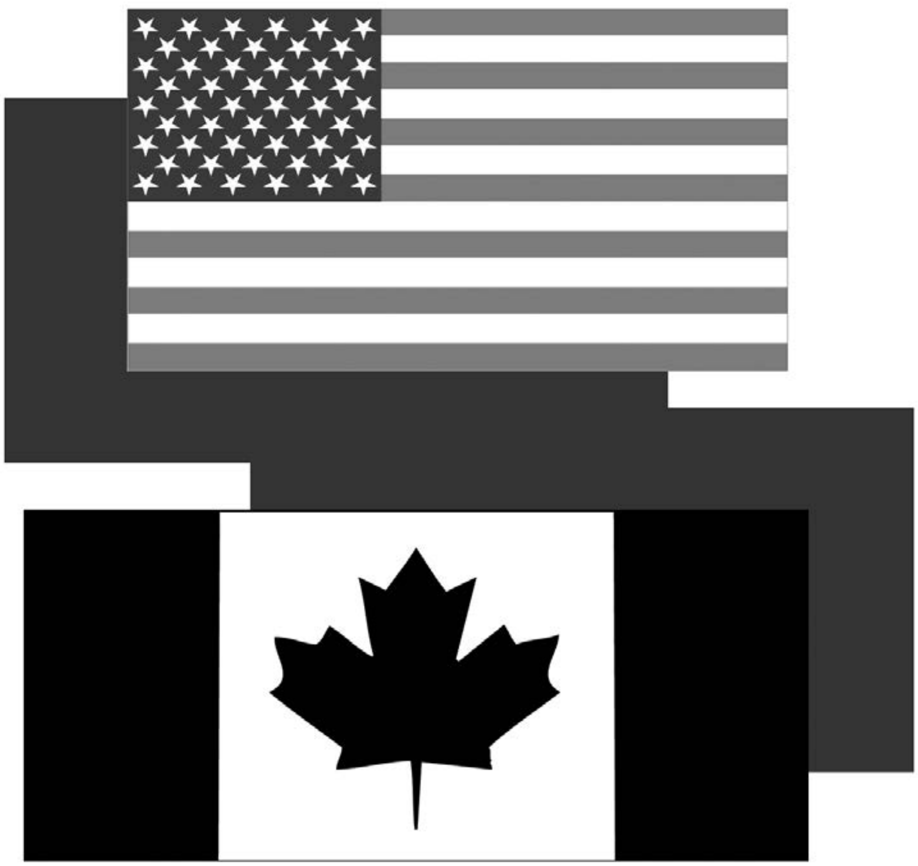
Report of the Technical Subcommittee of the Canada-United States Groundfish Committee

55th Annual Meeting of the TSC

April 29 - April 30, 2014
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
2014	April 29-30	Seattle, WA	Dykstra	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 29-30, 2014 in Seattle, Washington. This year's meeting was hosted by the International Pacific Halibut Commission (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 (2013) research achievements and projected current year (2014) 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. Elisa Russ (Alaska Department of Fish and Game, representing CARE) reported on CARE activities in 2013/14.

The TSC discussed the need to either sponsor or organize a maturity working group or a workshop. Members noted that lots of stock assessment models are based off of one maturity estimate, despite documented variability in maturity within stocks, and that more maturity work needs to be done. TSC also again 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) The TSC recognizes the value of the 2014 Visual Survey Workshop and understands that there will be more information forthcoming from the survey follow-up. While interest was expressed to form a working group or second workshop, the TSC agreed to discuss this at the next meeting, pending the outcomes of two NOAA initiatives and feedback from the 2014 survey participants. 2) The TSC recognizes the importance of climate shifts and that some agencies are looking to be "climate ready". Members suggested that this could be a topic for the 2016 Western Groundfish Conference, although some suggested limiting it to changes in species distributions. 3) The TSC discussed the need to either sponsor or organize a maturity working group or a workshop.

The 56th Annual Meeting of TSC is scheduled for **April 28 – April 29, 2015,** in Sydney, BC to be hosted by the Department of Fisheries and Oceans, Canada.

C. Minutes of the Technical Subcommittee

Minutes
Fifty Fifth Annual Meeting of the
Technical Subcommittee (TSC) of the
Canada-U.S. Groundfish Committee
April 29-30, 2014
International Pacific Halibut Commission
2320 W. Commodore Way, Suite 300
Seattle, WA 98199
Host: Claude Dykstra, IPHC
Chair: Traci Larinto, CDFW

Tuesday, April 29

I. Call to Order – Traci Larinto, Chair, called the meeting to order at 1:10 pm

II. Appointment of Secretary – Kate Rutherford (April 29), Ali Dauble (April 30)

III. Introductions – Claude provided housekeeping information (washrooms, fire procedures). Reports that were made available online before the meeting, or provided at the meeting, including the 2013 TSC Report, and the 2014 reports from ADFG, AFSC, CDFW, DFO Canada, IPHC, NWFSC, ODFW, SWFSC, WDFW, and CARE.

IV. List of Participants

- 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)
- Peter Frey, Northwest Fisheries Science Center, Seattle, WA, (Peter.Frey@noaa.gov)
- Kristen Green, Alaska Department of Fish and Game, Juneau, AK, (Kristen.Green@alaska.gov)
- Jon Heifetz, Alaska Fisheries Science Center, NOAA, Auke Bay Lab, Juneau, AK (Jon.Heifetz@noaa.gov)
- Aimee Keller, Northwest Fisheries Science Center, Seattle, WA, (Aimee.Keller@noaa.gov)
- Traci Larinto, California Department of Fish and Wildlife, Los Alamitos, CA (Traci.Larinto@wildlife.ca.gov)
- Dayv Lowry, Washington Department of Fish and Wildlife, Olympia, WA, (Dayv.Lowry@dfw.wa.gov)
- Kirsten MacTavish, International Pacific Halibut Commission, Seattle, WA, (Kirsten@iphc.int)
- Wayne Palsson, Alaska Fisheries Science Center, NOAA, Seattle, WA, (Wayne.Palsson@noaa.gov)

- Kate Rutherford, Science Branch, Pacific Biological Station, Department of Fisheries and Oceans Canada, Nanaimo, BC (Kate.Rutherford@dfo-mpo.gc.ca)
- Tom Wilderbuer, Alaska Fisheries Science Center, NOAA, Seattle, WA, (Tom.Wilderbuer@noaa.gov)
- Lynne Yamanaka, Science Branch, Pacific Biological Station, Department of Fisheries and Oceans Canada, Nanaimo, BC (Lynne.Yamanaka@dfo-mpo.gc.ca)
- Elisa Russ, CARE Chair, Alaska Department of Fish and Game, Homer, AK, (Elisa.Russ@alaska.gov)
- Stephen Phillips, Pacific States Marine Fisheries Commission, Portland, OR, (SPhillips@psmfc.org)

V. Approval of 2013 report – The report was approved. Past reports may be found at: www.psmfc.org/tsc2/.

VI. Approval of 2014 agenda – The agenda was approved.

VII. Working Group Reports

A. Committee of Age Reading Experts (CARE)

Presented by Elisa Russ, ADFG, CARE Chair. Written report will be provided covering the 2013 calendar year. CARE meeting had 37 attendees from 8 agencies. Topics covered ergonomics, age validation using stable isotopes and radio bomb carbon, dogfish ageing methods (dorsal spines vs vertebra) and long term storage of otoliths in glycerin. The CARE charter was also reviewed. The CARE working group report included updates to the glossary section, updates to Pacific halibut, QA/QC and accuracy sections for the CARE age determination manual. The CARE Charter committee continues on and three new members joined. The next International Otolith Symposium will be in Spain in October 2014. Some CARE members want to attend, pending agency approvals.
Important topics:

- Sablefish *ad hoc* working group has been conducting otolith exchanges and identified patterns of slow growth in young fish, and has made a recommendation to revise the sablefish ageing procedures to be incorporated into the CARE manual at the 2015 meeting.
- Website needs updated, it is hosted on PSMFC site. Need to decide on new software for the website, currently using older version of Joomla which is slow and clunky. Looking at newer version of Joomla, WordPress or WebText.
- The 2013 CARE meeting focused on the long-term storage of otoliths. One CARE member looked at otoliths that had been stored in various media from 1970 to 1985. Samples stored in ethanol and water were not changed, although evaporation occurred. Otoliths stored in glycerin, water and thymol seeped glycerin for days when removed and had a white powdery residue on the edge that concealed many rings (5-15 annuli). Other agencies had the same problem and CARE will take this up again at their 2015 meeting. It was suggested by a TSC member that a citable paper be produced by CARE documenting storage

media for short and long term storage and associated issues with each. (see TSC to CARE recommendations at the end of the minutes.)
- Issues of storage capacity, and processing time for labor intensive structures such as dogfish spines and lingcod fin rays were discussed. This led into a discussion of lingcod fin rays vs. otoliths. ADFG still ages both, depending on the lab, and some programs have switched from fin rays to otoliths, although only fin rays are age validated. It was also pointed out that there may be some geographic differences with age structure patterns for lingcod (and rockfish) sometimes being clearer from catch locations further north and getting progressively difficult to age as catch location moves south. NWFSC noted that they had no one to read lingcod or spiny dogfish. Aimee suggested that her lab might be able to help by prepping fin rays. Maybe an IPHC contractor could help with ageing, or the sport lab in AFSC.
- Ergonomics will be discussed in recommendations at the end of the meeting.

VIII. Other Topics

A. Marine Reserves

CDFW – After a long process all 124 marine protected areas (MPAs) in California have been adopted, comprising about 16 percent of state waters. CDFW held a symposium on 5 year survey/monitoring of central coast MPAs (the first region to be implemented), and there is a link provided in the TSC report. Since 2011 there has been a mobile MPA app showing all of the MPAs– it is web-based so only works nearshore. California MPAs are now included in a nationwide listing of MPAs. CDFW is transitioning into a phase of long-term monitoring, comparing inside and outside of MPAs. Remotely Operated Vehicle (ROV) surveys are starting up with 4 regions going through baseline monitoring. CDFW is working with partners for the monitoring phase. Several questions were asked: was the 16 percent close to the initial target? Yes. Is the 16 percent surface area of inside waters only? Yes, within state waters (3 miles). Also pointed out that there are various levels of use in the MPAs with some fishing allowed, depending on species. There was a question on research take and California is looking closely at this and adjusting as needed.

ODFW – There are two new marine reserves with harvest prohibitions at Cascade Head and Point Perpetua. This brings the total to four with a fifth area, Cape Falcon, to be implemented on January 1, 2016. This will be about 9 percent of territorial seas (within 3 miles from shore). ODFW is now working on site management plans which include outreach, compliance, etc. Baseline information was collected for two years before implementation using underwater video surveys (ROVs, video lander, scuba and hook and line) and limited oceanographic monitoring in the MPAs.

WDFW – They have a policy of no new MPAs, until data proving efficacy of existing protection measures can be collected. They have been monitored several existing MPAs in 1990s and early 2000s. WDFW is currently working on a comprehensive report of monitoring data. There are 5 or 6 sites with enough data to evaluate long-term. Until evaluations are complete there will be no movement on new MPAs. The Puget Sound Partnership produced a report in 2013, following on work completed by WDFW in 2009, which inventories MPAs in the Sound and the relative level of protection provided by each. The Rockfish working group includes various user groups, including tribes, non-government entities, and members of the federal Rockfish Recovery Team. The working group will be advising the Puget Sound Partnership on issues relating to monitoring and evaluation of rockfish in the Puget Sound.

B. Genetics

DFO Canada – Collaborating with AFSC on collection of DNA for rougheye/blackspotted rockfish. Collection includes visual identification as rougheye or blackspotted which will be compared with the genetic results. It is possible there are true blackspotted, rougheye and hybrids. Also collecting DNA for Pacific cod and English sole.

AFSC – Collaborating with DFO on rougheye/blackspotted rockfish genetics. Taking a dorsal fin clip and are able to have about 1000 clips analyzed in 4 days. They are finding that the visual identification of rougheye vs. blackspotted rockfish is about 80 percent correct. AFSC is also working on giant grenadiers, which have three distinctly different otolith shapes. They are collecting genetic material and otoliths but don't have any results to report yet. AFSC is also doing some work on sleeper sharks and deepwater coral. They are also working on Pacific cod stock structure, coastal vs. offshore.

NWFSC – working in southern California to separate vermilion and sunset rockfish by collecting DNA (fin clips), looking at differences in length at age, age at 50 percent maturity, etc. and also comparing with oceanographic conditions. There is also some work being done on eDNA (environmental DNA) which is basically analyzing sea water to see what species have been there. Jay Orr, AFSC, has a key to ID blackspotted vs. rougheye rockfish.

WDFW – They are doing some work on Pacific cod, herring and surf smelt in Puget Sound. It's possible that there are more than the three distinct herring stocks. WDFW is working on sixgill sharks in conjunction with the Seattle Aquarium; looking at multi-paternal litters. It looks like there are two lineages, one coastal and one offshore. They have also recently completed a project with sevengill sharks again in collaboration with Seattle Aquarium, assessing genetic variation between populations in Willapa and San Francisco Bays. Together with NWFSC, they have worked on designation of critical habitat for yelloweye, canary and bocaccio looking at sub-basin differences. They are considering utilizing eDNA analysis via a triggered water sample that has equilibrated for about a week. IPHC offered to do some sixgill shark collections in Puget Sound as they will be working in the area.

C. Western Groundfish Conference 2014

Lynne Yamanaka (DFO) gave an overview of the conference. Registration (139 participants) was down considerably from previous years but the conference did make a profit of about $15,000. The 2016 conference will be in Oregon, location to be determined. Newport is preferred but Astoria and Portland are options. All of the 2014 information will be forwarded to Lynn Mattes.

D. Visual Surveys Workshop

Kristen Green (ADFG) presented a summary of the workshop which was chaired by Kristen, Lynne Yamanaka (DFO) and Dayv Lowry (WDFW). The workshop was held April 8-9, 2014 with 32 participants representing 13 agencies. Topics covered included: survey design, stock assessment, video review and analysis, and equipment/technology. Proceedings of the workshop will be produced and will include various surveys, presentations and minutes of the working group. They will also be developing a fish behavior identification guide for use in visual surveys of all sorts. Participants will be polled on what the next meeting should focus on. There was a discussion on whether this was a working group of the TSC and how to keep the working group "alive". The group is looking for a shared system to house "grey" literature, photos for fish identification, and as a means for communication. Currently, Dropbox is being used to support part of these needs. Also, there was a discussion on automated identification of fish species seen on video. There are two NOAA initiatives providing funding: 1) selectivity and bias in video avoidance and attraction – work in Gulf of Mexico on grouper and snapper; getting accurate size and distance using fixed cameras, and 2) automated pattern recognition for rapid through-put species identification.
The role of the TSC was determined to be valuable in helping to set up this, and other, workshops. Proceedings will be posted on the TSC's website hosted by PSMFC. The initial focus of the workshop was meant to be on stock assessment and management but ended up broader with participants from sanctuaries being involved. There is a need for habitat identification as part of fish surveys in order to identify strata and where to fish.

IX. Review of Agency Groundfish Research, Assessment and Management

A. Agency Overviews

CDFW – The Department has been renamed the California Department of Fish and Wildlife to better reflect what the Department works on. Very little has changed in terms of marine work. There is more involvement with the Pacific Fishery Management Council (PFMC) and there will be an increased number of state management plans in the future. The Marine Region has a new Regional Manager, Craig Shuman, who was previously the Marine Advisor to the Fish and Game Commission.

ODFW – The Marine Resources Program has avoided most of the substantial budget cuts so far but won't know for sure until next year. There has been increased funding for the Marine Resources Program but it has been mainly federal funding. Working on Marine Fisheries Management Plan to produce a framework for how specific management plans are developed for different species/stocks.

WDFW – On the outer coast they have started Coastal Marine Spatial Planning, which involves mapping all coastal resources and human use of those resources. This means increased surveys of the outer coast. In 2012, there was a Puget Sound-wide ROV survey which built on previous surveys in 2008 and 2010; reports will be out soon. Video analysis has been slow. On the outer coast there may be a pilot ROV survey within state waters (3 miles) along with increased number of dive surveys which are related to MPAs, young-of-year rockfish and lingcod nests. In terms of management there are no removals of various sharks (i.e., sevengill, sixgill, and thresher sharks) permitted in state waters. The commercial smelt fishery has been evaluated and a 60,000 pound annual quota put into place to reduce fishery pressure. There is no information on the recreational fishery and funding is being sought to increase monitoring effort. They are working with NOAA on critical rockfish habitat and there will be targeted habitat surveys over the next two years via visual surveys with an ROV.

DFO Canada – The Pacific Region Regional Director of Science, Laura Richards, is retiring in June. Within the Groundfish Section there have been a number of retirements and staff numbers in the Section are down. There have been changes to how some surveys are funded by the federal government. After a court ruling that did not permit the Minister to allocate fish to fund surveys, Federal funding was provided in 2006 to 2012 for this purpose. However, this was stopped in 2013 concurrent with changes made to the Fisheries Act to allow the use of fish to pay for surveys. Several surveys did run in 2013, as not all fishing industry groups had worked out joint project agreements with the Department. The offshore hook and line and the IPHC surveys did not proceed and agreements are still pending.

NWFSC – There have been some staffing changes and some vacancies. The main need is for a new data manager and staffing is underway. After 2 years, Ian Stewart's position has been filled. There has been some repurposing of people as there were full time employees needing jobs. Due to the federal sequestration, large portions of surveys were lost (one full vessel and part of a second vessel). The hake survey this year is for research. There was a Committee of Independent Experts review of data used in assessments – to keep surveys going need more people. There is a hope that the findings will be taken into account. The hook and line survey is going again this year and will be permitted into the Cowcod Conservation Areas. Doing assessment of data poor species but results not yet known. NWFSC (and IPHC) wants to be able to sell research catches in California – Traci Larinto (CDFW) said that there may be a change in scientific collection permits (SCP) to allow this. The 5-year report on essential fish habitat has just been released.

ADFG – Budgets have not been too badly cut. Not many changes in programming to report. Kevin McNeal has been hired to replace Kristen Monk in the ageing lab. More biological information is being collected in the sport fishery.

AFSC – There are about 300 people in AFSC working on groundfish distributed between the Auke Bay lab, REFM (stock assessment) and RACE (surveys and oceanography). Budgets are down and positions are being shed to provide more money for operations. This has also resulted in reduced travel and conference attendance. There has also been a reduction in surveys – using two boats instead of three. The furlough caused problems. There is a new director for RACE, Jeff Napp. The observer program is developing electronic monitoring technology. The economic group is expanding.

*** At this point there was a brief discussion on how much information should be submitted for TSC agency reports. Important to think about what people will look back at in 40 years. There seems to be varying degrees of participation within the various agencies.*** (See TSC to itself recommendations at the end of the minutes.)

IPHC – Budgets have been somewhat affected by USA and Canada. The IPHC is able to use proceeds of fish caught during survey to offset some of the costs of that effort. Staffing - a new administrative assistant has been hired, Chris Johnson has been hired as a technician in the ageing lab. Gregg Williams is retiring this week after 36 years so will be hiring someone to run research programs. There have been some changes to the Commissioners. Since the Performance Review conducted two years ago the IPHC has been implementing the recommendations, e.g., webcasts of all meetings, increasing communications using Facebook and Twitter.

B. Multispecies Studies

CDFW – Since 2010 the recreational survey has been taking on more duties which has meant increased training of samplers and processing of data. The Department is now producing catch estimates rather than RecFIN, a coastwide recreational fisheries sample and catch estimation database.

ODFW – Recreational and commercial sampling continues. A number of multi-species studies are underway:

a. Relational database for state observer data from the sport fishery which can be linked to dockside data for comparison - in conjunction with SWFSC.
b. Outreach program – to increase the release of rockfish at depth. Stickers with "No Floaters Release at Depth", along with the distribution of about 5000 descending devices.
c. Commercial nearshore fishery – statewide, annual summary focused on nearshore groundfish.
d. Ageing – work continues.
e. Maturity reports – Copper rockfish was finished and available online. Blue Rockfish in progress.
f. Various acoustic telemetry studies
g. Discard mortality of rockfish due to barotrauma focusing on canary and yelloweye rockfishes; yelloweye did better.
h. North coast rocky reef ROV surveys – in conjunction with baseline monitoring of MPAs and other areas.
i. Coastal and marine area mapping – developing a shore zone mapping protocol.
j. Developing a video lander – high definition, cool toys. 2014 is the pilot year for nearshore surveys with lander.

WDFW highlights include:

a. The coastal black rockfish tagging program has been expanded to become the nearshore rockfish tagging program. Using mainly Floy and Passive Integrated Transponder (PIT) tags but also some acoustic tags.
b. The video review of the Puget Sound survey is almost complete. Looking at habitat diversity, amongst other things. Distilling bottom types down to a few important parameters. Will be working with SeaDoc Society to develop predictive models for identifying key groundfish habitat based on species-specific covariates with occurrence.

c. As part of the sound-wide trawl survey, WDFW is starting to do stomach contents again for ecosystem studies. This involves doing a gastric lavage for every fish and a total sample, (i.e., sacrifice of every 10th fish). Vertical plankton tows have also been added to the trawl protocol and will continue for several years. Looking for partners to fund processing and analysis of ichthyofauna, potentially including genetic identification of rockfish larvae. This lead into a discussion on bycatch permits and how poor the collection of information has been for annual summaries. Requests are now going into a database and what has been taken can now be compared to what was allowed. This had made the requests more restrictive and allows for better tracking.

DFO – Continuing to work on stock assessment priorities by describing the process for selecting/ranking species for assessment. However, funding cutbacks have delayed completion of this work. There seems to be more targeted funding for special projects, e.g., the Canadian Fisheries Research Network project started in 2010 and is running for 5 years. All surveys have been rebranded as "multispecies".

ADFG – not much to report on multispecies but they still conduct surveys each year.

NWFSC – highlights include:

a. Quantitative analysis of flatfish herding by trawl sweeps – this happens and needs to be accounted for.
b. Stomach content analysis using isotope analysis – stalled due to equipment.
c. Manuscript report out on juvenile rockfish.
d. Habitat studies – looked for association of corals/sponges and fish. Associations showed rosethorn and greenspotted rockfish with corals but not flatfish.
e. Diet study of Humboldt squid – using stable isotopes and Bayesian model.
f. Spawning potential of dogfish and other sharks.
g. Life history study for values in FISHBASE-type databases.
h. Video beam trawl system – 56 tows completed, looked at young-of-year fish.
i. Catch and species richness in three types of areas –rockfish conservation areas, partially opened/closed areas and always open areas. Significantly higher number of species in closed areas and also differences in sizes of fish between the areas.
j. Integrated ecosystem assessment – ongoing and is on the web. However, funding has been decreased.
k. Synchronized recruitment – looked at 52 stocks; tied to environmental drivers.

AFSC – conduct 6 multispecies surveys in eastern Bering Sea, Aleutian Islands and Gulf of Alaska using bottom trawl, midwater trawl and longline. Work is underway on 35 research topics including:

a. Tagging – sablefish, thornyheads and Greenland halibut. Some acoustic tags.
b. Gulf of Alaska integrated ecosystem study – looked at a number of species including Pacific cod, sablefish, Pacific ocean perch, arrowtooth flounder and pollock. Examined processes that affect recruitment. Used surface trawls to catch young-of-year pollock and rockfish. Next part will be to model transport and habitat suitability.
c. Work on estimated unreported bycatch in the halibut fishery.

d. Nationwide coral project – 11 substudies, in its 3rd year of funding. Looking at species identification. Chris Rooper has done work, using bottom trawl data, on predicting where sponges and corals would be present. Field testing is now underway. There is also some work on recruitment and regeneration.
e. Work on detailed bathymetry of Gulf of Alaska and the Aleutian Islands.
f. Recruitment processes
g. Habitat resource group – primarily in the Bering Sea.
h. Multispecies stock assessment – partially "fed" by stomach sampling.

C. By Species

1. Pacific cod

WDFW – attempted to catch Pacific cod for a special research project in Puget Sound but was unsuccessful. They are now collaborating on a coast-wide genetic variability assessment with NWFSC and University of Washington.

DFO Canada – working on feedback simulation, evaluating the effects of changes in monitoring and assessment frequency on management advice. The agency report provides more details and also gives an overview of the assessment.

AFSC – examining movements of juvenile Pacific cod near Kodiak, using acoustic telemetry to track the onset of onshore and offshore movements. Other projects include looking at the vertical availability of Pacific cod to trawls in the Bering Sea and dispersal patterns in the Bering Sea. The agency report provides information on the assessments; the Aleutian Islands assessment has been split from Bering Sea because the stocks are different.

ADFG – there was a tagging program but it has been discontinued. Most recoveries were made within 10-15 miles from the release location but there were some individuals that went further afield. There has been a contribution of length data to the national assessment staff for the central and western region. Southeast Alaska was not included as it is a different type of fishery (i.e., nearshore).

2. Nearshore rockfish

ODFW – Black rockfish PIT tagging project was ongoing in 2013. Exploitation rates are on average around 3.5-5 percent. The funding was lost for this project, but they will be monitoring for tag returns through the end of the 2014 summer season.

CDFW – The copper rockfish ageing project was ongoing in 2013 and will hopefully be completed in 2014. This project is working with historic otoliths from 1970s and 1980s.

WDFW – Puget Sound-wide ROV study will result in occurrence and density maps for all groundfish species, including rockfish, as well as Sound-wide abundance estimates with quantified variability.

ADFG – Southeast region is trying to use improved hydroacoustic surveys to estimate black and dark rockfish populations.

DFO Canada – Agency is trying to resurrect the outside longline rockfish survey but not sure if will happen because DFO has to have a cooperative agreement with the industry in order to conduct it. There were no surveys in 2013 and there are no stock assessments planned for 2014. The outside yelloweye assessment was pushed back to 2015. DFO is conducting the inside longline survey in 2014. A question was asked about what happens to the commercial catch of copper rockfish, to which Lynne replied that it mainly goes to the live fish market.

NWFSC – Data moderate assessments were conducted for brown, china, and copper rockfishes. Kristen asked what data was included in a "data-moderate" assessment. Aimee replied that it varied depending on the species but included more data than just catch, which is the only data source for data-poor assessments.

3. Shelf Rockfish

AFSC – The Gulf of Alaska dusky rockfish was assessed in 2013. The Acceptable Biological Catch (ABC) increased 17 percent but the CV's were higher for the survey.

NWFSC – There were data-moderate assessments conducted for sharpchin, yellowtail and stripetail rockfishes. There was an assessment update to bocaccio and data reports for canary, Pacific ocean perch and yelloweye rockfishes. A full assessment for cowcod was conducted.

ADFG – 2013 was the third year of the ROV survey to assess demersal shelf rockfishes (DSR). A federal stock assessment for DSR was accepted in 2013 by the North Pacific Fishery Management Council that used ROV and historical submersible survey datasets. The Southeast Region collaborated with the Central Region to conduct DSR surveys. They are utilizing their ROV and pilot to conduct the project, which will continue in 2014. Kristen was asked to clarify which regions participated, to which she replied that the Central Region was a collaborator, but only data from the Southeast Region was used in the stock assessment.

CDFW – There are currently two Experimental Fishing Permits issued by the PFMC for schooling rockfish. One is for using troll longline gear for chilipepper rockfish and the second is for using commercial jig gear for yellowtail rockfish. The commercial jig gear got 87 percent yellowtail and widow rockfishes. Ali asked if fishermen use troll gear for yellowtail in California, to which Traci replied that they don't typically.
DFO Canada – There was a silvergray rockfish coastwide assessment completed in 2013. There were decision tables included in the assessment, which concluded that the coastwide population was in pretty good shape. They are planning a yellowtail rockfish assessment this year.

4. Slope Rockfish

AFSC – A barotrauma study was ongoing for blackspotted rockfish in very deep waters. They tagged approximately 200 fish, most of which were released at depth in cages with video cameras. About 60 fish were recompressed and kept for laboratory workups. In past years,

survival was approximately 30-40 percent but when fish were recompressed at slower rates this year, survival increased to about 80 percent. They also had one return on the released fish. There was a paper that predicted abundance of Pacific ocean perch associated with corals and sponges in the Aleutian Islands published in 2013. This paper found a large number of significant variables predicted Pacific ocean perch associations with larger structures.
Lots of maturity information for deep water rockfishes has been published recently, including Pacific ocean perch for the Gulf of Alaska (GOA) and for rougheye rockfish. Rougheye rockfish were found to mature at 15.5 years and there was substantial evidence for skip-spawning (approximately 50 percent). Stock assessments for the GOA indicate that all the slope rockfish are doing well. Overall, ABCs were up about 10-20 percent. Additionally, Aleutian Islands Pacific ocean perch and northern rockfish are doing well. However, shortraker rockfish is in a long decline, although no overfishing is occurring. It was noted that there was a new fish maturity working group formed in advance of a national workshop planned in Seattle in November. It was suggested that TSC could sponsor a west coast specific workshop. There was also some discussion of the development of standards for maturity collection protocols. For example, Alaska still uses visual histology year round, though recent studies have suggested that this is only accurate during spawning season.

NWFSC – There were full assessments for darkblotched, aurora, rougheye/blackspotted rockfishes and Pacific ocean perch. None of these fish were experiencing overfishing. Darkblotched rockfish is in the middle of a rebuilding plan, but at 36 percent, the population is close to being declared recovered. A question was asked on how rougheye and blackspotted are differentiated in the field, and Aimee replied that they are not for the most part, and they take fin clips for genetic identification. There was also another question about who reviews the stock assessments in the PFMC. Aimee and others replied that a Stock Assessment Review Panel (aka STAR) reviews assessments, in addition to the PFMC's Science and Statistical Committee. Harvest specifications (Overfishing Limit/ABC) are set via the PFMC's process. Maturity information for darkblotched rockfish was updated and found that they have a lower age at maturity than what is being used in the assessments. Maturity of Pacific ocean perch is ongoing. NWFSC is grateful to ODFW for spawning season samples on rockfishes.

DFO Canada – The slope rockfish program is working on developing modeling language in *R* and a redbanded rockfish assessment is scheduled for 2014 using new software. They want to model ageing error for a large number of species as well. They are also continuing with rougheye and blackspotted differentiation work.

5. Thornyheads

AFSC – The stock assessments indicate that a high proportion of the biomass is in very deep water that the surveys do not typically go out to. Currently, the assessments extrapolate the biomass to cover the deep water portion of the stock but these are highly uncertain. There are three boats available for the GOA survey next year and the survey plans to assess deep waters to reduce the uncertainty involved with this extrapolation.

NWFSC – There were stock assessments for both shortspined and longspined thornyheads in 2013 which showed that both were lightly exploited but that biomass was decreasing. They're also trying to age thornyheads with lasers. Jason Cope, NWFSC, is looking at alternative methods to age thornyheads (for example, weighing otoliths). Lynne noted that DFO is also working on aging thornyheads. ADFG noted that they have been producing thornyhead ages for years in their Juneau lab. Jon noted that there was a North Pacific Research Board (NPRB) proposal to assess shortspine thornyhead maturity.

6. Sablefish

AFSC – The center continued tagging sablefish caught in the surveys. There's also a new manuscript out that models movement using these data, which includes 30 years of tagging data. The survey in Sitka for the relatively long series of juvenile CPUE continued in 2013. There was also a project in this area that looked at juvenile feeding habits. Maturity work is ongoing. There is substantial evidence for skip-spawning, particularly on the shelf. In 2011, it was discovered that about 90 percent of shelf sablefish were immature compared to those of the same age on the slope, though it was noted that this may not be a representative portion of the population. Satellite tagging work continued and they are working on the analysis for this project. The stock assessment for sablefish in the GOA showed declining population, and the ABC was reduced, though the stock is not considered overfished. There is an area apportionment for the execution of this fishery in the GOA.

NWFSC – There was a coastwide maturity study on sablefish. It found differences by depth and by geographic area in the maturity schedule, and there is potential for northern and southern stocks on the west coast. A question was asked about how skip-spawning was determined (ovary characteristics). Aimee noted that there is not much evidence for skip spawning on the west coast. This initiated a discussion about doing double reads on maturity in order to confirm evidence of skip spawning.

ADFG – Kristen noted that in inside waters, there is a high proportion of mature fish in the north (in the state-managed Northern Southeast Outside subdistrict), but closer to the Canadian border (in the state-managed Southern Southeast Outside subdistrict), most of the fish are immature. In 2013, ADFG discussed using minimum size limits for sablefish, similar to DFO Canada's regulations. Kristen noted that this was not implemented at the time. A tag-recapture study in the Southeast region continued and they are moving to an age-structured assessment for sablefish in this region. The survey was expanded to cover new areas in the fishery in the southern Southeast Outside subdistrict. A graduate project in St. Johns Bay to implant acoustic transmitters into juvenile sablefish will begin in 2015. This study is trying to assess movement of juveniles in and out of the bay.

DFO Canada – DFO is continuing sablefish pot surveys in 2014. In 2013, they deployed cameras on the traps. This is intended to assist with habitat suitability modeling efforts and attempting to assess the impact of the traps on the bottom habitat. The sablefish fishery proposed a Total Allowable Catch (TAC) floor and the policy was revised to incorporate this suggestion. TACs for the 2014 fishery were just above the TAC floor. There is also a management strategy evaluation planned for 2015.

7. Halibut and IPHC projects

There are multiple ongoing projects. First, IPHC is monitoring juvenile abundance on the NMFS trawl surveys in the north Pacific. There are a few archival tag projects, including testing the mounting protocols. They wanted to start coastwide deployment in 2014 but the tags are not working properly yet, now scheduled to begin in 2015.

There is a pilot project to re-assess the halibut length-weight relationship and to re-test the head conversion factor.

The annual IPHC survey was expanded into California in 2013 in response to increased sport removals. The survey extended from 42° North Latitude (OR-CA border) down to 40° North Latitude (just below Cape Mendocino). There was no drop in catch rates from 42° to 40° North Latitude. They are looking to expand further south in 2014, down to 39° North Latitude (near Point Arena). IPHC continued deploying a water column profiler on the survey, which began in 2009.

There is an ongoing project to assign maturity stages. There's also an ongoing otolith increment analysis project initiated in 2013 that uses archived otoliths.

Mercury contaminants work is ongoing with the Alaska Department of Environmental Conservation.

Projects related to the discovery of *Ichthyophonus*, a parasite, in halibut are ongoing. The pilot project in 2011 showed a high prevalence of *Ichthyophonus*, with the highest incidence in Prince William Sound (76.7 percent) with lower intensity in the other two regions Oregon and northern Bering Sea (33.8 and 26.6 percent, respectively). Sampling was expanded to all areas in 2012 averaging 47 percent overall, with the highest rate in Prince William Sound (over 70 percent) and the lowest at Attu Island (15 percent). It is unknown how the variable intensity of *Ichthyophonus* affects the fish. This is the third year that sites on the survey were tested for the presence of *Ichthyophonus*. They are also in the process of developing growth experiments. Additionally, IPHC got NMFS trawl samples, which consisted of smaller fish without the presence of the parasite. *Ichthyophonus* is known to cause die-offs in herring, and is also in sockeye salmon and pollock in the eastern Bering Sea. There was a lot of discussion around the *Ichthyophonus* monitoring and projects with the IPHC.
In 2013, a pilot project collecting skate biological and maturity samples for NMFS on the annual IPHC survey was initiated and this has been expanded to the entire survey area in 2014. There's a remote data-entry project ongoing and IPHC is looking at collecting logbook data on tablets. The annual survey is gradually moving over to tablets for data collection as well. Port samplers are testing the tablets in 2014, though they also have paper copies too, as a backup. Kirsten noted that they are using Panasonic Toughpads (Windows-based) in response to a question about the unit they're using. This initiated some discussion on the new technologies available for data collection in the field. Jon noted that the meeting of the Alaska Chapter of the American Fisheries Society meeting will have a workshop on electronic data collection. There's also a fish and technology session that's chaired by Kirsten. Claude noted that IPHC had an electronic workshop in 2009 and that IPHC is trying to improve their data processing times.

In 2014, there will be an experiment on hooking success of larger fish on the annual survey using GoPro cameras *in situ*. Also, IPHC will be looking at retention rates using recoveries of dummy tags. PIT and archival tags on fish in Area 4B show few returns in the area, suggesting the possibility of a Russian halibut stock. The IPHC will also be releasing pop-up archival transmitting (aka PAT) tags in the Salish Sea to look at halibut movement.

IPHC also noted that they will be expanding the depth range of their survey. Currently, the survey ranges from 20 to 275 fathoms, and they will be moving to 10 – 400 fathoms. This was piloted in 2011 on the west coast, and in 2013 a 5-year plan was approved to groundtruth the appropriate depth range for the survey. In 2014, the survey will fish the expanded depths in Areas 2A, 4A and a southern portion of the Bering Sea. IPHC also noted that with the expansion of the survey into California in 2013, this would change the apportionments for Area 2A. The annual survey may not go into California waters every year.

Claude provided additional detail on the mercury monitoring. He noted that he will be presenting at an EPA Forum on Contaminants in September which focusses on fish consumption advice. There are typically increased contaminants in fish from the western Aleutian Islands, because they're closer to Asia. He noted that he was attending a talk on radiation from the Fukushima, Japan nuclear disaster, but that studies show that radiation in halibut are very low, similar to albacore. In 2007, the Alaska Department of Health created recommendations targeted to pregnant women and children. These are set at very low thresholds generally, but they do monitor poison events. There was a lot of discussion about mercury consumption.

8. Flatfish

AFSC – There were several species, including yellowtail and flathead soles, with maturity work in the eastern Bering Sea supported by NPRB recently. Also, there is cooperative survey for a GOA flatfish survey, collected maturity from port sampling. Most flatfish are in good shape.

NWFSC – There were stock assessments for Petrale sole and Pacific sanddab. There were also data-moderate assessments for rex and English soles. Petrale sole was above the rebuilding plan thresholds and was declared rebuilt in 2013. There's also a diet study planned for 2014 for arrowtooth flounder and sanddabs.
DFO Canada – There was a rock sole stock assessment. The northern and southern rock sole were assessed together. They use a female spawning biomass model. In 2014, there will be a coastwide assessment for arrowtooth flounder.

9. Lingcod

ADFG – Agency is exploring the use of ROV data to assess lingcod in state waters (Central Region) but there is no stock assessment yet. There was a new paper on lingcod movement using tag/recapture data published in 2014 by the Southeast Region. The Agency has been tagging opportunistically for some years with about 9000 lingcod tagged since 1996.

AFSC – Some lingcod were tagged with satellite tags in 2013 to investigate movement patterns.

NWFSC – There is a lingcod diet study planned for 2014.

DFO Canada – There was a paper published on a study that looked at sex-specific seasonal migration impacts on the stock assessment for lingcod. There was a stock assessment scheduled for 2014 but it looks like it's not moving forward now.

10. Pacific Whiting (Hake)

CDFW – There is no hake fishery with the new Individual Transferable Quota (ITQ) fishery implemented now. Fishermen are trading quota to OR and WA.

NWFSC – Hake is assessed annually. The biomass was up in 2012 and 2013, but there is lots of uncertainty in the assessment, which folks are working to reduce. It was noted that there was less uncertainty when using the groundfish survey and Aimee said that she'd prefer to drop the hake survey.

DFO Canada – 2013 survey catches were dominated by 3-year old fish.

11. Walleye Pollock

AFSC – It was noted that the Latin name for pollock has now changed to *Gadus chalcogrammus*. The study on the larval and juvenile stages of pollock in the eastern Bering Sea and GOA is ongoing. This work has shown that that the cold pool in the eastern Bering Sea can change the distribution of adults and juveniles. This has been linked to energetics and oceanography models. There was a PhD thesis that dealt with distribution and vulnerability of pollock to the various types of survey gears, particularly the acoustic and bottom trawl survey. There are recently published papers on this, with more to come. There was a study at the Auke Bay Lab that looked at forage fishes in the GOA, which included pollock. In the Newport lab, there are ongoing studies looking at climate change impacts on pollock and Arctic cod. Also, a study was published on the effect of ocean acidification on the growth and survival of pollock. This found no differences in survival but did find high bone accumulation in the otoliths at lower pHs. The stock assessment in the GOA indicated an increase in pollock abundance, with lots of juveniles present in the survey. The assessment in the Bering Sea showed variable abundance, with a TAC of just over 1.2 million metric tons for 2014 and 2015.

ADFG – The state managed pollock fishery in Prince William Sound finalized a state guideline harvest level (GHL) in 2012 of 2.5 percent of the total GOA ABCs but since then, abundance has increased dramatically. In 2014, the GHL was 8.5 million pounds but the fishery is now running up against a rockfish bycatch cap, as the pollock GHL has increased, causing an early closure to the fishery.

12. Dogfish and other sharks

AFSC – There are now approximately 200 satellite tags on dogfish from the sablefish longline survey. They are getting returns on fish, with some fish that were tagged in Alaska showing up in southern California. There are also tags from the Puget Sound area and from British Columbia. Jon noted that most of the fish with satellite tags are female, because they need to be larger fish to support the tags. There are some dogfish from the Puget Sound area that also have acoustic tags, which are picked up by various arrays in Puget Sound. These fish have shown that the geo-locating on the satellite tags is relatively inaccurate. Work is continuing on ageing dogfish through vertebrae. The stock assessment for sharks in the north Pacific shows that most sharks are caught as bycatch. There was a report published on halibut bycatch, but these amounts are still below the dogfish ABC. There was discussion initiated about using acoustic tags.

ADFG – There was a paper published on salmon shark life history, which was in collaboration with AFSC. They are seeing more sleeper sharks in their surveys. It was noted that the Central region has tagged sharks in the past, but no longer continues this program.

IPHC – The Commission continued to measure and sex all dogfish caught in the annual survey. They also collected tissue samples from sleeper sharks on the annual survey in 2013, in addition to meristic measurements, but this was discontinued for 2014.

CDFW – White sharks still are a candidate species under the California Endangered Species Act. The decision will be made whether to list them as a state endangered species in June or August 2014. There is some evidence that the population has increased as the number of juveniles caught in gillnets has increased along with the number of sightings and suspected white shark attacks on sea otters.

WDFW – In 2014 it was made illegal to retain three species of shark in any recreation or commercial fishery in Washington State waters: sixgill sharks, sevengill sharks, and thresher sharks.

DFO Canada –The inside dogfish longline survey is planned for 2014, which is conducted every three years. They are considering discontinuing this fixed station survey and using indices from the depth stratified, random sample inside longline survey.

13. Skates

ADFG – The Agency continued tagging big, longnose, and Aleutian skates, but there's little information on recaptures so far. The skate fishery is usually bycatch only.
DFO Canada – Big and longnose skate stock assessments were completed in 2013. The inside longline survey is planned for 2014, which is conducted every three years. They are considering dropping this survey.
AFSC – There is a report coming out next year that categorizes hooking injuries with a graduate student. This is needed to get a handle on discard mortality in the survey and the fishery. Jerry Hoff is also working on delineating skate nursery areas in the Bering Sea and GOA.

