status of the allocated blocks for the 2012 West Coast Haida Gwaii Multi-Species Synoptic Bottom Trawl Survey.

Table 6. Number of tows, catch weight, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the 2012 West Coast Haida Gwaii Multi-Species Synoptic Bottom Trawl Survey.

Species	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
Pacific Ocean Perch	86	58824	4699	0.22
Rougheye/ Blackspotted Rockfish	66	17558	3006	0.38
Sharpchin Rockfish	67	15108	1215	0.49
Silvergray Rockfish	75	12405	1058	0.30
Yellowmouth Rockfish	24	9081	1041	0.34
Redstripe Rockfish	39	6342	314	0.43
Shortspine Thornyhead	116	4346	630	0.14
Arrowtooth Flounder	104	3145	316	0.25
Sablefish	69	2568	640	0.29
Pacific Hake	47	1649	312	0.32
Widow Rockfish	21	1102	111	0.48
Shortraker Rockfish	22	971	179	0.53
Dover Sole	92	743	121	0.23
Rex Sole	99	718	80	0.20
Pacific Halibut	45	708	70	0.29
Splitnose Rockfish	16	638	149	0.61
Pacific Grenadier	23	629	271	0.26
Redbanded Rockfish	83	618	66	0.28
Rosethorn Rockfish	76	509	48	0.20
Longspine Thornyhead	26	462	164	0.24
Giant Grenadier	22	450	199	0.37
Walleye Pollock	67	425	60	0.23
Pacific Cod	34	381	36	0.37
Popeye	22	368	61	0.37
Harlequin Rockfish	37	363	25	0.65

2.3 Strait of Georgia Multi-species Synoptic Bottom Trawl Survey

The Strait of Georgia Multi-Species Synoptic Bottom Trawl Survey was conducted on the Canadian Coast Guard Ship W. E. Ricker between March 14 and 24. We conducted a total of 53 tows; 52 were successful and 1 was a failure due to hang ups or insufficient bottom time. We assessed a total of 108 blocks (Table 7).

A total of 11 different DFO staff and one contractor participated in the survey.

The total catch weight of all species was 14,855 kg. The mean catch per tow was 280 kg, averaging 23 different species of fish and invertebrates in each. The most abundant fish species encountered were English Sole (*Parophrys vetulus*), North Pacific Spiny Dogfish (*Squalus suckleyi*), Spotted Ratfish (*Hydrolagus colliei*), and Walleye Pollock (*Theragra chalcogramma*). Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 9,913 individual fish of 46 different species. Oceanographic data, including water temperature, depth, salinity, and dissolve oxygen were also recorded for most tows.

Table 7. 2012 Strait of Georgia Multi-Species Synoptic Bottom Trawl Survey final block summary showing the number of blocks rejected based on fishing master's knowledge or by on-ground inspection, number of failed blocks (due to hang-ups or insufficient bottom time), number of successful tows, and number of un-fished blocks (due to other reasons such as tide, weather, or other vessels) per survey stratum.

Depth Stratum (m)	**Rejected Prior**	**Rejected Inspected**	**Failed**	**Success**	**Not Fished**	**Total**
10 - 75	9	5	0	7	0	21
75 - 150	9	9	0	8	0	26
150 - 250	4	7	1	16	0	28
250 - 500	7	6	0	20	0	33
Total	**29**	**27**	**1**	**51**	**0**	**108**

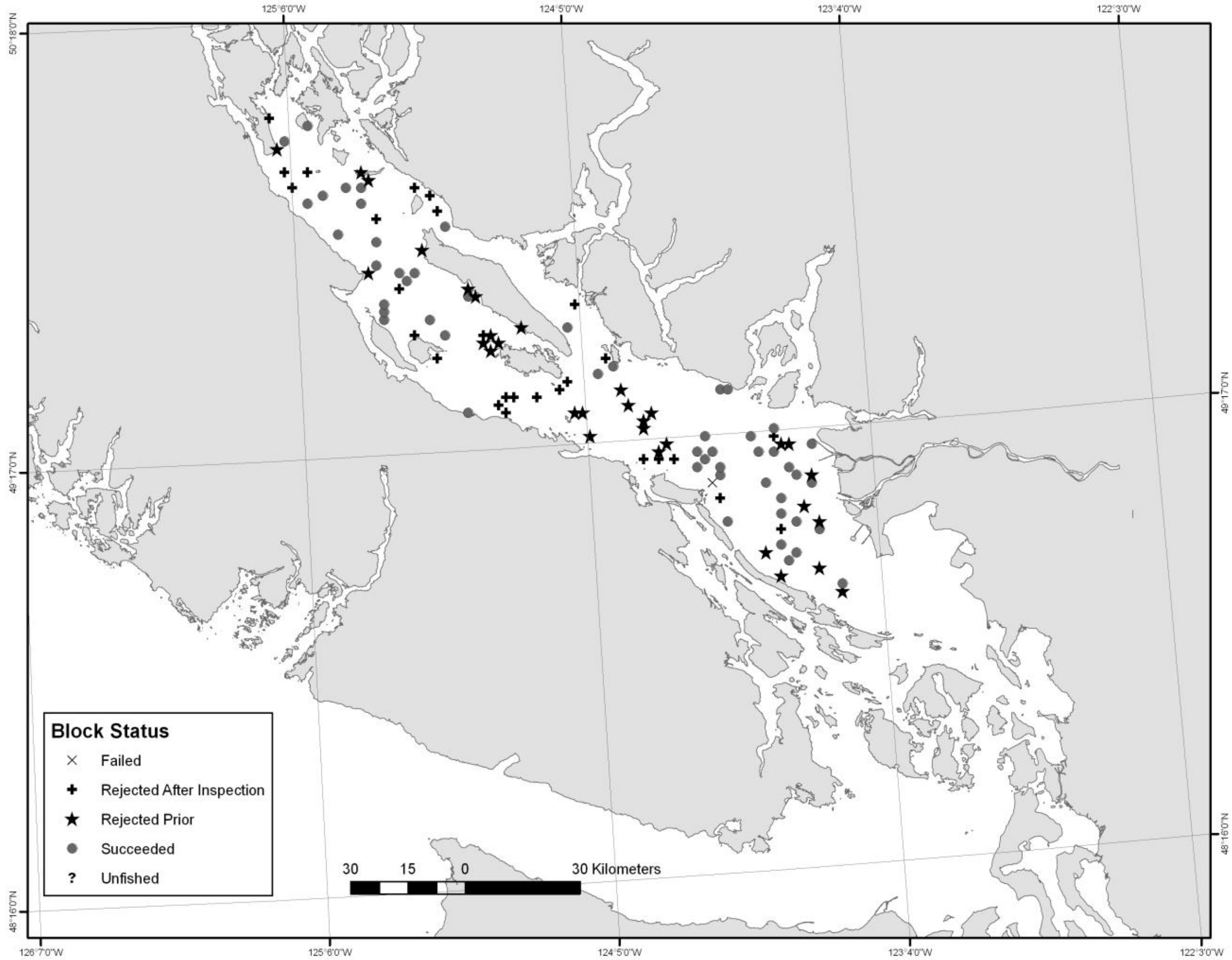

Figure 8. Final status of the allocated blocks for the 2012 Strait of Georgia Multi-Species Synoptic Bottom Trawl Survey.

Table 8. Number of tows, catch weight, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the 2012 Strait of Georgia Multi-Species Synoptic Bottom Trawl Survey.

Species	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
English sole	48	2615	4834	0.45
North pacific spiny dogfish	48	2271	1926	0.14
Spotted ratfish	50	2250	1924	0.13
Walleye pollock	44	2084	1791	0.36
Shiner perch	8	948	917	0.7
Slender sole	48	776	826	0.3
Pacific hake	45	591	538	0.24
Pacific cod	14	388	518	0.77
Southern rock sole	11	373	397	0.52
Flathead sole	22	336	1422	0.82
Starry flounder	3	236	369	0.53
Plainfin midshipman	18	192	224	0.42
Dover sole	41	188	141	0.2
Pacific sanddab	6	164	291	0.47
Rex sole	33	51	71	0.34
Arrowtooth flounder	26	51	47	0.29
Longnose skate	29	50	44	0.23
Blackbelly eelpout	16	47	123	0.65
American shad	21	30	25	0.25
Pacific herring	17	26	28	0.26
Greenstriped rockfish	14	22	26	0.3
Lingcod	5	21	21	0.55
Splitnose rockfish	13	20	18	0.42
Brown cat shark	23	19	13	0.2
Eulachon	11	12	11	0.33

APPENDIX 3. PARTIAL LIST OF GROUNDFISH RELATED REPORTS WITH 2012 PUBLICATION DATES.

PRIMARY

Edwards, A.M., Freeman, M.P., Breed, G.A., and Jonsen, I.D. 2012. Incorrect likelihood methods were used to infer scaling laws of marine predator search behaviour. ***PLOS ONE,*** **7(10)**: e45174.

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APPENDIX 3. GROUNDFISH STAFF IN 2013

Greg Workman	Section Head
Schon Acheson	Technician, Pacific Hake, port sampling and surveys
Bill Andrews	Technician, surveys
Kristina Anderson	Technician, Sablefish and surveys
Karina Cooke	Technician, Database support and surveys, Inshore Rockfish
Andrew Edwards	(Program Head) Statistical and mathematical modelling, stock assessment
Robyn Forrest	Scientist, Pacific Cod, Pacific Halibut, stock assessment
Chris Grandin	Program Head, Pacific Hake stock assessment and Port sampling
Rowan Haigh	Statistical and exploratory data analysis, stock assessment, R packages
Kendra Holt	Program Head, Lingcod, Flatfish stock assessment, ERAEF
Jackie King	Scientist, Elasmobranchs, Climate studies
Brian Krishka	Biologist, Database support and analysis, Flatfish
Rob Kronlund	Program Head Sablefish, Analytical programs
Lisa Lacko	Biologist, GIS specialist and database manager, Sablefish
Sandy McFarlane	Emeritus scientist
Wendy Mitton	Technician, Sablefish
Norm Olsen	Biologist, Programmer/GIS, Groundfish Statistics, Shelf Rockfish
Kate Rutherford	Biologist, Database manager, Groundfish Statistics, Shelf Rockfish
Jon Schnute	Emeritus scientist
Alan Sinclair	Emeritus scientist
Rick Stanley	Program Head, Shelf Rockfish assessment and biology, Groundfish Statistics.
Maria Surry	Technician, Elasmobranchs
Nathan Taylor	Program Head, Groundfish surveys, Shelf Rockfish, Pacific Hake stock assessment
Malcolm Wyeth	Biologist, Groundfish surveys
Lynne Yamanaka	Program Head, Inshore rockfish research and stock assessment

2013 IPHC Research Report for TSC
Review of 2012 Projects and Proposals for 2013
International Pacific Halibut Commission Staff

Introduction
This report reviews research conducted by the IPHC staff in the past year as well as research proposed for the upcoming year. The report is divided into three sections: the first section briefly reviews staff changes over the past and upcoming year(s), the second section reviews the status of research conducted in 2012, and the third section presents the preliminary staff research proposals for 2013 and a summary of ongoing projects. This report does not include annual staff tasks such as data collection and processing that are necessary for the management of the fishery.

SECTION I: Staffing Updates

In 2012, the IPHC hired Dr. Ian Stewart (lead Stock Assessment Scientist), Dr. Steve Martell (Quantitative Scientist), Jim Traub (Database Administrator), Ed Henry (Survey Operations Technician), and Eva Luna (Administrative Assistant). Currently, the IPHC is hiring for an Age Technician after the departure of Stephen Wischniowski. These are in addition to some standard turnover seen in both the port and sea sampling seasonal positions.

SECTION II: Review of 2012 - Project summaries

This section provides a brief recap of projects conducted in 2012. Full reports on each project can be found in the 2013 RARA.

Project 604.00: Monitoring juvenile halibut abundance via NMFS trawl surveys
Start Date: 1996
Anticipated ending: Continuing
Personnel: L. Sadorus, A. Ranta, I. Stewart

The NMFS trawl survey data series on halibut, parallel to our assessment survey data, is extremely valuable as a second fishery-independent data source for stock assessment. Trawl data are particularly useful because they include large numbers of juveniles (ages 3-7) that do not appear in large numbers in the setline survey. Otoliths have been collected on the NMFS trawl surveys since 1996 and provide relevant age information. These data are incorporated into and stored in IPHC's database, and expanded to estimates of relative abundance and age/size composition by IPHC area (NMFS calculates estimates by INPFC area). For 2012, samplers were deployed in the Bering Sea and Aleutian Island surveys.

Project 610.13: Oceanographic monitoring of the north Pacific and Bering Sea continental shelf with water column profilers

Start date: 2009
Anticipated ending: Continuing
Personnel: L. Sadorus, P. Stabeno (NMFS PMEL)

The IPHC maintains one of the most extensive sampling platforms in the North Pacific. This platform provides enormous potential for collection of valuable oceanographic data. In particular, understanding the dynamics of the structure of the mixed layer depth – a major GLOBEC goal - requires *in situ* vertical profiling. Since 2001, IPHC has successfully deployed a SeaBird SBE-19 water column profiler during the annual stock assessment survey. A second profiler was added to the program in 2007. In 2009, a NOAA grant provided for the complete outfitting of all chartered survey vessels, resulting in a complete coastwide deployment. Annual costs are directed towards maintenance and calibration of the profilers, and data preparation necessary for submission to the National Ocean Data Center. Over 1,200 casts were made in 2012.

Project 618.00: Undergraduate Internship

Start Date: 2002
Anticipated duration: Continuing
Personnel: L. Sadorus, 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. The intern is tasked with designing and executing said project. A final report and presentation are given at the conclusion of the employment term. The report is usually included in the RARA. Unfortunately, in 2012, we were unsuccessful in hiring an intern to develop an image-based technology solution for fish sampling.

Project 636.00: Evaluation of Pacific halibut macroscopic maturity stage assignments

Start: 2004
Anticipated Ending: Continuing
Personnel: K. MacTavish, other staff as needed

The staff believes it is necessary to re-evaluate our classification criteria for female gonad maturity stage. The method currently used on the assessment surveys is based on visual criteria established in the early 1990s and modified in 1995. These survey data combined with the age data are important components in the stock assessment model. Four maturity stages are presently assigned to female halibut; immature (F1), maturing (F2), spawning (F3) and resting (F4). Once a female halibut has spawned, the gonad transitions to a resting phase, back to maturing, and then to spawning again. Our criteria for classification also assume that the immature (F1) stage is only seen in immature fish but we are seeing anomalies during the survey that question this assumption. Gonad samples were collected in 2004 from which to base this study. In 2012, work was undertaken to look for a size gradient for oocytes dependent on their location within the gonad to begin the design of a sampling protocol for measurement of oocyte diameters.

Project 642.00: Assessment of mercury and contaminants in Pacific halibut

Start Date:	2002
Anticipated ending:	Continuing
Personnel:	C. Dykstra, B. Gerlach (ADEC)

The staff continued in our collaboration with the Alaska Department of Environmental Conservation (ADEC) in 2012, collecting halibut tissue samples for analysis of heavy metal and organic pollutant loading. Results from a 2002 collection of halibut samples led the Alaska Division of Public Health, in 2003, to conclude that the concentrations of heavy metals in Alaskan Pacific halibut were not a public health concern. In 2004, the first results regarding organic pollutants (PCB's, pesticides) were released demonstrating that halibut had the lowest concentrations of the five species (including salmon and sablefish) examined. The Alaska Division of Public Health updated their advice on fish consumption in 2007 with some restrictions on the number of meals of halibut for women of child bearing age and young children. 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 2012 with a targeted collection of 70 samples (15 fish between 10-20 lbs., 15 fish between 20-40 lbs., 30 fish between 40-100 lbs., and 10 fish greater than 100 lbs.) from each of four sites. Fifty-five (55) samples were obtained from Semidi, 67 from Seward, 56 from northern Washington, and 50 from southern Oregon. Since 2002, the IPHC has submitted 1,894 samples for testing by ADEC. The average total mercury content to date has been 0.30 ppm, with a maximum of 1.9 ppm.

Project 650.13: Archival tags: tag mounting protocols (OCA)

Start Date:	2009
Anticipated ending:	2014
Personnel:	T. Loher

In 2012, halibut continued to be held in tanks at the Oregon Coast Aquarium (OCA) in Newport, OR to investigate alternate mounting protocols for the externally-mounted archival tags. The 2008 releases in Area 2B were our first experience with using an external mount, and that process suggested some revisions and improvements could be possible which would reduce any effect the tags may have on the fish's behavior. Additional improvements to tag design may also be helpful in creating a different mounting device. A total of 30 halibut were captured via hook-and-line and transported live to the OCA. The fish are treated for parasites, examined regularly to assess healing and/or relative infection rates among mounting types, and behavior monitored. At the end of the holding period, fish will be measured to assess relative growth among treatment groups, and tags will be removed to examine the effects of the tag mounts on the tissue and musculature at the attachment site, or internal interactions in the case of an internal-external-streamer modification. The results will support the anticipated use of this type of technology in subsequent years.

Project 650.14: Archival tags: tag attachment protocols
Start Date: 2009
Anticipated ending: 2014
Personnel: T. Loher

External and internal tag recovery rates are being tested in the field release of archival test tags. In August-September 2009, 200 fish were tagged off southern Kodiak Island (in Areas 3A and 3B), half with external tags and half with internal implants. Fish were also tagged with a bright pink cheek tag, and rewards of $100 will be given for all tags recovered. Three of these fish were recovered in 2012.

Project 650.16: Archival tags: Area 4B site selection
Start date: 2010
Anticipated ending: 2014
Personnel: T. Loher, J. Forsberg, survey team

In 2009, 773 fish were tagged in Area 4B to evaluate tag recovery rates in preparation of a future release of archival tags in the area. Recovery rates of PIT tags released in the Aleutians were quite low, without evidence of recovery hotspots. This suggests that if archival tags were deployed in the Aleutians, we would likely recover relatively few of those tags. This would result in either too few data to draw any conclusions or require that a very large number of tags be initially deployed. Given that archival tags cost $500-1200 each, resorting to a very large deployment would be financially prohibitive and problematic. Our goal is to locate at least two release sites which will yield a sufficient number of recoveries. Eleven tags were recovered in 2011. In 2012, only five tags were recovered.

Project 650.17: Archival tags: geomag tag performance
Start Date: 2011
Anticipated ending: 2012
Personnel: T. Loher, J. Nielsen (UAF Juneau)

In 2011, we deployed both Desert Star and Lotek geomagnetic tags on 30 halibut in two regions of the Gulf of Alaska: in Area 2C, just offshore of southern Prince of Wales Island; and in Area 3A, offshore of southern Kodiak Island. Tagging was restricted to large fish (110-150 cm FL), most likely to be mature females and likely to conduct a spawning migration shortly after tagging, and was divided into two deployment locations because the coastline and bathymetry of the areas are largely perpendicular to one another with respect to the magnetic environment. In Area 2C, total magnetic field gradients run largely parallel to shore, whereas in Area 3A around Kodiak that gradient runs perpendicular to shore. As such, we hypothesized that geomagnetic positioning based on total field strength would more accurately detect onshore-offshore movement in 2C and alongshore migration around Kodiak. Only one tag has been recovered to date.

Project 661.11: *Ichthyophonus* prevalence in halibut

Start Date: 2012
Anticipated ending: 2012
Personnel: C. Dykstra, G. Williams, J. Gregg (USGS), P. Hershberger (USGS)

In 2012, tissue samples were collected in all survey areas to further describe the spatial nature of the prevalence. In addition, samples were collected from smaller juveniles caught on the NMFS trawl survey in the Bering Sea. Prevalence of infection measured at ten longline survey sites ranged from 15% near Attu Island to over 70% in Prince William Sound, with a mean overall prevalence (Bering Sea to Oregon Coast) of 47%. Prevalence in smaller halibut (<60 cm) captured by trawl in the Bering Sea and Aleutian Island was 2.4%, indicating infections establish after some ontogenetic shift in diet, habitat, or behavior. The prevalence of infection reported here is higher than that which has been observed in studies of other sympatric fish species, including other pleuronectids, suggesting that either susceptibility and/or infection pressures are higher in halibut. While ichthyophoniasis has been shown to reduce growth rate, decrease swimming stamina, and cause mortality in other fish hosts, its effects on Pacific halibut are unknown.

Project 421.11: Examination of potential alternative bait for the assessment survey

Start Date: 2012
Anticipated ending: 2012
Personnel: R. Webster, S. Kaimmer, C. Dykstra, survey team

A coastwide comparison of alternative baits for the assessment survey was conducted in 2012. A 2011 pilot study conducted to refine the experimental design also led to the decision to examine pollock and pink salmon as alternatives to the standard #2 chum salmon, in this year's study. There were significant differences in O32 WPUE between chum salmon and the two alternative baits that varied by regulatory area. Most notably, WPUE for pollock was somewhat higher in general than WPUE for the two salmon baits in the Gulf of Alaska, but much lower in parts of Area 4. There was also evidence for differences in catch rates of U32 halibut and bycatch species among the three baits. We also compared the length and age distributions of halibut caught using the three baits. The results will be further analyzed in 2013, with the expectation that any change would not be implemented until 2014, at the earliest.

Project 02.11: Hook modification study to reduce rockfish bycatch on circle hooks

Start date: 2012
Anticipated ending: 2012
Personnel: S. Kaimmer, S. Wischniowski

A pilot study was conducted to see if circle hooks could be modified to reduce rockfish bycatch. Spring wires were attached across the gap of the hook, hypothesizing that fish with less aggressive hook attacks might not hook as readily due to the wires. Although previous camera work showed hesitant hook attacks by rockfish, this study encountered larger individuals, and their attacks were aggressive enough that they could easily bend the wires across the hook gaps to become hooked.

SECTION III: Research Proposed for 2013 - Overview

Projects to be carried out in 2013 consist of new research as well as the continuation of several projects currently underway.

The IPHC conducts numerous projects annually to support both major mandates: stock assessment and basic halibut biology. Current projects include standardized stock assessment fishing surveys from northern California to the end of the Aleutian Islands, as well as field sampling in major fishing ports to collect scientific information from the halibut fleet. In conjunction with these ongoing programs, the IPHC conducts numerous biological and scientific experiments to further the understanding and information about Pacific halibut.

The 2012 IPHC Performance Review recommended the creation of a Five Year Research Plan and an Annual Research Plan (ARP). The plans would provide linkage to Commission objectives, with an accompanying process for input and periodic reviews by the Commission, interested stakeholders, the Research Advisory Board, and a peer review. The IPHC staff was tasked with developing the preliminary ARP for presentation to the Commission at the Interim Meeting in November 2012, where discussion of overall research priorities, individual studies and associated budgets occurred. The staff further developed the ARP following the Interim Meeting and presented a final ARP at the Annual Meeting, in January 2013, for Commission approval.

Research Focus and Priorities

Nearly all of the research done by the IPHC is directed toward one of three continuing objectives of the Commission: 1) improving the annual stock assessment and quota recommendations; 2) developing information on current management issues; and 3) adding to knowledge of the biology and life history of halibut. In each of these areas, the work program applies the best information and methods available, and the research program aims to improve the information and methods by answering the most important outstanding questions.

IPHC research is conducted within four areas of study as identified within the Five Year Research Plan. These areas, which connect to the IPHC mission and support the assessment and management objectives of the Commission, are: 1) assessment and stock identification; 2) management strategy; 3) biology; and 4) ecology.

The ARP is based on management and assessment needs as prioritized by the IPHC staff and Commission. It is the Commission’s long term goal to also obtain the views and advice of its Research Advisory Board (RAB) and external scientific input in the formulation and prioritization of the ARP. For 2012, this process was still being developed, so input from those sources will be brought into the process during the 2013 research development cycle.

For the past several years, two primary topics have been at the forefront of discussions about the halibut resource. The first has been the continuing decline in size at age (SAA), with the resulting effects and impacts on the assessment, harvest policy, and stock status. The second issue has been the migratory behavior of the stock, specifically seasonal and ontogenetic migration, including sex- and age-specific differences in spawning migration timing and duration. In the following section, studies for 2013 were proposed which address both topics. Briefly, the IPHC staff proposes to begin an otolith increment study which would examine growth patterns during earlier time periods. Understanding migration patterns is the overarching goal of the archival tag program, which has several aspects examining tag type, location, tag shedding and resolution of geomagnetic location data.

Proposed for 2013

Research proposed by IPHC staff goes through an internal review process by the staff Science Board. The Board met in early October, 2012 to review staff proposals for 2013 research. For each proposal, the Board discussed the merits, objectives, design, and coherence with the Commission's research goals and objectives. The Principle Investigator (PI) subsequently joined the Board for a broad discussion of the project. Concerns, questions and need for refinements or revisions, if any, about the proposal were communicated to the PI at that time. Following a full review of all proposals, the Board assigned a priority rating to each project, based on the following criteria:

High Research which has a direct bearing on the assessment or its inputs, harvest policy, or current management structure. Postponement of a high priority project would have a significant and immediate impact on management or IPHC operation.

Medium Research which addresses an assessment issue or management question/need. Postponement will not have an immediate significant impact on fishery management or IPHC operation but may impact future analyses.

Low Research which addresses current issues of any subject but is not considered having a timely need or being crucial to current IPHC management or operation.

Based on the Science Board discussions and the topics previously outlined, the IPHC staff recommends the following research studies for funding in FY2013.

Assessment and stock identification

Project 604.00: Monitoring juvenile halibut abundance via NMFS trawl surveys

Priority: High
Start Date: 1996
Anticipated ending: Continuing
Personnel: L. Sadorus, A. Ranta, I. Stewart

The NMFS trawl survey data series on halibut, parallel to our assessment survey data, is extremely valuable as a second fishery-independent data source for stock assessment. Trawl data are particularly useful because they include large numbers of juveniles (ages 3-7) that do not appear in large numbers in the setline survey. Otoliths have been collected on the NMFS trawl surveys since 1996 and provide relevant age information. These data are incorporated into and stored in IPHC's database, and expanded to estimates of relative abundance and age/size composition by IPHC area (NMFS calculates estimates by INPFC area). For 2013, samplers will be deployed in the Bering Sea and Gulf of Alaska surveys.

Project 636.00: Evaluation of Pacific halibut macroscopic maturity stage assignments

Priority: High
Start: 2004
Anticipated Ending: Continuing
Personnel: K. MacTavish, other staff as needed

The staff believes it is necessary to re-evaluate our classification criteria for female gonad maturity stage. The method currently used on the assessment surveys is based on visual criteria established in the early 1990s and modified in 1995. These survey data combined with the age data are important components in the stock assessment model. Four maturity stages are presently assigned to female halibut: immature (F1), maturing (F2), spawning (F3) and resting (F4). Once a female halibut has spawned, the gonad transitions to a resting phase, back to maturing, and then to spawning again. Our criteria for classification also assume that the immature (F1) stage is only seen with immature fish, but we are seeing anomalies during the survey that question this assumption. Gonad samples were collected in 2004 from which to base this study. In 2013, work will continue on finalizing a sampling protocol for measurement of oocyte diameters, and contract slide preparation for gonads. The PI will also begin assessment of archived gonads from a set of previously-prepared slides.

Project 650.13: Archival tags: mounting protocols (OCA)

Priority: Medium
Start Date: 2009
Anticipated ending: 2014
Personnel: T. Loher

For 2013, the staff intends to continue holding halibut in tanks at the Oregon Coast Aquarium (OCA) in Newport, OR to investigate alternate mounting protocols for the externally-mounted archival tags. A total of 30 halibut were captured via hook-and-line and transported live to the OCA. The fish are treated for parasites, examined regularly to assess healing and/or relative infection rates among mounting types, and behavior monitored. At the end of the holding period, fish will be measured to assess relative growth among treatment groups, and tags will be removed to examine the effects of the tag mounts on the tissue and musculature at the attachment site, or internal interactions in the case of an internal-external-streamer modification. The results will support the anticipated use of this type of technology in subsequent years.

Project 650.14: **Archival tags: tag attachment protocols**

Priority: High
Start Date: 2009
Anticipated ending: 2014
Personnel: T. Loher

External and internal tag recovery rates are being tested in the field release of archival test tags. In August-September 2009, 200 fish were tagged off southern Kodiak Island (in Areas 3A and 3B), half with external tags and half with internal implants. Fish were also tagged with a bright pink cheek tag, and rewards of $100 will be given for all tags recovered. Nine fish were recovered in 2011. Note that because of a subsequent decision to focus only on an external mount protocol, this project is proposed to be redone in Area 3A in 2013.

Project 650.15: **Archival tags: coastwide deployment**

Priority: High
Start Date: 2016
Anticipated ending: Continuing
Personnel: T. Loher, B. Leaman, R. Webster, J. Forsberg

In preparation for a coastwide release of archival tags in 2016, the staff has been working with Lotek Wireless (St. John's, NL) on a specific tag design and configuration for IPHC use. Although no field activity is planned for 2013, Lotek is continuing their work on our requirements and construction. Results from the 2009 release of dummy archival tags in Area 3A and the examination of several mounting protocols on fish being held at the Oregon Coast Aquarium will feed into the design of the tag and its attachment to the fish.

Project 650.16: **Archival tags: Area 4B site selection**

Priority: High
Start date: 2010
Anticipated ending: 2014
Personnel: T. Loher, J. Forsberg, survey team

In 2009, 773 fish were tagged in Area 4B to evaluate tag recovery rates in preparation of a future release of archival tags in the area. Recovery rates of PIT tags released in the Aleutians were quite low, without evidence of recovery hotspots. This suggests that if archival tags were deployed in the Aleutians, we would likely recover relatively few of those tags. This would result in either too few data to draw any conclusions or require that a very large number of tags be initially deployed. Given that archival tags cost $500-1200 each, resorting to a very large deployment would be financially prohibitive and problematic. The goal is to locate at least two release sites which will yield a sufficient number of recoveries.

Project 650.17: Archival tags: geomag tag performance

Priority: Low
Start Date: 2011
Anticipated ending: 2012
Personnel: T. Loher, J. Nielsen (UAF Juneau)

In 2011, we deployed both Desert Star and Lotek geomagnetic tags on 30 halibut in two regions of the Gulf of Alaska: in Area 2C, just offshore of southern Prince of Wales Island; and in Area 3A, offshore of southern Kodiak Island. Tagging was restricted to large fish (110-150 cm FL), most likely to be mature females and likely to conduct a spawning migration shortly after tagging, and was divided into two deployment locations because the coastline and bathymetry of the areas are largely perpendicular to one another with respect to the magnetic environment. In Area 2C, total magnetic field gradients run largely parallel to shore, whereas in Area 3A around Kodiak that gradient runs perpendicular to shore. As such, we hypothesized that geomagnetic positioning based on total field strength would more accurately detect onshore-offshore movement in 2C and alongshore migration around Kodiak. Recoveries are expected in 2013 to enable testing of the hypothesis. Note that because of a tag internal architecture redesign, this project is proposed to be redone in Area 4A in 2013.

Project 2013-03: Estimate of length/weight relationship and head/ice/slime adjustment (NEW)

Priority: Low
Start: 2013
Anticipated Ending: open ended
Personnel: R. Webster, L. Erickson, K. MacTavish, H. Gilroy

The purpose of this study is to collect data for use in estimating the relationship between fork length and net weight, including the estimate of adjustments necessary to convert head-on weight to net weight. Data will be collected coastwide at sampled ports throughout the season in order to estimate spatial and seasonal variation in the length to weight relationship. In the current length-weight relationship, adjustments are made for head, ice, and slime, and are used when estimating the net weight of commercial offloads. The current relationship between fork length and net weight includes adjustments for the weight of the head, and of ice and slime: gross weight is assumed to include 12% head weight and 2% ice and slime, which combine to give a multiplier of 0.8624 to convert gross to net weight. In practice, deductions of 12% in Areas 2A and 2B, and 11.8% in Alaska, are applied to commercial landings at the plants to convert from gross to net weight. These both include the 2% deduction for ice and slime assumed in the IPHC length-net weight relationship, but 10% for the head. IPHC port samplers will be tasked to collect data at plants within their port. Therefore, in addition, data collected during the study will provide direct estimates of adjustment factors to compare with the currently assumed values, and will allow us to assess variability in the weight of heads and ice and slime. The end result is expected to be new adjustment factors that, if appropriate, can be applied consistently across all ports, or be allowed to vary with regulatory area.

Project 2013-04: Archival tags: tag attachment protocols (NEW)
Priority: High
Start: 2013
Anticipated Ending: 2015
Personnel: Loher

This proposal is an update of 650.14, which was a 2009 release of 200 tags – half external tags, and half with internal implants. It is proposed to be redone to fully evaluate external attachment. The Board was supportive of this project, as the results are needed to evaluate three potential tag attachment sites on the fish. The release is being designed to occur from the surveys to reduce costs while still achieving a broad distribution of releases. Design issues regarding the number of tags to be deployed and shedding rates are being refined. The study was given a high priority because a suitable external tag attachment site is crucial to the success of the coastwide archival tag study.

Project 2013-05: Archival tags: geomag performance (NEW)
Priority: High
Start: 2013
Anticipated Ending: 2016
Personnel: Loher

This proposal is an update of 650.17, which was a 2011 release of 30 tags in Area 2C and 3A to examine location resolution of geomag tags. The study is proposed to be redone because an improved geomag design has recently been released, which is expected to perform better than the design used in 2011. The proposed study entails releasing ~30 fish on the Area 4A-south assessment survey.

Project 2013-06: SSA Expansion – California pilot (NEW)
Priority: Medium
Start: 2013
Anticipated Ending: unknown
Personnel: C. Dykstra, survey team

The IPHC staff is considering extending the assessment survey into the waters off northern California. Currently, the survey stops at the Oregon/California border, which has traditionally been the southern end of commercial fishing in recent years. However, recent reports of previously unknown but significant sport fishery harvests of halibut from northern California waters, which contributed to exceeding the catch limit for that area, have indicated the potential for a larger share of the resource in this area than has been assumed. Adding this area into the assessment requires a measure of fish density, which would be provided by the survey. This issue also has implications for the Pacific Fishery Management Council's Area 2A Catch Sharing Plan, which allocates a portion of the Area 2A catch limit to the area south of Humbug Mountain, Oregon, including California. The current staff proposal would extend the 10 x 10 nm systematic survey grid off northern California, to a terminus of 40^o N., based on a review of halibut sport fishery sampling by California Fish and Game.

Management Strategy

Project 2012-01: Otolith increment analysis (New)
Priority: High
Start Date: 2013
Anticipated ending: 2015
Personnel: T. Loher, age room staff (TBD)

This study is an internal IPHC project but may be part of a broader, comprehensive study to examine potential causes for the recent changes in halibut size at age (SAA) as well as an integrated approach to incorporating SAA dynamics into halibut assessment and management. The broader study would be funded through a grant application to the North Pacific Research Board, in cooperation with National Marine Fisheries Service and the University of Alaska. For the internal IPHC project staff will mine the otolith archives for historical samples which were collected at prescribed time intervals and measure the otolith growth increments. The relation between otolith growth and somatic growth is not well understood in many fishes, including halibut. But the IPHC otolith archives provide a unique opportunity to potentially examine changes in otolith growth over time and, by extension, halibut growth. Anticipated work in 2013 includes refining the study design, otolith selection, cross sectioning, and aging.

Ecology

Project 610.13: Oceanographic monitoring of the north Pacific and Bering Sea continental shelf with water column profilers
Priority: Medium
Start date: 2009
Anticipated ending: Continuing
Personnel: L. Sadorus, P. Stabeno (NMFS PMEL)

The IPHC maintains one of the most extensive sampling platforms in the north Pacific. This platform provides enormous potential for collection of valuable oceanographic data. In particular, understanding the dynamics of the structure of the mixed layer depth – a major GLOBEC goal - requires *in situ* vertical profiling. Since 2001, IPHC has successfully deployed a SeaBird SBE-19 water column profiler during the annual stock assessment survey. A second profiler was added to the program in 2007. In 2009, a NOAA grant provided for the complete outfitting of all chartered survey vessels, resulting in a complete coastwide deployment. Annual costs are directed towards maintenance and calibration of the profilers, and data preparation necessary for submission to the National Ocean Data Center.

Project 642.00: Assessment of mercury and contaminants in Pacific halibut

Priority: Medium
Start Date: 2002
Anticipated ending: Continuing
Personnel: C. Dykstra, B. Gerlach (ADEC)

The staff proposes to continue our collaboration with the Alaska Department of Environmental Conservation (ADEC) in 2013, collecting halibut tissue samples in the Ommaney, Albatross, and Sanak charter regions for analysis of heavy metal and organic pollutant loading. This work has been ongoing since 2002. Results from a 2002 collection of halibut samples led the Alaska Division of Public Health, in 2003, to conclude that the concentrations of heavy metals in Alaskan Pacific halibut were not a public health concern. In 2004, the first results regarding organic pollutants (PCB’s, pesticides) were released demonstrating that halibut had the lowest concentrations of the five species (including salmon and sablefish) examined. The Alaska Division of Public Health updated their advice on fish consumption in 2007 with some restrictions on the number of meals of halibut for women of child bearing age and young children. Since 2002, the IPHC has submitted 1,894 samples for testing by ADEC. 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.

Northwest Fisheries Science Center

National Marine Fisheries Service

Agency Report to the Technical Subcommittee of the Canada-U.S. Groundfish Committee

April 2013

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. At the current time the Environmental Conservation and Resource Enhancement and Utilization Technologies Divisions are being restructured to form a single new division. 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.

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

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

During 2012, FRAMD continued to: implement a West Coast observer program; conduct a coast wide survey program that includes West Coast groundfish acoustic, hook and line, and trawl surveys; develop new technologies for surveying fish populations; and expand its stock assessment, economics, and habitat research. Significant progress continues in all programs.

For more information on FRAMD and groundfish investigations, contact the Division Director, Dr. Michelle McClure at Michelle.McClure@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. John Stein at John.Stein@noaa.gov, (206) 860-3200.

B. Groundfish Studies

1. Research

a. Quantitative video analysis of flatfish herding behavior and effective area swept of a survey trawl

Investigators: K.L. Bosley, D. Bryan, A.C. Hicks, W.W. Wakefield and M. Haltuch

Uncertainty in fish behavior can introduce bias into density calculations from fishery-independent bottom trawl surveys that provide relative abundance estimates and population trends for stock assessments. *In situ* video was used to quantify flatfish behavioral responses to a bottom trawl to determine effective area swept and improve survey and assessment accuracy and precision. The behavior of 632 flatfishes was recorded during four tows. Neither stationary nor reacting fish were randomly oriented with respect to trawl sweeps and over 90% were facing in a direction perpendicular or away from sweeps indicating a herding response. There was no significant effect of fish length on fish orientation or whether it reacted or stayed stationary during the observation. Only 1.3% of fish were observed escaping over or under the sweeps. A generalized linear model was used to estimate that at a distance of 73.8 cm (± 3.4 SE) 50% of observed fish reacted to the sweep. The mean reaction distance for a stationary fish was 36.6 cm (± 2.0 SE). Quantitative analysis clearly indicates that flatfish herding occurs along trawl sweeps and area swept calculations used to provide relative abundance estimates should include a portion of the area swept by the sweeps to improve accuracy.

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

b. Can trip limits and time-area closures keep commercial catches of longnose skate and spiny dogfish shark below their harvest limits?

Investigators: D. Erickson, J. Cope and C. Niles

Commercial catches of spiny dogfish shark (*Squalus suckleyi*) and longnose skate (*Raja rhina*) off the U.S. west coast have recently reached levels that would exceed their annual harvest specifications. In general, both are incidentally caught in commercial trawl and fixed gear fisheries targeting other groundfish species. Limited commercial markets exist for these species, so targeting may occur, especially for dogfish shark. Life history characteristics of both species limit their resilience to overfishing. For example, dogfish sharks may not reach sexual maturity until approximately 35 years old, and may produce only 2-16 pups per litter over an 18-22 month gestation period. Such slow dynamics would translate into long recovery times if harvest were to reduce these populations to low levels. Setting appropriate harvest levels is therefore of high importance for these species. The most common management measures used to control fishing mortality for west coast commercial groundfish fisheries are landing ("trip") limits and time-area closures. Such measures may have limited effectiveness for spiny dogfish shark and longnose skate. The geographic distribution of each is broad, extending along the entire U.S. west coast at depths from < 50 fathoms to > 600 fathoms. In addition, both species are often discarded at sea due to their limited marketability.

The potential use of trip limits and time-area closures to control the fishing mortality of longnose skate and spiny dogfish shark was investigated off Washington, Oregon, and California. The potential efficacy of these management measures was evaluated through analysis of logbook, fish ticket, and at-sea observer data. The authors also discuss the potential impacts such management measures may have on commercial fisheries and coastal communities.

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

c. Temporal and spatial summer groundfish assemblages in trawlable habitat off the West Coast of the USA, 1977 to 2009

Investigators: J. Cope and M. Haltuch

Increasingly, multispecies interactions are being considered by U.S. management councils during decision making, which highlights the need for identification of fish assemblages across varying spatial and temporal resolutions. On the U.S. West Coast, previous groundfish assemblage analyses have focused either on particular species groups (i.e. *Sebastes)* or limited time frames and/or geographic regions within the groundfish fishery. The present study expands on previous work to identify groundfish assemblages across the full spatial extent of the West Coast groundfish fishery from 1977−2009, by using two fishery-independent trawl surveys. Species assemblages were identified using two clustering methods (partitioning analysis and hierarchical analysis) and two realizations of the data (presence-absence and log+1 transformed catch-per-unit effort, CPUE). The analysis using presence-absence data provides information on species that co-occur while the CPUE data provides information on species that occur at similar magnitudes. Temporally and spatially persistent assemblages were detected by both clustering methods through most years. Assemblages identified using CPUE were often subsets of those identified using presence-absence, indicating that the members of an assemblage may occur together, but not necessarily at the same magnitude, a result that should be considered when choosing the clustering metric. Identification of species assemblages is applicable to bycatch models and informative when evaluating the implementation of spatial management measures, and thus germane to current challenges faced by marine resource managers.

For more information, contact Jason Cope at Jason.Cope@noaa.gov or Melissa Haltuch at Melissa.Haltuch@noaa.gov

d. Feeding ecology of juvenile rockfishes off Oregon and Washington, based on stomach-content and stable-isotope analyses

Investigators: K. Bosley, T. Miller, R.D. Brodeur, K.M. Bosley, A. Van Gaest and A. Elz

The feeding habits of pelagic, juvenile rockfishes (*Sebastes* spp.) collected off Oregon and Washington during 2002 and 2006, were examined using stomach-content and stable-isotope analyses. The predominant species were darkblotched (*S. crameri*), canary (*S. pinniger*), yellowtail (*S. flavidus*), and widow (*S. entomelas*) rockfishes. Stomach-content analysis revealed that darkblotched rockfish had highly variable diets, and canary, yellowtail, and widow rockfishes exhibited a high degree of overlap. Multivariate analysis revealed significant differences in diet based on distance from shore, fish size, and species. Stable-isotope analysis showed all species were feeding at about the same trophic level within each year, with a 1.5‰ difference in $\delta^{15}N$ between years. Depleted $\delta^{13}C$ values indicate that the juveniles that were collected likely resulted from offshore spawning, and were subsequently advected or migrated onto the shelf, representing a potentially important cross-shelf transport of carbon to the shelf. Comprehensively, these results add to our understanding of some of the important environmental factors that affect young-of-the-year rockfish during their pelagic phase.

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

e. Relating groundfish biomass, species richness and community structure to the presence of corals and sponges using NWFSC bottom trawl survey data

Investigators: K.L. Bosley, K.M. Bosley, C.E. Whitmire and A.A. Keller

Some cold-water corals and sponges occur in such dense aggregations that they provide structurally complex habitats which support a diverse assemblage of associated invertebrates and fish. In many cases, marine fishes have been linked to the presence of epibenthic invertebrates, although the specific nature of this relationship is often unknown. The Northwest Fisheries Science Center's West Coast Groundfish Bottom Trawl Survey has collected approximately 250 coral specimens per year since 2006, and has identified, on average, 200 sites (of 750) per year where sponges are present. For this study, we investigated the relationship between these two groups of epibenthic invertebrates and their associations with demersal fish using trawl survey data from 2003-2010, when the survey covered continental shelf and slope waters from Cape Flattery, Wash., to the Mexican border. Regression models were used to correlate fish biomass and species richness with coral and sponge densities. Fish biomass was correlated with sponge density, but the relationship was not precise ($P<0.0001$, $R^2=0.043$). No other significant correlations were uncovered among these variables. Multivariate analyses were used to assess fish community structure in relation to coral and sponge densities, and to environmental parameters including depth, latitude and bottom temperature. There were strong correlations between species composition and both depth and bottom temperature, but no strong correlations with coral or sponge densities. Indicator species analysis was done to determine species that were associated with four levels of sponge and coral densities (high, medium, low and zero). Shortspine thornyhead, rosethorn rockfish and greenspotted rockfish were associated with high sponge catches, while flatfishes were typically associated with the absence of sponges. Shortspine thornyhead, Dover sole, longspine thornyhead, aurora rockfish and darkblotched rockfish were associated with high coral catches, and rex sole, English sole, and greenstriped rockfish with the absence of corals. These results provide information about broad-scale associations between corals, sponges and demersal fish that may be useful for developing studies that are specifically focused on the function of corals and sponges as habitats for fish, and the role they may play in their life-histories.

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

f. A stable isotope-based perspective on the contribution of prey to Humboldt squid (*Dosidicus gigas*) in the northern California Current

Investigators: T.W. Miller, K.L. Bosley, J. Shibata, R.D. Brodeur, K. Omori and R. Emmett

Diet studies have shown Humboldt squid *Dosidicus gigas* to be aggressive opportunistic predators, yet this approach has provided only a limited and potentially biased view of their trophic feeding behavior. As an alternative, we measured the $\delta^{13}C$ and $\delta^{15}N$ of *D. gigas* and their prey from the northern California Current ecosystem (NCC) and applied stable isotope Bayesian mixing models (Stable Isotope Analysis in R [SIAR]) to assess if *D. gigas* isotopically matched NCC or southern California Current (SCC) migratory end-members and to examine the proportional trophic contributions of prey groups from the NCC to their diet. For the trophic SIAR model, cluster analysis of prey taxa by their respective $\delta^{13}C$ and $\delta^{15}N$ values was first applied to consolidate prey into groups, which were then incorporated into the model as source groups to the diet mixture. Model results from examination of NCC and SCC migratory end-members indicated greatest contributions from the NCC system, suggesting *D. gigas* was more integrated with the regional NCC isotopic signature. From the trophic SIAR model, the results indicated mixed but lower trophic-level feeding by *D. gigas* relative to previous diet-based studies, with greatest contributions from macrozooplankton, ichthyoplankton, and nekton such as juvenile rockfish, market squid, sand lance, and juvenile Pacific hake. Sensitivity analyses of the SIAR model based on varying isotopic fractionation factors of $\delta^{13}C$ and $\delta^{15}N$ showed that proportional contributions of prey to squid diets were resilient to change.

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

g. Distribution, biomass and size of grooved Tanner crabs (*Chionoecetes tanneri*) from annual bottom trawl surveys (2003–2010) along the U.S. West Coast (Washington to California)

Investigators: A.A. Keller, J. H. Harms, J.C. Buchanan

Catch and distribution of grooved Tanner crab (*Chionoecetes tanneri* Rathbun, 1893) from the Northwest Fisheries Science Center's bottom trawl survey (55–1280 m) were examined along the U.S. west coast (lat. 32°30′N–48°30′N). Grooved Tanner crabs were present in 28% of tows and occurred primarily at depths from 300 to 1280 m. Annual biomass (metric tons, mt) indices and density (kg km^{-2}) estimates for the population varied significantly throughout the study area and within five International North Pacific Fisheries Commission (INPFC) statistical areas. Highest estimates occurred in the Monterey INPFC area (lat. 36°N–40°30′N) and within the 601–800 m depth interval. Depth distribution varied by year and coast-wide catch-weighted average depths (m) were significantly correlated with average annual Pacific Decadal Oscillation (PDO) indices (2003–2010), a measure of Pacific climate variability. Annual mean carapace widths (CW), measured from 2005 to 2010, were always greater for males (96.9–113.9 mm) relative to females (85.3–95.8 mm). Size frequency distributions varied by year with strong recruitment for both sexes apparent in 2010. Grooved Tanner crabs were partially segregated by depth and stage. Males and females were found in all depth intervals but the average depth of adult females was significantly shallower (756 m) than adult males (837 m); adults were significantly shallower than subadult female (907 m) and subadult male (927 m) crabs.

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

h. Variation is age and growth of greenstriped rockfish (*Sebastes elongatus*) along the U.S. west coast (Washington to California)

Investigators: A.A. Keller, K. Molton, A.C. Hicks, M. Haltuch and C. Wetzel

Greenstriped rockfish, *Sebastes elongatus*, are a common commercial and recreational species often taken as bycatch in commercial fisheries off the U.S. West Coast. We evaluated weight-length relationships and size-at-age using von Bertalanffy growth models for greenstriped rockfish sampled along the U.S. West Coast from 2003 to 2008. Based on regression analyses, populations were subdivided into two depth strata (55–122 m and 122–450 m) and four geographic regions (48°10' N – 48°28' N, 40°26' N – 48°10' N, 34°27’ N – 40°26' N, and 32°30' N – 34°27' N) and differences in length, age, and growth examined by gender. Strong evidence of variation in weight-length relationships was found north and south of Cape Mendocino (40°26' N) but little variation was noted for depth or gender. In contrast, variations in von Bertalanffy growth models were highly dimorphic between sexes with consistent patterns across depth and geographic regions. Females grew more slowly and reached larger asymptotic sizes (L_∞, cm) relative to males in all regions examined. Asymptotic size for both males and females tended to increase at higher latitude and increased depth. However, the smallest asymptotic sizes occurred in the region from Pt. Conception to Cape Mendocino, CA (34°27' N – 40°26' N), rather than lower latitudes south of Pt. Conception (32°30' N – 34°27' N). Greenstriped rockfish growth coefficients (k, yr^{-1}) exhibited a more complex pattern. Higher growth coefficients were associated with regions within the northern California Current System characterized by high productivity.

i. Variations in Eastern North Pacific demersal fish biomass based on the U.S. West Coast groundfish bottom trawl survey (2003–2010)

Investigators: A.A. Keller, J. Wallace, B. Horness, O. Hamel and I. Stewart

In response to declining biomass of Northeast Pacific groundfish in the late 1990s and to improve the scientific basis for management of the fishery, the Northwest Fisheries Science Center standardized and enhanced their annual bottom trawl survey in 2003. The survey was expanded to include the entire area along the U.S. West Coast at depths of 55–1280 m. Coast-wide biomass and species richness significantly decreased during the first eight years (2003–2010) of this fishery-independent survey. We observed an overall tendency toward declining biomass for 62 dominant taxa combined (fishery target and nontarget species) and four of seven subgroups (including cartilaginous fish, flatfishes, shelf rockfishes, and other shelf species), despite increasing or variable biomass trends in individual species. These decreases occurred during a period of reduced catch for groundfish along the shelf and upper slope regions relative to historical rates. We used information from multiple stock assessments to aggregate species into three groups: 1) with strong recruitment, 2) without strong recruitment in 1999, and 3) with unknown recruitment level. For each group, we evaluated whether declining biomass was primarily related to depletion (using year as a proxy) or environmental factors (i.e., variation in the Pacific Decadal Oscillation). According to Akaike's information criterion, changes in aggregate biomass for species with strong recruitment were more closely related to year, whereas those with no strong recruitment were more closely related to climate. The significant decline in biomass for species without strong recruitment confirms that factors other than depletion of the exceptional 1999 year class may be responsible for the observed decrease in biomass along the U.S. West Coast.

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

j. Shifts in condition and distribution of eastern North Pacific flatfish along the U.S. West Coast (2003–2010)

Investigators: A.A. Keller, V. Simon and M. Bradburn

Flatfish condition indices and distribution were examined along the U.S. West Coast (55–1280 m) in relation to environmental variability and biomass using data from ten frequently occurring species collected in annual groundfish surveys from 2003 to 2010. The study was conducted during a period characterized by a cooling trend in the northern California Current system and by declining biomass for flatfish in general. Annual condition indices for six species (arrowtooth flounder, Dover sole, English sole, Pacific sanddab, petrale sole, and rex sole) were significantly related either to large-scale climatic indices (Pacific Decadal Oscillation, Multivariate El Niño–Southern Oscillation Index, North Pacific Gyre Oscillation) and/or annual biomass levels. Condition was most closely related to environmental effects rather than either biomass alone or both variables, with condition typically higher during cool climatic conditions. A similar analysis revealed that changes in distribution (measured as variation in annual catch-weighted mean latitude, longitude, depth and temperature) tended to be best described by models incorporating environmental effects and biomass rather than either variable alone. Linear trends in the center of distribution along a southeast-northwest axis were significant for seven species (arrowtooth flounder, deepsea sole, Dover sole, flathead sole, Pacific sanddab, petrale sole, and slender sole) with a tendency for flatfish to be displaced towards the southeast as environmental conditions shifted from warm to cooler conditions and biomass declined. A spatial distribution analysis indicated that for the majority of species (80%) the greatest magnitude of displacement (km) occurred when the centers of biomass were compared between environmental-phases (average annual displacement 34 km) rather than changing biomass levels (average displacement 24 km). Taken together, both approaches revealed that environmental changes and variation in biomass play significant roles in flatfish distribution.

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

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

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

Fishery-independent surveys are an important source of information for stock assessment and management worldwide. Research surveys often use trawl gear to capture commercially valuable species and calculate indices of relative abundance or density. However, many species of interest do not occur in direct contact with the bottom, or occur in areas where high-relief habitat precludes trawl operation. This paper introduces a standardized hook and line survey for rockfish conducted by NOAA Fisheries' Northwest Fisheries Science Center in the Southern California Bight. The survey uses fishing gear similar to that used in many recreational fisheries to sample approximately 120 locations covering a wide range of depths and habitats. To provide an example of how these data can be analyzed for direct inclusion in stock assessments, we standardize catch rates of bocaccio rockfish from 2004–2008 using a Bayesian Generalized Linear Model to account for site, fishing time, survey vessel, angler, and other statistically significant effects. Results indicate that the bocaccio stock vulnerable to this survey in the Southern California Bight has shown a relatively flat trend over recent years. Length frequency distributions indicate the presence of several strong cohorts that should be detectable in future stock assessments of bocaccio for use in U.S. West Coast groundfish management. This survey is the only available tuning index for the adult portion of the bocaccio population in recent years as historically used recreational catch per unit effort indices have been compromised due to changes in bag limits and other management restrictions.

For more information, please contact John Harms at John.Harms@noaa.gov

l. Distribution and life history characteristics for vermilion rockfish (*Sebastes miniatus*) and its cryptic pair, sunset rockfish (*S. crocotulus*) in Southern California

Investigators: J.H. Harms, J. Hempelmann, O. Rodriguez, M. Head, R.M. Barnhart, P. McDonald, J.A. Benante and A.A. Keller

Recent genetic research by Hyde et al. (2008) at NOAA Fisheries' Southwest Fisheries Science Center identified a cryptic pair of the vermilion rockfish from specimens collected along the U.S. West Coast and suggested some depth and biogeographic partitioning between the two species. Using specimens and catch data collected during the hook and line survey, NWFSC researchers analyzed depth and latitudinal differences and similarities between vermilion and sunset rockfish and developed unique life history characteristics for the two species. These include age at length, annual growth estimates, length-weight relationships, and age at maturity. This information can be combined with the unique indices of abundance outlined in the previous paper to support separate stock assessments for vermilion and sunset rockfish.

For more information, please contact John Harms at John.Harms@noaa.gov

m. A fishery-independent multi-species examination of recent population trends for key species of shelf rockfish (Genus: *Sebastes*) in Southern California

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

Fishery-independent surveys are an important source of information for stock assessment and management worldwide. Research surveys often use trawl gear to capture commercially valuable species and calculate indices of relative abundance or density. However, many species of interest do not occur in direct contact with the bottom, or occur in areas where high-relief habitat precludes trawl operation. This research was undertaken during a standardized hook and line survey for rockfish conducted by NOAA Fisheries' Northwest Fisheries Science Center (NWFSC) in the Southern California Bight. The survey uses fishing gear similar to that used in many recreational fisheries to sample approximately 120 locations covering a wide range of depths and habitats. The methods described in Harms et al. (2010) were applied to hook and line survey data for six important species of shelf rockfish to generate fishery-independent abundance indices, including the first unique indices for vermilion rockfish (*S. miniatus*) and its cryptic pair, sunset rockfish (*S. crocotulus*). This survey is the only available ongoing tuning index for the adult portion of many structure-associated shelf rockfish species in the region, as historically-used recreational catch per unit effort indices have been compromised due to changes in bag limits and other management restrictions.

For more information, please contact John Harms at John.Harms@noaa.gov

n. Recent developments: Southern California shelf rockfish hook and line survey

Investigators: R.M. Barnhart, J.H. Harms and J.A. Benante

The Fisheries Resource and Analysis and Monitoring Division of the Northwest Fisheries Science Center conducts an annual hook and line survey for shelf rockfish (Genus: *Sebastes*) in the Southern California Bight. The project, which began in 2002, targets demersal rockfish species associated with rocky, untrawlable habitats that are generally not sampled well by the division's other groundfish monitoring cruises. The hook and line survey is a collaborative effort with Pacific States Marine Fisheries Commission and the sportfishing industry in southern California. The time series of catch-per-unit-effort data and associated biological data are used to calculate an index of relative abundance for several important rockfish species including bocaccio, vermilion rockfish, greenspotted rockfish, and speckled rockfish. Bocaccio and vermilion rockfish, two primary species of interest, have been encountered at over 65% of survey sites in every year of the survey. Survey personnel are currently working with the NWFSC Genetics & Evolution Program to develop separate indices of abundance for vermilion and sunset rockfish by analyzing the finclips collected from each of the vermilion rockfish complex specimens collected during sampling.

Recent efforts include expanding the collection of environmental and oceanographic data during sampling including the acquisition of seawater temperature, dissolved oxygen, salinity, and turbidity information at depth from survey sites. These data may provide informative covariates reducing uncertainty associated with the model used to estimate indices of abundance and may also be useful in tracking shifts in oceanographic regimes in the region. In addition, the past two years work has been conducted to estimate size at maturity for the vermilion, sunset, and bocaccio rockfish. Efforts to collect video habitat information and further develop genetic biopsy hooks continue to move forward. The survey is improved by its collaboration with the sportfishing industry and has strengthened the working relationship between NOAA Fisheries and stakeholders in the region.

o. Environmental sampling, hypoxia and the Northwest Fisheries Science Center's Cooperative U.S. West Coast Groundfish Bottom Trawl Survey

Investigators: A. A. Keller, W.W. Wakefield, V. H. Simon, J.A. Barth, and S. Pierce

The NOAA NMFS Northwest Fisheries Science Center (NWFSC) currently conducts a number of groundfish research and monitoring projects that are cooperative and collaborative with the fishing industry. These include a West Coast Groundfish Bottom Trawl Survey (WCGBTS), a hook and line survey of shelf rockfishes in the Southern California Bight, pelagic trawl surveys of juvenile groundfishes, and acoustical optical pilot surveys of pelagic rockfishes in untrawlable habitats. In the context of such cooperative research programs, advancements in sampling technologies have allowed new types of data to be collected during traditional NMFS surveys. For example, environmental sensing packages are attached to trawls and record a full array of environmental parameters (e.g., depth, temperature, salinity, dissolved oxygen, chlorophyll fluorescence, turbidity, and light). These improved environmental sensing capabilities have led to collaborations with academic partners and with the developers and manufacturers of sensing packages. In 2007, the NWFSC added an environmental sampling program to the WCGBTS that included collaboration with physical oceanographers at Oregon State University. This program was initiated, in part, in response to hypoxia that was observed on the continental shelf of the Pacific Northwest, in a region not previously characterized by hypoxic conditions. Fishery and environmental sampling is conducted from chartered commercial trawlers from 55 to 1280 meters and from the U.S.–Canada border to the U.S.–Mexico border. A nested sampling design encompasses the oxygen minimum zone of the California Current as well as a known hypoxic area on the continental shelf off the Oregon coast.

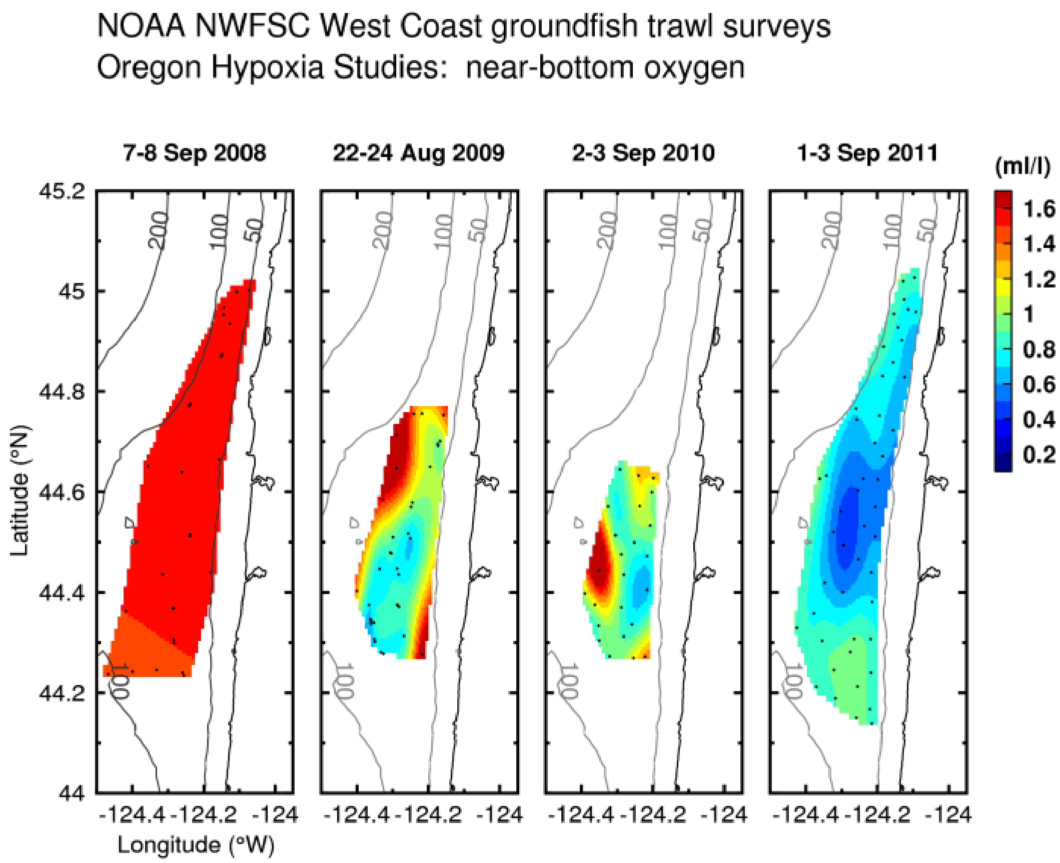

Figure 1. Varying concentrations of near-bottom dissolved oxygen (ml l^{-1}) are shown during late summer from 2008 through 2011 on the continental shelf of the Pacific Northwest off Oregon, in a region not previously characterized by hypoxic conditions. Moderate to severe hypoxia was noted in 2009 – 2011.

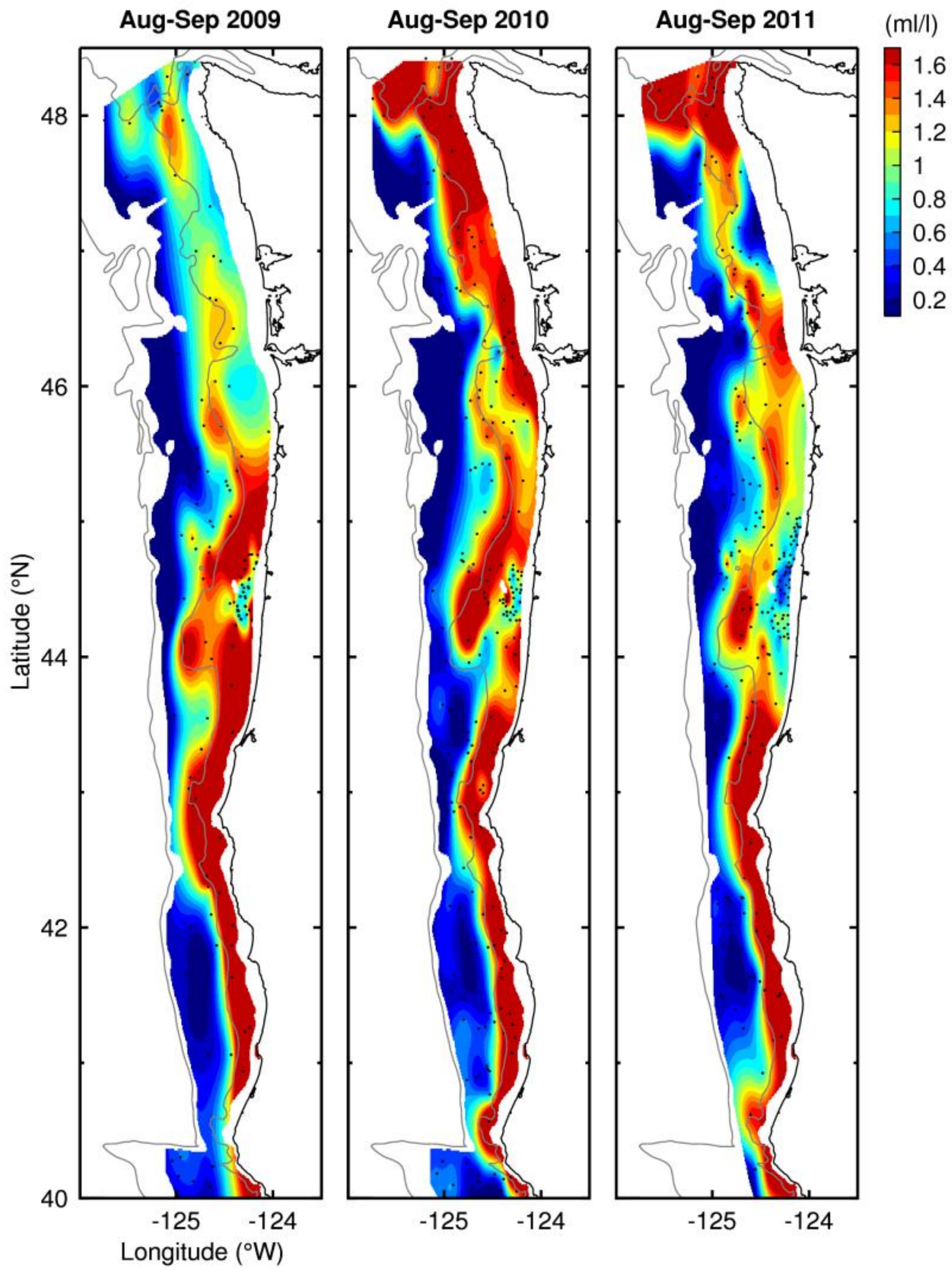

Figure 2. Distribution of near bottom oxygen concentration over a greater extent of the Northeast Pacific from 2009 to 2011 collected during bottom trawl surveys. Sampling indicates low DO in deep water within the OMZ during in all years and varying levels of low oxygen in shallower offshore of both Washington and Oregon by year.

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p. A review of essential fish habitat for Pacific Coast groundfish

Investigators: W.W. Wakefield, M.M. McClure, and K. Griffin

A review of Essential Fish Habitat (EFH) for 91 species of Pacific Coast groundfish was ongoing in 2012. Some of the key products developed for this review are now available to the public. Initial EFH designations were based on best available data developed from 2002 to 2005; NOAA's National Marine Fisheries Service (NMFS) implemented these designations in May 2006. Beginning in 2010, the Pacific Fisheries Management Council (PFMC), Northwest and Southwest Fisheries Science Centers, and the NMFS Regions initiated the next 5-year review for EFH provisions of the groundfish Fishery Management Plan. In Phase I of this process, new and relevant information were compiled and summarized for the review. Sources of information included published scientific literature and unpublished scientific reports, solicitation of data from interested parties, and the review of previously unavailable or inaccessible data sets. Coast-wide maps were updated for (1) bathymetry and interpreted groundfish habitat types, (2) the distribution and extent of commercial fishing effort (as potential impact to EFH), (3) the distribution and relative abundance of biogenic habitat (i.e., sponges and corals), and (4) spatial management boundaries (as potential mitigation of impacts). This complete body of information, in the form of a written report and supporting Internet data catalog, was presented to the PFMC, its advisory bodies and the public at the Council's September 2012 meeting (Phase I Report:
http://www.pcouncil.org/groundfish/background/document-library/pacific-coast-groundfish-5-year-review-of-efh/; online data catalog.
http://efh-catalog.coas.oregonstate.edu/overview/). NMFS is currently conducting an analysis of the information in the Phase I Report, and will deliver a synthesis to the Council in April 2013. During Phase II, the Council will solicit proposals to modify EFH and Habitat Areas of Particular Concern (HAPC). If the Council decides to amend EFH, Phase III of the process will begin and may require an amendment to the groundfish Fisheries Management Plan. This 5-year review represents a major update of the groundfish habitat assessment for the California Current and will have research and management applications well beyond satisfying the regulatory guidelines associated with EFH.

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2. Stock Assessment

a. Stock assessment model development

Stock Synthesis (SS) is an assessment model in the class termed integrated analysis and is the basis for West Coast groundfish assessments and many other assessments around the world. SS is built with a population sub-model that simulates a stock's growth and mortality processes, an observation sub-model to estimate expected values for various types of data, and a statistical sub-model to characterize the data's goodness of fit and to obtain best-fitting parameters with associated variance. It includes a rich feature set including age- and size-based population dynamics and the ability to specify observational phenomena, such as ageing imprecision. Model parameters can vary over time or be specified as functions of environmental data. SS includes routines to estimate MSY and exploitation levels that correspond to various standard fishery management targets. It supports assessments spanning several geographic areas and can use tag-recapture data. A customizable harvest policy is used to conduct a forecast in the final phase of running the model. The model is coded in ADMB (www.admb-project.org). SS is included in the NOAA Fisheries Assessment Toolbox (http://nft.nefsc.noaa.gov/) incorporating a graphical user interface developed by Alan Seaver (NEFSC). It is now at version 3.24j as of November 2012).

In 2012, Stock Synthesis was featured in the following non NWFSC publications as well as numerous publications reported below in section 10:

MacCall, A.D., Teo, S.L.H. *in press*. A hybrid stock synthesis- Virtual population analysis model of Pacific bluefin tuna. Fisheries Research. *special edition.*

Maunder, M.N., Punt, A.E. *in press.* A review of integrated analysis in fisheries stock assessment. Fisheries Research. *special edition.*

Punt, A.E., Maunder, M.N. *in press*. Stock Synthesis: Advancing stock assessment application and research through the use of a general stock assessment computer program. Fisheries Research. *special edition.*

Stewart, I.J., Hicks, A.C., Taylor, I.G., Thorson, J.T., Wetzel, C., Kupschus, S. *in press.* A comparison of stock assessment uncertainty estimates using maximum likelihood and Bayesian methods implemented with the same model framework. Fisheries Research. *special edition.*

Whitten, A.R., Klaer, N.L., Tuck, G.N., Day, R.W. *in press*. Accounting for cohort-specific variable growth in fisheries stock assessments: A case study from south-eastern Australia. Fisheries Research. *special edition.*

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

b. Stock Synthesis: a biological and statistical framework for fish stock assessment and fishery management

Investigators: R. Methot and C.R. Wetzel

Stock Synthesis (SS) is a statistical age-structured population modeling framework that has been applied in a wide variety of fish assessments globally. The framework is highly scalable from data-weak situations where it operates as an age-structured production model, to complex where it flexibly incorporates multiple data sources and accounts for biological and environmental processes. SS incorporates compensatory population dynamics through use of a function relating mean recruitment to spawner reproductive output. This function enhances its ability to operate in data-weak situations and enables SS to estimate fishery management quantities such as fishing rates that would provide for maximum sustainable yield and to employ these rates in forecasts of potential yield and future stock status. Complex model configurations such as multiple areas and multiple growth morphs are possible, tag-recapture data can be used to aid estimation of movement rates between areas, and most parameters can change over time in response to environmental and ecosystem factors. SS is coded using Auto-Differentiation Model Builder, so inherits powerful capability to efficiently estimate hundreds of parameters using either maximum likelihood or Bayesian inference.

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c. Hiding or dead? A computationally efficient model of selective fisheries mortality

Investigators: I. Taylor and R. Methot

100 years after Rosa Lee (1912) showed that higher mortality on faster growing fish can alter length-at-age distributions in fish populations, we present a computationally-efficient and parsimonious method for modeling size-selective mortality within a commonly-used assessment model, Stock Synthesis. Stock Synthesis allows the normal distribution of length-at-age to be partitioned into three or five overlapping platoons with slow, medium, or fast growth trajectories. The platoons are tracked separately in the model, and experience different degrees of size-selective fishing pressure and mortality, but are assumed to be unobservable except through changes in the length distribution. Simulations are used to explore this phenomenon in conjunction with dome-shaped selectivity, an alternative explanation for observing fewer than expected large fish in sampled data, but with very different implications for population productivity. For data simulated both with and without platoons, misspecification of the assumptions about growth are found to bias model results, with selectivity often incorrectly identified as the cause of fewer observations of larger fish. Trends in dome-shaped selectivity were explored as a potential diagnostic of model misspecification.

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d. A stock-recruitment relationship based on pre-recruit survival illustrated with application to spiny dogfish shark

Investigators: I. Taylor, V. Gertseva, R. Methot, and M. Maunder

Understanding the relationship between abundance of spawners and subsequent recruitment is one of the central issues in fisheries stock assessment. We developed a new, pre-recruit survival based stock–recruitment model that enables explicit modeling of survival between embryos and age 0 recruits, and allows the description of a wide range of pre-recruit survival curves. The model is especially useful for low fecundity species that produce relatively few offspring per litter and exhibit a more direct connection between spawning output and recruitment than species generating millions of eggs. The proposed model provides additional flexibility in the stock–recruitment options that may be explored in any fishery stock assessment, and it is now available within the Stock Synthesis assessment platform. In this paper, we describe the mathematical formulation of the new stock–recruitment model, explain how this model can be specified within Stock Synthesis, and use it to model the stock–recruitment relationship of the spiny dogfish shark in the Northeast Pacific Ocean. We compare the results of the application of our new stock–recruitment model, with those from traditional Beverton–Holt relationship, and illustrate why the new approach is more appropriate for this species.

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e. Stock Synthesis training workshop at the Institute of Marine Science in Lysekil, Sweden

Investigators: A.C. Hicks and I. Taylor

The workshop provided an overview of Stock Synthesis, a fisheries assessment model used to conduct fish stock assessments on the west coast, such as Pacific hake, sablefish, various soles, and many species of rockfish. Stock Synthesis, originally developed by NMFS Senior Scientist Rick Methot, is now used in many U.S. stock assessments because it integrates data from many sources, regardless of the amount of data available for a stock, and has the ability to incorporate different factors into its analyses, such as changes in biology or fishery behavior over time. As a result of the workshop, assessment models using Stock Synthesis are now being developed for at least 4 species, including Black Sea turbot.

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f. Extending catch-only Stock Synthesis models to include indices of abundance

This work provides an extension of the Stock Synthesis (SS) catch-only method (SS-CO or SSS (Cope 2012)) by including indices of abundance, and in a couple of cases, length composition data. The resultant catch limits and other management quantities of this extended SSS model (exSSS) is compared against the category 1 assessment base case models to indicate how well these data-limited models perform relative to assessments considered "the best available science".

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g. Spawning biomass reference points for exploited marine fishes, incorporating taxonomic and body size information

Investigators: J.T. Thorson, J.M. Cope, T.A. Branch, and O.P. Jensen

Surplus production represents the processes that affect sustainable fishery harvest and is central to the ecology and management of marine fishes. Taxonomy and life history influence the ratio of spawning biomass at maximum sustainable yield to average unfished spawning biomass (SBMSY/SB0), and estimating this ratio for individual stocks is notoriously difficult. A database of published landings data and stock assessment biomass estimates was used to determine that process errors predominate in this data set by fitting a state–space model to data from each stock individually. Multispecies process-error models were then fit while treating SBMSY/SB0 as a random effect that varies by taxonomic order and maximum length. The estimated SBMSY/SB0 = 0.40 for all 147 stocks is intermediate between the values assumed by the Fox and the Schaefer models, although *Clupeiformes* and *Perciformes* have lower and

Gadiformes and *Scorpaeniformes* have higher SBMSY/SB0 values. Model selection supports the hypothesis that large-bodied fishes for a given taxonomic order have relatively higher SBMSY/SB0. Results can be used to define reference points for data-poor fisheries or as input in emerging assessment methods.

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h. Development and application of an agent-based model to evaluate methods for estimating stock abundance for shoaling fishes such as Pacific rockfish (*Sebastes* spp.)

Investigators: J.T. Thorson, I. Stewart and A. Punt

Bottom trawl sampling is used to estimate trends in stock abundance for groundfishes worldwide including Pacific rockfishes (*Sebastes* spp.). However, trawl sampling efficiency varies spatially, and the distribution of groundfish populations may change among easy- and difficult-to-survey areas over time. These concerns have prompted interest in using underwater vehicles (UVs), for which catchability is likely to decrease less in rocky habitats. In this study, we use simulation modeling to evaluate the abundance trends arising from bottom trawl sampling given density-dependent habitat selection and spatially-varying catchability. We first demonstrate that relative abundance indices in this case will generally be biased measures of changes in population abundance. We also propose and evaluate a sampling design that combines data from bottom trawl and UV gears. Combined sampling has greater precision than UV sampling, lower bias than bottom trawl sampling, and is robust to moderately-violated assumptions regarding sampling strata or spatial catchability. We conclude by recommending future research that could test the assumptions under which combined sampling is a feasible solution to spatially-varying catchability.

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i. Applied science for informed management: The supporting role of NWFSC science in Pacific West Coast groundfish management

As appointed stewards of our nation's marine ecosystems, NOAA's National Marine Fisheries Service counts among its goals sustainable fisheries and recovered protected species. These goals prescribe a balance among the following objectives: maintenance of healthy fisheries, elimination of overfishing, rebuilding of overfished stocks, and increasing the long-term economic and social benefits to the nation. This complex task requires the comprehensive expertise of biologists, fisheries scientists, economists, social scientists, and policy analysts to help inform the Pacific Fishery Management Council's (PFMC) management decisions. The author described one aspect of this process: how NWFSC data and analytical products provide science-based information critical to advising management actions in the socially, culturally, and economically important Pacific West Coast groundfish fishery.

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j. Change we can perceive in: Using the concepts of "status", "scale", and productivity" to interpret changes in management quantities across stock assessments as applied to U.S. West Coast groundfishes

Investigators: J.M. Cope, O. Hamel, C. Niles, J. DeVore, E.J. Dick, J. Grebel, and R. Jones

Fisheries stock assessments provide the scientific information used to calculate management quantities (e.g., maximum sustainable yield, the overfishing level, and time to rebuild) for application in precautionary fisheries management. Uncertainty in data inputs and model specification, though, can change our perception of a stock's population dynamics from assessment to assessment, and thus the resultant management quantities. These changes can be complex and technical in nature, sometimes resulting in what may seem to be contradictory outcomes. For instance, a new assessment may demonstrate that an overfished stock is more depleted than previously determined, yet able to support higher forecasted catches. Changes in assessment results like these have been particularly consequential to the Pacific Fishery Management Council's efforts to rebuild overfished stocks. Three general stock assessment concepts that help reconcile such apparent management contradictions include: (1) "Status" refers to what proportion of a stock's abundance remains since fishing began; (2) "Scale" describes the absolute level of biomass; and (3) "Productivity" is the internal capacity of a population to grow. These three dimensions are represented using simple metrics. Changes in these metrics from assessment to assessment explain directional changes in the management quantities. This method was applied to six groundfishes currently under the Pacific Fishery Management Council's rebuilding plans. This approach allows one to anticipate and interpret changes in important management quantities without requiring a detailed understanding of the technical complexities involved in modeling past, current, and future trends in stock status and abundance.

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k. Advice for estimating fishery management reference points given low frequency between-year environmental variability

Investigators: M.A. Haltuch, A.E. Punt, and M.W. Dorn

There is strong evidence that low frequency between-year environmental variability, in addition to fishing, is able to affect fish population abundance via recruitment. However, scientific advice regarding catch limits is often based on control rules that depend on the estimation of biomass reference points which typically do not explicitly consider the effects of trends over time in reference points caused by environmental variability. Harvest rates based on commonly used biological reference points such as the level of un-fished spawning biomass (B0), the current size of the stock in relation to B0, and BMSY that are sustainable under current environmental conditions may be unsustainable under different environmental conditions. Although several methods exist for estimating biomass reference points, it is unclear which of these are most robust to the effects of long term, low frequency environmental variability. Therefore, simulation is used to evaluate alternative estimators, which differ in terms of how the stock–recruitment relationship is modeled, and whether explicit estimators or proxies are used for B0, the steepness of the stock–recruitment relationship, and current spawning biomass relative to B0. The simulations consider three life histories: a long-lived unproductive rockfish, a moderately long-lived and productive flatfish, and a moderately long-lived and productive hake with highly variable recruitment. Results indicate that in the presence of low frequency autocorrelated forcing of recruitment, biomass reference points should be based on average recruitment and/or dynamic B0 if catch and survey data are available for at least one full period of the environmental variable. In contrast, previous analysis suggests that in the absence of autocorrelated environmental forcing of recruitment, and if the available catch and survey data do not span at least, in this case, 50 years which is one full period of the environmental variable, biomass reference points should be based on the fit of the stock–recruitment relationship. Life history affects the estimability of biomass reference points, which are more difficult to estimate for species with more rapid dynamics such as hake. The method used to calculate the reference points given the results of a stock assessment has a larger effect on estimability than the configuration of the stock assessment method, for the three stock assessment model configurations investigated in this study.

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l. Projecting U.S. West Coast sablefish (*Anoplopoma fimbria*) recruitment under global climate change scenarios

Investigators: M.A. Haltuch, N.A. Bond, and M.J. Schirippa

U.S. West Coast sablefish (*Anoplopoma fimbria*) recruitment has been correlated with changes in July sea surface height (SSH) measured at Crescent City, CA. This SSH index has been correlated with zooplankton abundance and previous research suggests that feeding conditions as indexed by zooplankton abundance and SSH are the mechanism driving sablefish recruitment. Given that the SSH-recruitment relationship has held up over time it was evaluated as a component of the 2011 sablefish stock assessment model. Assessment results found that the use of the environmental index did not have a large effect on model results due to the reasonably consistent signals from fishery and survey data sources regarding year-class strengths. This analysis focuses on using multi-decadal SSH forecasts to allow management to better respond to shifts in productivity before they occur, rather than refining our 'hindsight' further. Future environmental conditions, as manifested by changes in the timing, dynamics and productivity of the California current ecosystem, via climate change, or cycles similar to the historical period, are considered a significant source of uncertainty in the stock status projections. Therefore, this project investigates methods for scaling between the currently used local environmental covariate and larger scale measurements of SSH such as those produced by SODA for past conditions and IPCC-class climate models for future conditions. This project then produces long term projections of the sablefish population under alternative global climate change scenarios using the 2011 stock assessment to assess possible directional changes in sablefish recruitment on multi-decadal time scales.

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m. A California current bomb radiocarbon reference chronology and petrale sole age validation

Investigators: M.A. Haltuch, O.S. Hamel, K.R. Piner, P. McDonald, C.R. Kastelle and J.C. Field

As petrale sole (*Eopsetta jordani*) is a valuable groundfish harvested in the California Current, proper ageing is important for its assessment and management. This study presents the first bomb radiocarbon reference chronology for the California Current and petrale sole age validation. Break-and-burn and surface ages are negatively biased by approximately 1 year and 2–3 years, respectively. The reference and validation curves are more variable and show a lag in the rate of radiocarbon increase in comparison to most other time series of bomb radiocarbon in marine systems. Upwelling in the California Current produces a lagged rate of increase in radiocarbon levels owing to the introduction and mixing of radiocarbon-depleted deep waters with surface waters that interact with the atmosphere. The variable and lagged rate of radiocarbon increase in the petrale sole data may be due to their spending a substantial portion of their first year of life in areas subject to variable upwelling, illustrating the importance of using reference curves for age validation that are region and species specific when possible.

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n. Evaluating the law and policy of rebuilding overfished groundfish at the Pacific Fishery Management Council

Investigators: C. Niles, J. Budrick, J.M. Cope, E.J. Dick, D.L. Erickson, J. Grebel, R. Jones, R.A. Kosaka, L. Mattes, H.J. Reed, E.C. Waters

The Pacific Fishery Management Council (PFMC) manages eight groundfish stocks under rebuilding plans, all but one being rockfishes of the genus *Sebastes*. The Magnuson Stevens Fishery Conservation and Management Act (MSA) requires the rebuilding to be "as short as possible" (i.e., by closing the fishery) unless delay is justifiable based on specific factors, with the "the needs of the fishing communities" being the most prominent. The MSA limits delay to 10 years for stocks able to rebuild that quickly, yet is ambiguous on the outer time limit for stocks that cannot.

The rebuilding rockfishes present extreme circumstances for these MSA rebuilding provisions. Even absent fishing, some would not be expected to rebuild for decades. The incidental catch allowed in support of commercial and recreational targeting of other groundfish extends the expected rebuilding timeline decades longer for some species. These long rebuilding times have attracted 10 years of litigation. The courts have overturned individual rebuilding plans on two occasions, most recently in April 2010. On both occasions, the courts' main finding was that the long rebuilding times place disproportionate emphasis on short-term economic concerns.

The rebuilding plans are of consuming focus at the PFMC. The authors focused on key aspects of the courts' analysis while providing context for two related presentations on the PFMC's rebuilding experience. They evaluated the courts' treatment of rebuilding against the principles of fisheries science and management and show how the lines between law, science, and policy have blurred. Particular attention was paid to the assumption about overemphasis of short-term economics and how this assumption has gone untested. The authors then argue for analysis of the MSA's rebuilding provisions based on long-term conservation tradeoffs.

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

Investigators: J. Wallace, J. Harms, I. Stewart

Fishery-independent surveys are an important source of information for stock assessment and management worldwide. Research surveys often use trawl gear to capture commercially valuable species and calculate indices of relative abundance or density. However, many species of interest do not occur in direct contact with the bottom, or occur in areas where high-relief habitat precludes trawl operation. This analysis introduces a standardized hook-and-line survey for rockfish conducted by the Northwest Fisheries Science Center in the Southern California Bight. The survey uses rod-and-reel fishing gear similar to that used in many recreational fisheries to sample nearly 100 locations covering a wide range of depths and habitats. To provide an example of how these data can be analyzed for direct inclusion in stock assessments, we standardize catch rates of bocaccio rockfish from 2004 – 2011 using a Bayesian Generalized Linear Model to account for site, fishing time, survey vessel, angler, and other effects. Results are more precise than other indices of abundance that are currently available and indicate the bocaccio stock in the southern California Bight has shown a relatively flat trend over recent years. This survey is likely to be the only available tuning index for recent years as historically-used recreational catch per unit effort indices have been largely compromised due to changes in bag-limits and other management restrictions.

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p. Assessing the quality of life history information in FishBase, a publicly available database

Investigators: J.T. Thorson, J.M. Cope, and W. Patrick

Single-species life history parameters are central to ecological research and management, including the fields of macro-ecology, fisheries science, and ecosystem modeling. However, there has been little independent evaluation of the precision and accuracy of the life history values in global and publically available databases. The authors develop a novel method based on a Bayesian error-in-variables model that compares database entries with estimates from local experts, and illustrate this process by assessing the accuracy and precision of entries in FishBase, one of the largest and oldest life history databases. This model distinguishes biases among seven life history parameters, two types of information available in FishBase (i.e., published values and those estimated from other parameters) and two taxa (i.e., bony and cartilaginous fishes) while accounting for additional variance caused by sex- and region-specific life history traits. For published values in FishBase, the model identifies a small positive bias in natural mortality and negative bias in life span, perhaps caused by unacknowledged mortality caused by fishing. For life history values calculated by FishBase, the model identified large and inconsistent biases. The model also demonstrates greatest precision for body size parameters, decreased precision for values derived from geographically distant populations, and greatest between-sex differences in age at maturity. The authors recommend that parameter estimates be used in future error-in-variables models as a prior on measurement errors. This approach is broadly applicable to global databases of life history traits, and if used, will encourage further development and improvements in these databases.

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q. Improved biological realism in the design and analysis of surveys

Ecological research frequently uses survey data to provide interpretable estimates of biological processes and behaviors and information regarding changes in relative abundance over time. However, the models that are commonly used to analyze survey data are susceptible to errors and biases when biological and behavioral assumptions are violated. Several novel survey analysis methods were tested that are robust to behaviors that are likely to be present for many fish and animal populations worldwide.

A mixture distribution model was examined that incorporates shoaling behaviors for Pacific rockfish and an agent-based simulation model was developed that is used to test the relative accuracy of the mixture distribution and conventional models when estimating an annual index of abundance for shoaling and non-shoaling species. Several sampling designs were proposed that incorporate data from bottom trawl and *in situ* underwater vehicles (ISUVs). Finally, a multi-state, robust design tag-resighting model was developed that accounts for range expansion and skip-nesting behaviors, which is demonstrated by application to sea turtle populations in South Africa.

The mixture distribution models confirm that shoaling behaviors are implicated in the extreme catches that are occasionally observed for Pacific rockfish, and the simulation results demonstrate that the mixture model can improve accuracy of resulting indices of abundance for shoaling species without appreciably increasing errors for non-shoaling species. Simulation modeling shows that the sampling designs for combined bottom trawl and ISUVs can decrease the biases caused by spatially-varying catchability while increasing accuracy compared with trawl sampling. The tag-resighting model supports the hypothesis that an apparent lack of population recovery for leatherback sea turtles is being caused by range expansion rather than longline fishing effort. In summary, increased biological realism in biological models is useful to account for spatial behaviors that are likely to be present for many fish and animal species worldwide.

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r. Ichs, herps, and splines: How approximating time-varying parameters can improve model accuracy and interpretability

Many population dynamics models can be estimated with time-varying parameters. Conventional estimation approaches and software packages for capture-mark-recapture, occupancy, and stock assessment models present the choice between constant and annually varying forms for parameters representing survival, detectability, and abundance (to name a few examples). Time-constant parameters may results in biased estimation, while annually varying forms may not be parsimonious, estimable, or interpretable given available data.

A fixed-knot spline approximation to time-varying parameters was examined, where the Akaike Information Criterion was used to select an appropriate degree of smoothness, which includes both constant and annually varying forms as extreme cases. The simulation modeling was first used with data for 53 species of chondricthyes in Australia to demonstrate the improvements in accuracy and parsimony arising from this approximation in occupancy models. Data for two sea turtle species in South Africa was then used to demonstrate improvements in interpretability arising from this approximation in multistate, robust design capture-mark-recapture models. Other model types and applications for which this approximation may be appropriate were discussed. These applications can potentially improve accuracy, parsimony, or interpretability for a variety of model and data types.

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s. Growth variability of the splitnose rockfish (*Sebastes diploproa*) in the Northeast Pacific Ocean: Pattern revisited

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

Understanding patterns of somatic growth within populations greatly contributes to fisheries stock assessment. Splitnose rockfish, *Sebastes diploproa*, was reported as having a striking pattern of latitudinal growth variability from studies conducted in the 1980s. We investigated variation in growth parameters of splitnose rockfish by latitude using recent data from the NOAA Fisheries Groundfish Survey (2003- 2008), current ageing techniques, and advanced modeling and statistical methods to provide an updated understanding of growth along this species' latitudinal range. Sex-specific age data were fit to a von Bertalanffy growth function incorporating ageing error, and growth parameters were estimated for 5 areas along the U. S. west coast, specified based on biogeographic boundaries. Resampled values of each growth parameter were then fit to linear models, and Akaike's information criterion (AIC) was used to evaluate hypotheses for growth parameter relationship with latitude. We found that splitnose rockfish exhibited a cline in asymptotic length (L-infinity), with L-infinity increasing with rising latitude. We also found that although the growth coefficient (k) was smallest in the most southern area, there was no apparent cline along the coast; a northward cline in k has previously been reported in the literature. We propose that differences in fishing intensity could be responsible for the cline in L-infinity, as higher fishing pressure in the south could skew the size distribution of the population in that region and reduce southern L-infinity estimates. We also attribute slower growth in the southern area to oceanographic characteristics and low productivity of the area south of Point Conception.

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t. Preliminary life history variability of longnose skate (*Raja rhina*) across two large marine ecosystems: Gulf of Alaska and California Current System

Investigators: C. Gburski, T. Helser, V.V. Gertseva, J.R. King, and D.A. Ebert

The longnose skate, *Raja rhina*, is common in the eastern North Pacific Ocean ranging from the Bering Sea to Baja California and occurs from close inshore to a maximum of 1000 m depth. In the Gulf of Alaska (GOA), it has a maximum total length and age of 145 cm and 25 years, respectively. A directed fishery for *Raja* spp. off Kodiak Island, Alaska was initiated in 2003, ending in 2005. An experimental fishery in Prince William Sound, Alaska was reinstated in 2009. The vulnerability of elasmobranchs to over exploitation from commercial fishing, either from bycatch or a directed fishery, is well- documented. This inter-agency and institutional (AFSC, NWFSC, DFO and MLML/PSRC) collaborative study quantitatively compares growth and age/size at sexual maturity of the longnose skate across two large marine ecosystems, the GOA and California Current Ecosystem (CCE), on a spatial and temporal scale. Potential environmental (e.g., bottom water temperature) and oceanographic influences on life history traits between the GOA and CCE are also examined. Vertebrae (n=500) for this study were collected off the GOA, British Columbia (BC) 'current break' and U.S. West Coast states between 2001 and 2009 from research surveys and via port sampling. Ages were estimated from vertebrae prepared with the standard (unstained) thin sectioning technique in this preliminary study. A new histological (stained) method will be applied to archival vertebrae in the future. Age estimates from the standard technique and a new histological method will be compared to validated ages from a longnose skate 14C study. The methods estimated ages that best fit the validated ages will be used to standardize ageing criteria among agencies therefore optimizing age determination for use in stock assessment and management.

This study was presented at the Western Groundfish Conference in February 2012, in Seattle. This study is a part of larger collaborative study on variability of life history traits of skates across large marine ecosystems.

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u. Summary of stock status for assessed Pacific Coast groundfish species

Investigators: J. Hastie, S. Miller, and J.M. Cope

Over the past decade, an increasing number of species have been assessed using methods that allow stock status to be estimated. Some stocks have been found to be in need of rebuilding, and they have had a substantial impact on the management of all sectors of the groundfish fishery. Of these rebuilding stocks, those which have not yet reached rebuilding targets have exhibited continuing growth throughout this period (to the extent that the available data are adequate to discern a trend). A high percentage of the other assessed species, as of their most recent assessments, are either near or above their target levels of spawning potential. The authors summarize trends in the status of assessed Pacific Coast groundfish stocks over the last half-century, with particular focus on the recent rebuilding period. They also highlight data, research, and methods that are needed to improve the number and quality of stock-status determinations that are available to inform future management.

For more information, please contact Jim Hastie at Jim.Hastie@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. The 2012 Pacific hake assessment was reviewed under the auspices of a treaty with Canada for the first time in 2012. A schedule for Stock Assessment Review (STAR) panels for full assessments of species to be conducted in 2013, along with the 2012 Hake Scientific Review Group meeting, is shown in Table 1.

Table 1. 2012 and 2013 Review Schedule for Full Groundfish Assessments.

STAR PANEL	STOCK	AUTHOR(S)	REVIEW PANEL DATES	STAR PANEL LOCATION
Hake SRG* Panel	Pacific hake/ whiting	Ian Stewart Robin Forrest Nathan Taylor Chris Grandin Allan Hicks	February 21-24, 2012	Seattle, WA
Hake SRG* Panel	Pacific hake/ whiting	Allan Hicks Nathan Taylor Chris Grandin Ian Taylor Sean Cox	February 19-22, 2013	Vancouver, British Columbia Canada
1	Data Moderate: Brown, China, Copper, Sharpchin, Stripetail, Vermilion, Yellowtail rockfish; Rex and English sole	Jason Cope E.J. Dick	April 22-26, 2013	Santa Cruz, CA
2	Petrale Sole Darkblotched rockfish	Melissa Haltuch Vlada Gertseva	May 13-17, 2013	Seattle, WA
Updates Data Reports	Bocaccio rockfish Canary rockfish Pacific ocean perch Yelloweye rockfish	John Field John Wallace Owen Hamel Ian Taylor	June 18, 2013	Garden Grove, CA

3	Rougheye rockfish Aurora rockfish	Allan Hicks Owen Hamel	July 8 – 12, 2013	Seattle, WA
4	Shortspine thornyhead Longspine thornyhead	Ian Taylor Andi Stephens	July 22 -26, 2013	Seattle, WA
5	Cowcod Pacific sanddab	E.J. Dick Xi He	August 8-12, 2013	Santa Cruz, CA

*****Scientific Review Group – for international review of Pacific hake under treaty with Canada

1. Shelf Rockfish - West Coast

a. Stock Assessments

No shelf rockfish assessments were conducted during 2012. Full assessments of cowcod and data moderate rockfish species brown, china, copper, sharpchin, stripetail, vermilion, and yellowtail will be conducted in 2013. An update of the 2009 assessment of bocaccio and data reports on canary and yelloweye rockfish will also be conducted in 2013.

Yelloweye rockfish: The complete version of: Status of the U.S. yelloweye rockfish resource in 2011(Update of 2009 assessment model) can be viewed online at:
http://www.pcouncil.org/wp-content/uploads/Yelloweye_2011_Assessment_Update.pdf

For more information on the yelloweye rockfish assessmen,t please contact Ian Taylor at Ian.Taylor@noaa.gov

Widow rockfish: The complete version of: Status of the widow rockfish resource in 2011 can be viewed online at:
http://www.pcouncil.org/wp-content/uploads/Widow_2011_Assessment.pdf

Bocaccio: An update of the 2009 bocaccio assessment will be conducted in 2013 by the SWFSC. The complete version of: Status of bocaccio, *Sebastes paucispinis*, in the Conception, Monterey and Eureka INPFC areas for 2009 can be viewed online at:
http://www.pcouncil.org/wp-content/uploads/Bocaccio_Final_Jan15_2010.pdf

Greenstriped rockfish: The complete version of: Status of greenstriped rockfish (*Sebastes elongatus*) along the outer coast of California, Oregon, and Washington can be viewed online at:
http://www.pcouncil.org/wp-content/uploads/GreenstripedSAFE.pdf

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

Canary rockfish: The complete version of: Status of the U.S. canary rockfish resource in 2011 can be viewed online at: http://www.pcouncil.org/wp-content/uploads/Canary_2011_Assessment_Update.pdf

For more information on the canary rockfish assessment, contact John Wallace at John.Wallace@noaa.gov

Cowcod: The complete version of: Updated status of cowcod, *Sebastes levis*, in the Southern California Bight can be viewed online at: http://www.pcouncil.org/wp-content/uploads/cowcod_update_assessment_2009.pdf

Greenspotted rockfish: The complete version of: Status of greenspotted rockfish, *Sebastes chlorostictus*, in U.S. waters off California can be viewed online at: http://www.pcouncil.org/wp-content/uploads/Greenspotted_Rockfish_2011_Assessment.pdf

2. Slope Rockfish

a. Stock assessments

No slope rockfish assessments were conducted during 2012. Full assessments of darkblotched, rougheye, and aurora rockfish and a data report on Pacific ocean perch will be conducted in 2013.

Blackgill rockfish: The complete version of: Status of the blackgill rockfish, *Sebastes melanostomus*, in the Conception and Monterey INPFC areas for 2011 can be viewed online at: http://www.pcouncil.org/wp-content/uploads/Blackgill_2011_Assessment.pdf

For more information on blackgill rockfish, please contact John Field at John.Field@noaa.gov.

Darkblotched rockfish: The complete version of: Status and future prospects for the darkblotched rockfish resource in waters off Washington, Oregon, and California in 2011 can be viewed online at: http://www.pcouncil.org/wp-content/uploads/Darkblotched_2011_Assessment.pdf

For more information on darkblotched rockfish, please contact Andi Stephens at Andi.Stephens@noaa.gov

Pacific ocean perch: The complete version of: Stock assessment of Pacific ocean perch in waters off the U.S. West Coast in 2011 can be viewed online at: http://www.pcouncil.org/wp-content/uploads/Pacific_Ocean_Perch_2011_Assessment.pdf

For more information on Pacific Ocean perch, contact Owen Hamel at Owen.Hamel@noaa.gov.

3. Thornyheads

a. Stock Assessments

No thornyhead assessments were conducted during 2012. Full assessments of the shortspine and longspine thonyhead will be conducted in 2013.

For more information on thornyheads, contact Ian Taylor at Ian.Taylor@noaa.gov.

4. Sablefish

a. Stock Assessments

No sablefish assessment was conducted in 2012 and none is planned for 2013. The complete version of: Status of the U.S. sablefish resource in 2011 can be viewed online at: http://www.pcouncil.org/wp-content/uploads/Sablefish_2011_Assessment.pdf

For more information on sablefish, contact James Thorson at James.Thorson@noaa.gov.

5. Flatfish

a. Stock Assessments

No assessments for flatfish were conducted during 2012. Full assessments of petrale sole, rex sole, English sole, and Pacific sanddab are planned for 2013.

Dover sole: The complete version of: The status of Dover sole (*Microstomus pacificus*) along the U.S. West Coast in 2011 can be viewed online at: http://www.pcouncil.org/wp-content/uploads/DoverSole_2011_DRAFT_Assessment.pdf

For more information, please contact Allan Hicks at Allan.Hicks@noaa.gov

Petrale sole: The complete version of: Status of the U.S. petrale sole resource in 2010 can be viewed online at:
http://www.pcouncil.org/wp-content/uploads/Petrale_2011_Assessment.pdf

For more information, please contact Melissa Haltuch at Melissa.Haltuch@noaa.gov

6. Pacific Hake

This assessment reports the status of the coastal Pacific hake (or Pacific whiting, *Merluccius productus*) resource off the west coast of the United States and Canada. This stock exhibits seasonal migratory behavior, ranging from offshore and generally southern waters during the winter spawning season to coastal areas between northern California and northern British Columbia during the spring, summer and fall when the fishery is conducted. In years with warmer water temperatures, the stock tends to move farther North during the summer and older hake tend to migrate farther than younger fish in all years. Separate, and much smaller, populations of hake occurring in the major inlets of the northeast Pacific Ocean, including the Strait of Georgia, Puget Sound, and the Gulf of California, are not included in this analysis.

This assessment reports a single base-case model representing the collective work of the Joint Technical Committee (JTC). The assessment depends primarily upon the acoustic survey biomass index (1995, 1998, 2001, 2003, 2005, 2007, 2009 and 2011) for information on the scale of the current hake stock. The 2011 index value is the lowest in the time-series. The aggregate fishery age-composition data (1975-2011) and the age-composition data from the acoustic survey contribute to the assessment model's ability to resolve strong and weak cohorts. Both sources show a strong 2008 cohort, but differ somewhat in the relative magnitude of the weaker 2005 and 2006 cohorts.