14. Grenadiers

AFSC – There's lots of information on giant grenadiers. The NPFMC designated grenadiers in the Alaska groundfish programmatic fishery management plan (includes both Bering Sea-Aleutian Islands and GOA) as an ecosystem component species. This means there is no formal stock assessment and no annual catch limits assigned, though there are requirements for monitoring and informal assessments conducted. There is new interest in a potential market for grenadiers. There is also the new genetic study that looks at giant grenadiers with three different otolith shapes mentioned yesterday.

15. Other Species

a. Kelp greenling

ODFW – The Agency is continuing efforts to assess kelp greenling maturity. Recent data analysis concluded that there was a gap at a critical size where the proportion mature increases dramatically. Specific efforts to collect samples in this size range are ongoing in 2014 in both the south and central coast.

AFSC – Wayne noted that the WDFW survey in the San Juan Islands documented sleeping kelp greenling.

b. Hagfish

DFO Canada – The experimental hagfish fishery occurred again in 2013. A preliminary survey conducted depletion experiments. A review will be conducted in a month or so. DFO has been collecting lots of biological samples and are developing a maturity description.

ODFW – Ali noted that the hagfish fishery in Oregon has been developing over the last 10 years and that there is interest in developing a population estimate using recently approved data-poor assessment techniques.

ADFG – Kristen noted that there was interest in developing a hagfish fishery in the Southeast Region of Alaska.
CDFW – Traci also noted that in California, the hagfish fishery has been ongoing for some time, though landings have decreased recently. She also noted that CDFW has been collecting biological samples.

c. Octopus

AFSC – There have been recent studies on octopus bycatch, looking at mortality in the Pacific cod pot fishery. These have shown that immediate mortality is very low, and that delayed morality in a laboratory setting was also very low. There's also a paper looking at octopus maturity and reproduction timing in the GOA. Also EcoFOCI (Ecosystem & Fisheries-Oceanography Coordinated Investigations) has been looking at recruitment processes in blue king crab and in snow crab, associated with their pollock recruitment studies. This was noted as a potential area for TSC involvement – looking at evidence for climate shifts in multiple areas (Alaska, British Columbia and the west coast), including coastwide range shifts using El Niño as a proxy.

d. Miscellaneous species

AKFSC – Working on systematics for some hard to identify fishes like snailfishes, sand lances, and other cryptic species
NWFSC – Looking into bycatch reduction devices to reduce bycatch of eulachon, Pacific halibut, and other species. Last year a lot of eulachon were caught in the trawl survey.

D. Other Related Studies

1. Ecosystem Studies

AFSC – Jon noted that they already brought up most of this work under multi species work, but he also noted that the FATE (Fisheries and the Environment) project is ongoing, which is working on refining an ocean health index. Also, the reauthorization of the Magnuson-Stevens Act included language on ecosystem-based fisheries management.

DFO Canada – There was a study on the vulnerability of Canadian fisheries to ocean acidification. This spurred a short discussion of invasive species and range shifts.

AFSC – Wayne noted that a new draft checklist of marine invertebrates has been developed for Alaska waters. Also, the conservation engineering group at AFSC is working on developing gear modifications for decreasing crab and coral bycatch. They've also been lending underwater cameras to trawl fishermen.

NWFSC – There has been a decrease of widow rockfish in the rockfish fisheries. There's a decrease in halibut bycatch in the groundfish trawl fishery since ITQs were implemented. Also they're working with ODFW on reducing eulachon bycatch in the pink shrimp fishery, and the 2013 trawl survey caught a lot of eulachon.

E. Other Items

1. Marine Mammal Predation

ADFG/AFSC – There is a joint proposal to use pots in the sablefish survey to reduce whale predation.

IPHC – Octopus were sampled (sex, weight) in 2013 during the annual survey in cooperation with Liz Connors's work in the GOA.

ODFW – There are ongoing Steller sea lion diet studies on the southern Oregon coast. Past work has shown they predate on groundfish more than their counterparts in the Columbia. The Stellar sea lion eastern distinct population segment was declared recovered and removed from the federal Endangered Species Act in 2013.

NWFSC – The NWFSC is experimenting with a towed echosounder to extend the egg survey.

X. Progress on 2013 Recommendations

A. From TSC to Itself

1. *TSC recommended examining long-term health exposures and issues resulting from evaluating fish age structures*.

   No progress was made on this issue because the letter to the agencies was not sent out. It will be included in the agency letter this year and will include the TSC and CARE's concerns.

2. *TSC recommended hosting a visual survey workshop to be held in early 2014.*

   The visual survey workshop was held April 8-9, 2014 with 32 participants representing 13 agencies, and was considered a success (see report VIII.D.). Proceedings of the workshop will be posted on the PSMFC website.

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 was not completed as it should have been included in the agency letter, and will be included this year.

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 contacted Mark Wilkins, who was unable to take on the task of updating the document. Stephen will be contacting Rick Stanley, retired DFO and former TSC member, about updating the TSC accomplishments document.

5. *TSC recognizes the importance of the TSC annual reports and requests that each Agency make them and the TSC website more visible.*

   This was not completed as it should have been included in the agency letter, and will be included this year.

   The Chair apologized saying that she was unaware of the responsibility to draft the letter to the agencies, but that it will be completed this year and will include all the 2013 TSC recommendations. The group felt that the minutes from the TSC- sponsored visual survey workshop should be included in the agency letter. It was also noted that the list of agency directors needs to be updated as well.

   Stephen noted that PSMFC typically sponsors groundfish conferences and members suggested that this may be an opportunity to advertise the TSC. It was noted that there is a logo for the TSC. This initiated a larger discussion focused on marketing the TSC. Members noted that anytime the TSC sponsors something like a workshop (e.g., the visual survey workshop) TSC logo should be included. Also, several members felt that the annual reports are under-utilized.

B. From TSC to the Parent Committee

1. *TSC recommends that the Parent Committee supports the visual methods workshop.*

   The Parent Committee supported the visual methods workshop by having TSC members from Canada and the U.S. as workshop chairs.

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.*

   This was not completed as it should have been included in the agency letter, and will be included this year.

3. *TSC recommends that the Parent Committee remind the Agencies about the valuable information available on the TSC website*.

   This was not completed as it should have been included in the agency letter, and will be included this year.

C. From 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.*

The TSC noted that they supported last year's recommendations, but the agency letter didn't go out in 2013, so this will be noted in the 2014 letter.

XI. 2014 Recommendations

A. From TSC to Itself

1. The TSC recognizes the value of the 2014 Visual Survey and understands that there will be more information forthcoming from the survey follow-up. That information will be shared with the TSC at the next meeting. While interest was expressed to form a working group or second workshop, the TSC agreed to discuss this at the next meeting, pending the outcomes of two NOAA initiatives and feedback from the 2014 survey participants.

2. The TSC recognizes the importance of climate shifts and that some agencies are looking to be "climate ready". Members suggested that this could be a topic for the 2016 Western Groundfish Conference, although some suggested limiting it to changes in

species distributions. Wayne Palsson, AFSC, agreed to see if there was interest in a Climate Workshop and report back to the TSC in 2015.

3. The TSC discussed the need to either sponsor or organize a maturity working group or a workshop. Members noted that lots of stock assessment models are based off of one maturity estimate, despite documented variability in maturity within stocks, and that more maturity work needs to be done. AFSC noted that they have a maturity working group but encouraged more coastwide representation. Several agencies noted that they would be interested in participating in this, if established. Wayne Palsson noted that he would gauge interest at the national workshop in November. Tom Wildebuer, Jon Heifetz and Wayne Palsson, all AFSC, volunteered to be leads on this recommendation and to report back at the 2015 TSC meeting.

4. The TSC recommends including the 2013 recommendations that were not in the 2013 agency letter, including:

    a. TSC recommended examining long-term health exposures and issues resulting from evaluating fish age structures.
    b. 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*).
    c. TSC recognizes the importance of the TSC annual reports and requests that each Agency make them and the TSC website more visible

5. The TSC recognizes the value of the 2014 Visual Survey and recommends that the Proceedings of the workshop be posted to the TSC website.

6. The TSC agreed to discuss the possibility of another trawl survey workshop at the 2015 annual meeting. This workshop could be held in conjunction with the 2016 Western Groundfish Conference or separately.

7. TSC recognizes that the meeting and annual reports should be examined for flow, structure, and content. A subcommittee should be established to examine the need, identify options, and recommend a new format if need.

B. TSC to Parent Committee

1. 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). *Held over from 2013.*

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). *Held over from 2013*.

2. The TSC understands that CARE is looking into issues surrounding long-terms storage of otoliths. TSC suggests that CARE researchers document their findings and develop a set of best practices for short and long term otolith preservation and storage.

XII. Schedule and location of 2015 TSC Meeting

The next TSC meeting will be held April 28-29, 2015 in British Columbia with DFO hosting. Some members noted that there may be difficulties traveling out of country in the current budget climate. Lynne Yamanaka, DFO, agreed to act as a backup chair if Traci Larinto, CDFW, is unable to attend due to travel restrictions.

The meeting was adjourned at 12:14pm.

D. Parent Committee Minutes

Minutes of the 55th 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, April 30, 2014.

II. The Agenda

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

III. The 2013 Parent Committee meeting minutes

The Parent Committee minutes were adopted as presented

IV. Progress on 2013 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. (Note: This action was deferred to 2014).

Action: The TSC Visual Survey Methods Workshop was held April 8-9, 2014 at the NOAA Fisheries Alaska Fisheries Science Center (AFSC) in Seattle, Washington. Further information on the workshop can be found at http://www.psmfc.org/tsc2/TSC_Visual_Survey_Methods_Workshop_2014.html

V. 2014 Parent Committee Recommendations

a) Parent Committee agrees with the 2013/2014 TSC recommendation that agencies examine the long-term health exposures and issues resulting from evaluating fish age structures. This "ergonomic remedies" item will be reflected in the annual letter to agencies.

b) The Parent Committee agrees with the TSC on updating the TSC "Agency Overview" document. An updated document will be reviewed at the 2015 meeting.

VI. 2015 Meeting Location

Parent Committee agrees with the proposed location and schedule for the 2015 TSC and Parent Committee Meeting: British Columbia, Canada, April 28 and 29, 2015. DFO 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 International Pacific Halibut Commission staff for setting up and hosting the meeting.

VIII. The Parent Committee meeting was adjourned at 10:45 am, Wednesday April 30, 2014.

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

2013 Agency Report

to the

Technical Subcommittee of the

Canada-US Groundfish Committee

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VIII. REVIEW OF AGENCY GROUNDFISH RESEARCH, ASSESSMENTS, AND MANAGEMENT IN 2013

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 and Bering Sea groundfish. All Divisions work closely together 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 Program (SAP), and Research Fishing Gear/Survey Support. These Programs operate from three locations in Seattle, WA, Newport, OR, and Kodiak, AK.

In 2013 one of the primary activities of the RACE Division continued to be fishery-independent stock assessment surveys of important groundfish species of the northeast Pacific Ocean and Bering Sea. Regularly scheduled bottom trawl surveys in Alaskan waters include an annual survey of the crab and groundfish resources of the eastern Bering Sea shelf and biennial surveys of the Gulf of Alaska (odd years) and the Aleutian Islands and the upper continental slope of the eastern Bering Sea (even years). Two Alaskan bottom trawl surveys of groundfish and invertebrate resources were conducted during the summer of 2013 by RACE Groundfish

Assessment Program (GAP) scientists: the annual eastern Bering Sea shelf survey, and the biennial Gulf of Alaska survey..

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 Gulf of Alaska as well as winter acoustic trawl 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 Jeffrey Napp at (206)526-4148.

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 studies on benthic habitat. Presently, the program is staffed by 14 scientists and 1 post doc. ABL’s Ecosystem Monitoring and Assessment Program (EMA) has also been conducting groundfish-related research for the past few years.

In 2013 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) satellite tagging and life history studies of spiny dogfish and sablefish; 3) recompression experiments on rougheye and blackspotted rockfish; 4) a large-scale, epipelagic trawl survey of the northern Bering Sea shelf conducted by ABL's EMA Program; and 5) an upper trophic level fisheries oceanography survey of the Gulf of Alaska.

Ongoing analytic activities in 2013 involved management of ABL's sablefish tag database, analysis of sablefish logbook and observer data to determine fishery catch rates, and preparation of eleven status of stocks documents for Alaska groundfish: Alaska sablefish, Gulf of Alaska Pacific ocean perch, northern rockfish, dusky rockfish, rougheye/blackspotted rockfish, shortraker rockfish, "Other Rockfish", and thornyheads, and Gulf of Alaska and Eastern Bering Sea sharks and grenadiers. Other analytic activities in 2013 included analysis of sablefish maturity and calculation of estimates of bycatch in the unobserved Pacific halibut fishery.

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

2013 Eastern Bering Sea Continental Shelf Bottom Trawl Survey – RACE GAP

The thirty-second in a series of standardized annual bottom trawl surveys of the eastern Bering Sea (EBS) continental shelf was completed on 9 August 2013 aboard the AFSC chartered fishing vessels *Aldebaran* 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 2013 were 4.6 million metric tons (t) for walleye pollock, 81 thousand t for Pacific cod, 2.3 million t for yellowfin sole, 1.8 million t for rock sole, 24.9 thousand t for Greenland turbot, and 184 thousand t for Pacific halibut. There were slight increases in estimated total biomass compared to 2012 levels for walleye pollock, yellowfin sole, and Greenland turbot, and slight decreases for Pacific cod, rock sole, and Pacific halibut.

Average surface and bottom temperatures increased in 2013, from 5.1°C to 6.4°C for the surface and from 0.9°C to 1.7°C for the bottom. Both average surface and bottom temperatures were 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 .

2013 Biennial Bottom Trawl Survey of Groundfish and Invertebrate Resources of the Gulf of Alaska – RACE GAP

The thirteenth in a series of comprehensive bottom trawl surveys of groundfish resources in the Gulf of Alaska (GOA) region was conducted from May 24 through August 6, 2013 with actual trawling occurring from May 29th to August 4th. This regional survey began in 1984 and was conducted triennially until 1999 and was then conducted biennially thereafter. The standard GOA survey area begins at the Islands of the Four Mountains (170° W longitude) and extends east along the shelf and upper slope of the GOA and then south to Dixon Entrance. Sampled depths range from approximately 15 to 1000 m during a typical survey but during the past two surveys the upper slope has only been sampled to a depth of 700 m. Commercially and ecologically valuable species of flatfish, roundfish, rockfish, and invertebrates inhabit the area. 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 and invertebrate systematics, etc) and improving survey methodology.

The survey design is a stratified-random sampling scheme based 54 strata of depths and regions and applied to a grid of 5x5 km^2 cells. Stations that were previously identified as untrawlable were excluded from the sampling frame. Stations were 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. The preferred amount of stations (825) was reduced by one third during 2013 Survey fishing because of budget limitations. Instead of three vessels, only two chartered commercial trawlers, the F/V *Alaska Provider* and the F/V *Sea Storm*, were used to conduct trawling operations at 550 pre-planned stations during the 75 day sampling period. 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 548 stations at original or nearby alternate sites, ranging in depth from 17 to 688 m. Just over 354 mt fish of fish and 6.5 mt of invertebrates were captured during the survey, and the catch consisted of 185 fish taxa and 405 invertebrate taxa. Pacific ocean perch was the most abundant fish species found in the survey, followed by arrowtooth flounder, walleye pollock, Pacific cod, giant grenadier, and northern rockfish. The eight most abundant fish species comprised 94% of the sampled fish.

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

Winter Acoustic-Trawl Surveys in the Gulf of Alaska -- MACE Program

The MACE Program conducted winter acoustic-trawl (AT) surveys in 2013 aboard the NOAA ship *Oscar Dyson*, targeting walleye pollock (*Gadus chalcogrammus*) in Sanak Trough, the Shumagin Islands, Morzhovoi Bay, Marmot Bay, Shelikof Strait, and along the shelf break southeast of Chirikof Island. Midwater and near-bottom acoustic backscatter was sampled using an Aleutian Wing 30/26 Trawl (AWT), and on-bottom backscatter was sampled with a poly Nor'eastern (PNE) bottom trawl.

The Shumagin Islands survey was delayed for 2.5 weeks from original plans due to vessel mechanical issues that required returning to Kodiak for repairs following initial acoustic system calibration. The survey was subsequently conducted 26 February through 1 March 2013 along parallel transects spaced 5 nautical miles (nmi) apart within Shumagin Trough, 1 nmi apart east of Renshaw Point, and 2.5 nmi apart elsewhere. The Sanak Trough survey was conducted 2 March 2013 along transects spaced 2 nmi apart, and the Morzhovoi survey was conducted 3 March 2013 along transects spaced 2.5 nmi apart.

Dense aggregations of walleye pollock were observed in the West Nagai Strait, Unga Strait, and Shumagin Trough portions of the Shumagin Islands survey. However, fish aggregations were low in the Renshaw Point area, where the highest quantities of adults have historically been detected. The vast majority of walleye pollock detected in the Shumagin Islands were age-1 walleye pollock (8-14 cm fork length (FL)). The unweighted maturity composition for males longer than 40 cm FL was 0% immature, 14% developing, 67% pre-spawning, 8% spawning, and 11% spent. The maturity composition of females longer than 40 cm FL was 0% immature, 24% developing, 69% pre-spawning, 3% spawning, and 4% spent. The combined percentage of spawning and spent female fish was low and together with the high percentage of pre-spawning females indicates that survey timing was appropriate. The mean gonadosomatic index (GSI: ovary weight/body weight) for mature pre-spawning females was 0.12. The pollock AT survey abundance estimate in the Shumagin Islands area was 91,295 t (48% of which was age-1 pollock), based on catch data from 9 trawl hauls and acoustic data from 408 nmi of survey transects.

The densest pollock aggregations in Sanak Trough were located over the northeast portion of the trough and consisted primarily of adult pollock 40-73 cm FL (mode 55 cm). A large number of age-1 walleye pollock, which have not been seen in Sanak Trough in significant numbers in the past, were also present in the southwest portion of the trough. The unweighted maturity composition for males longer than 40 cm was 1% immature, 6% developing, 66% pre-spawning, 12% spawning, and 15% spent. The unweighted maturity composition for females longer than 40 cm FL was 3% immature, 6% developing, 78% pre-spawning, 9% spawning, and 4% spent. The average GSI for pre-spawning females was 0.15. The abundance estimate for Sanak Trough of 13,282 t was the lowest in the survey's history and was based on catch data from 2 trawl hauls and acoustic data from 96 nmi of survey transects.

Walleye pollock were diffusely scattered throughout Morzhovoi Bay and mainly consisted of age-1 fish in the 9-14 cm FL range. The unweighted maturity composition for males longer than 40 cm FL was 0% immature, 0% developing, 30% pre-spawning, 4% spawning, and 65% spent. The maturity composition of females longer than 40 cm FL was 0% immature, 10% developing, 40% pre-spawning, 0% spawning, and 50% spent. The average GSI for pre-spawning females was 0.16. The biomass estimate for Morzhovoi Bay was 2,476 t based on catch data from 1 trawl haul and acoustic data from 47 nmi of survey transects.

The MACE Program also conducted winter AT surveys in Marmot Bay, Shelikof Strait, and along the shelf break southeast of Chirikof Island. Marmot Bay was surveyed 15-16 March 2013 along parallel transects spaced 2 nmi apart in the outer bay and 1 nmi apart in the inner bay and in Spruce Gully. The Shelikof Strait sea valley was surveyed from Black Cape on Afognak Island to due west of Chirikof Island 16-25 March 2013 along parallel transects spaced 7.5-nmi apart. The shelf break from Chirikof Island to the mouth of Barnabas Trough was surveyed 25-27 March 2013 along transects spaced 6-nmi apart along the 300 m contour.

In Marmot Bay dense schools of 45 to 70 cm FL walleye pollock were detected northwest of Spruce Island and in Spruce Gully. A large aggregation of fish was also detected near Whale Island that consisted of two smaller size groups, 10 to 16 cm FL (age-1 fish) and 25 to 35 cm FL. The unweighted maturity composition in Marmot Bay for males longer than 40 cm FL was 0% immature, 2% developing, 49% pre-spawning, 49% spawning, and 0% spent. The maturity composition of females longer than 40 cm FL was 0% immature, 4% developing, 95% pre-spawning, 1% spawning, and 0% spent. The biomass estimate for Marmot Bay was 19,942 t from 5 trawl hauls and acoustic data from 150 nmi of survey transects.

As in previous years the highest walleye pollock densities found in Shelikof Strait were observed along the northwest side of the Strait near Kukak Bay. Within this deepest section of the strait along the steep banks of the Alaska Peninsula, dense aggregations of pre-spawning adult fish, primarily in the 45 to 65 cm FL range, were detected. These pre-spawning adult fish were predominantly between the ages of 5 and 9 years old, with some as old as 15 years. Dense midwater aggregations were detected throughout the remainder of the Strait. In the northeast near Afognak Island these aggregations consisted mainly of age-1 walleye pollock in the 9 to 16 cm FL range. Near bottom aggregations located in the north-central thru southern regions of the Strait also contained age-1 fish along with several different adult size groups up to 73 cm FL.

In Shelikof Strait, the unweighted maturity composition for males longer than 40 cm FL was 7% immature, 6% developing, 23% mature pre-spawning, 63% spawning, and 1% spent. The maturity composition of females longer than 40 cm FL was 8% immature, 5% developing, 83% pre-spawning, 4% 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 0.14. The pollock abundance estimate for Shelikof Strait of 891,261 t is the largest seen in the region since 1985 and is 40% greater than the historical mean for this survey. The 2013 estimate was based on catch data from 27 trawl hauls and acoustic data from 683 nmi of survey transects. An additional 7 AWT experimental hauls were conducted in midwater at 2 locations in Shelikof Strait to quantify escapement of juvenile walleye pollock from the net.

Most walleye pollock backscatter in the Chirikof survey was detected on two separate transects, one due south of the Trinity Islands and east of Chirikof Island and the other just west of the mouth of Barnabas Trough. The walleye pollock caught were adults ranging in length from 47-75cm FL. The unweighted maturity composition for males longer than 40 cm FL was 0% immature, 0% developing, 27% pre-spawning, 73% spawning, and 0% spent. The unweighted maturity composition for females longer than 40 cm FL was 0% immature, 0% developing, 92% pre-spawning, 8% spawning, and 0% spent. The average GSI for pre-spawning females was 0.2. The abundance estimate of 63,008 t is 1.7 times larger than the 2002-2012 mean for this survey and is based on catch data from 4 trawl hauls and acoustic data from 166 nmi of survey transects.

Summer Acoustic-Trawl Survey on the Eastern Bering Sea Shelf -- MACE Program

The MACE Program completed a summer 2013 acoustic-trawl (AT) survey of walleye pollock (*Gadus chalcogrammus*) across the Gulf of Alaska (GOA) shelf from the Islands of Four Mountains eastward to Yakutat Trough aboard the NOAA ship *Oscar Dyson*. The summer GOA shelf survey also included smaller-scale surveys in several bays and around islands. Midwater and near-bottom acoustic backscatter was sampled using an Aleutian Wing 30/26 Trawl (AWT), and on-bottom backscatter was sampled with a poly Nor'eastern (PNE) bottom trawl. A Methot trawl was used to target midwater macro-zooplankton, age-0 walleye pollock, and other larval fishes. Conductivity-temperature-depth (CTD) casts were conducted to characterize the physical oceanographic environment. A trawl-mounted stereo camera ("Cam-Trawl") was used during the survey to aid in determining species identification and size of animals encountered by the AWT at different depths. During night operations small scale grid surveys were also performed across the shelf based on the AFSC groundfish survey's trawlability grid. Trawlable (n=18) and untrawlable (n=16) grids were surveyed using the EK60 acoustic system (18-, 38-, 70-, 120-, and 200-kHz) and a Simrad ME70 multibeam sonar to assess the trawlability designation of the grid. Grid sampling was augmented with stereo-video drop camera deployments to groundtruth bottom classification and estimate species abundance.

The survey of the GOA shelf and shelf break was conducted between 9 June and 5 August 2013 and consisted of 38 transects spaced 25 nautical miles (nmi) apart. Walleye pollock distribution was patchy across the shelf. The areas of greatest walleye pollock density on the shelf transects were south of the Unimak Pass, between Mitrofania and Nakchamik Islands, south of the Trinity Islands, and south of the Kenai Peninsula in dense aggregations spread across the Portlock Bank area. Based on catch data from 29 AWT and 16 PNE hauls, two major length modes of walleye pollock were caught on the GOA shelf, one ranging from 13 to 22 cm FL with a mode of 18 cm FL representing age-1 fish, and the other ranging from 35 to 70 cm FL with a mode of 54 cm FL. The walleye pollock biomass estimate for the GOA shelf of 269,131 t from the 1,671 nmi of trackline surveyed was approximately 32% of the total walleye pollock biomass observed for the entire survey.

Sanak Trough was surveyed 15 June along transects spaced 4 nmi apart. The sparse backscatter attributed to walleye pollock in Sanak Trough was patchy and scattered throughout the 50 nmi of transects surveyed. Pollock captured in the one AWT haul in Sanak Trough were primarily in the 27 to 61 cm FL range with a mode of 44 cm FL, resulting in a biomass estimate of 927 t.

Morzhovoi Bay was surveyed 15 June along transects spaced 2.0 nmi apart. Backscatter in Morzhovoi Bay attributed to walleye pollock was diffuse and evenly scattered along the 48 nmi of survey transects. Walleye pollock captured in 2 AWT hauls in Morzhovoi Bay had 2 distinct length distributions, one ranging from 12 to 16 cm with a mode of 14 cm, and the other from 49 to 72 cm, with some larger fish up to 80 cm, and a mode of 59 cm. The biomass estimate for the 48 nmi of trackline surveyed in Morzhovoi Bay was 5,758 t.

Pavlof Bay was surveyed 16 June along transects spaced 2.0 nmi apart. The acoustic backscatter attributed to walleye pollock in Pavlof Bay was sparse and distributed throughout the bay with a large school observed at the mouth of the bay. Walleye pollock captured in Pavlof Bay from 1 AWT and 1 PNE haul were predominantly in the 10 to 16 cm FL range (age-

1), with fewer fish in the 17 to 73 cm FL range. The biomass estimate in Pavlof Bay was 2,150 t from the 46 nmi of trackline surveyed.

The Shumagin Islands were surveyed on 19-23 June along transects spaced 3.0 nmi apart in West Nagai Strait, Unga Strait, and east of Renshaw Point, 7.5 nmi apart in Shumagin Trough, and 11 nmi apart on the outer shelf. In the Shumagin Islands walleye pollock were most abundant in the Unga strait area and in the Shumagin Trough. Walleye pollock from 6 AWT hauls ranged in length from 10 to 70 cm FL, with the majority of fish in the 10 to 16 cm FL range, representing age-1 walleye pollock. The biomass estimate for the Shumagins Islands of 33,605 t was approximately 4.5 times higher than any previous summer Shumagin acoustic survey estimate and was 90% composed of age-1 fish. 280 nmi of tracklines were surveyed.

Mitrofania Island was surveyed 22-23 June along transects spaced 3.5 nmi apart. The majority of acoustic backscatter attributed to walleye pollock near Mitrofania Island was to the west and south of the island. The vast majority of walleye pollock captured in the 3 AWT hauls near the island ranged from 11 and 18 cm FL with a mode at 14 cm, representing age-1 fish. The biomass estimate in Mitrofania was 2,459 t along the 65 nmi of tracklines surveyed.

Nakchamik Island was surveyed 24-25 June along transects spaced 3.0 nmi apart. Backscatter attributed to walleye pollock near Nakchamik Island was evenly dispersed across the 48 nmi of surveyed transects. Walleye pollock captured in the one AWT haul near Nakchamik Island ranged from 44 and 64 cm with a mode at 54cm. The biomass estimate for the Nakchamik Island area was 8,861 t.

Shelikof Strait was surveyed from 1-7 July along transects spaced 15 nmi apart. The highest walleye pollock densities in Shelikof Strait were found in the north between Afognak Island and the Alaska Peninsula, and in the middle of the survey area between the western end of Kodiak Island and the Alaska Peninsula. Unlike the winter survey, the majority of the biomass in the northern half of the strait was age-1 walleye pollock. Age-1 pollock were also present in the middle of the survey area west of Kodiak Island, along with larger fish in the 35 to 45 cm FL range, while fish in the 40 to 65 cm FL range were primarily caught in the south of the strait. Lengths were obtained from 13 AWT hauls. The biomass estimate for the 578 nmi of trackline surveyed in Shelikof Strait was 423,031 t, which accounted for approximately 48% of the entire GOA summer survey pollock biomass estimate, and almost 3 times the biomass estimate of any previous summer survey of Shelikof Strait. Approximately 25% of the biomass detected in Shelikof Strait were age-1 walleye pollock (89% by numbers).

Alitak Bay was surveyed 9-10 July along transects spaced 3.0 nmi apart in the outer bay, and along zig-zag transects in the inner Deadman Bay area because of the narrowness of the bay. The densest pollock aggregations in Alitak Bay occurred in the inner part of Deadman Bay. Walleye pollock ranged in length from 25 to 35 cm FL in the one AWT haul conducted in Deadman Bay. Two PNE hauls conducted in the mouth of Alitak Bay resulted in walleye pollock between 45 and 70 cm FL. The biomass estimate for the Alitak/Deadman Bay area was 15,149 t along 59 nmi of trackline surveyed. Even though the aggregation in Deadman Bay was very dense, the overall Alitak/Deadman Bay biomass estimate was less than 2% of the entire summer survey biomass because of the small geographic area contained within the bay.

Barnabas and Chiniak Troughs were surveyed between 11 and 18 July along transects spaced 3.0 nmi apart. Large aggregations of adult walleye pollock were detected in Barnabas and Chiniak Troughs. Walleye pollock caught in 10 AWT hauls in Barnabas Trough and 8 AWT hauls in Chiniak Trough had bimodal size ranges, one from 16 to 24 cm FL, and another from 35 to 70 cm FL, with modes in both areas at 18-20 cm and 54-56 cm FL. The biomass estimate for the 300 nmi of trackline surveyed in Barnabas Trough was 62,818 t, approximately 7% of the entire GOA summer survey biomass estimate. The biomass estimate for the 184 nmi of trackline surveyed in Chiniak Trough was 24,470 t, approximately 3% of the entire GOA summer survey biomass.

Marmot Bay was surveyed 16-17 July along transects spaced 2.0 nmi apart in the inner bay and spruce gully, and 4.0 nmi apart in the outer bay. Izhut Bay was surveyed 17 July along zig-zag transects because of the narrowness of the bay. Adult and juvenile walleye pollock were detected throughout the Marmot and Izhut Bay surveys. Walleye pollock lengths from the 4 AWT hauls in Marmot Bay and one AWT haul in Izhut Bay ranged from 15 to 70 cm FL with modes at 17 cm, 36 cm, and 60 cm FL. The biomass estimate for Marmot Bay was 8,210 t along the 97 nmi of trackline surveyed, and in Izhut Bay the biomass estimate was 803 t along the 6.5 nmi of trackline surveyed.

Prince William sound was surveyed 29 July-1 Aug. along transects spaced 8.0 nmi apart. Backscatter in Prince William Sound was very sparse, with most fish located on the outer shelf south of Montague Island. Trawl hauls were conducted within Prince William Sound with one AWT haul (adults ranging in length from 45 to 65 cm FL), and on the outer shelf south of Montague Island with two AWT hauls (age-1 fish ranging in length from 15 to 20 cm FL) and one PNE trawl (mix of 15 to 21 cm FL age-1 fish and larger fish 25-66 cm FL). The biomass estimate for the 218 nmi of trackline surveyed in Prince William Sound was 16,062 t, of which only 6,000 t was within the sound proper.

Kayak Island and Yakutat Troughs were surveyed 3-7 Aug. along transects spaced 12.0 nmi apart. Backscatter was relatively light and diffuse in both the Kayak Island Trough and Yakutat Trough with the densest backscatter detected along the transects near the mouth of Yakutat Bay. In the Kayak Island Trough one AWT trawl resulted in two length groups of pollock, one ranging from 13 to 22 cm FL with a mode at 18 cm FL, and another from 35 to 70 cm FL with a mode at 54 cm FL. In the Yakutat Trough four AWT and one PNE hauls resulted primarily in age-1 fish ranging in length from 14 to 22 cm FL and a few larger fish ranging in length from 28 to 69 cm FL with a mode of 54 cm FL. The biomass estimate for Kayak Island Trough was 5,005 t for the 46 nmi of transects surveyed, and the biomass estimate for Yakutat Trough is 5,441 t for the 91 nmi of transects surveyed.

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

Longline Survey - ABL

The AFSC has conducted an annual longline survey of sablefish and other groundfish in Alaska from 1987 to 2013. 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 2013, the thirty-fifth annual longline survey of the upper continental slope of the Gulf of Alaska and eastern Bering Sea was conducted. One hundred-fifty-two longline hauls (sets) were completed during May 30 – August 26, 2013 by the chartered fishing vessel *Ocean Prowler*. Total groundline set each day was 16 km long and contained 160 skates and 7,200 hooks baited with squid except in the eastern Bering Sea where 180 skates with 8,100 hooks were set.

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 56,969 sablefish, with an estimated total round weight of 178,198 kg (392,859 lb), were caught during the survey. This represents a decrease of nearly 13,000 sablefish over the 2012 survey catch. Sablefish, shortspine thornyhead, and Greenland turbot (*Reinhardtius hippoglossoides*) were tagged with external Floy tags and released during the survey. Electronic archival tags were implanted in 36 Greenland turbot. Pop-up satellite tags (PSAT) were implanted in 27 sablefish, 6 spiny dogfish, and 4 lingcod. Length-weight data and otoliths were collected from 1,619 sablefish. Killer whales depredating on the catch occurred at eleven stations in the Bering Sea, two stations in the western Gulf of Alaska, and two stations in the central Gulf of Alaska. Sperm whales *(Physeter macrocephalus)* were observed at twenty-seven stations in 2013 and were reported depredating on the gear at twelve stations which is consistent to previous years.

Several special projects were conducted during the 2013 longline survey. Greenland turbot were tagged with archival temperature/depth tags in the Bering Sea and lingcod were tagged in the West Yakutat and central Gulf of Alaska regions. Satellite pop-up tags were deployed on spiny dogfish, sablefish, and lingcod throughout the Gulf of Alaska. Information from these tags will be used to investigate movement patterns within and out of the Gulf of Alaska and potentially help identify spawning areas for sablefish. Additionally, genetic tissue and otoliths of giant grenadier were sampled to see if geographic stock structure exists and to determine if three distinct otoliths shapes identified in previous work correspond to different subspecies or subpopulations. Bubblegum coral genetic and specimen samples were collected to elucidate patterns of genetic connectivity among Paragorgid populations in the Gulf of Alaska. Finally, opportunistic photo identification of both sperm and killer whales were collected for use in whale identification projects.

Longline survey catch and effort data summaries are available through the Alaska Fisheries Science Center's website: http://www.afsc.noaa.gov/ABL/MESA/mesa_sfs_ls.php. Full access to the longline survey database is available through the Alaska Fisheries Information Network (AKFIN). Catch per unit effort (CPUE) information and relative population numbers (RPN) by depth strata and management regions are provided. These estimates are available for all species caught in the survey. Previously RPN's were only available for depths that corresponded to sablefish habitat but in 2013 these depths were expanded to 150m - 1000m. Inclusion of these shallower depths provides expanded population indices for the entire survey time series for species such as Pacific cod, Pacific halibut, and several rockfish species.

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

Projects and proposals

Heppell, Selina, Paul Spencer, Nathan Schumaker, Andi Stephens (FATE) An individual-based model for evaluation of maternal effects and spatio-temporal environmental variability on dynamics and management of Pacific ocean perch, *Sebastes alutus.* (Funded $116,216)

Quinn, T., P. Hulson, J. Ianelli (ASAM) Time-varying natural mortality: random versus covariate effects. (Funded $186,116)

Hollowed, A., Aydin, K., Holsman, K. (International Science) An international workshop for ecosystem projection model inter-comparison and assessment of climate change impacts on global fish and fisheries. (Funded $24,900) (Part of future meeting)

Helser, T. TenBrink, T., Spencer, P., Conrath, C. (NPRB) Improving stock assessments and management for Tier 5 rockfish through ageing methods and maturity at age analysis for shortspine thornyhead, shortraker, harlequin, and redstripe rockfish.

Spies, I., TenBrink. T., Aydin, K. (NPRB) Filling critical data gaps for data-poor sculpins in the Gulf of Alaska: life history and diet information for stock assessment and ecosystem modeling.

Beaudreau,A. Hunsicker, M., Dorn, M., and Ciannelli, L. (PCCRC) Developing an index of predation to improve the assessment of walleye pollock in the Gulf of Alaska. (Funded)
This project will look at spatial overlap between pollock and arrowtooth (and halibut and cod) in the GOA, in addition to ideas about how to incorporate new information about spatial overlap into assessment models, e.g. ways to incorporate changes in natural mortality over time into assessment models.

Hauser, L., Canino, M., Spies, I., Dorn, M. (FATE) Rapid genetic adaptation to changing climate and its effect on walleye pollock population dynamics and management in the Gulf of Alaska.

Heppell, S, P. Spencer, N. Schumaker, and A. Stephens. (FATE) An individual-based model for evaluation of maternal effects and spatio-temporal environmental variability on dynamics and management of Pacific ocean perch, Sebastes alutus.

Laurel, B., Thompson, G., and Canino, M. (ASAM) - Ben Laurel, Grant Thompson and Mike Canino. Comparing near shore and large scale surveys to estimate gadid recruitment. (FUNDED)

Conners, E. Cooperative Research - Developing pot survey gear for octopus. (FUNDED)

Logerwell, E., Dorn, M., Kruse, G., McDermott, S., Ladd, C., Cheng, Wei. (FATE). Spatial and temporal variability of walleye pollock fecundity estimates for the Gulf of Alaska and eastern Bering Sea. Sandi Neidetcher will be a project lead and Ben Williams, who is a UAK PhD student, will utilize part of this research for his dissertation. (FUNDED)

McDermott, S., Logerwell, L., and Todd Loomis. (NPRB). Small scale abundance and movement of Atka mackerel and other Steller sea lion groundfish prey in the Western Aleutian Islands. Field work starts in Summer of 2014. (FUNDED)

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

2. Research

Correcting Density Dependent Effects in Abundance Estimates from Bottom Trawl Surveys — RACE, REFM, Univ. of Washington

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.

FY13 Research Activities

In FY13, the primary focus of AKCSI researchers was to conduct remote operated vehicle surveys and sample collections in Primnoa thickets in Southeastern Alaska. In August 2013, concurrent cruises aboard the chartered fishing vessel *Alaska Provider* and Alaska Department of Fish and Game research vessel *Medeia* were conducted at previously mapped (in FY12) locations; Dixon Entrance, Prince of Wales, Fairweather Grounds, and Cape Ommaney, on the continental shelf and slope in the southeastern Gulf of Alaska . These cruises were to survey suspected areas of high density Primnoa habitats (thickets), collect size information from the thickets and collect samples for genetic analysis. Survey transects were completed at 3 of the 4 sites with the ROV aboard the *Alaska Provider* and at two sites with a stereo drop camera aboard the *Medeia*. Size data and images to estimate density of Primnoa habitats were collected at all four sites. Additionally, 8 settlement plates were deployed at locations in Primnoa thickets using the stereo drop camera. Samples for genetic analysis were collected at two of the four study sites. Samples were also collected to provide specimens for natural products studies and geological substrate interpretation.

Two other directed research cruises were planned for FY13, but were not completed due to contracting difficulties and the government-wide shutdown. The first of these was a research cruise to examine the ecology and production of FMP species from coral and non-coral habitats. Samples of rockfish for reproductive potential and bioenergetics were collected for this project during the Gulf of Alaska bottom trawl survey in July 2013. The final research cruise was to conduct underwater camera drops at 150 locations in the central and eastern Aleutian Islands from Unimak Pass to Petrel spur. Due to the government-wide shutdown, this research cruise has been postponed until April 2014.

In addition to these cruises funded by AKCSI, there were also a number of field data collections carried out in partnership with other research activities in Alaska. In FY13 the second phase of 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 tested throughout the winter of 2013. It was successfully deployed in the Gulf of Alaska during the AFSC longline survey in July 2013. Cooperation with the longline survey allowed us to deploy the camera system on two longline sets during a two day gear experiment. The images collected during the deployment were suitable for measuring the distance the longline travelled over the seafloor during deployment, fishing and retrieval.

In FY13, with partners in the AFSC RACE division we collected O2, salinity, turbidity and pH measurements on the headrope of bottom trawls used to conduct annual stock assessment surveys. Oceanographic data were collected on 218 tows from the Islands of Four Mountains in the eastern Aleutian Islands to Dixon Entrance in the eastern Gulf of Alaska.

Oceanographic equipment to measure O2, pH, salinity and temperature were installed at a long-term study site in Tracy Arm (southeastern Alaska) and has been collecting oceanographic data since January 2013 on 6-hour intervals.

Field activities also included the collection of sponge and coral specimens for morphological taxonomic study and coral tissue samples for genetic analysis through collaboration with the Gulf of Alaska bottom trawl survey.

Additional work was conducted at the AFSC and U.S. Geological Survey to compile bathymetry and sediment maps from NOAA smooth sheets for the Aleutian Islands and Gulf of Alaska in anticipation of completing a geologically interpreted substrate map for these regions in FY14. The compiled sediment and bathymetry map for the Aleutian Islands region was released as a NOAA Technical Memorandum. The data compilation in the Gulf of Alaska has been completed for the majority of this region as well, thanks to collaboration with the NPRB-funded Gulf of Alaska-Integrated Ecosystem Research Program, which has similar needs for bathymetric data.

Planned FY14 Activities

In FY14 there will be three major field programs that will build on the activities from the FY12-13. First, the spatial distribution modeling project will focus its efforts on the western Aleutian Islands during another 15-day cruise. During this cruise, images will be collected at an additional 150 randomly selected sites. Once the fieldwork is complete and the images analyzed, the models will be re-evaluated with respect to their accuracy in predicting coral and sponge distribution, abundance and diversity.

Second, the FMP production project will collect fish and video data on the differences in production between sites with and without coral and sponge communities in the summer (August) of 2014. This project will collect a second year of data at the same locations as in FY12. Additional funding (from NPRB) to expand the sampling into winter and spring periods will be used to fund two additional cruises in April 2014 and January 2015. Samples and video collected in the field to date will be analyzed leading to data analysis scheduled for the summer of FY15.

Third, the main field effort in FY14 will again focus on projects at the Dixon Entrance, Prince of Wales, Fairweather Grounds, and Cape Ommaney sites. We will again use a remotely operated vehicle (ROV) to conduct transect surveys at two of the study sites in southeastern Alaska that were not completed in FY13 (Fairweather Grounds and Dixon Entrance). The stereo drop camera will again be used to measure size structure of *Primnoa* at these sites, plus some additional transects at the Prince of Wales site. Samples for genetics analysis will also be collected at two sites (Dixon Entrance and Fairweather Grounds) to complete the collections for that project. In addition, two of the settlement plates deployed in FY13 will be recovered in FY14 and any newly settled recruits collected. Then the plates will be redeployed for collection at a later date.