The assessment is fully Bayesian, with the base-case model incorporating prior information on two key parameters (natural mortality, M, and steepness of the stock-recruit relationship, h) and integrating over estimation and parameter uncertainty to provide results that can be probabilistically interpreted. The base-case stock assessment model indicates that the Pacific hake female spawning biomass was well below the average unfished equilibrium in the 1960s and 1970s. The stock is estimated to have increased rapidly after two or more large recruitments in the early 1980s, and then declined rapidly after a peak in the mid- to late 1980s to a low in 2000. This long period of decline was followed by a brief increase to a peak in 2003 (median estimate of 1.29 million mt in the SS model) as the exceptionally large 1999 year class matured. The stock is then estimated to have declined with the aging 1999 year class to a time-series low of 0.38 million mt in 2009. This recent decline is much more extreme than that estimated in the 2011 assessment. The current median posterior spawning biomass is estimated to be 32.6% of the average unfished equilibrium level (SB_0). However, this estimate is quite uncertain, with 95% posterior credibility intervals ranging from historical lows to above the average unfished equilibrium levels. The estimate of 2012 is 0.62 million mt, much smaller than the two estimates in the 2011 assessment (1.87, and 2.18 million mt). This change is largely driven by the very low 2011 acoustic survey biomass index. Recent catch and levels of depletion are presented in figure 3.

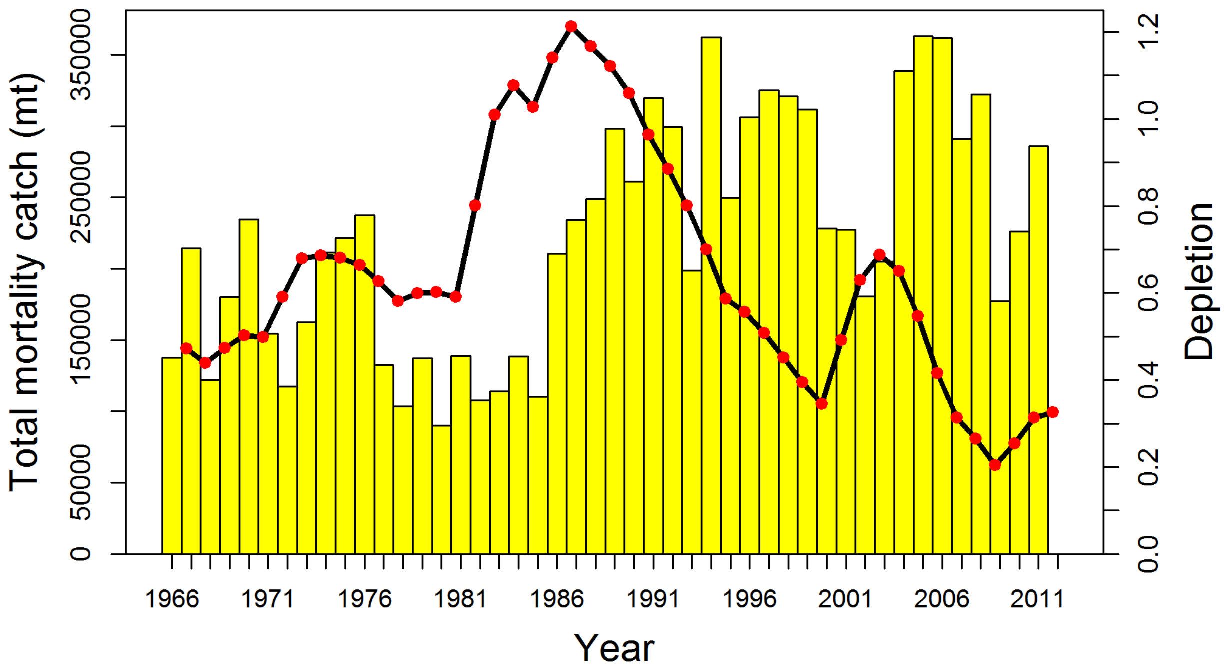

Figure 3. Total catch (mt; bars) and depletion (relative to average unexploited equilibrium level; line) for Pacific hake, 1966-2012.

The complete document: "Status of the Pacific hake (Whiting) stock in U.S. and Canadian Waters in 2012" can be viewed online at:
http://www.nwr.noaa.gov/fisheries/management/whiting/pacific_whiting.html

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

7. Other species

a. Stock assessments

Cabezon: The complete version of: Status of cabezon (*Scorpaenichthys marmoratus*) in California and Oregon Waters as assessed in 2009 can be viewed online at:
http://www.pcouncil.org/wp-content/uploads/Cabezon09_FINAL.pdf

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

Lingcod: The complete version of: Status and future prospects for lingcod in waters off Washington, Oregon, and California as assessed in 2009 can be viewed online at:
http://www.pcouncil.org/wp-content/uploads/Lingcod_Assessment_2009_Final_SAFE_version.pdf

For more information, please contact Owen Hamel at Owen.Hamel@noaa.gov

Spiny dogfish: The complete version of: Status of the spiny dogfish resource off the continental U.S. Pacific Coast in 2011 can be viewed online at: http://www.pcouncil.org/wp-content/uploads/Spiny_Dogfish_2011_Assessment.pdf

For more information, please contact Vlada Gertseva at Vlada.Gertseva@noaa.gov

D. Other Related Studies

1. The PaCOOS, West Coast habitat data portal

The PaCOOS West Coast Habitat Data Portal and associated server were conceived in 2005 as a Local Data Access Center (LDAC) of the Integrated Ocean Observing System (IOOS). Funding for its development was provided by the NOAA IOOS Program through the FRAM Division of the Northwest Fisheries Science Center. The database and GIS system had its origin the data collected together for the West Coast Essential Fish Habitat Environmental Impact Statement, which was completed in 2005/2006. Maintained jointly by FRAM and Oregon State University, College of Oceanic and Atmospheric Sciences Seafloor Mapping Laboratory and in collaboration with PSMFC, the portal provides access to data (search, connection, and download), a visualization environment, and integrated navigation tools. The data portal houses an ever expanding array of information including but not limited to geological and geophysical data, benthic habitat maps, fisheries survey datasets, and ocean climatologies. Data access, which includes data searching and metadata harvesting, is provided through IOOS Data Management and Communications (DMAC) compliant pathways such as OPeNDAP, OGC WMS, and ESRI ArcIMS map services. The portal's centerpiece is its unique map viewer environment (http://pacoos.coas.oregonstate.edu/), an online application that provides a map interface to data holdings with custom tools for data downloads and queries. There is a growing user base that includes local, state, and federal agencies within the California Current Large Marine Ecosystem.

The functionality of the PaCOOS data portal is continually being improved and new data sets are being added. During the latter part of 2011 and continuing into 2012, the Active Tectonics and Seafloor Mapping Lab will transition the PaCOOS server from ESRI ArcIMS Internet Map Server software to the current ESRI ArcGIS Server software, and upgrade the application underlying the West Coast Habitat server. Datasets and metadata developed as part of the current Pacific Coast groundfish EFH 5-year review will be placed on the PaCOOS West Coast Habitat Server. During the transition period, all new information and updates will be placed on the "Consolidated GIS Data Catalog and Online Registry for the 5-Year Review of Pacific Coast Groundfish EFH (or EFH Catalog for short) at http://efh-catalog.coas.oregonstate.edu/overview/.

For more information, contact Waldo Wakefield at waldo.wakefield@noaa.gov, Chris Goldfinger at gold@coas.oregonstate.edu or Chris Romsos at cromsos@coas.oregonstate.edu

2. Bycatch Reduction Research

Recent conservation engineering work in US West Coast Groundfish Fisheries

Beginning in 2004, the NOAA Fisheries Northwest Fisheries Science Center (NWFSC) initiated a fisheries conservation engineering program within its Fisheries Resource Analysis and Monitoring Division. Through key regional collaborations with the Pacific States Marine Fisheries Commission, Oregon Department of Fish and Wildlife, Alaska Fisheries Science Center, and the fishing industry, the NWFSC has been able to pursue a wide-ranging array of conservation engineering projects relevant to reducing bycatch and habitat impacts from mobile fishing gear in the west coast groundfish trawl fishery. In the past two years, these projects include: 1) Reducing Chinook salmon, rockfish, and Pacific halibut bycatch in west coast groundfish fisheries using bycatch reduction devices, 2) Bycatch reduction in the ocean shrimp fishery (juv. groundfishes, ESA listed eulachon, megafaunal invertebrates, 3) Providing loaner video camera systems to the fishing industry, 4) Examining selectivity characteristics of codends that differ in mesh size and configuration in the bottom trawl fishery. Much of our current work has been in response to the fishing industries rising concerns over IBQ (Individual Bycatch Quota) for Pacific halibut allocated in the Pacific Coast Groundfish Trawl Rationalization Catch Share Program. The trawl rationalization program, starting in January 2011, (through amendments to the Groundfish Fisheries Management Plan) will establish formal Annual Catch Limits (ACLs) and individual catch share quotas. It has been projected that these complex fishery management measures will create increased demand for bycatch solutions in the groundfish trawl fishery. In addition to ACLs, fishing opportunities may also be limited by hard caps or IBQs for non-groundfish species (e.g., ESA Chinook salmon in the Pacific hake fishery and Pacific halibut in the bottom trawl fishery). Bycatch of overfished species in the West Coast groundfish trawl fishery has the potential to constrain the fishery such that a substantial portion of available harvest may be left in the ocean.

Reducing Chinook Salmon and Rockfish bycatch in the Pacific hake Fishery

In 2012, the NWFSC and PSMFC conducted a pilot study testing the efficacy of a flexible sorting grid rockfish excluder in the U.S. Pacific hake fishery. This project was the outcome of a collaborative workshop between agencies and the fishing industry. This study examined two versions of a flexible sorting grid rockfish excluder in the U.S. Pacific hake fishery. The designs tested (design-A and design-B) were developed following a collaborative workshop held between gear researchers and Pacific hake fishing industry participants. Tests occurred off Oregon and Washington during 2012 aboard the F/V Perseverance. A recapture net was used to quantify the escapement of Pacific hake and non-target species. Both designs retained a relatively high proportion of Pacific hake (>93%). However, the two designs did not perform equally with design-B being much more effective at reducing bycatch. Results showed rockfish bycatch was reduced by 70.2% under design-B and only 15.4% under design-A. For both designs, the mean lengths of Pacific hake caught between the codend and the recapture net did not differ significantly. A reduction in the catch of Pacific halibut and Chinook salmon, which are prohibited take species, was also noted. Unfortunately, both designs tested were only effective under slow-to-moderate fish volumes. Under heavy fish volumes both designs tended to clog. Results of this research suggest there is potential for reducing rockfish bycatch in the Pacific hake fishery using a flexible sorting grid excluder.

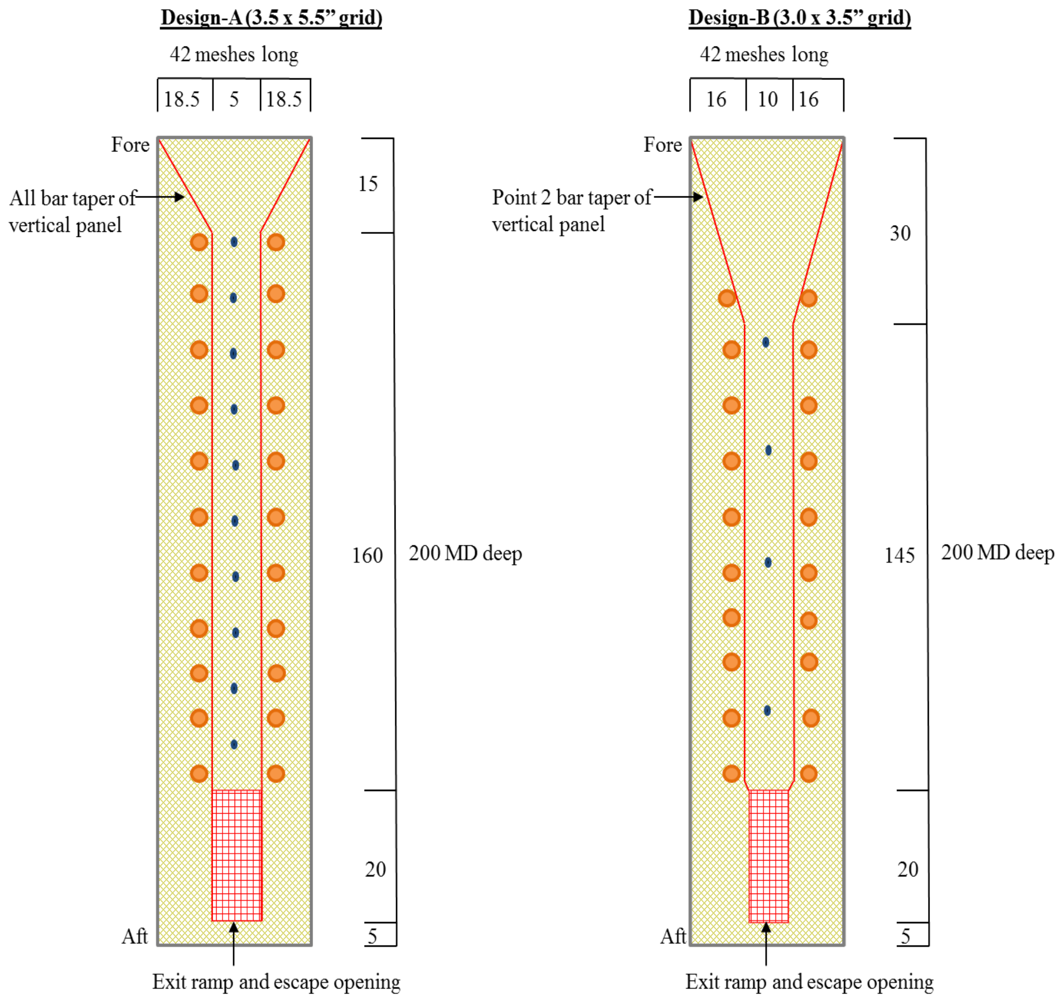

Figure 4. Top view diagram depicting the differences between design-A and B. Solid red lines represent the vertical sorting panels, whereas the red grids represent the exit ramp. The orange circles represent 8" centerhole floats. The blue oval shapes represent the ropes with chaffing gear wedged through them. MD = diamond mesh. Note: this diagram is not drawn to scale.

Figure 5. Photos illustrating results from a tow when testing design-B. Left image shows a portion of the codend catch (mostly Pacific hake), whereas the right top image shows the entire recapture net catch (mixture of rockfishes and Pacific hake). The bottom right image shows baskets of rockfishes sorted (mixture of yellowtail rockfish, widow rockfish, and rougheye rockfish) from the recapture net catch. For this tow the retention of hake was 95.1% while the escapement of rockfishes was 71.1%.

For more information, contact Waldo Wakefield at Waldo.Wakefield@noaa.gov or Mark Lomeli at MLomeli@psmfc.org or visit http://www.nwfsc.noaa.gov/research/divisions/fram/habitat.cfm

Reducing Pacific Halibut bycatch in bottom trawl fisheries

In response to fishermen's concern about Pacific halibut bycatch, the NWFSC and PSMFC tested a flexible sorting grid excluder designed to reduce halibut bycatch in the US West Coast groundfish bottom trawl fishery. Tests occurred off Washington during 2011 aboard a commercial trawler. A recapture net was used to quantify the retention rates of target and non-target species. Pacific halibut bycatch was reduced 61.6% by weight and 57.0% by numbers. Exclusion was greatest for Pacific halibut weighing more than 4.5 kg. A significant difference in the mean total length was also noted between Pacific halibut caught in the codend and the recapture net, with larger fish occurring in the recapture net. The retention of primary target groundfishes of marketable size ranged from 76.7 to 89.3%. We demonstrated the capability of a flexible sorting grid excluder to reduce Pacific halibut bycatch in the groundfish bottom trawl fishery while retaining a relatively high proportion of the targeted species.

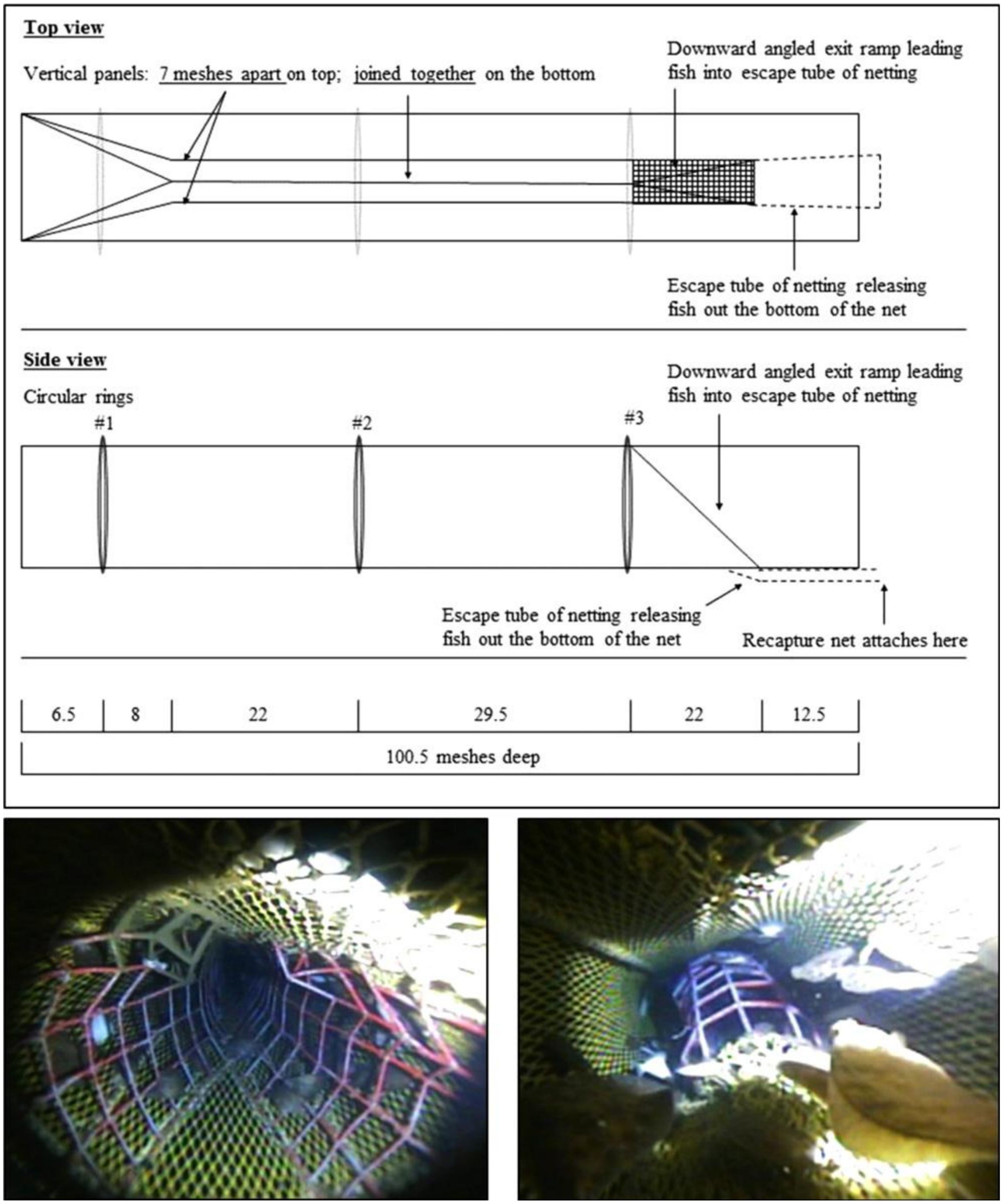

Figure 6. Schematic diagram of the Pacific halibut flexible sorting grid excluder tested (top); aft view of the forward portion of the excluder where fish enter and encounter the device (bottom left); forward view of the downward-angled exit ramp with fish moving aft toward the codend (bottom right).

Figure 7. Comparison of fish caught between the trawl codend and recapture codend during one tow.

For more information, contact Waldo Wakefield at Waldo.Wakefield@noaa.gov or Mark Lomeli at MLomeli@psmfc.org or visit http://www.nwfsc.noaa.gov/research/divisions/fram/habitat.cfm

Providing direct observation video camera systems to fishermen for use in evaluating industry-designed approaches to reducing bycatch and impacts to benthic habitats

Since 2010, the NWFSC, working in collaboration with PSMFC, has operated an underwater video camera loaner to make systems available to commercial fishers and other sectors of the industry for their use in evaluating industry-designed bycatch reduction devices. In 2011, the NWFSC added two additional video systems to the pool (Figures 8-9). These camera systems have been used extensively across the Pacific hake midwater trawl fishery, groundfish bottom trawl fishery, and the pink shrimp trawl fishery.

For more information, contact Waldo Wakefield at Waldo.Wakefield@noaa.gov or Mark Lomeli at MLomeli@psmfc.org or visit http://www.nwfsc.noaa.gov/research/divisions/fram/habitat.cfm

Figure 8. One of four autonomous direct observation video camera systems developed at the NWFSC.

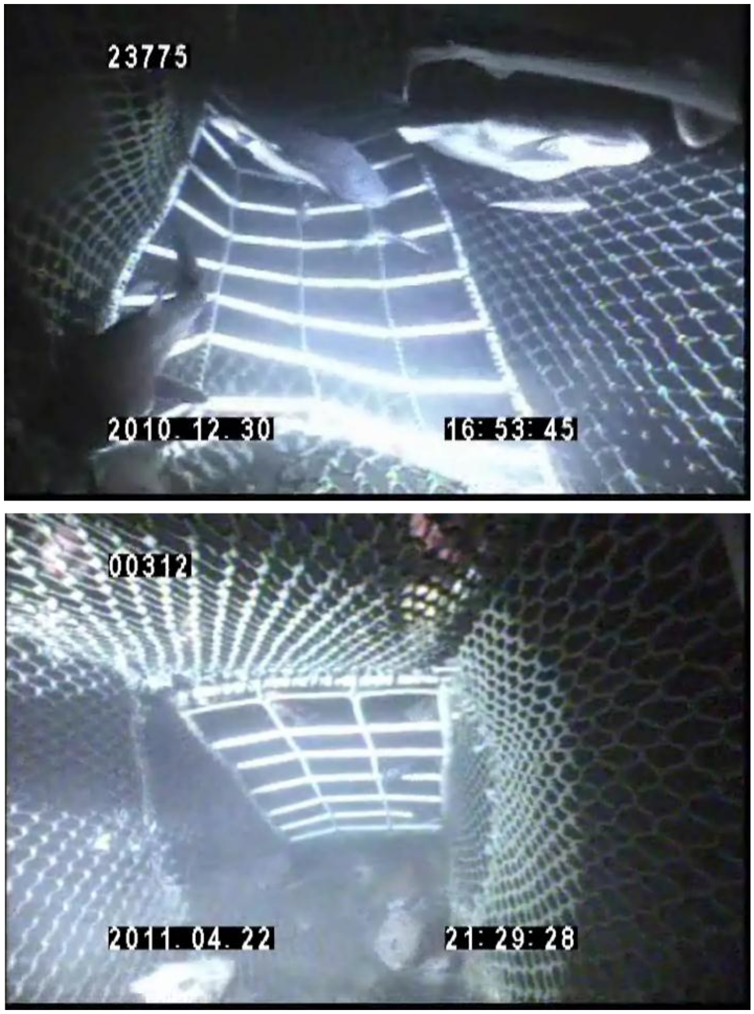

Figure 9. Video frame grabs showing flexible sorting grates developed by the fishing industry to reduce Pacific halibut bycatch in the groundfish bottom trawl fishery. Information gained from the videos was used to improve the performance of the grates.

For more information, contact Waldo Wakefield at Waldo.Wakefield@noaa.gov or Mark Lomeli at MLomeli@psmfc.org or visit http://www.nwfsc.noaa.gov/research/divisions/fram/habitat.cfm

Effect of mesh size and configuration on codend selectivity in the groundfish bottom trawl fishery

In 2012, the NWFSC, working in collaboration with PSFMC, studied the effect of mesh size and configuration on codend selectivity in the groundfish bottom trawl fishery. This project examined the selectivity characteristics between 4.5 and 5.5” T90 mesh (conventional diamond mesh that has been turned 90° in orientation) and 4.5” diamond mesh codends and evaluated their efficacy at reducing discards in the U.S. West Coast groundfish bottom trawl fishery. Findings showed the conventional 4.5” diamond codend was the least effective at reducing discards of juvenile and unmarketable-sized roundfishes and exhibited a relatively high percent loss of marketable-sized flatfishes. The 5.5” T90 codend was extremely effective at reducing discards of both juvenile and unmarketable-sized flatfishes and roundfishes, however, exhibited a high percent loss of marketable-sized groundfishes. On the other hand, the 4.5" T90 codend retained the highest percentage of marketable-sized groundfishes while effectively reducing discards of juvenile and unmarketable-sized roundfishes, however, it was not as effective at reducing flatfish discards compared to the other codends examined. Results from this research have led fishermen and gear researchers to believe that a 5.0" T90 codend could be effective at reducing the discards of both juvenile and unmarketable-sized flatfishes and roundfishes while maintaining catch levels of marketable-sized groundfishes.

For more information, contact Waldo Wakefield at Waldo.Wakefield@noaa.gov or Mark Lomeli at MLomeli@psmfc.org or visit http://www.nwfsc.noaa.gov/research/divisions/fram/habitat.cfm

3. Cooperative Ageing Unit

The Cooperative Ageing Project (CAP) operates under a grant from the Northwest Fisheries Science Center to Pacific States Marine Fisheries Commission and provides direct support for U.S. West Coast groundfish stock assessments by providing fish ages derived primarily from otoliths. In 2012, CAP aged more than 17,000 otoliths from the following species for inclusion in 2013 assessments: Pacific hake, petrale sole, darkblotched rockfish, aurora rockfish and vermillion/sunset rockfish. Work continues through May 2013 on several of those species, as well as rougheye rockfish. CAP also completed over 3,600 age reads of Pacific ocean perch and sablefish, for use in 2015 assessments. CAP continued the practice of recording otolith weights prior to breaking and burning, in support of research into alternative methods of age determination.

For more information, please contact Jim Hastie at Jim.Hastie@noaa.gov

4. Resource Surveys

a. U.S. West Coast Groundfish Bottom Trawl Survey

The NWFSC conducted its fifteenth annual bottom trawl resource survey for groundfish off the coasts of Washington, Oregon, and California. The objective of the 2012 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,* and *Noah's Ark* were contracted to survey the area from Cape Flattery, WA to the Mexican border in Southern California, beginning in the later part of May and continuing through October. Each chartered was for a period of 11-12 weeks with the *Ms Julie* and *Noah's Ark* surveying the coast during the initial survey period from May to July. The *Excalibur,* and *Noah's Ark* operating in tandem, surveyed the coast during a second pass from mid-August to late October. The survey area was partitioned into ~12,000 adjacent cells of equal area (1.5 nm long. by 2.0 nm lat., Albers Equal

Area projection) with each vessel assigned a primary subset of 188 randomly selected cells to sample. An Aberdeen-style net with a small mesh (1 1/2" stretch) liner in the codend was used for sampling. The survey followed a stratified random sampling scheme with 15-minute tows within 2 geographic strata (80% N of Pt. Conception, CA and 20% S) and 3 depth strata. The depth strata were: shallow (30-100 fms), middle (100-300 fms), and deep (300-700 fms). The sample design consisted of 752 sampling locations, with a minimum of 30 tows per strata.

In 2012, 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) Maturity investigations for blackgill rockfish (*Sebastes melanostomus*) – Southwest Fisheries Science Center; 3) Collection of sablefish otoliths, visual maturity information, and finclips for genetic studies along entire coast - AFSC; 4) Record all sightings of basking sharks – Moss Landing Marine Laboratories; 5) Collections of sandpaper skate, *Bathyraja kincaidii* – Moss Landing Marine Laboratories; 6) Collection of any Pacific black dogfish, *Centroscyllium nigrum* - Moss Landing Marine Laboratories; 7) Collection of all unusual or unidentifiable skates, deepsea skate, *Bathyraja abyssicola*, Pacific white skate, *Bathyraja spinossisima*, fine-spined skate, *Bathyraja microtrachys*, Aleutian skate, *Bathyraja aleutica*, and broad skate, *Amblyraja badia*, – Moss Landing Marine Laboratories; 8) Collection of all unusual or unidentifiable sharks including small sleeper sharks, *Somniosus pacificus* - Moss Landing Marine Laboratories; 9) Collection of any chimaera that is not *Hydrolagus colliei*, including: *Harriotta raleighana*, *Hydrolagus* spp. and *Hydrolagus trolli* – Moss Landing Marine Laboratories; 10) Collection of voucher specimens for multiple fish species – Northwest Fisheries Science Center; 11) Collection of vouncher specimens for multiple fish species – Oregon State University; 12) collection of squid species: *Octopoteuthis deletron, Chiroteuthis calyx, Galiteuthis phyllura, Taonius borealis, Vampyroteuthis infernalis, Japetella diaphana, Abraliopsis felis, Histioteuthis heteropsis, Histioteuthis dofleini,* and *Cranchia scabra* – Montery Bay Aquarium Research Institute.

Several other research initiatives were undertaken by the Survey Team including: 1) Use of stable isotopes and feeding habits to examine the feeding ecology of rockfish (genus *Sebastes*); 2) Fin clip collection for various shelf rockfish species; 3) Collection of stomachs for various rockfish species; 4) Collection and identification of cold water corals; 5) Fish distribution in relation to bottom dissolved oxygen concentration in the oxygen minimum zone; 6) Composition and abundance of benthic marine debris collected during the 2012 West Coast Groundfish Trawl Survey from May to October 2012; and 7) Collection of ovaries from hake, aurora rockfish, darkblotched rockfish, sablefish, shortspine thornyheads and canary rockfish to assess maturity.

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

b. Southern California shelf rockfish hook-and-line survey

In early Fall 2012, FRAM personnel conducted the ninth hook and line survey for shelf rockfish in the Southern California Bight (SCB). This project is a cooperative effort with Pacific States Marine Fisheries Commission (PSMFC) and the southern California sportfishing industry aimed at developing an annual index of relative abundance and time series of other biological information for structure-associated species of rockfish (genus *Sebastes*) such as bocaccio (*S. paucispinis*), greenspotted rockfish (*S. chlorostictus*), and the vermilion rockfish complex (e.g., *S. miniatus* and *S. crocotulus*) within the SCB.

The F/V *Aggressor* (Newport Beach, CA) and F/V *Mirage* (Port Hueneme, CA) were each chartered for 12 days of at-sea research, with nine biologists participating during the course of the survey. The two vessels sampled a total of 121 sites ranging from Point Arguello in the north to 9 Mile Bank and the US-Mexico EEZ boundary in the south. Approximately 3,314 sexed lengths and weights, 3,209 fin clips, and 3,104 otolith pairs were taken during the course of the entire survey representing 35 different species of fish and 2 invertebrate species.

Several ancillary projects were also conducted during the course of the survey. Ovaries were collected from key species to develop maturity curves. Several dozen individual fish were retained for use in species identification training for west coast groundfish observers and for a genetic voucher program conducted by the University of Washington. Researchers also deployed a new underwater video sled to capture visual observations for habitat analysis, species composition, and fish behavior studies. Work with a patented non-lethal biopsy hook to capture genetic information *in situ* is ongoing.

For more information, please contact John Harms at John.Harms@noaa.gov

c. 2012 joint U.S.-Canada integrated acoustic and trawl survey of Pacific hake and Pacific sardine

The joint U.S.-Canada integrated acoustic and trawl survey was conducted in U.S. and Canadian waters by two U.S. teams (NWFSC/FRAM and SWFSC/FRD) on the NOAA ship *Bell M. Shimada* from 27 June 2012 to 23 August 2012, and by a Canadian team (DFO/PBS) on the CCGS *W.E. Ricker* from 15 August 2012 to 6 September 2012. In addition, a third U.S. team (NWFSC/FRAM and NWFSC/REUT) worked on the fishing vessel *Forum Star* from 28 June 2012 to 11 August 2012 in collaboration with the *Shimada*. The data collected during the survey were processed to provide an estimate of the abundance and spatial distribution of the coastal Pacific hake stock shared by both countries. The survey covered the slope and shelf of the U.S. and Canada West Coast from roughly 35.8°N (in between Morro Bay and Monterey Bay) to 55.3°N (Southeast Alaska and Dixon Entrance) with acoustic transects spaced 10 or 20 nm apart. Acoustic data were collected on the *Shimada* with an EK60 echosounder operating at frequencies of 18, 38, 70, 120, and 200 kHz, on the *Ricker* with a 38-kHz and 120-kHz EK60 echosounder, and on the *Forum Star* with a 38-kHz and 120-kHz ES60 echosounder. The survey resulted in 118 transects with 4,621 nautical miles of acoustical transect that were used for the biomass estimate. Aggregations of adult (age 2+) Pacific hake were detected on 94 transects from the start of the survey, north along the U.S. and Canadian coast, in the Queen Charlotte Sound and

Hecate Strait, through Dixon Entrance, and at the southwest tip of Haida Gwaii (known formerly as the Queen Charlotte Islands). Highest concentrations of Pacific hake were observed along the California coast from Monterey Bay to south of Cape Mendocino, from just south of Crescent City, California to the southern Oregon coast, in between Newport and Astoria, Oregon, and in the Dixon Entrance area. Concentrations of Pacific hake were relatively moderate off Washington and Vancouver Island, minimal in Hecate Strait, and essentially absent in southeast Alaska and along the west coast of Haida Gwaii. Midwater trawls equipped with a camera system, along with a bottom trawl, were conducted to verify species composition of observed backscatter layers and to obtain biological information (i.e., size distribution, age composition, sexual maturity). A total of 117 successful trawls (73 by the *Forum Star* and 44 by the *Ricker*) resulted in a total hake catch of 21,406 kg (17,420 kg from the *Forum Star* and 3,986 kg from the *Ricker*). The estimated total biomass of adult Pacific hake in 2012 was 1.381 million metric tons (of which 1.261 million metric tons—or over 91%—was from U.S. waters). With over 51% of the survey-wide observed biomass, age-2 hake were the largest component, followed by age-4 hake at 21%. Age-3 hake came in third at just under 12%.

For more information, please contact Larry Hufnagle at lawrence.c.hufnagle@noaa.gov.

5. NOAA Program: Fisheries And The Environment (FATE)

Project Title: Modeling Pacific hake (*Merluccius productus*) summer distribution

Investigators: M. Haltuch, C. Holt, E.C. Clarke and A.E. Punt

Funding obtained via the NOAA Fisheries and the Environment (FATE) Program as well as funding via the Department of Fisheries and Oceans (DFO) Canada, International Governance Strategy Funds during 2010-2011 led to a joint project between the Northwest Fisheries Science Center (NWFSC) and DFO, Nanaimo focusing on building a model to describe hake distribution during the summer migratory season, with the long term goal of being able to both hind-cast and forecast hake distribution. The motivation for this work is that Pacific hake exhibits strong environmentally-driven inter-annual variation during the stock's annual summer northerly migration that impact monitoring, assessment, and management of hake. Being able to describe and forecast hake distribution could impact management via optimized survey design and planning, resulting in improved estimates of hake distribution and density. Specifically, survey effort could be distributed to minimize (expected) variance given the ability to predict hake distribution and density prior to a survey, resulting in more precise estimates of abundance that form the basis for stock assessment and management advice. Hind-casting hake distribution could also be useful for investigating hake selectivity and availability in the stock assessment model. Essentially, the ability to model hake selectivity as a function of a covariate(s) would reduce the number of parameters in the stock assessment model. Finally, understanding and forecasting of hake distribution during migration is important for both short-term management decisions and long-term planning under future climate scenarios.

This project is using the depth aggregated hake acoustics survey data (1992-2007) to investigate space (latitude and longitude), population age composition, and environmental drivers of the north-south and cross-shelf distribution of hake along the West Coast of North America. A set of hypotheses have been proposed in order to investigate potential mechanisms underlying the hake summertime distribution. The null hypothesis is that the north-south summertime distribution of hake is determined by latitude and the population age structure; and that the cross-shelf distribution of hake is determined by bathymetry. Three hypotheses have been developed that address possible climate mechanisms forcing hake summer distribution. Hypothesis 1 proposes that the intensity and location of the poleward undercurrent impacts the period of active migration, with stronger poleward flow leading to the population moving farther north. Hypothesis 2 suggests that formation and distribution of mesoscale structure in the CCE, e.g. eddies, is different between warm and cool years, impacting the distribution of hake's main prey resource, euphausiids. The hake distribution then tracks the changes in the distribution of euphausiids. Hypothesis 3 concerns the timing of the spring transition and in turn the intensification of upwelling, which impacts the timing and distribution of euphausiid availability and therefore hake distribution. A suite of environmental data from both satellite data on surface ocean conditions (e.g,. SST) and regional ocean model (ROMS) outputs (e.g,. poleward flow) are being used to test these hypotheses.

A delta general additive modeling (GAM) approach is used to predict hake backscatter. This is a two-step hurdle model consisting of a presence-absence model and a positive data model (all zeroes excluded) and is often used for zero-inflated data. GAMs are extensions of generalized linear models that apply semi-parametric smoothing functions to each independent variable and additively calculate the component response. Zero-inflation is often found in ecological data and needs to be accounted for when modeling abundance data. The hurdle model also has the advantage that it is possible to model different variables for the binary and the positive abundance response, as they can be driven by different processes. In the first step, a binomial GAM is used to model the occurrence (presence-absence) of hake backscatter. In the second step, lognormal GAMs and variable coefficient GAMs are fit to the positive backscatter (presence data). The variable coefficient GAM allows for the testing of a variable spatial effect of the covariates on hake distribution in the California Current. The two models are merged by multiplying the predictions from both steps, resulting in the final model. Model fits are evaluated using residual plots, deviance explained by the model, and AIC is used for model selection. A runs test for randomness is used to test for problems with autocorrelation in model residuals, to avoid inflating the statistical significance of model results and to decrease the likelihood of type 1 errors (false positives).

The null model is explored by examining the spatial pattern of hake biomass-at-age composition data by applying two spatial indicators, center of gravity (spatial mean location) and the associated inertia (spatial variance). The population age structure is clearly contributing to both within and between year differences in hake distribution. The centers of gravity for young ages were found at more southerly locations than those of older ages. In warm years and years when there are proportionally more old fish in the population (e.g., 1998), the population is distributed further north. In cold years and years when there are proportionally fewer old fish in the population (e.g., 2001,) the population is distributed further south. Based on the exploration of the hake biomass-at-age-and-latitude data and information on hake maturity, the hake age data are classified into juvenile (age 3) and adult categories (age 3+) for further modeling.

Each hake acoustic line transect is treated as the sampling unit for the GAM modeling described above, yielding a model that has hake backscatter summed for each transect and an average spatial scale of 50 to 100 kilometers. GAM model results show that the population age structure, satellite SST and ROMS temperature at depth and pole-ward velocity are drivers of hake distribution, supporting both the null and alternative hypotheses. Model fits are generally good, explaining between 35%-40% of the variability in the data, and runs tests indicate a lack of autocorrelation in the model residuals. Comparisons between the observed and predicted also indicate that the model fits the data well but generally under predicts the level of backscatter observed. Forecasts, in which one year of data are removed from the model and a forecast is made without those data, are reasonable. The final sets of alterative models are being finalized and a peer review publication is in preparation.

The funding for this project ended during September 2011 and alternative funds have not been identified to support further investigations at this time.

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6. Ecosystem Studies

a. Fish Ecology Division Summary Report

The Fish Ecology Division completed four monthly field surveys in 2012 for larval fishes using plankton nets and juvenile fishes using trawls. Sampling in 2012 was done in conjunction with prey field studies resulting in additional sampling on some of the survey lines. Field surveys are used to assess spawning success of a variety of groundfish species in relation to oceanographic conditions and climate variability, with the intent of establishing recruitment success indices to enhance stock assessment. All four cruises were done aboard the chartered fishing vessel *Miss Sue*. All larval and juvenile fish have been sorted and identified for 2012. Preliminary results have shown a substantial increase in the abundance of rockfishes in our plankton nets and trawls in the past year as opposed to last year when they were a dominant species caught. Moreover, there have been moderate increases in flatfish larvae/juveniles of several commercially important species. Gelatinous zooplankton (salps and ctenophores) were substantially lower than in the past two years. We have been examining diets of four of the most common rockfish species using direct stomach and stable isotope analysis and have recently submitted a manuscript on this. We are also continuing to look at the species composition of rockfish based on genetics.

Products:

- Auth, T.D., R.D. Brodeur and J. Peterson. MS. Anomalous ichthyoplankton distributions and concentrations in the northern California Current resulting from the 2010 El Niño and La Niña events. To be submitted to *Progress in Oceanography.*
- Takahashi, M., D.M. Checkley Jr., M.N.C. Litz, R.D. Brodeur, and W.T. Peterson. 2012. Responses in growth rate of larval northern anchovy (*Engraulis mordax*) to anomalous upwelling in the northern California Current. *Fish. Oceanogr*. 21:393-404.
- Bjorkstedt, E., R. Goericke, S. McClatchie, E. Weber, W. Watson, N. Lo, W. Peterson, R. Brodeur, S. Bograd, T. Auth, J. Fisher, C. Morgan, J. Peterson, R. Durazo, G. Gaxiola-

Castro, B. Lavaniegos, F. Chavez, C.A. Collins, B. Hannah, J. Field, K. Sakuma, W. Satterthwaite, M. O'Farrell, W. Sydeman, S.A. Thompson, P. Warzybok, R. Bradley, J. Jahncke, R. Golightly, S. Schneider, J. Largier, S.Y. Kim, S. Melin, R. DeLong, and J. Abell. 2012. State of the California Current 2011-2012: Ecosystems respond to local forcing as La Niña wavers and wanes. *CalCOFI Rep*. 53:41-76.

- Daly, E.A., R.D. Brodeur, T.D. Auth, and W.T. Peterson. In revision. Winter ichthyoplankton biomass as a predictor of early summer prey fields and ultimate survival of juvenile salmon. Submitted to *Marine Ecology Progress Series*.
- Roegner, G.C., E.A. Daly, and R.D. Brodeur. MS. Surface distribution of brachyuran megalopae and ichthyoplankton in the Columbia River plume during transition from downwelling to upwelling conditions. Submitted to *Cont. Shelf Res*.
- Bosley, K.L, T.W. Miller, R.D. Brodeur, K. Bosley, A. Van Gaest and A. Elz. MS. Feeding ecology of juvenile rockfishes off Oregon and Washington: insights into life history patterns based on stomach content and stable isotope analyses. Submitted to *Mar. Biol.*
- Miller, T.W., K. L. Bosley, J. Shibata, R.D. Brodeur, K. Omori and R.L. Emmett. 2013. A stable isotope-based perspective on the contribution of prey to Humboldt squid (*Dosidicus gigas*) in the northern California Current. In press *Mar. Ecol. Prog. Ser*.

For more information, please contact Rick Brodeur at Rick.Brodeur@noaa.gov.

b. 2012 Integrated Ecosystem Assessment of the California Current

Investigators: P.S. Levin and B.K. Wells, eds.; numerous contributors from the NWFSC, SWFSC and partner institutions

An integrated ecosystem assessment (IEA) is a science support element for ecosystem-based management (EBM); the IEA process involves synthesizing and analyzing information through steps that include scoping, indicator development, risk analysis, and evaluating management strategies. The primary goal of the California Current IEA is to inform the implementation of EBM by melding diverse ecosystem components into a single, dynamic fabric that allows for coordinated evaluations of the status of the California Current ecosystem. We also aim to involve and inform a wide variety of stakeholders and agencies that rely on science support for EBM, and to integrate information collected by NOAA and other federal agencies, states, non-governmental organizations, and academic institutions. The essence of IEAs is to inform the management of diverse, potentially conflicting ocean-use sectors. As such, a successful California Current IEA must encompass a variety of management objectives, consider a wide-range of natural drivers and human activities, and forecast the delivery of ecosystem goods and services under a multiplicity of scenarios. This massive undertaking will evolve over time.

The 2012 iteration of the California Current IEA focused on 4 ecosystem components (ecosystem integrity, fisheries of groundfish and coastal pelagics, protected species, and vibrant coastal communities) and 11 drivers and pressures of those components; drivers and pressures were broadly binned (e.g., shipping, coastal development, fishing, aquaculture, climate change). The 2012 IEA update is divided into 4 sections that describe: (1) scoping conversations with managers; (2) status and trends of drivers and pressures; (3) status and trends of ecosystem components; and (4) scenario-based evaluation of management strategies. Within the sections are subsections that contain specific analyses. Groundfish-related analyses include: a risk assessment for groundfish to fisheries and non-fisheries threats; status and trends of ecosystem integrity, which features groundfish populations as key indicators; the potential effects of emerging fisheries on several groundfish species; overlap between groundfish stocks and cetaceans; and the system-wide effects of the trawl fishery rationalization.

The 2012 IEA study as a whole is a 900+ page document that is currently in review and will be available some time in 2013 as an online publication, edited by Levin and Wells.

For more information, please contact Phil Levin at NOAA's Northwest Fisheries Science Center, Phil.Levin@noaa.gov

c. Screening California current fishery management scenarios using the Atlantis end-to-end ecosystem model

Investigators: I.C. Kaplan, P.J. Horne, and P.S. Levin

End-to-end marine ecosystem models link climate and oceanography to the food web and human activities. These models can be used as forecasting tools, to strategically evaluate management options and to support ecosystem-based management. Here, we report the results of such forecasts in the California Current, using an Atlantis end-to-end model. We worked collaboratively with fishery managers at NOAA's regional offices and staff at the National Marine Sanctuaries (NMS) to explore the impact of fishery policies on management objectives at different spatial scales, from single Marine Sanctuaries to the entire Northern California Current. In addition to examining status quo management, we explored the consequences of several gear switching and spatial management scenarios. Of the scenarios that involved large scale management changes, no single scenario maximized all performance metrics. Any policy choice would involve trade-offs between stakeholder groups and policy goals. For example, a coast-wide 25% gear shift from trawl to pot or longline appeared to be one possible compromise between an increase in spatial management (which sacrificed revenue) and scenarios such as the one consolidating bottom impacts to deeper areas (which did not perform substantially differently from Status Quo). Judged on a coast-wide scale, most of the scenarios that involved minor or local management changes (e.g. within Monterey Bay NMS only) yielded results similar to Status Quo. When impacts did occur in these cases, they often involved local interactions that were difficult to predict a priori based solely on fishing patterns. However, judged on the local scale, deviation from Status Quo did emerge, particularly for metrics related to stationary species or variables (i.e. habitat and local metrics of landed value or bycatch). We also found that isolated management actions within Monterey Bay NMS would cause local fishers to pay a cost for conservation, in terms of reductions in landed value. However, this cost was minimal when local conservation actions were part of a concerted coast-wide plan. The simulations demonstrate the utility of using the Atlantis end-to-end ecosystem model within NOAA's Integrated Ecosystem Assessment, by illustrating an end-to-end modeling tool that allows consideration of multiple management alternatives that are relevant to numerous state, federal and private interests.

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d. Cumulative impacts of fisheries in the California Current

Investigators: I.C. Kaplan, I.A. Gray, and P.S. Levin

Ecosystem-based fisheries management calls for the consideration of the indirect and cumulative effects of fishing, in addition to estimating direct fishing mortality. Here, we quantify such effects of fishing fleets, and their interactions, using a spatially explicit Atlantis simulation model of the food web and fisheries in the California Current. Simulations testing the effects of single fleets suggested that bottom trawl, fixed gear, and hake (*Merluccius productus*) trawl primarily have direct impacts on their target and bycatch species. Few indirect effects from these three fleets extended through predator–prey links to other parts of the food web. In contrast, effects of the purse seine fleet extended beyond the three groups it harvested, strongly altering the abundance of predators, planktonic prey, and benthos. In terms of nine ecosystem attributes, our experiments involving single fleets identified six fleets that caused the bulk of negative impacts. Specific fleets impacted different aspects of the ecosystem, for instance with groundfish gears causing reductions in piscivore abundance, and hake trawl and purse seine increasing krill through reducing abundance of planktivores. In terms of interactions among fleets' effects, the vast majority of effects were simply additive – the combined effect of two fleets was simply the sum of the individual fleets' effects. The analyses offer one way to sharpen the focus of ecosystem-based fisheries management in the California Current, emphasizing impacts and interactions of particular stressors.

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e. Integrating diet and movement data to identify hot spots of predation risk and areas of conservation concern for endangered species

Investigators: E.J. Ward, P.S. Levin, M.M. Lance, S.J. Jeffries, and A. Acevedo-Gutierrez

Effective management of threatened and endangered species requires an understanding of how species of conservation concern are distributed spatially, as well as the spatial distribution of risks to the population, such as predation or human impacts (fishing, pollution, and loss of habitat). Identifying high-risk areas is particularly important when designing reserves or protected areas. Our novel approach incorporates data on distribution, movement, and diet of a generalist marine predator (harbor seals) to identify and map hot spots of predation risk for an endangered prey species (rockfish). Areas with high concentrations of seals (including some current marine reserves) are also estimated hot spots for rockfish predation. Although marine reserve planning currently targets areas with good habitat and low human disturbance, our modeling suggests that future terrestrial and marine reserve design may be made more effective by incorporating other components of the food web that either directly or indirectly interact with target species.

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f. Potential overlap between cetaceans and commercial groundfish fleets operating in the California Current large marine ecosystem

Investigators: B.E. Feist, M.A. Bellman, E.A. Becker, K.A. Forney, M.J. Ford, and P.S. Levin

Many cetacean populations are confronted by many anthropogenic threats, including commercial whaling, anthropogenic noise, vessel collisions, gear entanglement, resource competition, habitat disturbance and global climate change. There is evidence that commercial fishing activities can have both direct (e.g., gear entanglement and bycatch) and indirect effects (e.g., prey reduction, noise) on cetaceans. However, few studies have addressed the potential vulnerability of a given cetacean species to an entire fishing fleet operating over a large marine ecosystem. In this study, we overlaid spatially explicit multi-year mean predicted densities of 11 cetacean species and one species guild within the California Current Large Marine Ecosystem with West Coast Groundfish Fishery commercial fishing effort data for fixed-gear, at-sea hake midwater trawl, and bottom trawl fleets. We quantified the exposure of each species to each fleet type by multiplying the predicted mean cetacean density by the measured fishing fleet effort. We found that there was large interspecific and interfleet variability in the overlap between cetaceans and fishing fleets. While many of the species had relatively low overlap rates, others had substantial exposure to some of the fishing fleets, particularly those species with more nearshore distributions. While direct mortality from these fleets has been documented to be low, our results suggest there is opportunity for fisheries interactions with some cetacean species, particularly in the fixed gear fleets. Our analyses are an important first step in generating formal risk assessments for quantifying the population impacts of various fishing fleets on cetacean species that occur in the California Current Large Marine Ecosystem.

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g. Combining fishing and acoustic monitoring data to evaluate the distribution and movements of spotted ratfish *Hydrolagus colliei*

Investigators: K.S. Andrews and T.P. Quinn

Direct and indirect methods have been used to describe patterns of movement of fishes, but few studies have compared these methods simultaneously. We used 20 years of trawl survey data and one year of acoustic telemetry data to evaluate the vertical and horizontal movement patterns of spotted ratfish *Hydrolagus colliei* in Puget Sound, WA, USA. Densities of large ratfish ($\geq$ 30 cm) were higher at the deepest depths trawled (70 m) during daylight hours, whereas densities were similar across depth zones (to 10 m) at night. Acoustic tracking of ratfish showed distinct diel patterns of movement and activity level; ratfish moved into shallow, nearshore habitats at night from deeper, offshore habitats during the day and made ~three times more moves at night than day in shallow habitats. Broader spatial patterns depended on where ratfish were tagged: one tag group remained in one general location with few excursions, whereas a second tag group moved within a 20-km band with some individuals moving > 90 km. These data will help inform food web models' abilities to quantify interspecific interactions between ratfish and other components of their community.

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h. Ecosystem-level consequences of movement: the predatory impact of spiny dogfish in Puget Sound.

Investigators: K.S. Andrews and C.J. Harvey

Spatio-temporal patterns of species abundance influence the strength of trophic interactions, while movement of individuals helps determine those patterns of abundance. Thus, understanding movement is a basis for quantifying interactions within a food web. In Puget Sound, Washington, USA, the North Pacific spiny dogfish *Squalus suckleyi* is an abundant top predator with a diverse, generalist diet. Coastal dogfish populations make seasonal north−south migrations, but populations in inland waters are thought to be more resident. In this study, we combined acoustic telemetry and bioenergetics modeling to determine patterns of movement and to quantify seasonal variation in the predatory impact of dogfish in Puget Sound. All tagged dogfish migrated out of Puget Sound in the winter and were absent until the following summer. Individuals that returned to Puget Sound in subsequent years showed consistent timing and duration of residence across years, but these metrics varied across individuals. Incorporating movement data into the bioenergetics model resulted in a 70% decrease in the predatory impact of dogfish in the winter and a 30% decrease in the summer, compared to a year-round resident Puget Sound population. Incorporating metrics of movement into food web or ecosystem models will increase our understanding of species interactions and will improve our ability to predict changes in food web dynamics under various environmental and management scenarios.

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i. An empirical movement model for sixgill sharks in Puget Sound: combining observed and unobserved behavior.

Investigators: P.S. Levin, P. Horne, K.S. Andrews, and G. Williams.

Understanding the movement of animals is fundamental to population and community ecology. Historically, it has been difficult to quantify movement patterns of most fishes, but technological advances in acoustic telemetry have increased our abilities to monitor their movement. In this study, we combined small-scale active acoustic tracking with large-scale passive acoustic monitoring to develop an empirical movement model for sixgill sharks in Puget Sound, WA, USA. We began by testing whether a correlated random walk model described the daily movement of sixgills; however, the model failed to capture home-ranging behavior. We added this behavior and used the resultant model (a biased random walk model) to determine whether daily movement patterns are able to explain large-scale seasonal movement. The daily model did not explain the larger-scale patterns of movement observed in the passive monitoring data. In order to create the large-scale patterns, sixgills must have performed behaviors (large, fast directed movements) that were unobserved during small-scale active tracking. In addition, seasonal shifts in location were not captured by the daily model. We added these 'unobserved' behaviors to the model and were able to capture large-scale seasonal movement of sixgill sharks over 150 days. The development of empirical models of movement allows researchers to develop hypotheses and test mechanisms responsible for a species movement behavior and spatial distribution. This knowledge will increase our ability to successfully manage species of concern.

For more information, please contact Phil Levin at NOAA's Northwest Fisheries Science Center, Phil.Levin@noaa.gov

j. Scale and pattern of broadnose sevengill shark *Notorhyncus cepedianus* movement in estuarine embayments.

Investigators: G.D. Williams, K.S. Andrews, S.L. Katz, M.L. Moser, N. Tolimieri, D.A. Farrar, and P.S. Levin.

The detailed movements of 32 acoustically tagged broadnose sevengill shark *Notorynchus cepedianus* were documented in and around north-east Pacific Ocean estuarine embayments from 2005 to 2007. Arrangements of passive acoustic receivers allowed analysis of movement at several spatial scales, with sex and size examined as possible factors influencing the pattern and timing of these movements. *N. cepedianus* exhibited a distinctly seasonal pattern of estuary use over three consecutive years, entering Willapa Bay in the spring, residing therein for extended periods of time during the summer and dispersing into nearshore coastal habitats and over the continental shelf during the autumn. *N. cepedianus* within Willapa Bay showed spatio-temporal patterns of segregation by size and sex, with males and small females using peripheral southern estuary channels early in the season before joining large females, who remained concentrated in central estuary channels for the entire season. Individuals displayed a high degree of fidelity not only to Willapa Bay (63% were documented returning over three consecutive seasons), but also to specific areas within the estuary, showing consistent patterns of site use from year to year. Cross-estuary movement was common during the summer, with most fish also moving into an adjacent estuarine embayment for some extent of time. Most winter and autumn coastal detections of *N. cepedianus* were made over the continental shelf near Oregon and Washington, U.S.A., but there were also examples of individuals moving into nearshore coastal habitats further south into California, suggesting the feasibility of broad-scale coastal movements to known birthing and nursery grounds for the species. These findings contribute to a better understanding of *N. cepedianus* movement ecology, which can be used to improve the holistic management of this highly mobile apex predator in regional ecosystems.

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k. How does the definition of 'home range' affect predictions of the efficacy of marine reserves?

Investigators: N. Tolimieri, K.S. Andrews and P.S. Levin.

Understanding how animals use space is fundamental to the employment of spatial management tools like marine protected areas (MPAs). A commonly used metric of space use is home range—defined as the area in which an individual spends 95% of its time and often calculated as 95% of the utilization distribution (UD), which is a probabilistic map describing space use. Since home range represents only 95% of an animal's time, it is important to understand whether the other 5% matters to the design of MPAs. We developed an MPA-population model for lingcod *Ophiodon elongatus* that examined the population recovery under six characterizations of space use ranging from one mean home range to nine real lingcod UDs. Mean home range and similar estimates (based on the area in which a fish spent 95% of its time) predicted higher biomass and numbers relative to the more complete analysis of space use like the UD (which represented 99.99% of a fish's time) and underestimated the size of reserves necessary to achieve the same level of recovery of biomass. Our results suggest failing to account for the full extent of a fish's time overestimates the effectiveness of marine reserves.

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l. Linking changes in mean trophic level of groundfishes to ecosystem structure and function on the U.S. West Coast

Investigators: N. Tolimieri, J.F. Samhouri, V. Simon, B.E. Feist, and P.S. Levin

Indicators, which are an essential component of ecosystem-based management, need to be linked to changes in the structure and function of ecosystems. Mean trophic level (MTL) is an ecosystem indicator that measures the relative abundance of species across a spectrum of trophic levels. The ubiquity and causes of a general decline in the MTL of fisheries catch through time have engendered much attention. However, the consequences of this pattern for broader ecosystem structure and function remain virtually unexplored. We document a decline in the ecosystem MTL of groundfishes along the Pacific U.S. Coast from 2003-2011, the proximate cause of which was a decrease in the biomass of higher trophic level groundfishes. Using a food web model, we illustrate how these shifts in ecosystem structure may have resulted in short-term positive responses by competitors and many lower trophic level species in the broader ecosystem. In the longer-term, the model predicts that initial patterns of prey release may be tempered in part by lagged responses of non-groundfishes, higher trophic level species, such as salmon and seabirds. While ecosystem functions related to specific groups like piscivores (excluding high TL groundfishes) changed, aggregate ecosystem functions altered little following the initial reorganization of biomass, probably due to functional redundancy within the predator guild. Efforts to manage and conserve marine ecosystems will benefit from a fuller consideration of the information content contained within, and implied by, fisheries-independent trophic level indicators.

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m. Beta diversity of demersal fish assemblages in the Northeastern Pacific: interactions of latitude and depth.

Investigators: M.J. Anderson, N. Tolimieri, and R. Millar.

Knowledge of broad-scale global patterns in beta diversity (i.e., variation or turnover in identities of species) for marine systems is in its infancy. We analyzed the beta diversity of groundfish communities along the North American Pacific Coast, from trawl data spanning 32.57°N to 48.52°N and 51 m to 1341 m depth. Analyses were based on both the Jaccard measure and the probabilistic Raup-Crick measure, which accounts for variation in alpha diversity. Overall, beta diversity decreased with depth, and this effect was strongest at lower latitudes. Superimposed on this trend were peaks in beta diversity at around 400-600 m and also around 1000-1200 m, which may indicate high turnover around the edges of the oxygen minimum zone. Beta diversity was also observed to decrease with latitude, but this effect was only observed in shallower waters (<200 m); latitudinal turnover began to disappear at depths >800 m. At shallower depths (<200 m), peaks in latitudinal turnover were observed at ~43°N, 39°N, 35°N and 31°N, which corresponded well with several classically observed oceanographic boundaries. Turnover with depth was stronger than latitudinal turnover, and is likely to reflect strong environmental filtering over relatively short distances. Patterns in beta diversity, including latitude-by-depth interactions, should be integrated with other biodiversity measures in ecosystem-based management and conservation of groundfish communities.

For more information, please contact Nick Tolimieri at NOAA's Northwest Fisheries Science Center, Nick.Tolimieri@noaa.gov

n. Larval rockfish survival decreases in an elevated CO_2 environment

Investigators: S. Norberg, D.S. Busch, and P. McElhany

Information regarding the effects of high-CO_2 environments on fish is limited. In vertebrates, high levels of environmental pCO_2 can lead to lethal hypercapnia-induced acidification of intracellular body fluids. Fish can tolerate brief exposures to high pCO_2 because of their ability to accumulate buffering ions from the water through transport across cell membranes. Larval fish, which must meet the large daily energy requirements for growth and development, may not be able to contend with the extra energetic expense of increased ion transport. We explored the impacts of CO_2 on growth, development, and survival of China rockfish (*Sebastes nebulosa*) larvae. We reared larvae in three different pH treatments: 7.70, 8.05, and 8.10. These conditions approximate past (280 ppm), present (400 ppm), and future (1000 ppm) global average atmospheric pCO_2 levels. Larvae exposed to high pCO_2 had significantly lower survival over a 20-day period (21%) than larvae exposed to moderate pCO_2 (70%). After two weeks of exposure to treatment conditions, larvae that survived in high pCO_2 were shorter than larvae in moderate and low pCO_2, though they had greater body depth than larvae in moderate pCO_2. At the end of the experiment, larval size and shape was similar in all treatments. However, otolith diameter relative to body size in larvae reared in moderate pCO_2 treatments was significantly larger than those reared in high and low pCO_2. From these results, we conclude that high pCO_2 conditions negatively impacted the growth, development and survival of larval China rockfish.

For more information, please contact Paul McElhany at NOAA's Northwest Fisheries Science Center, Paul.McElhany@noaa.gov

o. Spatial and seasonal variation in $\delta^{15}N$ and $\delta^{13}C$ values in a mesopredator shark, *Squalus suckleyi*, revealed through multitissue analyses.

Investigators: J.C.P. Reum and T.E. Essington

We used variance decomposition to explore the importance of body size, sex, location, and sampling period as predictors of intrapopulation variation in $\delta^{15}N$ and $\delta^{13}C$ values in spiny dogfish *Squalus suckleyi* from the Puget Sound–Strait of Georgia basin. Isotopes in two tissues with long (dorsal white muscle) and short (liver) isotopic turnover rates (~1 year and ~3–4 months, respectively) were sampled to evaluate whether the relative importance of each variable differed depending on the time span over which diet information was integrated. Significant spatial variation was observed in both muscle and liver isotopic composition, whereby location uniquely explained 25 and 17 % of the total variance, respectively. The remaining variables explained considerably less variation in both tissue types. Furthermore, evidence of seasonal isotopic shifts in $\delta^{15}N$ and $\delta^{13}C$ values was apparent, but differed widely in direction and magnitude among groups. These findings suggest that members of spiny dogfish schools may share a common feeding history, possibly by spending extended time periods (weeks to months) foraging in a spatially fixed region. Another explanation is that individuals may move and feed in aggregations that exist for extended periods. These complex group-level patterns suggest that even for large-bodied, motile predators such as sharks, population-level diet estimates derived from averaging isotope ratios of individuals collected from only a few locations may poorly reflect the true population mean.

For more information, please contact Jon Reum at NOAA's Northwest Fisheries Science Center, Jonathan.Reum@noaa.gov

p. Season and prey type influence size dependency of predator−prey body mass ratios in a marine groundfish assemblage

Investigators: J.C.P. Reum and M.E. Hunsicker

Marine and freshwater food webs are strongly structured by size-dependent predator−prey interactions. Predator−prey body mass ratios (PPMR) are important parameters in size-based food-web models, but studies evaluating the temporal stability of PPMR or its relationship to predator feeding modes are scant. Using a large data set of predator−prey pairs from a diverse demersal fish community sampled in summer, fall, and winter, we showed that community-level PPMR varied with predator mass in a nonlinear (dome-shaped) manner. PPMR was higher in the summer relative to the fall and winter for all predator body size classes regardless of whether prey were fish or invertebrate. Further, the size dependency of PPMR was dome-shaped for invertebrate prey but positive and linear for fish prey. We empirically show that community-level PPMR is dynamic rather than fixed, which is in agreement with general expectations set by simulation studies of biomass spectra. However, we are presently unable to identify the specific processes underlying these patterns. Size-based models of marine ecosystems offer considerable promise over traditional taxa-based approaches, and our analyses provide insight into major patterns of variation in PPMR in a temperate marine system.

For more information, please contact Jon Reum at NOAA's Northwest Fisheries Science Center, Jonathan.Reum@noaa.gov

q. Variability in rockfish (*Sebastes* spp.) fecundity on the California coast: species contrasts, maternal size effects, and spatial differences

Investigators: S.G. Beyer, S.M. Sogard, C.J. Harvey, and J.C. Field

Investigators studied the reproductive ecology of three rockfish species residing in the California Current System: chilipepper, *Sebastes goodei*, yellowtail, *S. flavidus* and speckled rockfish, *S. ovalis*. Females were sampled from four locations along the coast of California in the winter spawning seasons (November through March) of 2009, 2010 and 2011 to assess temporal and spatial effects on fecundity. Maternal size and age were positively correlated with relative fecundity (Φ_{rel}, larvae per g somatic weight) for all three species and indicated a disproportionately greater reproductive output by older, larger females. Yellowtail rockfish had the highest absolute and Φ_{rel}, the greatest maternal size effect, and produced the smallest eggs. Size-dependent Φ_{rel} relationships were incorporated into published stock assessment models that originally assumed egg production to be directly proportional to spawning biomass. The updated models showed a reduction in larval output when large, old females were removed from the population by fishing for both chilipepper and yellowtail rockfish. In addition, fecundity varied spatially among sampling sites (chilipepper and yellowtail) and by year (chilipepper). Speckled rockfish lacked adequate sample size to assess spatiotemporal trends in fecundity. Chilipepper and speckled rockfish produced multiple broods annually in Southern California and to a lesser extent in Central California, complicating estimates of annual fecundity. Egg production was positively correlated with female condition, indicating environmental variability in oceanographic conditions and productivity may drive changes in fecundity and reproductive strategy (i.e., single versus multiple broods) in these species.

For more information, please contact Ms. Sabrina Beyer at NOAA's Southwest Fisheries Science Center, Sabrina.Beyer@noaa.gov

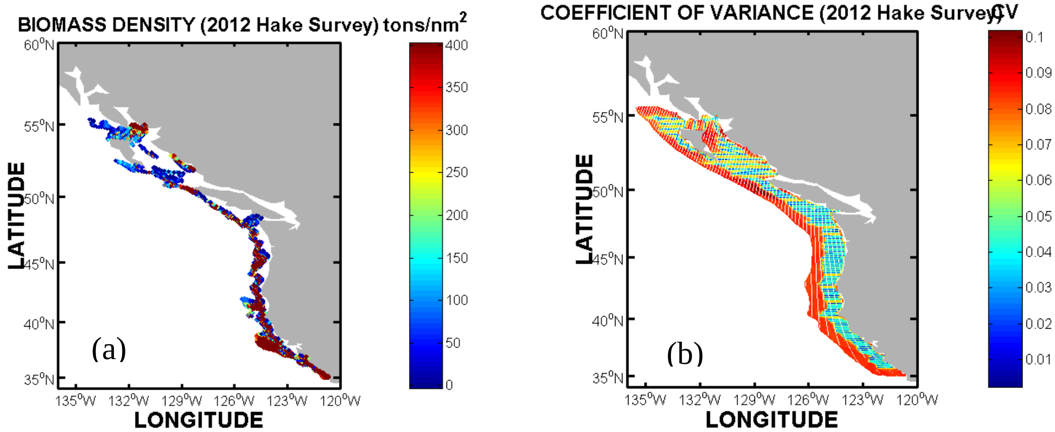
7. Acoustic Modeling and Research

a. Refinement of the EchoPro software package with inclusion of a geo-statistical technique (kriging) to process the 2012 Integrated Acoustic and Trawl Survey (IATS) data for hake biomass estimate

The EchoPro software package developed in FY11 has been refined to increase flexibility and reduce program complexity. It reads the Nautical Area Scattering Coefficient exported from

EchoView (Myriax) and can provide length-, age-, and sex-structured biomass estimates promptly. Data processing is totally independent of any Oracle database and the processing cycle is much shorter. In addition, because the 2012 hake biomass estimate was obtained using kriging (a geostatistical method and local estimator used to interpolate a spatially distributed quantity in an unobserved location), the coefficient of variation (CV) was provided at the same time (Figures 10a, 10b). Kriging has been considered suitable for estimating fish abundance and precision by an ICES Study Group. In addition, a sensitivity analysis of the biomass estimate in terms of the stratification scheme, kriging grid cell resolution, kriging variables, and the kriging parameters was performed which indicated that the biomass estimate was robust.

For more information, contact Larry Hufnagle at Lawrence.C.Hufnagle@noaa.gov



Figures 10a and 10b. Kriging maps of 2012 hake survey estimated biomass and coefficient of variation (CV) maps. (a) kriged biomass distribution (1.38 mmt); (b) kriging CV distribution (4.75%).

b. Development of an age-1 hake index and analysis of historical data

An age-1 index for Pacific hake is under development, with a preliminary analysis of 2003 to 2011 data concluded February 2011. This analysis included an overall index of abundance as well as a spatial component of age-1 echosign. This index of abundance was joined to the 1995–2001 historic AFSC data set of age-1 abundance. Initial results indicate that the age-1 index was consistent with major recruitment events; however, more years of data and a full spatial analysis are needed. Currently, work is proceeding on converting historic 1995–2001 echogram data, with hopes to get a full spatial component similar to that in spatial years. Also, as the adult hake biomass estimate is currently calculated using kriging methods, but the age-1 index currently is calculated using simple linear interpolation, a goal is for the age-1 index to incorporate kriging as well eventually.

For more information, contact Larry Hufnagle at Lawrence.C.Hufnagle@noaa.gov

c. Application of low-frequency broadband technology to acoustic characterization of fish

The goal of the proposed research is to develop a technology capable of discriminating Pacific hake from other marine species using a commercially available broadband echosounder system (EdgeTech SB-0512i wideband FM sub-bottom profiler operating between 500 Hz and 12 kHz). The broadband system can provide a much improved signal-to-noise ratio (SNR) and range resolution with pulse compression technique. Most importantly, it can provide a wide spectrum that covers a large range of acoustic resonance frequencies for adult hake, a swimbladder-bearing fish species.

During the 2012 Joint U.S.-Canada Integrated Acoustic and Trawl Survey of Pacific hake (*Merluccius productus*) and Pacific sardine (*Sardinops sagax*), a total of 11 deployments were conducted off the NOAA Ship *Bell M. Shimada*. Echograms showing several hake aggregations off Washington coast are shown in figure 11. A field calibration of the broadband system was conducted prior to the survey on an earlier research cruise funded by the Office of Naval Research (ONR) on the R/V Oceanus (figure 12).

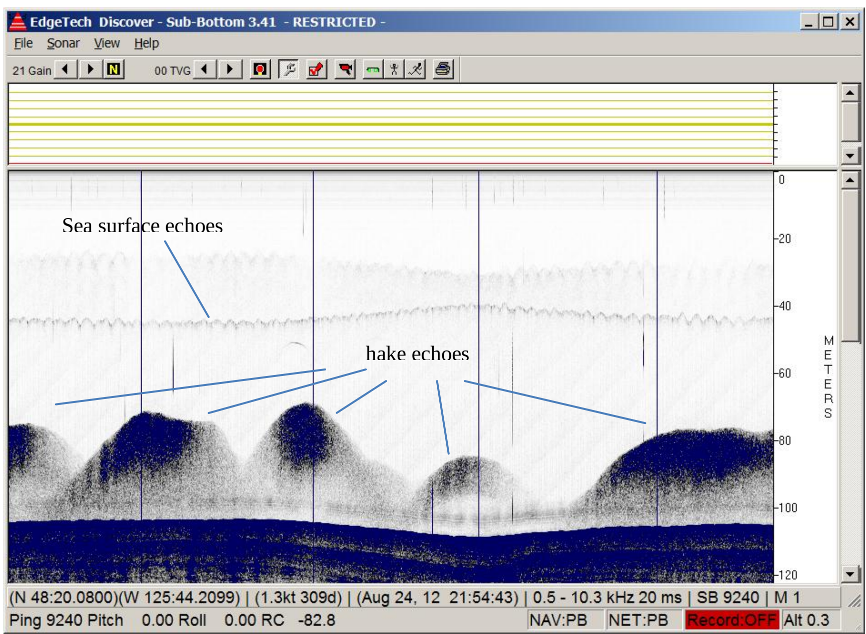


Figure 11. Raw echograms of a series of Pacific hake aggregations.

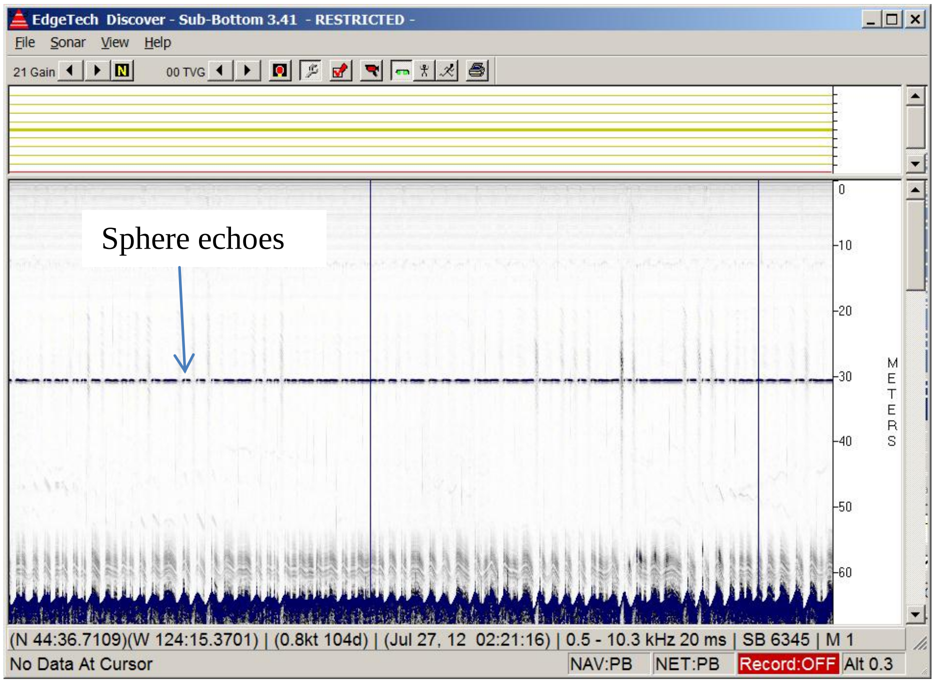


Figure 12. Echogram showing echoes from the calibration sphere AL300 (300-mm diameter).

The schools classified as "hake" were aggregated between 60 and 100 m from the towfish. The EdgeTech broadband system was towed at about 40 m at about 2.5 knots, i.e., fish schools were between 100 and 150 m depths. The aggregations at similar locations and depths were trawled within 10 days but were not sampled just prior and post to the deployment of the EdgeTech system. However, based on the characteristics of the echogram, aggregations were thought to be hake.

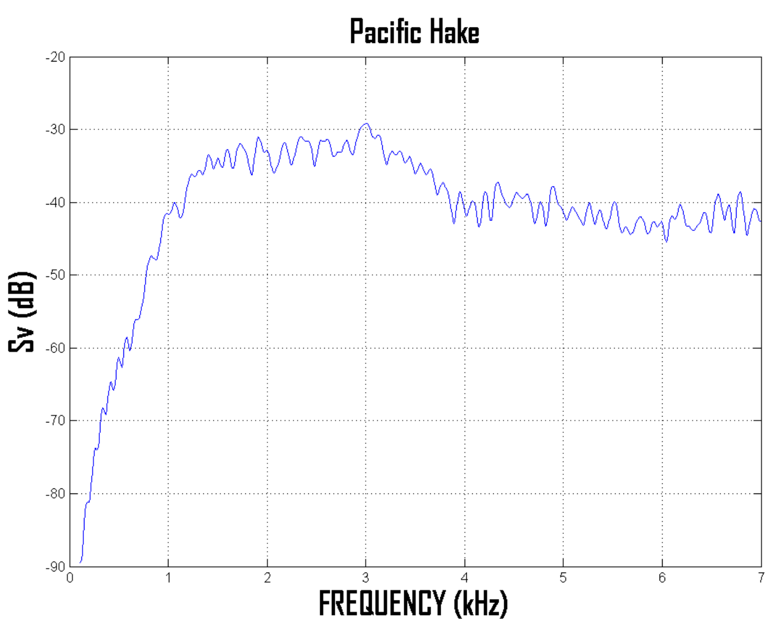


Figure 13. Sv of the "hake" aggregation.

The frequency response of S_v of the "hake" aggregations is shown in figure 13. Note that the frequencies corresponding to "peaks" of S_v for "hake" are very broad spanning from about 1.2 to 3.4 kHz, indicating that the aggregations were "hake" with a wide length distribution, could be bi-modal with mixed age class.

For more information, contact Larry Hufnagle at Lawrence.C.Hufnagle@noaa.gov

8. Economic Data Collection and Analysis

a. Why economics matters for understanding the effects of climate change on fisheries

Investigators: A.C. Haynie and L. Pfeiffer

Research attempting to predict the effect of climate change on fisheries often neglects to consider how harvesters respond to changing economic, institutional, and environmental conditions, which leads to the overly simplistic prediction of "fisheries follow fish". However, climate effects on fisheries can be complex because they arise through physical, biological, and economic mechanisms that interact or may not be well understood. Although most researchers find it obvious to include physical and biological factors in predicting the effects of climate change on fisheries, the behavior of fish harvesters also matters for these predictions. A general but succinct conceptual framework for investigating the effects of climate change on fisheries that incorporates the biological and economic factors that determine how fisheries operate is presented. The use of this framework will result in more complete, reliable, and relevant investigations of the effects of climate change on fisheries. The uncertainty surrounding long-term projections, however, is inherent in the complexity of the system.

For more information, please contact Lisa Pfeiffer at Lisa.Pfeiffer@noaa.gov

b. From krill to convenience stores: forecasting the economic and ecological effects of fisheries management on the U.S. West Coast

Investigators: I.C. Kaplan, J. Leonard

There is a need to better understand the linkages between marine ecosystems and the human communities and economies that depend on these systems. Here those linkages are drawn for the California Current on the US West Coast, by combining a fishery ecosystem model (Atlantis) with an economic model (IO-PAC) that traces how changes in seafood landings impact the broader economy. The potential effects of broad fisheries management options are explored, including status quo management, switching effort from trawl to other gears, and spatial management scenarios. Relative to Status Quo, the other scenarios here involved short-term ex-vessel revenue losses, primarily to the bottom trawl fleet. Other fleets, particularly the fixed gear fleet that uses pots and demersal longlines, gained revenue in some scenarios, though spatial closures of Rockfish Conservation Areas reduced revenue to fixed gear fleets. Processor and wholesaler revenue tracked trends in the bottom trawl fleet, which accounted for 58% of total landings by value. Income impacts (employee compensation and earnings of business owners) on the broader economy mirrored the revenue trends. The long-term forecast (15 years) from the Atlantis ecosystem model predicted substantial stock rebuilding and increases in fleet catch. The 15 year projection of Status Quo suggested an additional ~$27 million in revenue for the fisheries sectors, and an additional $23 million in income and 385 jobs in the broader economy, roughly a 25% increase. Linking the ecological and economic models here has allowed evaluation of fishery management policies using multiple criteria, and comparison of potential economic and conservation trade-offs that stem from management actions.

For more information, please contact Isaac Kaplan at NOAA's Northwest Fisheries Science Center, Isaac.Kaplan@noaa.gov

c. The role of charter boat operations in fishing communities: a social and economic analysis of the marine charter boat fleet in Oregon and Washington

This study utilizes results from a Washington and Oregon marine charter survey to characterize the current composition, estimate the economic contribution, and examine the existing economic conditions of the charter industry. Historically, the chief target species of the industry was salmon. Despite negative shocks to salmon allocations and abundance, fees for recreational salmon fishing trips remain the largest source of revenue for charter businesses in Washington and Oregon. While salmon recreational fishing is the largest single source of revenue, other sources such as groundfish recreational fees and halibut fees combined represent 65% of revenue. The cost and earnings estimates obtained from the survey are used to create a charter industry sector in IMPLAN (IMpact analysis for PLANning) software. Our economic contribution estimates using primary data are considerably higher, particularly for employment, than prior research that utilized default IMPLAN sectors.

In assessing their economic conditions, the investigator found that the majority of charter businesses experienced fewer clients in 2006 than during five years prior and had an unfavorable expectation of the future of the industry. Furthermore, charter operators with greater time involved in the industry are less optimistic about the future, which is likely due in part to their use of larger, more powerful vessels that are more costly to operate.

For more information, please contact Jerry Leonard at NOAA's Northwest Fisheries Science Center, Jerry.Leonard@noaa.gov

d. West Coast limited entry groundfish cost earnings survey protocol and results for 2008

Protocols and empirical results from an economic cost earnings survey of the West Coast (Washington, Oregon, and California) limited entry groundfish fleet were examined. The surveyed population consisted of owners of active commercial fishing vessels that: 1) landed at least $1,000 from fishing on the West Coast during 2008 and 2) had a limited entry groundfish permit. Vessels that participated in the at sea whiting (*Merluccius productus*) fishery but did not participate in any shoreside West Coast fisheries were not surveyed. There were 255 vessels in the survey population. In-person interviews were completed with owners of 123 vessels, representing a 48% response rate. The response rate was higher for vessels in the limited entry groundfish trawl fleet (57%) than for vessels in the limited entry groundfish fixed gear fleet (39%).

Responses were used for statistical inference on costs, revenues, and vessel operating characteristics (such as crew size and fuel consumption) and represent results for trawl and fixed gear fleets, as well as the primary vessel types in each fleet. For the limited entry groundfish trawl survey respondents, the average vessel had revenue from all sources of $585,041, reported costs of $469,068, economic costs of $507,660, and economic net revenue of $77,381 during 2008. Since economic cost only includes costs incurred prior to the shoreside delivery of fish and does not include shoreside management and administration costs, it provides a measure of economic profit that is biased upward. Amounts such as revenue, cost, and net revenue reflect operations in all fisheries (West Coast and Alaska). Vessels that operated primarily in Alaska fisheries and the West Coast shoreside whiting fishery earned higher economic net revenue than vessels that operated primarily in the West Coast non-whiting groundfish trawl fishery. Vessels that operated primarily in the West Coast non-whiting groundfish trawl fishery earned positive but smaller economic net revenue, on average ($16,562 in 2008).

For the limited entry groundfish fixed gear survey respondents, the average vessel had revenue from all sources of $324,189, costs reported on the survey of $247,003, economic costs of $261,876, and economic net revenue of $62,313 during 2008. As in the limited entry groundfish trawl fleet, the vessels earning the most net revenue were Alaska vessels, which earned per vessel economic net revenue of $422,151. Economic net revenue was lower for vessels that operated primarily in the West Coast limited entry fixed gear fishery. Sablefish fixed gear vessels earned an average economic net revenue of $36,410 in 2008 and other groundfish fixed gear vessels earned an average economic net revenue of $8,641.

For more information, please contact Carl Lian at NOAA's Northwest Fisheries Science Center, Carl.Lian@noaa.gov

e. Bycatch risk pools for the West Coast groundfish fishery

Investigators: D.S. Holland and J. Jannot

Individual transferable quotas (ITQs) in multispecies fisheries create incentives for fishermen to avoid bycatch of species for which quota is scarce. However, when bycatch is highly uncertain, individual quota demand and prices may be volatile creating substantial financial risk for fishermen. The U.S. Pacific Groundfish fishery recently introduced an ITQ system with low quotas for several overfished species with highly uncertain bycatch rates. Some fishery participants are considering pooling bycatch quota. While these risk pools reduce risk for individuals they also create moral hazard and adverse selection problems. We present an analysis of key issues of risk pool design.

For more information, please contact Daniel Holland at NOAA's Northwest Fisheries Science Center, Dan.Holland@noaa.gov

9. Advanced Technologies

a. Advanced technologies for monitoring fish and their habitat on the U.S. West Coast

Investigators: M.E. Clarke, E. Fruh, C.E. Whitmire and H. Singh

The Northwest and Pacific Islands Fisheries Science Centers have worked with researchers at Woods Hole Oceanographic Institution (WHOI) to redesign the Seabed AUV to overcome the difficulty of monitoring fish populations and habitat in rocky areas. Traditional fish monitoring techniques such as bottom trawl surveys have some limitations for assessing groundfish populations and their habitat throughout their range because of the abundance of rugged terrain. Hover-capable bottom tracking AUVs, on the other hand, offer a unique tool that is appropriate for work in such areas. In addition, this group is collaborating with other researchers to gather information to assess multiple technologies in a variety of habitats.

b. Developing the SeaBED AUV to monitor West Coast groundfish and their habitat

Investigators: M.E. Clarke, E. Fruh and C.E. Whitmire

Many of the commercially important species of demersal fish off the U.S. West Coast inhabit rocky habitats of varying relief that are not accessible with traditional survey gears such as bottom trawls. Due to the number and geographic extent of these habitats, and the number of fish stocks that must be assessed on a regular basis, there is a need for cost-effective tools to survey these areas. Over the past several years, we have been developing a SeaBED type AUV (Autonomous Underwater Vehicle) to survey various benthic habitats for fish and biogenic structure-forming invertebrates (e.g., deep-sea corals, sponges). The SeaBED AUV, developed by Hanumant Singh's lab at Woods Hole Oceanographic Institution, is a bottom tracking AUV that collects high-resolution digital still images of the seafloor and associated fauna. This AUV can be deployed from a variety of vessels ranging from fishing boats to larger oceanographic research vessels. The AUV is primarily an imaging platform that can provide high-resolution georeferenced images as well as associated oceanographic information such as temperature and salinity. We have configured the AUV with both orthogonal (vertical) and oblique (forward) perspective cameras to provide multiple views to aid in the identification of fish and invertebrates. Utilizing its very precise inertial navigation system, we have also employed the AUV to validate habitat information interpreted from high-resolution multibeam sonar imagery. Results from initial surveys show that many fish species can be identified from the images and that associations between fish and emergent fauna (e.g, deep-sea corals) can be quantified. The ability to collect precisely positioned still images has also facilitated photo-mosaicing techniques that show a broader view of the relationships between fauna and habitat than by individual images alone. Some limitations of this AUV relative to ROVs and manned submersibles are that samples cannot be collected and that there is more limited navigational control of the AUV during missions. This limits opportunistic adjustments while surveying, but also minimizes operator chosen diversions from the survey track. In general, AUVs have the advantage of being untethered. This can allow the support vessel to conduct other operations in the vicinity thereby maximizing the data that can be collected per sea day. Furthermore, the complexity of operating the SeaBED AUV in relatively deep depths up to 1500 meters is generally less than those for tethered devices.

For more information, contact Elizabeth Clarke at Elizabeth.Clarke@noaa.gov

c. Southern California shelf rockfish hook-and-line survey external review

In April 2012, the design, methods, and analytical techniques associated with the hook and line survey were reviewed through the Center for Independent Experts (CIE). The CIE provided 2 reviewers, and one independent reviewer served as chair of a panel that evaluated the survey. The survey's design and methods received generally favorable remarks, and several new approaches were suggested for generating indices of abundance and addressing issues associated with gear saturation and inter-specific competition for hooks. Survey staff are currently developing a formal response to the recommendations provided by the review panel.

d. Bias in survey results arising from spatially varying bottom trawl gear efficiency, and a proposed solution involving in situ underwater vehicles

Investigators: J.T. Thorson, E.M. Clarke, and I.J. Stewart

Information regarding several intensively managed groundfish species off the U.S. West Coast is obtained from a randomized bottom trawl survey. However bottom trawl survey efficiency varies spatially due to trawl hangs and presumed decreases in bottom trawl efficiency in rocky habitats. In this study, we use simulation modeling to demonstrate that spatially-varying bottom trawl efficiency can result in a biased relative index of abundance if the target stock undergoes changes in spatial distribution over time. We also propose a sampling design that combines information from bottom trawl and in situ underwater vehicles, within a stratified sampling design. This sampling design mitigates biases seen in bottom trawl sampling, but also has greater precision than only using in situ vehicles. We explore how many in situ vehicle samples are necessary each year to obtain major improvements over bottom trawl designs, and discuss future research that is necessary to further explore the proposed sampling design.

For more information, please contact James Thorson at James.Thorson@noaa.gov

10. Observer Data Collection and Analysis

The FRAM West Coast Groundfish Observer Program (WCGOP) continued collecting fishery-dependent data during 2012 on groundfish fleets along the entire U.S. West Coast. The groundfish fishery is broken down into two main categories the catch share fisheries and the non-catch share fisheries. The catch share fisheries require 100% observer and shore side monitoring. The non-catch share fisheries require observer coverage upon request and coverage is randomly assigned by fishery and port group.

Table 2. Number of observers deployed by the WCGOP in 2012

2012	
Number of catch share observers	86
Number of non-catch share observers	39

a. Catch Shares

There are three sectors in the catch share program: shorebased, motherships (includes motherships and mothership catcher-vessels), and catcher-processors. All vessels participating in the shorebased sector or acting as mothership catcher-vessels (MSCV's) must carry one observer on all trips. Motherships and catcher-processors carry two observers each trip. The shorebased sector is managed through Individual Fishing Quotas (IFQ's) and includes all vessels that land catch at shoreside processors. Catch shares regulations allow the shorebased sector to use trawl, longline, or pots to harvest IFQ species. The mothership and catcher-processor sectors target Pacific hake using trawl gear and process it entirely at-sea. Motherships and catcher-processors have formed cooperatives to ensure sectors can attain Pacific hake quota without exceeding bycatch caps for overfished species or salmon. Table 3 below provides information on observer activities in the catch share fishery.

Catch Share observers are deployed in the following catch share fisheries:

- All vessels participating in the Shore-based Individual Fishing Quota (IFQ) program including hake and non-hake groundfish trawl and fixed gear vessels
- All motherships participating in the at-sea hake fishery
- All mothership catcher-vessels participating in the at-sea hake fishery
- All catcher-processors participating in the at-sea hake fishery

Table 3. Summary of observer coverage and sea days in the catch share fisheries

DESCRIPTION	SS IFQ Trawl	SS IFQ Fixed Gear	SS Hake	MSCV	A-SHOP
Number of vessels	67	25	24	16	14
Number of trips*	1122	1281	718	37	48
Number of hauls	9215	2214	1594	956	2060
Number of Sea days*	4991		1926	536	1138**
Number of Observers	86		43	20	33

*Includes trips and/or sea days where no fishing activity occurred.
**Includes both Lead and Second observers

Note: Totals as of 2/06/2013. Since data have not been finalized, these could change in the future.

SS IFQ trawl: vessels targeting non-hake groundfish with trawl gear and landing at shorebased processors.

SS IFQ Fixed Gear: vessels targeting non-hake groundfish using longlines or pots and landing at shorebased processors. **b)**

SS Hake: vessels targeting hake using trawl gear and landing at shorebased processors.

MSCV: mothership catcher-vessel targeting hake with trawl gear

A-SHOP: motherships and catcher-processors targeting hake using trawl gear

Non-catch shares

The observer program collects data in other West Coast fisheries that are not part of the catch share program. The program had 1,979 sea days in the non-catch share fisheries in 2012 aboard vessels ranging in size from skiffs to larger fixed gear vessels and depths ranging from less than 20 fm to more than 300 fm.

Table 4. Non-Catch Share sea day summary by fisheries/sectors:

FISHERY DESCRIPTION	SEA DAYS*
CA Halibut	49
CA Nearshore	200
CA Pink Shrimp	56
Limited Entry Sablefish	441
Limited Entry Zero Tier	145
OR Blue/Black Rockfish	84
OR Blue/Black Rockfish Nearshore	161
OR Pink Shrimp	610
WA Pink Shrimp	149
WC Open Access Fixed Gear	84

*Includes sea days where no fishing activity occurred.

Due to its unique data collection circumstances in both the catch shares and non-catch shares fisheries, the program continues to stress safety and data quality.

c. Data and analytical reports

The data collected by observers is used to improve total catch estimates, primarily for fish discarded at-sea. T he data are used in assessing a variety of groundfish species, by fisheries managers, and by other fishery, protected resource, and other scientists.

Summaries of data collected on observed trips are routinely published on the NWFSC web site. All WCGOP reports can be obtained at:
http://www.nwfsc.noaa.gov/research/divisions/fram/observer/datareport/index.cfm.

For more information, please contact Jon McVeigh at Jon.McVeigh@noaa.gov

11. Recent Publications

Anderson, M.J., Tolimieri, N., Millar, R. 2013. Beta diversity of demersal fish assemblages in the north-eastern Pacific: interactions of latitude and depth. PLoS One. In press.

Andrews, K.S., Harvey, C.J. 2013. Modeling growth and reproduction of chilipepper rockfish under variable environmental conditions. Marine Ecology Progress Series 473:247-260.

Andrews, K.S., Quinn, T.P. 2012. Combining fishing and acoustic monitoring data to evaluate the distribution and movements of spotted ratfish *Hydrolagus colliei*. Marine Biology 159: 769-782.

Bosley, K.L., Bosley, K.M., Whitmire, C.E., Keller, A.A. 2012. Relating groundfish biomass, species richness and community structure to the presence of corals and sponges using NWFSC bottom trawl survey data. *17th Western Groundfish Conference, Seattle, WA, February 7-10, 2012.*

Bosley, K.L., Miller, T., Brodeur, R.D., Bosley, K.M., VanGaest, A., Elz, A. (In revision) Feeding ecology of juvenile rockfishes off Oregon and Washington, based on stomach contents and stable isotopes. Mar. Biol.

Bradburn, M. 2102. Light availability during bottom trawls affects catchability of Eastern Pacific groundfish species. *17th Western Groundfish Conference, Seattle, WA, February 7-10, 2012.*

Bryan, D.R., Bosley, K.L., Hicks, A.C., Haltuch, M.A., Wakefield, W.W. 2013. Quantitative video analysis of flatfish herding behavior and effective area swept of a survey trawl. ICES J Mar Sci.

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NMFS Southwest Fisheries Science Center

Draft Agency Report to the Technical Subcommittee

of the Canada-U.S. Groundfish Committee

April 2013

Edited by Xi He and John Field

With contributions from John Hyde,

Andrew Thompson, Cindy Thomson, Susan Sogard, and Mary Yoklavich

A. AGENCY OVERVIEW

The Southwest Fisheries Science Center (SWFSC) conducts fisheries and marine mammal research at three laboratories in California. Activities are primarily in support of the Pacific Fishery Management Council, the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), as well as a number of international fisheries commissions and conventions. The Director is Dr. Francisco Werner and the Deputy Director is Kristen Koch. All three SWFSC laboratories have supported the essential needs of the NMFS and the Pacific Fishery Management Council (PFMC) for groundfish, including as active members of the PFMC's Scientific and Statistical Committee (SSC), the Groundfish Management Team, and other management teams and advisory bodies.

The Center is headquartered in La Jolla, which hosts three divisions that conduct research on a wide range of Pacific and Antarctic fish, marine mammals, sea turtles, and marine habitats; the Antarctic Ecosystem Research Division (led by Dr. George Watters), the Marine Mammal and Turtle Division (formerly the Protected Resources Division, led by Dr. Lisa Ballance), and the Fisheries Resources Division (led by Dr. Russ Vetter). The Fisheries Resources Division (FRD) conducts research on groundfish, large pelagic fishes (tunas, billfish and sharks), and small coastal pelagic fishes (anchovy, sardine and mackerel), and is the only source of groundfish research at the La Jolla facility. The Fisheries Research Division is also the primary source of federal support for the California Cooperative Oceanic Fisheries Investigations (CalCOFI) surveys that have taken place along much of the California coast since 1951. Researchers at FRD 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. Steve Lindley, comprises two research branches. The Fisheries Branch (led by Michael Mohr) conducts research and stock assessments in salmon population analysis, economics, groundfish, and fishery oceanography of salmonids and groundfish. The Ecology branch (led by Dr. Susan Sogard) conducts research on the early life history of fishes, salmonid ocean and estuarine ecology, habitat ecology, and the molecular ecology of fishes. Specific objectives of the FED groundfish programs include: (1) collecting and developing information useful in assessing and managing groundfish stocks; (2) conducting stock assessments and improving upon stock assessment methods to provide a basis for harvest management decisions at the PFMC; (3) characterizing and mapping biotic and abiotic components of groundfish habitats, including structure-forming invertebrates; (4) disseminating information, research findings and advice to the fishery management and scientific communities; and (5) providing professional services (many of which fall into the above categories) at all levels, including inter-agency, state, national and international working groups. An FED economist represents the SWFSC on the Pacific Council's Groundfish Management Team.

The Environmental Research Division (ERD) is led by Acting Director Dr. Steven Bograd and is located at the Pacific Fisheries Environmental Laboratory (PFEL) in Pacific Grove. The ERD is a primary source of environmental information to fisheries researchers and managers along the West Coast, and provides science-based analyses, products, and information on environmental variability to meet the agency's research and management needs. The objectives of ERD are to: (1) provide appropriate science-based environmental analyses, products, and knowledge to the SWFSC and its fishery scientists and managers; (2) enhance the stewardship of marine populations in the California Current ecosystem, and other relevant marine ecosystems, by understanding and describing environmental variability, the processes driving this variability, and its effects on the production of living marine resources, ecosystem structure, and ecosystem function; and (3) provide science-based environmental data and products for fisheries research and management to a diverse customer base of researchers, decision-makers, and the public. The ERD also contributes oceanographic expertise to the groundfish programs within the SWFSC, including planning surveys and sampling strategies, conducting analyses of oceanographic data, and cooperating in the development and testing of environmental and biological indices that can be useful in preparing stock assessments.

B. MULTISPECIES STUDIES

1. Factors affecting rockfish fecundity

Investigators: Susan Sogard (FED, SWFSC), John Field (FED, SWFSC), Chris Harvey (FRAM, NWFSC), and Sabrina Beyer (UCSC)

The Fisheries Ecology Division has been studying spatial and temporal variability in fecundity for rockfish species residing in the California Current. We have obtained sufficient numbers for analysis of 3 species thus far: chilipepper, *Sebastes goodei*; yellowtail, *S. flavidus;* and speckled rockfish, *S. ovalis*. Females were sampled from four locations spanning the coast of California from Eureka to Santa Barbara during the winter parturition seasons (November through March) of 2009, 2010 and 2011 to assess spatiotemporal effects on fecundity. Summary results were submitted for publication (Beyer et al., in review). Maternal size and age were positively correlated with relative fecundity (Φ_{rel}, larvae per g somatic weight) for all three species, indicating a disproportionately greater reproductive output by older, larger females (Figure B1). Yellowtail rockfish had the highest absolute fecundity and Φ_{rel}, the greatest maternal size effect and produced the smallest eggs. Size-dependent Φ_{rel} relationships were incorporated into published stock assessment models that originally assumed egg production to be directly proportional to spawning biomass. Spawning biomass tended to overestimate egg production of the stock compared to the updated model that explicitly accounted for size-dependent fecundity; especially when larger, older females were removed from the population through exploitation. In addition, fecundity varied spatially among sampling sites (chilipepper and yellowtail) and by year (chilipepper). Speckled rockfish lacked adequate sample size to assess spatiotemporal trends in fecundity. Chilipepper and speckled rockfish produced multiple broods annually in southern California and to a lesser extent in central California, complicating estimates of annual fecundity. Yellowtail, in contrast, have not been found to produce multiple broods. Egg production was positively correlated with female condition, indicating that environmental variability in oceanographic conditions and productivity may drive changes in fecundity and reproductive strategy (i.e. single versus multiple broods) in these species.

A companion project begun in 2012 is comparing capture rates of rockfish and other groundfish species in areas that have been closed to fishing for at least a decade (via Rockfish Conservation Areas) versus areas that have been open to fishing throughout this time. This project is focused on the central coast of California. We are comparing current CPUE with rates measured by CDFW researchers in the late 1980s/early 1990s, using closely matched fishing methods.

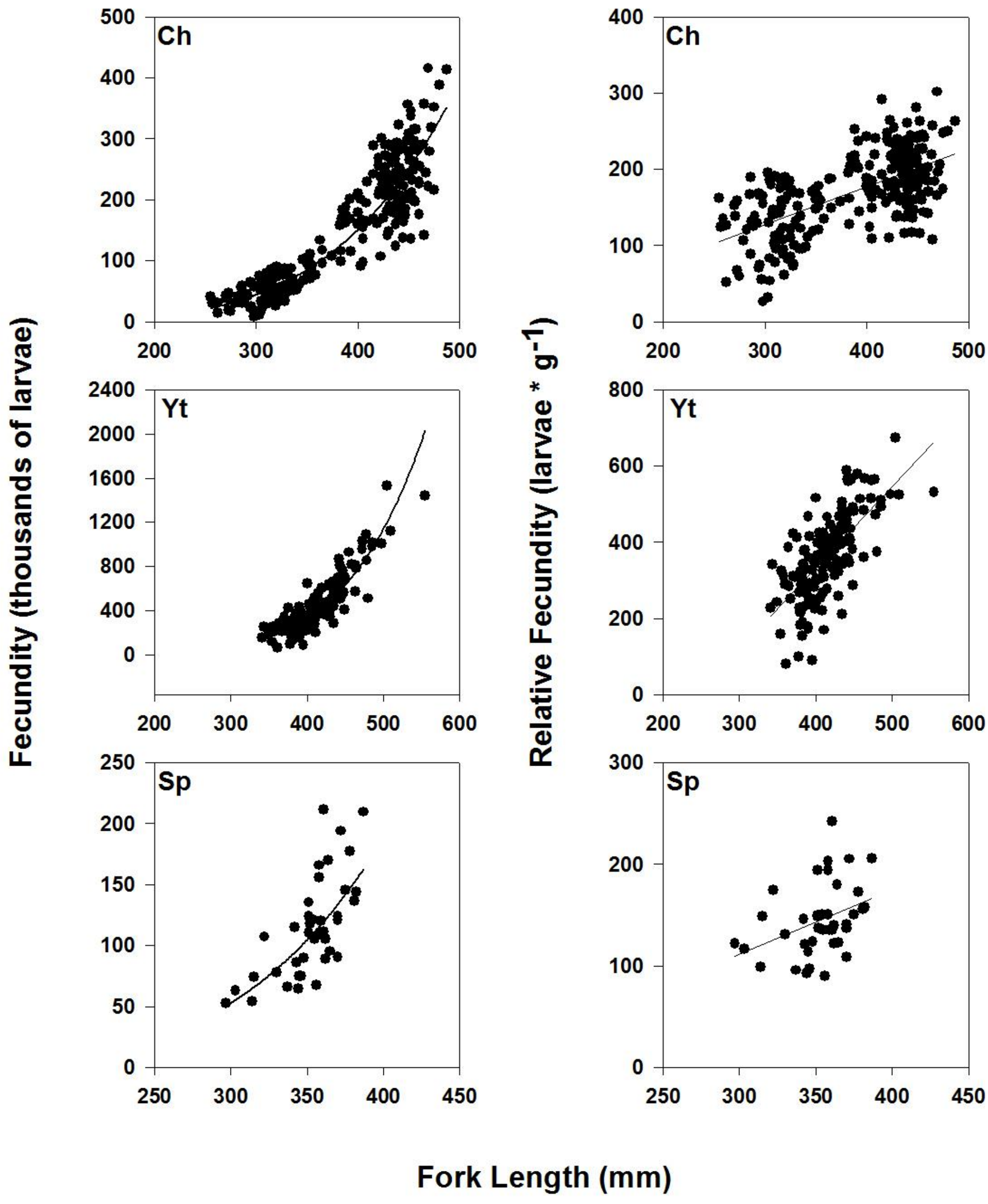

Figure B1. Relationship of maternal size with absolute fecundity (left) and Φ_{rel} (right) for chilipepper (Ch), yellowtail (Yt), and speckled (Sp) rockfish.