Other activities will also be continued in FY13. The project to deploy a camera system on commercial longline gear will go into production mode and data will be collected during an entire leg of the longline survey. Data and images resulting from this project should be available for analysis by late summer FY14.

In FY14, oceanographic data will be collected from the bottom trawl surveys scheduled for the Aleutian Islands and the eastern Bering Sea slope. The oceanographic instruments purchased and tested in FY12 will be deployed on the headrope of AFSC research trawls during all three legs of both bottom trawl surveys to collect O2, pH, turbidity and salinity from the Islands of Four Mountains to Stalemate Bank in the Aleutian Islands at depths to 500 m and from Bering Canyon to the U.S.-Russian border along the eastern Bering Sea slope at depths to 1000 m.

The instrument package at the long-term monitoring site at a shallow population of *Primnoa* (30 m depth) in Tracy Arm will be recovered. Since there are no funds available to routinely collect and deploy this instrumentation after FY14, we are attempting to develop a partnership with the USGS to deploy the instrument package at a similar site in Glacier Bay where it can be routinely serviced at little cost.

New partnerships will be developed and existing partnerships continued to collect specimens of corals and sponges for taxonomic resolution and for special studies of paleoclimatology and medicinal purposes. These collections will occur both during the ROV fieldwork as well as during the 2014 Aleutian Islands and eastern Bering Sea slope bottom trawl surveys.

Finally, in FY14, researchers at the University of Alaska Fairbanks and the Tombolo Institute will continue to collaborate with NOAA and USGS researchers to compile an interpreted (from geology) substrate and sediment map for Alaskan waters based on existing multibeam bathymetry, sidescan images, the new bathymetric and sediment database compiled from NOAA smooth sheets, other sediment and bedrock data, and available seafloor imagery.

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. A final site visit is planned for summer 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 — RACE GAP

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 spring and summer of 2012 two research cruises were conducted in May and August. During these cruises 34 camera drops and 11 trawl tows were conducted. In the upcoming years additional research cruises will take place in spring 2014, summer 2014, and winter 2014/2015.

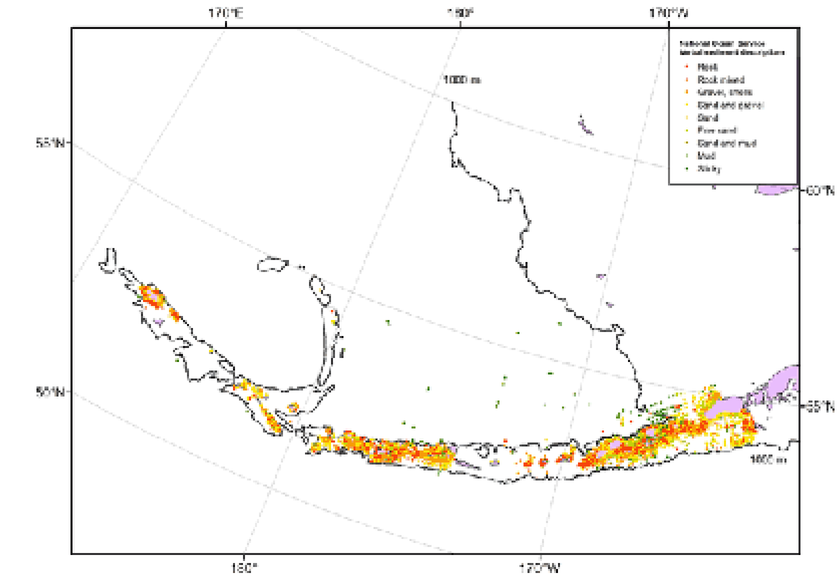
For further information contact Christina Conrath, (907) 481-1732

Bathymetry of the Aleutian Islands – RACE GAP

AFSC scientists with the RACE Groundfish Program corrected, digitized, and assembled 2.1 million National Ocean Service (NOS) bathymetric soundings from 290 hydrographic surveys represented by smooth sheets, extending 1,900 km along the Aleutian Islands from Unimak Island in the east to the Russian border in the west. The original, uncorrected smooth sheet bathymetry data sets are available from the National Geophysical Data Center (NGDC), which archives and distributes data that were originally collected by the NOS and others. Details of our processing methods can be found in Smooth Sheet Bathymetry of the Aleutian Islands, NOAA Tech Memo NMFS-AFSC-250.

Sediments of the Aleutian Islands

We also digitized 25,000 verbal surficial sediment descriptions from 234 of the smooth sheets, providing the largest single source of sediment information for the Aleutian Islands.



Map of National Ocean Service verbal sediment descriptions.

Data Available for Download (NOTE: Data are not to be used for navigation).

- A zipped file of a 100-m resolution grid (raster surface) of the bathymetry.
- Bathymetry grid metadata.
- A zipped shape file of the sediment point data.
- Sediment metadata.

Users of the data should cite it as Zimmermann, M., M. M. Prescott, and C. N. Rooper. 2013. Smooth Sheet Bathymetry of the Aleutian Islands. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-250, 43p.

Guide for Working with Alaskan Smooth Sheets--What are Smooth Sheets? - RACE GAP
Physically, a paper smooth sheet with muslin backing was the final product of a hydrographic survey. The soundings were drawn on a smooth sheet, along with the shoreline, geographic features (e.g., kelp beds, rocky reefs, islets, rocks), seafloor substrates (e.g., gravel, sand, mud), and the navigational signals in order to provide a visual record of the hydrographic survey, which could be annotated as new information became available.

Though more detailed than navigational charts, smooth sheets are **not** intended for use in navigation. Instead the smooth sheets, many dating back to the 1930s, were used as internal documents by the hydrographic agency. Only after they were scanned, digitized, and posted to NGDC (Wong et al. 2007) did they become widely used by non-hydrographers. The NOS navigational charts (not smooth sheets) are the legal standard for safe navigation on the ocean (Title 33 Code of Federal Regulations 164).

All scientists who conduct research on the ocean have probably used the small-scale navigational charts for a variety of cruise planning and data analysis tasks without knowing that perhaps ten times as much information was available from the precursor hydrographic surveys, represented by the smooth sheets. Others who are aware of the smooth sheet resource might not understand some of the details about successfully using this rich data resource. Therefore, now that electronic copies of the smooth sheets are readily available, it is worthwhile for non-hydrographers to understand how to use them.

The guide "Smooth sheets: How to work with them in a GIS to derive bathymetry, features and substrates" is intended to provide the user with enough information to understand and properly utilize the smooth sheets and their associated data. The guide should be cited as: Zimmermann, M. and J. Benson. 2013. Smooth sheets: How to work with them in a GIS to derive bathymetry, features and substrates. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-249, 52p.

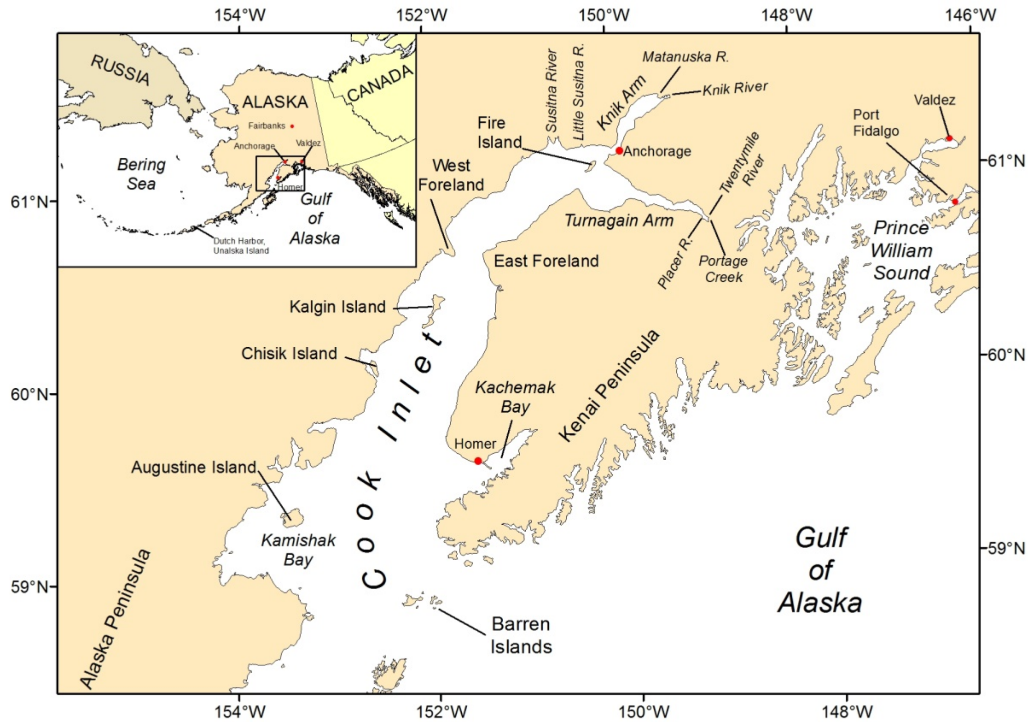
Contact Mark.Zimmermann@noaa.gov

Smooth sheet bathymetry of Cook Inlet, Alaska - RACE GAP

Scientists with the AFSC's Groundfish Assessment Program (GAP) have expanded earlier mapping efforts for the Aleutian Islands to include Cook Inlet, Alaska. This work is part of an effort to provide better seafloor information for fisheries research. The Cook Inlet project included the same smooth sheet bathymetry editing and sediment digitizing as the Aleutian Islands effort, but also included:

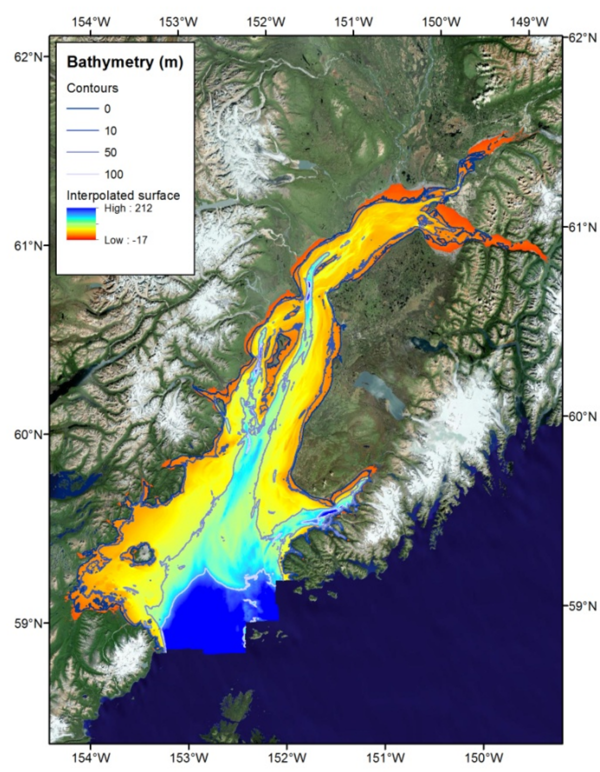
1) digitizing the inshore features, such as rocks, islets, rocky reefs, and kelp beds;
2) digitizing the shoreline; and
3) replacing some areas of older, lower resolution smooth sheet bathymetry data with more modern, higher resolution multibeam bathymetry data.

   The smaller area of Cook Inlet, greater amount of project time, and higher quality of smooth sheets than in the Aleutian Islands made these additions possible. The NMFS Alaska Regional Office's Essential Fish Habitat funding made much of this work possible.

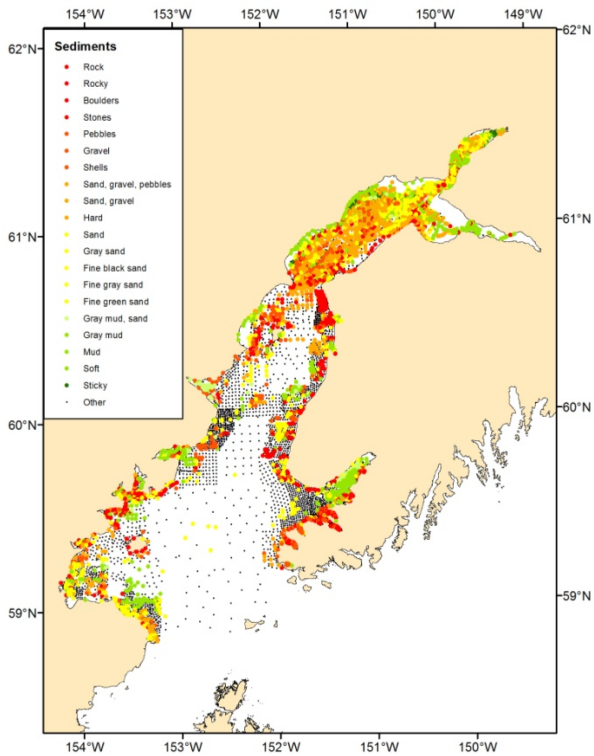


Bathymetry of Cook Inlet – RACE GAP

A total of 1.4 million National Ocean Service (NOS) bathymetric soundings from 98 hydrographic surveys represented by smooth sheets in Cook Inlet were corrected, digitized, and assembled. Overall, the inlet is shallow, with an area-weighted mean depth of 44.7 m, but is as deep as 212 m at the south end near the Barren Islands. The original, uncorrected smooth sheet bathymetry data sets are available from the National Geophysical Data Center (NGDC), which archives and distributes data that were originally collected by the NOS and others.



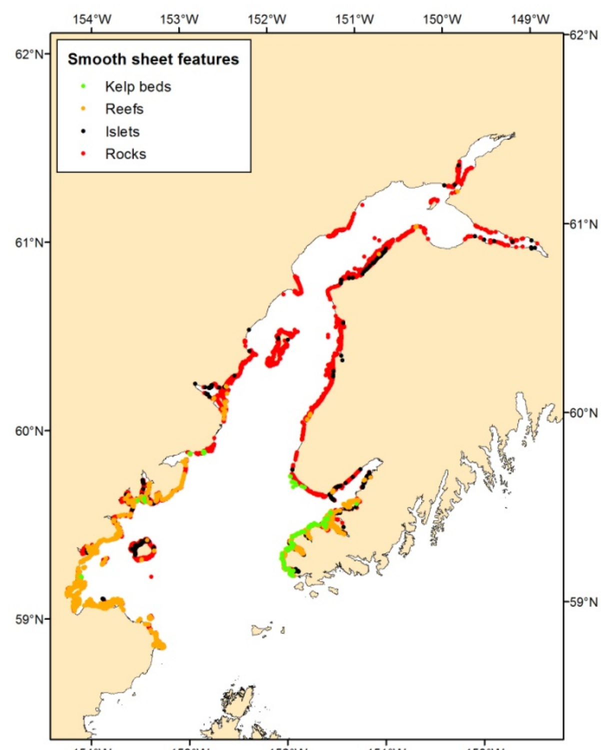
Sediments of Cook Inlet



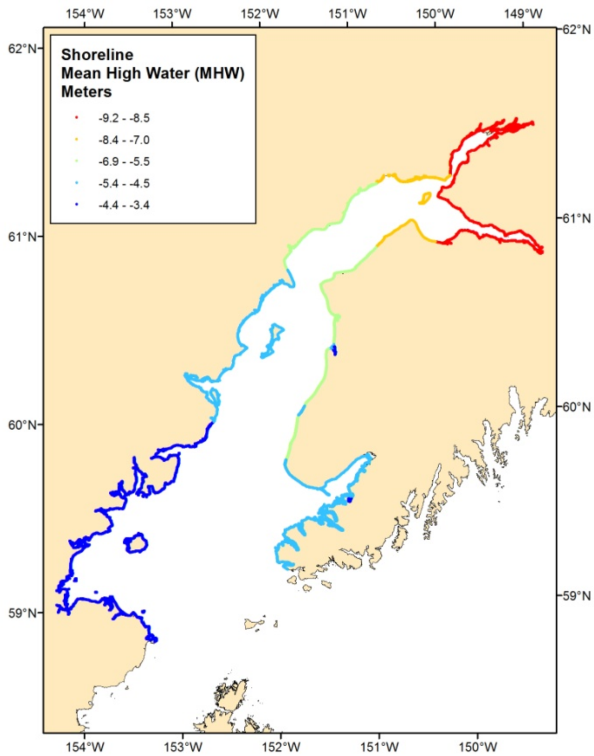
A total of 9,000 verbal surficial sediment descriptions from 96 smooth sheets were digitized, providing the largest single source of sediment information for Cook Inlet. There were 1,172 unique verbal descriptions, with most of the sediment description categories (58%) only having a single occurrence. That means that most descriptions were fairly lengthy and specific. Of the sediment descriptions which occurred more than once, Hard (n = 1335), Sand (n = 721), Rocky (n = 608), and Mud (n = 365) were the most common, which ranged from Rock to Clay, Sand ridges to Mud flats, Weeds to Stumps, and Mud to Coral. The 20 most common sediment categories are depicted along a color gradient in the Figure, where red shows larger/harder sediments such as Rock, Rocky, and Boulders, and green shows smaller/softer sediments such as Mud, Soft, and Sticky.

Smooth Sheet Features of Cook Inlet

A total of 12,000 features such as rocky reefs, kelp beds, rocks, and islets were digitized from the smooth sheets and added to the original files from NGDC, resulting in a total of 18,000 features. Almost 10,000 of these points indicated the edge of rocky reefs, covering much of the shore in Kamishak Bay, the southern shore of Kachemak Bay, and near Chisik Island, but reefs were rare north of there. More than 7,000 rocks and more than 800 islets were found along most of the Cook Inlet shore. There were less than 300 kelp beds, almost all of which occurred in outer Kachemak Bay. Altogether there were almost 18,000 rocks or rock ally features such as rocky reefs, kelp beds, and islets, which were added to the sediment data set.



Shoreline of Cook Inlet



A total of 95,000 individual shoreline points were also digitized, describing 2,418.3 km of mainland shoreline and 528.9 km of island shoreline from 507 individual islands, providing the most detailed shoreline of Cook Inlet. The shoreline is defined on the smooth sheets as MHW (Mean High Water), the same vertical tidal datum as the bathymetry, which typically ranges only as shallow as MLLW (Mean Lower Low Water), defined as zero meters depth. The MHW shoreline was highest in the northern end of Cook Inlet, ranging up to -9.2 m in Turnagain Arm, and -9.1 m in Knik Arm, and lowest at Augustine Island and Kamishak Bay (-4.4 to -3.4 m, respectively).

By adding the digitized shoreline to the digitized bathymetry, a complete bathymetry map for Cook Inlet was assembled without the typical gaps between the shallowest soundings and the shoreline. Thus, researchers were able to determine that at high tide (MHW) the total volume of the inlet is 1,024.1 km^3 and the total surface area is 20,540 km^2. When the tide drops from MHW to MLLW, the Inlet loses 99.7 km^3 of water, or 9.7% of its volume, and exposes 1,616 km^2 of seabed, or 7.9% of its surface area.

While the Alaska Fisheries Science Center has been conducting marine research for decades in Alaskan waters, a lot of basic information about the seafloor, such as depth, is generally not known beyond what is depicted on small scale (1:100,000) NOS Navigational Charts. Therefore GAP scientists have been creating more detailed bathymetry and sediment maps in order to provide a better understanding of how studied animals interact with their environment. This information is being used by NOAA's Deep Sea Coral Research and Technology Program to predict the presence/absence and abundance of corals and sponges (Rooper et al., 2013). GAP scientists who conduct stock assessment bottom trawl surveys are also using the information to delimit areas that cannot be sampled effectively with bottom trawls. The results from this project may result in a separate survey conducted by another method, such as underwater cameras or acoustics, to assess the abundance of fish in the untrawlable areas. An inter-agency collaboration called the Gulf of Alaska Integrated Ecosystem Research Program (GOA-IERP) sponsored by the North Pacific Research Board (NPRB) is using the detailed bathymetry and sediment information to predict the preferred settlement habitat juveniles of five important groundfish species. Results from GOA-IERP will be used towards developing a better understanding of the ecosystem processes that regulate stock recruitment. The Alaska

Regional Office will investigate use of the bathymetry and sediment information to oversee sustainable fisheries, conduct Essential Fish Habitat (EFH) reviews, and manage protected species. The Bureau of Ocean Energy Management may use the information for preparing National Environmental Policy Act (NEPA), Essential Fish Habitat (EFH), and Endangered Species Act (ESA) documents for the possibility of a federal lease sale in lower Cook Inlet.

Details of the processing methods for the smooth sheet data for Cook Inlet will be published in the NOAA Technical Memorandum series.

Rooper, Chris, Mike Sigler, Gerald Hoff, Bob Stone, and Mark Zimmermann. 2013. Determining the Distributions of Deep-sea Corals and Sponges Throughout Alaska. AFSC Quarterly Report Feature (October-November-December 2013) 4 p.

Evaluating Smooth Sheet Bathymetry for Determining Trawlable and Untrawlable Habitats - RACE GAP

This project supported by NMFS' Habitat Assessment Improvement Plan (HAIP) evaluates whether enhanced bathymetric and other sea floor data obtained from hydrographic smooth sheets can predict whether the sea floor can be trawled during research surveys. Biennial bottom trawl surveys in the Gulf of Alaska (GOA) and Aleutian Islands (AI) provide fishery independent estimates of catch per unit effort, abundance, and biological parameters used in stock assessments for managed fisheries and species in the North Pacific. The quality and precision of these estimates depend, in part, on proper survey stratification and are likely affected by differential fish abundance between soft, flat and smooth areas where trawling is a good sampling tool and hard, steep and rough areas where trawling is not a good sampling tool. The AI/GOA bottom trawl surveys exclude known untrawlable areas determined from previous attempted survey tows and during surveys, stations may be dropped from the survey if they are found to be untrawlable. An analysis conducted in the GOA area by AFSC staff in 2006 determined that this trawl station history indicated strata trawlability ranged from 8.2% to 100%. Despite untrawlable stations being excluded from the sampling frame, mean catch per unit effort estimates are expanded by the total areas including both trawlable and untrawlable habitats. The assumption that fish are distributed without regard to trawlable and untrawlable habitat is likely to be violated by the behaviors of rockfishes, codfishes, flatfishes, and other species of management concern. Ideally, survey scientists would have a perfect delineation and sampling frame of untrawlable habitat in the GOA and AI. AFSC scientists and their colleagues have developed multi-frequency acoustic, optical, and fisher experiences to identify untrawlable habitats. However, these methods require extensive new surveys to map untrawlable habitats that are presently impractical or too expensive.

Hydrographic smooth sheets developed by Zimmerman (see above) and information obtained from AFSC GOA and AI Biennial Bottom Trawl Surveys are being used in predictive models to determine if factors such as slope, rugosity, and current relate to fishing success or sea floor characterizations from fishing echosounders. Project objectives are: 1. Identify criteria to predict untrawlable habitat from smooth sheet data, 2. Test criteria and predictive model with known areas of rocky habitat and unsuccessful bottom trawls, and 3. Assemble and interpret existing smooth sheet data into a map of untrawlable habitat that can be evaluated in future surveys and studies. If the predictive model is successful, smooth sheet data will be assembled and used to generate a preliminary sampling frame of trawlable and untrawlable habitat. This sampling frame would not be used immediately, but would be evaluated for data gaps, priorities for further mapping, and for possible field testing during upcoming bottom trawl surveys.

For further information, contact Matthew Baker (matthew.baker@noaa.gov), Mark Zimmermann or Wayne Palsson.

Bering Sea Infauna Communities and Flatfish Habitats - RACE GAP
Research continues on characterizing flatfish habitat and productivity on the eastern Bering Sea (EBS) shelf. Focus in recent studies was on juvenile habitats, specifically pertaining to the prey environment, of yellowfin sole (Limanda aspera) and rock sole (Lepidopsetta spp.). In 2011 and 2012, benthic samples and juvenile flatfish (<20 cm) were collected at bottom-trawl survey stations in the southernmost part of the EBS shelf along the Alaska Peninsula to evaluate juvenile habitat quality. High concentrations (hotspots) of both northern rock sole and yellowfin sole juveniles were found in Bristol Bay and near Unimak Pass. Analysis of prey fields and associated fish diets and conditions in and out of hotspots is in progress. A future study is planned to characterize another possible juvenile flatfish hotspot in the northern part of the EBS shelf near Nunivak Island. The main objective is to investigate whether northern and southern hotspots were utilized alternately – the former during periods of “warm” oceanographic environment in the EBS, and the latter during “cold” periods.

For more information, contact Cynthia Yeung, e-mail: cynthia.yeung@noaa.gov

Northern Rock Sole and Yellowfin Sole Nursery Habitats in the Bering Sea - RACE FBEP
The Fisheries Behavioral Ecology program is collaborating with the RACE-Recruitment Processes Program to examine the use of coastal nursery habitats by important flatfish species. Work in 2013 focused on processing of specimens collected in the vicinity of Port Moller along the Alaska Peninsula in Autumn 2012 and initial work on distributional patterns across species. Northern rock sole and yellowfin sole were the most common flatfishes encountered in coastal habitats.

Age-0 flatfish (northern rock sole and yellowfin sole <50 mm) were captured at high abundances (>50 per tow) at a small number of stations (n=4) along the Alaska Peninsula. Depths of these stations were 38, 33, 32, and 23 m. The age-0 cohort of these species was generally absent from deeper and shallower sites.

Age-1 and age-2 northern rock sole and yellowfin sole (50-150mm TL) were more widespread, using both coastal waters along the Peninsula and coastal embayments. They were more abundant in coastal samples near Port Moller (mean 43 NRS and 8 YFS per tow) than in the coastal embayments of Port Moller and Herendeen Bay (mean 7 NRS and 4 YFS per tow) and in offshore Bering Sea shelf samples (<5 fish per tow). Both species tended to be absent from shallow (<3 m) wave-swept areas along the coast. There was a trend for NRS to be found in higher abundances on sandier sediments with YFS on muddier sediments, both along the coast and in coastal embayments. The high abundances of these species in coastal waters is consistent with previous observations along other portions of the Alaska Peninsula.

Long-term Monitoring of Demersal Macrofauna in Alaskan Arctic Seas Using Bottom Trawls: A Comparison Study - RACE GAP

Long-term monitoring of the Arctic marine biota is needed to understand how community structure is changing in response to diminishing ice (i.e., climate change) and increasing anthropogenic stimuli. Dating back to 1959, bottom trawls (BT) have been a primary research tool for investigating bottom fishes, crabs and other demersal macrofauna in the Arctic (; however, the BTs used in past surveys have varied widely in terms of their construction, dimensions, mesh-sizes, etc. Moreover, the spatial and temporal coverage of past BT surveys has been patchy, and sampling procedures employed using various BTs have generally lacked standardization. Such inconsistencies prohibit synthesizing results into a coherent time series for investigating changes in the community structure. By adhering to rigorous standards, BTs can be effective research tools for monitoring general population trends and detecting geographic shifts of bottom fishes, crabs and other demersal macrofauna. Although relatively limited in their application, two BT gears have been used in Arctic surveys employing moderately consistent sampling techniques: the University of Alaska Fairbanks 3 m plumb-staff beam trawl (PSBT) and the Alaska Fisheries Science Center 83-112 Eastern bottom trawl (EBT). The PSBT has been used periodically for small-scale surveys on the eastern Bering Sea shelf since 2000. North of the Bering Strait, the PSBT was first used in 2004 for a transboundary study of demersal fishes, crabs and other macrofauna in the eastern and western Chukchi Sea. Since 2007, there have been annual demersal surveys using the PSBT in either the Chukchi or Beaufort Seas. In comparison, the EBT's primary use has been for investigating the population dynamics of commercial bottom fishes and crabs on the eastern and northern Bering Sea shelf. North of the Bering Strait, the EBT has also been used for surveying demersal macrofauna in the eastern Chukchi Sea in 1976, 1990,1991, and 2012 and in the Beaufort Sea in 2008.

The objective of this study was to do a paired comparison experiment in the eastern Chukchi Sea to investigate differences between the PSBT and EBT in terms of catch composition and size selectivity of bottom fishes, crabs and other demersal macrofauna. Experimental results will help managers and scientists to interpret results from existing and future BT surveys, as well as underscore the importance of using standard gear and survey methods for long-term monitoring. Managers and scientists need to compare the catching characteristics of the PSBT and EBT compare to understand how data from the two bottom trawls can best be utilized for understanding ecosystem processes and for long-term monitoring of demersal macrofauna in the Alaskan Arctic region.

For more information, contact Bob Lauth, e-mail: bob.lauth@noaa.gov

RACE Recruitment Processes (RPP)

The Recruitment Processes Program's (RPP) 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.

Shelf-associated Flatfish Juveniles in the Bering Sea
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 small fish (ages 2 and 3) 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. Age-2 and age-3 fish distributions were significantly correlated with EBS temperatures two and three years prior to the survey (i.e. in years when the small juveniles were age-0 fish), however distributions were not significantly correlated with current survey year temperatures, suggesting that temperature in the age-0 year controls distribution small juveniles more that temperature in the current year.

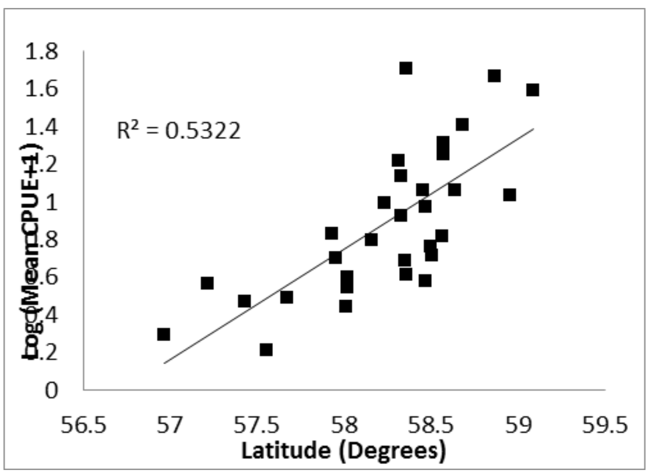


Figure 1. Relationship between annual mean catch per unit effort and the latitude of the catch-weighted center of age-2 and age-3 sized northern rock sole in the EBS groundfish survey from 1982 through 2012.

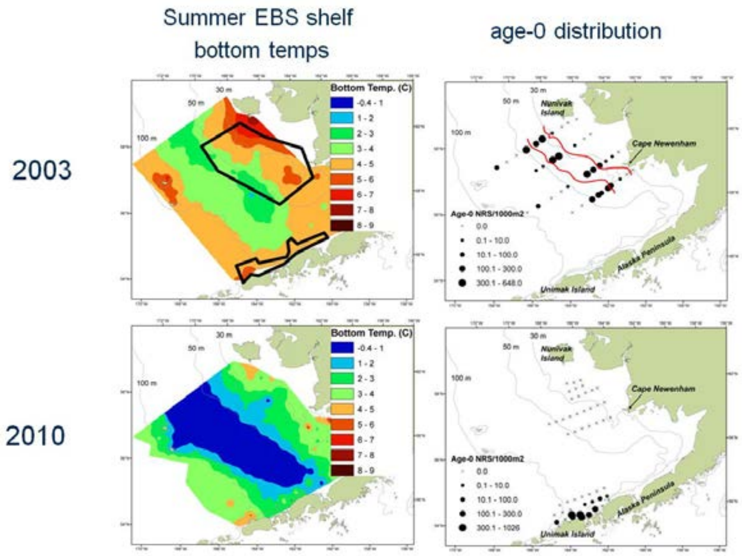


Figure 2. EBS Summer bottom temperatures in 2003 (upper left) and 2010 (lower left) and autumn age-0 northern rock sole distributions in 2003 (upper right) and 2010 (lower right). Age-0 northern rock sole mean length is higher in warm, nearshore areas than in cold, offshore areas, suggesting temperature dependent growth and/or shoreward movement after settlement.

Contributed by D. Cooper, e-mail: Dan.Cooper@noaa.gov

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 (*Hippoglossus stenolepis*), two deep-sea spawning flatfish in the eastern Bering Sea. Distribution and abundance of adults, larvae and juveniles are seasonally assessed using field surveys and results are compared to predominant circulation patterns. Transport along and across the Bering Slope was derived from 23 years (1982-2004) of simulations from an ocean circulation model (ROMS). It was hypothesized that changes in the strength and position of the Bering Slope Current would affect recruitment of Greenland halibut, Pacific halibut and arrowtooth flounder. Seasonal variations in flow were observed, with transport typically highest during fall and winter months. Significant correlations were found between transport, position, and recruitment. In particular, it was noted that Pacific halibut recruitment increased in relation to increased on-shelf transport through southern canyons.

Contributed by J. Duffy-Anderson, e-mail: Janet.Duffy-Anderson@noaa.gov

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 were used to test the predictive ability of habitat models developed in GOA bays for application over the continental shelf. The models predict presence or absence of specific species-age groups of juvenile flatfishes depending on variables such as bottom temperature, bottom depth, and sediment composition (e.g., mud, sand, or gravel percent of total weight). The models performed well for two of the species-age groups. We are currently exploring whether model performance improves with the introduction of new independent variables and parameters. This study is increasing our knowledge of juvenile flatfish habitat in the GOA, including improving estimates of juvenile flatfish habitat for GOAIERP models.

Contributed by M. Wilson, e-mail: Matt.Wilson@noaa.gov

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

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.

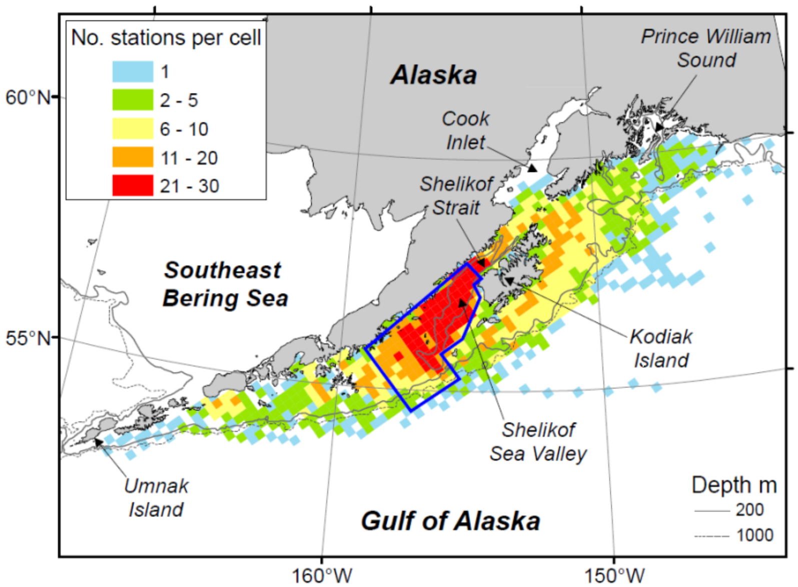
As part of the Lower Trophic Level Component of the GOAIERP program, the Recruitment Processes Program has been involved in the planning and carrying out of ichthyoplankton, and oceanographic sampling in the eastern and western GOA for the 2011 and upcoming 2013 field years. Results from the 2010 pilot 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.

Lower Trophic Level Contributions to the GOAIERP Project

The Gulf of Alaska Integrated Ecosystem Program (GOA-IERP) is a four year (2011–2014) multi-disciplinary study examining the interactions between physical and biological oceanography to understand how the environment influences the survival of early life history stages (egg to age-0 juvenile) and recruitment of five commercially and ecologically important groundfishes: *Gadus chalcogrammus* (walleye pollock), *Gadus macrocephalus* (Pacific cod), *Atheresthes stomias* (arrowtooth flounder), *Anoplopoma fimbria* (sablefish), and *Sebastes alutus* (Pacific Ocean perch). The program has had two primary field years (2011 and 2013) to conduct biological and oceanographic surveys in the eastern and western Gulf of Alaska. More than 40 scientists (fishery biologists, oceanographers, and modelers) from 11 institutions are taking part in this study funded by the North Pacific Research Board.

As part of the Lower Trophic Level Component of the GOA-IERP program, the Recruitment Processes Program has been involved in the planning and execution of ichthyoplankton, and oceanographic sampling in the eastern and western Gulf of Alaska for the 2011 and 2013 field years. Currently, we are analyzing results from the 2011 surveys. In the spring (May), larvae of all five target taxa were collected, with all occurring in both the eastern and western Gulf of Alaska except for Pacific cod. Larval Pacific cod were only collected in the western Gulf of Alaska and only at the western most stations. In the summer months (July–August) only two target taxa were collected. *Sebastes* larvae were collected in both the eastern and western Gulf of Alaska and sablefish were collected in low abundance in the eastern Gulf of Alaska only. It should be noted that at this time we are unable to identify larval *Sebastes* collected in our samples to the species level due to ambiguous physical characters. Genetic analysis on specimens collected in the spring and summer has shown that in the spring Pacific Ocean perch make up the majority of *Sebastes* larvae collected, while in the summer it appears that another rockfish species is dominant. We are still processing samples from the 2013 field year with results expected by the end of this year.

Contributed by L. De Forest, e-mail: Lisa.DeForest@noaa.gov



Early Life History Ecology and Recruitment Processes of Fish Species in the Gulf of Alaska Ichthyoplankton surveys that sample the early ontogeny phase of fish integrate information on a diverse range of species with variable adult habitats and ecologies. Synthesis of these ichthyoplankton and associated environmental data from historical (spanning four decades) and ongoing surveys in the Gulf of Alaska (GOA) ecosystem continue both at a single species and multiple species level. The broad objective is to evaluate species' pelagic environmental exposure patterns and response outcome during early ontogeny. This research provides a mechanistic understanding of environmental forcing on early life history aspects of recruitment processes. Results are applied to the development of models both at the level that represent the ontogenetic pathway of an individual from egg stage to recruitment (Individual Based Models), as well as at the level of integrating physical and biological processes across different trophic levels in the pelagic ecosystem (Integrated Ecosystem Assessments).

Historical sampling is concentrated in the western GOA and has been most intense during mid-May through early June in the vicinity of Shelikof Strait and Sea Valley from where data has been developed into a time series of larval abundance and length indices for the numerically dominant species (Fig. 1). This time series spans from 1981 through 2011 annually, and from 2013 onwards sampling occurs every other year. It has been updated through 2011 and is presented and reviewed in the 2013 Ecosystem Considerations chapter of the Stock Assessment and Fisheries Evaluation report. The time series continues to provide valuable information on interannual trends in early ontogeny stages of important commercial and ecologically important species, and associated ecological patterns and environmental forcing. It has been incorporated into the retrospective analysis component of the North Pacific Research Board sponsored Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP), as well as the development of three new research proposals in 2013.

Figure 1. Distribution of historical ichthyoplankton sampling in the GOA by the Alaska Fisheries Science Center (1972, 1977-2009), based on 60-cm bongo net sampling of the upper

100 m of the water column. The polygon outlined in blue is the area from which the late spring ichthyoplankton time series has been developed.

Retrospective analysis of GOA historical ichthyoplankton data for the GOAIERP program has been completed this year. Syntheses of data for the five focal species (Walleye Pollock, Pacific Cod, Sablefish, Pacific Ocean Perch, and Arrowtooth flounder) have been incorporated into a) the development of Individual Based Models for each species by the Modeling component of the GOAIERP program, and b) a manuscript that presents a comprehensive review of the early life history patterns and processes for these species in the GOA. The manuscript is in review for submission to the GOAIERP special issue of Deep Sea Research II.

Synthesis of historical data continues with the investigation of phenology of the early ontogeny phase across GOA (and Bering Sea in the future) species and pelagic habitats. The timing and temporal extent of occurrence of eggs and larvae in the pelagic environment is a primary gradient of early life history variation among GOA fish species, and progression along this gradient is associated with variable patterns of exposure that modulate species response to environmental forcing[1]. For instance fish larvae of various species are present in the plankton during all seasons, and the period and extent of peak abundance varies (Table 1). For many species, larvae are temporally or spatially separated from the major spring production of copepod nauplii that are considered the primary source of nutrition for fish species during early ontogeny. This prompts many questions regarding the temporal and spatial availability of components of the zooplankton as food for fish larvae, and the feeding habits and prey selectivity among different species at different times of year and sub-intervals of early ontogeny. New research is proposed to address these questions by examining larval gut contents from archived samples.

Contributed by M. Doyle, e-mail: Miriam.Doyle@noaa.gov

Table 1. Schematic of monthly succession in occurrence and relative abundance of numerically dominant species of fish larvae in historical Gulf of Alaska ichthyoplankton samples (Doyle, unpublished data).

Species	**Common Name**	**H**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**
Hippoglossus stenolepis	Pacific Halibut												
Atheresthes stomias	Arrowtooth Flounder												
Leuroglossus schmidtii	Nrthrn. Smoothtongue												
Hemilepidotus hemilepidotus	Red Irish Lord #												
Hexagrammos decagrammus	Kelp Greenling #												
Pleurogrammus monopterygius	Atka Mackerel #												
*Ammodytes personatus**	Pacific Sand Lance												
Gadus macrocephalus	Pacific Cod												
Gadus chalcogrammus	Walleye Pollock												
Lepidopsetta polyxystra	Northern Rock Sole												
Stenobrachius leucopsarus	Northern Lampfish												

[1] Doyle, M.J. and Mier, K.L. 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.

Pleuronectes quadrituberculatus	Alaska Plaice	Shelf				Lowest	Highest	Moderate	Lowest				
Anoplopoma fimbria	Sablefish #	Slope/Deeper				Lowest	Highest	Moderate	Lowest				
Ophiodon elongatus	Lingcod #	Shelf			Lowest	Lowest	Highest	Moderate	Lowest				
Clupea pallasi	Pacific Herring	Coastal					Highest	Highest	Lowest				
Hippoglossoides elassodon	Flathead Sole	Shelf				Moderate	Highest	Highest	Moderate		Lowest	Lowest	
Platichthys stellatus	Starry Flounder	Coastal			Lowest	Moderate	Highest	Highest	Lowest				
Glyptocephalus zachirus	Rex Sole	Slope/Deeper				Lowest	Highest	Highest	Highest	Lowest	Lowest		
Microstomus pacificus	Dover Sole	Slope/Deeper				Lowest	Highest	Highest	Highest		Lowest		
Bathymaster spp.	Ronquils	Shelf			Lowest	Lowest	Highest	Highest	Moderate	Lowest	Highest	Moderate	Moderate
Lepidopsetta bilineata	Southern Rock Sole	Shelf				Lowest	Moderate	Highest			Moderate		
Isopsetta isolepis	Butter Sole	Coastal					Moderate	Highest	Moderate				
Sebastes spp.	Rockfish	Slope/Deeper				Lowest	Moderate	Highest	Highest	Moderate	Moderate	Lowest	
Mallotus villosus	Capelin	Coastal		Moderate	Lowest	Lowest	Lowest	Lowest	Lowest	Highest	Highest	Highest	Moderate
Limanda aspera	Yellowfin Sole	Coastal								Lowest		Highest	

*Used to be considered *A. hexapterus* prior to Mecklenberg et al. (2011)[2]

#Larvae associated with neuston

Level of abundance: Lowest, Moderate, Highest, Absent

Primary larval habitat (**H**): Coastal, Shelf, Slope/Deeper

Modeling Contributions to the GOAIERP Project

Eco-FOCI personnel have been involved in the Modeling Component of NPRB's Gulf of Alaska Integrated Ecosystems Research Program (GOAIERP, aka the GOA Project). This project is focused on examination of recruitment dynamics of five focal groundfish species in the GOA. Several types of models have been done for this project to complement the GOAIERP field work. A time series run of the 3km GOA implementation of the ROMS model (with integrated Nutrient-Phytoplankton-Zooplankton, NPZ, dynamics) has been run, from 1996 to 2011. This biophysical model has been used to show current patterns and patterns of scalars such as temperature and salinity, plus mesoscale dynamics such as eddies, all of which can influence transport of early life stages of fish. One product of the Modeling Component has been the development of a method to identify eddies in the ROMS output with the goal of examining the role of eddies in recruitment dynamics. At this initial stage, some correlations between indices based on these eddies, and recruitment has been found.