2. Juvenile Surveys

The Fisheries Ecology Division of the SWFSC has conducted an annual midwater trawl survey for juvenile rockfish and other pelagic micronekton along the Central California coast in late spring (May-June) since 1983. The survey targets pelagic juvenile (pelagic age 0) rockfish for fisheries oceanography studies and stock assessments, while simultaneously monitoring the micronekton forage assemblage (including other juvenile fishes, krill, coastal pelagic species, and mesopelagic species) and collecting oceanographic information. The results here summarize trends in the core area since 1990, as not all species were consistently identified in earlier (1983-1989) years of the survey. The standardized anomalies from the log of mean catch rates are shown by year for six key forage species and assemblages that are sampled in this survey (Figure B2). Trends in 2011 and 2012 were of higher productivity for the species and assemblages that tend to do better with cool, high transport conditions, including juvenile rockfish, market squid and krill (see also Santora *et al*. 2012). In 2011, juvenile rockfish were more abundant then they had been since the early 2000s, and juvenile abundance remained relatively high in 2012. Market squid and krill were at above average levels in 2011, and very high levels in 2012; with market squid in particular estimated to be at the highest relative abundance in the time series. Other coastal pelagic species (adult northern anchovy and Pacific sardine) continued to be encountered at low levels, although this is likely a greater reflection of their local availability and ocean conditions rather than their coastwide or regional abundance. Notably, in 2012 the abundance of several types of gelatinous zooplankton was extraordinarily high, particularly that of several species of salps (pelagic tunicates), as well as pyrosomes and heteropods. The abundance was sufficiently great that the mass of gelatinous zooplankton damaged sampling gear, and resulted in some offshore trawl stations being abandoned for the first time in the 30 year history of this survey.

Several publications from this survey were completed or are in press related to this survey. Ralston et al. (in press) report on nearly three decades of interannual variability in pelagic juvenile rockfish abundance, and evaluate the relationship between indices of abundance and both physical environmental correlates as well as the results of age structured stock assessments. They found that juvenile rockfish abundance is strongly correlated with relative sea level height anomalies, suggesting that although basin scale climate indices (such as MEI, PDO, NPGO, and NOI) are poorly correlated with abundance, large scale processes (transport) are important drivers of year-to-year variability in recruitment. A comparison of the shared trend in juvenile abundance with recruitments from five rockfish stock assessments shows that the time series are significantly correlated, although there are indications that indices from a broader spatial scale will be more appropriate. Another study evaluated catch data of a wide range of micronekton species, together with physical data from CTD casts and satellite and other observational data, to characterize pelagic habitat structure (Santora *et al*. 2012). This study found strong correlations between environmental (physical, primary productivity) conditions and micronekton community (krill, coastal pelagics, juvenile groundfish, mesopelagic species), indicative of significant coupling between physics and productivity (phytoplankton), secondary consumers (micronekton/forage species) and higher trophic level predators (seabirds, marine mammals).

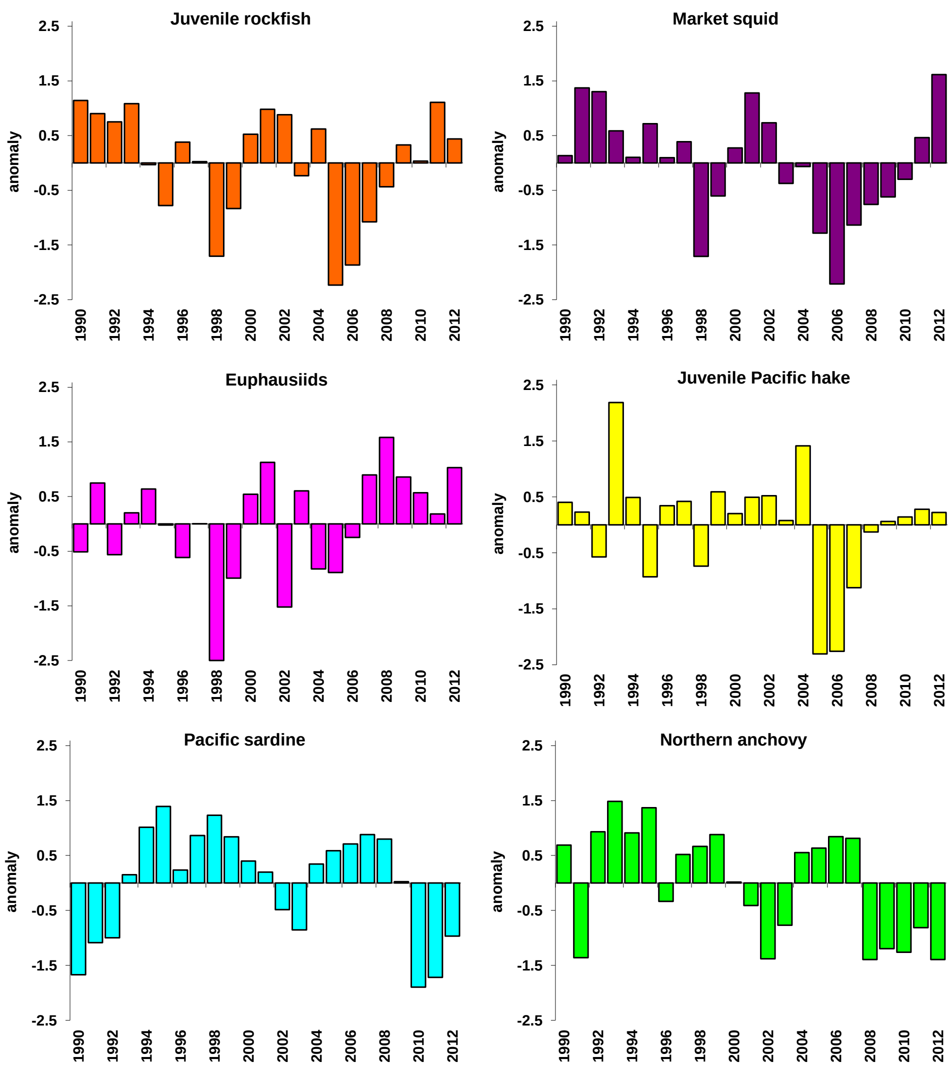

Figure B2: Long-term standardized anomalies of several of the most frequently encountered pelagic forage species from the central California rockfish recruitment survey in the core region (1990-2012).

3. Ichthyoplankton and larval Rockfish Research (Fish Ecology group, FRD)

During the past year, FRD scientists conducted research on larval rockfishes in two areas. First, they completed genetic identification of rockfish larvae collected from approximately 98 bongo samples within and around the Cowcod Conservation Area in February, 2005. Staff are currently in the process of analyzing and writing up the results of this work. Preliminary results identified 34 different species of rockfishes and revealed potential biogeographic breaks within the Southern California Bight as the rockfish assemblage differed significantly east and west of the Santa Rosa ridge and north and south of the Channel Islands. Second, researchers made significant progress sorting larval rockfishes from ethanol-preserved CalCOFI bongo samples.

CALCOFI samples have been stored in ethanol since 1997, and our goal is to develop a species-specific rockfish time series. Currently, we have sorted samples from 2002-2005 and are working on 2011. During the next year, we plan to begin using genetic tools to identify the CALCOFI rockfish larvae to test whether the assemblage has changed over the past 15 years in the Southern California Bight.

C. BY SPECIES, BY AGENCY

1. Shelf Rockfish

a. Rockfish barotrauma and behavior research (Fish Ecology group, FRD)

The SWFSC Genetics and Physiology program continues to evaluate post-release survival of rockfish (*Sebastes* spp.) suffering from barotrauma and released using recompression devices. This work relies upon the use of externally attached acoustic tags equipped with depth and accelerometer sensors to send data to a receiver array that allows us to determine survival and behavior of released fish. Building upon previous work we expanded our receiver array at the 43 fathom bank to allow us to incorporate 3D tracking of individual fish in addition to the basic behavior and survival data that we were previously collecting. These tracking data will provide a rare insight into natural movements (horizontal and vertical) at fine temporal (~ 4min data points) and spatial (+/- a few meters) scales, allowing us to better understand habitat and foraging behavior which ultimately will inform capture probabilities in visual and acoustic based surveys. In addition to fish tracking, two oxygen loggers were deployed at ~80m and ~180m to characterize the seasonal incursion of hypoxic water into this important depth habitat for rockfishes in southern California and allow us to monitor behavior of fish in relation to oxygen saturation.

In FY13, we have deployed 12 tags on bocaccio (*S. paucispinis*) and 20 on cowcod (*S. levis*) and plan to deploy an additional 20 tags on cowcod in coming months. The survival estimates from our FY12 project are currently being considered by the management council for incorporation into management decisions. However, as sample size for most species was ~ 12 animals (n=9 cowcod) there is a need to gather more data to refine these estimates and hopefully the FY13 efforts will satisfy this need for cowcod.

Though precision of these mortality estimates needs to be improved, there is no question that in situ recompression confers a higher probability of survival than surface releases. As a proactive measure, we have been working with CPFV captains and industry representatives to encourage the use of descending devices aboard all CPFV boats in California that target rockfish. As part of the outreach component, we have partnered with other groups to produce a humorous and educational outreach video (https://www.youtube.com/watch?v=EiZFghwVOyI) which has been disseminated widely on the internet and used as an outreach video at several fishing trade shows.

b. Stock assessments

FED staffs are currently developing a number of stock assessments for shelf and nearshore rockfish for the 2013 PFMC stock assessment cycle. Bocaccio rockfish (*Sebastes paucispinis*) will undergo an update assessment in 2013, and preliminary results suggest that the 2010 year class continues to be a strong presence in both fisheries and survey data, while the 2012 year class is also likely to be fairly strong. Both of these year classes should accelerate progress towards rebuilding the stock. A full cowcod stock assessment will also be developed in 2013. Finally, a series of data-moderate assessments are currently under development by E. J. Dick and Alec MacCall, working with UCSC/CSTAR student Braden Soper. These models, and a similar set of models developed by NWFSC staff, were developed for brown rockfish, China rockfish (two areas), copper rockfish, sharpchin rockfish, stripetail rockfish, nominal vermilion rockfish (two areas), and yellowtail rockfish (two areas). Models for two flatfish species, English sole and rex sole, are also being developed. The common feature of these data-moderate assessments was that they used only indexes of abundance, and do not use information on age or length compositions. The FED team took a Bayesian approach developed as an extension of Depletion-Based Stock Reduction Analysis, and the NEFSC team used Stock Synthesis, a maximum likelihood approach. These models will be reviewed in April of 2013.

1. Flatfish

A stock assessment of Pacific sanddab (*Citharichthys sordidus*) is currently under development for review in the summer of 2013. To improve on available age, reproductive ecology and other life history data, field data collection and laboratory examinations for Pacific sanddab have been conducted since early 2012, including estimation of spawning season and relationships between maturity and fecundity to fish size. The data were important inputs for the stock assessment since the species is being assessment in the first time. In addition, over ten thousand otoliths of Pacific sanddab from commercial fisheries and surveys were processed and provided to the stock assessment team. Finally, a series of data-moderate assessments are currently under development; although most of these represent assessments of rockfish (Sebastes) species, data-moderate assessments are also being conducted for English sole and rex sole.

D. OTHER RELATED STUDIES

1. SWFSC FED current habitat activities

The SWFSC/FED Habitat Ecology Team conducts research in response to the mandates of the Magnuson-Stevens Reauthorization Act of 2006, with a focus on deep-water California demersal communities. Our goal is to provide sound scientific information to ensure the sustainability of marine fisheries and the effective management of marine ecosystems, with objectives to: (1) improve stock assessments, especially of overfished rockfish species in complex habitats; (2) characterize fish and habitat associations to improve EFH identification and conservation; (3) contribute to MPA design & monitoring and to Coastal and Marine Spatial Planning; and (4) understand the significance of deep-sea coral as groundfish habitat. The habitat team uses a variety of survey tools and approaches to improve assessments of demersal fishes, macro-invertebrates (including members of deep-water coral communities), and associated seafloor habitats in water depths from 20 to 900 meters off central and southern California. Habitat-specific distribution and densities of juvenile and adult life stages of numerous Pacific Coast demersal species have been determined from non-extractive, visual surveys conducted with remotely operated vehicles (ROV), manned submersibles, scuba, and towed cameras, coupled with seafloor maps of the continental shelf and upper slope off California. These surveys have resulted in habitat-specific assemblage analyses on multiple spatial scales; fishery-independent stock assessments; baseline monitoring of MPAs; documentation of marine debris on the seafloor; and predictive models of the distribution and abundance of deep sea coral communities.

a. Underwater technologies to survey West Coast groundfishes

The FED Habitat Ecology Team completed a final report (Yoklavich *et al*. 2013) of demersal fishes in southern California using Nuytco's occupied *Dual Deepworker* submersible (Figure D1). This survey is part of a "calibration study" to understand the capabilities of various technologies and methods to assess West Coast groundfishes. In addition to abundance and biomass estimates for demersal fishes surveyed with a manned submersible, preliminary comparisons are made between these data and those from an ROV survey conducted close to this time period at the same study site. The accuracy and precision of such results, and the extent of associated ecosystem information collected during such a survey, will be more fully evaluated in consideration of results from the NWFSC/PIFSC Seabed AUV and the SWFSC COAST methodologies, both of which were part of this study. Results from this comparative study will be useful in future surveys of groundfishes in habitats that are not adequately surveyed by bottom trawls, and can be used to develop long-term plans to assess some West Coast groundfish species.

Figure D1. Two-person submersible *Dual Deepworker* being launched off the F/V *Velero* during a survey of demersal fishes and habitats on the Footprint seamount in the Southern California Bight.

b. Development of predictive models to relate population abundance of Rockfishes and habitats

FED Habitat Ecology Team members are developing statistical models that predict densities and biomass of demersal fish species in untrawlable areas, and are coupling these models with broad-scale seafloor habitat maps in a geographical-information-systems (GIS) environment to spatially predict fish densities/biomass on a regional basis. We are basing these models on fish data (identification, counts, sizes) collected during visual surveys conducted from manned submersibles off central California (Figure D2), and on a number of associated habitat variables (e.g., depth, substratum type, patch size and configuration). Spatial data sets are being compiled and the most up-to-date multibeam sonar data sets are being synthesized to provide a bathymetric base layer to support the spatially predictive models. These results will provide managers, policy makers, and the public with information that can be used in the conservation and management of sustainable marine resources (both the fisheries and associated habitats). Development of models of co-occurring species and associated habitats will have application to ecosystem-based management, providing information needed to manage a more complete demersal fish community. By including measures of spatial variability, this work will advance our understanding of the ecological processes that influence demersal fish distribution and abundance.

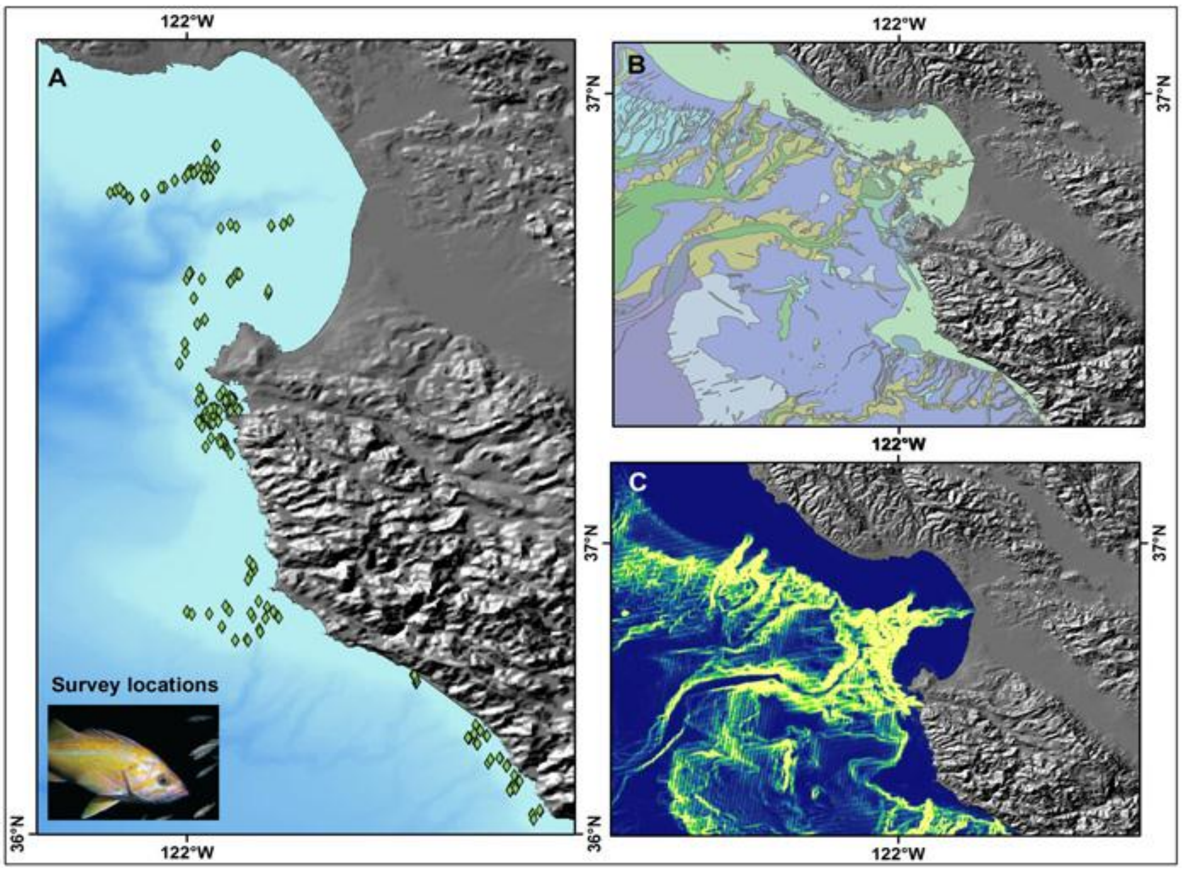

Figure D2. Spatial data sets compiled to support predictive modeling, including (A) map of submersible survey locations, (B) benthic habitat map, and (C) multibeam-derived product (e.g., habitat complexity, or rugosity).

c. Predicting distribution of benthic macro-invertebrates

As part of the California Seafloor Mapping Project (CSMP), the FED Habitat Ecology team continues to collaborate with USGS and others to create a suite of maps detailing seafloor morphology and geology and characterizing potential benthic habitats derived from high-resolution multibeam sonar data. These efforts are being conducted coastwide, from the Oregon-California border to Mexico. We have used a towed camera sled to groundtruth these data and to survey biological components of the habitats. From presence/absence of macro-invertebrates associated with specific sediment types, depth, and latitude, we have developed multivariate models using logistic regression to predict the distribution of various species. Coupling these results with spatial information on bottom type and depth, we have created maps of probability of occurrence of these important components of seafloor communities (Krigsman *et al*. 2012). These maps will provide managers, policy makers, and the public with information that can be used in the conservation and management of sustainable marine resources. Members of the FED Habitat Ecology Team have completed a draft manuscript describing models that predict distribution of density and sizes of the black coral (Anthipathes dendrochristos) using covariates of ocean currents, water depth, and primary productivity. Describing the relationships of these corals and environmental factors helps in understanding the demersal community structure and function.

2. SWFSC FED Economics Team Activities

The FED's Economics Team hosted a Workshop on Productivity Measurement on June 11-13, 2012 in Santa Cruz. Productivity is a key metric for understanding profitability change, and has been identified as an indicator of economic performance in commercial fisheries for NMFS national reporting purposes. The major fishery on the Pacific coast for which such indicators are needed is the groundfish fishery. The Workshop was organized by FED and NEFSC economists and funded by NMFS Economics and Social Analysis Division. Workshop attendees included NMFS economists and other productivity experts from academia and federal agencies (U.S. Department of Agriculture, Environmental Protection Agency). The Workshop Proceedings (Mamula and Walden 2013) provide a compendium of the papers presented at the meetings.

The FED's Economics Team plans to conduct an economic survey of California anglers that focuses on recreational groundfish regulations as they relate to angler preferences and behavior. The survey is being designed in coordination with the California Department of Fish and Wildlife and groundfish biologists from FED and University of California, Santa Barbara. The survey will be conducted in early 2014, contingent on approval by the Office of Management.

E. GROUNDFISH PUBLICATIONS OF THE SWFSC, 2012 – PRESENT

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Beyer, S.G., Sogard, S.M., Harvey, C.J., and J.C. Field. In review. Variability in rockfish (*Sebastes* spp.) fecundity on the California coast: species contrasts, maternal size effects, and spatial differences. Mar. Ecol. Prog. Ser.

Butler, J. L., M. S. Love, and T. E. Laidig. 2012. A guide to the rockfishes, thornyheads, and scorpionfishes of the northeast Pacific. University of California Press. 185 p.

Field, J.C., C. Elliger, K. Baltz, G. Gillespie, W.F. Gilly, I. Ruiz-Cooley, D. Pearse, J.S. Stewart, W. Matsubu and W. Walker. In press. Foraging ecology and movement patterns of the Humboldt squid in the California Current. Deep Sea Research II.

Haltuch, M. A., O. S. Hamel, K. R. Piner, P. McDonald, C. R. Kastelle, and J. C. Field. 2013. A California Current bomb radiocarbon reference chronology and petrale sole (*Eopsetta jordani*) age validation. Canadian Journal of Fisheries and Aquatic Sciences 70(1):22-31.

Krigsman, Lisa M., Mary M. Yoklavich, E.J. Dick, and Guy R. Cochrane. 2012. Models and maps: predicting the distribution of corals and other benthic macro-invertebrates in shelf habitats. Ecosphere 3(1).

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Mason, J., R. Kosaka, A. Mamula, and C. Speir. 2012. Effort changes around a marine reserve: The case of the California Rockfish Conservation Area. Marine Policy 36(5):1054-1063.

Ralston, S., K.M. Sakuma and J.C. Field. In press. Interannual Variation in Pelagic Juvenile Rockfish Abundance– Going With the Flow. Fisheries Oceanography.

Santora, J.A., J.C. Field, I.D. Schroeder, K.M. Sakuma, B.K. Wells and W.J. Sydeman. 2012. Spatial ecology of krill, micronekton and top predators in the central California Current: implications for defining ecologically important areas. Progress in Oceanography 106: 154-174.

Santora, J. A., W. J. Sydeman, I. D. Schroeder, C. S. Reiss, B. K. Wells, J. C. Field, A. M. Cossio, and V. J. Loeb. 2012. Krill space: a comparative assessment of mesoscale structuring in polar and temperate marine ecosystems. ICES Journal of Marine Science 69(7):1317-1327.

Shelton, O., E. J. Dick, D. Pearson, S. Ralston, and M. Mangel. 2012. Estimating species composition and quantifying uncertainty in multispecies fisheries: hierarchical Bayesian models for stratified sampling protocols with missing data. Canadian Journal of Fisheries and Aquatic Sciences 69: 231–246.

Woodson, L. E., B. K. Wells, C. B. Grimes, R. P. Franks, J. A. Santora, and M. H. Carr. 2013. Water and otolith chemistry identify exposure of juvenile rockfish to upwelled waters in an open coastal system. Marine Ecology Progress Series 473:261-273.

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2. Other Publications

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Dick, E.J., A. MacCall, B. Soper, and M. DeYorio. 2012. Exploration of Bayesian stock reduction analysis for assessment of West Coast groundfish. Report submitted to the Review Panel Meeting on Assessment Methods for Data-Moderate Stocks (26-29 June 2012, Seattle, Washington). Pacific Fishery Management Council, Portland, Oregon. 27 p.

MacCall, A. D. 2012. A data-poor assessment of the US wreckfish fishery. Briefing book report to the Scientific and Statistical Committee Meeting, October 23-25, 2012. South Atlantic Fishery Management Council, North Charleston, South Carolina. 10 p.

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Yoklavich, M., T. Laidig, D. Watters, and M. Love. 2013. Understanding the capabilities of new technologies and methods to survey west coast groundfishes: results from a visual survey conducted in 2011 using the Dual Deepworker manned submersible at Footprint and Piggy Banks off Southern California. Final report to NMFS F/ST (R. Methot). 28 p.

STATE OF ALASKA

GROUNDFISH FISHERIES

ASSOCIATED INVESTIGATIONS IN 2012

Prepared for the Fifty-third Annual Meeting of the Technical Subcommittee
of the Canada-United States Groundfish Committee

With new contributions from:

Mike Byerly, Bob Chadwick, Heather Fitch, Barbi Failor, Dr. Ken Goldman, Kristen Green, Lee Hulbert, Mike Jaenicke, Scott Meyer, Chris Siddon, Jan Rumble, Elisa Russ, Mark Stichert, Gail Smith, Trent Hartill, Charles Trebesch, and Carrie Worton

April 2013
ALASKA DEPARTMENT OF FISH AND GAME
DIVISION of COMMERCIAL FISHERIES & DIVISION of SPORT FISH
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STATE OF ALASKA GROUNDFISH FISHERIES AND ASSOCIATED INVESTIGATIONS IN 2012

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 (DSR) 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 GOA FMP. In 2007 the dark rockfish was removed from both the GOA and the Bering Sea and Aleutian Islands (BSAI) FMP. Thus in these areas, the state manages these species in both state and federal waters. The state also manages the lingcod resource in both state and federal waters of Alaska. The State of Alaska manages some groundfish fisheries occurring in Alaska waters in parallel with NOAA fisheries, adopting federal seasons and in some cases allowable gear types as specified by NOAA. The information related in this report is from the state-managed groundfish fisheries only.

The State of Alaska is divided into three maritime regions for marine commercial fisheries management. The Southeast Region extends from the Exclusive Economic Zone (Equi-distant line) boundary in Dixon Entrance north and westward to 144^{o} W. longitude and includes all of Yakutat Bay (Appendix II). The Central Region includes the Inside and Outside Districts of Prince William Sound (PWS) and Cook Inlet including the North Gulf District off Kenai Peninsula. The Westward Region includes all territorial waters of the Gulf of Alaska south and west of Cape Douglas and includes North Pacific Ocean waters adjacent to Kodiak, and the Aleutian Islands as well as all U.S. territorial waters of the Bering, Beaufort, and Chukchi Seas.

a. Southeast Region

The **Southeast Region** Commercial Fisheries Groundfish Project is based in Sitka with the groundfish project leader, fisheries biologist, and one full-time fisheries technician located there. Two full-time biologists and one full time research analyst for this project are based in Douglas. Seasonal technicians and port samplers are employed in Petersburg, Ketchikan and Sitka. The project also receives biometric 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 in federal waters for demersal shelf rockfish (DSR), black, blue, and dark rockfishes, and lingcod. 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 NPFMC Gulf of Alaska Groundfish Plan Team and produces the annual stock assessment for DSR for consideration by the NPFMC.

Project activities center around fisheries monitoring, resource assessment, and in-season management of the groundfish resources. In-season management decisions are based on data collected from the fisheries and resource assessment surveys. Primary tasks include fish ticket collection, editing, and data entry for both state and federally-managed fisheries; dockside sampling of sablefish, lingcod, Pacific cod, and rockfish landings; and logbook collection and data entry. Four resource assessment surveys were conducted during 2012. The R/V *Medeia*, home ported Juneau, conducts a variety of groundfish research activities in Southeast Region waters.

b. Central Region

Central Region groundfish staff is headquartered in Homer and is comprised of a regional groundfish/shellfish management biologist, a regional groundfish/shellfish research project leader, a groundfish sampling coordinator, a groundfish fish ticket entry position, two marine research biologists, one GIS analyst, five to six seasonal technicians, and one seasonal commercial catch sampler. An assistant area management biologist and a seasonal commercial catch sampler are also located in Cordova and regional support is in Anchorage. The regional groundfish management biologist serves as a member of the North Pacific Fishery Management Council's (NPFMC) Gulf of Alaska Groundfish Plan Team and the research project leader serves on the NPFMC Non-Target Species Committee. The R/V *Pandalus*, home ported in Homer, and the R/V *Solstice,* in Cordova, conduct a variety of groundfish research activities in Central Region waters.

Groundfish staff responsibilities include research and management of groundfish species harvested in state waters of **Central Region,** which includes Cook Inlet (CI) and Prince William Sound (PWS) areas, as well as in federal waters for black, blue, and dark rockfishes, and lingcod. Within Central Region, groundfish species of primary interest include sablefish, Pacific cod, pollock, lingcod, rockfishes, skates, sharks, and flatfishes. Data are collected through commercial catch sampling, fishermen interviews, logbooks, onboard observing, and through ADF&G trawl, pot and remotely operated vehicle (ROV) surveys. Commercial harvest data (fish tickets) are processed in Homer for state and federal fisheries landings in Central Region ports. For some fisheries, logbook data are required and these are collected and entered to provide additional information including catch composition, depth, and location data.

c. Westward Region

The **Westward Region** Groundfish management and research staff is located in Kodiak and Dutch Harbor. Kodiak staff is comprised of a regional groundfish management biologist, an area groundfish management biologist, an assistant area groundfish management biologist, a groundfish research project leader, a groundfish research project assistant biologist, a groundfish dockside sampling coordinator, a trawl survey biologist, two seasonal fish ticket processing technicians, and several seasonal dockside samplers. A full-time area management biologist, an assistant area groundfish management biologist and a seasonal fish ticket processing technician are located in the Dutch Harbor office. Seasonal dockside sampling also occurs in Chignik, Sand Point, and King Cove. The R/V *Resolution*, R/V *K-Hi-C*, and R/V *Instar* hail from 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 NPFMC Bering Sea/Aleutian Island Groundfish Plan Team (Dave Barnard) and the Gulf of Alaska Groundfish Plan Team (Mark Stichert).

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 ADF&G statewide AKFIN contract and the PSMFC sponsored AKFIN Support Center (AKFIN-SC) in Portland, Oregon. The ADF&G has primary responsibility for collecting, editing, maintenance, analysis, and dissemination of these data and performs this responsibility in a comprehensive program.

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 related to the groundfish fisheries 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 determine ages for groundfish samples using age structures (as otoliths, vertebrae, and spines) arising from statewide commercial catch and resource survey sampling conducted by ADF&G;
3) to provide the support mechanisms needed to collect, store, and report commercial groundfish harvest and production data in Alaska;
4) to integrate existing fishery research data into secure and well maintained databases with consistent structures and definitions;

5) 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 via web-access while maintaining the department's confidentiality standards;
6) to provide GIS services for AKFIN fishery information mapping to ADF&G Division of Commercial Fisheries staff and participate in GIS and fishery data analyses and collaboration with other AKFIN partner agencies;
7) to support economic analysis as needed prior to implementation of state and federal fishery regulations; and
8) 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.

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 species landed, and age determination based on samples of age structures collected from landed catches. A dockside sampling program provides for collection of accurate biological data (e.g., size, weight, sex, maturity, and age) and verifies self reported harvest information submitted on fish tickets from shoreside deliveries of groundfish throughout coastal Alaska. In addition, the Gulf of Alaska Groundfish FMP and the Bering Sea and Aleutian Islands Groundfish FMP require the collection of groundfish harvest data (fish tickets) in the north Pacific. The AKFIN program is necessary for management and for the analytical and reporting requirements of the FMPs.

The state's AKFIN program is supported by a strong commitment to development and maintenance of a computer database system designed for efficient storage and retrieval of the catch and production data on a wide area network and the internet. It supports the enhancement of the fish ticket information collection effort including; regional fishery monitoring and data management, GIS database development and fishery data analysis, catch and production database development and access, the Age Determination Unit laboratory, database management and administration, fisheries data collection and reporting, fisheries 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 are 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 are routinely reviewed for accuracy with corrections applied as required. Within the confines of confidentiality agreements, raw data are distributed to the NMFS (both NMFS-ARO and NMFS-AFSC), the 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 (BOF), NMFS, NPFMC and the AKFIN Support Center.

The fishery information collected by the AKFIN program is not only essential for managers and scientists who must set harvest levels and conserve the fisheries resources, but it is also valuable for the fishermen and processors directly involved in the fisheries, as well as the general public. To meet those needs, the department has designed, implemented, and continues to improve database systems to store and retrieve fishery data, and continues to develop improvements to fishery information systems to provide data to other agencies and to the public.

The department also conducts economic analyses of these data for use in the NPFMC arena. The need for an economic analysis component of the AKFIN program arises from jurisdictional obligations, pressing economic needs, and impacts of environmental regulations. The ADF&G is the management agency for state fisheries under its jurisdiction, and also a lead agency in policy making for federal fisheries of the region through its role in the NPFMC and the Pacific Salmon Commission (PSC). Economic analysis of seafood and fishery management policy is essential for the state to determine how proposed policies will impact the industry, Alaska regions, and coastal localities of the state. The role of state personnel is especially crucial under the rationalization plan currently being refined by the NPFMC, which will directly impact the state managed groundfish fisheries in the Gulf of Alaska.

Groundfish fishery milestones for this ongoing ADF&G AKFIN program are primarily the annual production of catch records and biological samples. In calendar year 2011, ADF&G AKFIN staff processed 21,750 groundfish fish tickets, collected 32,569 groundfish biological samples and measured 32,435 age structures (see tables below for regional breakdown). These basic measures of ongoing production in support of groundfish marine fisheries management by AKFIN-funded ADF&G staff are representative of the level of annual productivity by the AKFIN program since its inception in 1997. (Contact: Lee Hulbert)

Groundfish Fish Tickets Processed -Calendar Year 2012

ADF&G Region	
1 - Southeast	3,270
2 - Central	4,827
4 - Westward; Kodiak, AK Pen.	12,227
4 - Westward; BSAI	1,426
Total	21,750

Groundfish Biological Data Collection - Calendar Year 2012

ADF&G Region	AWL Samples Collected	Age Structures Measured
1 - Southeast	20,389	20,561
2 - Central	8,988	4,827
4 – Westward	3,192	7,047
Total	32,569	32,435

Intergency Electronic Reporting System (contact Gail Smith)

ADF&G 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 are stored in an Oracle relational database and available to Headquarters and regional staff via the State of Alaska wide-area network.

Beginning in 2001, the agencies tasked with commercial fisheries management in Alaska (ADF&G, NMFS, IPHC) began development of a consolidated landing, production, and IFQ reporting from a sole source – the Interagency Electronic Reporting System (IERS). The goal is to move all fisheries dependant data to electronic reporting systems. The web-based reporting component of this system is ***eLandings.*** The desktop application for the at-sea catcher processor fleet is ***seaLandings***. Vessels using the seaLandings application email landing and production reports to the centralized database as an email attachment. ***tLandings*** was developed to address electronic reporting on-board groundfish and salmon tender vessels. The application and the landings reports are stored on a portable hard drive and delivered to the shoreside processor for upload to the eLandings database. Fisheries management agencies use a separate application, the ***IERS Agency Interface***, to view and edit landing reports. The IERS management/development team are developing and implementing an electronic logbook application, ***eLogbook***, currently used by groundfish catcher processors. The ***eLogbook*** has expanded to be used with groundfish and crab catcher vessels. The IERS has been in successful operation in Alaska's commercial fisheries since July 2006.

Our approach, throughout this project has been staged implementation, which allows a small staff to successfully manage this ambitious project. We expect the IERS will be fully implemented with the salmon fishery by the end of the 2014 season. Statewide shellfish and herring fisheries will be addressed in 2015.

The IERS features include electronic landing and production reports, real time quota monitoring, immediate data validation, and printable (.pdf) fish ticket reports. The IERS provides processors with a web-based electronic catch and production data extraction using an XML output. ADF&G personnel, funded by AKFIN, Rationalized Crab Cost Recovery funds and IFQ Halibut/Sablefish Cost Recovery funds, participate in the IERS project on the development, implementation, and maintenance levels. During 2012, the IERS recorded more than 93,300 landing reports in crab, groundfish and salmon fisheries.

The IERS is extensively documented on a public and secure wiki at https://elandings.alaska.gov/confluence/

Local ADF&G personnel in six locations throughout the state of Alaska (Petersburg, Sitka, Juneau, Homer, Kodiak and Dutch Harbor) maintain close contact with groundfish fishers, processors and state/federal enforcement to maintain a high quality of accuracy in the submitted fish ticket records. The Interagency Electronic Reporting System – eLandings , seaLandings, tLandings and eLogbook applications, with immediate data validation and business rules, has improved data quality and allows personnel to function at a higher level. User support on a 24/7 basis is being provided by GCI, an Alaska based telecommunications company. IFQ reporting support is provided by the NMFS Data Technicians.

Landing and production data are submitted to a central database, validated and reviewed, and pulled to the individual agency databases. Landing data are available to agency personnel within seconds of submission of the report. Printable documentation of the landing report and the Individual Fishery Quota debit are created within the applications. Signed fish tickets continue to be submitted to local offices of ADF&G for additional review and comparison to other data collection documents. These documents include vessel/fisher logbooks, agency observer datasets, and dockside interviews with skippers.

Within the confines of confidentiality agreements, raw data are distributed to the State of Alaska Commercial Fisheries Entry Commission (CFEC) and to the National Marine Fishery Service NMFS-AK Region and the 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 are provided to the BOF, the North Pacific Fisheries Management Council, and to the State of Alaska legislature as requested.

e. Gene Conservation Laboratory

In the past, the ADF&G Gene Conservation Laboratory collected genetic information on black rockfish, light and dark dusky rockfish, and pollock (a list of *Sebastes and* pollock tissue samples stored at ADF&G's Gene Conservation Laboratory can be found in Appendix III).

f. Age Determination Unit

The ADFG's statewide age reading program at the Age Determination Unit (ADU) in Juneau continued to provide age data to ADF&G regional managers in 2012. Age structures from 8,914 specimens representing 11 groundfish species were received from statewide commercial and survey harvest sampling efforts. A total of 14,227 age data were distributed to managers, which included data from samples received in previous years, but processed in 2012. Sablefish is the most prominent species aged by ADU and 10,118 ages were distributed statewide this year. Quality of age data is routinely assessed through precision testing of at least 15% of each sample and 4,101 additional age data were produced through this process. Also, 3,897 age data were produced through training and calibration procedures. In total, ADU age readers evaluated over 22,225 specimens as part of production protocols.

All age structures that are received by the ADU are measured for length, weight, etc. Measurement data is used to assess potential errors arising from specimen handling, data entry, species misidentifications, and as part of age data quality assessments. A total of 32,435 age structures (representing over 15,454 specimens) were measured in 2012.

The majority (>70%) of funding for this project is through AKFIN with the remainder from State funding. The ADU employed five people in 2012 for approximately 56 work months to age groundfish and invertebrates, process samples, enter data, maintain sample archives, measure samples, and other support tasks.

Effort continued toward increasing objective information (age structure measurements, age validation) to strengthen foundation of pattern interpretation for all species.

One of these projects, called the ADU Data Filter, involves the use of objective age structure measurements to assess data errors and age data quality. A preliminary model predicting age structure dimensions of each age class has been developed. This Filter compares the dimensions of each specimen to the prediction intervals of the measurement and highlights specimens that are not within expected ranges. Those specimens falling outside the range will then be reviewed for possible age or data entry errors, etc. This process is in development for sablefish and is under evaluation prior to full implementation in the ADU program. Other work in 2012 includes bomb radiocarbon age validation studies, and evaluating otolith accretion rates of known-age pollock.

This year, the ADU continued to develop and improve methods for managing data and tracking samples through web based interfaces used by fishery managers. These improvements have made sample and request processing more efficient.

The ADU participated in the Canada-US Groundfish Committee's working group, Committee of Age Reading Experts (CARE). This included an age structure exchange of known-age sablefish and developing narrative for updates to the CARE sablefish age reading manual. (Contact Chris Siddon)

2. Description of the State of Alaska recreational groundfish fishery program (Sport Fish Division)

ADF&G manages all recreational groundfish fisheries within the internal waters of the state, in coastal waters out to three miles offshore, and throughout the EEZ. The Alaska BOF extended existing state regulations governing the sport fishery for all marine species into the waters of the EEZ off Alaska in 1998. This was done under provisions of the Magnuson-Stevens Fishery Conservation and Management Act, which stipulate that states may regulate fisheries that are not regulated under a federal fishery management plan or other applicable federal regulations. No recreational fisheries are included in the Gulf of Alaska Fishery Management Plan.

Most management and research efforts are directed at halibut, rockfish, and lingcod, the primary groundfish species targeted by the recreational fishery. Statewide data collection programs include an annual mail survey to estimate overall harvest (in number of fish) of halibut, rockfishes (all species combined), lingcod, Pacific cod, sablefish, and sharks (all species combined), and a mandatory logbook to assess harvest of selected species in the charter boat fishery. The statewide bottomfish coordinator (Scott Meyer) coordinates federal data requests and develops scientifically-based advice for assessment and management of halibut and groundfish.

Regional programs with varying objectives address estimation of recreational fishery statistics including harvest and release magnitude and biological characteristics such as species, age, size, and sex composition. Research was funded through state general funds and the Federal Aid in Sport Fish Restoration Act. There are essentially two maritime regions for marine sport fishery management in Alaska. The Southeast Region extends from the EEZ 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, assistant project biologist for the northern southeast Alaska ports, the project biometrician, and the project research analyst are based in Juneau, while the assistant project biologist for the southern southeast Alaska ports is based out of Ketchikan. A total of 25 technicians worked at the major ports in the Southeast region, where they interviewed anglers and charter operators and collected data from sport harvests of halibut and groundfish while also collecting data on sport harvests of salmon. Data collected on groundfish were limited to species composition, lengths of harvested rockfish, halibut and lingcod, and sex of lingcod; no otoliths or other age structures were collected. Data were provided to the Alaska BOF, other ADF&G staff, the public, and a variety of other agencies such as the NPFMC and the IPHC.

The Regional Management Coordinator and Area Management Biologists in Yakutat, Haines, Sitka, Juneau, Petersburg, Craig, and Ketchikan are responsible for groundfish management in those local areas. The demersal shelf rockfish and lingcod sport fisheries are managed under the direction of the Demersal Shelf Rockfish Delegation of Authority and Provisions for Management (5 AAC 47.065) and the Lingcod Delegation of Authority and Provisions for Management (5 AAC 47.060) for allocations set by the Alaska Board of Fish.

b. Southcentral Region Sport Fish

The **Southcentral Region** groundfish staff consisted of two Regional Management Biologists as well as Area Management Biologists and assistants for the following areas: (1) PWS and the North Gulf areas, (2) Lower Cook Inlet, and (3) Kodiak, Alaska Peninsula, and the Aleutian Islands. In addition, a region-wide harvest assessment project was based in the Homer office, consisting of a project leader, project assistant, and seven technicians. The research project biometrician was located in Anchorage. Ongoing assessment of sport harvest and fishery characteristics at major ports throughout the region is the primary activity. Data were collected from harvested halibut, rockfishes, lingcod, and sharks, and anglers and charter boat operators were interviewed for fishery performance information. All age reading was done in Homer, and the staff members 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 IPHC 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 hindered development of abundance-based fishery objectives. As a result, management is based on building a conservative regulatory framework specifying bag and possession limits, seasons, and methods and means that are hoped to provide for sustained yield over the long term. Lack of stock assessment information coupled with increasing effort and harvest in several groundfish sport fisheries accentuate the need for a comprehensive management plan and harvest strategy.

Typical duties included providing sport halibut harvest statistics to IPHC and NPFMC, assisting in development and analysis of the statewide charter logbook program and statewide harvest survey, providing information to the Alaska BOF, advisory committees, and local fishing groups, drafting and reviewing proposals for recreational groundfish regulations, and dissemination of information to the public.

B. By Species

1. Pacific cod

Catch rate and biological information is gathered from fish ticket records, port sampling programs, a tagging program, and during stock assessment surveys for other species. A mandatory logbook program was initiated in 1997 for the state waters of Southeast Alaska. Commercial landings in Southeast, Central Region and the Westward Region are sampled for length, weight, age, sex, and stage of maturity.

a. Research

The **Westward Region** has discontinued the cod-tagging program that was initiated in 1997 in the Central, Western, and Eastern Gulf of Alaska. A total of 18,670 tags have been released. Tagged cod continue to be captured from earlier years, and by year’s end, 26 tags had been recovered. Fish spent from 100 to 500 days at liberty; a few over 1,000 days. Recovery rates averaged 5.6% per year. While the vast majority of Pacific cod are recovered within 10-20 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 and Unlaska into the Bering Sea, the Alaska Peninsula to Kodiak waters, and several fish tagged in Kodiak waters were recovered in Cook Inlet and Southeast Alaska.

b. Stock Assessment

No stock assessment programs were active for Pacific cod during 2012.

c. Management

Regulations adopted by the Alaska BOF during November 1993 established a guideline harvest range (GHR) of 340 to 567 mt for Pacific cod in the internal waters of **Southeast Alaska**. The internal waters of Southeast Alaska are comprised of two areas, the Northern Southeast Inside (NSEI) Subdistrict and the Southern Southeast Inside (SSEI) Subdistrict. The GHR was based on average historic harvest levels rather than on a biomass-based ABC estimate. This fishery has the most participation in the winter months, and in season management actions such as small area closures are implemented to spread out the fleet and reduce the risk of localized depletions. Pacific cod in state waters along the outer coast are managed in conjunction with the Total Allowable Catch (TAC) levels set by the federal government for the adjacent EEZ.

In 1996, the BOF adopted Pacific cod Management Plans for fisheries in five groundfish areas, **Prince William Sound**, **Cook Inlet**, **Kodiak**, **Chignik** and **South Alaska Peninsula**. The plans did not restrict participation to vessels qualified under the federal moratorium program. Included within the plans were season, gear and harvest specifications. State-waters fishing seasons were set to 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. However, in 2011, the BOF adjusted state-waters seasons in Prince William Sound (PWS) for pot gear and jig gear to open 24 hours following the closure of the initial federal season; and for longline gear in PWS to open seven days following the initial federal season closure or concurrent with the individual fishing quota (IFQ) halibut season opening date, whichever occurs later. The BOF restricted the state-waters fisheries to pot or jig gear in an effort to minimize halibut bycatch and avoid the need to require onboard observers in the fishery. However, in 2009, a new BOF regulation became effective permitting use of longline gear in PWS. This change was largely in response to the very low levels of effort and harvest and the high level of interest from the longline gear group. With the exception of longline gear in PWS, guideline harvest levels (GHL) are allocated by gear type; however, in 2011 the BOF adopted thresholds for PWS whereas longline gear will close when 85% of the GHL is reached and pot gear will close when 90% of the GHL is reached.

The NPFMC recently established sector allocations for the federal CGOA Pacific cod fisheries. The NPFMC's action established unique Pacific cod harvest allocations for pot, jig, trawl, and longline gear vessels. Beginning in 2012, the federal/parallel Pacific cod season for each federal gear sector was prosecuted independently of other Pacific cod federal gear sectors, resulting in staggered federal season closure dates. Prior to federal sector allocations, all gear types competed for federal/parallel Pacific cod during a single derby-style fishery. In order to coordinate state-waters Pacific cod fisheries, a BOF meeting was held in October 2011 to adopt or amend regulations anticipating these federal changes. In most cases, starting in 2012, state-waters fisheries opened independently for each gear type

In October 2011, the BOF held a special meeting to coordinate state-managed Pacific cod fisheries with changes occurring in the federal fisheries due to the implementation of gear sector splits (differential allocations of the TAC by gear type), and adjust Pacific Cod Management

Plans and related regulations accordingly. The BOF adopted regulatory changes to align the parallel seasons with the federal seasons for each legal gear type. In PWS, the parallel longline season was aligned with the federal catcher vessel less than 50 foot hook-and-line gear sector. Different parallel season closures by gear type resulted in different seasons for each gear type in the state-waters seasons, and ADF&G considered these changes manageable. The annual GHLs are based on the estimate of acceptable biological catch (ABC) of Pacific cod as established by the NPFMC. Current GHLs are set at 25% of the Western Gulf ABC to be reserved for the South Alaska Peninsula Area, 25% of the Central Gulf ABC to be apportioned between the Kodiak, Chignik and Cook Inlet Areas and 25% of the Eastern Gulf ABC for the Prince William Sound Area. Action by the BOF in 2004 reduced the GHL in Prince William Sound to 10% of the Eastern Gulf ABC with a provision to increase subsequent GHLs to15% and then 25% if the GHL is achieved in a year; in 2011 the Prince William Sound GHL was set at the maximum level of 25% after achieving the GHL the two previous years, and in 2011, the BOF removed the step-up provision, as there was no mechanism to lower the GHL to previous levels.

Additional regulations include a 58' vessel size limit in the Chignik and South Alaska Peninsula 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 after October 31 on exclusive area registrations, vessel size, and gear limits to increase late season harvest to promote achievement of the GHL. In addition, observers are occasionally used on day-trips to document catches and at-sea discards in the nearshore pot fisheries.

In February of 2006, the Alaska BOF adopted a Pacific cod Management Plan for a nonexclusive Aleutian Islands District, west of 170° W longitude, state-waters fishery. Included within the plan were season, gear and harvest specifications. The fishery GHL was set by regulation at three percent based on the estimate of acceptable 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 BOF amended the Pacific cod Management Plan for the **Aleutian Islands**. Beginning in 2007, a new regulation set the opening date of the fishery at four days after the initial closure of the federal Bering Sea – Aleutian Islands catcher vessel trawl season. Additional regulations introduced new vessel size limits of 125' or less overall length for pot vessels, 100' or less overall length for trawl vessels and 58' or less overall length for longline and jig vessels. In 2009, vessels participating in the B season were restricted to under 60' overall length for all legal gear types. In 2010, this regulation was once again changed to allow pot vessels 125' or less to participate in the B season beginning August 1. Prior to August 1, during the B season, all vessels must still be less than 60'.

As of 2012, the state-waters A season opens January 1 in waters between 175° W long and 178° W long to vessels 60 feet overall length (OAL) or less using trawl, pot, and jig gear, and vessels 58 feet OAL or less using longline gear. Harvests between 175° W long and 178° W long will accrue toward the GHL, while harvest in state waters east of 175° W long and west of 178° W long will initially be managed under parallel fishery regulations with harvest accruing toward federal TAC. If the state-waters A season GHL has not been taken by April 1, when the federal catcher-vessel trawl B season opens, the state-waters A season in waters east of 175° W long and west of 178° W long will close and a parallel fishery will immediately open in those waters.

Within state waters from 175° W long to 178° W long, the state-waters A season will remain open to vessels 60 feet OAL or less using trawl, pot, and jig gear, and vessels 58 feet OAL or less using longline gear. If state-waters A season GHL remains when the federal catcher-vessel trawl B season closes, the state-waters A season will reopen in all waters west of 170° W long until the state-waters A season GHL is reached, or through June 9. During this time trawl vessels may not be greater than 100 feet OAL, pot vessels may not be greater than 125 feet OAL, and vessels using mechanical jig or longline gear not greater than 58 feet OAL.

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 staff for each vessel-trip interview. Size and age data are collected opportunistically. No information is collected in the Southeast Region creel survey program on the Pacific cod sport fishery.

d. Fisheries

Most of the Pacific cod harvested in **Southeast Alaska** are taken by longline gear in the NSEI Subdistrict during the winter months. Pots have been the dominant gear in **Cook Inlet** and longline gear the dominant gear in recent **Prince William Sound** fisheries. Overall, Pacific cod harvest from the Cook Inlet and PWS areas during the parallel season increased in 2012, back to levels similar to 2000, after a general decline over the past decade. In the **Westward Region state-managed Pacific cod fisheries**, pot gear vessels take over 68% of the total harvest, with the remainder split between trawl, jig, and longline gear. Pot and jig gear are the only legal gear types during state-waters fisheries in the Kodiak, Chignik, and South Alaska Peninsula Areas. Pot gear vessels take approximately 75% of the total Pacific cod catch annually. In the Aleutian Islands, trawl gear took 49% of the harvest, pot gear took 48%, and the remainder was split between longline and jig gear. Trawl gear was used primarily during the A season and pot and longline gear in the B season.