The output of this biophysical model is being used to drive individual-based models (IBMs) for the five GOAIERP focal species. These models are intended to allow us to examine connectivity between spawning and nursery areas, and also the environments encountered by the early life stages of the fish, for the purposes of examining how these factors affect recruitment variability. IBMs for Pacific cod and walleye pollock have been developed by Eco-FOCI personnel. A time series run (1996-2011) of the Pacific cod IBM has been completed, and initial connectivity analyses are done. Figure 1 shows the connectivity zones used for analyzing the output of the Pacific cod IBM.

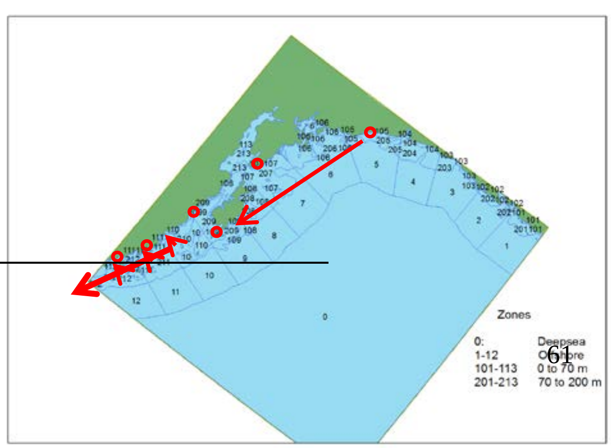


Figure 1. Connectivity zones for Pacific cod. Spawning zones are 101-113 and 201-213. Nursery zones are 101-113. Red circles and arrows indicate areas where variability in connectivity due la Nina may be high (see below).

[2] I ... versity of arctic marine fishes: taxonomy and

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Figure 2 shows the mean connectivity matrix for the years 1996-2011. From this figure it can be seen that retention (i.e. settlement in the same locations as spawning occurred, indicated by the white line) is important for Pacific cod. It is clear in this matrix that Pacific cod are not generally transported great distances between spawning zones and nursery areas. This is in accord with several other studies indicating that Pacific cod have very local distributions. It is also clear from this matrix that few Pacific cod seem to be transported to offshore areas.

Another analysis of connectivity showed that there may be an association between variability in connectivity in the western GOA (but not the eastern GOA) and La Nina (see Figure 1).
Results of analyses of IBM output will be incorporated into a Multispecies Model for the GOA, in an attempt to discover how recruitment variability affects other elements of the ecosystem.

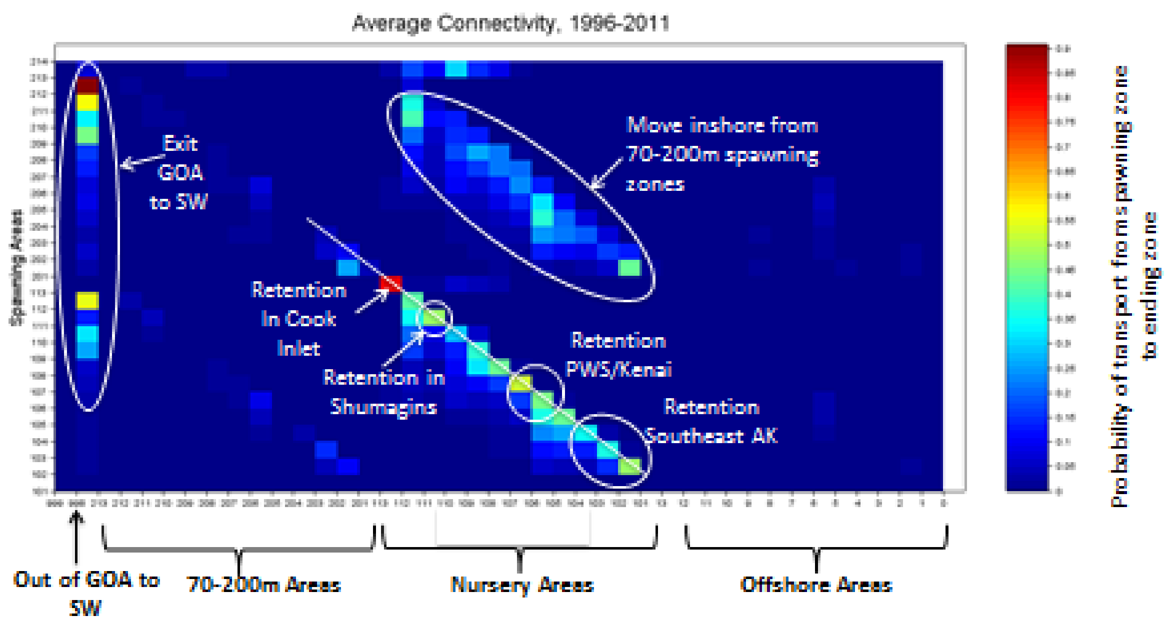


Figure 2. Mean connectivity matrix for the years 1996-2011 (right) from the Pacific cod IBM. The X-axis represents ending zones of individuals, the Y-axis indicates spawning (start) zones. Zones 101-113 represent nursery areas.

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 3 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.

Gulf of Alaska Project: Fisheries Oceanographic Surveys - ABL

The Gulf of Alaska Project completed the final Upper Trophic Level (UTL) fisheries oceanographic survey in 2013 as part of the North Pacific Research Board's (NPRB) Gulf of Alaska Integrated Ecosystem Research Program (GOA Project). The GOA Project is focused on comparing and contrasting ecological function in the southeast and central regions of the Gulf of Alaska (GOA). This interdisciplinary 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. An examination of EOF modes by the Retrospective Modeling team has shown that there is a spatial breakpoint around 148° W beyond which fish density increases, fish diversity decreases, and downwelling relaxes. Sea-surface temperature, phytoplankton production and salinity appear to co-vary from the eastern to western GOA within the vicinity of 148° W as well. This is the location where the two predominant currents change direction from northwest to southwest and the mean current flow velocity for the surface 50 m over the 1000 m isobaths from 1969-2005 shows a mean velocity of onshore flow to the east of 148° W and a mean offshore flow to the west. These flow patterns presumably support onshore flow of passive particles onto the narrow shelf in the eastern GOA and offshore diffusion across the broad shelf in the western GOA.

The 2013 UTL survey season of this integrated project was conducted during summer as field operations planned for fall were canceled due to the federal government shutdown. However, two fisheries oceanographic surveys were conducted off southeast Alaska and one off 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 2013 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. 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.

Acoustic data was collected by a Simrad ES-60 echosounder and a hull-mounted 38 and 120 kHz splitbeam transducer. Thus, acoustic transects, orthogonal to shore, were not run between all rope trawling stations. 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.

All five focal species were captured in surface trawls during the 2013 field season (Table 1). The 2013 focal fish surface trawl catch was dominated by YOY pollock which resulted in the largest sample retention for a species during the GOA Project (n>1000). The second most abundant species was rockfish, followed by P. cod, and arrowtooth flounder (ATF). Sablefish were the least abundant species. The summer catch of YOY pollock in the surface waters was 8 times higher in the Eastern Gulf and 3 times higher in the Central Gulf relative to 2012, while only a few individuals were encountered at 3 of 245 stations sampled in 2011 (Figure 1). During 2013 YOY pollock were uniformly distributed in the EGOA while the distribution in the CGOA was less homogeneous, and localized on the Portlock Bank. YOY pollock were absent in the surface trawls in the EGOA fall survey. Mid-water trawls, which were not conducted in 2012, encountered YOY pollock at depths of up to 200 meters and up to 80 miles offshore. YOY Pollock were only captured once during midwater trawling during 2011.

Catch of YOY rockfish in the summer surface waters increased relative to 2012 in the EGOA with dense patches at the outermost stations 80 miles offshore (Figure 1), and genetic analyses indicating that ~95% were Pacific Ocean Perch (POP). Fewer rockfish were captured during 2011 relative to 2012 and 2013; however, the survey grid only extended to 60 miles offshore and higher densities may have occurred between 70-80 miles offshore. YOY rockfish were only encountered at two stations in the CGOA, resulting in a total catch of 57 individuals compared to a catch of 6409 in 2012. Rockfish were the only focal species encountered in significant numbers at the surface during the fall EGOA survey, although the majority was identified as non-POP type onboard.

YOY Pacific cod were rarely encountered in the EGOA (Figure 1), which resembled the patterns observed in 2012 and 2011. The numbers caught in the CGOA decreased significantly from a catch of 469 in 2012 where they were abundant from the Portlock Bank south to the Albatross Bank to a catch of 72 in 2013. A total of 4 YOY P. cod were captured at two stations during 2011.

Arrowtooth flounder catch decreased in 2013 relative to 2012, with catches resembling those during the 2011 survey (Figure 1). Similar to 2013, ATF were primarily located in the EGOA and mostly absent in the CGOA (n=3), whereas they were distributed in both the CGOA and EGOA in 2012. The distribution of ATF in the EGOA spread from the innermost to the outermost stations and no large patches were encountered. Sablefish were, practically absent from the trawl catch (n=4) in 2013. Combined sablefish catches in 2011 and 2012 were fewer than 4 individuals however the LTL have intercepted post-larval sablefish using neuston nets samples the surface 20 cm of the water column.

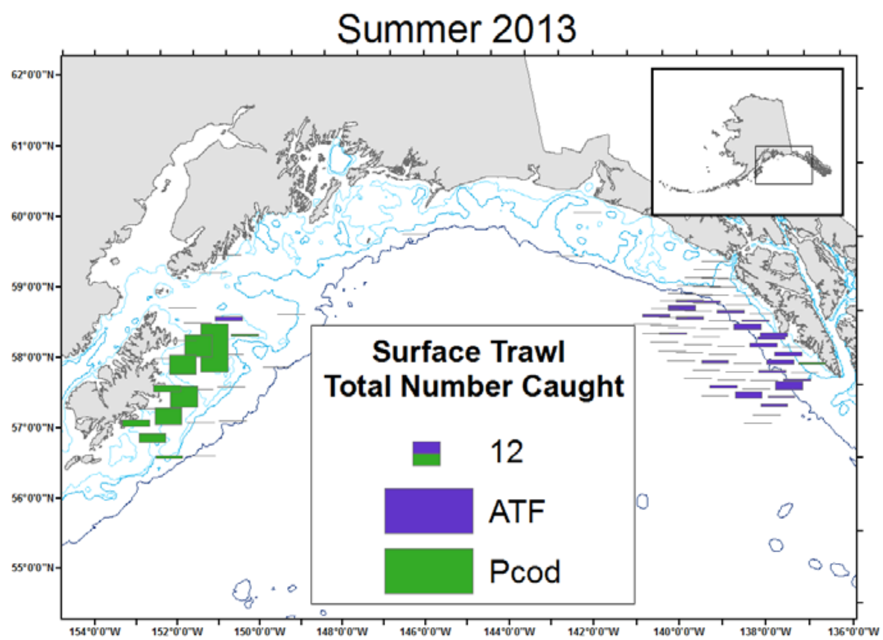
2013 was another record year for returning adult pink salmon to the EGOA and catches were similar in magnitude with our 2011 survey. The prolonged cold spring experienced by the riparian environment in Alaska delayed the emergence of juvenile pink and chum salmon and thus the catch of these species was significantly lower in July relative to years past. This is of interest to UTL researchers that have observed adult pink salmon predation on the GOAIERP focal fish and have also observed prey sharing and predation by juvenile pink salmon on focal species.

We intend to again sample the eastern region of the GOA during summer 2014. For more information, contact Jamal Moss at (907)-789-6609 or jamal.moss@noaa.gov

Table 1. 2013 Trawl catch summary of age-0 arrowtooth flounder (ATF), Pacific cod, walleye pollock, rockfish, and sablefish on UTL surveys in the eastern (EGOA) and central (CGOA) Gulf of Alaska

2013 GOAIERP Trawl Catch in Numbers

Region	Trawl type	Season	ATF	P. cod	W. pollock	Rockfish	Sablefish
EGOA	Surface	Summer	34	1	3964	1363	2
EGOA	Mid-water	Summer	12	1	3376	0	0
EGOA	Surface	Fall	0	0	1	60	2
EGOA	Mid-water	Fall	0	0	6	2	0
CGOA	Surface	Summer	3	72	1648	57	0
CGOA	Mid-water	Summer	3	164	6154	0	0
		Total	**52**	**238**	**15164**	**1482**	**4**



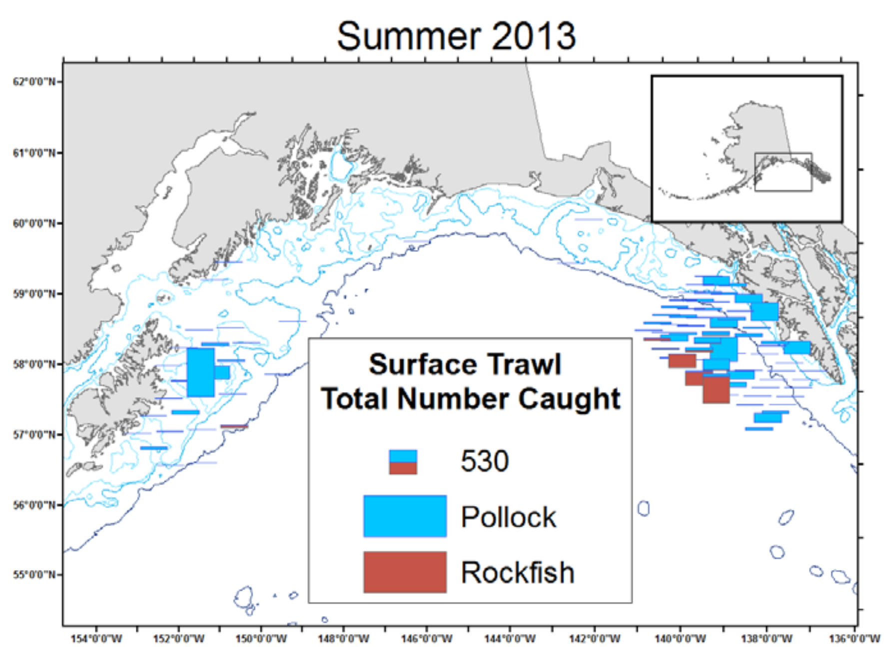


Figure 1. Surface catches for age-0 focal fish species in the eastern, gap, and central region for summer 2013 surveys. Note differences in scale between the top and bottom map.

Gulf of Alaska Project: Benthic Habitat Research - ABL

The primary goal of the Gulf of Alaska (GOA) benthic habitat research project is to characterize the preferred settlement habitat for the five focal groundfish species specified by the GOA Project Upper Trophic Level component. There are five main objectives for the habitat project: 1) conduct a literature review and synthesis of early life (EL) preferred habitat and observational data of five focal species, 2) collect, validate, digitize, and grid available benthic habitat data, 3) create benthic metrics from habitat data, 4) model species-specific habitat by early life stage, and 5) generate species-specific suitability maps of the modeling results. The first two objectives have been completed by the habitat team which includes ELH tables of habitat preference for the five focal species, extensive EndNote library of the literature synthesis, collection and validation of high resolution bathymetry (over 20 million soundings) and sediments (100 thousand plus points), GIS framework with digitized species observations, and preliminary derived benthic habitat metrics (e.g. slope and bathymetric position index, Figure 2).

Preliminary suitability models have been developed for the five focal species based on the literature information and draft suitability maps have been created. Our next step is to utilize available observational data to develop presence-only models of habitat suitability for the five focal species and include any newly available survey captures from the afore mentioned fisheries-oceanographic surveys. We are now coordinating with the modeling component to generate the appropriate scaled (3 km grid) habitat suitability maps to be useful for post-processing the survival indicators of their individual based model (IBM) particle trajectories. In the future, we plan to take the full trajectory locations from these models and update potential settlement indicators by using higher resolution habitat information from the habitat suitability maps. We are also coordinating with the middle trophic level component to determine if fine-scale suitability maps may be useful for understanding local pressures on survival and potentially utilizing their survey information to develop localized suitability models. For more information, please contact Kalei Shotwell at (907) 789-6056 or kalei.shotwell@noaa.gov

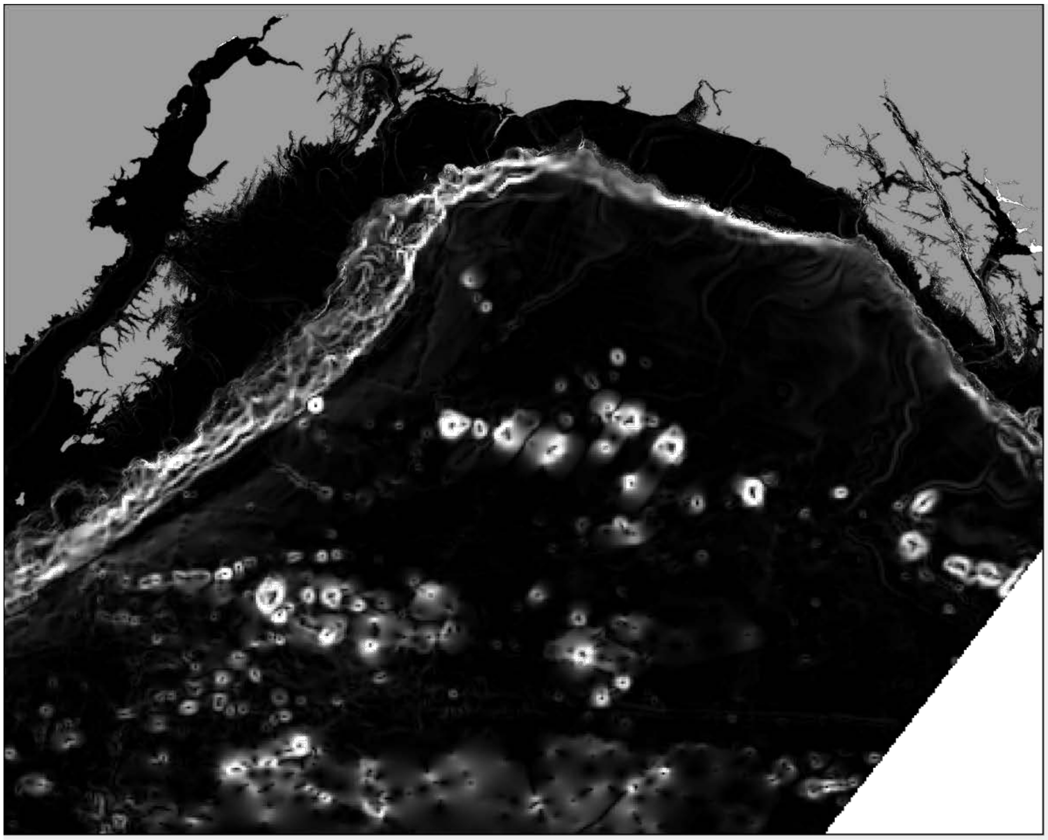


Figure 2. Draft GOA-wide slope derived from high resolution bathymetry data and shows rate of change of terrain in an area. Grid contributed by Jodi L Pirtle

RACE Habitat Research Group (HRG)

Scientists in the RACE Habitat Research Group (HRG) continue research on essential habitats of groundfish, including identifying informative predictor variables for building quantitative habitat models, developing efficient tools to map these variables over large areas, investigating activities with potentially adverse effects on EFH, such as bottom trawling, and conducting benthic community ecology studies to characterize groundfish habitat requirements and assess fishing gear disturbances. Research in 2013 was primarily focused on evaluating acoustic backscatter as a predictor of groundfish distributions in the eastern Bering Sea (EBS) and the development of next generation habitat-utilization models for managed species. An analysis of short-term trawling effects on soft-bottom benthos was completed, and a global study of mobile bottom-contact fishing gears was initiated as part of a international effort.

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 HRG 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), but 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.

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[3] 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[4,5] 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 in 2012 collected more than 3,800 gigabytes of acoustic data and groundtruthing information on multiple tracklines spanning strong gradients in groundfish and crab abundances (Fig. 1). Five different sonars were deployed on multiple passes over each line and these data were post-processed in 2013, for multiple purposes. Bathymetric data were cleaned and submitted for nautical charting. Backscatter data have been post-processed to produce standardized statistics, using quantitative sediment properties from grab samples to normalize the values. Still image mosaics of the seafloor were generated from towed video to serve as additional groundtruthing for the acoustic data.[6] Thirty-two years of trawl survey data (catch per unit effort, kg ha^{-1}) have been assembled and statistical analyses with the backscatter statistics are being prepared to compare the contributions of the different sonar systems in the habitat models. The most cost–effective sonar system will be used to systematically map and characterize the seabed of the EBS shelf (Fig. 2), and will be the basis for improved EFH models for multiple species.

[3] 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.
[4] 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.
[5] Yeung, C. and R.A. McConnaughey. 2008. Using acoustic backscatter from a side scan sonar to explain fish and invertebrate distributions: a case study in Bristol Bay, Alaska. ICES J. Mar. Sci. 65: 242–254.
[6] Representative video and the corresponding geo-referenced mosaic are available at http://www.afsc.noaa.gov/Quarterly/jas2012/divrptsRACE4.htm.

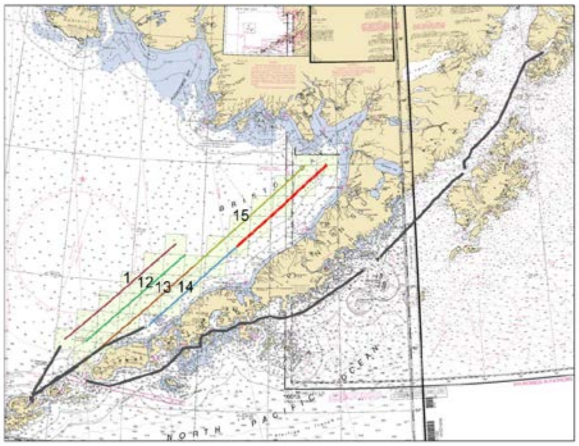


Figure 2. Completed FISHPAC 2012 survey tracklines. Shaded boxes represent 20 by 20 nautical mile squares centered on RACE bottom trawl survey stations for the Bering Sea shelf. Each line was surveyed with five different sonar systems, with the exception that only multibeam echosounder data were collected over the northeast section of line 14 and during the transits to and from the numbered tracklines. For additional information, see http://www.afsc.noaa.gov/RACE/surveys/cruise_archives/cruises2012/results_Fairweather_FISHPAC-2012.pdf.

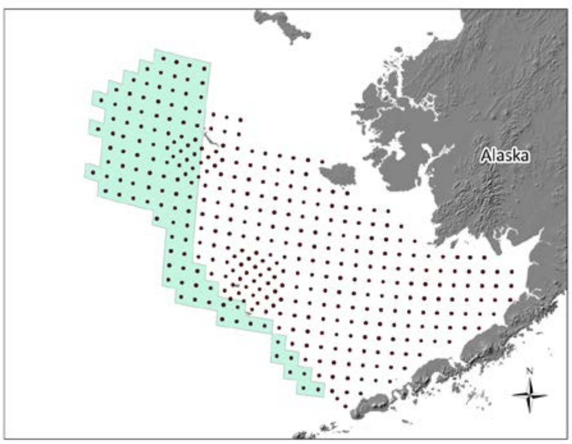


Figure 3. The first sector of the Bering Sea shelf that will be systematically mapped to improve groundfish habitat models and fishery stock assessments. Quantitative sonars will be used characterize the seafloor at the 104 trawl-survey stations in the shaded polygon, during a planned multi-mission cruise that will also produce IHO-quality bathymetric data for updating nautical charts of areas with outdated or non-existent information.

Tool Development for Broad-scale Habitat Mapping

The Klein 7180 long-range side scan sonar (LRSSS) is new technology that was purpose-built for HRG fish-habitat research. It is distinguished from all other sonar systems by its ability to collect fully adjusted quantitative information about seafloor characteristics and is thus ideally suited for modeling applications. The very large swath coverage (to 1.0 km) and high maximum tow speed (12 kts) of the LRSSS greatly increase the efficiency of survey operations thereby reducing costs and the time required to complete missions. Multiple acoustic, environmental and navigational sensors generate co-registered high-resolution backscatter and bathymetry from a dynamically focused multibeam side scan sonar and integrated nadir-filling sonars.

Secondary acoustic systems, including a 38 kHz single-beam echosounder, a Mills-cross-configured downward-looking sonar, and a pair of scatterometers also provide bathymetric and/or backscatter data for interpretation. Calibrated backscatter is available across the entire survey area with an innovative "cascade calibration" that uses overlapping swaths of data to transfer the calibrated backscatter from a simple downward-looking sonar (altimeter) to the other acoustic subsystems covering the nadir (under the towfish) and the outlying side-scan regions. This Mills-cross type altimeter is easily removed for tank calibration and can then be readily reinstalled in a fixed position as needed for periodic recalibration of the LRSSS system.

The Rolls Royce FFCPT[7] is a 52 kg instrumented probe that is designed to free fall through the water column and can penetrate up to 3 meters into the seabed. Measurements of deceleration and pore pressure allow for the determination of undrained sheer strength and a profile of sediment types. Sensor data are captured 2000 times per second on flash memory and transmitted to topside computers where they can be quickly processed with specialized software. In addition to sediment data, an instrument in the tail fin of the FFCPT acquires sound velocity profiles for use by the ship's acoustic systems. When combined with an appropriate winch, it is possible to yo-yo the instrument through the water column and into the seafloor while the ship is underway at speeds up to 6 kts, thereby improving surveying efficiency over more traditional sediment- and sound-velocity-sampling methods that require the ship to slow or even stop headway for data acquisition. The geotechnical data are being evaluated as new predictor variables for use in the HRG habitat models.

A triplet of optical sensors (Wet Labs Puck; 660 nanometer wavelength) incorporated into the LRSSS towfish continuously measures colored dissolved organic matter (370/460 nm excitation/emission), chlorophyll-a fluorescence (470/680 nm), and turbidity by particle scattering (660 nm) in the pelagic environment. These properties show considerable spatial variability, may be related to fish-habitat quality, and are also being considered for use in next generation models.

HAIP-QTC Opilio

The HRG is also investigating whether acoustic backscatter from the seafloor can be used to improve stock assessments. In stock assessment models, catchability is the link between an index of relative abundance from a fishery-independent survey and the modeled population size. For bottom trawl surveys that estimate the population size using swept-area methods, catchability can be estimated because it is largely determined by sampling efficiency (*i.e.*, the proportion of animals within the sampled area that is caught) which can be experimentally measured. However, estimating survey catchability is complicated because trawl efficiency has been shown to vary over a survey area in response to variation in bottom sediment type.

Catchability experiments have been conducted on the bottom trawl used for the annual EBS survey[8], resulting in a survey-wide estimate of catchability for snow crab (*Chionoecetes opilio*) which, when included in the stock assessment model, produced significant changes in the Allowable Catch Limit. This catchability model accounted for spatial variation in trawl efficiency as a function of crab size, sex, depth, and sediment type. Unfortunately, sediment

[7] For additional information, see http://www.brooke-ocean.com/document/product_sheet-RRCLNM-FFCPT-660_(4-page)-2011-01-web_Rev1_(2012-05-02).pdf

[8] For additional information, see http://www.afsc.noaa.gov/RACE/groundfish/ebs.htm

data over the geographic distribution of snow crab are quite fragmentary due to the remoteness of the area, and direct estimates of sediment properties such as grain size are generally unavailable at the trawl-sampling locations.[9] In some cases, estimates were based on sediments collected over 60 miles away. The option to collect sediment data at all 270 trawl-sampling stations included in the snow crab distribution is prohibitively expensive considering the additional ship time required and the sample processing costs.

This project is examining whether indices of bottom type, derived from standardized and calibrated ES-60 acoustic data collected at each snow crab sampling station, are more informative in the snow crab bottom trawl catchability model than measured values of sediment type that were broadly extrapolated. This determination will be based solely on the amount of spatial variation in the snow crab efficiency model that is explained by the two kinds of sediment information. While the currently used data are based on a directly measurable attribute of the sediment (mean grain diameter), the acoustically derived index is related to this attribute but also to a variety of previously unmeasured variables affecting the time-dependent shape of the bottom echo. Although there is not a simple mathematical relationship between the two types of information, we believe an acoustic index is sufficiently related, will be more reliable, can be collected more efficiently, and will result in a better fitting catchability model for EBS snow crab. In the future, it may be possible to expand this study to other species after completion of the systematic acoustic survey of all EBS trawl-survey stations (Fig. 2).

Effects of Bottom Trawling

In 2013, the HRG completed an analysis of short-term effects of bottom trawling on soft-bottom benthos of the EBS.[10] In particular, a Before-After Control-Impact (BACI) experiment was conducted to investigate the effects of a commercial bottom trawl on benthic invertebrates in a sandy and previously untrawled area of the EBS. Six pairs of experimental and control corridors were sampled with a research trawl before and after four consecutive tows with the commercial otter trawl. A major storm event occurred during the experiment and it was possible to differentiate its effect from that of the trawling using the BACI model. Species composition changed very little; *Asterias amurensis* and *Paralithodes camtschaticus* comprised over 80% of the total invertebrate biomass (kg ha^{-1}) during each year of the study. In general, the commercial trawl did not significantly affect the biomass of the benthic invertebrate populations. The trawling effect after 4-14 d was statistically significant for three of the 24 taxa that were analyzed, a number expected due to nothing more than random variation with $\alpha = 0.10$. Biomass immediately after the trawling disturbance was lower for 15 of the taxa and higher for the other nine, with a median change of -14.2%. Similarly, the effect of trawling on invertebrate biomass after one year was not statistically significant for any of the taxonomic groups ($p \geq 0.23$), indicating no evidence of a delayed response to the commercial-trawl disturbance. Further analysis suggests that storms have an overall greater effect on the benthos than do bottom trawls at this location. Both the numbers of taxa significantly affected by trawling and the storm (3 *vs.* 12), as well as the median sizes of these effects (-14.2% *vs.* -22.0%), were greater for the storm event. Results from this study are combined with those from a related investigation of chronic trawling effects (Fig. 3) to propose an adaptive

[9] Smith, K. R. and R. A. McConnaughey. 1999. Surficial sediments of the eastern Bering Sea continental shelf: EBSSED database documentation. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-104. 41 p. For additional information, see http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-104.pdf

[10] McConnaughey, R. A. and S. E. Syrjala. 2014. Short-term effects of bottom trawling and a storm event on soft-bottom benthos in the eastern Bering Sea. ICES J. Mar. Sci. (in press).

management strategy for the study region, including rotating area closures to mitigate for temporary trawling effects.

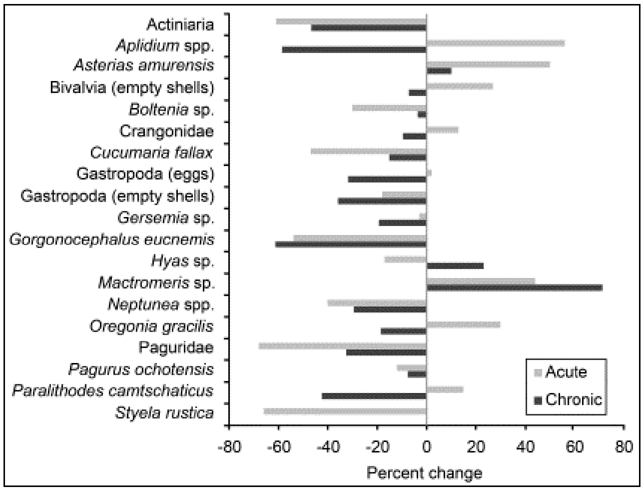


Figure 4. Changes in the biomass (kg ha^{-1}) of benthic invertebrate taxa 4-14 d after four consecutive passes of a commercial trawl (acute effects; present study) and after decades of intensive trawling by the fishery (prior HRG study of chronic effects). The chronic effect for *Styela rustica* was 0%.

International Committee Forms to Study Bottom-trawl Effects

There is considerable evidence that mobile bottom-contact gears (MBCG) such as trawls and dredges affect the integrity of benthic environments that support prey and provide habitat for managed populations of fish and crab. Widespread use of these gears could thus have substantial effects on the growth, survival, and productivity of these stocks. There is, however, considerable variability in the magnitude and characteristics of the effects. Hard-bottom areas with surface-dwelling invertebrate fauna are particularly sensitive, whereas soft-bottom areas with frequent natural disturbances are relatively insensitive. Given that approximately 25% of world fish catch comes from the use of these gears, a clear understanding of the overlap between trawling effort and different benthic habitats is of considerable global importance.

An international group has formed to summarize the global use of mobile fishing gears, their impacts on marine habitats and the productivity of fish stocks, and related management practices. The committee is comprised of individuals from both academia and government and is being lead by Professors Ray Hilborn (University of Washington, Seattle), Simon Jennings (Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, U.K.), and Michel Kaiser (Bangor University, Bangor, U.K.). Other members of the committee are Drs. Adriaan Rijnsdorp (Wageningen University and Research Center, IJmuiden, Netherlands), Roland Pitcher (Commonwealth Scientific and Industrial Research Organization, Brisbane, Australia) , Bob McConnaughey (NOAA Alaska Fisheries Science Center, Seattle), Jeremy Collie (University of Rhode Island, Narrangansett), Jan Hiddink (Bangor University, Bangor, U.K.), and Ana Parma (Argentine Council for Science and Technology, Chubut, Argentina). Two post-doctoral research associates (Drs. Ricardo Amaroso and Kathryn Hughes) are also actively working on the project.

The full project will consist of five phases spread over the next 2 years. The first phase of this project will systematically map MBCG effort and its distribution with respect to benthic

habitats. Phase 2 will compile and evaluate data about the impacts of MBCG on the abundance and diversity of biota. [11] Phase 3 will use information from the first two phases to conduct a risk assessment of the effects of trawling and to illustrate trends in the risk of change to seabed habitats and communities. Phase 4 will look at the medium- and long-term impact of trawling on the productivity and sustainable yield of different target species and ecosystems. Phase 5 will identify and test a range of management options and industry practices that may improve the environmental performance of trawl fisheries, with a view to defining 'best practice.' Additional details about the project and the study group are available at http://trawlingpractices.wordpress.com/.
Benthic Invertebrate Ecology

Invertebrate Species Synopsis - *Asterias amurensis*
Invertebrates constitute an important element in the benthic ecology of the EBS continental shelf, playing an important part in the food web supporting not only the benthos, but also commercially important demersal fish species. The HRG is synthesizing sparse literature and reports to produce synopses of the life history and ecology of significant species. The second in a series of NOAA Technical Memoranda has been completed to aid the interpretation of mobile fishing gear effects on these invertebrates, their linkages to fishery production, and their overall role in the ecosystem.[12] The document presents a synopsis of the current knowledge of the life history and ecology of the *Asterias amurensis*; it includes detailed maps of its distribution in the EBS based on abundance data from the 1982-2013 RACE bottom trawl-surveys. The biological characterizations are from the available published literature and are based on observations of populations in the native and invaded ranges of the species.

The asteroid species *Asterias amurensis* represents a major portion of the benthic invertebrate biomass over most of the shelf, but it is especially prevalent in the inshore domain out to about the 50 m isobath. The species is also native to coastal areas of the northwestern Pacific, including the Tatar Strait, eastern and western Sea of Japan, and the east coast of Japan. It is a predator upon numerous shelled mollusk species, as well as other invertebrates of limited motility, and is also an opportunistic scavenger. Asteroids appear to have few predators, and in food webs *A. amurensis* is a terminal consumer. It therefore competes with some commercially important demersal fish species, as well as commercially important invertebrates such as the king crab *Paralithodes camtschaticus*. A possible mitigating circumstance in its ecological role is the large contribution to secondary production constituted by the release of potentially millions of eggs by each spawning female during the annual reproductive cycle. With its low susceptibility to predation, the species has proven a major threat to the ecological balance in areas where it is not native, but has been inadvertently introduced by such means as release of planktonic larvae in ballast water jettisoned by foreign ships in port; for example, in some

[11] Hughes, K. M., M. J. Kaiser, A. S. Pullin, R. Amoroso, J. S. Collie, J. G. Hiddink, R. Hilborn, S. Jennings, R. A. McConnaughey, A. Palmer, R. C. Pitcher, A. D. Rijnsdorp. 201 . Investigating the effects of mobile bottom fishing on benthic biota: A systematic review protocol. Environmental Evidence (submitted).

[12] Smith, K. R. and C. E. Armistead. 2014. Benthic Invertebrates of the eastern Bering Sea: A synopsis of the life history and ecology of the sea star *Asterias amurensis*. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-273, 58 p.

coastal waters of southeastern Australia and Tasmania. Here native species of bivalves have proven especially vulnerable to the predator.

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 Ocean and Chukchi Sea. During 2013, AFSC personnel analyzed the stomach contents of a wide variety of species from the eastern Bering Sea, the Aleutian Islands, the Gulf of Alaska, the northern Bering Sea, and the Chukchi Sea regions. The contents of 10,359 stomach samples were analyzed in the laboratory and 4,710 stomach samples were analyzed at sea during the Gulf of Alaska groundfish survey. This resulted in about 39,000 records added to AFSC's Groundfish Food Habits Database in 2013. Support of seasonal energy flow modeling in Alaska's marine ecosystems was also provided through preparation and stable isotopic analysis of about 1,200 muscle and liver tissue samples.

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. In total, 1,359 stomach samples were collected during the survey of the Gulf of Alaska, and 5,594 stomach samples were collected during the survey of the eastern Bering Sea shelf. These samples were supplemented by the collection of 2,374 stomach samples from Alaskan fishing grounds by Fishery Observers. Specimens were also collected from every species possible during scientific trawling operations in the eastern Chukchi Sea resulting in 970 specimens collected for stomach content analysis.

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.

Seabird Bycatch Estimates for Alaskan Groundfish Fisheries, 1993-2012

Seabirds are caught as bycatch in Alaskan commercial Groundfish fisheries operating in federal waters of the U.S. Exclusive Economic Zone. Fisheries Observers record seabird bycatch from their sample and other sources while on board these demersal longline, pot, pelagic trawl, and non-pelagic trawl vessels. The AFSC produces annual estimates of total seabird bycatch from these fisheries each year. Estimates are based on two sources of information, (1) data provided by NMFS-certified Fishery Observers deployed to vessels and floating or shore side processing plants, and (2) industry reports of catch and production. The 2007 - 2012 seabird bycatch estimates presented here (Table 1) are produced from the NMFS Alaska Regional Office Catch Accounting System.

These estimates update those previously reported from 1993 to 2006. These numbers do not apply to gillnet, seine, troll, or halibut longline fisheries. Data collection on the Pacific halibut longline fishery began in 2013 and will be summarized in future documents. Figure 1 is provided to report seabird bycatch in the groundfish fisheries for 1993 through 2012, using results from two analytical methods employed. The AFSC produced estimates from 1993 through 2006 and the CAS from 2007 through 2012.

The 2012 numbers for the combined groundfish fisheries (Table 1) are 40% below the rolling 5-year average for 2007-2011 of 8,295. Albatross bycatch was reduced in 2012 by 27% compared to the previous 5 years, with the greatest decrease in Laysan (*Phoebastria immutabilis*) versus Black-footed (*P. nigripes*) Albatross (36% and 11% declines, respectively). Northern fulmar (*Fulmaris glacialis*) bycatch, down by 39% compared to the 5-year average and 52% from the year before, remained the highest proportion in the catch at 61%. Fulmar bycatch has ranged between 45 to 76% of the total seabird bycatch since 2007. Average annual mortality for fulmars since 2007 has been 4,586. However, when compared to estimates of total population size in Alaska of 1.4 million, this represents an annual 0.33% mortality due to fisheries. There is however some concern that the mortality could be colony-specific possibly leading to local depletions.

The demersal longline fishery in Alaska typically drives the overall estimated bycatch numbers and constitutes about 91% of seabird bycatch annually (but see comment regarding trawl estimates below). Bycatch in the longline fishery showed a marked decline beginning in 2002 (Figure 1) due to the deployment of streamer lines as bird deterrents. Since then, annual bycatch has remained below 10,000 birds, dropping as low as 3,704 in 2010. Numbers increased to 8,914 in 2011, the second highest in the streamer line era, but fell back to 4,544 in 2012. The increased numbers in 2011 were due to a doubling of the gull (*Larus* spp.) numbers (1,084 to 2,206) and a 3-fold increase in fulmars, from 1,782 to 5,848. These species group numbers have decreased in 2012 as well, to 885 and 3,016 respectively. There are many factors that may influence annual variation in bycatch rates, including seabird distribution, population trends, prey supply, and fisheries activities. Work has continued on developing new and refining existing mitigation gear.

Albatross bycatch varied annually. The greatest numbers of albatross were caught in 2008. In 2012, 57.0% of albatross bycatch occurred in the GOA (down from 87% in 2011). The GOA typically accounts for 10 to 20% of overall seabird bycatch. Only Laysan albatross were taken in the BSAI, and all Black-footed Albatross were taken in the GOA (along with about 14 Laysan). While the estimated bycatch of black-footed albatross underwent a 4-fold increase in bycatch (44 to 206) between 2010 and 2011, the 2012 numbers are about 11% under the long-term average of 153 birds per year. Although the black-footed albatross is not endangered (like its relative, the short-tailed albatross), it was considered for listing as threatened and is currently a Bird of Conservation Concern by the U.S. Fish & Wildlife Service. Of special interest is the endangered short-tailed albatross (*Phoebastria albatrus*). Since 2003, bycatch estimates were above zero only in 2010 and 2011, when 2 birds and 1 bird were incidentally hooked respectively, resulting in estimated takes of 15 and 5 birds. This incidental take occurred in the Bering Sea area. No observed takes occurred in 2012 (or 2013 either). The expected incidental take of 4 birds every two years, since the Biological Opinion was revised in 2003, totals to 20 observed takes while the realized observed take has been 3 birds.

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. For example, the 2010 estimate of trawl-related seabird mortality is 823, while the additional observed mortalities (not included in this estimate and not expanded to the fleet) were 112. Observers now record the additional mortalities they see on trawl vessels and the AFSC Seabird Program is seeking funds to support an analyst to work on how these additional numbers can be folded into an overall estimate. The challenge to further reduce seabird bycatch is great given the rare nature of the event. For example, in an analysis of 35,270 longline sets from 2004 to 2007 the most predominant species, Northern fulmar, only occurred in 2.5% of all sets. Albatross, a focal species for conservation efforts, occurred in less than 0.1% of sets. However, given the vast size of the fishery, the total estimated bycatch can add up to hundreds of albatross or thousands of fulmars (Table 1).