Prior to 1993, much of the cod taken in **Southeast** commercial fisheries was utilized as bait in fisheries for other species. In recent years in Southeast Alaska, the Pacific cod harvest has been largely sold for human consumption. In 2012, 29% of the Pacific cod catch was recorded as being used for bait. In other areas of the state, Pacific cod are harvested in both state and federal waters and utilized primarily as food fish. Harvests of Pacific cod in the Southeast state-managed (internal waters) fishery during 2012 totaled 207 mt.

The 2012 GHLs for the state-waters Pacific cod seasons in the Cook Inlet and Prince William Sound Areas of the **Central** Region were 2,135 mt and 657 mt, respectively. Harvest from the

Cook Inlet Area state-waters Pacific cod fishery totaled 1,992 mt and the Prince William Sound Area harvest totaled 634 mt. In 2013, Cook Inlet will receive its maximum allocation of 3.75% of the CGOA ABC, which was increased to that level by the BOF in 2004, and the PWS allocation will receive 25.0% of the EGOA ABC, adopted as a set level (instead of maximum) by BOF in 2011.

In the **Westward** Region, the Kodiak Area state-waters Pacific cod GHL is based on 12.5 percent of the annual CGOA Pacific cod ABC while the Chignik Area GHL is based on 8.75 percent of the annual CGOA ABC. The South Alaska Peninsula Area state-waters Pacific cod GHL is based on 25% of the WGOA Pacific cod ABC. Legal gear is limited to pot and jig gear during state-waters Pacific cod fisheries in these three areas. The 2012 Pacific cod GHLs were 7,118 mt in the Kodiak Area, 4,982 mt in the Chignik Area and 7,008 mt in the South Alaska Peninsula Area. Total state-waters Pacific cod catch in the Kodiak, Chignik and South Alaska Peninsula was 6982 mt, 4,151 mt and 6,966 mt respectively. In the Aleutian Islands District state-waters, Pacific cod GHL is based on 3 percent of the annual BSAI Pacific cod ABC. Legal gear is limited to non-pelagic trawl, pot, longline and jig gear during state-waters the Pacific cod fishery in this area. Total state-waters Pacific cod catch in the Aleutian Islands was 5,598 mt.

There are no bag, possession, or size limits, and no closed season for the recreational Pacific cod fishery. Estimates of the 2012 recreational harvest of Pacific cod are not yet available from the statewide harvest survey, but the 2011 estimates were 12,361 fish in **Southeast** and 35,522 fish in **Southcentral Alaska**. The average estimated annual harvest for the prior five-year period (2006-2010) was 9,761 fish in **Southeast** Alaska and 16,982 fish in **Southcentral** Alaska.

2. Rockfishes

Commercial rockfish fisheries are managed under three assemblages: demersal shelf (DSR), pelagic shelf (PSR), and slope rockfish. DSR include the following species: yelloweye, quillback, china, copper, rosethorn, canary, and tiger. PSR include black, blue, dusky, dark, yellowtail, and widow. Slope rockfish contain all other *Sebastes* species, except *Sebastolobus*, which are defined separately.

a. Research

In the **Southeast Region,** port sampling effort for rockfish expanded in 2008 to include the sampling of DSR caught as bycatch in the IFQ halibut fishery. The sampling of the halibut fishery was started in part to obtain more samples in years that the directed fisheries was not opened. The mandatory logbook program for all groundfish fisheries continued. The logbook program is designed to obtain more detailed information regarding specific harvest location. The port-sampling program collects biological samples. In 2012, the directed fishery for DSR opened in the East Yakutat (EYKT), Central Southeast Outside (CSEO), and Southern Southeast Outside (SSEO) area of the Southeast Outside District (SEO). Length, weight and age structures were collected from 1543 yelloweye rockfish caught in the directed fishery. Northern Southeast Outside (NSEO) Section did not open to directed fishing because the portion of the TAC allocated to that area was not large enough to support an orderly fishery. The directed fishery for DSR opened in internal waters. Landings were minimal in NSEI and SSEI. No biological samples of yelloweye rockfish were collected from the internal waters fishery. An additional 771 yelloweye rockfish biological samples were collected from the commercial halibut fishery in SEO.

Rockfish habitat mapping projects continue in the **Southeast Region,** but have not been conducted since 2010. 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 2,238 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 1,118 km^2 of rocky habitat has been mapped, approximately 37% of our mapping goal. No habitat mapping occurred in 2012. Work is still in progress on an age-structured assessment model for yelloweye rockfish (Contact Kristen Green).

Skipper interviews and port sampling of commercial rockfish deliveries in **Central Region** during 2012 occurred in Homer, Seward, Whittier, Kodiak, and Cordova. Efforts throughout the year were directed at the sampling of rockfish delivered as bycatch to other groundfish and halibut fisheries, primarily slope and demersal shelf species. The directed jig fishery in the Cook Inlet Area that targets pelagic rockfish begins July 1 and historically had been the focus of rockfish sampling during the last half of the year. Limited fishing effort drastically reduced sampling opportunities from 2006 to 2009 until an increase in effort in 2010 and 2011 resulted in additional sampling opportunity. In 2012, harvest of pelagic shelf rockfish decreased to half of the 2010 level, and sampling opportunities were again reduced, with 246 samples collected from the fishery. An additional 46 pelagic shelf, 1,496 demersal shelf, and 554 slope and thornyhead rockfish samples were collected from bycatch fisheries in CI and PWS. Sample data collected included date and location of harvest, species, length, weight, sex, gonad condition, and otoliths. Homer staff determined ages of pelagic and demersal shelf rockfish otoliths, and otoliths from slope and thornyhead rockfish species were sent to the Age Determination Unit. Additional sampling occurred during the CI and PWS trawl surveys. (Contact Elisa Russ).

Seafloor mapping efforts continued in **Central Region**. A skunk stripe multibeam survey was conducted over a 2,800 km^2 area of the North Gulf Coast of the outer Kenai Peninsula in May of 2012. The survey was conducted on the R/V Pandalus with acoustic acquisition and data processing done by TerraSond LTD, a contractor. The area mapped included those waters between the approximate 30 and 150 m contours from the eastern Barren Islands to western Harris Bay. Together with five areas that were previously mapped using multibeam, this comprises approximately 75% of the North Gulf Management District. Transect lines oriented perpendicular to the shoreline and spaced approximately 4 km apart were surveyed along with a series of cross-lines run longitudinally. A total of 1407 km of transect line was surveyed. Though the extent of these data area is broad in relation to the size of the management area, they represent just a sample of high resolution data that can accurately classify substrate type. These data will be will be used to estimate the precision and accuracy of classifying rocky seafloor features using singlebeam sonar alone, with the goal of estimating the total available area of rocky substrate for the entire management area along with an estimate of variability in that delineation. (Contact Mike Byerly or Dr. Ken Goldman).

The **Westward Region** continued port sampling of several commercial rockfish species and Pacific cod in 2012. Rockfish sampling concentrated on black and dark rockfish with opportunistic sampling of other miscellaneous *Sebastes* species. Skippers were interviewed for information on effort, location, and bycatch. Length, weight, gonadal maturity, and otolith samples were collected (Contact Sonya El Mejjati). Staff from the Kodiak office has completed aging black rockfish otoliths through the 2012 season. Pacific cod otolith aging is ongoing.

The **Westward Region** also continued to conduct hydroacoustic surveys of black and dark rockfish in the Northeast Section, of the Kodiak Management Area in 2012 in an effort to generate biomass estimates for both black and dark rockfish; data are currently being analyzed. Surveying of the Northeast District in the Kodiak Management Area will continue in 2013 (Contact Carrie Worton).

The **Division of Sport Fish—Southeast Region** continued to collect catch and harvest data from rockfish as part of a marine harvest onsite survey program with rockfish harvests tabulated back to 1978 in some selected ports. Rockfish objectives included estimation of 1) species composition, 2) weight and length composition, and 3) the geographic distribution of harvest by the fleets by port. Primary species harvested in Southeast Alaska included yelloweye, black, copper, and quillback rockfish. Approximately 8,365 rockfish were sampled from the sport harvests at Ketchikan, Craig, Klawock, Wrangell, Petersburg, Juneau, Sitka, Gustavus, Elfin Cove, and Yakutat in 2012 (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 4,215 rockfish were sampled from the sport harvests at Seward, Valdez, Whittier, Kodiak, and Homer in 2012 (Contact Barbi Failor).

The Division of Sport Fish published a paper regarding prediction of submergence success of yelloweye and quillback rockfish caught and released using sport fishing gear. Random forests classification models were used to identify the relative importance of eleven predictor variables. Capture depth was identified as the most important variable for prediction of yelloweye rockfish submergence success. A barotrauma impairment index and maximal gas retention factor were identified as important predictors for both species. The findings suggest that the impairment index, unlike capture depth, was able to account for individual variability in submergence success of quillback rockfish (Contact Sam Hochhalter).

b. Stock Assessment

The **Southeast Region** conducts a multi-year stock assessment survey for DSR in the Southeast District. Biomass is estimated by management area as the product of yelloweye rockfish density determined from line transect surveys, the area of rocky habitat within the 100 fm contour, and the yelloweye rockfish average weight. Yelloweye rockfish density for the stock assessment is based on the most recent estimate by management area. Yelloweye rockfish densities for each area are multiplied by the current year's average commercial fishery weight of yelloweye rockfish specific to that management area. During the last submersible survey in 2009, density surveys were conducted in EYKT. The SSEO area was last surveyed in 2005, CSEO was last surveyed in 2007 and NSEO was surveyed in 2001. The most recent density estimates by area range from 1,068 to 3,557 yelloweye rockfish per km^2. Allowable biological catch for the SEO is set by multiplying the lower bound of the 90% confidence interval of total biomass for yelloweye rockfish by the natural mortality rate (0.02) and increasing the biomass estimate by 2–4.0% (depending on the current year's weight ratio of other species landed in the DSR assemblage). There is no stock assessment information available for NSEI and SSEI rockfish.

In August 2012, we collaborated with the Central Region staff to conduct an ROV pilot study survey in the Central Southeast Outside Subdistrict (CSEO) with the eventual goal of replacing the *Delta* submersible with an ROV for collecting yelloweye rockfish density data. In 2012, our goals were to 1) test the ROV's capability in the Eastern Gulf of Alaska terrain and weather, 2) evaluate whether we could meet line transect sampling assumption using the ROV, and 3) collect sufficient yelloweye rockfish observations to calculate a density estimate. In 2012, we completed 26 line transects using distance sampling methods and a stereoscopic camera system to estimate horizontal sighting distances to observed fish. We identified and enumerated 161 yelloweye rockfish. Lingcod, halibut, and other Demersal shelf rockfish species were also identified and enumerated. Additionally, accurate length measurements were obtained by the stereo camera system. Yelloweye rockfish, lingcod, and halibut total lengths were measured using the stereo camera imaging software (SeaGIS, Ltd). Yelloweye density analyses and biomass estimates are currently in progress. No surveys for non-DSR species, (e.g., black rockfish) have been conducted since 2002.

Central Region conducts ROV surveys along the north Gulf of Alaska coast from the Kenai Peninsula to Prince William Sound to monitor the local abundance of lingcod and DSR in selected index sites. These sites are on the order of 100's of sq km and tend to be relatively isolated rocky banks boarded by land masses, deep fjords, and/or expanses of deeper soft substrates. An ROV survey was conducted in August 2012 to estimate the abundance and biomass of lingcod and DSR in southwestern Prince William Sound. Previous ROV surveys had used strip transect sampling using a conventional camera system. This survey employed distance sampling methods using a stereoscopic camera system to estimate horizontal sighting distances to observed fish. Additionally, accurate length measurements were obtained by the stereo camera system which will be used for biomass estimates. Seventy-five transects were completed within three stratified habitat types. All of the video data has been reviewed for quality assessment, habitat characterization, and fish measurements. Further analysis is continuing.

The camera system on the Central Region ROV is being upgraded to a high definition Gigabit Ethernet camera system. The research and design of this system has continued throughout the winter and spring of 2012. It is expected that the increase in image quality will translate into better species detection and identification and more precise distance and length measurements. (Contact Mike Byerly or Dr. Ken Goldman).

In the **Westward Region,** hydroacoustic equipment was deployed in a preliminary effort at stock assessment of black and dark rockfish. Surveyed areas included the Westside District of the Kodiak Management Area and the Chignik Management Area (contact Carrie Worton).

c. Management

Management of DSR in the **Southeast Region** is based upon a combination of GHRs, seasons, gear restrictions, and trip limits. Directed commercial harvest of DSR is restricted to hook-and-line gear. Directed fishing quotas are set for the four outside water management areas (NSEO, CSEO, SSEO, and EYKT) based on the stock assessment. Directed fishery quotas for the two internal water management areas (NSEI and SSEI) 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 BOF meeting in early 2006, the season for the directed DSR fishery in SEO was changed to occur only in the winter from January 5th until the day before the start of the commercial halibut IFQ season, or until the annual harvest limit is reached whichever occurs first. At this meeting, the total allowable catch (TAC) for DSR was allocated 84% to the commercial sector and 16% to the sport sector. At the 2009 BOF meeting, it was decided that the anticipated harvest of DSR in the subsistence fisheries would be deducted from the ABC before the split in allocation is made between commercial and sport fisheries. The 2013 ABC for DSR was 303 mt, which resulted in an allocation of 249 mt to commercial fisheries and 47 mt to sport fisheries (after a deduction of 7 mt for the subsistence fishery) (Green et al. 2012). A significant portion of the total commercial harvest is taken as bycatch during the halibut fishery; each year this is estimated and decremented from the commercial TAC. Prior to the 2012 fishery, we had used IPHC survey data to determine bycatch rate by depth and apply this to the commercial catch to estimate DSR bycatch. In 2012, commercial landing data was used to calculate the commercial bycatch rate of DSR in the halibut fishery and this bycatch rate was applied to the current year's quota to estimate bycatch of DSR. This change in methodology was made since five years of full retention DSR landings are available for analysis and this was more accurate than using the IPHC survey bycatch rate to estimate mortality. Full retention of DSR has been in regulation in state waters since 2002 and in federal waters since 2005.

Management of the commercial black rockfish fishery in the **Southeast Region** is based upon a combination of GHLs and gear restrictions. Directed fishery GHLs are set by management area, and range from 11 mt in EYKT and IBS to 57 mt in SSEOC, totaling 147 mt. A series of open and closed areas was also created so managers could better understand the effect a directed fishery has on black rockfish stocks. Halibut and groundfish fishermen are required to retain and report all black rockfish caught. The directed fishery for black rockfish continues to have very little participation and the total reported harvest for Southeast directed and commercial groundfish and salmon troll bycatch fisheries was 14.3 mt in 2012. Shortspine thornyhead, shortraker rockfish, rougheye rockfish and redbanded rockfish may be taken as bycatch only (no directed fishing). A total of 69 mt of slope rockfish were landed in NSEI and SSEI during 2012, an increase from the 60 mt reported in 2011. (Contact Kristen Green).

Rockfish in **Central Region's** Cook Inlet and PWS Areas are managed under their respective regulatory Rockfish Management Plans. Plan elements include a fishery GHL of 68 mt for each area and 5-day trip limits of approximately 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 BOF formalized the 68 mt GHL into a harvest cap for all rockfish species in Cook Inlet and PWS and adopted a 5% rockfish bycatch limit for jig gear during the state-waters Pacific cod season. In 1998, the BOF adopted a directed rockfish season opening July 1 for the Cook Inlet Area and restricted legal gear to jigs, primarily because the fishery typically targets pelagic shelf rockfish species. At the spring 2000 BOF meeting, the OF 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 BOF 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 the sablefish fishery, 5% during the parallel Pacific cod season and 10% during other directed fisheries. Those rockfish bycatch levels have been maintained in PWS, however in 2010; the BOF adjusted rockfish bycatch levels for Cook Inlet to 10% during halibut and directed groundfish, other than rockfish, and 20% nonpelagic rockfish during the directed pelagic shelf rockfish fishery. Proceeds from rockfish landed in excess of allowable bycatch levels are surrendered to the State of Alaska. (Contact Jan Rumble).

The **Westward Region** has conservatively managed black rockfish since 1997, when management control was relinquished to the State of Alaska. Area GHLs 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 2.3 mt 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 2012, 38 mt of black rockfish were harvested from five sections in the Kodiak Area. GHLs were attained in three sections. Harvest in the Chignik and South Alaska Peninsula Management areas remain confidential. In 2012, no vessels made directed black rockfish landings in the Aleutian Islands Area. Fishers are allowed to retain up to 5% of black rockfish by weight incidentally during other fisheries. The incidental harvest in the Aleutian Islands Area is confidential due to limited participation. 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 Mark Stichert).

Statewide, the majority of sport caught rockfish is taken incidental to recreational fisheries for halibut or while trolling for salmon. Size limits have never been set for rockfish harvested in the sport fishery, although there has been a progression of bag and possession limit changes over the last 20 years.

For the 2012 season, the entire **Southeast Alaska** region’s sport bag and possession limit for pelagic rockfish was 5 fish per day, 10 in possession. The non-pelagic rockfish regulations were set as follows:

Southeast Alaska Outside Waters: 1) resident 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; 2) nonresident bag limit was 2 fish, only 1 of which could be a yelloweye, 4 fish in possession, of which no more than 1 could be yelloweye; all non-pelagic rockfish caught must be retained until the bag limit is reached; and an annual limit of 1 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.
Southeast Alaska Inside Waters: 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.

For the entire Southeast Alaska region, charter operators and crewmembers could not retain rockfish while clients are on board the vessel (Contact Bob Chadwick).

As a result of the pervasive lack of quantitative stock assessment information, rockfish regulations in **Southcentral Alaska** have been designed to discourage targeting of rockfish yet allow and mandate retention of incidental harvest. Bag limits are reduced for demersal and slope species because of their lower natural mortality rates. The bag limit in Cook Inlet was five rockfish daily, only one of which could be a non-pelagic species (DSR or slope species). The bag limit in Prince William Sound during the period May 1-September 15 was four rockfish, no more than two of which could be a non-pelagic species. During the period September 16-April 30, the bag limit was eight rockfish, of which no more than two could be non-pelagic species. During both periods, the first two non-pelagic rockfish caught were required to be retained. The bag limit in the North Gulf Coast area was four rockfish daily, including no more than one non-pelagic rockfish. The bag limit in the Kodiak and Alaska Peninsula areas was five rockfish, no more than two of which could be non-pelagic species, and no more than one of the non-pelagic species could be a yelloweye.

d. Fisheries

Directed fisheries for DSR and black rockfish occurred in **Southeast** in 2012. Effort in the directed black rockfish fishery was moderate with six vessels participating. In the black rockfish fishery, 4.2 mt were harvested in 2012. The directed DSR fishery in 2012 in outside waters was opened in EYKT, CSEO, and SSEO for a total harvest of 103.7 mt. There was also a directed DSR fishery in internal waters in 2012 (SSEI and NSEI); the total harvest in SSEI and NSEI combined was 4.6 mt.

The total amount of rockfish (all species) taken as bycatch in all commercial fisheries conducted east of 140^0 W Longitude in 2012 in state and federal water was 540 mt. DSR bycatch made in conjunction with the IFQ halibut fishery in outside as well as internal waters contributed 128 mt toward this total.

In the **Central Region**, total rockfish harvest in 2012 was 73 mt. The 2012 Cook Inlet Area directed rockfish fishery opened July 1 and closed December 31 with a harvest of 5.8 mt of pelagic shelf rockfish. Total rockfish harvest in the Cook Inlet Area including bycatch to longline, pot and jig fisheries was 21.3 mt. Total rockfish harvest for the PWS Area bycatch-only fishery was 51.5 mt from jig, trawl, and longline fisheries. This included an 8.2 mt incidental catch of rockfish from the walleye pollock trawl fishery and a 41.4 mt incidental harvest of demersal and slope rockfish primarily from the sablefish, Pacific cod, and halibut longline fisheries.

Estimates of **sport harvest** are obtained through the Statewide Harvest Survey (SWHS) and through charter vessel logbooks (guided sector only). Harvest reporting areas for these programs are different than commercial reporting areas making direct comparisons difficult. Additionally, species-specific data are available only from creel surveys.

The SWHS reported harvest for the general category of "rockfish" (all species combined), and the charter vessel logbooks mandatory reporting of rockfish harvest in three categories - pelagic, yelloweye, and other nonpelagics. Recreational rockfish harvest is typically estimated in numbers of fish. Estimates of the 2012 harvest are not yet available from the SWHS, but the 2011 estimates were 109,157 fish in Southeast and 102,279 fish in Southcentral Alaska. The average estimated annual harvest for the prior five-year period (2006-2010) was 99,667 rockfish (all species) in Southeast Alaska and 106,378 fish in Southcentral Alaska.

3. Sablefish

a. Research

In 2011, 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 fishery CPUE for NSEI was slightly up in 2012 (0.96 lb/ hook from 0.86 lb/hook in 2011). The cost of these surveys is offset by the sale of the fish landed, but in 2012, three commercial fishermen that participated in the surveys were allowed to sell their Personal Quota Share (PQS) from the total testfish harvested in the survey, thus reducing the total testfish harvest impact on the quota by approximately 33%. The department plans to allow permit holders to harvest their PQS aboard the 2013 survey as well.

In the SSEI stock assessment, analyses revealed a slight decline in the overall longline survey and CPUE index (round lb/hook) from 2011(0.79) to 2012 (0.76). Despite the decline in the overall survey CPUE round lb/hook, CPUE trended upwards in number of fish/hook, indicative of a greater abundance of small fish in 2012 than in 2011. In 2013, we plan to expand our survey station coverage in Dixon Entrance. This is an important area to the commercial fishery (40 to 60% of the annual commercial harvest), yet this area has been underrepresented in the department survey.

In 2012, ADF&G transitioned our mark/recapture study in NSEI from a contract vessel to the ADF&G *R/V Medeia.* In May and June 2012, 7,582 fish were marked and released in NSEI over the course of the pot tagging survey. Over the 21 day survey, 29 longline pot sets were made. Sablefish were targeted by area and depth in proportion to the commercial catch using logbook data from the three previous years. The mark-recapture results serve as the basis of our NSEI stock assessment. Another pot tagging survey is planned for May 2013 (Contact Kristen Green).

Central Region, ADF&G conducted longline surveys for sablefish from 1996 through 2006 in Prince William Sound. Longline survey effort was extended into the North Gulf District in 1999, 2000 and 2002. All longline surveys were discontinued due to lack of funding, and with the goal of transitioning to a pot longline survey, particularly in PWS. Between 1999 and 2005, sablefish were opportunistically tagged in PWS on ADF&G trawl surveys. A sablefish tagging survey was conducted in PWS in 2011 using pot longline gear. There were 1,203 sablefish tagged and 161 recaptured from the commercial fishery in 2011 and 54 from the 2012 fishery. Seventy-nine percent of recaptured fish in 2011 moved less than 10 nm and maximum straight line distance was 439 nm. Six fish (3.7%) were recaptured outside of PWS. Fifty percent of the recaptured fish in 2012 moved less than 10 nm and maximum straight line distance was 1,366 nm. Of the 2012 recaptures, 20 fish (37%) were recaptured outside of PWS. A second PWS sablefish tagging survey is planned for March, 2013.

Long-term goals include obtaining funding to pursue more sablefish tagging; working towards tag-recapture analysis potentially in combination with an age-structured model. (Contact Dr. Ken Goldman).

Skipper interviews and port sampling occurred in Whittier, Valdez, Cordova and Seward for the PWS Area commercial 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. Logbooks are required for both fisheries and provide catch and effort data by date and location. (Contact Elisa Russ).

b. Stock Assessment

In **Southeast**, the department is using mark-recapture methods with external tags and fin clips to estimate abundance and exploitation rates for sablefish in the NSEI Subdistrict. Sablefish are captured with pot gear in May or June, marked with a tag and a fin clip then released. Tags are recovered from the fishery and fish are counted at the processing plants and observed for fin-clips. The 2012 recommended ABC of 1,160,674 round pounds was calculated by applying 2012 fishery mortality at age (based on a harvest rate of 7.5% using the $F_{50\%}$ biological reference point (BRP)) to the 2012 forecast of total biomass at age and summing across all ages. The 2012 ABC is an 11% increase from the 2011 ABC (1,046,873 round pounds), which was also based on the $F_{50\%}$ BRP (the harvest rate was 7.0% for 2011). Since 2009, BRPs have become more conservative, i.e., $F_{45\%}$ in 2009, and $F_{50\%}$ since 2010.

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. In SSEI, only an annual longline survey is conducted to provide biological data as well as relative abundance information. Unlike NSEI, the department does not currently estimate the absolute abundance of SSEI sablefish. There appears to be substantial movement of sablefish in and out of the SSEI area, which violates the assumption of a closed population, consequently, Peterson mark-recapture estimates of abundance or exploitation rates are not possible for this fishery. Instead, the SSEI sablefish population is managed based on relative abundance trends from survey and fishery CPUE data, as well as with survey and fishery biological data that are used to describe the age and size structure of the population and detect recruitment events. (Contact Kristen Green).

c. Management

There are three separate internal water areas in Alaska which have state-managed limited-entry commercial sablefish fisheries. The NSEI and SSEI (**Southeast Region**), and the Prince William Sound Inside District (**Central Region**) each have separate seasons and GHRs. In the Cook Inlet Area, there is an open access sablefish fishery.

In the **Southeast Region,** both the SSEI and NSEI sablefish fisheries have been managed under a license limitation program since 1984. In 1994, the BOF adopted regulations implementing an equal share quota system where the annual GHL 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. There were currently 79 permit holders eligible to fish in 2012 in NSEI and 23 permit holders eligible to fish in SSEI.

The SSEI quota was set at 265 mt for 2012.

During the February 2009 BOF meeting, the BOF made no changes affecting the regulation of commercial sablefish fisheries. The BOF did however establish bag and possession limits for sablefish in the sportfish fishery. At the 2012 BOF meeting, a regulation was passed to require personal use and subsistence use sablefish permits.

Commercial sablefish fisheries in outer coastal state waters (0-3 miles) have been managed in conjunction with the federal-managed fishery in the EEZ. There is no open-access sablefish fishery in the Southeast Outside District as there are limited areas that are deep enough to support sablefish populations inside state waters. In some areas of the Gulf, the state opens the fishery concurrent with the EEZ opening. These fisheries, which occur in Cook Inlet Area's North Gulf District and the Aleutian Island District, are open access in state waters, as the state cannot legally implement IFQ management at this time. The fishery GHLs are based on historic catch averages and closed once these have been reached.

Within the **Central Region,** the Cook Inlet North Gulf District sablefish GHL is set using an historic baseline harvest level adjusted annually by the same relative change to the TAC in the federal Central Gulf of Alaska Area. The 2012 fishery GHL was 31.3 mt. In 2004, the BOF adopted sablefish fishery-specific registration, a logbook requirement, and a 48-hour trip limit of 1.36 mt in Cook Inlet. For PWS, a limited entry program that included gear restrictions and established vessel size classes was adopted in 1996. 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. In 2009, the commissioner's permit requirement was removed by BOF action and regulations adopted which included a registration deadline, logbooks, and catch reporting requirements.

The GHL for the Aleutian Island District is set 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 BOF 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 ADF&G weekly processing reports.

The Southeast Alaska **sport fishery** for sablefish was regulated for the first time in 2009. Sport limits in 2012 were 4 fish per day, 4 in possession, with an annual limit of 8 fish applied to nonresidents only. A small number of sablefish were sampled during creel surveys in Southeast Alaska, suggesting that recreational sablefish harvest at sampled ports was small relative to other species. The sablefish sport fishery in Southcentral Alaska was unregulated in 2012, with no bag, possession, or size limits. Port samplers in Southcentral Alaska encountered 3 sablefish from the sport harvest, again suggesting relatively small harvests.

d. Fisheries

In the **Southeast Region,** the 2012 NSEI sablefish fishery opened August 15 and closed November 15. The 79 permit holders landed a total of 440 mt of sablefish. The fishery is managed by equal quota share; each permit holder was allowed 5.6 mt. In the NSEI fishery, the overall CPUE adjusted for hook spacing expressed in round lb/hook was 0.96 in 2012, up from 0.86 lb/hook in 2011. The 2012 SSEI sablefish fishery opened June 1 and closed November 15. Twenty-two permit holders landed a total of 237 mt of sablefish, each with an equal quota share of 11.5 mt. In SSEI, 20 permits were designated to be fished with longline gear and the remaining three fished with pot gear. One of the longline permits did not fish in 2012. Longline fishery CPUE declined in all areas but northern Clarence Strait (0.33 round lb/hook in 2012 versus 0.38 round lb/hook in 2011). (Contact Kristen Green).

In the **Central Region,** the 2012 open access sablefish fishery in the Cook Inlet North Gulf District opened at noon July 15 and closed at noon August 24. Twelve vessels harvested 30.6 mt. In 2009, new season dates adopted by the BOF for PWS sablefish, April 15 – August 31. The new season opening date, one month later than in previous years, was adopted to reduce the opportunity for orca depredation on hooked sablefish which predominately occurred prior to May 1. The 2012 PWS harvest totaled 92.5 mt (Contact Jan Rumble).

Within the **Westward Region**, only the Aleutian Islands have sufficient habitat to support mature sablefish populations of sufficient magnitude to permit commercial fishing. All other sections within the region are closed by regulation to avoid the potential for localized depletion from the small amounts of habitat within the jurisdiction of the state. Bycatch from the areas closed to directed fishing is limited to 1% for trawl gear only, no bycatch is allowed for all other gear types. The 2012 Aleutian Island fishery opened on May 15. Additional requirements for the fishery include registration and logbook requirements. The GHL was set at 214 mt for the state managed fishery. The harvest from the 2012 Aleutian Islands sablefish fishery was 103 mt. The season remained open until the November 15 closure date (Contact Charles Trebesch or Heather Fitch).

The most recent sablefish recreational harvest estimates from the SWHS are for 2011. The estimated harvest was 6,705 fish in Southeast Alaska and 3,842 fish in Southcentral Alaska. Charter logbooks indicated guided harvests of 5,127 sablefish in Southeast Alaska and 251 sablefish in Southcentral Alaska in 2011. (Contact Bob Chadwick).

4. Flatfish

a. Research

There was no research on flatfish during 2012.

b. Stock Assessment

There are no stock assessments for flatfish.

c. Management

Trawl fisheries for flatfish are allowed in four 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 no effort in the **Southeast** fishery for the past ten years. The Southeast flatfish trawl areas are also the sites of a shrimp beam trawl fishery. In the past, most of the Southeast harvest was 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 2012.

5. Pollock

a. Research

Pollock continue to be a dominant species in the **Central Region** ecosystem. Skipper interviews and biological sampling of PWS commercial pollock deliveries during 2012 occurred in Seward and Kodiak. Sample data collected included date and location of harvest, species, length, weight, sex, and gonad condition. Otoliths were collected from approximately half of sampled fish. Homer staff determined ages of 801 pollock otoliths (Contact Elisa Russ).

Beginning in 1998, spatial patterns of genetic variation were investigated in six populations of walleye pollock from three regions: North America – Gulf of Alaska; North America – Bering Sea; Asia – East Kamchatka. The annual stability of the genetic signal was measured in replicate samples from three of the North American populations. Allozyme and mtDNA markers provided concordant estimates of spatial and temporal genetic variation. These data show significant genetic variation between North American and Asian pollock as well as evidence that spawning aggregations in the Gulf of Alaska, such as Prince William Sound, are genetically distinct and may merit consideration as distinct stocks. These data also provide evidence of inter-annual genetic variation in two of three North American populations. Gene diversity values show this inter-annual variation is of similar magnitude to the spatial variation among North American populations, suggesting the rate and direction of gene flow among some spawning aggregations is highly variable. This study was published in 2002 in the Fishery Bulletin (Olsen et al. 2002). (Contact Bill Templin).

b. Stock Assessment

No stock assessment work was conducted on pollock in 2011 (Contact Dr. Ken Goldman).

c. Management

Prince William Sound pollock pelagic trawl fishery regulations were amended by BOF action and for 2009 included a January 13 registration deadline, logbooks, catch reporting, check-in and check-out provisions, and accommodation of a department observer upon request. Prior to 2009, these requirements were stipulated as terms of a commissioner's permit. The Prince William Sound Inside District is divided into three sections for pollock management: Port Bainbridge, Knight Island, and Hinchinbrook, with the harvest from any section limited to a maximum of 60% of the GHL. Additionally, the fishery is managed under a 5% maximum bycatch allowance that is further divided into five species or species groups. For **Cook Inlet,** directed fishing for pollock is managed under a "Miscellaneous Groundfish" commissioner's permit. However, due to pelagic trawl closures associated with Steller sea lion conservation measures, no directed fishing has occurred in the Cook Inlet Area since 2000. (Contact Jan Rumble).

d. Fisheries

The 2012 **Prince William Sound** fishery opened on January 20 with a GHL of 2,767 mt. The Hinchinbrook section closed by emergency order at 12:00 midnight February 2 while the Knight Island and Bainbridge sections closed by emergency order at 12:00 midnight February 13. Total pollock harvest for all sections combined was 2,624 mt. Total bycatch was 18.6 mt, 0.6 percent of the GHL and was dominated by rockfish at 7.7 mt. (Contact Jan Rumble).

6. Sharks

a. Research

In 2009, **Central Region** Commercial Fisheries Division began tagging all sharks with spaghetti-type external tags. A research project on the reproductive biology of salmon sharks was initiated in the summer of 2010 continues with the goal of providing an accurate and precise estimate of the timing of reproductive activity (annual vs. biennial) and length-at-maturity via the examination of blood hormone concentrations. However, over the past several years, 16 mature female salmon sharks (several of which were pregnant) captured in surveys, commercial and sport fisheries have provided data that allowed a collaborative manuscript (by NOAA/NMFS and ADF&G staff; Conrath et al. in prep.) to be produced, which indicates that salmon sharks have a biennial reproductive cycle and a gestation period of no longer than 10 months. This manuscript resides in agency review at this time, but will be submitted for review in May of 2013 to Fisheries Research for publication. A research project to examine the energetics of salmon sharks was started in the summer of 2012, which includes the concurrent application of temperature transmitters and accelerometers. (Contact Dr. Ken Goldman)

The **Division of Sport Fish—Southcentral Region** collected harvest and fishery information on sharks through the groundfish harvest assessment program although no specific research objectives were identified. Few samples were collected in 2012. Interviews also provided estimates of the numbers of salmon sharks and spiny dogfish kept and released by ADF&G statistical area (Contact Barbi Failor).

b. Stock Assessment

There is no stock assessment work being conducted on sharks in Central Region. (Contact Dr. Ken Goldman).

c. Management

The Alaska BOF prohibited all directed commercial fisheries for sharks in 1998. In 2000, the BOF increased the commercial 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 a vessel. However in 2004, the BOF amended Cook Inlet Area regulations to provide for a directed fishery for spiny dogfish in the Cook Inlet area under terms of a permit issued by the commissioner.

Also in 2000, the BOF prohibited the practice of “finning”, requiring that all sharks retained must be sold or utilized and have fins, head and tail attached at the time of landing. “Utilize” means use of the flesh of the shark for human consumption, for reduction to meal for production of food for animals or fish, for bait or for scientific, display, or educational purposes.

Recreational fishing for sharks is allowed under the statewide Sport Shark Fishery Management Plan adopted by the BOF in 1998. The plan recognizes the lack of stock assessment information, the potential for rapid growth of the fishery, and the potential for over harvest, and sets a statewide daily bag limit of one shark and a season limit of two sharks of any species except spiny dogfish which have a daily bag limit of five. Recreational demand for spiny dogfish remains low and they are widely considered a nuisance species. There is, however, a directed charter boat fishery for salmon sharks in Southcentral Alaska, primarily in Prince William Sound. Pacific sleeper sharks are occasionally caught but rarely retained.

d. Fisheries

No applications for permits to target spiny dogfish in Cook Inlet were received in 2012.

Estimates of recreational shark harvest in 2012 are not yet available from the SWHS, but in 2011 an estimated 56 sharks of all species were harvested in Southeast Alaska and 475 sharks were harvested in Southcentral Alaska. The precision of these estimates is low; the Southeast estimate has a CV of 57% and the Southcentral estimate has a CV of 40%. The statewide charter logbook program also required reporting of the number of salmon sharks kept and released in the charter fishery. Charter anglers are believed to account for the majority of the recreational salmon shark harvest. The 2011 reported charter harvest from logbooks was 0 salmon sharks in Southeast Alaska and 8 salmon sharks in Southcentral Alaska.

7. Lingcod

a. Research

Since 1996, 9,185 lingcod have been tagged and 472 fish recovered in Southeast Region. Opportunistic tagging of 10 lingcod in the vicinity of Sitka occurred during 2012. Length, sex and tagging location are recorded for all tagged fish. Dockside sampling of lingcod caught in the commercial fishery continued in 2012 in Sitka and Yakutat with over 1,813 fish sampled for biological data. Otoliths were sent to the ADU in Juneau for age determination. (Contact Kristen Green).

In the **Central Region**, skipper interviews and port sampling were conducted in Cordova, Seward, and Homer. Data obtained included date and location of harvest, length, weight, sex and age. There were 401 lingcod samples collected and 78% were from the Prince William Sound Area, as there was little effort in the directed fishery in the Cook Inlet Area. Otoliths were sent to the ADU in Juneau for age determination. Gonad condition was generally not determined as nearly all fish were delivered gutted (Contact Elisa Russ).

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 2012 included Juneau, Sitka, Craig/Klawock, Wrangell, Petersburg, Gustavus, Elfin Cove, Yakutat, and Ketchikan. Length and sex data were collected from 1,836 lingcod in 2012, primarily from the ports of Sitka, Ketchikan, Craig, Gustavus, Elfin Cove, and Yakutat (Contact Mike Jaenicke).

The **Division of Sport Fish—Southcentral Region** continued collection of harvest and fishery information on lingcod through the groundfish harvest assessment program. Lingcod objectives include estimation of 1) the age, sex, and length composition of lingcod harvests by ports and 2) the geographic distribution of harvest by each fleet. A total of 1,053 lingcod were sampled from sport harvest at Seward, Valdez, Whittier, Kodiak, and Homer in 2012. These ports accounted for the majority of recreational lingcod harvest in Southcentral Alaska (Contact Barbi Failor).

b. Stock Assessment

The **Southeast Region** is not currently able to reliably estimate lingcod biomass or abundance. Lacking abundance estimates, and given the complex life history and behavior of lingcod, impacts to lingcod populations from fishing are difficult to assess. Analysis of catch per unit effort data (CPUE) from fishery logbooks, in terms of fish per hook-hour for 1988–1998, showed that CPUE had declined between 21 to 62% in areas where a directed fishery and increased recreational catch had developed. Consequently the quota for lingcod was reduced in all areas in 2000. Commercial logbook data for the period 2002–2009 shows CPUE in fish per hook hour trending up since 2000 in CSEO but down from 2008 to 2010. CSEO CPUE was up in 2011. There is not much fishery data available in NSEO or SSEOC. EYKT CPUE has been fairly stable since 2000 with a slight increase in the past few years. IBS has been fairly stable since 2004 with an increase in the past two years. No fishery CPUE analysis was conducted for 2012.

Central Region conducts ROV surveys along the north Gulf of Alaska coast from the Kenai Peninsula to Prince William Sound to monitor the local abundance of lingcod and DSR in selected index sites. These sites are on the order of 100's of sq km and tend to be relatively isolated rocky banks boarded by land masses, deep fjords, and/or expanses of deeper soft substrates. An ROV survey was conducted in August 2012 to estimate the abundance and biomass of lingcod and DSR in southwestern Prince William Sound. Previous ROV surveys had used strip transect sampling using a conventional camera system. This survey employed distance sampling methods using a stereoscopic camera system to estimate horizontal sighting distances to observed fish. Additionally, accurate length measurements were obtained by the stereo camera system which will be used for biomass estimates. Seventy-five transects were completed within three stratified habitat types. All of the video data has been reviewed for quality assessment, habitat characterization, and fish measurements. Further analysis is continuing.

The camera system on the Central Region ROV is being upgraded to a high definition Gigabit Ethernet camera system. The research and design of this system has continued throughout the winter and spring of 2012. It is expected that the increase in image quality will translate into better species detection and identification and more precise distance and length measurements. (Contact Mike Byerly or Dr. Ken Goldman)

c. Management

Management of lingcod in **Southeast Alaska** is based upon a combination of GHRs, season and gear restrictions. Regulations include a winter closure for all users, except longliners, between December 1 and May 15 to protect nest-guarding males. GHLs 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 are requested to keep a portion of their lingcod with the head on, and proof of gender to facilitate biological sampling of the commercial catch. Vessel registration is required 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 (BOF) established a super-exclusive directed fishery registration for lingcod permit holders fishing in the IBS Subdistrict.

Regulations for the **Central Region commercial** lingcod fishery include open season dates of July 1 to December 31 and a minimum size limit of 35 inches (89 cm) overall or 28 inches (71 cm) from the front of the dorsal fin to the tip of the tail. In 1997, the BOF adopted a jig only gear requirement for the directed lingcod fishery in the Cook Inlet Area. Resurrection Bay, near Seward is closed to commercial harvest of lingcod. In 2009, a new BOF regulation permitted retention of lingcod at a 20% bycatch level in PWS waters following closure of the directed season.

In **Southeast Alaska**, the sport fishery for lingcod prior to 2000 had a open season of May 1 to November 30, and a region-wide bag and possession limit of two per day, four in possession, with no size limits. Area-specific exceptions to this included: 1) The Pinnacles area near Sitka has been closed to sport fishing year-round for all groundfish since 1997, and 2) the nonresident sport anglers bag and possession limit for the Sitka Sound LAMP area was one per day, two in possession during 1997-2000.

Beginning in 2000, the open season has been set at May 16 to November 30. Sport harvests of lingcod in Southeast Alaska as of the year 2000 have been incorporated into a region wide lingcod management plan, which reduced GHLs for all fisheries (combined) in seven management areas, and allocated a portion of the GHL for each area to the sport fishery. Since 2000, harvest limits reductions, size limits, and mid-season closures have been implemented by emergency order in various management areas to ensure sport harvests do not exceed allocations.

In 2012, lingcod daily bag limits for all anglers were one fish per day, with two fish in possession for residents and one fish in possession for nonresidents. There were no size limits for resident anglers. Throughout central outside and northern Southeast Alaska, nonresident anglers were allowed to keep only fish between 30 and 35 inches, or fish 55 inches or longer. In southern Southeast Alaska and in the Yakutat area, nonresident anglers were allowed to keep only fish between 30 and 45 inches, or fish 55 inches or longer. Nonresidents were also constrained by a two fish annual limit. The open season was May 16-November 30 throughout Southeast Alaska. Sport fishing guides and crew members were prohibited from retaining lingcod when clients were on board. (Contact Robert Chadwick).

Harvest strategies were established in 1993 for recreational lingcod fisheries in **Southcentral Alaska** in light of the lack of quantitative stock assessment information. Resurrection Bay remained closed to lingcod fishing year-round to rebuild the population, although there is no formal rebuilding plan. The season was closed region-wide from January 1 through June 30 to protect spawning and nest guarding lingcod. Daily bag limits in 2012 were 2 fish in all areas except the North Gulf, where the daily bag limit was one fish. All areas except Kodiak had a minimum size limit of 35 inches to protect spawning females (Contact Matt Miller or Tom Vania).

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 and halibut longline and salmon troll fisheries. At the 2009 BOF meeting, a regulation was adopted that allowed Southeast management staff to adjust the lingcod bycatch levels in the halibut fishery to maximize the harvest of the lingcod longline allocations. The directed fishery landed 112.5 mt of lingcod in 2012. An additional 69.8 mt was landed as bycatch in halibut and other groundfish fisheries and 15.7 mt in the salmon troll fishery).

Central Region commercial lingcod harvests have primarily occurred in the North Gulf District of Cook Inlet and PWS. In 2012, the Cook Inlet GHL was 24 mt and the PWS GHL was 15 mt. Lingcod harvests in 2012 totaled 4.3 mt in Cook Inlet and 17.5 mt in PWS. Approximately 17 % of the lingcod harvest in Cook Inlet resulted from directed jig effort. In PWS, approximately 81 % of lingcod harvest was from directed longline effort. In both areas, the remaining harvest resulted from bycatch to other directed (primarily halibut) longline fisheries. The Outside District of PWS closed at noon August 16 when district GHL was achieved. The Inside District of PWS and the Cook Inlet Area remained open through December 31. (Contact Jan Rumble).

No directed effort occurred for lingcod in the **Westward Region** during 2012. Most lingcod are taken as bycatch to federally managed bottom trawl fisheries. Incidental take by trawl vessels peaked in 2008 when 250 mt of lingcod were harvested in 2008. In response, ADF&G reduced bycatch limits in 2009 from 20% to 5%. In response, incidental take of lingcod had ranged between 30 to 50 mt per year since 2009. Most lingcod are harvested in federal waters northeast of the Port of Kodiak.

Recreational lingcod harvest estimates for 2012 are not yet available from the statewide mail survey, but in 2011 an estimated 9,320 lingcod were harvested in Southeast Alaska and 23,622 lingcod were taken in Southcentral Alaska. The average estimated annual harvest for the prior five-year period (2006-2010) was 12,549 fish in Southeast Alaska and 22,980 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” if they wish to participate in a directed fishery for all species that do not already have regulations in place for such. Permits do not have to be issued if there are management and conservation concerns. 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 the **Central Region**, skates may only be harvested in a directed fishery under the authority of commissioner’s permit. 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. A directed fishery in the Prince William Sound Area for big and longnose skates was prosecuted under this authority in 2009 and 2010, however, the fishery was deemed unsustainable and no permits were issued in 2011 or 2012. Skates may also be retained as bycatch up to 20% during other directed fisheries for groundfish or halibut. Retention of skates has been increasing in recent years and in 2012 the bycatch harvest of combined big and longnose skates was 65.5 mt in the PWS Area and 57.4 mt in the Cook Inlet Area.

In 2009, **Central Region** Commercial Fisheries Division began tagging all big, longnose and Aleutian skates greater than 70 cm total length with spaghetti-type tags. Starting in 2010, all skate species of all sizes were tagged on ADF&G surveys. Between the Kamishak and Southern District, large mesh trawl surveys conducted in 2012, there were 102 longnose skate, 33 big skate, 3 Aleutian skate, and 112 sandpaper skate tagged. Contact Dr. Ken Goldman)

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 in Southeast and Southcentral Alaska. Harvest estimates are provided annually to the IPHC for use in an annual stock assessment, and to the NPFMC. The council’s Scientific and Statistical Committee has periodically reviewed the state’s estimation and projection methods, and the council incorporates the information in the design and analysis of regulations for the sport charter fishery (Contact Scott Meyer).

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. The Sedna database project is currently in MS Access and is awaiting transition to Oracle by regional staff. Queries are complete for calculating CPUE and biomass estimates from all trawl surveys and survey areas. All data are being additionally captured in a GIS for spatial analysis. The long-term goal is to have the database house all Central Region commercial fisheries survey and port sampling data in a GIS relational format.

ADF&G manages state groundfish fisheries under regulations set triennially by the BOF.

ADF&G 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.

1. Dixon Entrance Area

Total removals (including those from test fishing) from the Dixon Entrance area (Alaska statistical areas 325431, 315431, 325401, and 315401). The table below lists the catch by species group from 1988 through 2012 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	<1	9	138	<1	148
2006	43	32	1	12	167	1	181
2007	32	31	<1	19	165	1	184
2008	27	32	1	16	101	<1	118
2009	29	34	1	18	132	2	153
2010	34	35	2	17	107	2	128
2011	31	32	<1	16	112	2	130
2012	30	26	<1	18	116	4	139

2. Marine Reserves

In September of 1997, the ADF&G submitted proposals to both the BOF and the NPFMC requesting that they implement a small no-take marine reserve in **Southeast**. The purpose of these proposals was to permanently close a 3.2 sq. mile area off Cape Edgecumbe to all bottomfish and halibut fishing (including commercial, sport, charter, bycatch and subsistence) and anchoring to prevent over-fishing and to create a groundfish refuge. Two large volcanic pinnacles that have a diversity and density of fishes not seen in surrounding areas dominate the Edgecumbe Pinnacles Marine Reserve. The pinnacles rise abruptly from the seafloor and sit at the mouth of Sitka Sound where ocean currents and tidal rips create massive water flows over this habitat. These two pinnacles provide a very unique habitat of rock boulders, encrusted with *Metridium*, bryozoans and other fragile invertebrate communities, which attracts and shelters an extremely high density of juvenile rockfishes. The area is used seasonally by lingcod for spawning, nest-guarding, and post-nesting feeding. Yelloweye rockfish and pelagic rockfish species as well as large numbers of prowfish and Puget Sound rockfish also densely inhabit the pinnacles. This closure protects the fragile nature of this rare habitat, and prevents the harvest or bycatch of these species during critical portions of their life history. In February 1998, the BOF approved of the reserve and the NPFMC approved of the reserve at their June 1998 meeting. The NPFMC recommended to the BOF that they consider closure of the area to salmon trolling which would make the area a complete-no take zone. In February 2000, the BOF rejected closing the area to salmon trolling. The area is an important “turn-around” area for commercial trollers and the BOF did not believe there was sufficient conservation benefit to warrant closing the area to salmon fishing.

3. User Pay/ Test Fish Programs

The department 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,** several projects are funded through test fish funds (total receipt authority is approximately 600k), notably the sablefish longline assessments and mark-recapture work, the king crab survey, the herring fishery and some salmon assessments.

4. GIS

The ADF&G Division of Commercial Fisheries Headquarters Office is using ArcGIS 9.2 for general map production, project planning and spatial analysis. Basemaps are maintained in ArcGIS format. Statistical area charts have been updated using ArcGIS 9.0 and the NAD83 datum. All data and map requests are made in NAD83 (the State of Alaska standard) or will be converted into NAD83, if possible. Final output and all metadata will be in NAD83. Users in other divisional and area offices use ArcGIS 8, ArcView 3.x, and MapInfo 9.0 for their GIS work.

Hardcopy and digital groundfish and shellfish statistical area charts are available. Digital are available in Abode PDF and can be viewed or downloaded at http://www.cf.adfg.state.ak.us/geninfo/statmaps/charts.php . (Contact Mike Plotnick)

5. Logbooks

In 1997, logbooks became mandatory for all state-managed commercial fisheries in Southeast Alaska. Logbooks for rockfish and lingcod had been mandatory for a number of years.

Number of commercial fishery logbooks collected by fishery, target species, and year.

SE	Longline				Jig/dinglebar			
Year	DSR	Pacific cod	Slope Rock	Sablefish (includes pot gear)	Lingcod	Black rockfish	DSR	PSR
1986	21	1						
1987	25							
1988	20							
1989	19							
1990	50	1	2					
1991	232	8	1					
1992	259	7						
1993	190	8						
1994	197	9	3		108			
1995	140	13			215			
1996	261	8			252	31	6	
1997	204	98	4	466	177	64	8	1
1998	177	135	15	552	153	70	3	4
1999	165	223	9	405	89	21	1	1
2000	153	97	4	421	153	30		
2001	128	48	2	332	44	2	2	
2002	143	27	5	276	53	31	4	0
2003	115	53	closed	298	54	37	2	closed
2004	139	97	closed	283	40	23	3	closed
2005	17	53	closed	249	52	23	2	closed
2006	8	65	closed	241	97	8	0	closed
2007	2	83	closed	200	115	2	0	closed
2008	27	113	closed	190	91	2	0	closed
2009	37	87	closed	164	152	3	0	closed
2010	30	85	closed	170	104	5	0	closed
2011	25	78	closed	137	113	5	0	closed
2012	64	65	closed	132	117	15	0	closed

Since 1998, marine recreational charter operators have been required to log port of landing, effort and harvest, and ADF&G statistical area for every charter trip made. In 2012, catch and harvest were reported for each individual angler, along with their name and fishing license number (if required). Other data collected for each vessel trip included port of landing, statistical area fished, effort for salmon and bottomfish, and harvest and/or release (in numbers) of Chinook, coho, sockeye, other salmon, halibut, pelagic rockfish, yelloweye rockfish, other rockfish, lingcod, sablefish, and salmon sharks. The Sport Fish Division conducted a three-year evaluation of logbook data, including comparisons to an independent end-of-season survey of anglers, to estimates from the statewide harvest survey, and to data from onsite interviews. This evaluation was presented to the North Pacific Fishery Management Council in October and December 2009.

Web Pages

ADF&G Home Page: http://www.adfg.alaska.gov
Commercial Fishing home page:
http://www.adfg.alaska.gov/index.cfm?adfg=fishingCommercial.main
News Releases: http://www.adfg.alaska.gov/index.cfm?adfg=newsreleases.main

Sport Fishing home page: http://www.adfg.alaska.gov/index.cfm?adfg=fishingSport.main
Rockfish Conservation page:
http://www.adfg.alaska.gov/index.cfm?adfg=fishingSportFishingInfo.rockfishconservation

Age Determination Unit Home Page: http://tagotoweb.adfg.state.ak.us/
Region 1 Groundfish Home Page:
http://www.cf.adfg.state.ak.us/region1/finfish/grndfish/grndhom1.php

Region II Groundfish Home Page:
http://www.adfg.alaska.gov/index.cfm?adfg=CommercialByFisheryGroundfish.groundfishareas
ADF&G Groundfish Overview Page:
http://www.adfg.alaska.gov/index.cfm?adfg=CommercialByFisheryGroundfish.main

Commercial Fisheries Entry Commission: http://www.cfec.state.ak.us/
State of Alaska home page: http://www.alaska.gov
Gene Conservation Laboratory Home Page:
http://www.adfg.alaska.gov/index.cfm?adfg=fishinggeneconservationlab.main

Demersal shelf rockfish stock assessment document:
http://www.afsc.noaa.gov/refm/docs/2012/GOAdsr.pdf
Adobe PDF versions of groundfish charts can be viewed or downloaded at
http://www.adfg.alaska.gov/index.cfm?adfg=CommercialByFisheryGroundfish.groundfishmaps

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APPENDIX I.

ALASKA DEPARTMENT OF FISH AND GAME PERMANENT FULL-TIME GROUNDFISH STAFF DURING 2012.

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SOUTHCENTRAL REGION

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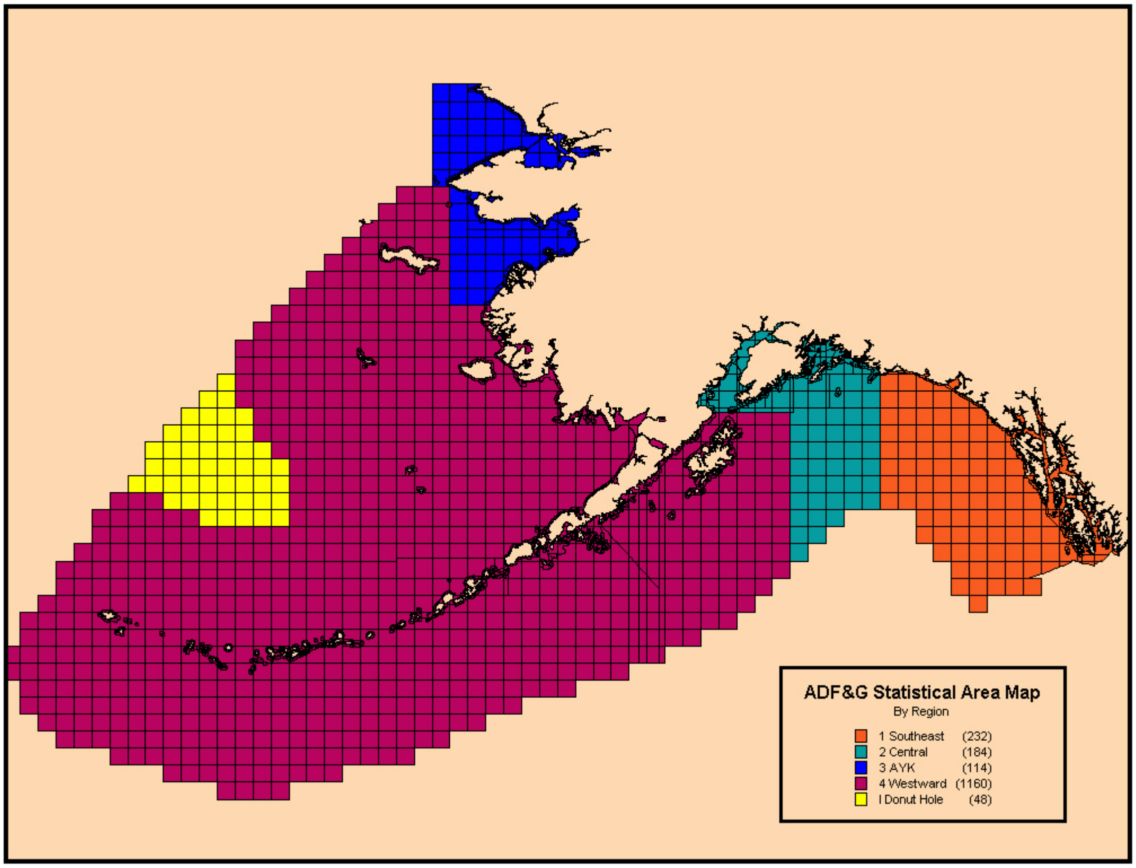
Appendix II.



Map Depicting State of Alaska Commercial Fishery Management Regions.

Appendix III.

Tissue samples of *Sebastes* species and pollock collected for genetic analyses and stored at Alaska Department Fish and Game, Gene Conservation Laboratory, Anchorage. Species, sampling location year collected, sample size, and tissue type are given.

Species	Location	Year	Sample size	Tissues
Yelloweye rockfish *Sebastes ruberrimus*				
	Gravina,Danger,Herring	1991	27	muscle, liver, eye
	Knight Is./Naked Islands area	1998	100	fin
	Whittier	2000	97	fin
		2000	50	fin
	Kachemak Bay	1999	58	fin
	Kodiak Island	1999	115	fin
	Resurrection Bay	1999	100	fin
	Fairweather Grounds	1999	100	fin
	Flamingo Inlet	1998	46	fin, larvae
	Tasu Sound	1998	50	fin
	Topknot	1998	49	fin
	Triangle Island	1998	63	fin, larvae
	Sitka	1998	49	fin
	SE Stat Areas 355601, 365701 (CSEO)	1999	100	fin
Black rockfish *S. melanops*				
	Carpa Island	1998	40	fin
	Castle Rock near Sand Point	1999	60	fin
	Akutan	1999	100	fin
	Dutch Harbor	2000	6	fin
	Chignik	2000	100	fin
	Ugak Bay, Kodiak Island	1997	100	muscle,liver,heart,eye
	Eastside Kodiak Is.: Ugak and Chiniak Bays	1998	100	fin
	Southwest side Kodiak Island	1998	86	fin
	Westside Kodiak Island	1998	114	fin
	Kodiak Island	1996	2	muscle,liver,heart,eye
	North of Fox Island	1998	24	fin
	Resurrection Bay - South tip Hive Island	1997	82	muscle,liver,heart,eye,fin
	Yakutat Bay	2003	130	fin

Species	Location	Year	Sample size	Tissues
	Valdez	2000	13	fin
		2001	50	fin
	Whittier	2000	16	fin
		2001	93	fin
	Oregon - Pacific Northwest	1999	50	muscle, liver, heart
	Washington - Pacific Northwest	1998	20	fin
	Sitka	1998	50	fin
	SE Stat Areas 355631, 365701 (CSEO)	1999	83	fin
	Sitka Sound Tagging study	1999	200	fin
Dusky rockfish *S. ciliatus*				
	Sitka	2000	23	liver, fin
		2000	23	fin
	Sitka Black RF Tagging study	1999	15	muscle,liver,heart,eye
	Harris Bay - Outer Kenai Peninsula	2002	37	muscle
	North Gulf Coast - Outer Kenai Peninsula	2003	45	fin
	Resurrection Bay	1998	3	fin
	Eastside Kodiak Is.: Ugak, Chiniak, Ocean Bays	1998	100	muscle,liver,heart,eye
	Kodiak Island	1997	50	muscle,liver,heart,eye
Walleye pollock *Theragra chalcogramma*				
	Exact location unknown; see comments	1997	402	fin
	Bogoslof Island	1997	120	muscle,liver,heart
		1998	100	muscle
		2000	100	muscle,liver,heart
	Eastern Bering Sea	1998	40	muscle,liver,heart
	Middleton Island	1997	100	fin
		1998	100	muscle,liver,heart
		2000	100	muscle,liver,heart
	NE Montague/E Stockdale	1997	100	fin
	Orca Bay, PWS	1997	100	fin
	Prince William Sound	2000	100	muscle,liver,heart
	Port Bainbridge	1997	100	fin
		1998	100	muscle,liver,heart
	PWS Montague	1999	300	heart
	Eastern PWS	1999	94	heart
	Resurrection Bay	1998	120	fin

Species	Location	Year	Sample size	Tissues
	Kronotsky Bay, E. Coast Kamtchatka	1999	96	muscle,liver,heart,eye,fin
	Avacha Bay	1999	100	
	Shelikof Strait	1997	104	muscle,liver,heart,eye,fin
		1998	100	muscle,liver,heart
		2000	100	muscle,liver,heart

California Contribution to the 53rd Annual Meeting of the Technical Sub-Committee (TSC) of the Canada-U.S. Groundfish Committee April 30 – May 1, 2013

Report from the

California Department of Fish and Wildlife

Will be submitted at a later date.

OREGON'S GROUNDFISH FISHERIES AND INVESTIGATIONS IN 2012

OREGON DEPARTMENT OF FISH AND WILDLIFE

2013 AGENCY REPORT
PREPARED FOR THE 30 APRIL - 1 MAY 2013 MEETING OF THE TECHNICAL SUB-COMMITTEE OF THE CANADA-UNITED STATES GROUNDFISH COMMITTEE

Edited by:

Alison Dauble

Contributions by:

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Oregon Department of Fish and Wildlife
Marine Resources Program
2040 SE Marine Science Drive
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OREGON DEPARTMENT OF FISH AND WILDLIFE
April 2013

A. AGENCY OVERVIEW – MARINE RESOURCES PROGRAM

MRP Program Manager: Dr. Caren Braby
Resource Management and Assessment: Dave Fox
Fishery Management: Gway Kirchner
Technical and Data Services: Maggie Sommer

The Marine Resources Program (MRP) is within the Oregon Department of Fish and Wildlife (ODFW) and has the jurisdiction over marine fish, wildlife, and habitat issues coastwide. MRP is headquartered at Newport in the Hatfield Marine Science Center, with field stations at the cities of Astoria, Charleston, Brookings and Corvallis. MRP is tasked with the responsibility for assessment, management, and sustainability of Oregon's marine habitat, biological resources and fisheries. In addition to direct responsibilities in state waters (from shore to three miles seaward), MRP provides technical support and policy recommendations to state, federal, regional, and international decision-makers who develop management strategies that affect Oregon fish and shellfish stocks, fisheries, and coastal communities. Staffing consists of approximately 60 permanent and more than 60 seasonal or temporary positions. The current annual program budget is approximately $8 million, with about 70% coming from state funds including sport license fees, commercial fish license and landing fees, and a small amount of state general fund. Grants from federal agencies and non-profit organizations account for the remaining 30% of the annual program budget.

B. MULTISPECIES STUDIES

1. Sport Fisheries Project

Sampling of the ocean boat sport fishery by MRP's Ocean Recreational Boat Survey (ORBS) continued in 2012. Starting in November 2005, major ports were sampled year-round and minor ports for peak summer-fall season. We continue to estimate catch during unsampled time periods in minor ports based on the relationship of effort and catch relative to major ports observed during summer-fall periods when all ports are sampled. Samplers were stationed in all ports during the winter of 2011-2012, to attempt to groundtruth estimates for minor ports in unsampled periods. This was the result of a review of the ORBS program and funded through the National Marine Recreational Information Program (MRIP). Black rockfish (*Sebastes melanops*) remains the dominant species caught in the ocean boat fishery. Lingcod (*Ophiodon elongatus)*, several other rockfish species, cabezon (*Scorpaenichthys marmoratus)* and kelp greenling (*Hexagrammos decagrammus)* are also commonly landed. Oregon's fishery for Pacific halibut (*Hippoglossus stenolepis)* continues to be a popular, high profile fishery requiring International Pacific Halibut Commission (IPHC), federal, and state technical and management considerations.

The ORBS program continued collecting information on species composition, length and weight of landed groundfish species at Oregon coastal ports during 2012. Since 2003, as part of a related marine fish ageing research project, lingcod fin rays and otoliths from several species of nearshore groundfish including rockfish species, kelp greenling and cabezon, were gathered. Starting in 2001, from April through October, a portion of sport charter vessels were sampled using ride-along observers for species composition, discard rates and sizes, location, depth and catch per angler (CPUE).

Starting in 2003, the recreational harvest of several groundfish species is monitored inseason for catch limit tracking purposes. Pre-season, the cabezon season was reduced to April 1 through September 30; however, inseason action was still necessary in 2012 to prohibit retention of cabezon by anglers fishing from boats and shore to avoid exceeding allowable catch limits. As in recent years, the retention of canary rockfish (*S. pinniger)* and yelloweye rockfish (*S. ruberrimus)* was prohibited year round. In order to remain within the yelloweye rockfish impact cap (via discard mortality), the recreational groundfish fishery was restricted pre-season to inside of 30 fathoms from April 1 to September 30. Landings in the sport Pacific halibut fisheries were monitored weekly for tracking the status of catch limits. The majority of halibut continue to be landed in the central coast sub-area, with the greatest landings in Newport. Other ODFW management activities in 2012 include participation in the U.S. West Coast Recreational Fish International Network (RecFIN) process, data analysis, public outreach and education, and public hearings to discuss changes to the management of Pacific halibut and groundfish fisheries for 2013.

Starting in 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 comprised the majority of both shore- and estuary-based boat landings by number of fish, but have not dominated catch in recent years. ODFW continues to pursue funding opportunities to reinstate the shore and estuary sampling program.

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2. Commercial Fisheries Monitoring and Sampling

Data from commercial groundfish landings are collected throughout the year and routinely analyzed by ODFW to provide current information on groundfish fisheries and the status of the stocks. This information is used in management, including inseason adjustments of the commercial nearshore fishery, which is conducted in state waters, and participation in the Pacific Fisheries Information Network (PacFIN). Species composition sampling of rockfish and biological sampling of commercially landed finfish continued in 2012 for commercial trawl, fixed gear, and hook and line landings. Biological data including length, age, sex, and maturity status continued to be collected from landings of major commercial groundfish species.

Contact: Carla Sowell (541) 867-0300 ext. 222 (Carla.Sowell@state.or.us)

3. Continuation of Marine Fish Ageing Project at MRP

In May 2012, Lisa Kautzi became the new Marine Age Reading Specialist for the Marine Resources Program's ageing project. Since starting, work has focused on production ageing of commercially and recreationally caught black rockfish collected during the position's vacancy. A total of 2,403 ages were generated with 474 (19.7%) of those samples examined a second time to check for precision. Ages are compiled in separate databases for both commercially and recreationally captured fish.

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4. Developing an improved rockfish species composition expansion model

Work was initiated in 2010 to develop a better model to apply species composition data collected by port samplers to fisheries catch data. The original framework relies on a series of borrowing rules based on temporal and spatial factors in order to estimate unsampled ports and landings. Documentation on the original borrowing rules and rationale are no longer available. While many different fish families are potentially affected by these rules, rockfish, due to their high species diversity and nominal category designation, are most in need of a better expansion model. In 2012, using feedback from both port samplers and local stock assessment authors, staff from the Technical and Data Services section evaluated several different borrowing rule options. These options included: one, borrowing from the same quarter in previous years; two, borrowing from other quarters in the same year; and three, a combination of both scenario one and two. Using simulations with hypothetically missing data, these scenarios were not found to be dramatically different and all were found to provide reasonable estimates of species compositions after borrowing rules had been applied. Given this information, staff felt that scenario one would be the best option for the new expansion model. If the minimum number of samples (5) were not met, scenario three would be the next option to boost sample sizes. If both of these scenarios did not meet the minimum sample size, the data would be submitted to PacFIN as nominal, as per the current process.

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5. Rockfish 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. A report detailing age and length at maturity data for vermilion rockfish was completed in 2012, available at: http://www.dfw.state.or.us/MRP/publications/#Research. Maturity was evaluated visually for 335 female vermillion rockfish and histology slides were developed and reviewed for 237 of these. Samples were collected from 2000 to 2011. Results indicate a broad seasonal peak in ovarian development, with ripe ovaries encountered from April through October.

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6. Movement of Rockfishes Using Acoustic Telemetry

2012 work was focused on attempting to acoustically tag yelloweye rockfish at Stonewall Bank and evaluate home range and movements within a VPS receiver grid, placed along the boundary of a Marine Protected Area. Eleven fish were tagged and all either died or shed their surgically-implanted tags within 5 days of tagging. This conflicts with cage-survival studies that show very high survival rates of untagged fish with capture-related barotrauma from these same depths, but is consistent with some anecdotal reports from other researchers about poor survival of acoustically-tagged yelloweye rockfish. To further investigate the causes of poor survival, fish were surgically tagged and then held in cages for up to 4 days, with 100% survival. Additional investigations are planned for 2013.

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7. Development and Testing of a Video Lander for Studying Demersal Fishes on Nearshore Rocky Reefs

We continued work developing and testing a video lander as a survey tool for rocky reef fishes. Progress in 2012 included publication of the 2010/2011 results, development and testing of a high definition lander system and initial experimentation and development of a stereo high-definition system that can be used to estimate fish lengths from video. Work will continue in 2013 at Stonewall Bank.

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8. Reducing Eulachon Entrainment at the Footrope of a Shrimp Trawl

We continued field studies in 2012 examining how footrope changes can be used to reduce entrainment and subsequent bycatch of eulachon and other small demersal fish in a shrimp trawl. A field study was conducted evaluating a “footrope window”, created by eliminating a short (5 ft.) section of groundline under the central portion of the trawl fishing line. The concept is to allow fish escapement through the “window” via herding behavior towards the center of the groundline, while minimizing shrimp escapement under the fishing line by keeping most of the groundline intact. Initial results were promising, however additional field tests were considered necessary due to high between-haul variation. Work will continue in 2013.

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9. Discard mortality of hook-and-line-caught rockfish with barotrauma

We conducted additional cage-survival experiments in 2012, extending published work on 2-day post-recompression survival of yelloweye and canary rockfish (< 64 meters (m) capture depth) to deeper depths and longer cage-holding intervals. So far, results suggest high 3-4 day post-recompression survival of yelloweye rockfish out to 84 m capture depth and that canary rockfish survival begins to decline outside 64 m capture depth, however canary rockfish sample sizes are small so far. Work will continue into 2013.

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10. Marine Reserves in Oregon

Status of sites: Harvest prohibitions took effect on January 1, 2012 for Oregon's first two established marine reserve sites, Redfish Rocks and Otter Rock. Three new marine reserve sites (Cape Perpetua, Cascade Head and Cape Falcon) have been identified and are to be established, as mandated by Senate Bill 1510, which was passed by the 2012 Oregon Legislature. Additionally, in 2012, administrative rules were adopted for Oregon's system of five marine reserve and protected area sites.

Start of harvest prohibitions:

- January 1, 2012 for Redfish Rocks and Otter Rock sites
- January 1, 2014 for Cape Perpetua and Cascade Head sites
- January 1, 2016 for Cape Falcon site

Monitoring: Monitoring plans, for the ecological and human dimensions (economic, social, cultural) aspects of Oregon's marine reserve system, were completed in 2012. The monitoring plans are available on the Oregon Marine Reserves website at www.oregonocean.info/marinereserves (click on the 'Science' tab). Data collection is conducted by ODFW staff, in collaboration with external scientific research partners. Local fishing vessels are contracted when and where feasible to assist with ecological monitoring efforts. Two years of ecological and human dimensions baseline data collection were completed in 2011 for the Redfish Rocks and Otter Rock sites. Ongoing, long-term monitoring is currently underway at these sites. A first year of baseline data collection was completed in 2012 for the Cape Perpetua and Cascade Head sites. A second year of baseline data collection will be conducted in 2013, prior to the implementation of harvest restrictions. Baseline monitoring reports for Redfish Rocks and Otter Rock are in prep and will be completed in 2013.

Management plans: Site management plans outline strategies for ecological and human dimensions monitoring, reporting, and evaluation; outreach; compliance and enforcement; and community and public engagement. The plans also highlight priorities and implementation efforts of local communities that complement those of the state. The management plan for the Redfish Rocks site was completed in 2012. A draft management plan for the Otter Rock site was completed in 2012 and is to be finalized in 2013. These plans are available on the Oregon Marine Reserves website at www.oregonocean.info/marinereserves (click on the link for the respective site). Development of site management plans for the Cape Perpetua and Cascade Head sites will begin in 2013 and be completed in 2014. Development of a site management plan for Cape Falcon will begin in 2014.

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11. North Coast Rocky Reef ROV Surveys

The Marine Habitat project conducted a survey of seafloor biota at six rocky reefs areas on the northern Oregon coast (Government Point, Cascade Head, Cape Kiwanda, Cape Meares, Manzanita, and Cannon Beach) with a Remotely Operated Vehicle (ROV) during September and October of 2012. Our objective was to conduct the first visual survey of these recently mapped rocky reef areas. The video from this survey is slated to be reviewed during the spring of 2013. Cascade Head is designated as one of three new marine reserve sites in Oregon state waters, and these efforts are part of the baseline data collection at this site, as mentioned in the previous section.

Contact: Dave Fox (541) 867-0300 ext. 228 (David.S.Fox@state.or.us)

12. Ongoing Hypoxia Monitoring

Personnel from ODFW's Marine Habitat project partnered with the Partnership for Interdisciplinary Study of Coastal Oceans (PISCO) at Oregon State University to continue and expand documentation of the ecological effects, including disturbance and recovery, of hypoxia events on seafloor communities off the Oregon coast. In October of 2012, the Marine Habitat Project returned to Cape Perpetua and Yaquina Head to continue monitoring the ecological effects of hypoxia on these rocky reef complexes. A report documenting the Marine Habitat project's efforts to this ongoing monitoring project is currently in prep and scheduled to be completed in 2013.

Contact: Dave Fox (541) 867-0300 ext. 228 (David.S.Fox@state.or.us)

13. Ocean and Estuary Shoreline Habitat Mapping

Marine Resources Program staff are currently working on a project to classify and map Oregon's ocean and estuary shorelines using the ShoreZone mapping protocol. ShoreZone is a coastal habitat mapping and classification system in which aerial imagery is collected specifically for the interpretation and delineation of geomorphic and biological features of the intertidal zone and shoreline environment. The overall goal of ShoreZone mapping is to provide a representation of the coastal and estuarine shoreline morphology and a basic framework for the biophysical characterization of the coast. This mapping protocol has been used extensively in Alaska, British Columbia, and Washington, and is now being extended into Oregon. The project is divided into 2 phases. Phase 1, the aerial surveys, was completed in 2011 and Phase 2, aerial image interpretation and mapping, is 80% complete at the time of this report. Staff has contracted with Coastal Ocean Resources, Inc. (the same firm used for the Alaska, B.C., and Washington projects) to do the work. The aerial photography is viewable at http://www.coastalatlas.net/shorezone/, and the mapping products for the 80% completed so far will be made available in the summer of 2013. We are pursuing funding to complete the final 20% of the shoreline habitat interpretation and, if successful, hope to have that done within a year.

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C. BY SPECIES

1. Black Rockfish PIT Tagging

Black rockfish comprise approximately 50% of the catch in Oregon's recreational groundfish fishery, making this species an important component of managing the fishery. 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 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. Tags are injected in the hypaxial musculature below the gill arches, determined to be the best site by a previous PIT tag retention study by ODFW. Since PIT tags are invisible to anglers, there is no tag non-reporting bias and tag detection rates can be estimated directly. The program has been ongoing since 2002. The minimum size for tagging was increased from 29 centimeters (cm) to 32 cm in 2007.

In 2012, PIT tags (12 millimeters (mm) x 2mm) were inserted in 3,035 black rockfish during 15 days of fishing near Newport, Oregon. Categorical barotrauma symptoms of each fish tagged were recorded. Fish with significant barotrauma symptoms that were unable to submerge when released were recompressed in a cage and released at depth. The total number of black rockfish ≥ 32 cm tagged since the project began in 2002 is now 32,181. Carcasses of black rockfish are counted and electronically scanned for tags year-round upon being landed by recreational fishers. In the study recovery year (July 1 2011 to June 30 2012), 30,347 black rockfish landed in Newport and 11,744 landed in nearby Depoe Bay were scanned for tags, an estimated 76% and 40% of the total black rockfish landed in each port, respectively. In 2011/2012, we recovered 323 tags, all in Newport. Tags were recovered from all eleven tagging cohort years. Estimates of annual exploitation rate derived from this project vary from 3.40% to 4.97% and are less than expected assessment values of approximately 5%. The annual exploitation rate in 2010/2011 was 4.43%. Exploitation rates for 2011/2012 will be available in 2013. Annual population estimates range from 1.2 to 1.9 million fishery-sized fish.

Black rockfish in Oregon and California were assessed in 2007. Results from this study were included in the 2007 assessment as an index of abundance for the assessed population. Based on the input of the assessment author and reviewers, this index will likely be incorporated in future assessments of black rockfish.

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2. Photograph-based Length Estimation of Recreational Yelloweye Rockfish Discards

In 2012, we continued a portion of a 2010 pilot project designed to collect data on the length distribution of yelloweye rockfish discarded in the recreational groundfish and halibut fisheries off Oregon. Due to the prohibition on yelloweye rockfish retention in most U.S. West Coast fisheries, data of this type has become extremely limited in recent years. Anglers were asked to photograph any yelloweye encountered with a known-size reference object in the photograph frame. The relationship between the length of the fish and the size of the reference object in the photograph can then be used to estimate the length of fish using computer software. In 2012, we provided digital cameras to crewmembers of 10 participating charter vessels, and asked that they photograph all yelloweye rockfish encountered over the course of the season. Participation by charter vessels was substantially lower in 2012 than in 2010 or 2011. The reason most commonly given for not participating was the competing demands on crew time created when attempting to photograph fish, release them with a descending device, and serve paying passengers. We suspended work with private vessels in 2011 due to the high effort required and low number of photos obtained until a more efficient method can be developed. In 2010 and 2011, 101 and 181 usable photographs were collected respectively. All fish from 2011 were digitally measured in 2012. Mean length of fish did not differ greatly between 2010 and 2011 at 40.31 and 40.07 cm respectively. The number of usable photographs and fish measurements for 2012 were not available at the time of this report, but will be evaluated in 2013.

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3. Kelp greenling growth and maturity work

In 2012, ODFW renewed efforts to fill in data gaps on the growth and maturity of kelp greenling in Oregon waters. A review of data collected to date indicated that additional samples of small kelp greenling (<25 cm) were needed. Efforts to collect fish through fishing, beach seining and collaborations with an Oregon State University graduate student yielded 12 kelp greenling >25 cm. Six fish were collected in Siletz Bay and six from Yaquina Bay, both on the central Oregon coast. Fish ranged from 8.9 to 14.3 cm with weights from 7.4 to 31.7 grams (g). Nine of the 12 fish (75%) were females. Gonad weights of females ranged from 0.0063 to 0.0238 g. Additional sampling efforts are anticipated to continue in 2013.

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D. PUBLICATIONS

Hannah, R. W. and M. T. O. Blume. 2012. Tests of an experimental unbaited video lander as a marine fish survey tool for high-relief deepwater rocky reefs. Journal of Experimental Marine Biology And Ecology 430-431:1-9.

Hannah, R.W. and S.A. Jones. 2012. Evaluating the behavioral impairment of escaping fish can help measure the effectiveness of bycatch reduction devices. Fisheries Research 131-133:39-44.

Hannah, R.W. and L.A. Kautzi. 2012. Age, growth and female maturity of vermilion rockfish (*Sebastes miniatus*) from Oregon waters. Oregon Dept. Fish Wildl., Information Rept. Ser., Fish. No. 2012-05. 15 p.

Hannah, R. W., P. S. Rankin and M. T. O. Blume. 2012. Use of a novel cage system to measure post-recompression survival of Northeast Pacific rockfish. Marine and Coastal Fisheries: Dynamics, Management and Ecosystem Science 4:46-56.

E. PROJECTS PLANNED FOR YEAR 2013

1. Maturity studies for rockfish and kelp greenling

Maturity data for solid blue rockfish will be evaluated and summarized in an upcoming ODFW report. Data collection efforts for small kelp greenling will also continue in 2013.

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2. Rockfish Movement

Planned work in 2013 will evaluate whether cage confinement following surgical tag implantation, followed by delayed-release at depth, can improve survival of tagged yelloweye and provide movement data.

Contact: Bob Hannah (541) 867-0300 ext. 231 (bob.w.hannah@state.or.us), Polly Rankin (541) 867-0300 ext. 273 (polly.s.rankin@state.or.us)

3. Testing a Video Lander for Surveying Rocky Reefs

Work planned for 2013 includes the field tests of a stereo high-definition lander system to compare abundance and species composition of demersal fishes with and without bait as an attractant, at Stonewall Bank.

Contact: Bob Hannah (541) 867-0300 ext. 231 (bob.w.hannah@state.or.us), Matthew Blume (541) 867-0300 ext. 286 (matthew.blume@state.or.us)

4. Reducing eulachon entrainment at the footrope of a shrimp trawl

We plan to conduct additional trials testing a "footrope window" in a shrimp trawl in 2013.

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5. Discard Mortality of Rockfishes

We anticipate extending 2012 studies on yelloweye and canary rockfish post-recompression survival into even deeper waters, more representative of capture depths for rockfish bycatch in the Pacific halibut fishery. Sample sizes at capture depths of 50-84 m will also be increased.

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6. Incorporating Discard Mortality Rates with use of Descending Devices into Management

In 2013, the Pacific Fisheries Management Council is developing adjusted mortality rates for rockfish released using descending devices from the recreational fishery. Once those rates are determined, a methodology will be developed to incorporate those rates into inseason management of the recreational fisheries. This will be followed by incorporation into projection models used for setting future years' season structure and regulations.

Contact: Lynn Mattes (541) 867-0300 ext. 237 (lynn.mattes@state.or.us), Patrick Mirick (541) 867-0300 ext. 223 (patrick.p.mirick@state.or.us)

7. Black Rockfish Ageing

MRP's new ageing specialist will continue efforts to age commercially and recreationally captured black rockfish otoliths into 2013.

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Washington Contribution to the 2013 Meeting of the Technical Sub-Committee (TSC) of the Canada-US Groundfish Committee

April 30th – May 1st, 2013

Edited by:
Dayv Lowry

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Washington Department of Fish and Wildlife
April 2013

Review of WDFW Groundfish/Forage Fish Research, Assessment, and Management Activities in 2012

A. Puget Sound Area Activities

Staff of the Puget Sound Marine Fish Science (MFS) Unit includes Dayv Lowry, Robert Pacunski, Larry LeClair, Kurt Stick, James Selleck, Adam Lindquist, Jim Beam, Erin Wright, Andrea Hennings, and Lisa Hillier. In addition, Courtney Adkins and Peter Sergeeff work as MFS employees during the spring bottom trawl survey. Unit tasks are primarily supported by supplemental funds from the Washington State Legislature for the recovery of Puget Sound bottomfish populations. The main activities of the unit include the assessment of bottomfish and forage fish 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).

1. Puget Sound Groundfish Monitoring, Research, and Assessment (***Contact: Theresa Tsou*** *360-902-2855, tien-shui.tsou@dfw.wa.gov; Dayv Lowry 360-902-2558, dayv.lowry@dfw.wa.gov)*

a. ESA-listed Rockfish Critical Habitat Designation

Working with NOAA staff at the Northwest Fisheries Science Center, MFS staff provided data to inform the designation of critical habitat for bocaccio, canary rockfish, and yelloweye rockfish, which were listed under the ESA in 2010. Data provided included occurrences of these three species in all historic and contemporary WDFW research and fishery datasets available. To the extent possible, characterization of the habitat associated with these occurrences was also provided. In the case of tethered drop camera (Visual Assessment Technique [VAT]) and remotely operated vehicle (ROV) recordings the nature of the benthic habitat could be explicitly detailed. The posting of critical habitat maps to the federal register for public review is expected within the next two months.

b. Participation in the Federal Rockfish Technical Recovery Team and Rockfish Working Group

In late 2012, Lowry and Pacunski were both appointed to NOAA's Rockfish Technical Recovery Team, which has been charged with developing a detailed recovery plan for the three ESA-listed species in Puget Sound and the Strait of Georgia. To date, this group has met twice. The recovery plan is expected to be complete and ready for public review by the end of 2013.

Several members of the Rockfish Technical Recovery Team are also members of a less formal, regional Rockfish Working Group. This group contains members from state and federal government, academia, the aquarium trade, and fishery organization. They meet quarterly to discuss and coordinate regional research activities and share recent technology, research, and outreach developments. In 2013, this group will be formalized as an advisory technical workgroup under the auspices of the Puget Sound Partnership (PSP). In this incarnation, the workgroup will advise the PSP on issues relating to the monitoring and evaluation of rockfish in Puget Sound with the ultimate goal of "recovering" the Sound by 2020.

c. Update of Washington State's Priority Habitats and Species List

The Priority Habitats and Species List is a catalogue of habitats and species considered by the state of Washington to be of prime significance for conservation and management. At an interval of approximately every four years WDFW updates this list. In 2012, MFS staff participated in the update process and added the following marine species and habitats to the list: cabezon, Pacific halibut, sevengill sharks, sixgill sharks, giant Pacific octopus, Puget Sound king crab, deepwater marine biodiversity hotspots, and marine riparian forests. Representation on the list draws research and management interest and, often, increases options for fund sources as species/habitats become recognized as playing an important role in ecosystem health.

d. 2008 San Juan Archipelago ROV Survey Report: Habitat Stratified

The results of a rocky habitat-focused ROV survey conducted in the San Juan Islands in 2008 were finalized and published as a WDFW Technical Report. The report is available in pdf format at: http://wdfw.wa.gov/publications/01453/. This report is the first in a series of documents detailing recent ROV-based assessments of fish/habitat associations and distribution in the San Juan Islands and the entirety of Puget Sound.

e. 2010 San Juan Archipelago ROV Survey Report: Stereology

Based on the success of the habitat-stratified surveys conducted in 2008, WDFW returned to the San Juan Islands in 2010 to conduct a survey of all habitat types. The survey design was based on stereology, a technique borrowed from histology and forestry, which systematically surveys locations using a fixed grid with a random starting point. The advantage of this technique is that it allows estimates of fish abundance to be generated for the entirety of the survey area, rather than within a single habitat stratum. The survey grid included 168 stations and also allowed for adaptive stations to be occupied when ESA-listed rockfishes, or high densities of other rockfishes, were observed. A report comparing the results from the 2008, habitat-stratified survey and the 2010 stereology-based survey was drafted in late 2012 and is currently under revision. A final report is planned for release by summer 2013.

f. 2012 Puget Sound-wide ROV Survey: Stereology

Building on the results of the 2008 and 2010 surveys in the San Juan Islands, WDFW embarked on a Sound-wide ROV survey based on a stereological design in April of 2012. A fixed grid of points separated by approximately 3 NM was overlaid on Puget Sound, generating 215 survey stations from the Canadian border to the Bonilla-Tatoosh line at the mouth of the Strait of Juan de Fuca, to South Sound. Transect time was increased from 15 or 30 minutes, as in past studies, to 60 minutes per site. The ability to complete a 60-min transect in shipping lanes was greatly enhanced by the addition of a Class II Automatic Information System (AIS) aboard the R/V MOLLUSCAN.

The 2012 Puget Sound Stereological ROV survey began on 15 March 2012 and concluded on 4 April 2013 with a total of 197 stations out of a planned 215 stations sampled. Several stations near Port Angeles and most stations near Point Roberts in the southern Gulf of Georgia were not sampled due to weather and logistical constraints. To control for possible diel fish behaviors, the survey was stratified into three time periods; 0000-0759 (morning), 0800-1559 (day), and 1600-2359 (evening). Our goal was to distribute sampling effort equally among periods, however, safety and logistical considerations combined with shorter tidal sequences in the morning and evening hours resulted in a greater proportion of daytime sampling. The final station breakdown by strata was 47 morning (24%), 110 day (56%), and 38 evening (20%).

Video review has been conducted concurrently with the survey and is ongoing, with approximately 35% of transect videos having been reviewed at least once thus far. Our current timeline for completion (including second reviews) is March/April 2014. Based on the 76 stations reviewed to date, sand and mud have been the dominant substrates encountered, accounting for 81% of the total number of habitat segments (30 seconds of video). In contrast, rock and boulder substrates represent less than 2% of the habitat segments. Excluding unidentified small fish, the dominant taxa encountered thus far have been unidentified eelpouts, unidentified flatfish, unidentified gadids, spotted ratfish, blackfish sculpin, and English sole. Few species typically associated with rock or high-relief substrates have been observed. Quillback rockfish are the most common rockfish species seen to date (n = 98), with this number split almost evenly between rock/cobble and sand/mud bottoms. The only other rockfishes seen thus far include seventeen Puget Sound rockfish, four copper rockfish, one greenstriped rockfish and one unidentified red rockfish. Hexagrammids observed include ninety-four kelp greenling, eleven lingcod, two whitespotted greenling and two unidentified hexagrammids.

g. Continued investigation of the 2006 Recruitment Event of Young-of-the-Year Rockfishes in Puget Sound

As noted in the 2010 report to the TSC, in 2006 an exceptional recruitment of juvenile rockfish was observed by MFS biologists throughout nearly all of Puget Sound. Based on the genetic analyses of post-settlement juveniles sampled in 2006, and length, density, and species composition data acquired from regularly surveyed index sites subsequent to 2006, the recruitment event appears to have been dominated by quillback-, copper-, and black rockfish. Marine Fish Science staff hypothesized that the unusually large numbers of sub-adult black rockfish observed in Puget Sound was the result of an influx of juveniles from coastal waters. As a partial test of the hypothesis, in 2012, MFS biologists sampled black rockfish from the outer coast, southern Puget Sound, Hood Canal, and the San Juan Islands to look for evidence of genetic differences between inland and coastal populations. The samples have been genotyped and a preliminary analysis of the data indicates that there are no detectable genetic differences between the two regions. Otolith ageing shows that nearly all of the black rockfish inland samples are from the 2006 cohort. Survey data from an ongoing long-term monitoring project at an artificial reef in central Puget Sound indicate that a significant shift in species composition is occurring at that location and may be the result of the 2006 recruitment event. Prior to 2006, rockfish fauna on the reef consisted almost entirely of brown rockfish, which were not believed to have been involved in the recruitment event. The reef is now dominated by copper rockfish and a prominent 2006 year-class spike (based on length) can be seen in the data. Due to shifting priorities and lack of available resources, juvenile rockfish index sites were not surveyed in 2012.

h. Bottom Trawl Surveys of Puget Sound

Since 1987, WDFW has conducted bottom trawl surveys in Puget Sound that have proven invaluable as a fisheries-independent indicator of population abundance for fishes living on unconsolidated habitats. These surveys have been conducted at irregular intervals and at different scales sin ce 1987. Early surveys between 1987 and 1991 were synoptic surveys of the entire Puget Sound, later were stratified, random surveys focusing on individual sub-basins, and in 2008 became synoptic again with stations at fixed index sites.

From April 30th through June 1st, 2012, WDFW conducted a bottom trawl survey to assess the abundance of groundfishes in the Puget Sound. This survey was the fifth "Index" survey of Puget Sound, a departure from the stratified-random designs used prior to 2008. This new design is better for assessing changes in the relative abundance of key groundfish species because reoccupying fixed stations will minimize variation in habitat and provide more powerful inter-annual comparisons. The complete "Index" survey design includes 51 stations partitioned among Puget Sound's eight oceanographic basins which include the Eastern and Western Strait of Juan de Fuca, San Juan Archipelago, Strait of Georgia, Whidbey Basin, Central Basin, South Puget Sound, and Hood Canal. Each basin was divided into two geographic subareas (north/south or east/west) except for Central Basin, which includes a third subarea (middle) to better represent this latitudinally elongate basin. We selected previously trawled stations within each subarea from pre-existing depth zones such that one station would be situated between depths of 30 to 120 feet, 120 to 240 feet, 240 to 360 feet, and greater than 360 feet. Depths less than 30 feet are excluded from the survey because they are too shallow for the trawl vessel to operate. Two replicate trawl samples were collected at each stations and were spaced several hundred meters apart to be close to each other but not directly overlapping. The specific objectives of the survey were to estimate the relative abundance, species composition, and biological characteristics of groundfish species at pre-selected, permanent index stations. Key species of interest include Pacific cod, walleye pollock, Pacific whiting, English sole, spiny dogfish, and skates, but all species of fishes and invertebrates will be identified and recorded.

The trawling procedure of the survey was similar to previous WDFW trawl surveys (Palsson et al. 2002, 2003). The 58-foot F/V CHASINA was the chartered sampling vessel, and it was equipped with an agency-owned 400-mesh Eastern bottom trawl fitted with a 1.25 inch codend liner. The net was towed at each station for a distance of 0.40 nautical miles at a speed of 1-3 knots, and the tows lasted approximately 12 minutes. Net openings ranged from 8 to 14 m depending upon depth and the amount of cable towing the net. The resulting catch was identified to the lowest taxonomic level, weighed and enumerated, and most of the catch was returned to the sea. The density of fish at each station was determined by dividing the catch numbers or weight by the area sampled by the net. Some of the catch was taken for biological samples that were sampled on deck or preserved for laboratory analysis.

During the 22 survey days, we occupied 42 stations and conducted 84 bottom trawls (Figure 1). Due to concerns for endangered Chinook salmon in 2012, NOAA restricted the survey from operating in the shallowest depth zone (30-120 feet), eliminating nine stations (18 trawls) from the 2012 survey frame. An estimated 60,000 individual fish among 80 species/taxa weighing 11 mt were collected. By weight, spotted ratfish constituted 62% of the catch, followed by English sole at 12.5%. The next most abundant species were big skate, walleye pollock, Pacific whiting, Pacific sanddab, Pacific cod, spiny dogfish, blackbelly eelpout, starry flounder and longnose skate, which in aggregate accounted for 15% of the catch by weight (1% to 3% per species). Similar to 2011, Pacific cod remained as one of the most abundant species in the survey. Compared to the previous year, Pacific cod in 2012 were slightly larger, measuring between 25 and 70 cm and averaging 54 cm in total length, corresponding to a fish in its third to fourth year of life. Most of the cod were distributed in the western Strait of Juan de Fuca, the southern Strait of Georgia and the central basin of Puget Sound, with only a few cod captured in other basins. For the first time in the 26 year history of the trawl survey, a bocaccio rockfish was recorded in the catch. The specimen was captured at a station in the western Strait of Juan de Fuca several miles west of the DPS boundary established for endangered bocaccio in Puget Sound. The fish measured 20 cm in total length and a genetic sample (fish clip) was collected. After a short period of reacclimation in a live tank, the fish was returned alive to the ocean.

i. Marine Reserve Monitoring: Evaluation of No-Take Refuges for Rocky Habitat Fishes

Very little reserve monitoring has occurred since 2011 due to changes in program priorities and staffing limitations associated with the 2012 ROV survey of Puget Sound. The only activity to report in 2012 was the continuation of lingcod nest surveys at four sites in the San Juan Islands. Three of the four sites were sampled twice and one site was sampled once during February and March 2012. Overall, nest densities were much lower than previous years, but densities at reserve sites were much higher than at fished sites. With the exception of 2011, this survey has been conducted annually since 2000, and for the first time ever one of the fished site had no nests recorded on both dives.

j. Groundfish Surveys at U.S. Navy Facilities

In the interest of documenting the occurrence of various marine species in the waters within and immediately adjacent to U.S. Navy facilities on the Kitsap Peninsula, the Navy contracted with WDFW to conduct both ROV-based and hook-and-line sampling of these waters. The presence of specific species in Navy-controlled waters is of relevance to management of these species under the auspices of the Puget Sound Groundfish Management Plan, Endangered Species Act, and several other policy and management documents. It also has implications for future construction at Naval facilities, especially as it applies to Environmental Impact Statements.

Though details cannot be shared until final documents are approved for release by the Navy, three regions of the Naval Base Kitsap (NBK) Bremerton facility were surveyed with the ROV and a fourth is currently being surveyed using hook-and-line. In addition, three areas near the NBK Keyport facility were surveyed with the ROV. Funding is currently being negotiated to expand surveys to a second, complementary, season of sampling at NBK Bremerton and a series of surveys at NBK Bangor. The NBK Bangor survey could include other sampling methods, such as trawl, scuba, or beach seining.

k. ROV-based Surveys of the Nisqually Delta with the USGS

In August 2012, WDFW entered into a contract with the USGS to conduct an ROV survey of selected geologic features in south Puget Sound and the Nisqually delta. This survey follows a similar ROV survey conducted in central Puget Sound for the USGS in 2011. The purpose of these surveys was to collect video information to be used in classifying the seabed geology in support of ongoing USGS efforts to develop a seafloor habitat map of the Puget Sound basin. In 2012, we surveyed twenty-eight pre-selected and *ad hoc* sites over three days. ,Deployment sites ranged from 8 m to 170 m in depth but most sites were between 30 m and 70 m. Transects lasted from 15 to 61 minutes but most were 20 to 30 minutes in duration.

Most sites were characterized by soft bottom substrates, with a macro-invertebrate community dominated by sea pens, burrowing anemones, shrimp, seastars, and hydroids. Species composition varied based on habitat and provided clues about the underlying substrate that was often covered with silty sediments and sand. Small benthic fishes such as eelpout and flatfish were the most abundant species observed. Other fish observed included gadids, gobies, and quillback rockfish. The few rockfish we observed appeared to be smaller than 30 cm. All of the video imagery and tracking data from the ROV were supplied to the USGS with copies of the data held by WDFW for later analysis to examine fish-habitat relationships.

l. Participation in Conferences and Workshops

In 2012, staff of the Puget Sound MFS Unit presented at, and/or arranged symposia at, several regional scientific meetings, as indicated below.

- Western Groundfish Conference, February 7-10. Presenters: Robert Pacunski, James Selleck, Andrea Hennings, Erin Wright, Henry Cheng (no longer with WDFW)
- NOAA/WDFW Cooperative Research Symposium at Pt. Adams, February 23. Presenters: Dayv Lowry, Kurt Stick. Organizers: Dayv Lowry
- A Friday Harbor Labs Symposium: Biology and Management of Forage Fish in the Salish Sea,
September 12-14. Presenters: Dayv Lowry, Jim West, Kurt Stick, Adam Lindquist, James Selleck.
Organizer: Dayv Lowry
- South Sound Science Symposium, October 30. Organizer: Dayv Lowry
- Northwest Straits Commission Annual Meeting for Marine Resource Committees, Nov 2-3. Presenter: Dayv Lowry.

m. Other Activities

Dayv Lowry was appointed to the Northwest Association of Networked Ocean Observing Systems (NANOOS) Governing Board in 2012 and participated in three meetings in this role. The funding for NANOOS, and ocean observing systems in general, will likely increase in 2013 and the complexity, and utility, of this system for habitat monitoring is expected to increase as a result.

Bob Pacunski serves on the Nisqually Reach Aquatic Reserve Implementation Committee and participated in two meetings in 2012.

2. **Forage Fish Stock Assessment and Research** (*Contact: Dayv Lowry 360-95-2558, dayv.lowry@dfw.wa.gov; Kurt Stick (360) 466-4345 ext. 243, kurt.stick@dfw.wa.gov*)

1. Annual Herring Assessment in Puget Sound

Annual herring spawning biomass was estimated in Washington in 2012 using spawn deposition surveys. WDFW staff based in the Mill Creek, La Conner, and Point Whitney offices conduct these assessment surveys of all known herring stocks in Washington's inside waters annually. Stock assessment activities for the 2013 spawning season are in progress.

The herring spawning biomass estimate for all Puget Sound stocks combined in 2012 is 8,517 tons (see table below). The cumulative total is a decrease from the 2011 total of 14,705 tons and considerably lower than the mean cumulative total for the previous ten-year (2002-2011) period of 13,376 tons.

The combined spawning biomass of south/central Puget Sound (including Hood Canal) herring stocks in 2012 of 5,846 tons is a decrease from 2011, when the cumulative spawning biomass for this region was 11,189 tons. Spawning biomass for this region in 2012 was again dominated by the Quilcene Bay and Holmes Harbor stocks. Spawning abundance for these two stocks has been relatively very high in recent years, while many other stocks in the region are at low levels of abundance.

Cumulative biomass of north Puget Sound stocks, excluding the Cherry Point stock, in 2012 overall remained at a low level of abundance. The spawning biomass of the Cherry Point stock in 2012 was a decrease from 2011 and this stock, which is thought to be genetically distinct from other herring stocks in Puget Sound and British Columbia, continues to be at a critically low level of abundance. Estimated herring spawning activity for the Strait of Juan de Fuca region was similar to 2011, with an estimated spawning biomass of 148 tons.

PUGET SOUND HERRING SPAWNING BIOMASS ESTIMATES (SHORT TONS) BY STOCK AND REGION, 2003-2012

	YEAR									
	2012	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**
Squaxin Pass	589	565	750	817	1025	557	755	436	828	2201
Purdy	135	711	500	125	496					
Wollochet Bay	31	21	50	359	45	35	27	67	52	152
Quartermaster Harbor	108	96	143	843	491	441	987	756	727	930
Elliot Bay	290									
Port Orchard-Port Madison	217	123	350	1755	1186	1589	2112	1958	700	1085
South Hood Canal	264	156	150	156	223	70	244	210	176	207
Quilcene Bay	2626	4443	2012	3064	2531	2372	2530	1125	2342	916
Port Gamble	404	1464	433	1064	208	826	774	1372	1257	1064
Kilisut Harbor	0	0	0	0	0	24	54	170	184	448
Port Susan	61	138	152	251	345	643	321	157	429	450
Holmes Harbor	678	3003	673	1045	686	572	1297	498	673	678
Skagit Bay	443	469	500	1027	1342	1236	2826	1169	1245	2983
South-Central Puget Sound Total	5846	11189	5713	10506	8578	8365	11927	7918	8613	11114
Fidalgo Bay	89	119	103	15	156	159	323	231	339	569
Samish/Portage Bay	430	387	640	320	409	348	412	218	351	299
Int. San Juan Is.	5	0	17	0	60	33	285	41	67	72
N.W. San Juan Is.	0	0	0	0	0	0	0	0	0	13
Semiahmoo Bay	879	1605	1000	990	662	1124	1277	870	629	1087
Cherry Point	1120	1301	774	1341	1352	2169	2216	2010	1734	1611
North Puget Sound Total	2523	3412	2534	2666	2639	3833	4513	3370	3120	3651
Discovery Bay	105	0	26	205	248	42	1325	33	252	207
Dungeness/Sequim Bay	43	104	75	46	69	34	0	0	22	44
Strait of Juan de Fuca Total	148	104	101	251	317	76	1325	33	274	251
Puget Sound Total	8517	14705	8348	13423	11534	12274	17765	11321	12007	15016

2. Unique Herring Spawning and Pending Genetic Research

In late April, a WDFW field technician (Roy Clark) on loan from another unit observed what appeared to be a herring spawning event in Elliot Bay, just offshore from Seattle. The location of this spawning event was unprecedented and the timing matched only one other known spawning population -- the high-profile Cherry Point Stock, which has been previously petitioned for ESA listing. Further investigation validated the presence of spawning and produced a spawning biomass estimate of 290 tons. Eggs collected during spawning surveys are being combined with genetic samples of three other herring stocks in Puget Sound to determine whether the Elliot Bay fish are more closely related to the nearest spawning stock (Port Orchard/Port Madison), a geographically proximate member of the genetically identified 'Other stocks' complex (Henderson Bay/Purdy Stock), or the Cherry Point Stock. Results are expected by August of 2013.