Table 1. Total estimated seabird bycatch in Alaskan federal groundfish fisheries, all gear types and Fishery Management Plan areas combined, 2007 through 2012.

Species/ Species Group	Year					
	2007	2008	2009	2010	2011	2012
Unidentified Albatross	16	0	0	0	0	0
Short-tailed Albatross	0	0	0	15	5	0
Laysan Albatross	17	420	114	267	189	128
Black-footed Albatross	176	290	52	44	206	136
Northern Fulmar	4,581	3,426	7,921	2,357	6,214	3,016
Shearwater	3,602	1,214	622	647	199	510
Storm Petrel	1	44	0	0	0	0
Gull	1,309	1,472	1,296	1,141	2,208	885
Kittiwake	10	0	16	0	6	5
Murre	7	5	13	102	14	6
Puffin	0	0	0	5	0	0
Auklet	0	3	0	0	0	7
Other Alcid	0	0	105	0	0	0
Other Bird	0	0	136	0	0	0
Unidentified	509	40	166	18	259	284
Total	10,228	6,914	10,441	4,596	9,298	4,977

The AFSC remains committed to work with the fishing industry, Washington Sea Grant, and others to meet the challenges of further reducing seabird bycatch. 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. 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.

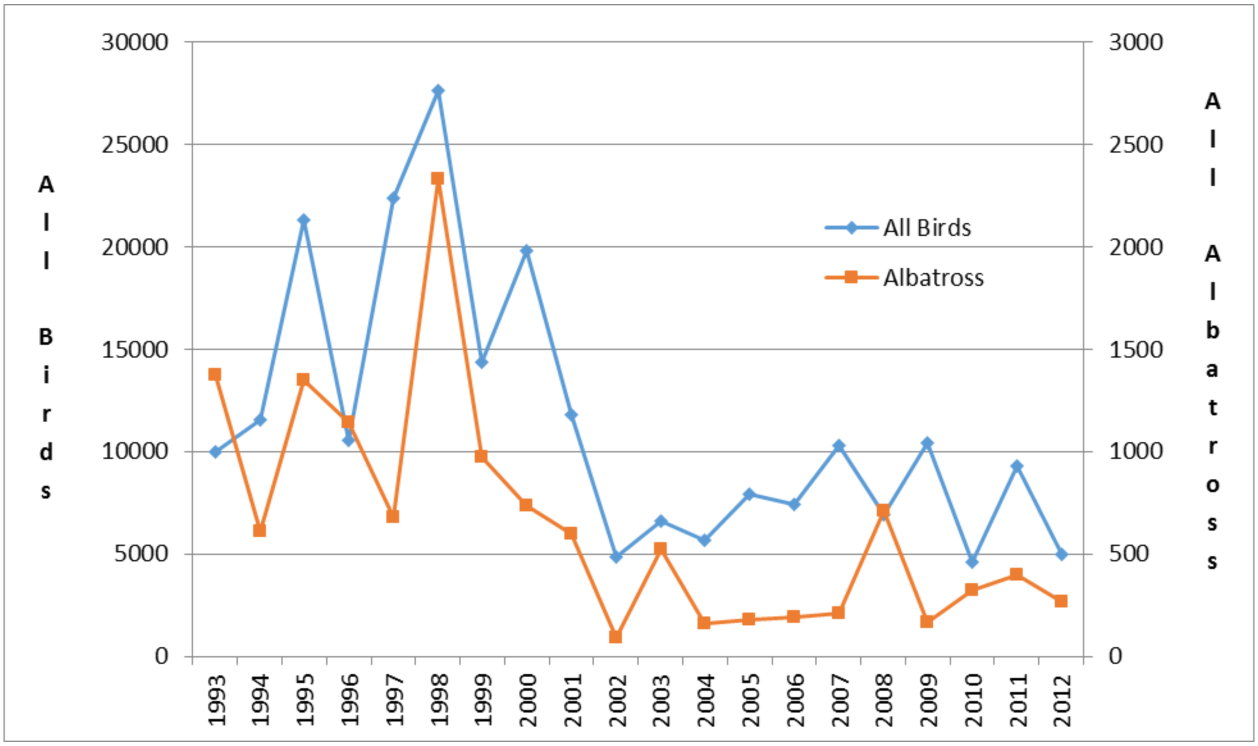


Figure 1. Seabird bycatch in Alaskan groundfish fisheries, all gear types combined, 1993 to 2012. Total estimated bird numbers are shown in the left-hand axis while estimated albatross numbers are shown in the right-hand axis.

Climate Impacts on Spawning Stock-recruitment Relationships from Multi- and Single-Species Stock Assessment Models

As part of a management strategy evaluation for the Bering Sea, the relationships between climate (i.e., water column temperature) and productivity (i.e., spring and fall zooplankton biomass) on spawning stock and recruitment relationships for three species of groundfish, walleye pollock, Pacific cod, and arrowtooth founder have been investigated. For this approach, recruitment estimates were first derived from a multi-species stock assessment models (MSM) fit to historical survey and fishery data. The model was run in multi-species mode, where each species is linked through a predation sub-model, as well as in single-species mode, where no predation interactions occur. This produced a time-series of spawning stock biomass and recruitment from the multi-species and single-species models. ROMS model estimates for mean water column temperature and spring and fall zooplankton biomass were then used as covariates on a Ricker stock recruitment curve, such that:

$$log(\hat{R}_{p,y}) = \log(\alpha_{R,p} \cdot SSB_{p,y-1}) - \beta_{R,p} \cdot SSB_{p,y-1} + \beta_{Z,p}^{spr} \cdot Z_y^{spr} - \beta_{Z,p}^{fall} \cdot \left(\delta_{p,1,y}^{fut} \big/ Z_y^{fall} \right) + \varepsilon$$

Where $\hat{R}_{p,y}$ is estimated recruitment in year *y* for species *p*, $SSB_{p,y-1}$ is the spawning stock biomass from the multi-species model, Z_y^{spr} and Z_y^{fall} are the total spring and fall zooplankton biomasses predicted from the ROMS/NPZ model for the Bering Sea, $\delta_{p,1,y}^{fut}$ is the ration of the youngest age class for each species, and $\alpha_{R,p}$, $\beta_{R,p}$, $\beta_{Z,p}^{spr}$, $\beta_{Z,p}^{fall}$ are parameters of the recruitment function fit through maximum likelihood to recruitment from the multi-species model ($R_{p,y}$) such that $\varepsilon \sim N(0,\sigma^2)$ (Figure

3). Model estimates were compared via AIC and top models for each species were selected for use in projections of the multi-species model under future climate scenarios from ROMS/NPZ projections based on down-scaled IPCC climate model scenarios (Figure 4).

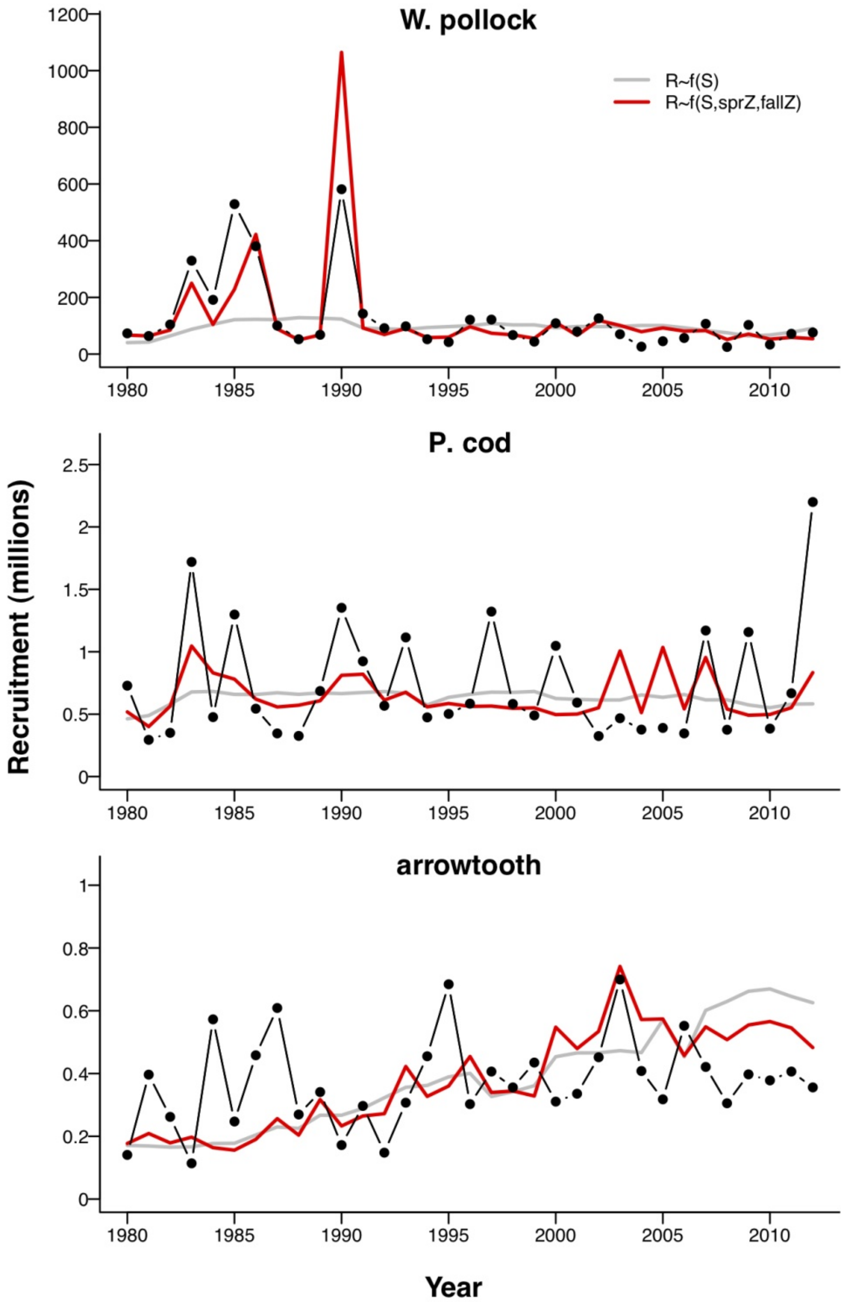


Figure 3. Recruitment estimates from the multi-species stock assessment model (black lines) and stock-recruitment regression model estimates for recruitment functions without zooplankton covariates (gray) and with zooplankton covariates (red).

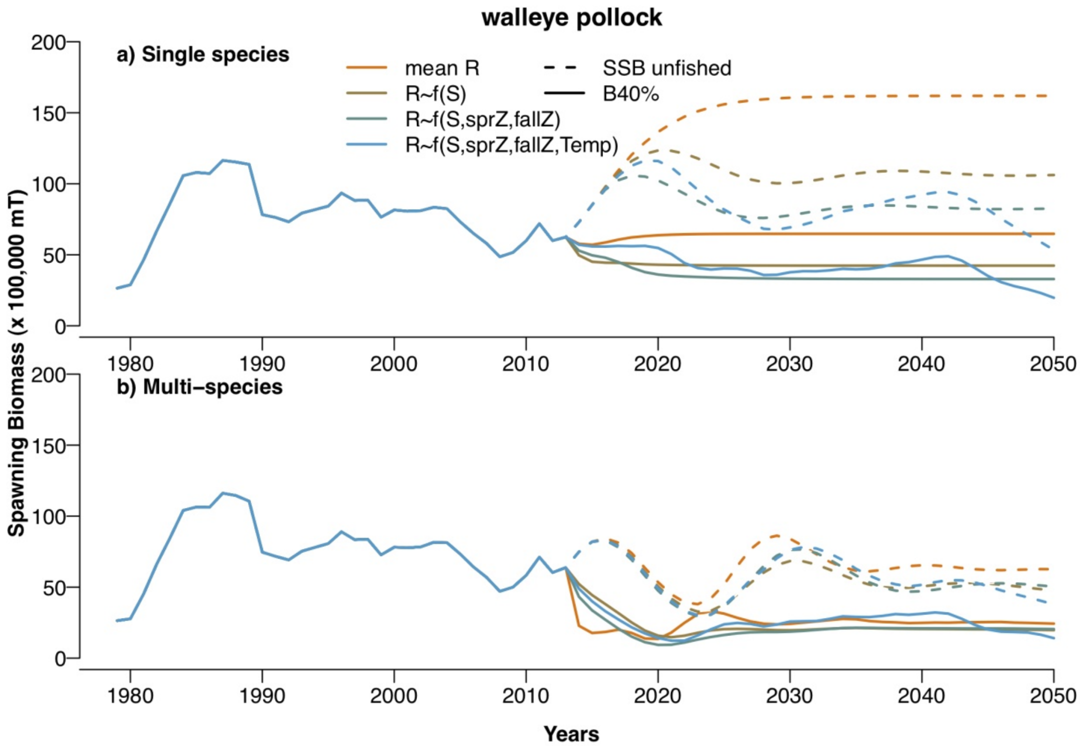


Figure 4. Projected spawning stock biomass for walleye pollock predicted from single (a) and multi-species (b) modes of MSM under various recruitment relationships and no harvest ("SSB unfished"; dashed line) or harvest that yields 40% of SSB on average during the last five years (2045-2050) of the projection (B40%; solid line).

Multispecies Management Strategy Evaluations

The North Pacific Fisheries Management Council (NPFMC) has stated that one of four priority objectives is to incorporate and monitor effects of climate change on Bering Sea and Aleutian Islands marine ecosystems and their dependent fisheries. Climate change is expected to impact marine ecosystems globally, with the largest changes anticipated for arctic and sub-arctic ecosystems. The 2 ^{o}C projected increase in mean summer sea surface temperature for Alaskan marine ecosystems may alter trophic demand, predator and prey distributions, and overall system productivity. REEM scientists are collaborating with REFM and PMEL scientists to use multi-species food-web and assessment models to link changes in the physical environment and food-web to recruitment and survival and help distinguish fishery impacts from large-scale climate pressures. Recently, model runs have been completed for the Bering Sea using a 10km^2 Regional Ocean Modeling System (ROMS) model coupled to a Nutrient-Phytoplankton-Zooplankton (NPZ) model to produce detailed hindcasts for the period 1970-2012 and forecasts using IPCC scenarios through 2040. These results drive a climate-driven Multispecies Statistical Model (MSM) for use in a management strategy evaluation of three groundfish species from the Bering Sea (walleye pollock, Pacific cod, arrowtooth flounder). First, ROMS model results modulate bioenergetics, food supply, growth, recruitment, and species overlap (i.e. functional responses and predation mortality) as fit in the MSM using hindcast-extracted time series. Then the MSM model is applied to downscaled IPCC climate projections via a ROMS and NPZ model projection of temperature, circulation, and zooplankton abundance. Results of model simulations have helped REEM scientists understand and predict how future climate driven changes to the system may impact predation and fishery harvest limits (Figure 5).

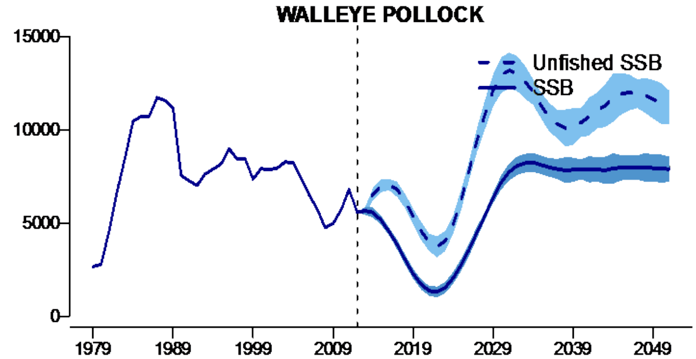


Figure 5. An example output from a multi-species stock assessment model that accounts for climate effects on future fished and unfished biomass estimates.

Alaska Integrated Ecosystem Assessments

The national IEA website team has recently completed an IEA website and it is now live at: www.noaa.gov/iea. The website serves as a portal for IEA research and highlights a number of recent advancements in regional IEAs (Figure 6). In addition, IEA scientists have recently completed a manuscript detailing the process for developing IEAs in a given region.

Figure 6. IEA home page summarizing processes and products.

Lastly, an integral component of the IEA process is to synthesize the response of ecosystem indicators to changes in natural and anthropogenic drivers (e.g., fishing and climate change) and develop ecosystem indicators and targets for conducting risk analyses. Ecosystem components identified as at risk are then targeted for intervention and evaluated for management actions through subsequent management strategy evaluations. AFSC and IEA scientists have recently leveraged efforts of an ongoing North Pacific Marine Science Organization (PICES) working group (WG-28) and FATE (Fisheries And The Environment) funded project to derive a composite index of ecosystem condition from combined risk scores for Alaskan marine habitats. The approach provides information on the relative risk of each habitat to combined climate and anthropogenic pressures (Figure 7; $Risk_h$) as well as an overall index of the present condition of the ecosystem that can be compared to a target Ecosystem Reference Point (ERP). The ERP and $Risk_h$ values can also be used to evaluate the probability of dropping below a specified ERP (and/or individual $Risk_h$) threshold under status quo or future climate conditions and management actions. The ERPs and included risk scores will be applied directly to the Alaska IEA and reported annually in the Ecosystem Assessment section of the regional stock assessment and fishery evaluation report. This report is reviewed annually by regional members of the North Pacific Fisheries Management Council.

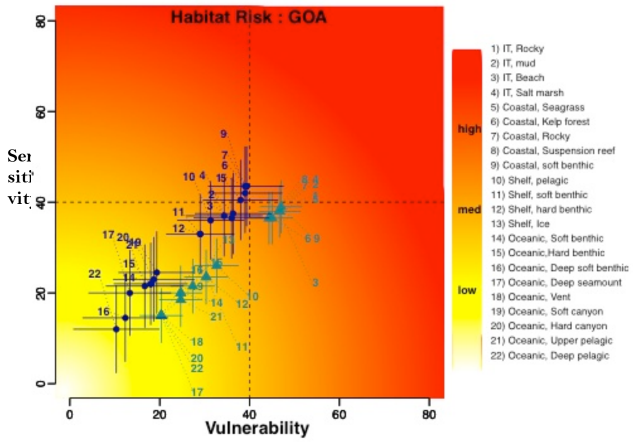


Figure 7. Habitat specific risk (cumulative for all pressures) for EBS and GOA ecosystems based on results of surveys from reviewers 1 and 2 (circles and triangles, respectively). Adapted from Samhouri and Levin (2012). Error bars represent uncertainty indices for each habitat (scored from 1 to 4; low to high).

Some promising groundwork towards an ecosystem risk assessment has recently been completed and new IEA and FATE support will help move this work towards a comprehensive synthesis for GOA and EBS marine ecosystems. Final $Risk_h$ and ERP values calculated and evaluated through this project will directly inform the Risk Assessment step of the Alaska IEA, and will serve as a framework for ecosystem risk analysis in regional IEAs that are in development elsewhere. Further, since the $Risk_h$ and ERP values can be improved through management actions as well as increased research and data quality (i.e., increase the certainty score), then this project can help identify both future management and research priorities.

Alaska Marine Ecosystem Considerations

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, the Gulf of Alaska, and the Alaskan Arctic. Consistent with ecosystem assessments of the eastern Bering Sea, Gulf of Alaska, and Aleutian Islands, the Arctic assessment includes 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. Including the Alaskan Arctic to the Ecosystem Considerations report provides 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. The final report was presented to the Science and Statistical Committee and Council Advisory Board in December when the 2014 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

Fishery Interaction Team (FIT), SSMA, REFM

The Fishery Interaction Team (FIT), a part of the Status of Stocks and Multispecies Assessment Program, 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.

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 2013, staff estimated local abundance and movement probability inside and outside trawl exclusion zones with an integrated model that uses maximum likelihood to estimate all parameters simultaneously. These studies are needed to improve our understanding of whether trawl exclusion zones are effective at maintaining sufficient quantities of Atka mackerel prey for Steller sea lions foraging in the Aleutian Islands. In addition, data from multiple years of tagging will provide independent estimates of mortality rates that can be used to improve Atka mackerel stock assessment.

FIT staff also contribute to SSMA research objectives. In 2013, FIT staff began a two-year study
of spatial and temporal variability of walleye pollock fecundity. Stock assessments for the Gulf of Alaska and Eastern Bering Sea would be markedly improved by the incorporation of contemporary fecundity estimates under current stock levels and climate regimes. During the first year of this project, archived ovary samples from NMFS research cruises were examined to determine which fecundity assessment methodology is appropriate, given the condition and preservation medium of the samples. Second year work will be an analysis of the demographic and environmental drivers of spatial and temporal variability observed in the fecundity estimates.

FIT also supports giant Pacific octopus stock assessments. In 2013 FIT staff initiated a field project to continue development and testing of habitat pot gear for directed octopus research. The AFSC wishes to develop this gear to facilitate life history, tagging, and other studies in support of the federal stock assessment for the octopus species group. The main objective is to determine the scope, effort, and costs that would be associated with a species-specific biomass index survey for octopus, using habitat pot gear. The project provided a loan of habitat pot gear from AFSC to two selected vessels in Kodiak, Alaska. These vessels fish the habitat pot gear on their own schedule and experiment with different configurations, soak times, and fishing methods. The participating vessels will provide AFSC and ADF&G researchers with detailed catch data and periodic access to the catch for life history specimens. This project represents a partnership between AFSC, ADF&G, and industry. Industry partners are interested in assessing the potential of octopus as a possible commercial species. AFSC and ADF&G need to develop field methodologies that will support future management decisions for octopus.

FIT research supports SSMA and AFSC priorities to advance ecosystem based fishery management, in particular in the Arctic. FIT participated in a multi-disciplinary survey of the Chukchi Sea in 2013. The Chukchi Sea is important for marine mammals, marine birds, numerous fish species, invertebrates and subsistence hunters of northern Alaska. Ecosystem studies in the Chukchi Sea have been limited in spatial and temporal coverage. For this reason, there is not enough information to characterize the status of the main tropic levels (fish and invertebrates) that support the majority of the top predators in the Chukchi Sea. The goals for this project (lead by the North Slope Borough, NSB) will be to collect data on: (1) water mass properties; 2) species composition, distribution and abundance of marine invertebrates 3) species composition, distribution and abundance of fish; and 4) fish diet. This information will be collected by providing research vessels as a platform of opportunity to various researchers, including staff from SSMA FIT. SSMA FIT staff, in collaboration with NSB and RACE surveyed the distribution and abundance and collected samples of demersal fish and benthic invertebrates.

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 - RACE GAP
In 2013, we finished the data collection for 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 and movement 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, we conducted a laboratory trial that examined the effects of intra-peritoneal tag implantation on juvenile Pacific cod and the results indicated this was a valid technique. In the fall of 2011 and 2012, 22 juvenile cod were captured in the field and fitted with acoustic transmitters. 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. 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. 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 early winter movements and residency patterns were highly variable among the tagged individuals. Some individuals briefly transited the acoustic gate during the fall and left the study area, while others resided in close proximity of the acoustic array near the mouth of the bay throughout the early winter months. Final analysis is ongoing and a manuscript will be completed in 2014. 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.

Coastal Age-0 Pacific Cod Survey– Gulf of Alaska - RACE FBEP

The Fisheries Behavioral Ecology Program conducts research on the early life-history habitat requirements of commercially important Alaskan fish and crab species. Age-0 stages of Pacific cod are often restricted to surface waters or coastal nursery habitats where they are not available to the stock assessment trawl survey. As such, there are few direct measures of age-0 abundance data to fit stock-recruitment models and examine recruitment processes at this important early life stage. The Newport laboratory has been conducting an annual summer beach seine and camera survey of two coastal nurseries in Kodiak, AK across 16 sites since 2006. The survey samples are focused on age-0 and age-1 stages of juvenile Pacific cod, but also samples co-occurring juvenile walleye pollock and saffron cod. The Newport laboratory is examining this time-series and its efficacy of predicting year class strength locally (inshore) and more broadly (offshore) across the Gulf of Alaska. Models are also examining variance of sequential year class prediction as a function of habitat (e.g., structure, unstructured), spatial scale (within bay, across bay, regional), time of year (newly vs. late-settled fish) and environment (e.g., temperature, salinity). Mechanisms of such relationships will be examined using available seasonal and annual vital rate information for each species in each system

Vertical Availability of Pacific cod to Survey Bottom Trawls on the Eastern Bering Sea Shelf - RACE GAP

Pacific cod (*Gadus macrocephalus*) are an abundant and commercially valuable bottom fish in Alaska waters (REF). Bottom trawl (BT) surveys are the primary source of fishery independent data for informing stock assessment models about population trends of Pacific cod. Pacific cod occupy both demersal and pelagic habitats, so understanding their vertical availability to BT surveys is critical to the reliability of stock abundance estimates. Results from an archival tag study of Pacific cod suggested that BT survey abundance estimates were negatively biased because the tag data showed that 52.7% of cod resided above the functional height of the survey trawl headrope (2.5 m) making them unavailable to the survey BT gear. By increasing the functional headrope height to 7.0 m the total proportion of cod unavailable to the BT decreased to only 8.4%. Data from the archival tags were representative of the “average” Pacific cod living under natural and undisturbed conditions during daylight hours and did not record the behaviors of Pacific cod responding to external factors which may have affected their vertical distribution, such as presence of a trawl vessel or approaching trawl gear. Other limitations to the archival tag study were a low sample size (n=11) and narrow size range (60-81 cm) of

Pacific cod.

There is good evidence that gadoids, in general, dive in response to vessels, trawls, or both. Acoustic echograms from a stationary buoy or from a second vessel in the path of an approaching trawler have shown diving responses for Pacific hake (*Merluccius productus*) and haddock (*Melanogrammus aeglefinus*). From the analysis of 20,000 individual acoustic targets collected by a free-floating buoy in the path of a BT vessel, it was concluded that a dive response in gadoids was triggered by the start-trawling event. In a detailed analysis of BT efficiency using a combination of trawl and acoustic data, it was estimated that walleye pollock (*Gadus chalcogrammus*) within 16 m of the seafloor were vertically herded into a survey trawl having a 2.5 m mean headrope height. The vertical availability of Pacific cod relative to bottom-trawling activity has not been studied and more detailed knowledge is needed in order to understand the precision and reliability of BT survey abundance estimates of Pacific cod used in stock assessment models.

To investigate vertical availability of Pacific cod to the BT, this study used a side-by-side BT experiment and analysis of acoustic data collected during the side-by-side experiment and from other BT surveys. The side-by-side experiment was used to test the null hypothesis that there was no difference in the vertical availability of Pacific cod between a low-opening (2.5 m) and a high-opening (7.0 m) BT. If results from the archival tag study are a typical representation of the vertical structure of Pacific cod from across the Bering Sea shelf, and if vertical availability of Pacific cod to the BT is unaffected by bottom-trawling activity (i.e., diving response), the expectation would be that the low-opening trawl would have approximately half the catch rate of Pacific cod compared to the high-opening trawl. Acoustic data from the experiment and from other historical BT survey tows were also analyzed to investigate whether the vertical structure of Pacific cod and their availability to the BT changed by area, during different times of day, or at different bottom depths. Abundance estimates from the acoustic analyses and the proportion of Pacific cod between the seafloor and 2.5 m and between 2.5 and 7.0 m were compared to corresponding BT abundance estimates to determine if vertical availability of Pacific cod to the BT varies during general survey operations conducted in different areas on the shelf and at different bottom depths. Possible mechanisms for non-varying vertical availability of Pacific cod to the BT survey are also discussed.
For more information, contact Bob Lauth, e-mail: bob.lauth@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.

Pacific cod Dispersal Patterns and Nursery Habitat Use in the Bering Sea - RACE FBEP

The Fisheries Behavioral Ecology program is collaborating with the RACE-Recruitment Processes Program, ABL-Ecosystem Monitoring and Assessment Program, and Oregon State University to examine the dispersal patterns of larval and juvenile Pacific cod and their use of coastal nursery habitats. In 2013, data analysis focused on the basin-wide distribution of age-0 Pacific cod, with future work examining spatial variation in diet and growth rates.

Dispersal patterns:

Pacific cod in the southeastern Bering Sea aggregate at discrete spawning locations but there is little information on patterns of larval dispersal and the relative contribution of specific spawning areas to nursery habitats. Otolith elemental variation can be used as a natural biomarker reflecting patterns of dispersal and mixing. Age-0 Pacific cod from two cohorts (2006 and 2008) were examined to address the following questions: (1) does size, age, and otolith chemistry vary among known capture locations; (2) can variation in elemental composition of the otolith cores (early larval signature) be used to infer the number of chemically distinct sources contributing to juvenile recruits in the Bering Sea; and (3) to what extent are juvenile collection locations represented by groups of fish with similar chemical histories throughout their early life history? Hierarchical cluster (HCA) and discriminant function analyses (DFA) were used to examine variation in otolith chemistry at discrete periods throughout the early life history. HCA identified five chemically distinct groups of larvae in the 2006 cohort and three groups in 2008; however, three sources accounted for 80-100% of the juveniles in each year. DFA of early larval signatures indicated that there were non-random spatial distributions of early larvae in both years, which may reflect interannual variation in regional oceanography. There was also a detectable and substantial level of coherence in chemical signatures within groups of fish throughout the early life history. The variation in elemental signatures throughout the early life history (hatch to capture) indicates that otolith chemical analysis could be an effective tool to further clarify larval sources and dispersal, identify juvenile nursery habitats, and estimate the contributions of juvenile nursery habitats to the adult population within the southeastern Bering Sea.

Pacific cod nursery habitats:

In four years of demersal beam trawling on the southeastern Bering Sea shelf at depths of 20 – 140 m, age-0 Pacific cod were most abundant along the Alaska Peninsula at depths to 50 m. In addition, one year of spatially intensive beam trawl sampling was conducted at depths of 5 – 30 m in a nearshore focal area along the central Alaska Peninsula. In this survey, age-0 cod were more abundant along the open coastline than they were in two coastal embayments, counter to patterns observed in the Gulf of Alaska. Demersal sampling of the shelf and nearshore focal area in 2012 was conducted synoptically with surveys of surface and subsurface waters over the continental shelf. As observed in earlier studies, age-0 cod were captured in pelagic waters over the middle and outer shelf, with maximum catches occurring over depths of 60-80 m. The similar size distributions of fish in coastal-demersal and shelf-surface habitats and the proximity of concentrations in the two habitat types suggests that habitat use in the Bering Sea occurs along a gradient from coastal to pelagic. While capture efficiencies may differ among trawl types, CPUE of age-0 cod in demersal waters along the Alaska Peninsula was 25 times that observed in the highest density pelagic-shelf habitats, demonstrating the importance of coastal nursery habitats in this population. Despite representing a much smaller habitat area, the cumulative contribution of coastal waters along the Alaska Peninsula appears to be markedly larger than those of offshore pelagic and demersal habitats.

b. Stock Assessment

BERING SEA AND ALEUTIAN ISLANDS - REFM

There was a major change in the Pacific cod assessment this year. Previously an analytical assessment was done for cod in the eastern Bering Sea (EBS), and the abundance estimate from that assessment was extrapolated to the Aleutian Islands (AI) region on the basis of survey estimates of relative abundance. This year, in anticipation of separate regional specifications of OFL and ABC by the SSC, separate assessments were done for the EBS and AI regions. The assessment author and the Team recommended a Tier 3 assessment for the EBS and a Tier 5 assessment for the Aleutians.

For the current assessment all survey and commercial data series on CPUE, catch at age, and catch at length were updated. Survey CPUE has been mostly steady since 2010, with modest decreases between 2012 and 2013 (numbers down 24%, biomass down 11%). As in the last several years, a number of alternative candidate models were considered at Team/SSC meetings in May/June and September/October, but owing to the government shutdown in October none was implemented, so there were no changes in assessment methods from 2012. The 2013 assessment is a rerun of last year's accepted model (Model 1, the same as the 2011 accepted model) with updated data files.

The stock assessment model estimates that the 2006, 2008, and 2010 year classes are strong, the stock is at a high level and spawning abundance is expected to increase in the near term. $B_{40\%}$ for this stock is estimated to be 318,000 t and projected spawning biomass in 2014 according to Model 1 is 361,000 t, therefore this stock is assigned to Tier 3a. The author recommended that ABCs for 2014 and 2015 be set at the maximum permissible levels under Tier 3a, which are 255,000 t and 272,000 t, respectively. The corresponding OFLs are 299,000 t and 319,000 t. EBS Pacific cod is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

For the Aleutian Islands, for many years there has been concern that a disproportionate share of the BSAI TAC was being taken from the Aleutians. The separate specification of EBS and AI OFL/ABC for the AI region is a response to that practice. Although separate assessments of the AI stock have been included in the last two SAFE reports (an approach based on Tier 5 in 2011 and multiple age-structured models in 2012), none have yet been accepted by the SSC. This year's assessment contains two models that would be consistent with management under Tier 3, and two others that would be consistent with management under Tier 5. All four models were requested by the Team and SSC. The AI assessment data consist of catch in weight and catch length frequencies from the commercial fishery, and CPUE and length frequencies from the AI trawl survey. The only age data are from the 2012 survey.

The survey time series from 1991-2012 shows a fairly consistent decline in Pacific cod biomass throughout the Aleutian Islands. The Team Plan Team concluded that neither of the age-structured models performed credibly. For the time being, the author and the Team recommend a Tier 5 approach which utilizes the random effects model. Assuming a natural mortality rate of 0.34 (as in the EBS assessment), this method estimates the 2014 and 2015 maximum permissible ABCs at 15,100 t. The corresponding OFLs for both years are 20,100 t. Work on a Tier 3 assessment is anticipated to continue. This stock is not being subjected to overfishing. Assuming that the SSC concurs with the Team's recommendation to manage this stock under Tier 5, it is not possible to determine whether this assemblage is overfished or whether it is approaching an overfished condition.

GULF OF ALASKA

For the 2013 stock assessment the fishery data series was updated with catch for 2003-2013 (projected for 2013 expected totals) and updated 1997-2012 seasonal and gear-specific catch-at-length. The survey data series was updated with 2013 NMFS bottom trawl survey data for abundance and length composition. The 2013 trawl survey biomass estimate increased by 1% from the 2011 value. The 2013 GOA Pacific cod assessment author evaluated two models. Model 1 is identical to the final model configuration from 2012 that omitted all of the sub-27 survey data (abundances and size composition data for Pacific cod that are 27cm or less). Model 2 is identical to Model 1 but with age-0 recruits excluded from estimation for the 2010 and 2011 year classes (they are set to average levels). Model 1 only had the 2012 and 2013 year classes set to the average.

Model 2 was selected by the author as the preferred model primarily because the estimate of recruitment for the 2010 and 2011 year classes is highly uncertain and there is limited information in the data to estimate these year classes. The Plan Team accepted the author's recommendation to use Model 2 as the preferred model. The Team also noted that comparison of likelihood components indicated small differences in fits between the two model configurations, signifying that estimation of the two additional recruitment parameters in Model 1 is not justified.

Model results indicate that the estimated age-0 recruitment has been relatively strong since 2005, and stock abundance is expected to be stable and at a high level (well-above $B_{40\%}$) in the near term. $B_{40\%}$ for this stock is estimated to be 91,100 t and projected spawning biomass in 2013 according to Model 2 is 120,100 t, therefore this stock is determined to be 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 $F_{35\%}$ and $F_{40\%}$ are 0.69 and 0.54. The stock is not being subjected to overfishing and is neither overfished nor approaching an overfished condition.

In 2012 the ABC of Pacific cod was apportioned among regulatory areas based on trawl surveys using a Kalman filter approach. The SSC concurred with this method in December 2012. In this year's assessment the random-effects model was used (which is similar to the Kalman filter approach and adopted by the survey average working group). This method, using the updated trawl survey data, results in apportionments of 37% in the Western GOA, 60% in the Central GOA, and 3% in the Eastern GOA.

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 (*Gadus 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. 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 for inclusion in the EBS pollock stock assessment to help understand climate and ecosystem variability on pollock recruitment in an effort reduce the uncertainty in recommended total allowable catch .

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. For example, age-0 pollock energy density was low during 2002 to 2005, but significantly increased during 2006 to

2012. Recent data during the cool period suggests that age-0 pollock 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.

Factors Affecting the Availability of Walleye Pollock to Acoustic and Bottom Trawl Survey Gear - RACE GAP

Abundances of semi-pelagic fishes are often estimated using acoustic or bottom trawl surveys, both of which sample only a fraction of the water column. Acoustic instruments are effective at sampling the majority of the water column, but they have an acoustic dead zone (ADZ), where fish near the seafloor are undetected. Bottom trawls are effective near the seafloor, but miss fish that are located above the effective fishing height (EFH) of the trawl. Quantification of the extent of omission between these gears is needed, particularly in cases where environmental factors play a role. We developed logistic regression models to predict the availability (q_a) of walleye pollock (*Gadus chalcogrammus*) to both acoustic and bottom trawl gears using factors shown to affect q_a (depth, light intensity, fish length) and introducing additional factors (tidal currents, surface and bottom temperature, sediment size). Results build on earlier studies and quantify the uncertainty associated with the estimation of the ADZ correction using Bayesian methods. Our findings indicate that on average, availability of walleye pollock to the bottom trawl is larger than to the acoustics. Availability to both gears depends mostly on bottom depth, light conditions, and fish size, and to a lesser extent on sediment size. Availability to the acoustic gear depends also on surface temperature. Variability in availability to both gears also depends on environmental factors.

For more information, contact Stan Kotwicki, e-mail: stan.kotwicki@noaa.gov

Walleye Pollock Ichthyoplankton Dynamics in the Bering Sea - RACE Recruitment Processes

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 eastern Bering Sea. We conduct annual surveys in spring to assess abundance of eggs and larvae of walleye pollock (*Theragra chalcogramma*) over the eastern Bering Sea 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. We have previously documented spatial shifts in the distribution of early life stages to the east (middle domain) under warmer-than-average conditions over the Bering Sea shelf.

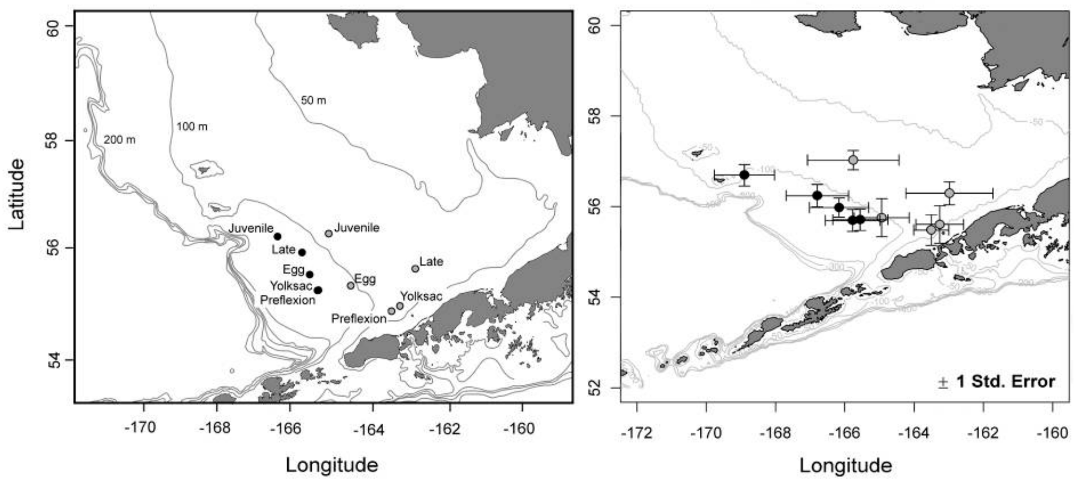


Figure 1. Early life stages of walleye pollock are distributed over the outer shelf during cold periods (filled circles) and over the middle shelf during warm years (open circles). Error bars denote 1 STD.

Most recently individual-based model of pollock early life stages was developed by coupling a hydrodynamic model (ROMS-NEP6) to a particle-tracking model with biology and behavior (TRACMASS). Simulation experiments were performed with the model to investigate the effect of wind on transport, ice presence on time of spawning, and water temperature on location of spawning. This modeling approach benefited from the ability to individually test mechanisms to quantitatively assess the impact of each on the distribution of pollock. Neither interannual variations in advection nor advances or delays in spawning time could adequately represent the observed differences in distribution between warm and cold years. Changes to spawning areas, particularly spatial contractions of spawning areas in cold years, resulted in modeled distributions that were most similar to observations (Figure 2). The location of spawning pollock in reference to cross-shelf circulation patterns is important in determining the distribution of eggs and larvae, warranting further study on the relationship between spawning adults and the physical environment.

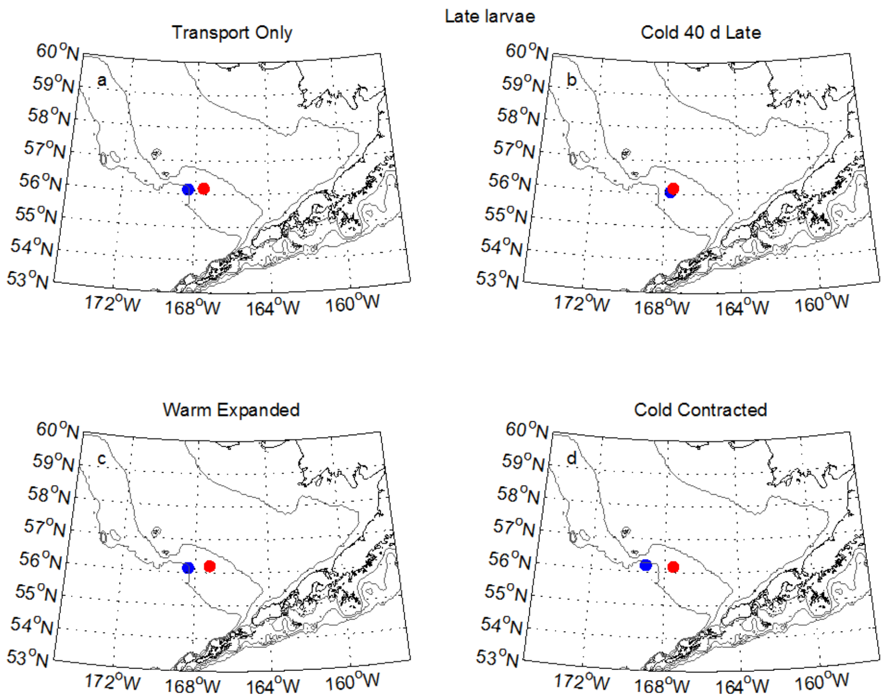


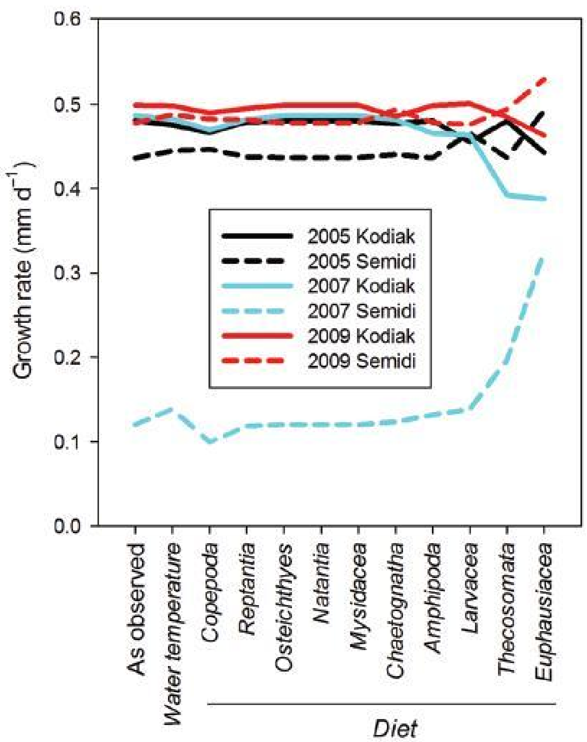
Figure 2. Modeled centers of gravity of pollock larvae (10-40 mm SL) in cold (blue) and warm (red) years for all model scenarios. Transport Only = interannual variations in advection, Cold 40 d Late = spawning delayed by 40 days under cold conditions, Warm Expanded = spawning distribution expanded eastward under warm conditions, Cold Contracted = spawning distribution contracted westward under cold 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.

Walleye Pollock Age-0 Ecology in the Gulf of Alaska - RACE Recruitment Processes

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 (Figure 1).

Figure 1. Bioenergetics model-based estimate of growth rate of a 70-mm SL age-0 walleye pollock with the observed weight-based diet at observed water temperatures. Lines show how growth rate estimates were affected when water temperature or the proportion of each dietary component was, in turn, equated between regions (Kodiak, Semidi).

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). In the GOA, small neritic fishes support a predator-dominated coastal food web. Samples of “forage fishes” collected with small-mesh midwater trawls are dominated by juvenile walleye pollock (*Gadus chalcogrammus*), a gadid, and two smelts (Osmeridae): capelin *Mallotus* *villosus* and eulachon *Thaleichthys pacificus*. These fishes consume copepods, euphausiids, and other zooplankton depending on predator species and size, and they exhibit species-specific responses to meso-scale spatial and temporal variation in the zooplankton community that relates to bathymetry and hydrography. The availability of body-mass data from these studies should enable us to verify a previously published predator-prey mass relationship, but we will use a broader collection of GOA forage fishes; existing data will also enable us to examine the mass ratio among species over several years and meso-scale geographic regions for evidence that size ratios are resilient to geographic variation in habitat quality and yet sensitive to taxonomic change. Work on this project is being done in consultation with AFSC ecosystem modelers due to its relevance to the REEM Program's FEAST model.

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 (Figure 2). Onset of the growing season corresponds with vernal lengthening of the photoperiod while autumnal slowing may reflect increased thermal stress.

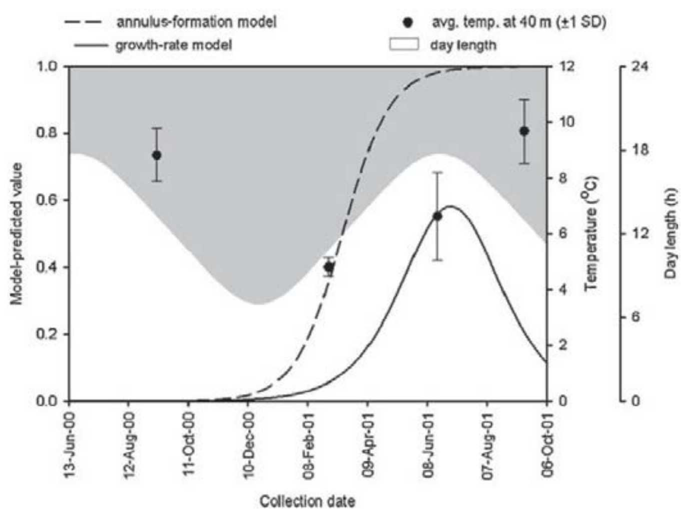


Figure 2. For age-0+ juvenile walleye pollock in the Gulf of Alaska, empirically derived models of first annulus formation and post-annulus growth rate are compared to time series of observed water temperature at 40-m depth and predicted day length.

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. Preliminary results indicate that the chemical signature of age-0 juvenile walleye pollock otoliths differ between fish collected off Kodiak Island versus those from farther southwest in the Semidi Bank vicinity. It appears that the Kodiak fish have concentrations of strontium and barium isotopes in recently deposited otolith material that are relatively high and low, respectively. This work is being done in collaboration with experts in otolith elemental composition at Oregon State University and at the AFSC, REFM's Age and Growth Program.

The survey conducted by Eco-FOCI during August-October 2013 to survey neritic fish populations, zooplankton, and physical oceanography encompassed an unprecedented geographic extent in the Gulf of Alaska from Unimak Pass to, but not including, Prince William Sound. Although the data and samples are currently being prepared for analysis and archival, preliminary results indicate that the 2013 year class of walleye pollock is likely to be large relative to those observed since 2000. This "early alert" has been included in presentations to the Plan Team on the Gulf of Alaska ecosystem status.

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. We have accomplished two activities. First, we conducted two paired-tow comparisons, each consisting of replicate tows, between the Cantrawl and the Stauffer (aka anchovy) trawl during the 2013 field season in Kalsin Bay, Kodiak Island, where the sea state was calm enough to safely change between the large Cantrawl doors and the small Stauffer-trawl doors. The catch and length data preliminarily indicate that size ranges of age-0 walleye pollock are similar between the two nets (50-80 mm SL), though greater numbers of the smallest sizes (<60 mm SL) were collected with the Stauffer trawl. Species catch compositions were similar, but absolute numbers collected and species biomass were greater using the Cantrawl. Second, we conducted a gear-trial experiment to investigate whether longer bridles compensate for overspreading of the Stauffer trawl when fished with over-size doors, which may be necessary for conducting paired-tow comparisons in the Bering Sea where the sea state will make door changes unsafe. Gear-trial results indicate that longer bridles mitigate overspreading, but their use resulted in a concerning large and rapid submergence of the trawl when initially deployed; interestingly, over-size doors only marginally decreased trawl mouth vertical opening and it is unknown if this was compensated for in terms of mouth area by increased horizontal spread. These activities were planned and executed in consultation with AFSC scientists in the EMA and MACE Programs.

Climate Induced Changes in Survival and Biogeographic Range Expansion - RACE FBEP
The Fisheries Behavioral Ecology Program examines physiological processes that may control fish and crab responses as oceans warm. The geographic range of fish is largely determined by their thermal preferenda i.e., the temperature at which physiological processes are optimal. These physiological processes include a suite of cellular activities (e.g., biochemical homeostasis, energy conversion efficiency, muscle performance, etc.) but are manifested collectively in terms of growth and condition of the animal. In the Bering Sea and Gulf of Alaska, walleye pollock (*Gadus chalcogrammus*) and Pacific cod (*Gadus macrocephalus*) represent two of the most important fisheries in terms of landings and value and there is growing interest in whether walleye pollock will expand their range northward as temperatures continue to increase or whether resident Arctic species (Arctic cod (*Boreogadus saida*) and saffron cod (*Eleginus gracilis*)) will hold their 'thermal niche' in polar regions. The Newport laboratory is conducting a standardized series of laboratory experiments to quantify optimal thermal habitats for walleye pollock and other gadid populations in Alaska. Projected thermal

habitats will be based on optimal growth and condition (energy storage) of juvenile gadids exposed to broad, temperature ranges in the laboratory (0 – 16ºC). Thus far, Arctic cod demonstrate a cold-water, stenothermic response in that there was relatively high growth at 0°C, limited growth beyond 5°C and negative impacts on condition, activity, growth and survival above 9°C. In contrast, juvenile walleye pollock and can grow 2 – 3 times faster than Arctic gadids across a relatively broad temperature range (i.e., 5 – 12°C), but cannot maintain growth at temperatures below 1°C.

Effects of Ocean Acidification on Walleye Pollock-RACE FBEP

The Fisheries Behavioral Ecology Program has been evaluating the impacts of ocean acidification on the early life history stages of these critical resource species. This includes three lines of research examining: a) the effects of OA on the growth of early life stages; and b) the effects of OA on behavioral responses of walleye pollock; and c) evaluation of the impact of OA on Alaskan communities.

Two papers present the results obtained in experiments with walleye pollock. Eggs, larvae, and juveniles of walleye pollock were reared at ambient and elevated CO_2 levels (to ~ 2100 µatm). In walleye pollock, there were no significant differences in hatch rates, larval or juvenile growth rates across multiple independent trials with each life stage. As observed in other species, hypercalcification of otoliths occurred in juvenile pollock held at high CO_2 levels. New experiments conducted with larval northern rock sole produced similar results, but suggest possible negative effects of OA in later larval stages as fish undergo metamorphosis. These results suggest a general resiliency of physiological capacity for growth in these species due to population acclimation or adaptation, while demonstrating the necessity of examining responses in multiple life stages.

Elevated CO_2 has been shown to disrupt sensory and behavioral responses in some tropical reef fish species, even when growth was not disrupted. In a separate experiment, we examined the behavioral responsiveness of juvenile walleye pollock, 58-97 mm, to prey scent cues under elevated CO_2. Baseline activity levels were not significantly different among CO_2 treatments, but fish reared at high CO_2 (> 800 µatm) were less likely to respond to injections of prey scent cues than fish reared at ambient CO_2 levels (~ 400 µatm). Future experiments are planned to examine the sensitivity of other behavioral responses in walleye pollock and provide species contrasts with Pacific cod. Such sensory and behavioral responses will be a significant determinant of how acidification affects the functioning of marine ecosystems.

The experimental information on the potential direct effects of OA on groundfishes and other animals harvested for commercial and subsistence purposes was incorporated into an evaluation of the vulnerability of Alaskan communities to Ocean Acidification. The project, led by researchers at NOAA's Pacific Marine Environmental Laboratory, used a variety of biological, economic, and social science data to evaluate the overall risk to each region of the state based on degree of the hazard, exposure to the hazard, and vulnerability to the hazard.

b. Stock Assessment

GULF OF ALASKA - REFM

The age-structured model developed using AD Model Builder and used for GOA W/C/WYK pollock assessment is very similar to the model used for the 2012 assessment. The model differences are primarily the three changes that were implemented based on recommendations of the July 2012 Center for Independent Experts (CIE) review: 1) removing two years of Biosonics acoustic survey time series (1992 and 1993) that were actually produced using the EK500 with the acoustic data analyzed at a higher noise threshold, 2) setting the CVs for the Biosonics acoustic survey estimates equal to the nominal value (0.2) of later acoustic surveys, and 3) removing the ADFG survey length data and increasing the input sample sizes for the ADFG survey age data. Further changes to the assessment should be anticipated as other CIE recommendations are incorporated in the assessment model in the future.

For comparison purposes, two alternative models were also presented: 1) a model with last year's configuration updated with recent fishery and survey data, and 2) a model with the new configuration with 2013 recruitment (2012 year class) set to the average value for yield projections. The Plan Team agreed with the authors that the new model configuration was preferred since it performed well and incorporated a number of improvements over the 2012 configuration. Given the multiple observations of high age 1 abundance, the Plan Team again agreed with the author that the 2013 estimate could be used directly and not replaced by an average.

This year's pollock assessment includes the following new data: 1) 2012 total catch and catch-at-age from the fishery, 2) 2013 biomass and age composition from the Shelikof Strait acoustic survey, 3) 2013 biomass and length composition from the NMFS bottom trawl survey, 4) 2012 age composition and 2013 biomass from the ADFG crab/groundfish trawl survey. Model fits to fishery age composition data are reasonable.

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. The model fit the rapid increase in the Shelikof Strait acoustic survey and the NMFS survey in 2013 poorly since an age-structured pollock population cannot increase as rapidly as is indicated by these surveys. In contrast, the model expectation is close to the ADFG survey in 2013. Although there is considerable variability in each survey time series, a fairly clear downward trend is evident to 2000, followed by a stable, though variable, trend to 2008. All surveys indicate a strong increase since 2008.

The 2013 Shelikof Strait acoustic survey biomass estimate is 2.7 times the biomass estimate for 2012, and is the largest biomass estimate from this survey since 1985.The 2013 NMFS bottom trawl survey biomass estimate is the highest in the time series, and is an increase of 43% from the 2011 estimate. In contrast, the ADFG crab/groundfish survey biomass estimate decreased by 40% from the 2012 estimate, but is close to the 2011 estimate. The estimated abundance of mature fish is projected to remain stable or to decrease gradually to 2015, and then to increase in subsequent years.

The model estimate of spawning biomass in 2014 is 308,541 t, which is 42.5% of unfished spawning biomass (based on average 1978-2012 one-year old recruitment). The B40% estimate is 290,000 t. This represents a 2% decrease from the 2012 assessment, which is a mostly a result of the decrease in mean recruitment. The Gulf of Alaska Pollock stock 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 2013 female spawning biomass is above $B_{40\%}$, the W/C/WYK Gulf of Alaska pollock stock is in Tier 3a. The Plan Team accepted the author's recommendation to reduce FABC from the maximum permissible using the "constant buffer" approach (first accepted in the 2001 GOA pollock assessment). The projected 2014 age-3+ biomass estimate is 972,750 t (for the W/C/WYK areas). Markov Chain Monte Carlo analysis indicated the probability of the stock being below $B_{20\%}$ will be negligible in the next 5 years. An exempted fishing permit (EFP) has been granted to evaluate the effect of salmon excluder devices in the pollock fishery in 2013 and 2014. The assessment used a projection model that accounted for the EFP catches by including the actual EFP pollock catch in 2013, and the projected 2014 EFP catch at the start of year in 2014. Therefore, the 2014 ABC accounting for these adjustments is 166,514 t (F_{ABC}= 0.20) for GOA waters west of 140°W longitude. To account for the Prince William Sound GHL this is reduced by 2.5% (4,163 t) to a 2014 ABC of 162,351 t. The 2014 OFL is 211,998 t (F_{OFL}= 0.26). In 2015, the recommended ABC and OFL values are 181,184 t (reduced by 4,646 t to account for the Prince William Sound GHL) and 248,384 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 estimated biomass in 2014 and 2015 from a random effects model fit to the 1990-2013 bottom trawl survey biomass estimates in Southeast Alaska. The result is a 2014 ABC of 12,625 t, and a 2014 OFL of 16,833 t. Recommendations for 2015 are the same as 2014. The Plan Team also recommended that revised winter acoustic survey numbers at age and biomass be evaluated to account for net selectivity and that the NMFS 2013 summer acoustic trawl survey be used. From 2012 Plan Team and SSC comments the authors should :1) estimate M to at least two significant digits, 2) consider using inter -annual smoothing for selectivity, 3) model the age 1 (and possibly age 2) age classes separately from the other age classes with their own variance structure, 4) explore spatial variations in female relative abundance. The Plan Team discussed the practice of including a year - class estimate for projections and excluding it from the reference point (B100%) calculations.

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

EASTERN BERING SEA - REFM
Walleye Pollock spawning biomass in 2008 was at the lowest level since 1980, but has increased by 71 percent since then, with a 2% decrease 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 slightly above average recruitment from the 2006 year class

and very strong recruitment from the 2008 year class along with reductions in average fishing mortality (ages 3-8) from 2009-2012. Spawning biomass is projected to be 23 percent and 16 percent above *BMSY* in 2014 and 2015, respectively.

New data in the 2013 assessment included the following: 2013 summer bottom trawl survey abundance at age; 2012 and 2013 abundance estimates from the "acoustic vessels of opportunity" index; updated 2012 summer acoustic-trawl survey abundance at age (data using an age-length key from that survey replaced those in last year's assessment that were based on an age-length key from the bottom trawl survey); updated catch at age and average weight at age from the 2012 fishery; and updated total catch, including preliminary value for 2013. There were no changes in the authors' recommended assessment model.

The SSC has determined that EBS pollock qualifies for management under Tier 1 because there are reliable estimates of *BMSY* and the probability density function for *FMSY*. The updated estimate of *BMSY* from the present assessment is 2.122 million t, similar to last year's estimate of 2.114 million t. Projected spawning biomass for 2014 is 2.606 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 0.469, down 4 percent from last year's value of 0.491. The harvest ratio of 0.469 is multiplied by the geometric mean of the projected fishable biomass for 2014 (5.391 million t) to obtain the maximum permissible ABC for 2014, which is 2.528 million t, up 10 percent and down 3 percent from the maximum permissible ABCs for 2013 and 2014 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 five reasons for doing so in the SAFE chapter.
Beginning with the 2010 assessment, the Team and SSC have based ABC recommendations on the most recent 5-year average fishing mortality rate. This year, the authors' base their 2014 and 2015 ABC recommendations on the same strategy, giving values of 1.369 million t and 1.258 million t, respectively. The Plan Team concurred with these recommendations, noting that this assessment is very much in line with projections made last year and noting also that the October government shutdown limited opportunities for analysis of alternative harvest strategies.

The OFL harvest ratio under Tier 1a is 0.518, 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 2014 determines the OFL for 2014, which is 2.795 million t. The current projection for OFL in 2015 given a 2014 catch equal to the Team's recommended ABC is 2.693 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 - REFM
This year's assessment estimates that spawning biomass reached a minimum level of about *B23%* in 1999 and then has generally increased, with a projected value of *B33%* for 2014. The

increase in spawning biomass since 1999 has resulted more from a dramatic decrease in harvest than from good recruitment, as there have been no above-average year classes spawned since 1989. Spawning biomass for 2014 is projected to be 79,029 t.

The new data in the model consist of updated catch information. There were no changes in the assessment methodology. The SSC has determined that this stock qualifies for management under Tier 3. The Team concurred and supported continued use of last year's model for evaluating stock status and recommending ABC. The model estimates *B40%* at a value of 96,006 t, placing the AI pollock stock in sub-tier "b" of Tier 3. The model estimates the values of *F35%* as 0.41 and *F40%* as 0.33. Under Tier 3b, with the adjusted value of *F40%*=0.26, the maximum permissible ABC is 35,048 t for 2014. The Team recommended setting 2014 ABC at this level. Following the Tier 3b formula with the adjusted value of *F35%*=0.33, OFL for 2014 is 42,811 t. Given a 2014 catch of 19,000 t, the maximum permissible ABC would be 32,950 for 2015 and the projected OFL would be 40,290 t. If the 2014 catch is only 1,294 t (i.e., equal to the five year average for 2008-2012), the 2015 maximum permissible ABC would be 39,412 t and the 2015 OFL would be 47,713 t. The Team recommended setting 2015 ABC and OFL at the latter levels. 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 - REFM
There was no Bogoslof pollock acoustic-trawl survey in 2013. 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 67,063 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 2014 would be 10,059 t (assuming M = 0.2 and F_{ABC} = 0.75 x M = 0.15): ABC = B_{2012} x M x 0.75 = 67,063 x 0.2 x 0.75 = 10,059 t. The projected ABC for 2015 is the same. Following the Tier 5 formula with M=0.20, OFL for 2014 is 13,413 t. The OFL for 2015 is the same.

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

3. Dusky Rockfish

a. Stock Assessment

GULF OF ALASKA - ABL
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).

Rockfish in the GOA are assessed on a biennial stock assessment schedule to coincide with the availability of new AFSC biennial trawl survey data. In 2013, a full assessment document with updated assessment and projection model results were presented. However, due to the 2013 government shutdown, no new alternative model configurations different from the previous assessment were explored or presented for dusky rockfish.

We use a statistical age-structured model as the primary assessment tool for Gulf of Alaska dusky rockfish which qualifies as a Tier 3 stock. This assessment consists of a population model, which uses survey and fishery data to generate a historical time series of population estimates, and a projection model, which uses results from the population model to predict future population estimates and recommended harvest levels.

For the 2014 GOA fishery, a maximum allowable ABC for dusky rockfish was set at 5,486 t. This ABC is a 17% increase from the 2012 ABC. This increase in ABC is attributable to a 19% increase in the trawl survey biomass estimate in 2013 from 2011. 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. 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.

From 2011-2013, we tagged and released 184 blackspotted rockfish fish at ~150-225 m and 60 others were recompressed in portable pressure tanks and slowly brought back to surface pressure. All fish exhibited some signs of barotrauma including exophthalmia ("pop-eye") (89%), everted esophagus (95%), subcutaneous emphysema (gas bubbles under the skin) (57%), and ocular emphysema (air bubble under the cornea) (83%). After re-pressurization in the tanks, the great majority of fish no longer had any external signs of barotrauma (Figure 1). In 2011, 50% of fish survived long term in the lab, 60% in 2012, and 78% in 2013. This increase in survival was likely related to experience with tanks and a longer decompression schedule in 2013. In 2013 a cage equipped with video capability was used to release fish at 75 m (Figure 2). Fish were all oriented downward when released and were capable of swimming. In March, 2014 a fish was recaptured in the Pacific halibut fishery 59 km away from the release location a year and a half later.

During the winter of 2013 and the winter of 2014 fish were sacrificed and their swim bladders were examined for ruptures. Approximately 50% had a rupture that had healed and we did not see signs of a rupture in the remaining specimen.

Figure 1. A blackspotted rockfish right after capture (top) and 1.5 months after capture (bottom).

Figure 2. Release cage used to video fish behavior during descent and release.

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).

Rockfish Reproductive Studies - RACE GAP

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: 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 these deeper water rockfish species has been complicated by the presence of a significant number of mature females that skip spawning. Preliminary results for rougheye rockfish, blackspotted, and shortraker rockfish are presented below. To complete these studies samples are needed from additional areas and time periods.

In addition, there is a need to examine the variability of rockfish reproductive parameters over varying temporal and spatial scales. It remains unknown if there is variability in rockfish reproductive parameters at either annual or longer time scales however, recent studies suggest variation may occur for the three most commercially important species, Pacific ocean perch, *Sebastes alutus*, northern rockfish, *S. polyspinis*, and dusky rockfish *S. variabilis.* Researchers at the AFSC Kodiak Laboratory will be examining annual differences in reproductive parameter estimates of Pacific ocean perch and northern rockfish in the upcoming years. Sampling for this study was initiated in 2012 and additional samples will be collected through at least the 2015 reproductive season.

Rougheye and blackspotted rockfish

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 rougheye rockfish and blackspotted rockfish within the GOA utilizing histological techniques to microscopically examine ovarian tissue. Maturity analyses for these 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 rougheye rockfish are 15.5 years and 43.9 cm FL with 36.3% of mature females not developing or skip spawning. Samples of blackspotted rockfish were also collected and analyzed during this time period. The analyses of these data is complicated by the presence of both skip spawning individuals within the sample as well as a large number of large and/or old immature individuals. More samples are needed to clarify the reproductive parameters of this species. These updated values for age and length at maturity have important implications for stock assessment in the GOA.

*Shortraker rockfish (*in collaboration with Charles Hutchinson, AFSC age and growth laboratory)
Currently stock assessments for shortraker rockfish, *Sebastes borealis* utilize estimates of reproductive parameters that are problematic due to limited sample sizes and samples taken during months of the years that may not be optimum for reproductive studies. The current study results indicate a length of 50% maturity of 49.5 cm which is a larger than the value currently used in the stock assessment of this species (44.5 cm). In addition this study found a skip spawning rate of over 50% for this species during the sampling period. Length at maturity data for this species were later utilized to derive an indirect age at 50% maturity for this species based on converting the length at maturity to an age at maturity. However, the ages used for this conversion were considered experimental, and additional samples are needed for updated, direct determination of the age at 50% maturity when the aging methodology for shortraker rockfish becomes validated. Researchers at the AFSC Age and Growth lab have initiated a study to initiate the aging of shortraker rockfish. Due to difficulties with aging this species which attains very old ages, additional collaborative work with other agencies is being pursued to develop a consistent methodology for aging this species.

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

b. Stock Assessment

Pacific Ocean Perch (POP)

BERING SEA AND ALEUTIAN ISLANDS - REFM
Pacific ocean perch (POP) assessments are conducted on a two-year cycle to coincide with planned Aleutian Islands surveys. Since the Aleutian Islands were not surveyed in 2013, an "update" is produced by revising the recent catch data and re-running the projection model using the results from the previous full assessment as a starting point. Therefore, this update does not represent any
change to the 2012 assessment methodology or input data, but does include updated catch estimates for 2013-2015. The 2012 assessment was a full assessment because the Aleutian Islands survey was conducted in 2012.

The survey biomass estimates in the Aleutian Islands and the Bering Sea Slope both were high in 2012. The updated projections were very similar to last year's projections because observed catches were very similar to the estimated catches used last year. Spawning biomass is projected to be 257,878 t in 2014 and to decline to 243,400 t in 2015, but still well above the target female spawning biomass levels.

The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, thereby qualifying Pacific ocean perch for management under Tier 3. The current estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ are 183,774 t, 0.063, and 0.076 respectively. Spawning biomass for 2014 (257,878 t) is projected to exceed $B_{40\%}$, thereby placing POP in sub-tier "a" of Tier 3. The 2014 and 2015 catches associated with the $F_{40\%}$ level of 0.063 are 33,122 t and 31,641 t, respectively, and are the authors' and Team's recommended ABCs. The 2014 and 2015 OFLs are 39,585 t and 37,817 t.

The ABCs are apportioned regionally based on the proportions in combined survey biomass as follows (values are for 2014): BS = 7,684 t, Eastern Aleutians (Area 541) = 9,246 t, Central Aleutians (Area 542) = 6,594 t, and Western Aleutians (Area 543) = 9,598 t. The recommended OFL for 2014 and 2015 is not regionally apportioned. Pacific ocean perch in the Bering Sea/Aleutian Islands is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

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 odd years (such as 2013's assessment for the 2014 fishery) there is new trawl survey data available. In these years, we conduct a full stock assessment update. The new data included were 2013 survey biomass estimates, 2011 survey age compositions, 2012 fishery age compositions, a final catch estimate for 2012 and a new catch estimate for 2013. For the 2014 fishery, we recommended the maximum permissible ABC of 19,309 t from the updated model. This ABC was an 18% increase from the 2013 ABC of 16,412 t. This increase was attributed to a 67% increase in the survey biomass estimate from the previous survey and resulted in a 20% higher ABC than the 2014 ABC projected last year. Overfishing was not occurring, the stock was not overfished, and it was not approaching an overfished condition.

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

Northern Rockfish

BERING SEA AND ALEUTIAN ISLANDS - REFM
Northern rockfish are assessed on a biennial stock assessment schedule to coincide with the availability of new survey data. For BSAI rockfish in alternate (odd) 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. For the 2013 assessment the projection model is run with updated catches. New data in the 2013 assessment included updated 2012 catch, and estimated 2013 and 2014 catches.

Northern rockfish age 3+ biomass has been on an upward trend since 2002. Spawning biomass has been increasing slowly and almost continuously since 1977. Female spawning biomass is projected to be 84,237 t in 2014. The SSC has determined that this stock qualifies for management under Tier 3 due to the availability of reliable estimates for *B40%* (59,167 t), *F40%* (0.063), and *F35%* (0.079). Because the female spawning biomass of 84,237 t is greater than *B40%*, sub-tier "a" is applicable, with maximum permissible *FABC* = *F40%* and *FOFL* = *F35%*. Under Tier 3a, the maximum permissible ABC for 2014 is 9,761 t, which is the recommendation for the 2014 ABC. Under Tier 3a, the 2014 OFL is 12,077 t for the Bering Sea/Aleutian Islands combined. The Team continues to recommend setting a combined BSAI OFL and ABC. The Team recommendation for 2015 ABC is 9,652 t and the 2015 OFL is 11,943 t. Northern rockfish is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

GULF OF ALASKA-ABL

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 2013 a full assessment was performed with new survey and catch data implemented into the stock assessment model to determine ABC. The result was a recommended ABC for 2014 of 5,324 t; this ABC was 4% larger than the 2013 ABC of 5,132 t. The increase in ABC can be attributed to an increase in the trawl survey biomass estimate; however, GOA northern rockfish are characterized by highly uncertainty trawl survey biomass estimates across the time series of the bottom trawl survey. While the 2013 survey biomass estimate increased, it had a coefficient of variation (CV) of 60%, thus, the stock assessment model did not respond to this survey biomass estimate strongly. 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 at pete.hulson@noaa.gov.

Shortraker Rockfish

BERING SEA AND ALEUTIAN ISLANDS - REFM

The 2013 stock assessment was presented in executive summary format, as a scheduled "off-year" assessment. The biomass estimate is based on the survey data through 2012 with no changes in the assessment methodology. Estimated shortraker rockfish biomass is 16,447 t and has trended slowly downward since 1980. The SSC has previously determined that there are only reliable estimates of biomass and natural mortality for the shortraker rockfish stock, qualifying the species for management under Tier 5. The Tier 5 biomass estimate is based on a surplus production model. Last year, the Team 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 0.0225. The ABC is 370 t for 2014 and 2015 and the OFL is 493 t for 2014 and 2015, identical to the respective values for 2013.

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.

GULF OF ALASKA - ABL

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. For 2013, the biomass estimate was updated with 2013 survey data. Estimated shortraker rockfish biomass is 58,797 t, which is an increase of 22% from the 2011 estimate. This increase is due to the high biomass in the 2013 survey, specifically in the eastern Gulf of Alaska. Catch data were updated as well.

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 2009, 2011, and 2013) to determine the recommended ABC. Estimated shortraker biomass is 58,797 mt, which is an increase of 22% from the 2011 estimate. Shortraker biomass in the GOA has generally shown a progressive increase since 1990. 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 1,323 t for the 2014 fishery. Gulfwide catch of shortraker rockfish was 765 t in 2012 and estimated at 682 t in 2013. Shortraker rockfish in the GOA 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 more information please contact Katy Echave at (907) 789-6006 or katy.echave@noaa.gov.

Blackspotted/rougheye Rockfish Complex

BERING SEA AND ALEUTIAN ISLANDS - REFM

The 2013 stock assessment was presented in executive summary format, as a scheduled "off-year" assessment. New data included updated catch for 2012 and for 2013 through October 19, 2013.

The projection model for the Tier 3 component of the assessment was re-run using the results from last year's full assessment as a starting point. Also, an alternative estimate of current biomass (using a random effects model) was provided for the Tier 5 component of the assessment. Total biomass for the AI component of the stock in 2014 is projected to be 29,087 t. Female spawning biomass in the AI is increasing. Application of the random effects model reduces the estimated projected biomass of the EBS-SBS slope area to 1,389 t from 1,774 t.

For the Aleutian Islands, this stock qualifies for management under Tier 3 due to the availability of reliable estimates for *B40%*, *F40%* (=0.035), and *F35%* (=0.043). Because the projected female spawning biomass for 2014 of 7,328 t is less than *B40%*, (10,502 t), the adjusted *F40%* values for 2014 and 2015 are 0.024 and 0.026, respectively, and the corresponding adjusted *F35%* values are 0.029 and 0.031. Under the Tier 3b formula, the maximum permissible ABC is 416 t, which is the 2013 assessment recommendation for the 2014 ABC. Under Tier 3b, the 2014 OFL is 505 t for the Bering Sea/Aleutian Islands combined. The apportionment of 2014 ABC to subareas is 239 t for the Western and Central Aleutian Islands and 177 t for the Eastern Aleutian Islands and Eastern Bering Sea. The recommendation for 2015 overall ABC is 478 t and the 2015 OFL is 580 t. The blackspotted and rougheye rockfish complex is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

GULF OFALASKA - ABL

Rougheye (*Sebastes aleutianus*) and blackspotted rockfish (*S. melanostictus*) have been assessed as a stock complex since the formal verification of the two species in 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 odd years we usually conduct a full stock assessment update. However, due to the 2013 government shutdown, we presented an executive summary, similar to an off-cycle year, to recommend harvest levels for the next two years. There was a large amount of new and updated data available for this stock complex (not just the most recent year) and there was not sufficient time for performing model evaluation and sensitivity analyses of this information. Additionally, for this update year, we did 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 2014 fishery, we recommend the maximum allowable ABC of 1,244 t from the updated projection model. This ABC is slightly more than last year's ABC of 1,232 t and slightly less than last year's projected 2014 ABC of 1,254 t. The stock is not overfished, nor is it approaching overfishing status.

A full stock assessment document with updated assessment and projection model results will be presented in next year's Stock Assessment and Fishery Evaluation (SAFE) report.

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

Other Rockfish Complex

BERING SEA AND ALEUTIAN ISLANDS - REFM

This chapter was presented in executive summary format, as a scheduled "off-year" assessment. A small change in the average survey biomass occurred because of the inclusion of some unidentified rockfish, which were inadvertently omitted from last year's assessment. New data in the 2013 assessment included updated catches for 2012 and 2013 and there were no changes in the assessment methodology. Trends in spawning biomass are unknown. The 2012 assessment reported that biomass of other rockfish in the EBS slope survey was at an all-time high in 2012, while biomass in the AI was down relative to 2010, but still higher than pre-2002 levels.

The Plan Team agreed with the approach recommended by the author 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 2014 and 2015 ABCs of 690 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 recommended that OFL be set for the entire BSAI area, calculated under Tier 5 by multiplying the best estimates of total biomass for the area by the separate natural mortality values and adding the results. This calculation gives an OFL of 1,550 t for 2014 and 2015.   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 using Tier 5 methodology.

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

GULF OF ALAKSA - ABL

“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 total complex is comprised of 25 species, but the composition of the complex varies by region. The species that are included across the entire GOA are the 15 rockfish species that were previously in the “Other Slope Rockfish” category together with yellowtail and widow rockfish, formerly of the “Pelagic Slope Rockfish”. The Pelagic Shelf rockfish category has since been dissolved and dusky rockfish are now managed as a stand-alone species. Northern rockfish are included in the Other rockfish complex in the eastern GOA and the Demersal Shelf rockfish species are included west of the 140 line (i.e. all of the GOA except for NMFS area 650). 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. While the trawl survey was conducted in 2013, a full assessment was not conducted due to the government shutdown. An expanded executive summary assessment was presented in 2013 which included updated survey biomass. The next full assessment will be completed in the fall of 2015.

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 2009, 2011, and 2013 surveys) is used to determine current exploitable biomass. This results in a current exploitable biomass of 83,383 t 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 4,079 t for 2014. This is an increase of 1% compared to the 2013 ABC of 4,045 t for Other rockfish. While the overall survey biomass was similar to the previous survey (85,774 t in 2011), the composition of the species included changed. The Demersal shelf rockfish species had not previously been included in the biomass calculations. With the inclusion of the new species, the large decline in biomass observed for silvergray rockfish did not impact the overall exploitable biomass substantially. Gulfwide catch of Other rockfish was 1,039 t in 2012, and estimated catch in 2013 was 760 t. Other rockfish is not considered overfished in the Gulf of Alaska, nor is it approaching overfishing status. However, in 2013, the apportioned ABC for the Central GOA was exceeded and the catch consisted of mostly harlequin rockfish, which is the most abundant of the Other rockfish species in that region, however the biomass is low.

Two notable results were seen for Other rockfish in the 2013 GOA trawl survey. First, compared to the 2011 survey, the biomass estimate for silvergray rockfish decreased by 81% from 100,049 t to 19,239. Second, the survey biomass of harlequin rockfish remained relatively low at only 7,485 t, but is an approximately 2 fold increase over the previous survey. Total estimated catch of harlequin rockfish for 2013 was 357 t, exceeding the estimated species specific ABC by 32% and OFL by 10% (ABC = 241 and OFL = 321). This could be a conservation concern because harlequin rockfish have comprised the majority of the commercial catch since 2003. However because harlequin rockfish are managed as part of complex with the ABC and OFL set for the complex as a whole, overfishing was not declared for harlequins rockfish. For more information contact Cindy Tribuzio at (907) 789-6007 or cindy.tribuzio@noaa.gov.

Thornyheads

GULF OF ALAKSA - ABL
Gulf of Alaska 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. For Gulf of Alaska thornyheads, in odd years we usually conduct a full stock assessment update. However, due to the 2013 government shutdown, we present an executive summary with updated survey biomass estimates to recommended harvest levels for the next two years. New data added for this assessment are biomass estimates from the 2013 trawl survey for shortspine thornyheads. The 2013 biomass estimate of 69,878 t is an 11% increase from the 2011 estimate and similar to the 2009 estimate for the 1-700 m strata. As with the 2011 survey, the 700-1000 m stratum was not sampled; therefore, the 2013 biomass estimate was also inflated to account for the lack of sampling in the deep strata. We used the same methods described in the 2011 assessment where 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 2013 area-specific biomass estimates were increased by these percentages. The modification results in a total estimated biomass of 81,816 t, which is a 17% increase in the observed biomass estimate of 2013.

For the 2014 fishery, we recommend the maximum allowable ABC of 1,841 t for thornyhead rockfish. 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

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 2013. Total sablefish tag recoveries for the year were around 660. Twenty eight percent of the recovered tags in 2013 were at liberty for over 10 years. About 33 percent of the total 2013 recoveries were recovered within 100 nautical miles (nm; great circle distance) from their release location, 36 percent within 100 – 500 nm, 17 percent within 500 – 1,000 nm, and 13 percent over 1,000 nm from their release location. The tag at liberty the longest was for approximately 35 years, and the greatest distance traveled of a 2013 recovered sablefish tag was 1,945 nm. Five adult sablefish and two juvenile sablefish tagged with archival tags were recovered in 2013. 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, spiny dogfish, and rougheye rockfish are also maintained in the Sablefish Tag Database. Nineteen thornyhead and one archival Greenland turbot tag were recovered in 2013.

Releases in 2013 totaled 2,589 adult sablefish, 602 juvenile sablefish, 1,125 shortspine thornyheads, and 50 rougheye rockfish. Electronic archival tags were implanted in 36 Greenland turbot and 101 juvenile sablefish. Pop-up satellite tags (PSAT) were implanted in 27 sablefish, 6 spiny dogfish, 4 lingcod, and 6 rougheye rockfish. The second year of extensive tagging of sablefish with pop-up satellite tags was conducted on the AFSC annual longline survey in 2013. Pop-off satellite tags were deployed on 27 sablefish throughout the Gulf of Alaska on the 2013 AFSC longline survey to study daily and large-scale movements. 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 2013. A total of 602 juvenile sablefish were caught, and 600 tagged and released in St John Baptist Bay near Sitka, AK over 5 days (July 8th – July 12th) with 124 rod hrs. A total of 106 archival tags were surgically implanted. Researchers from University of Alaska participated to continue an ecological study of the bay. Gastric lavages were conducted on 391 juvenile sablefish. The majority of these samples had recoverable stomach contents, which consisted primarily of small herring, jellyfish and assorted osmerids. Herring were omnipresent, and sea lions, seals, and humpback whales were frequenters of the bay. Spiny dogfish were more frequently caught in 2013, with a catch of 6 medium to large specimens. 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 likely be conducted again in 2014 during a similar timeframe.

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

Sablefish Maturity Study – RACE GAP and ABL

RACE and ABL cooperatively completed a cruise to collect female sablefish maturity information in December 2011 off Kodiak Island, Alaska. A manuscript is currently being prepared for publication. Although samples were not taken randomly, smaller females were found on the shelf and older, larger fish on the slope. The minority of fish on the shelf were mature (10%); whereas, 90% of the samples taken on the slope were mature. Skip spawning fish were identified primarily on the shelf (19 of 22 skip spawning fish were on the shelf, total study sample size = 394). Skip spawning fish could be identified the combination of 1) small ovaries that were flaccid, 2) perinucleolar oocytes, 3) atretic perinucleolar oocytes, and 4) a thicker ovarian wall, measured from histological slides. Weight specific fecundity was not related to fish size or age, indicating that relative reproductive output stays constant, verifying the assumption made in the stock assessment that reproductive output is linearly related to female spawning biomass. Four satellite tags were deployed during the cruise and programmed to pop-off after a month to two months. The sablefish exhibited sight fidelity; the two tagged on the slope remained on the slope and the two caught on the slope and released on the shelf, moved back to where they were caught on the slope.

The age at 50% maturity for the study data was 6.8; the age at 50% maturity of the combined annual maturity data from the longline survey in the central Gulf of Alaska was 7.0 years old. However, the model fit to the study data had a steeper slope and estimated that there were a greater proportion of mature fish at ages 6.5-12, and a lower proportion of mature fish at ages under age 5.7. This indicates that samples taken during the summer provide an overall lower estimate of the proportion of fish that are mature in the population than fish sampled in the winter just before spawning commences. Using the maturity curve from the winter study would result in an increase in the estimate of female spawning biomass in the sablefish population model used in the Alaska sablefish stock assessment. The quantity of the effect on spawning biomass will be examined in the future.

Juvenile Sablefish Ecology Study – ABL and UAF

Sablefish (*Anoplopoma fimbria*) are long-lived demersal fish inhabiting the waters of the North Pacific Ocean and the Bering Sea and among the most valuable commercial groundfish in Alaska. Juvenile sablefish are commonly found in nearshore bays; however, the characteristics that make this habitat preferable are not well understood. This joint study between ABL and UAF will investigate the diet composition of juvenile sablefish, quantify seasonal and ontogenetic shifts in diet, and assess their habitat use of nearshore bays.

To determine diet composition, samples were obtained over multiple seasons (July 2012, September 2012, May 2013, July 2013, and September 2013) from St. John Baptist Bay, Baranof Island, Alaska. In total 1140 juvenile sablefish were caught during daytime angling trips and their stomach contents sampled using gastric lavage. Food items identified include teleosts such as gadids, clupeids, pleuronectids, cottids and hexagrammids as well as invertebrates, primarily amphipods, euphausiids, polychaetes and larval crustaceans. Sablefish sampled in September (2012 and 2013) were feeding on salmon carcasses, organs and eggs. Preliminary multivariate analyses show there are differences in presence and abundance of prey items between July and September 2012 (Fig. 1 and Fig 2.).

Habitat use and movement patterns of juvenile sablefish will be elucidated through the analysis of acoustic telemetry data from St. John Baptist Bay collected from 2003-2004. Generalized linear models will be used to identify relationships between environmental factors and sablefish movement within the bay. Diet and habitat use information for the juvenile life stage will aid in identifying essential fish habitat (EFH) and may facilitate management and conservation of the species.