3. Recreational Surf Smelt Harvest Estimation

Fisheries for surf smelt in Washington State are currently managed under the assumption that recreational harvest is roughly comparable to commercial harvest on a Puget Sound-wide basis. This assumption may underestimate total fishing pressure and harvest, leading to localized or Sound-wide depletion and negative ecosystem impacts. Assessing recreational effort and harvest is complicated by the lack of a licensing requirement for fishers, the fact that fishing occurs throughout the year but tends to peak during locally specific time windows, and the ability of anglers to engage in the fishery from private shorelines in addition to public access points (e.g., boat ramps). In order to adequately estimate total recreational harvest, a survey method must be developed that accounts for spatiotemporally diverse harvest patterns over the entirety of Puget Sound. In collaboration with the SeaDoc Society, WDFW utilized a hybrid access point/boat survey design to intercept recreational fishers dip-netting for smelt along the northern shores of Camano Island during the traditional fishing 'season.' In addition to providing an estimate of harvest during this period in this location (4419 lbs), patterns of both fishing effort and catch were described through time, in association with tidal and other environmental variables, and compared between public access points and private beaches. Based on the site-specific estimate generated in the study, the capacity for Sound-wide recreational harvest to exceed the assumed 100,000 lbs exists and additional monitoring is warranted. By further optimizing sample size in both time and space, a logistically feasible design can be developed that will allow estimation of recreational smelt harvest for the entirety of Puget Sound. Efforts are ongoing to identify funding and personnel to expand sampling in 2013 and beyond.

3. **Puget Sound Ecosystem Monitoring Program (PSEMP)** *(Contact: Jim West 360-902-2842, James.West@dfw.wa.gov)*

The Washington Department of Fish and Wildlife is a key partner of the Puget Sound Ecosystem Monitoring Program Project (PSEMP), a multi-agency effort to assess the health of Puget Sound. WDFW's "Toxics in Biota" group is staffed by Jim West, Jennifer Lanksbury, Laurie Niewolny, Stefanie Orlaineta, Andrea Carey, and Sandie O'Neill. This group conducts regular status and trends monitoring of toxic contaminants in a wide range of indicator species in Puget Sound, along with evaluations of biota health related to exposure to contaminants. This group has recently conducted additional focus studies on toxic contaminants in Dungeness crab (*Cancer magister*), spot prawn (*Pandalus platyceros*), blue mussels (*Mytilus* spp), as well as a field experiment testing the effects of chemicals leaching from creosote-treated wooden pilings on the health of developing Pacific herring (*Clupea pallasi*) embryos.

B. Coastal Area Activities

Staff of the Coastal Marine Fish Science (MFS - Coast) Unit includes Lorna Wargo, Brad Speidel, John Pahutski, Bob Le Goff, Brian Walker, Donna Downs, and Vicky Okimura. Seasonal and project staff include Michael Sinclair, Mariko Langness, Erin Dilworth, Colin Jones, Phillip Weyland and Kristen Hinton. Unit tasks are supported through a combination of state general and federal funds. Long-standing activities of the unit include the assessment of groundfish populations off Washington coast, the monitoring of groundfish commercial landings, and the rockfish tagging project. More recently, unit activity has expanded to include forage fish management and research. The unit is completing a ESA Section 6 funded project to evaluate eulachon smelt bycatch in the Washington pink shrimp trawl fishery and beginning in 2012 undertook a survey of outer coast beaches in an effort to document seasonal and spatial pattern of spawning in surf smelt, night smelt, and sand lance to inform marine spatial planning.

Activities Related to Pacific Fishery Management and North Pacific Fishery Management Councils

The Department contributes technical support for coastal groundfish and forage fish management via participation on the Groundfish Management Team (GMT), the Coastal Pelagics Management Team (CPSMT), 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 and the CPSMT in the Stock Assessment and Fishery Evaluation (SAFE) document.

1. **Coastal Groundfish Management, Monitoring, Research, and Assessment** (*Contact: Theresa Tsou 360-902-2855, tien-shui.tsou@dfw.wa.gov; Lorna Wargo (360) 249-1221 Lorna.Wargo@dfw.wa.gov; Corey Niles, 360-249-1223, Corey.Niles@dfw.wa.gov), Intergovernmental Resource Management)*

1. Coastal Rockfish Tagging Project

In Washington, the first black rockfish tagging project began in 1981. The early tagging work concentrated on gathering biological information, such as movement and growth. Over the intervening years, the project has undergone changes as study objectives were re-defined and improvements in tagging protocols were made. The overall objective of this program has been to produce estimates of black rockfish abundance, growth, survival, and mortality for incorporation into population assessment models. Beginning in 2010, this long-term project was expanded to address some crucial limitations identified by the PFMC stock assessment review panel for black rockfish in 2007 and in a scientific review of the study design conducted in 2008 by Department staff. The limitations included: 1) limited geographic coverage – sample stations were located mid-coast only, 2) tag recovery dependent on fisheries – only recreational charter catches landed at Westport, and 3) narrow focus – only black rockfish. In response, WDFW scientists designed an expanded project to evaluate and correct these limitations. The following objectives were identified:

1. Correct possible bias in current black rockfish tagging project.
2. Extend geographic coverage to include all areas accounted for in the current stock assessment boundaries.
3. Develop simple cost effective long-term fisheries-independent monitoring strategies for black rockfish and other nearshore species.
4. Develop two or more reliable longitudinal rockfish abundance indices.
5. Estimate the growth curve of black rockfish and other tagged fish species from multi-recapture data.
6. Better understand the spatial distribution of nearshore rockfish along the Washington coast.

The expanded project design incorporated numerous changes including broader coverage through capture (and recapture) of *all* rockfish species, not just black rockfish, at fixed locations distributed along the entire Washington coast (Figure 1). Historically, tagging has only been conducted in the spring (March-April); the expanded project added a fall tagging period (September-October). For each sampling period, the target was to capture a minimum of 400 rockfish or to fish a maximum of two days per index station, whichever came first. At each index station, PIT (Passive Integration Transponder) tags were inserted in all rockfish species. In total, the project was expected to tag and capture more than 8000 fish each year. When complete, the expanded survey will comprise three fall and three spring surveys. The first expanded survey was conducted fall, 2010 with the final scheduled for spring 2013 (Table 1).

Tagging trips depart from Westport, La Push and Neah Bay and are conducted onboard recreational charter vessels staffed by captains and deckhands with bottomfish fishing expertise specific to each area. For a typical tagging trip, 10 to 12 volunteer anglers are recruited and tasked with catching rockfish. Tagged fish are recovered as carcasses delivered to Westport from recreational bottomfish charter trips and through recapture during tagging trips.

Figure 1. Tagging Site Locations

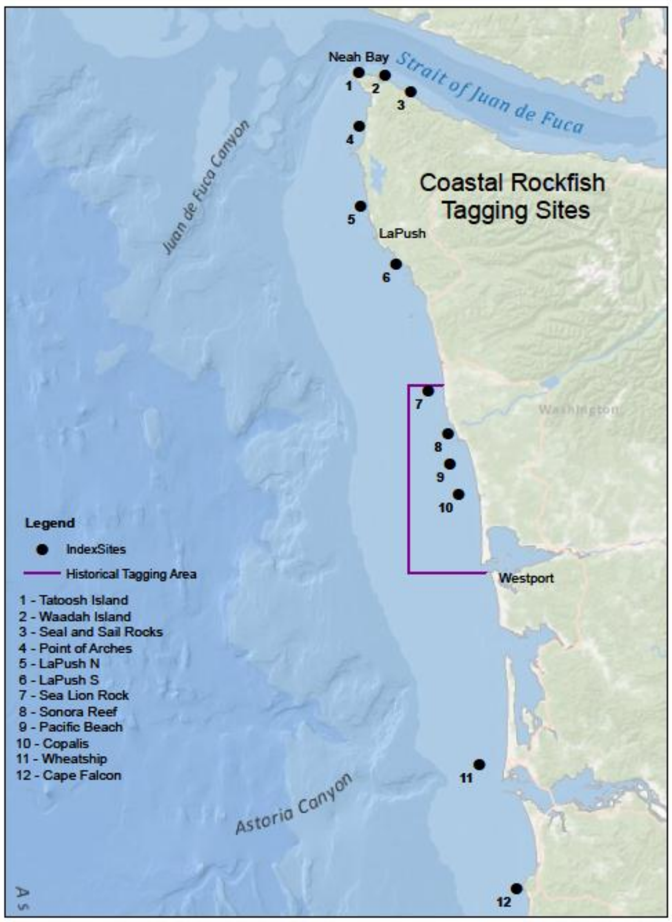

Table 1. Tagging Statistics

	2011		2012		
Season	Spring	Fall	Spring	Fall	**Totals**
Number of Trips	39	20	29	20	**108**
Total Fish Caught	6891	3227	8607	4052	**22777**
Total Fish Tagged	6320	3162	8297	4011	**21790**
Total Fish Released	6349	3196	8341	4039	**21925**
At Sea Tag Recoveries	29	34	44	28	**135**
Dockside Sampling					
	2011		2012		**Totals**
Fish Sampled Dockside	37741		40013		**77754**
Dockside Tag Recoveries	224		328		**552**

2. Rockfish Longline Survey

The Washington Department of Fish and Wildlife (WDFW) has been conducting longline surveys off the northern Washington coast to better understand seasonal changes in catch rates for rockfish that inhabit rocky habitat. Results from these research surveys will be used to improve future survey strategies to monitor and assess rockfish populations, evaluate the risk of localized depletion and survey effects, and to monitor the growth and movement of several important rockfish species.

Using IPHC survey design and data, WDFW has been refining survey strategies more specifically for rockfish that dwell in rocky habitat since 2006. The current survey design with 12 additional stations surrounding IPHC station 1082 (48^0 10' N and 125^0 23' W) in waters 50-100 fathoms in depth (Figure 1) was established in 2008. The R/V Pacific Surveyor has been chartered to complete the Yelloweye longline surveys. Due to their experience conducting summer IPHC surveys, the vessel and crew have maintained their gear and methods to IPHC survey standards for our research. Data collected include species composition, biological sampling, tag deployment, and CTD instrument deployment. WDFW biologists conduct 100 percent hook tally sampling for all stations. Biological data from non-rockfish species includes a LF sample of 20 percent of the catch. Catch from the first 20 hooks of each skate are measured. Retained rockfish are sampled for length, sex, weight, and age. Length, sex, tag numbers, and genetic samples are collected from Yelloweye rockfish. Non-rockfish species are released immediately unless they fall within the 20 percent Length Frequency (LF) sampling protocol. Rockfish, other than yelloweye, are retained on ice for biological sampling dockside and donated to a local food bank. Yelloweye rockfish are tagged with an external Floy tag and released at depth with a descending device.

In 2011, the Department began to explore potential seasonal effects on rockfish distributions around IPHC station 1082. Three surveys were completed between October 2011 and October 2012 with eleven, twelve, and nine stations covered respectively (Table 1). All sets deployed during these surveys were deemed to be successful sets. Station 1084 was not set in 2011 due to time constraints and its northernmost location. In October 2012, poor weather throughout the trip reduced fishing time to only three days and only stations 1082 and surrounding TRSS stations were set. A total of 227 yelloweye were successfully released with tags for all trips for an 86% tag rate of individuals encountered (Table 2). Most of the yelloweye encountered are consistently located on the southwest corner of the survey area (TRSS 1531). No tags have been recaptured at present. The total number of fish caught was 1768, 2101 and 1080 for fall 2011, spring 2012 and fall 2012, respectively (Tables 3, 4 and 5). Spiny dogfish comprised the majority of catch across all three surveys. The diversity of species encountered from the fall 2011 survey increased 54% in spring 2012 with number of species caught increasing from 13 to 20. Rockfish species encountered doubled with three species encountered in 2011 and six species in 2012. Total number of fish caught increased 19% and total kilograms caught increased 132%. The percentage of hooks with catch was similar for these surveys with a difference of 4%. The fall 2012 survey saw declines in catch rates and species diversity. Percent of hooks with catch in the fall 2012 was 35.75%, a decrease of 18% and the number of species encountered fell to ten species.

No tags have been recovered from the three surveys conducted in 2011 and 2012. Depending on sufficient yelloweye research set-asides, WDFW anticipates conducting surveys, both spring and fall, over the next several years to tag additional rockfish and to provide the opportunity to encounter previously tagged fish. Initially, WDFW mimicked IPHC survey methods but focused on rockfish stations. In 2012 and going forward, survey methods will diverge somewhat as IPHC conducts bait tests while WDFW has and will continue to follow the original IPHC protocols for bait. To expand survey interception of smaller rockfish, WDFW intends to test sablefish hooks with squid during surveys in 2013. WDFW has also proposed that the summer IPHC survey include the rockfish stations around Station 1082 to improve seasonal comparisons. (The summer rockfish survey was canceled in 2010 and 2011 due to the low catch limits set by the PFMC and IPHC revising their survey design.)

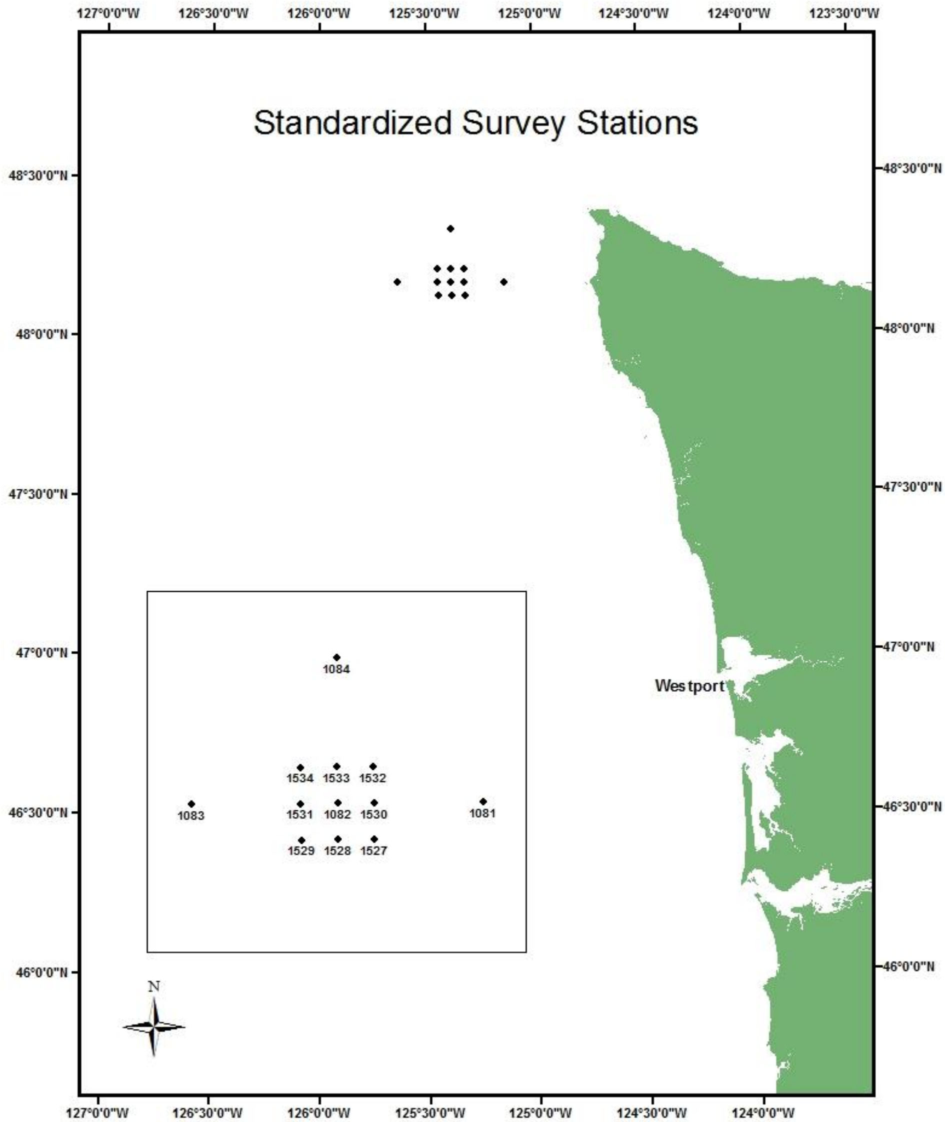

Figure 9. Standardized Survey Stations

Table 1. Trip Summary

Trip	Vessel	Survey	Days Fished	Number of Stations Set	Target Stations	Successful Sets
1	Pacific Surveyor	October 2011	4	11	12	100%
2	Pacific Surveyor	May 2012	4	12	12	100%
3	Pacific Surveyor	October 2012	3	9	12	100%
		Totals	**11**	**32**	**36**	

Table 2. Yelloweye Tagging Statistics

			Number Yelloweye Tagged by Station								
Trip	**Total YE Caught**	**YE Tagged and Released**	**1081**	**1082**	**1084**	**1528**	**1529**	**1530**	**1531**	**1533**	**1534**
1	97	65	1	8	0	12	4	9	14	12	5
2	110	108	13	9	3	30	2	0	43	4	4
3	56	54	0	14	0	9	1	0	26	3	1
Totals	**263**	**227**	**14**	**31**	**3**	**51**	**7**	**9**	**83**	**19**	**10**

Table 3. Fall 2011 Catch Statistics

						Number Caught by Station										
Species Name	**Total Caught**	**Average Weight (kg)**	**Total Weight (kg)**	**Percent of Catch by Weight**	**Percent of Catch by Number**	**1081**	**1082**	**1083**	**1527**	**1528**	**1529**	**1530**	**1531**	**1532**	**1533**	**1534**
Arrowtooth Flounder	3	1.00	3.00	0.07%	0.17%	1	0	0	0	0	0	2	0	0	0	0
Big Skate	2	5.00	10.00	0.22%	0.11%	1	1	0	0	0	0	0	0	0	0	0
Canary Rockfish	9	2.43	21.87	0.48%	0.51%	0	3	0	0	4	1	0	0	0	1	0
Lingcod	13	9.49	123.40	2.68%	0.74%	2	3	0	0	3	0	3	1	0	0	1
Longnose Skate	11	0.09	0.98	0.02%	0.62%	2	4	0	1	0	2	1	0	0	0	1
Pacific Halibut	77	7.91	609.08	13.24%	4.36%	19	16	0	0	8	5	7	3	2	15	2
Sablefish	5	5.00	25.00	0.54%	0.28%	2	0	2	0	1	0	0	0	0	0	0
Spiny Dogfish	1543	2.23	3443.88	74.88%	87.27%	201	237	188	125	134	119	100	109	119	92	119
Unidentified Sea Cucumber	1	0.10	0.10	0.00%	0.06%	0	0	0	0	0	0	1	0	0	0	0
Unidentified Sponge	1	0.10	0.10	0.00%	0.06%	0	0	0	0	0	0	0	0	0	1	0
Unidentified Starfish	5	0.10	0.50	0.01%	0.28%	1	0	0	1	0	2	1	0	0	0	0
Yelloweye Rockfish	97	3.72	360.49	7.84%	5.49%	1	11	0	0	21	4	10	23	0	16	11
Yellowtail Rockfish	1	1.00	1.00	0.02%	0.06%	0	0	0	0	1	0	0	0	0	0	0
Total Number Caught:	1768		4599.39	100.00%	100.00%	230	275	190	127	172	133	125	136	121	125	134
Number of Hooks:	4248															
Percent of Hooks with Catch:	41.62%															
Number of Sets:	11															
Number of Skates:	42															
Average Hooks per Skate:	101.143															

Table 4. Spring 2012 Catch Statistics

						Number Caught by Station											
Species Name	Total Caught	Average Weight (kg)	Total Weight (kg)	Percent of Catch by Weight	Percent of Catch by Number	1081	1082	1083	1084	1527	1528	1529	1530	1531	1532	1533	1534
Arrowtooth Flounder	1	1.00	1.00	0.01%	0.05%	0	0	0	0	0	0	0	1	0	0	0	0
Big Skate	7	20.00	140.00	1.31%	0.33%	2	2	0	2	0	0	0	0	1	0	0	0
Bocaccio	12	3.64	43.65	0.41%	0.57%	0	0	3	0	0	3	0	0	6	0	0	0
Canary Rockfish	8	2.30	18.39	0.17%	0.38%	0	2	0	0	0	2	0	0	4	0	0	0
Flathead Sole	1	1.00	1.00	0.01%	0.05%	0	1	0	0	0	0	0	0	0	0	0	0
Lingcod	25	7.91	197.83	1.86%	1.19%	5	3	1	0	1	5	5	0	4	0	1	0
Longnose Skate	64	5.38	344.44	3.23%	3.05%	34	6	3	4	7	0	3	1	4	0	0	2
Pacific Cod	1	1.00	1.00	0.01%	0.05%	1	0	0	0	0	0	0	0	0	0	0	0
Pacific Halibut	213	9.84	2096.79	19.69%	10.14%	40	39	36	15	14	3	15	2	25	0	8	16
Petrale Sole	1	1.00	1.00	0.01%	0.05%	0	0	1	0	0	0	0	0	0	0	0	0
Redbanded Rockfish	7	2.15	15.04	0.14%	0.33%	7	0	0	0	0	0	0	0	0	0	0	0
Sablefish	4	5.00	20.00	0.19%	0.19%	0	0	4	0	0	0	0	0	0	0	0	0
Silvergray Rockfish	1	3.32	3.32	0.03%	0.05%	0	0	0	0	0	0	0	0	1	0	0	0
Spiny Dogfish	1631	4.51	7353.09	69.04%	77.63%	64	196	175	233	143	148	108	159	44	174	111	76
Spotted Ratfish	3	1.00	3.00	0.03%	0.14%	3	0	0	0	0	0	0	0	0	0	0	0
Unidentified Idiotfish	3	1.21	3.63	0.03%	0.14%	3	0	0	0	0	0	0	0	0	0	0	0
Unidentified Sponge	1	0.10	0.10	0.00%	0.05%	0	0	0	0	0	0	0	0	1	0	0	0
Unidentified Starfish	4	0.10	0.40	0.00%	0.19%	1	1	0	0	1	0	0	1	0	0	0	0
Yelloweye Rockfish	110	3.61	397.48	3.73%	5.24%	13	9	0	3	0	31	2	0	43	0	4	5
Yellowtail Rockfish	4	2.32	9.30	0.09%	0.19%	0	0	0	0	0	3	0	1	0	0	0	0
Total Number Caught:	2101		10650.45	100.00%	100.00%	173	259	223	257	166	195	133	165	133	174	124	99
Number of Hooks:	4837																
Percent of Hooks with Catch:	43.44%																
Number of Sets:	12																
Number of Skates:	48																
Average Hooks per Skate:	100.77																

Table 5. Fall 2012 Catch Statistics

Species Name	Total Caught	Average Weight (kg)	Total Weight (kg)	Percent of Catch by Weight	Percent of Catch by Number	Number Caught by Station 1082	1527	1528	1529	1530	1531	1532	1533	1534
Canary Rockfish	11	2.38	26.15	0.81%	1.02%	7	0	0	2	0	2	0	0	0
Lingcod	6	8.28	49.66	1.53%	0.56%	2	0	1	0	0	3	0	0	0
Longnose Skate	1	1.00	1.00	0.03%	0.09%	0	0	1	0	0	0	0	0	0
Pacific Halibut	30	10.00	299.96	9.27%	2.78%	9	0	6	1	1	3	3	3	4
Rosethorn Rockfish	1	0.44	0.44	0.01%	0.09%	1	0	0	0	0	0	0	0	0
Sablefish	4	5.00	20.00	0.62%	0.37%	0	1	0	0	3	0	0	0	0
Silvergray Rockfish	1	3.99	3.99	0.12%	0.09%	1	0	0	0	0	0	0	0	0
Spiny Dogfish	969	2.70	2613.68	80.77%	89.72%	220	101	101	107	64	98	77	108	93
Spotted Ratfish	1	1.00	1.00	0.03%	0.09%	0	0	1	0	0	0	0	0	0
Yelloweye Rockfish	56	3.93	219.96	6.80%	5.19%	16	0	9	1	0	26	0	3	1
Total Number Caught:	1080		3235.83	100.00%	100.00%	256	102	119	111	68	132	80	114	98
Number of Hooks:	3021													
Percent of Hooks with Catch:	35.75%													
Number of Sets:	9													
Number of Skates:	30													
Average Hooks per Skate:	100.7													

3. Evaluation of Recreational Fisheries for Rockfish in Marine Catch Area 4B

In 2011, the MFS unit initiated a two-year research project at Neah Bay. The project's purpose is to evaluate conservation measures implemented in 2010 to protect rockfish specifically in Marine Catch Area "4B", an area that extends east from Tatoosh Island to the Sekiu River. New fishing regulations included a deep water (>120ft) closure for bottomfish fishing; no-retention of rockfishes other than black and blue; and a daily limit of six black and blue rockfish combined. Additionally, the aggregated daily limit for bottomfish was reduced from 15 to 10 in 2011.

A "test" fishery using recreational angling techniques and gears was conducted for rockfish in Area 4B to collect species composition, and temporal and spatial rockfish distribution. Data collected through established dockside sampling programs have been evaluated separately and in conjunction with test fishery data to assess the effectiveness of regulation changes in meeting the expected reductions in rockfish mortality in the sport fishery. In addition, a pilot effort is testing the use of a voluntary angler logbook as a cost-effective, long-term approach to monitoring the recreational bottomfish fishery. The logbook will be used to obtain detailed information about the chronology and catches from individual fishing trips throughout the whole year. A core group of sport anglers, enlisted in 2012, submit logbooks monthly.

4. Outreach and Education

In support of rockfish identification, and barotrauma and descending device outreach activities, coastal MFS staff expended considerable time and effort to obtain high quality photographs of rockfish, taking advantage of the access afforded through the tagging and 4B rockfish projects. Descending devices were also tested during both projects and photographed in use. These photographs now appear in agency produced barotrauma/descending device posters and brochures and in the 2013-2014 recreational fishery regulation pamphlet. Upgrades to the agency website are underway and these photographs are also being incorporated into the redesigned groundfish id webpage.

2. **Forage Fish Management, Monitoring, Research, and Assessment** (*Contact: Lorna Wargo (360) 249-1221 Lorna.Wargo@dfw.wa.gov; Dayv Lowry 360-95-2558, dayv.lowry@dfw.wa.gov*)

5. Washington – Outer Coast Smelt Spawning Beach Survey

Funded by proviso money from the Washington Legislature to inform marine spatial planning on the outer coast, WDFW staff undertook a 7-month survey, October 2012 to April 2013, of beaches in an effort to document seasonal and spatial patterns of spawning ground usage by surf smelt, night smelt, and sand lance. Substantial effort has been allocated in identifying forage fish spawning beaches in Puget Sound (over 30,000 surveys in over 30 years) and comparatively little effort on the outer coast (fewer than 100 surveys). Therefore, the distribution and timing of forage fish spawning on the Washington outer coast is incompletely known. This is the first comprehensive forage fish spawning survey of the Washington outer coast done in collaboration with the coastal tribes; Quinault, Hoh, Quileute, and Makah.

Sampling locations includes Washington outer coast (Columbia R. North Jetty to Cape Flattery) beaches identified as semi exposed cobble-mixed coarse and exposed sandy beaches based on DNR ShoreZone line feature GIS data. Based on the beach type criteria, there are 35 beaches, with each beach divided into equal sampling segments as close to 1000’ as possible. Based on our knowledge through extensive Puget Sound surveys, the chosen beach types have the potential to support spawning of surf smelt, night smelt, and sand lance, and 1000’ has been the historic sampling resolution. 10% of potential beach segments are selected for sampling monthly (84 segments/month), without replacement, for each month from October 2012 – April 2013. The 7 month survey will produce an expected sample size of 70% (588 segments) of potential spawning beaches, and these data will be used in an occupancy model to extrapolate spatial temporal patterns to the remainder of the sampling universe.

This study uses a variant of the bulk sediment sampling procedure used for forage fish spawning surveys in Puget Sound. The protocol has been modified to sample perpendicular to the beach, from the entire upper third of the recent tidal range, allowing us to account for the lack of knowledge about the specific tidal height at which eggs are deposited on the outer coast. At each station, 3 bulk sediment subsamples are collected 100’ apart. For each subsample, 4 evenly spaced scoops of sediment are collected within the estimated upper third of the tidal range. The sediment samples are run through a fixed set of sieves and the 0.5 mm sediment size fraction is “winnowed” to isolate the least dense elements. The remaining “light fraction” is examined under a microscope for egg presence and abundance. This study adopted the Puget Sound forage fish egg presence/absence laboratory protocol, with the WDFW standard for documenting a spawning site for a given species at 2+ eggs (live or dead) per single sample.

From the months of October 2012 – February 2013, we have sampled 330 of 420 (78.6%) planned sampling stations. Sampling loss is primarily due to limited site access and weather conditions. During these first 5 months of sampling, 329 stations were listed as “absent” of forage fish eggs, and 1 station “present” and documented as a spawning site. 1 of the 3 subsamples collected at this station had 2 smelt eggs (1 live, 1 dead/empty). The sample was collected by Hoh tribal technicians, mid-February, near the mouth of the Hoh River. March sample processing is currently incomplete; however, of the samples processed, 3 additional stations have been documented as spawning sites. All 3 stations are located in the Kalaloch region, between Kalaloch Creek and Steamboat Creek. Egg counts in 1 subsample ranged from 2 to 7 eggs and were all identified as smelt. All eggs found have been archived for future genetic testing to determine smelt species and to potentially identify demographically independent stocks of forage fish on the Washington outer coast.

The study initially planned a 7 month survey; however, it was hoped that sampling would continue through October 2013, for 1 full year of data, to fully assess the temporal patterns of coastal forage fish spawning. It is likely that sampling will continue for a full year, although it is currently pending confirmed funding from the Washington Legislature. Additionally, the Olympic National Park has expressed interest in funding the project through to a full year and the Department of Natural Resources has indicated a desire to continue funding, possibly for another 2 years of surveys during the months of February to October. At present, sampling is planned to continue past April and through to June 2013, in an effort to maximize data collection with currently secured funds. A report is currently expected to be submitted by summer 2013 unless sampling continues through fall, in which case the report will be submitted winter 2013 and later published as a WDFW Technical Report.

6. *Washington Commercial Shrimp Trawl Observer Program – Eulachon Bycatch Study (Contact: Lorna Wargo (360) 249-1221 Lorna.Wargo@dfw.wa.gov)*

The ocean pink shrimp (*Pandalus jordani*) trawl fishery is a vital component of Washington's coastal commercial fisheries, providing greater stability compared to other trawl fisheries. In 2010, eulachon were listed under the ESA as a threatened species. In that listing, the Pacific Northwest trawl fishery for ocean pink shrimp was deemed a moderate threat to eulachon recovery; the Eulachon Biological Review Team (BRT) ranked bycatch second among the severity of threats impacting recovery of eulachon stocks (Gustafson, et. al., 2010). The ocean pink shrimp fishery also encounters rockfish including "overfished" species, e.g., dark blotched rockfish *Sebastes crameri* and Pacific ocean perch *S. alutus* juveniles and yelloweye rockfish S. *ruberrimus*. Prior to 2010, very limited information about bycatch composition or rates existed for the Washington shrimp trawl fishery. To close this data gap, the Washington Department of Fish and Wildlife undertook two actions: 1) implemented regulations effective in 2010 to require participation of Washington licensed shrimp trawl fishers in the West Coast Groundfish Observer Program (WCGOP); and 2) sought and received a Species Recovery Grant to implement a state-based observer program (Studies of Eulachon Smelt in Oregon and Washington, NOAA Grant No.NA1ONMF4720038. This project concludes June 30, 2013; a final report is due December 31, 2013.

MFS-coastal unit staff conducted the state-based program, deploying observers on vessels during the 2011 and 2012 shrimp fishery seasons with simultaneous coverage by the WCGOP. In 2011, the WDFW observer program observed 819 tows (23.7%) across 50 trips (24.3%). Section 6 funding cuts reduced coverage in 2012 to 666 tows (15.9%) across 41 trips (16.1%). Sampling protocols largely followed the WCGOP and estimates of bycatch for eulachon smelt, plus other species or categories of fish will be reported. While the study had enumeration of bycatch and collection of eulachon biological data (including genetic sampling) as its primary objectives, formal and informal actions to reduce bycatch were also undertaken. Regulatory changes to allow only rigid panel excluders and to reduce the maximum bar spacing on excluder panels (or biological reduction device; BRDs) to ¾ inches were adopted and effective for the 2012 season. Staff encouraged voluntary gear and fishing practice changes by skippers to reduce bycatch, and deployed underwater camera equipment to collect video to further inform and guide these changes.

7. Participation in Conferences and Workshops

In 2012, staff of the Coastal MFS Unit presented at several regional scientific meetings, as indicated below.

- Western Groundfish Conference, Feb 7-10. Presenter: Donna Downs, Poster: Lorna Wargo.
- NOAA/WDFW Cooperative Research Symposium at Pt. Adams, Feb 23. Presenter: Lorna Wargo.
- Friday Harbor Labs Symposium: Biology and Management of Forage Fish in the Salish Sea, Sept 12-14. Presenter: Lorna Wargo.

Committee of Age-Reading Experts

2011 Committee Report

Prepared for the Fifty-third Annual Meeting of the Technical Subcommittee of the Canada-USA Groundfish Committee

12 May 2012

Prepared by
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CARE 2012 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. Members are charged with the task of developing and applying standardized age determination criteria and techniques. CARE members operate within the Terms of Reference approved by the TSC in 1986 and the CARE Charter developed in 2000, and approved by CARE in 2004.

CARE Workshop

CARE meets biennially for a three-day workshop. Workshops typically consist of one "business" day and one and a half days of hands-on calibration at microscopes to review and standardize age reading criteria. The next CARE workshop in 2013 will focus on the readability of archived otolith samples stored in alcohol versus those stored in glycerin.

Report Period

This report covers the work period of January1, 2011 through December 31, 2011. The most recent biennial CARE Workshop was held April 11 through April 15, 2011. It was attended by 38 agency members from Washington, Oregon, Alaska, California and British Columbia. This reporting period included information from the Executive Summary (prepared by past Chair MacLellan) dated May 3 through May 5, 2011. *For meeting details see the 2011 workshop minutes posted on the CARE website at www.psmfc.org/care/.*

B. CARE Subcommittee (Working Group) Reports

1. CARE Manual/Glossary Committee

The committee consists of Kamikawa, Goetz, Forsberg, and three incoming members in 2011 (Russ, B. Campbell, and Failor).

The Manual/Glossary Committee working group members develop age-reading charter sections or definitions for age-reading terms suggested by CARE members. These charters sections and definitions are subsequently approved by CARE members and added to the CARE Manual/Glossary.

During the 2011 CARE meeting, the rockfish section was reviewed and updated. Revisions were identified and Goetz agreed to update the section as necessary. The committee is currently reviewing two new drafts for the manual: the QA/QC techniques by B. Campbell and age determination of halibut by Forsberg.

These agencies plan to work on the following new species: a hake section by NWFSC and CDFO members, a lingcod otolith section by ADFG members and a skate section by AFSC. Minor revisions and updates to the age validation section will be done by AFSC.

Goetz offered to draft a section on ergonomics. The committee generated a CARE to CARE recommendation for 2011 to present the latest ergonomic information at the next CARE meeting.

2. CARE Website Committee – Short, Atkins

The appearance and operation of the CARE website is maintained with the cooperation of the PSMFC.

In 2011, the structure exchanges were updated to include aged PDFs of completed historical case invoices (1998-2009) linked to the table on the CARE website. The CARE charter, the citation, and the disclaimer were added to the footer. The 2011 minutes were also posted.

Atkins recommended the CARE Forum continue for one more rotation and asked that the members post general communications and check for new information on a regular basis.

The committee will continue to add the following information to the website: the 2011 photos, the 2010 production numbers, the 2010 structure exchanges, and the completed case inventory samples Russ (Vice-chair) recovers from the 1998-2005 historical case inventories. The committee is also looking into the feasibility of preparing an on-line summary of the material that is archived by each of the West Coast groundfish agencies in reply to TSC to CARE 2010.

Short recommended updating the version of JOOMLA to 1.5 for security reasons and submitted a CARE to CARE recommendation to that effect.

3. Charter Committee – Munk, Goetz

The Charter, initiated in 2000, provides a framework in which the original intent of CARE may continue. It also hastens familiarization of new CARE members to the function of CARE and the responsibilities of its officers and members. The committee is responsible for facilitating changes and updates to the Charter.

There was little activity to report in 2011. MacLellan stepped down from the committee in April. There was a call for new members and none stepped forward.

The committee recommends adding a working group section to highlight the purpose of the group and current activities with a link to past achievements.

4. <u>Sablefish ad hoc Working Group-</u> MacLellan, Neil, B. Campbell, Anderl, Helser, Kautzi, McDonald, Cavanagh, Hilwig, McNeel

The group reviewed the **WebEx** meeting and identified issues with examples of the known-age imaged sablefish otolith. The group outlined items for documentation to be developed into a scientific manuscript. The group discussed many ageing issues: burning techniques, breaking strategies, storage strategies, and identifying annuli versus checks. They generally agreed upon criteria documenting patterns and where they were unable to agree suggestions of possible interpretations were noted.

The group plans to develop a technical document and to update the CARE manual. They continue to work identifying the 1st annulus size range, discuss the pros and cons of each agency's storage methods, and each agency's protocols of Q/C.

C. Age Structure Exchanges

Age structure exchanges periodically occur to assess calibration among CARE age-reading agencies. Depending on results, specimens of interest (e.g. demonstrated biases) are then reviewed and discussed. Exchanges are tracked by the CARE Vice-chair. Data from exchanges are available on the CARE website.

Seven age structure exchanges initiated in 2010 are now complete. The species were Pacific whiting (CDFO, NWFSC), Pacific ocean perch for training (WDFW, CDFO) and lingcod for training (ADFG, ODFW), Pacific hake (NWFSC, CDFO), big skate (AFSC, CDFO), Longnose skate (AFSC, CDFO) and Longnose skate (ADF&G between the labs in Homer and Juneau).

Four exchanges initiated in 2011 are not yet completed. These exchanges are Big skate stained thin sections (AFSC, ADFG, ODFW), Longnose skate stained thin sections (AFSC, ADFG, ODFW) Longnose skate stained thin sections (AFSC, ODFW) and Longnose skate unstained thin sections (AFSC, ODFW) (Table 3).

D. Business Session Highlights and Discussion:

Demonstrations: There were three notable demonstrations during the CARE meeting. These demonstrations included imaging, (Anderl) micro-milling, (Kastelle) and elasmobranch vertebrae staining (Matta, Gburski). Anderl demonstrated AFSC's imaging system and the associate hardware and software. The demonstrations included information on Photoshop (image manipulation, hot keys, macros, annotation, layers, stitching, scale bars) and Portfolio image storage. Gburski and Matta demonstrated their staining technique for vertebrae. In their demonstration, the thin sections were decalcified, stained, restained, soaked in glycerin, and slide mounted. Kastelle demonstrated AFSC's new micro-mill instrumentation.

Scientific presentations: Six PowerPoint presentations were given: (1) CDFO's new groundfish age data sheet (MacLellan), (2) Preliminary age validation of Pacific cod using stable oxygen isotopes (Kastelle), (3) AFSC imaging system and its uses (Andler), (4) digital reference collections via Photoshop (Wischniowski), (5) management of AFSC images (Short) and (6) digital camera and AFSC new micromill (Kastelle).

Discussion: There were three noteworthy topics of discussion. First, concern was expressed that CARE was not following its mandate. Members conferred and concluded the concern to be unfounded. Second, the CARE forum's usefulness was discussed. The members agreed to continue supporting the forum and evaluate its usefulness again at the next CARE meeting in 2013. The last topic - imaging - was the main focus for the 2011 CARE meeting. Discussions about software (image editing, tagging metadata, archiving), hardware, and image-taking protocols were facilitated through the PowerPoints presented. Imaging was recognized as a powerful tool for exchanges and documentation but members clearly stated that imaging could not be substituted for actual scope work.

Workshop: Twenty-seven CARE members utilized the hands-on session to review sablefish, skate, Pacific ocean perch, dogfish, and geoduck, Albacore tuna, Pacific cod, yelloweye rockfish, shortraker rockfish, and salmon shark. (Table 2)

Recommendations C.A.R.E. ~TSC

In 2011, recommendations were made by CARE to CARE, TSC to CARE, and CARE to TSC. Some recommendations may take more than one cycle to complete.

2009 CARE to CARE

1. Charter Working Group: No advancement has been made to add a working group section to the charter to highlight their purpose or current activities with a link to past achievements ("archive") on the website. Charter members present at the 2011 meeting discussed this and suggested this information might be better located somewhere else on the website other than the charter. The committee needs to discuss this further and make a recommendation at the next CARE meeting in 2013.

2011 CARE to CARE

1. Forum Working Group: We recommend that the Forum continue for one more rotation.
2. Website Committee: We recommend updating the CARE website content management system from JOOMLA version 1.12 to version 1.5 to remain current with technology for security and bug fixes.
3. Manual Working Group: We recommend that CARE continue revision and expansion of the CARE manual to include sections on hake, lingcod otoliths, skates, age validation, and updated rockfish ageing information. In addition, we recommend that a section on ergonomics be added. These additions or revisions should be submitted to the CARE Manual Committee (led by Kamikawa) by April 2012 for committee review. The Manual Committee will submit all changes and updates to CARE for consideration at the 2013

CARE workshop. The CARE Manual Committee will review the halibut and QA/QC sections that were submitted at the 2011 CARE meeting and distribute final drafts to the CARE membership for review.

4. CARE recommends all members review the method and validation species information on the Species Information webpage to confirm the data is current. Updates or changes should be forwarded to Short. This table will be reintroduced into the biennial meeting agenda for agency updates.

5. CARE recommends that the 2013 agenda address the effects of long-term storage of otoliths.

Original 2010 TSC to CARE recommendation:

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

2011 CARE to TSC response:

Initial CARE Reply to TSC to CARE 2010 Recommendation: With regards to "…*examining the feasibility of preparing an on-line summary of the material that is archived by each of the west coast groundfish research agencies*": most agencies do not have publicly accessible age data sample inventories now, except AFSC. CARE recognizes that there are advantages and disadvantages associated with making inventories public. A CARE portal, (using the CARE website), may be a possible platform to identify inventories. CARE requests clarification on what data the TSC envisions would be made available on said inventory. Then CARE members will consult their agencies regarding the TSC recommendation and formulate a reply.

2011 TSC to CARE Recommendations:

TSC would like to fully endorse the activities of CARE and acknowledge their great contribution to groundfish research and stock assessment.

TSC thanks CARE for their discussions and consideration of the 2010 request to examine the feasibility of preparing an on-line summary of archived ageing material from their member agencies. Since most agencies do not currently maintain publicly accessible on-line inventories, TSC appreciates that this task will be laborious.

To clarify for CARE, TSC's 2010 information request includes the following by species:

1. Number of ageing structures collected by
    a. structure type
    b. agency
    c. year
2. Number of structures aged by year (already on the website)

3. A link to a contact person at each agency

CARE Chair query regarding 2011 archive recommendation:

"Am I correct in assuming that the TSC is looking for numbers of fish age structures (#1) collected for all groundfish species going back as far as each agency has records for?"

The TSC reply was:

This is something that we would like CARE to work toward beginning with the most recent years and progressing back in time if resources permit. This needn't be a scrupulously thorough and exhausting exhumation of numbers of structures and could be an effort that begins with the easiest information and gets added to as they can. But the more information, the better, eventually.

2011 CARE reply to TSC:

Three CARE member agencies are willing to compile and forward "an on-line summary of archived ageing material". This could increase as two more member agencies are willing pending approval. Each member agency has selected a contact person for the website link.

Three CARE member agencies chose not to participate. Some will link the CARE website to their agency website and provide a contact name.

The CARE executive committee is considering how to include the summary of archived ageing material on to the website. In 2012, changes will be made to the CARE website to record the summary of archived ageing material and be ready to implement after the 2013 CARE meeting, pending membership approval.

Table 1. Attendees of the 2011 CARE Workshop, 11-14 April 2011, Seattle, WA.

Last Name	First Name	Agency	Location
Anderl	Delsa	AFSC	Seattle
Atkins	Nikki	NWFSC	Newport
Benson	Irina	AFSC	Seattle
Blood	Cal	Retired	Seattle
Brogan	John	AFSC	Seattle
Campbell	Barb	CDFO	Nanaimo
Campbell	Lance	WDFW	Olympia
Cavanagh	Meredith	NWFSC	Newport
El Mejjati	Sonya	ADFG	Kodiak
Failor	Barbi	ADFG	Homer
Forsberg	Joan	IPHC	Seattle
Gburski	Chris	AFSC	Seattle

Gibbs	Linda	IPHC	Seattle
Goetz	Betty	AFSC	Seattle
Helser	Tom	AFSC	Seattle
Hiller	Lisa	WDFW	Olympia
Hilwig	Kara	ADFG	Juneau
Hutchinson	Charles	AFSC	Seattle
Johnston	Chris	AFSC	Seattle
Kastelle	Craig	AFSC	Seattle
Kautzi	Lisa	AFSC	Seattle
MacLellan	Shayne	CDFO	Nanaimo
Matta	Beth	AFSC	Seattle
McDonald	Patrick	NWFSC	Newport
McNeel	Kevin	ADFG	Juneau
Neil	Jodi	ADFG	Juneau
Piston	Charlie	AFSC	Seattle
Pollak	Andrew	ADFG	Homer
Rodriguez	Omar	NWFSC	Newport
Rosenfield	Sandy	WDFW	Olympia
Russ	Elisa	ADFG	Homer
Short	Jon	AFSC	Seattle
Sizemore	Bob	WDFW	Olympia
Thompson	Josie	ODFW	Newport
Tobin	Robert	IPHC	Seattle
Topping	Jenny	WDFW	Olympia
Wells	David	AFSC	Seattle
Wischniowski	Steve	IPHC	Seattle

Table 2. 2011 CARE Scope Time

Species	**Participants**	**Agencies**	**Comments**
Pacific cod etc	Lance Campbell	WDFW	Prep of otolith samples for LA-ICPMS
"	Craig Kastell	AFSC	"
Geoduck ageing	Craig Kastell	AFSC	Preparation & ageing methods, cross-dating
"	Lisa Hillier	WDFW	"
"	Bob Sizemore	WDFW	"
"	Shayne MacLellan	CDFO	"
Big/Longnose/skates	Elisa Russ	ADFG-Homer	Age calibration
"	Josie Thompson	ODFW	"
"	Chris Gburski	AFSC	"
"	Andrew Pollak	ADFG-Homer	"
"	Barbi Failor	ADFG-Homer	"
Albacore tuna	Barb Campbell	CDFO	Age calibration

"	David Wells	SWFSC	"
Pacific ocean perch	Sandy Rosenfield	WDFW	Age calibration
"	Jennifer Topping	WDFW	"
Pacific ocean perch	Sandy Rosenfield	WDFW	Comparing methods otolith preparation
"	Jennifer Topping	WDFW	"
"	Charlie Piston	AFSC	"
Pacific ocean perch	Sandy Rosenfield	WDFW	Alaska vs west coast growth patterns
"	Jennifer Topping	WDFW	"
"	Betty Goetz	AFSC	"
Dogfish	Sandy Rosenfield	WDFW	New WDFW training method for ageing
"	Jennifer Topping	WDFW	"
"	Lance Campbell	WDFW	"
"	Patrick McDonald	NWFSC	"
"	Omar Rodriguez	NWFSC	"
Dogfish	Chris Gburski	AFSC	Evaluate staining method, compare dorsal spine to vertebrae age
"	Omar Rodriguez	NWFSC	"
"	Patrick McDonald	NWFSC	"
Pacific cod	Sonya El Mejjati	ADFG-Kodiak	Age calibration
"	Chris Johnston	AFSC	"
Greenland halibut	John Brogan	AFSC	Age calibration
Sablefish	Kara Hilwig	ADFG-Juneau	Age calibration - known age otoliths X 3 occasions
"	Jodi Niel	ADFG-Juneau	"
Sablefish	Patrick McDonald	NWFSC	Age calibration
"	Meredith Cavanagh	NWFSC	"
"	Delsa Anderl	AFSC	"
"	Lisa Kautzi	AFSC	"
"	Kevin McNeel	ADFG-Juneau	"
Sablefish	Kara Hilwig	ADFG-Juneau	Sablefish working group - known age otoliths, calibration, documentation
"	Jodi Niel	ADFG-Juneau	"
"	Kevin McNeel	ADFG-Juneau	"
"	Shayne MacLellan	CDFO	"
"	Barb Campbell	CDFO	"
"	Delsa Anderl	AFSC	"
"	John Brogan	AFSC	"
"	Lisa Kautzi	AFSC	"
"	Patrick McDonald	NWFSC	"
"	Meredith Cavanagh	NWFSC	"
Skate/shark	Chris Gburski	AFSC	"
"	Sonya El Mejjati	ADFG-Kodiak	"
"	Elisa Russ	ADFG-Homer	Age calibration
Pacific cod	Delsa Anderl	AFSC	"

"	Barbi Failor	ADFG-Homer	"
"	Chris Johnston	AFSC	"
"	Andrew Pollak	ADFG-Homer	"
Yelloweye rockfish	Kara Hilwig	ADFG-Juneau	Age calibration
"	Kevin McNeel	ADFG-Juneau	"
"	Barb Campbell	CDFO	"
Yelloweye rockfish	Kara Hilwig	ADFG-Juneau	Age calibration
"	Jodi Niel	ADFG-Juneau	"
Yelloweye rockfish	Kara Hilwig	ADFG-Juneau	Age calibration
"	Kevin McNeel	ADFG-Juneau	"
"	Elisa Russ	ADFG-Homer	"
"	Andrew Pollak	ADFG-Homer	"
"	Kevin McNeel	ADFG-Juneau	"
Shortraker rockfish	Jodi Niel	ADFG-Juneau	Age calibration
"	Charles Hutchenson	AFSC	"
Salmon shark	Barbi Failor	ADFG-Homer	Age calibration
	Chris Gburski	AFSC	"

Table 3. CARE age structure exchanges initiated/completed from 2010-2011

Exchange ID No.	Exchange Year	Species	Stock	Originating Agency	Coordinator	Cooperator(s)
11-004	2011	Longnose Skate	US West Coast	ODFW	J. Thompson	AFSC
11-003	2011	Longnose Skate	US West Coast	ODFW	J. Thompson	AFSC
11-002	2011	Longnose Skate	Gulf of Alaska	AFSC	C. Gburski	ADFG, ODFW
11-001	2011	Big Skate	Gulf of Alaska	AFSC	C. Gburski	ADFG, ODFW
10-006	2010	Longnose Skate	Gulf of Alaska	AFSC	C. Gburski	CDFO
10-005	2010	Big Skate	Gulf of Alaska	AFSC	C. Gburski	CDFO
10-004	2010	Pacific whiting	US West Coast	CAP/PSMFC	O. Rodriguez	CDFO
10-003	2010	Pacific Ocean Perch	Pacific Northwest Coast	WDFW	S. Rosenfield	CDFO
10-002	2010	Lingcod	Gulf of Alaska	ADFG	K. Munk	ODFW
10-001	2010	Pacific whiting	Pacific Northwest Coast	CDFO	J. Groot	NWFSC