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

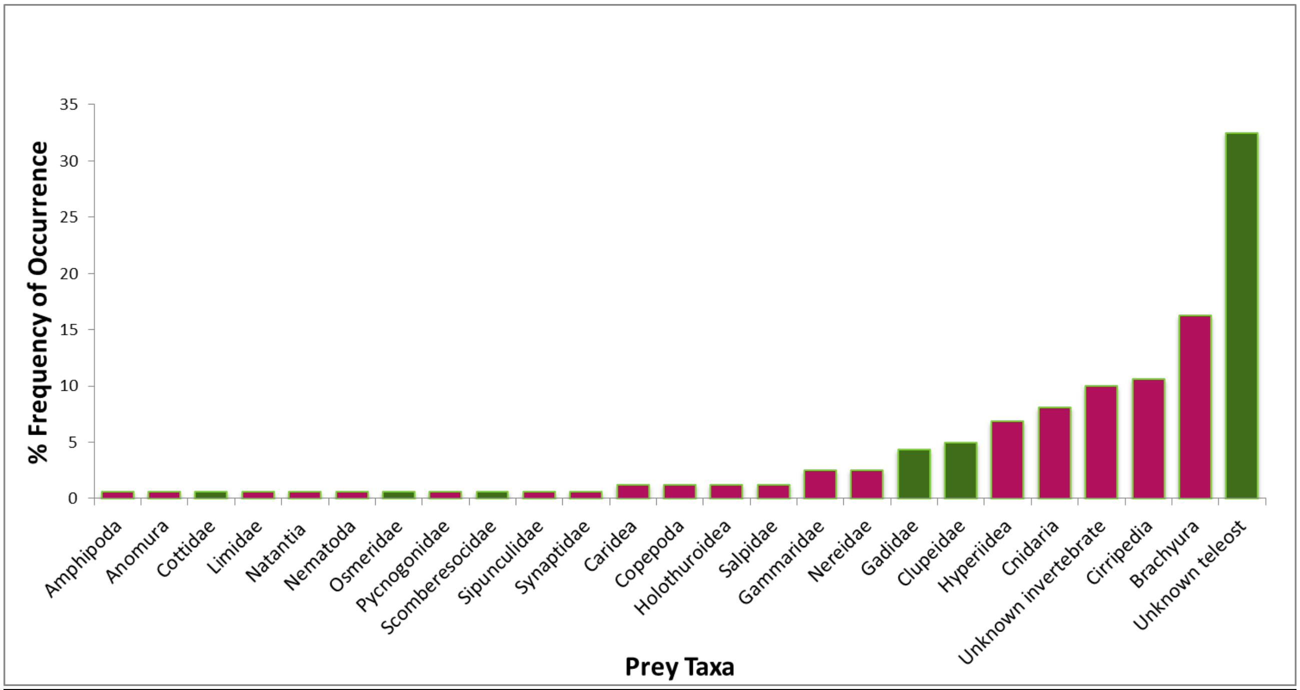


Figure 1. Frequency of occurrence of prey taxa in sablefish stomachs from July 2012 (N=142) with % occurrence shown on the y-axis and prey taxa shown on the x-axis. Magenta bars represent invertebrate prey and green bars represent teleost prey.

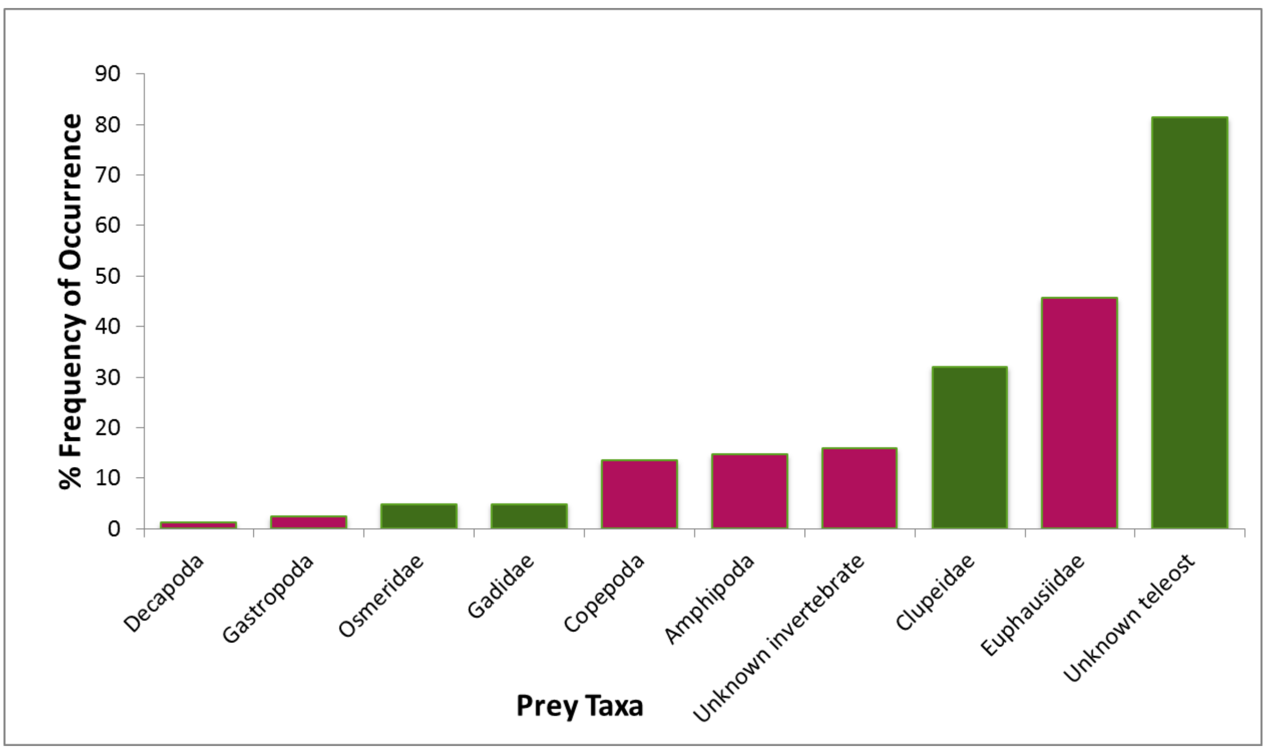


Figure 2. Frequency of occurrence of prey taxa in sablefish stomachs from September 2012 (N=85) with % occurrence shown on the y-axis and prey taxa shown on the x-axis. Magenta bars represent invertebrate prey and green bars represent teleost prey.

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. After a hiatus during 2013, data analysis will resume in 2014. For more information, contact Mike Sigler mike.sigler@noaa.gov or Pete Hulson pete.hulson@noaa.gov.

Sablefish Satellite Tagging - ABL

The second year of extensive tagging of sablefish with pop-up satellite tags was conducted on the AFSC annual longline survey in 2013. Pop-off satellite tags were deployed on 27 sablefish throughout the Gulf of Alaska on the 2013 AFSC longline survey to study daily and large-scale movements. These tags were programmed to release from the fish 1 January 2014 and 1 February 2014, 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. The 2013 released tags join the 48 tags that were released throughout the Gulf of Alaska and Aleutian Islands on the 2012 longline survey, and 4 tags that were released during a sablefish winter maturity cruise in December 2011. With just two years of data acquired from summer survey released tags 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 any directed movement by sablefish for spawning purposes. Admittedly, tags should be programmed to remain on the fish for an entire year in order to determine if sablefish are exhibiting any homing behavior for spawning purposes. Ideally, the fish would be tagged just before the spawning season in the winter and programmed to release the following winter during the spawning season. 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.

The December 2011 released tags, while on the fish for a short amount of time, were ideal for observing behavior during the spawning season. Two fish were captured, tagged, and released nearshore north of Portlock Bank on the shore side of Amatuli Trough at 58° 55' 12"N 150° 0' 35"W, and two fish were initially captured offshore on the Kodiak Slope at 57° 4' 47"N 151° 11' 59"W but were released nearshore at 57° 38' 24"N 151° 50' 59"W due to inclement weather. The tags were set to release from the fish during the spawning season; two released 35 days later on 2012 January 15 and two released 48 days later on 2012 February 1. The two fish that were initially captured, tagged, and released nearshore north of Portlock Bank on the shore side of Amatuli Trough at an approximate depth of 155 m remained within one kilometer of their tagging location on the shelf. Tagged specimens that were initially captured together offshore on the Kodiak Slope at an approximate depth of 400 m, but released that same day approximately 75 km (great circle distance) northwest on the shore side of Chiniak Gully, traveled back to the slope within 10 km of their initial capture location within 48 days. These results show that within the winter spawning season sablefish appear to have site fidelity. It is unknown whether this fidelity is consistent since very few fish were tagged over a small area relative to their spatial range and only females were tagged (an assumption based on the size of the fish). It is also unknown whether there is site fidelity from year to year. Even if there is no site fidelity from year to year, the behavior we saw may indicate that there are aggregations of spawning sablefish that the tagged fish moved back towards after being relocated. For more information, contact Katy Echave at (907) 789-6006 or katy.echave@noaa.gov.

b. Stock Assessment

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA - ABL
A full sablefish stock assessment was produced for the 2014 fishery. We added relative abundance and length data from the 2013 AFSC longline survey, relative abundance and length data from the 2012 longline and trawl fisheries, age data from the 2012 longline survey and 2012 longline fishery, abundance and length data from the 2013 Gulf of Alaska trawl survey, updated 2012 catch, and estimated 2013 catch to the assessment model.

The fishery abundance index decreased 3% from 2011 to 2012 (the 2013 data are not available yet). The longline survey abundance index decreased 5% from 2012 to 2013 following a 21% decrease from 2011 to 2012. The GOA trawl survey biomass index decreased 29% from the last trawl survey in 2011. Spawning biomass is projected to decrease from 2014 to 2018, and then stabilize. Sablefish are currently slightly below the spawning biomass limit reference point and well below the target, which automatically lowers the potential harvest rate. We recommended the maximum permissible yield for 2014 from an adjusted F40% strategy of 13,722 t. The maximum permissible ABC for 2014 is a 15% decrease from the 2013 ABC of 16,230 t. The 2012 assessment projected a 6% decrease. This larger decrease is supported by the lowest values of the time series for the domestic longline survey index in 2012 and 2013 that offset relatively high survey years in 2010 and 2011. The fishery abundance index was lower in 2012 than 2010 and 2011, and has been trending down since 2007. The GOA trawl survey biomass index decreased 29% from 2011. The 2012 IPHC sablefish index was not used in the model, but also declined 22% from 2011. In last year’s assessment, the estimate of the 2008 year class was increasing based on patterns in the age and length compositions. However the estimate in this year’s assessment is only just above average because the estimate is heavily influenced by the large recent overall decrease in the longline survey and trawl indices. Spawning biomass is projected to decline through 2018, and then is expected to increase, assuming average recruitment is achieved. The projection is toward decreasing ABCs with the maximum permissible ABC projected to decrease in 2015 to 12,400 t and 11,876 t in 2016.

Projected 2014 spawning biomass is 34% of unfished spawning biomass. Spawning biomass is higher than its low of 30% of unfished biomass in 2002 at 34% of unfished biomass projected for 2014, but is now trending downward. The 1997 year class has been an important contributor to the population but has been reduced and is predicted to comprise less than 8% of the 2014 spawning biomass. The 2000 year class is still the largest contributor, with 18% of the spawning biomass in 2014. The 2008 year class is slightly above average and will comprise 8% of spawning biomass in 2014 even though it is only 40% mature.

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

7. Yellowfin sole

a. Stock Assessment

BERING SEA - REFM
The 2013 EBS bottom trawl survey resulted in a biomass estimate of 2.28 million t, compared to the 2012 survey biomass of 1.95 million t (an increase of 14 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 (57% 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 6 of the past 22 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 is a contributor to the reservoir of female spawners. The 2013 catch of 165,000 t represents the largest flatfish fishery in the world 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:
• 2012 fishery and survey age compositions
• 2013 trawl survey biomass point estimate and standard error
• estimates of the discarded and retained portions of the 2012 catch
• estimate of total catch through the end of 2013.

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 2014 is 581,100 t. Projected spawning biomass for 2014 through 2019 indicates an increasing trend and a slow decline thereafter. The upward trend in the population biomass is due to strong 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 366,000 t. Corresponding 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 harvest ratio (the harmonic mean of the F_{MSY} harvest ratio) of 0.113. The current value of the OFL harvest ratio (the arithmetic mean of the F_{MSY} ratio) is 0.123. The product of the maximum permissible ABC harvest ratio and the geometric mean of the 2014 biomass estimate produced 2014 ABC of 239,800 t recommended by the author and Team, and the corresponding product using the OFL harvest ratio produces the 2014 OFL of 259,700 t. For 2015, the corresponding quantities are 248,300 t and 268,900 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. – RACE GAP and Fish Behavioral Ecology Program
Ampharetid polychaete worm tubes (*Sabellides sibirica*) are prevalent, small-scale habitat features in flatfish nurseries around Kodiak, Alaska, USA. Juvenile (age-0) northern rock sole (*Lepidopsetta polyxystra*) are the predominant member of flatfish assemblage in the nurseries and they associate with worm tubes in summer months. However, the functional role of this small-scale 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 *S. sibirica*, 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 rock sole 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 has been submitted to the journal Marine Ecology Progress Series for review.

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

Age-0 yr northern rock sole habitat studies around Kodiak Alaska - RACE FBEP
The Fisheries Behavioral Ecology Program, located in Newport Oregon, in cooperation with staff members from the Kodiak Laboratory, conduct research and test hypotheses designed to better understand annual recruitment of juvenile northern rock sole to coastal nursery areas in the Gulf of Alaska around Kodiak using a combination of field and laboratory studies. Laboratory studies focus upon specific habitat features which promote settlement and survival in these species, while field research focuses the recruitment of juvenile northern rock sole and their distribution among habitats. In addition, the program continues an annual survey (10-years in 2013) of juvenile recruitment that may ultimately prove useful in understanding annual variability in habitat features that control nursery production, subsequent year-class strength, and eventual adult recruitment to the fishery. In 2013 a study was completed that documented inter-annual variability in the depth distribution of juvenile northern rock sole on their nursery grounds around Kodiak Island, Alaska. This study evaluated whether this variability was a response to inter-annual changes in the availability of habitat created by polychaete tubes;

principally *Sabellides sibirica*. Worm tubes may constitute an alternative refuge and/or feeding habitat for juvenile flatfish. Accordingly, it was hypothesized that during years of low worm abundance, fish would concentrate in the shallows (< 10 m depth) where they would find refuge from predation, but would move to greater depths (> 15 m, where the worms occur) during years when the worms were abundant. Using data on worm abundance and fish density over 5 yr, this hypothesis was tested at 2 Kodiak nursery embayments. Whether worms were abundant in a given year or embayment had no influence on overall fish abundance, however, worm abundance did influence juvenile flatfish depth distributions. At one site, where worms tended to be scarce, fish were typically concentrated in shallow water. However, during the 1 year when worms were abundant, fish were concentrated in deeper water. At another site, where worms are more regularly found, fish tended to concentrate in deeper water, the exception being the one year when worms were nearly absent. Regression analysis for both sites and all years indicated that the percent of fish occupying shallow water (< 10m) decreased with increasing worm abundance. When worms were prevalent, fish were most commonly found on bottom with sparse to moderate worm cover, but avoided bottom where the worms were so dense as to form a 'turf'. These results demonstrate that the geographic and inter-annual variation in worm tube abundance has significant influence over the distribution of juvenile northern rock sole.

b. Stock Assessment

BERING SEA - REFM

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 2013 bottom trawl survey resulted in a biomass estimate of 1.75 million t, 8% lower than the 2012 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 2013 analysis include:
- 2012 fishery age composition;
- 2012 survey age composition
- 2013 trawl survey biomass point estimate and standard error
- updated fishery discards through 2012
- fishery catch and discards projected through the end of 2013.

Northern rock sole are assessed on an annual basis in the Bering Sea/Aleutian Islands region to coincide with the annual Bering Sea multispecies groundfish trawl survey conducted each summer. Due to a temporary lack of appropriations, the Department of Commerce implemented an orderly shutdown from October 1 – October 16 2013. Although the trawl survey was completed again in 2013, the shutdown did not allow time to produce a full stock assessment for northern rock sole and many other species. Therefore an executive summary was presented to provide management recommendations for the 2014 fishing season.

Northern rock sole are managed as a Tier 1 stock using a statistical age-structured model as the primary assessment tool. Details of the model can be found at http://www.afsc.noaa.gov/REFM/docs/2012/BSAIrocksole.pdf. The assessment model is not re-run for this update but instead, projections made from the recommended 2012 assessment (time-varying temperature/catchability) model are presented. The model assumes a 2013 and 2014 catch of 65,000 t and provides estimates of 2014 and 2015 ABC, OFL and FSB without re-estimating the stock assessment model parameters and biological reference points.

The stock assessment model estimates a 2014 spawning biomass of 638,300 t. This was equal to the 2014 value projected in last year's assessment, due to the fact that there were no changes in the data. According to last year's assessment, spawning biomass is expected to increase due to strong 2000-2005 year classes, if fishing mortality rates remain at recent levels. The SSC has determined that northern rock sole qualifies for management under Tier 1. Spawning biomass for 2014 is projected to be well above B_{MSY}, placing northern rock sole in sub-tier "a" of Tier 1. The Tier 1 2014 ABC harvest recommendation is 203,800 t (F_{ABC} = 0.15) and the 2014 OFL is 228,700 t (F_{OFL} = 0.16). The 2015 ABC and OFL values are 190,100 t and 213,310 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.

GULF OF ALASKA Shallow Water Complex - REFM

Shallow-water and deep-water flatfish are assessed on a biennial schedule to coincide with the timing of survey data. An executive summary was presented which included updated 2012 catch and the partial 2013 catch as well as projections using the updated catches from the northern and southern rock sole assessment.

The shallow water complex is comprised of northern rock sole, southern rock sole, yellowfin sole, butter sole, starry flounder, English sole, sand sole and Alaska plaice. The rock sole assessment model will be updated and presented in 2014. Stock status for shallow-water flatfish is based on the NMFS bottom trawl survey (triennial from 1984 to 1999 and biennial from 1999 to 2013). Survey abundance estimates for the entire shallow-water complex were lower in 2013 compared to 2011; decreasing by 35,156 t. By species, southern rock sole has a generally increasing trend in abundance. Northern rock sole survey trend has been variable in recent years and increased between 2011 and 2013. The remainder of the species in the shallow-water flatfish complex have varying trends. Notable declines were observed in the trends for butter sole and yellowfin sole from 2011to 2013. Information is insufficient to determine stock status relative to overfished criteria for the complex. For the rock sole species, the assessment model indicates they are not overfished nor are they approaching an overfished condition. Catch levels for this complex remain below the TAC and below levels where overfishing would be a concern.

Northern and southern rock sole are in Tier 3a while the other species in the complex are in Tier 5. An updated projection model for northern and southern rock sole was run this year; the remaining shallow water flatfish biomass estimates were from the 2013 survey. 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 40,805 t and OFL of 50,007 t for 2014. For 2015, the combined ABC is 37,505 t and the OFL is 46,207 t.

9. Flathead Sole

a. Stock Assessment

BERING SEA - REFM

The flathead sole assessment also includes Bering flounder, a smaller, less abundant species with a more northern distribution relative to flathead sole. The 2013 shelf trawl biomass estimate increased 29% from 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 3 years of poor recruitment. The assessment employs an age-structured stock assessment model.

This chapter was presented in executive summary format, as a scheduled “off-year” assessment. New information available to update the projection model for flathead sole consists of total catch for 2012 (11,386 t) and estimated catch for 2013 (17,246 t) and 2014 (assumed equal to 2013). The projected spawning stock biomass for 2014 is 239,985 t. Flathead sole are abundant and only lightly exploited. In last year’s assessment, spawning biomass was projected to decrease for the next several years.

The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, thereby qualifying flathead sole for management under Tier 3. The current values of these reference points are $B_{40\%}$=128,286 t, $F_{40\%}$=0.285, and $F_{35\%}$=0.348. Because projected spawning biomass for 2014 (239,985 t) is above $B_{40\%}$, flathead sole is in sub-tier “a” of Tier 3. The authors and Team recommend setting ABCs for 2014 and 2015 at the maximum permissible values under Tier 3a, which are 66,293 t and 64,127 t, respectively. The 2014 and 2015 OFLs under Tier 3a are 79,633 t and 77,023 t, respectively.

Flathead sole is not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

GULF OF ALASKA - REFM

A full assessment with a new model was presented for the 2013 stock assessment and was configured as follows. Catch data for 1978-1983 and 2012-2013 were included in the model. 2012 and 2013 fishery length composition data were added and 1985-1988, 2000, and 2008 fishery length composition data were excluded from the model due to low sample size. The number of hauls was used as the effective sample size of fishery length-composition data. The 2013 survey biomass index and survey length composition data were added to the model. Conditional age-at-length data were used instead of marginal age composition data. 2011 age composition data (within each length bin) were added to the model. The “plus” group was increased to age 29.

The assessment was conducted using the Stock Synthesis modeling platform with the fishery and survey selectivity curves estimated using an age-based double -normal function without a descending limb instead of an age-based logistic function. A conditional age-at-length likelihood approach was used: expected age composition within each length bin was fit to age data conditioned on length in the likelihood function, rather than fitting the expected marginal age-composition to age data that weren't conditioned on length. Growth parameters and an initial equilibrium fishing mortality rate were estimated within the model. Relative weights of composition data were adjusted using a data-weighting method that accounted for correlations in composition data. An ageing error matrix was incorporated into the model. Recruitment deviations prior to 1984 were estimated as "early-period" recruits separately from main- period recruitment deviations (1984-2008).The Plan Team endorsed the author's recommended model.

The 2014 spawning biomass estimate (84,076 t) is above $B_{40\%}$ (35,532 t) and projected to be stable through 2015. The stock is not overfished nor approaching an overfished condition. Catch levels for this species remain below the TAC. Flathead sole are determined to be in Tier 3a. For 2014 the recommendation is to use the maximum permissible ABC of 41,231 t. The FOFL is set at $F_{35\%}$(0.61) and gives an OFL of 50,664 t.

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10. Alaska Plaice

a. Stock Assessment - REFM

The Alaska plaice resource continues to be estimated at a high and stable level with very light exploitation. The 2013 survey biomass was 505,600 t is a 13% decrease over 2012 and is largely consistent with estimates from resource assessment surveys conducted since 1985. 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.

This chapter was presented in executive summary format, as a scheduled "off-year" assessment for 2013. New input for the projection model included the final estimate of the 2012 catch and preliminary estimates of 2013 and 2014 catch. The model assessment methodology was unchanged (only the projection model was run). 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. There was exceptionally strong recruitment from the 2002 year class. There may also be a strong 2004 year class.

Reliable estimates of *B40%*, *F40%*, and *F35%* exist for this stock, therefore qualifying it for management under Tier 3a. Last year's estimates (which were not updated this year) are *B40%* = 152,000 t, *F40%* = 0.158, and *F35%* = 0.19. Given that the projected 2014 spawning biomass of 250,600 t exceeds *B40%*, the ABC and OFL recommendations for 2014 were calculated under sub-tier "a" of Tier 3. Projected harvesting at the *F40%* level gives maximum permissible

ABCs of 55,100 t and 54,700 t for 2014 and 2015, respectively. These ABC values were adopted for management in 2014. The OFLs were determined from the Tier 3a formula, which gives a 2014 value of 66,800 t and a 2015 value of 66,300 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. Stock Assessment

This year's Greenland turbot assessment model included: updated 2013 catch data, 2013 EBS shelf survey biomass, 2013 ABL longline survey RPN, 2013 EBS shelf survey and ABL longline length composition estimates, 2010, 2011, 2012 shelf survey age data and updated fishery catch-at-length data for longline and trawl gear from 2013.

No new models were explored nor any refinements made to last year's model due to the government shutdown. The projected 2014 female spawning biomass is 22,010 t. This is a 17% decrease from the 2014 spawning biomass of 26,537 t projected in last year's assessment. Spawning biomass is projected to increase in 2015 to 27,624 t. While spawning biomass continues to decline as of 2013, large 2008 and 2009 year classes are still being observed in both the survey and fishery size composition data. These year classes are both estimated to be stronger than any other year class spawned since the 1970s. A near doubling of abundance in the 2012 slope survey estimate (relative to 2010) is largely attributable to an increase in small (30-50 cm) fish.

The SSC has determined that reliable estimates of *B40%*, *F40%*, and *F35%* exist for this stock. Greenland turbot therefore qualifies for management under Tier 3. Updated point estimates of *B40%*, *F40%*, and *F35%* from the present assessment are 39,906 t, 0.22, and 0.27, respectively. The stock remains in Tier 3b. The maximum permissible value of *FABC* under this tier translates into a maximum permissible ABC of 2,124 t for 2014 and 3,173 t for 2015, and a OFL of 2,647 t for 2014 and 3,864 t for 2015. These are the authors' and Team's ABC and OFL recommendations.
Greenland not being subjected to overfishing, is not overfished, and is not approaching an overfished condition.

12. Arrowtooth Flounder

a. Stock Assessment

BERING SEA - REFM
This chapter was presented in executive summary format, as a scheduled "off-year" assessment. New input data include: fishery size composition for 2010 and 2011, and updated 2012 catch and preliminary 2013 catch.

Because this is an "off-year" for the BSAI ATF, new survey information is not incorporated into the assessment model for this update. Instead, a projection model is run with updated catch information. This projection model run incorporates the most recent catch and provides estimates of 2014 and 2015 ABC and OFL without re-estimating the stock assessment model parameters and biological reference points. The projection model is based on the previous year's model, except that it incorporates a new maturity ogive, which was approved by the Team in September.

The 2012 stock assessment model (using a different maturity schedule) resulted in a 2014 age 1+ biomass projection of 1,021,060 t, compared to 1,023,440 t from this year's assessment. The corresponding values for 2014 spawning biomass are 638,377 t (last year's assessment) and 626,319 t (this year's assessment). This year's assessment projects a slight increase in female spawning biomass between 2014 and 2015. The stock is at a high and stable level.

The SSC has determined that reliable estimates of *B40%*, *F40%*, and *F35%* exist for this stock. Arrowtooth flounder therefore qualifies for management under Tier 3. The point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from last year's assessment were 246,476 t, 0.17, and 0.21, respectively; from this year's assessment, they are 231,015 t, 0.156, and 0.186, respectively. The projected 2014 spawning biomass is far above $B_{40\%}$ in both last year's and this year's assessments, so ABC and OFL recommendations for 2014 were calculated under sub-tier "a" of Tier 3. The authors and Team recommend setting F_{ABC} at the $F_{40\%}$ level, which is the maximum permissible level under Tier 3a, which results in 2014 and 2015 ABCs of 106,599 t and 106,089 t, respectively, and 2014 and 2015 OFLs of 125,642 t and 125,025 t.

Arrowtooth flounder is a largely unexploited stock in the BSAI. 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 - REFM
Arrowtooth flounder are assessed on a biennial schedule to coincide with the timing of survey data. A full assessment was completed this year to update the stock status using the 2013 GOA survey information. The 2013 NMFS GOA trawl survey biomass and length data were added to the stock assessment model. Catch for 2011 was updated, and updated catch for 2012 and 2013 was added. Fishery length data was updated for 2011 and fishery length data from 2012 and 2013 was added to the model. No new age data were available. There were no changes in assessment methodology. Arrowtooth flounder are managed as a Tier 3 stock, using a statistical age-structured model as the primary assessment tool. An age-based model was used with the same configuration as the 2011 assessment.

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. The age 3+ biomass estimates are slightly lower in the current assessment for the years since 2000 when compared to estimates from the 2011 assessment. Female spawning biomass in 2013 was estimated at 1,200,320 t, which is<1% less than the projected 2013 biomass of 1,278,530 t from the 2011 assessment. Age 3+ biomass is expected to decrease in 2015 .The stock is not overfished nor approaching an overfished condition. Catch levels for this stock remain below the TAC and below levels where overfishing would be a concern.

Arrowtooth flounder has been determined to fall under Tier 3a.The 2014 ABC using $F_{40\%}$=0.172 is 195,358 t, a decrease from the 2013 ABC of 210,451 t.The 2014 OFL using $F_{35\%}$=0.204 is 229,248 t. The 2015 ABC (189,556 t) and OFL (222,160 t) were estimated using the projection model and with total catch in 2012 and the estimated catch for 2013 and 2014. Catch in 2013 and 2014 was estimated using the recent 5-year average (F=0.02). Area apportionments of arrowtooth flounder for 2014 and 2015 are based on the fraction of the 2013 survey biomass in each area.

13. Other Flatfish

a. Stock Assessment

BERING SEA - REFM

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 2013. 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 2013 total catch and discard and 2013 trawl survey information. The 2013 EBS bottom trawl survey resulted in biomass estimates of 89,995 t, 9% lower 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 Aleutian Islands. 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 2013 estimate of 1,310 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 a high of 98,600 in 2007. This estimate has been decreasing since 2007 to 58,900 t in 2013. Conversely, EBS longhead dab decreased from a one-time high of 104,000 t in 1982 to 5,450 t in 2013. This estimate has fluctuated over time, though less dramatically from 1985 through the present. 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 37 t in 2012. Sakhalin sole are primarily found north of the standard survey area. Distributional changes, onshore-offshore or north-south, might affect the survey biomass estimates of other flatfish.

GULF OF ALASKA - REFM

The SSC has classified "other flatfish" as a Tier 5 species complex with harvest recommendations calculated from estimates of biomass and natural mortality. Natural mortality rates for rex (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 2014 ABC of 12,400 t for the "other flatfish" complex. The corresponding 2014 OFL (average *FOFL* = 0.15) is 16,700 t.

Before the implementation of Amendment 80, fishing for this complex was usually closed for trawl gear prior to attainment of TAC because of the bycatch of Pacific halibut, a prohibited species. With the implementation of Amendment 80, a higher TAC for "other" flatfish was assigned for 2007-2010, although it was subsequently decreased for 2011-2013.

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.

GULF OF ALASKA Deep-water flatfish - REFM

The deep water flatfish complex is comprised of Dover sole, Greenland turbot, and deep sea sole. The assessment included updated fisheries catch data for all three species through 2013. Dover sole are assessed with an a statistical stock assessment model whereas Greenland turbot and deep sea sole rely on survey biomass estimates alone. Dover sole fishery and survey length compositions, and survey age compositions were updated. The 2013 survey biomass estimate was included in the Dover sole model. The 1984, 1987, and 2001 length and age at length data were excluded from the Dover sole model due to survey biases in these years. The Stock Synthesis assessment platform was used to conduct the Dover sole assessment. A survey averaging random effects model was used to estimate survey biomass and variance in missing depth and area strata and these estimates were included in the survey biomass index. Male and female selectivity curves were estimated based on the survey biomass index and composition data from surveys that covered more than 500 m in depth. Separate sex-specific selectivity curves were estimated using only composition data from surveys that covered no more than 500 m in depth. A conditional age-at-length approach was used in the model and growth parameters were estimated internally. Fishery selectivity was changed to be length-based and double-normal, allowing for dome -shaped selectivity. An initial equilibrium fishing mortality rate was estimated. An ageing error matrix was incorporated into the model. Recruitment deviations prior to 1984 (1967–1983) were estimated separately from main-period recruitment deviations (1984–2008). Composition data sources were weighted using a method that accounted for intra-year correlations in residuals.

The Plan Team endorsed the use of the author's recommended model for setting catch limits. In addition to the author's recommended model, three alternate models were also presented. These encompassed treatment of early recruitment, and the exclusion of the 1984 and 1987 survey biomass estimates. The model estimate of spawning stock biomass in 2013 is 66,147 t, which is well above B35% (24,690 t). Thus the Dover sole stock is not overfished. Information is insufficient to determine stock status relative to overfished criteria for Tier 6 species. Catch levels for this complex remain well below the TAC and below levels where overfishing would be a concern. Last year ABCs and OFLs for Dover Sole were in Tier 5 last year (2012). This year (2013) the author and Plan Team recommend that Dover sole be moved to Tier 3a management. B40%for this stock is estimated to be 28,128 t and projected spawning biomass is

66,147 t. For the Dover sole Tier 3a assessment, the 2014 and 2015 ABC are 13,289 t and 13,120 t, respectively. The 2014 and 2015 OFL using Tier 3a results are15,915 t and 15,711 t, respectively. Both Greenland turbot and deep sea 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 2014 and 2015 ABC and OFLs. The GOA Plan Team agrees with the authors' recommendation to use the combined ABC (13,473 t) and OFL 16,159t) for the deep water flatfish complex for 2014 and 2015. The ABC is equivalent to the maximum permissible ABC. Area apportionment Area apportionments of deep water flatfish are based on the relative abundance (biomass) of each species in the stock complex in each management area. Area apportionments of deep water flatfish (Dover sole and others) ABCs for 2014 and 2015 are based on the fraction of the 2013 survey biomass in each area for Dover sole and the estimate of 2013 catch by area for Greenland turbot and deep sea sole.

14. Sharks and Skates

a. Research

Salmon Shark Life History – RACE GAP, ABL, 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. Female salmon sharks were found to have a biennial reproductive period with a 9-10 month gestation, a resting period of over a year, and a fecundity of approximately four pups per litter. The manuscript for this project is in press.

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. A total of 183 satellite pop-off tags have been deployed on spiny dogfish since 2009. Data has been successfully recovered from 147 tags, with some tags still at liberty. Three tags have been physically recovered and complete data sets are being downloaded from them. 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. Recovered data from the pop-off tags, which includes temperature, depth, and geographic location, are still being analyzed. Preliminary results suggest that spiny dogfish can undertake large scale migrations rapidly and that they do not always stay near the coast (e.g. a tagged fish swam from near Dutch Harbor to Southern California in 9 months in a mostly straight line, not following the coast). Also, the spiny dogfish that do spend time far offshore have a different diving behavior than those staying near

shore, with the near shore animals spending much of the winter at depth and those offshore having a significant diel diving pattern from the surface to depths up to 450 m. 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. Challenges to this ageing project were discussed at the last CARE meeting: vague ageing criteria and sample collection location (within an animal). As a result, new ageing criteria were established for both spines and vertebrae and the structures are being re-examined. Progress and preliminary results for this project have been presented at the Alaska Marine Science Symposium, the American Elasmobranch Society, Western Groundfish Conference and the Northeast Pacific Shark Symposium. For more information, contact Cindy Tribuzio at (907) 789-6007 or cindy.tribuzio@noaa.gov.

Population Genetics of Pacific Sleeper Sharks - ABL
Two species of the subgenus *Somniosus* are considered valid in the northern hemisphere: *S. microcephalus*, or Greenland shark, found in the North Atlantic and Arctic, and *S. pacificus*, or Pacific sleeper shark, found in the North Pacific and Bering Sea. The purpose of this study was to investigate the population structure of sleeper sharks in Alaskan waters. Tissue samples were opportunistically collected from 141 sharks from British Columbia, the Gulf of Alaska, and the Bering Sea. Sequences from three regions of the mitochondrial DNA, cytochrome oxidase c- subunit 1 (CO1), control region (CR), and cytochrome b (cytb), were evaluated. A minimum spanning haplotype network separated the sleeper sharks into two divergent groups, at all three mtDNA regions. Percent divergence between the two North Pacific sleeper shark groups at CO1, cytb, and CR respectively were all approximately 0.5%. Greenland sharks were found to diverge from the two groups by 0.6% and 0.8% at CO1, and 1.5% and 1.8% at cytb. No Greenland shark data was available for CR. The consistent divergence from multiple sites within the mtDNA between the two groups of Pacific sleeper sharks indicates a historical physical separation. There appears to be no phylogeographic pattern, as both types were found throughout the North Pacific and Bering Sea. Development of nuclear markers (microsatellites) is currently underway and will allow for a better understanding of the level of introgression, if any, between these two ‘populations’ of sharks. For more information, contact Cindy Tribuzio at (907) 789-6007 or cindy.tribuzio@noaa.gov.

b. Stock Assessment

Sharks - ABL
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 2013 an expanded executive summary assessment was presented for the GOA sharks instead of the full assessment due to the government shutdown. A full assessment for the BSAI sharks is planned for the fall of 2014 and in 2015 for the GOA sharks.

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 2003-2013 were updated from the NMFS Alaska Regional Office's Catch Accounting System. Total shark catch in 2013 was 1,019 t, up from 634 t in 2012. This is the highest since 2009, but was still below the maximum historical catch of 1,538 t in 2006 (over the years 2003 – 2012). Substantial changes to the observer program (referred to as "observer restructuring") likely affected the catch estimates for shark species. Smaller vessels are now subject to observer coverage, and this includes vessels fishing halibut IFQ, which were previously exempt from coverage. The increase in 2013 can be attributed mostly to an increase in the catch estimate of spiny dogfish in the Pacific halibut target fishery, which was 460 t, up ~300 t from the average catch from 2003 – 2012, but was still within the range of catches from this target group. Pacific sleeper shark catch in the halibut target group in 2013 (60 t) was significantly greater than the 2003 - 2012 average (7.4 t, SD = 18.3). An additional impact of observer restructuring was that estimated shark catches in NMFS areas 649 (Prince William Sound) and 659 (Southeast Alaska inside waters) for Pacific sleeper shark and spiny dogfish by the halibut target group in 2013 was 126 t and 52 t, respectively, whereas historically it has been small (<1 t for Pacific sleeper sharks and ~14 t average, SD = 23, for spiny dogfish). There was approximately 2 t of salmon shark and other shark estimated in these areas as well. The catch in NMFS areas 649 and 659 does not count against the federal TAC, but if it were included the total catch of sharks in 2013 would be 1,199 t, which is still below the recommended acceptable biological catch (ABC) for this complex.

Survey biomass was updated for the 2013 assessment. The trawl survey biomass estimates are only used for spiny dogfish. The 2013 survey biomass estimate (160,384 t, CV = 40%) is nearly four times greater than the 2011 biomass estimate of 41,093 t (CV = 22%); this variability is typical for spiny dogfish. The 3 – year average biomass from the trawl survey that is used in calculating the ABC and over fishing level (OFL) declined from 79,979 t (2007, 2009 and 2011 surveys) to 76,452 t (2009, 2011 and 2013 surveys) with the inclusion of the new survey data. The 2007 survey biomass estimate (161,965 t, CV = 35%) dropped out of the calculations, but because the 2013 estimate was nearly equal to the 2007 estimate, the average had only minimal change.

In the BSAI, estimates of shark catch from the Catch Accounting System from 2012 were 95 t and the estimated catch for the assessment in 2013 was 71 t. Pacific sleeper shark are the primary species caught. These catch estimates do incorporate the restructured observer program, but the impact appears to be minimal for BSAI sharks. The survey biomass estimates on the BSAI are highly uncertain and not informative for management purposes.

For the GOA assessment, spiny dogfish are a "Tier 6" species, but are calculated as a "Tier 5" species (this is due to the "unreliable" nature of the biomass estimates) and all other sharks a "Tier 6" species. The GOA-wide ABC and OFL for the entire complex is based on the sum of the ABC/OFLs for the individual species, which resulted in ABC=5,989 t and OFL= 7,986 t for 2014. In the BSAI, all shark species are considered "Tier 6" with the 2014 ABC = 1,020 t and OFL = 1,360 t. For more information, contact Cindy Tribuzio at (907) 789-6007 or cindy.tribuzio@noaa.gov.

15. Other Species

a. Research

Otolith Morphology and Microchemistry of Giant Grenadier – ABL (MESA and Genetics), REFM

Three very different shapes of otoliths have been observed in giant grenadier. A review of the literature and world-wide experts 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 were collected on the AFSC longline survey in the eastern, central, 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.

Octopus Life History – RACE GAP and REFM

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 has been submitted and is in review.

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

Octopus Delayed Discard Mortality - RACE GAP

Octopus are caught incidentally in trawl, longline, and pot fisheries; however, the majority of the catch comes from Pacific cod pot fisheries. There is concern that the establishment of annual catch limits (ACLs) for this group may unnecessarily constrain this and other commercial fisheries. During 2011, in the Bering Sea/Aleutian Islands regions the total allowable catch (TAC) for octopus was reached in August 2011 and octopus retention was prohibited starting September 1, 2011. The overfishing limit (OFL) for octopus was reached October 21, 2011 and directed fishing for Pacific cod pot gear was closed for the remainder of the year. Due to the lack of reliable abundance estimates and life history information about octopus in the Gulf of Alaska it is appropriate that they be managed conservatively, however better scientific data will ensure the most appropriate values are used for discard mortality rates for this assemblage. Observer data have documented the short term mortality of octopus captured within these pot fisheries is very low. Data on delayed or long-term mortality of this species will enable scientists to develop a gear-specific discard mortality factor. During the 2014 "A" season for Pacific cod, twenty octopus were collected for long term mortality studies from commercial fishing vessels utilizing pot gear. To date these octopus have exhibited low mortality rates and these data support the development of a gear specific discard mortality factor. Additional octopus specimens will be collected during the fall fishery for Pacific cod in 2014 and the winter fishery in 2015.

Blue King Crab Modeling in the Bering Sea - RACE Recruitment Processes

Eco-FOCI personnel are involved in modeling of blue king crab (BKC) in the Bering Sea in a project funded by NOAA's FATE program. We are adapting an existing individual-based model (IBM) of snow crab larval drift, for BKC. The snow crab IBM has been used to demonstrate connectivity patterns for snow crab across the eastern Bering Sea. BKCs are found in widely-separated populations in the Bering Sea, and stock structure is largely unknown. Population trends are very different between the Pribilof Islands regions and the St. Matthew region, however, there are no apparent barriers to adult dispersal between the regions. They are, however, infrequently taken in NMFS trawl surveys between those islands suggesting limited post-settlement dispersal as adults. General current structure in the region suggests that there may be a possible source-sink relationship of planktonic larvae released in the Pribilof Islands region that could settle in the St. Matthew region, but also potential retention in the area around the Pribilofs.

The objectives of the FATE project is to adapt a biophysical individual-based model (IBM) to determine connectivity between larval release and benthic settlement areas for eastern Bering Sea BKC populations. The study is examining the likelihood of exchange via larval drift among populations of BKC in different regions of the eastern Bering Sea, from near the Alaska Peninsula, the Pribilof Islands and St Matthew Island. Connectivity, or the lack of it, between these regions can shed light on populations structure of BKC in the Bering Sea.

The results of this study will directly inform the assessment and management of the Pribilof Islands and St. Matthew BKC stocks. Currently, stock boundaries are established based on geographical features and fishing practices without any information on stock overlap or connectivity. Information on larval drift and likely impacts of environmental conditions and habitat availability on settling locations may inform the management boundaries. This would affect the estimation of biomass, determination of removals, and subsequent definitions of stock status. An extreme yet possible outcome of the changes in boundary definitions might lead to the aggregation of the Pribilof Islands and St. Matthew stocks for overfishing determinations. This would obviously have dramatic impacts on the overfishing status of BKC in the eastern Bering Sea and have potentially lasting impacts on the Pribilof Islands ecosystem.

Contributed by S. Hinckley, e-mail: Sarah.Hinckley@noaa.gov

Distribution and Migration of Morphometrically Mature Male Snow Crab in the Eastern Bering Sea - RACE GAP
Tagging of adult male snow crab (*Chionoecetes opilio*) in the eastern Bering Sea, using pressure and temperature recording data storage tags, was conducted during 2010 and 2011 in an effort to determine the occurrence and extent of seasonal migrations. The research was designed to address the question of whether or not morphometrically mature males undergo a migration from offshore wintering areas northwest of the Pribilof Islands where the fishery occurs to more inshore areas where mature females reside. Fishery managers have recognized a spatial mismatch among larger commercial-sized (≥ 102 mm carapace width) snow crab males, which are found over the middle EBS shelf (< 100 m bottom depth) during annual summer bottom trawl surveys, but appear centered over the outer shelf (100 - 150 m bottom depth) during winter where the fishery occurs. Part of this mismatch occurs because, upon reaching morphometric maturity, adult males undergo an offshore migration during winter. Although this movement into deeper water during is firmly established, the timing and other particulars of a return migration (which might contribute to the mismatch), have not been demonstrated. Since mature females are thought to remain in the shallower areas throughout the year, the specifics of this return migration are also important because they are critical to understanding whether males continue to participate in breeding throughout their lives.

A total of 277 adult males were tagged and 33 were recovered by the fishery between 2011 and 2012. Analyses of the tag depth records indicated that most of these males underwent some limited inshore movements during spring, but that the timing and extent of these movements were highly variable among individuals. Comparisons of tag depth records with distributions of adult female snow crab during the two years in which tagged males were at liberty, indicated that inshore movements were likely made for the purpose of mating. However, the timing and extent of these migrations were such these males could only mate with females that had already released a brood in a prior years (multiparous), and not with those that were holding their first brood (primiparous).

For more information, contact Dan Nichol, e-mail: dan.nichol@noaa.gov

b. Assessment

Grenadiers - ABL
In February, 2014 the NPFMC moved grenadiers into the fishery management plans (FMPs) in Alaska. They were put into the FMPSs as “ecosystem components” and so landings are now required to be reported, but there are no OFL, ABC, and TACs. It is recommended that an “ecosystem component” be monitored for overfishing, but no definition of overfishing exists for this group. The only other “ecosystem component” is forage fish. An unofficial assessment has been conducted annually since 2006; ABL will continue to do a Stock Assessment and Fishery Evaluation Report (SAFE) as often as possible since there is no requirement to complete an assessment for an “ecosystem component”.

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 2013, an unofficial executive summary SAFE was done for grenadiers in Alaska. ABC recommendations remained the same since there has not been a trawl survey that has sampled deep enough to be used in calculations of giant grenadier ABCs. 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.

D. Other Related Studies

Fisheries Resource Pathology Program – RACE

During the 2013 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 2013 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 2013. A taxonomic revision of the sandlance genus *Ammodytes* of the North Pacific was submitted (Orr et al., in review). Based on molecular and morphological data, the revision recognizes two species in the eastern North Pacific (*A. hexapterus* in the Bering Sea and north; *A. personatus* in the southern Bering Sea and farther south) and describes and names a new species from Japan. The second part of a revision of the fish family Caristiidae (manefishes and veilfins), describing five new species, was recently published (Stevenson and Kenaley, 2013), as well as a comprehensive osteological description of the prowfish, *Zaprora silenus* (Hilton and Stevenson, 2013). A taxonomic revision of snailfishes in the *Careproctus rastrinus* species complex (Orr et al.), and a project documenting the genetic diversity of lumpsuckers (Cyclopteridae) across the North Pacific and marginal seas (Kai and Stevenson) are in draft. A guide to cods and cod-like fishes (Gadiformes) is nearly complete (Hoff, Orr, and Stevenson) and a manuscript clarifying the taxonomy and distribution of sculpins of the genus *Malacocottus* (Stevenson) is in review. An additional study, testing the hypothesis of cryptic speciation in northern populations of the eelpout genus *Lycodes* (Stevenson) is underway. In addition to taxonomic revisions, descriptions of new taxa, and guides, RACE systematists have collaborated with molecular biologists within and outside of the AFSC to identify snailfish eggs in crabs (Orr, Stevenson, Somerton, and Spies) and examine population-level genetic diversity in the skate *Bathyraja interrupta* (Stevenson, Orr, Hoff, and Spies), *Ammodytes* (Orr and Wildes), *Eumicrotremus* (Kai and Stevenson), and *Lycodes* (Stevenson and Paquin). 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 on a checklist of the fishes of the Salish Sea (Pietsch and Orr, in press) and notes on new records and range extension of other fishes (Kai et al., 2013; Maslenikov et al., 2013; Okamoto et al., in review; Paquin et al., in press).

With the support of NPRB and JISAO, an annotated checklist of the marine macroinvertebrates of Alaska comprising over 3500 species has been submitted (Drumm et al., in review). A new species of a tanaidaceiid crustacean was described (Drumm and Bamber, 2013). Two additional papers on new records of shrimps and crabs have been published or submitted (Fujita et al., 2012; Drumm et al., 2013; Drumm and Orr, in review). As a result of this checklist and following Stevenson and Hoff (2009), a processed report providing species-level confidence identification matrix for the Gulf of Alaska and Aleutian Islands is in press (Orr et al., in press) and another on species of the Bering Sea slope is nearly complete (Orr et al., in review).

Salmon Excluders – RACE Conservation Engineering (CE)

We continued our collaboration with industry on new designs for salmon excluders. Efforts have focused on testing and improving a new design that would allow escape from both above and below, resulting from a previous flume tank workshop. We began by participating in a model testing/development workshop at the flume tank in St. Johns, Newfoundland. 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.” This work was conducted both in the Bering Sea and the Gulf of Alaska Pollock trawl fisheries. There has been no substantial change in Chinook and Chum salmon escape rates. Pollock escape was insignificant at less than 1%. Because the new excluder system includes more and larger escape portals, escapes are being monitored with video instead of the more cumbersome recapture nets. The CE program developed a much more compact camera system for this work and up to six of these have been used during the same tow. This new camera system is expected to see wide use on Alaska fishing vessels. An additional model testing/development workshop at the flume tank in St. Johns, Newfoundland was conducted in Fall of 2013, including improvements to the new design and tests of new designs.

Develop alternative trawl designs to effectively capture pollock concentrated against the seafloor while reducing bycatch and damage to benthic fauna – RACE CE

The Alaska pollock fishery requires the use of pelagic trawls for all tows targeting that species. During some periods of the pollock fishery, these fish concentrate against the seafloor and, to capture them, fishermen have to put nets designed for midwater capture onto the seafloor. We are developing footropes raised slightly off of the seafloor to have less effect on seafloor habitats than the continuous, heavy footropes (generally chains) currently required on pelagic trawls. We have held several workshops with 20+ participants, including captains of pollock trawlers and industry representatives, as well as federal and university scientists to come up with ideas for alternative footropes to test. In May 2014 we will begin exploring these possibilities with experiments to compare the seafloor effects of the different alternative footropes.

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

In May, CE scientists continued the work from 2012 and 2013 but incorporated feedback from the Bering Sea flatfish trawl fleet to test alternative bottom trawl footropes to reduce potential damage to crabs. CE scientists spent two and half weeks testing alternative footrope designs, including those provided by the flatfish trawl fleet, for crab mortality rates, flatfish capture efficiency, and crab bycatch rates aboard the F/V Great Pacific. 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. We found that widening disk spacing, and hence reducing ground contact and potential for crab damage, had little effect on flatfish catch rates and improved crab mortality rates.

Provide underwater video systems to fishermen and other researchers to facilitate development of fishing gear improvements – RACE CE

We have continued to provide five underwater video systems to be used by the fishing industry to allow them to directly evaluate their own modifications to fishing gear. Beyond their direct use, exposure to NMFS systems has motivated many companies to procure similar systems for dedicated use on their vessels. Either way, the goal of better understanding of fishing gear operation and quicker development of improvements is being realized. Delivery, training and maintenance have been managed by contractors in the ports of Dutch Harbor and Kodiak with established contacts with the fishing industry. While the existing camera systems have been maintained, a significant advance in this area has been the development and testing of much more compact and inexpensive camera systems for use on commercial fishing gear. All camera system components are enclosed in a single 3.5 inch diameter acrylic tube mounted on a plastic plate. The entire system measures 21 x 10 x 9 inches and is of nearly neutral buoyancy in water. Two test trips (Kodiak and West Coast) and production use aboard the salmon excluder experiment have proven these to be very easy to use, durable and flexible. Six new systems will be built for our use and potential replacement of the older loaner systems. However, this design may be so inexpensive and functional that enough vessels will acquire their own systems and the loaner concept will no longer be needed.

APPENDIX I - AFSC GROUNDFISH-RELATED PUBLICATIONS AND DOCUMENTS
Published January 2012 through December 2012 (AFSC authors in bold text)

BABIJ, E., P. NIEMEIER, B. HAYUM, **A. HIMES-CORNELL**, **A. HOLLOWED**, P. LITTLE, M. ORBACH, and E. PIDGEON.
2013. International implications of climate change, p. 119-139. *In* R. Griffis, and J. Howard, (editors), Oceans and Marine Resources in a Changing Climate: A Technical Input to the 2013 National Climate Assessment. Island Press: Washington, D.C.

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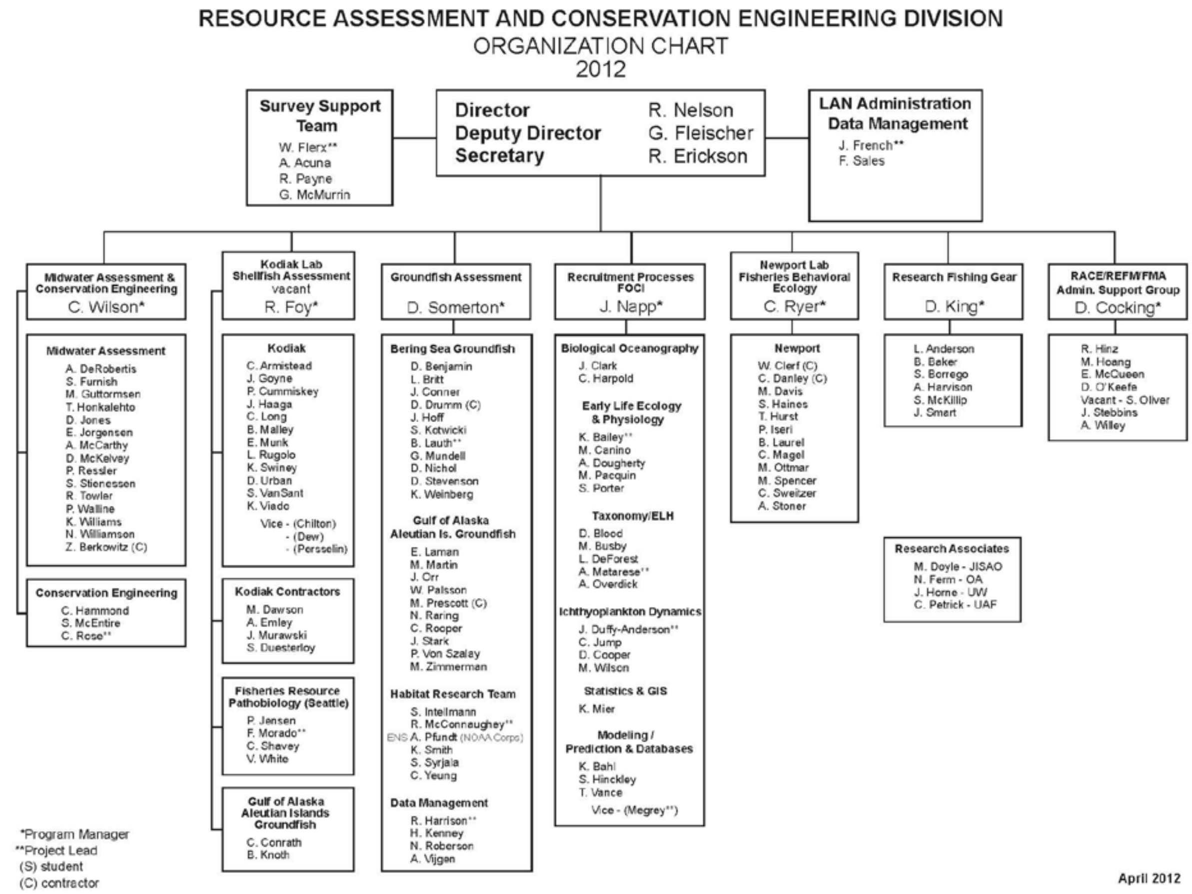
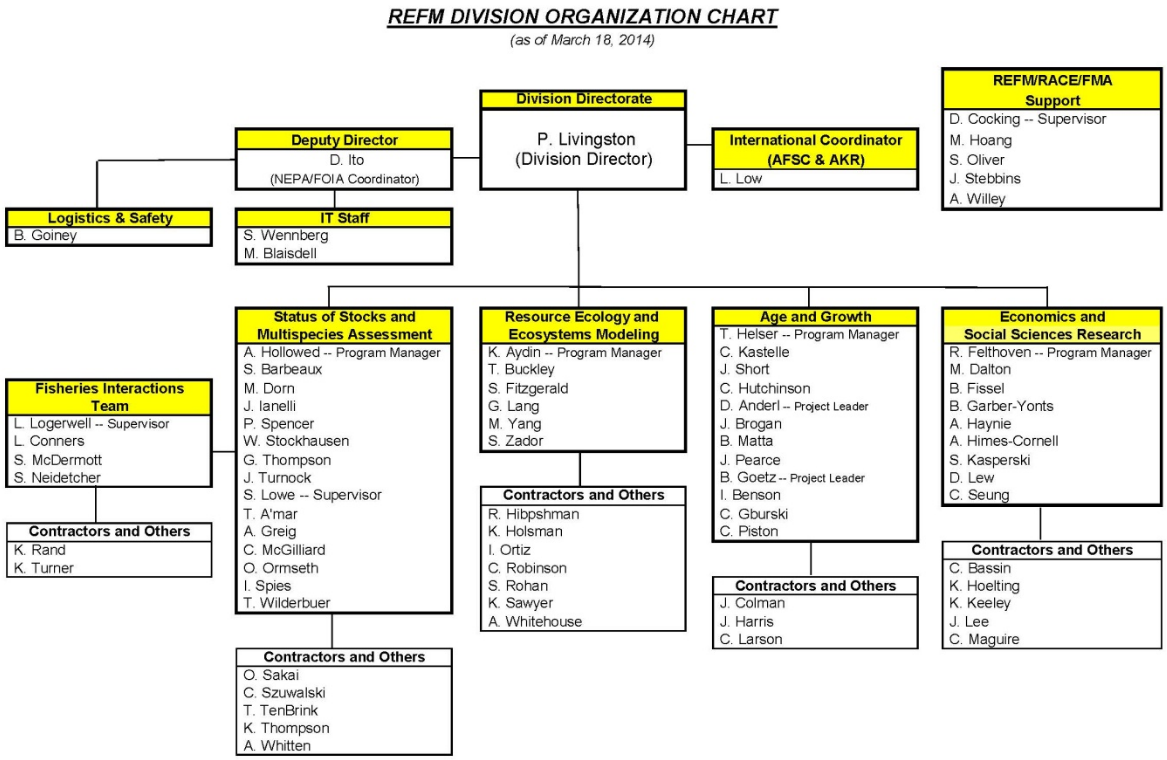
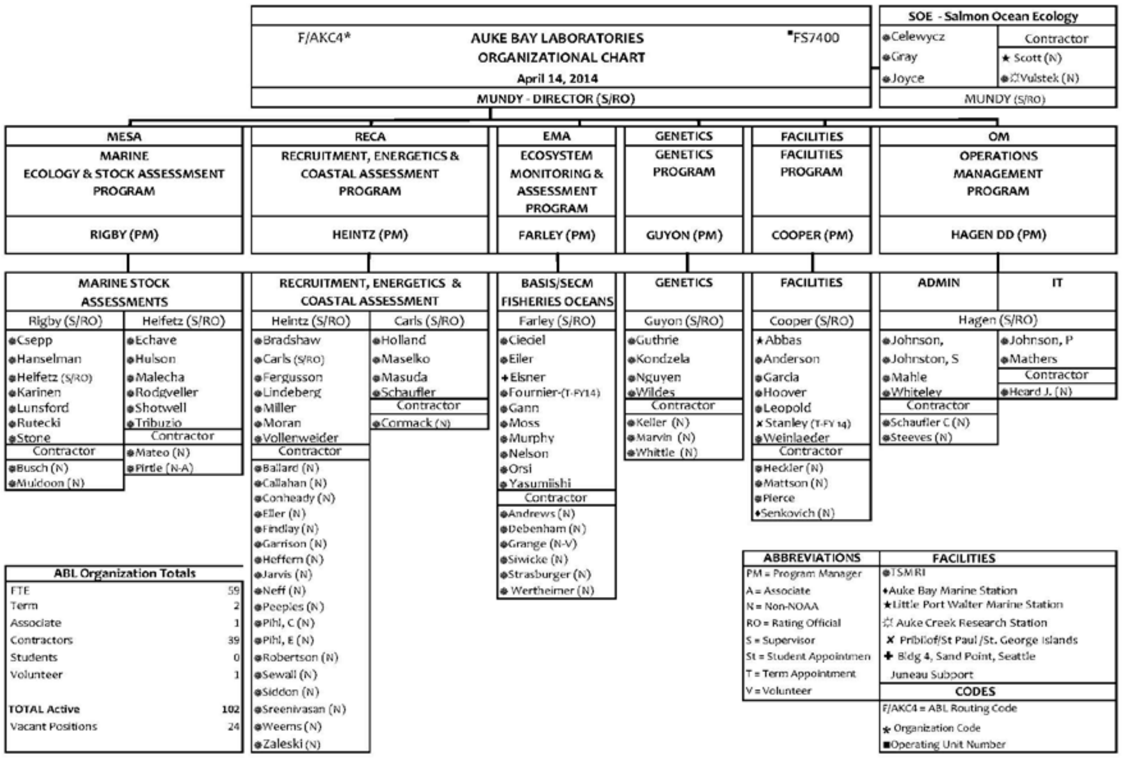
APPENDIX II. RACE ORGANIZATION CHART



APPENDIX III. REFM ORGANIZATION CHART



APPENDIX IV – AUKE BAY LABORATORY ORGANIZATIONAL CHART



CANADA

British Columbia Groundfish Fisheries and Their Investigations in 2013

May 2014

Prepared for the 55th Annual Meeting of the
Technical Sub-Committee of the Canada-United States Groundfish Committee
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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 and will be retiring in May 2014. 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. Dennis Rutherford (Acting)
Pelagic Fish Research & Conservation Biology	Dr. Nathan Taylor (Acting)
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 summarizes 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 2014 Groundfish Integrated Fisheries Management Plan can be viewed at 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 were transitioning to the new Fisheries Act provisions for the 2013-14 fiscal year, where stakeholders were willing.

Allocations of fish for financing scientific and management activities are identified in the Groundfish Integrated Fisheries Management Plan. Joint Project Agreements are being considered for 2014-15 between Fisheries and Oceans Canada and several partner organisations to support groundfish science activities through the allocation of fish to finance the activities.

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), and 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 Fisheries Research Network (CFRN)

Starting in 2010, Groundfish staff have participated in the National Sciences and Engineering Research Council of Canada's (NSERC) *Canadian Fisheries Research Network*. The CFRN 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

The 2014 Annual Meeting was held in February in Montreal and was attended by academics, DFO scientists, industry members and students from around the country. Students gave presentations and posters on progress to date, and discussions were held on future directions for the network. A report will be posted shortly on the CFRN website.

3. Summary of research surveys in 2013

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 2013, please see Appendix 2. Other research surveys conducted in 2013 include longline and trap surveys. These surveys are described under their respective species programs below.

By species

1. Pacific Cod

i. Research program in 2013

In 2013, staff in the Groundfish Section made significant progress on development of feedback simulation software to analyse the performance of alternative management procedures along a gradient of assessment complexity and frequency, for stocks with a range of life-history and data-availability. Preliminary results have tested the performance of alternative fishery reference points and assessment models under a set of alternative frequencies of surveys and assessments. Results for Pacific Cod were presented at National Workshop on Evaluating the Effects of Changes in Monitoring and Assessment Frequency on Management Advice for Canadian Fisheries (Ottawa, October 2013) and at the Western Groundfish Conference (Victoria 2014).

Dr Robyn Forrest has begun development of analyses to investigate alternative drivers of productivity and abundance of Pacific Cod in British Columbia. Simulation models and statistical analysis are being developed to evaluate competing hypotheses about contributors to large apparent cycles in recruitment and abundance of Pacific Cod since the 1950s. Alternative drivers include changes in fishing and fisheries management, climate drivers and predator-prey dynamics. A first step in this work is to evaluate alternative methods for developing a recruitment index, including length-based and age-based methods. The feedback simulation methods described above will be used to identify management procedures that are robust to uncertainty in underlying drivers of abundance and productivity.

Several analyses of age and length data have been done, including analysis of reader bias, and development of a new age-length key. Fishery-dependent and independent indices of abundance were developed for the 2013 stock assessment.

Genetic samples were collected from the 2013 Hecate Strait Synoptic Bottom Trawl survey and the Strait of Georgia Synoptic Longline survey. Genetic samples will be collected from the 2014 WCVI Synoptic Bottom Trawl survey. Collection from the commercial fishery during the spawning season has been delayed until 2015.

ii. Stock Assessments

A new stock assessment for Pacific Cod in Area 5AB (Queen Charlotte Sound) and 5CD (Hecate Strait) was developed in 2013. A Canadian Science Advisory Secretariat (CSAS) meeting was held January 9 - 10, 2014, to review the CSAS Working Paper Forrest et al. (in press).

The status of Pacific Cod populations in Hecate Strait and Queen Charlotte Sound were assessed using a delay difference model fit to fishery–independent survey data, commercial catch per unit effort data, commercial catch data, and estimates of annual mean weight. Pacific Cod stocks in BC are difficult to assess, primarily due to the relatively short time-series of fishery-independent stock index data, changes in fishery selectivity over time that result from trawl gear changes, the transition to quotas (early 1990s) and the introduction of 100% at-sea observer coverage (beginning in 1995/96). There is no reliable catch-at-age time series for this difficult-to-age species that would help estimate recruitment and selectivity patterns over time. Furthermore, it is unclear whether Pacific Cod in area 5AB and 5CD are biologically distinct populations.

Model estimates of biomass and stock status in both management areas were very sensitive to prior assumptions about natural mortality, variance in the mean weight data, and the fit to the indices of abundance, particularly the commercial catch per unit effort (CPUE) data. Estimates of fishery reference points based on equilibrium maximum sustainable yield (MSY) were poorly estimated, and differed substantially among model sensitivity cases; the use of MSY-based reference points was not supported for these stocks. Proposed reference points were based on values estimated from the stock reconstruction (called "historical" reference points), based on the precedent established by the previous assessment for Pacific Cod:

- a limit reference point defined as the minimum biomass from which the stock had recovered to an above average biomass level (biomass in 1985 for Area 5AB and biomass in 1971 for Area 5CD);
- an upper stock reference point based on the average biomass from 1956 to 2004; and
- a limit fishing rate based on average fishing mortality from 1956-2004.

Despite large uncertainty, biomass in Hecate Strait is estimated to have been on a gradual increasing trajectory since 2001, but is estimated to be in the Cautious Zone. Recruitment is estimated to have been below average for the past two decades. Advice to managers was provided using decision tables that summarized the probability of breaching reference points at a range of fixed catches for a one-year projection. Decision tables were developed using a model-averaging approach that integrated across major structural uncertainties in the model.

The Working Paper was accepted, with major revisions requested for the assessment of the 5AB stock, to address problems with calculation of annual mean weights. Minor revisions were requested for the assessment of the 5CD stock. A Research Document and Science Advisory Report are in press.

2. <u>Rockfish – inshore</u>

i. Research programs in 2013 and planned for 2014

    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 southern half of the study area in 2013. 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 2014 which will cover the northern half of the study area.

Visual surveys have not been conducted since 2012.

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 was not completed in time for a survey program in 2013 but a survey program is planned for 2014 under a “Use-of-Fish” policy.

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 was not secured for this program in 2013 but a survey program is planned for the southern portion of BC in 2014 under a “Use-of-Fish” policy which includes a collaborative agreement with industry.

ii. Stock assessment

There were no stock assessments prepared in 2013. An outside population stock assessment for Yelloweye Rockfish will be prepared in 2014 with a proposed review in May 2015.

iii. 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*. Quillback Rockfish remain unlisted in 2014.

3. <u>Rockfish – shelf</u>

i. Research Programs in 2013

There was no directed biological research work on shelf rockfish in 2013.

ii. Stock assessments in 2013

In 2013, an updated stock assessment (since 2002) for the Silvergray Rockfish (SGR, *Sebastes brevispinis*) stock along the BC coast was presented. This was the first time that SGR was assessed using a Bayesian model that generated decision tables for management use.

The estimated beginning year 2014 stock status (2014 spawning biomass relative to B_0) is 0.559 (5–95% range=0.405-0.698) (**Error! Reference source not found.**). The estimated ratio of spawning biomass at the start of 2014 to the equilibrium spawning biomass associated with MSY, $B_{2014}/B_{\mathrm{MSY}}$, is 2.035 (5–95% range=1.223-2.997). The estimated median MSY is 1,998 t (5–95% range=1,299–2,688). For reference, the average catch from 2008-2012 was 1,408 t.

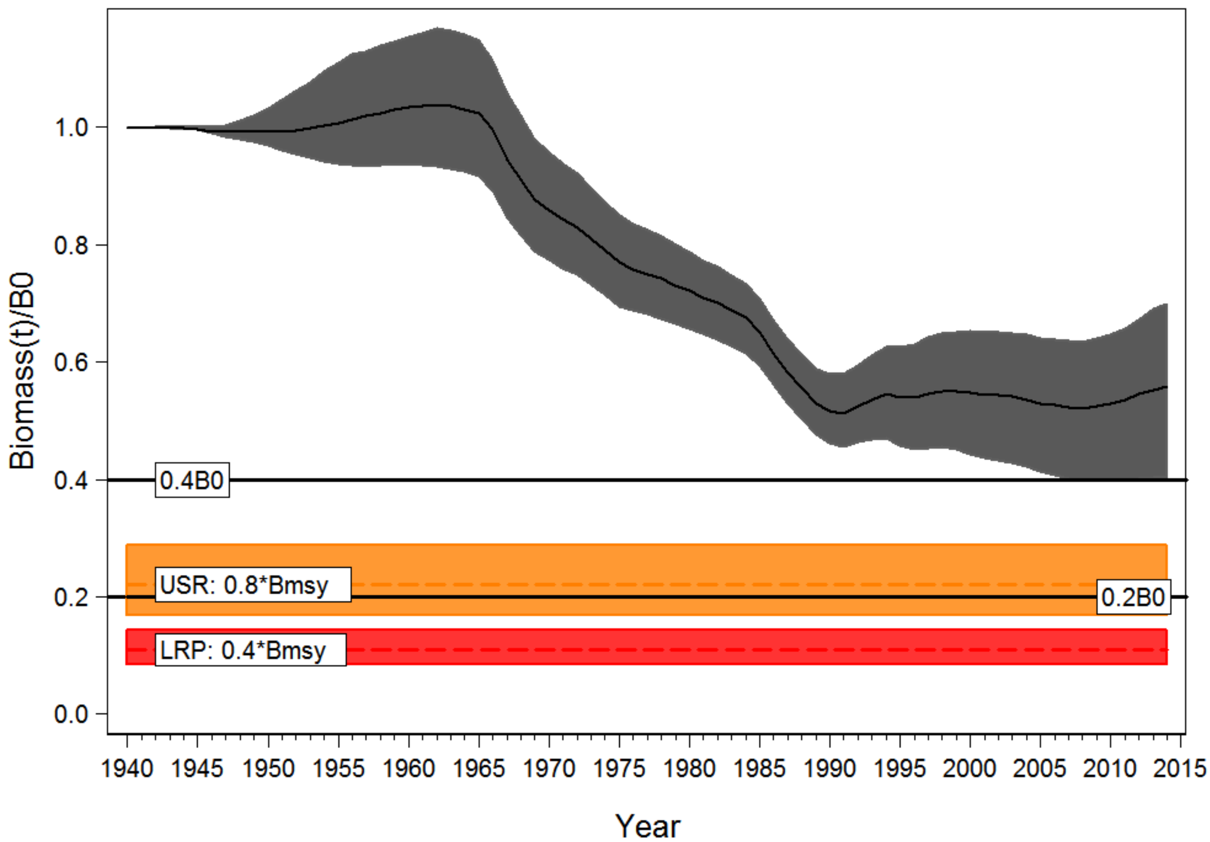

Figure 5. Posterior median estimates and 90% credibility intervals for female spawning biomass by year relative to B_0 for Silvergray Rockfish (black line and grey fill). Also shown are posterior median estimates and 90% credibility intervals for the MSY-based reference points (LRP: Limit Reference Point = $0.4B_{\mathrm{MSY}}$; USR: Upper Stock Reference Point = $0.8B_{\mathrm{MSY}}$) relative to B_0. The B_0 reference points: $0.2B_0$ and $0.4B_0$ are shown as solid black lines.

Two periods of high recruitment, 1982-1984 and 2000-2001, were estimated for this stock. Increased catch followed the large recruitment of 1982-1984, but not the large recruitment of 2000-2001.

Decision tables were presented using the provisional reference points from the Fisheries and Oceans Canada *Sustainable Fisheries Framework Precautionary Approach*, namely a limit reference point (LRP) of $0.4B_{\mathrm{MSY}}$ and upper stock reference (USR) point of $0.8B_{\mathrm{MSY}}$. Advice to management is presented in the form of decision tables using ten-year projections for a range of constant catch strategies up to 3,000 t/year, where t = metric tonnes; the mean annual coastwide catch was 1,408 t from 2008-2012. The probability of remaining above the LRP at the beginning of 2024 is estimated to be at least 0.99 for all catch strategies tested. The probability of remaining above the USR at the beginning of 2024 is estimated to be at least 0.89 for all catch strategies tested. Stock sizes are predicted to decrease at catch levels at or greater than 1,750 t/year. The probability that the exploitation rate at the beginning of 2024 will be below that associated with MSY at equilibrium is at least 0.56 for all catch strategies tested.

iii. Research activities planned for 2014

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

iv. Stock assessments planned for 2014

A Yellowtail Rockfish stock assessment is scheduled for November 2014.

4. Rockfish – slope

i. 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 continued 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. In 2013 we made substantial progress on a manuscript for publication entitled *Vulnerability of Canadian Pacific fisheries and marine ecosystems to ocean acidification*.

In 2013, 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, substantial changes were made to PBSawatea to accommodate (i) single-sex models, (ii) commercial CPUE index data, and (iii) variable CV process errors by index series. We will likely continue using Awatea (a variant of Coleraine) in 2014 for slope rockfish stock assessments, but will be testing the social network-facilitated iSCAM software (see research activities for 2014 below).

ii. Stock assessment

The slope rockfish group is scheduled to complete a stock assessment on Redbanded Rockfish (*S. babcocki*) in 2014. We will likely use the Awatea software for ADMB to derive our main analyses and results but also hope to explore the iSCAM (integrated Statistical Catch Age Model) software developed by Steve Martell (International Pacific Halibut Commission, Seattle WA)

iii. Research activities for 2014

The collaborative project on ocean acidification will continue until 2015, including completion and submission of the manuscript to PLoS ONE by June of 2014. The second phase will hopefully estimate biological responses to model predictions of $p\mathrm{CO}_2$ and pH off the west coast of Vancouver Island, depending on availability of output from physical models.

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. A postdoctoral fellow is due to start in May/June 2014.

Additional research projects include: (i) developing a new model for age proportions based on the Dirichlet distribution, (ii) modelling ageing error from fish otolith readings, and (ii) developing methods for calculating biomass size spectra, with a view to applying them to data on the groundfish community.

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.

5. Sablefish

i. Research activities in 2013 and planned for 2014

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

a) A **Traditional Standardized Program** (1990-2010)

This program was not conducted in 2011-2013 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.

b) A **Traditional Tagging Program** (1991-2007, discontinued)

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.

c) A **Randomized Tagging Program** (2003-2013)

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.

d) An **Inlets Program** (1995-2013)

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 2014 contingent on adequate resources from DFO and the Sablefish industry, but will include only the randomized program (c) and the inlets program (d).

A new introduction to the surveys in 2013 was the deployment of (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; and (3) standard oceanographic probes that measure in-situ depth and temperature data needed for gear mobility (depth) and habitat suitability modeling (both).

ii. Stock assessment activities in 2013 and planned for 2014

In 2013, fishing industry stakeholders proposed a TAC floor of 1,992 t, because lower quotas may increase economic risks. The existing management procedure was revised to implement this TAC floor and simulation analyses were conducted to determine whether the revised management procedure would continue to meet agreed conservation objectives. The revised procedure provides conservation performance that is comparable to the existing procedure. Applying the revised procedure to updated landings and biomass index data resulted in a harvest recommendation of 2,129 t, which was above the proposed TAC floor. Development of the Sablefish operating model used for feedback simulations will be conducted in 2014 for application to an updated Management Strategy Evaluation in 2015.

6. Flatfish

i. Research program in 2013

Ongoing data collection in support of the flatfish research program continued in 2013 through the Groundfish Synoptic Surveys, port sampling, and at-sea observer sampling. There was no directed biological research conducted on flatfish during 2013.

ii. Stock assessments in 2013

A stock assessment of Rock Sole (*Lepidopsetta* spp.) in British Columbia was conducted in 2013. Both Northern and Southern Rock Sole species occur in BC. The majority of Rock Sole encountered in BC fisheries and research surveys are believed to be Southern Rock Sole; however, the assessment was for the genus level (*Lepidopsetta* spp.) to allow for the possibility that some Northern Rock Sole occur in commercial catches and survey samples. Rock Sole stocks in Queen Charlotte Sound (Area 5AB) and Hecate Strait (5CD) were assessed as two independent stocks using a female-only catch-at-age model, implemented in a Bayesian framework. Rock Sole catches from commercial fisheries and research surveys in the other three management areas (West Coast Vancouver Island, Strait of Georgia, and West Coast Haida Gwaii), have historically been low and infrequent. As a result, no attempts were made to fit a population model to data from these three areas. Female spawning biomass in Area 5AB at the start of 2014 (B_{2014}) was estimated to be 0.37 (0.27 - 0.49) of unfished female spawning biomass (B_0), where numbers denote median (and 5-95 percentiles) of the Bayesian results. B_{2014} was estimated to be at 1.52 (0.98 - 2.26) of the female spawning biomass associated with maximum sustainable yield (B_{MSY}). In Area 5CD, B_{2014} was estimated to be at 0.80 (0.58 – 1.07) of B_0 and 3.22 (2.10 – 4.64) of B_{MSY}.

iii. Research activities planned for 2014

A review and summary of biological and abundance information collected from multiple flatfish species during Groundfish Synoptic Surveys between 2003 and 2013 is planned for 2014 – 2015.

iv. Stock assessments planned for 2014

A coastwide assessment of Arrowtooth Flounder in BC is planned for 2014.

7. Lingcod

i. Research programs in 2013

Ongoing data collection in support of the lingcod research program continued in 2013 through the Groundfish Synoptic Surveys, port sampling, at-sea observer sampling, and recreational creel surveys.

As part of the National Sciences and Engineering Research Council of Canada’s (NSERC) *Canadian Fisheries Research Network* project on the BC small boats groundfish fleet (lead by Dr. Murdoch McAllistair from the University of British Columbia), DFO staff contributed to a study of the effect of sex-specific seasonal migration patterns on fishery reference points that used BC Lingcod as a case study (Okamura et al. 2013).

ii. Stock assessments planned for 2014

The development of a stock assessment modelling framework for the inside (Strait of Georgia) Lingcod stock is planned for 2014.

8. Pacific Hake

i. Research programs in 2013

Triennial (until 2001), then biennial acoustic surveys, covering the known extent of the Pacific Hake stock have been run since 1995. An acoustic survey, ranging from California to northern British Columbia was run in 2013, to continue the biennial time series. The estimated biomass from the 2013 survey was 2.423 million metric tonnes with a CV of 0.0433. This estimate is approximately 1.75 times the 2012 survey estimate and 4.66 times the 2011 survey estimate. The survey catch was dominated by three-year olds at 76.2% of the total number. Nearly all the three-year olds were found in United States (US) waters, only 4.6% of the overall biomass was in Canadian waters at the time of the survey.

ii. Stock assessments planned for 2014

The majority of the Canadian Pacific Hake catch for the 2013 season was taken from the Southwest coast of Vancouver Island in the third quarter (July-Sept), however the shift in temporal and spatial distribution of Pacific Hake was still apparent with some of the catch being taken from the Quatsino region North of Brooks Peninsula and from Goose Island Gully in Queen Charlotte Sound (PMFC 5A and 5B). These areas have been targeted with regularity since 2008. The Joint Venture (JV) fishery did not choose to take part in 2013, despite being given an allocation. The total Canadian allocation for 2013 was 95,367 mt. The domestic sector was allocated all of this, including the unused JV allocation, and caught 54,359 mt (57% of total allocation).

Management of Pacific Hake is under Treaty between Canada and the United States. The 2014 harvest advice was prepared jointly by Canadian and US scientists working together, collectively called the Joint Technical Committee (JTC) as stated in the treaty. A single assessment model was used; Stock Synthesis 3 (SS3). The JTC agreed that in the past few years the Canadian (TINSS and CCAM) and U.S. models (SS2 and SS3) agreed closely. This decision also allowed the JTC the time to further investigate a Management Strategy Evaluation (MSE) framework for Pacific Hake. Both the assessment and MSE were reviewed by the Scientific Review Group (SRG) in February 2014.

The SS3 model was selected as the base model by the JTC (and endorsed by the SRG).

A notable feature of the 2013 assessment is the appearance of a very strong 2010 year class in the 2012/2013 commercial catch data and in the 2013 survey data. This apparent above-average recruitment event was strongly influential on model results in the 2013 assessment. The 2013 assessment estimated a very large recruitment for the 2010 cohort, at 15.364 billion individuals (posterior median), with the 2008 recruitment estimated at 5.148 billion. These numbers are encouraging to a stock which had no large recruitments since 1999. They were also seen by the 2013 survey, with a large number of age 3's sampled. The lack of large recruitments since 1999 has resulted in a low-aged population, however, with 76% of the stock being age 3 or under in 2013.

In addition to the assessment, the JTC presented a Management Strategy Evaluation (MSE) for Pacific Hake which examined several scenarios, including:

1. Expected long-term performance of applying the $F_{40\%}$-40:10 harvest rule.
2. Relative improvement in management performance of conducting Annual vs. Biennial surveys.
3. Whether or not implementing time-varying selectivity improves management performance.

The results were not used as a basis for allocation of quota for the year but instead as a continued introduction of the method to managers with the hopes of using it in place of traditional single-year assessments in the coming years. The justification of including time-varying selectivity in the base model which is used for advice was based on the MSE work done in part (3). The MSE scenarios in 2014 showed that there would not be any noticeable impact on the stock trajectories and age compositions if there were an annual survey vs. a biennial survey.

The final decision on catch advice for the 2014 fishing season was made at the meeting of the International Pacific Hake Joint Management Committee in Vancouver, BC on March 21, 2014. A coastwide TAC of 428,000 mt for 2014 was established. As laid out in the treaty, Canada will receive 26.12% of this, or 111,793 mt.

The final assessment document and other treaty-related documents are posted at:
http://www.nwr.noaa.gov/fisheries/management/whiting/pacific_whiting_treaty.html

9. Elasmobranchs

i. Research programs in 2013

ii. Stock assessment in 2013

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

iii. Management

There were no new elasmobranch management initiatives in 2013.

iv. Research activities for 2014.

Other related studies

1. <u>Statistics and Sampling</u>

i. Biological sampling and database work in 2013

Principal Statistics and Sampling activities in 2013 included the ongoing population of the groundfish biological database (GFBio). This database now includes almost 9,800,000 specimens. Data entry activities continue to concentrate on the input of current port sampling and observer biological data and recent research cruises. There was also some targeted funding that was utilized for the entry of historic research cruises and the scanning of original documents to electronic format.

The groundfish trawl fishery continues to be covered by 100% dockside and virtually 100% observer coverage. These observers also provided 360 length/sex/age samples and 177 length samples in 2013. In the lower mainland our port sampler provided an additional 30 samples, all except three samples with ageing structures (length/sex/age/weight). The focus of this sampling effort was from those fisheries not covered by at-sea observers. In addition, there were 59 samples collected in Ucluelet from the domestic hake fishery; 37 of the samples had ageing structures.

GFBioField was modified to facilitate its use on the Sablefish trap survey. This survey typically experiences rough seas and high winds, which have been barriers to the use of electronic data acquisition because marine scales are unable to output a stable printed weight under such conditions. This year we devised a method to continuously log scale output to a database server. This allowed us to compute average stable weights within a time frame of a few seconds, rather than rely on the scale print button. These modifications led to the successful deployment of GFBioField on the 2013 Sablefish trap survey.

ii. Catch monitoring in 2013

Staff continues to be actively involved in the Recreational Catch Monitoring Working Group.

iii. Field work in 2013

Staff participated on various bottom trawl surveys (see Summary of Groundfish Surveys in Appendix 2) including the Hecate Strait and Queen Charlotte Sound groundfish trawl surveys, the West Coast Vancouver Island, and Queen Charlotte Sound shrimp trawl surveys, as well as the Pacific Hake hydroacoustic 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.

iv. Proposed field and database work for 2014

Port sampling in the Vancouver area will continue in 2014, and will include the addition of sampling sablefish tag recoveries and frozen samples from seamount trips.

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

Development of “GFCatchAll” as a comprehensive database that will include all known sources of groundfish catch (1900-present) is still on hold but work will be initiated in 2014 on the documentation of various fishery sectors.

APPENDIX 1. REVIEW OF CANADIAN GROUNDFISH FISHERIES

1. Commercial fisheries

All catch figures for the 2013 calendar year are preliminary. Canadian domestic trawl landings of groundfish (excluding halibut) in 2013 were 89,761 t, a decrease of 12% from the 2012 catch. The major species in the trawl landings were Pacific Hake (60%), Arrowtooth Flounder (9%), Pacific Ocean Perch (5%), Yellowtail Rockfish (4%), and Walleye Pollock (4%). Trawl production was distributed amongst areas 3C (35%), 3D (26%), 5A (16%), 5B (6%), 4B (6%), 5D (4%), 5E (4%), and 5C (1%).

Canadian landings of groundfish caught by gear other than trawl in 2012 totalled 5,746 t. Landings of Sablefish by trap and longline gear accounted for 2,212 t, approximately 58% by trap gear, 40% by longline gear and 2% by unspecified. Landings of species other than Sablefish by trap, longline, handline and troll gear accounted for 3,266 t (49% rockfish, 27% Lingcod, 12% 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 2013, the estimates were generated from a combination of creel surveys and fishing lodge reports and covered the months of March to October. Provisional estimates of 2013 catches, landings and releases, for this 8-month period were 17,312 fish for Lingcod, 18,856 fish for all rockfish species, 581 fish for Pacific Halibut, 3,814 fish for Rock Sole, 1,511 fish for Starry Flounder, 2,057 fish for other flatfish species, 25,404 fish for North Pacific Spiny Dogfish, 2,231 fish for greenlings, 1,364 fish for Pacific Cod and 1,710 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 March to October. Provisional estimates for this 8-month period are 7,750 fish for Lingcod, 14,689 for all rockfish species, 8,108 fish for Pacific Halibut, 3,039 fish for all flatfish species, 17,248 fish for North Pacific Spiny Dogfish, 4,481 fish for greenlings, and 3,324 fish for other groundfish species.

Along the west coast of Vancouver Island catch estimates have been generated from creel surveys and fishing lodge reports. Data are available for June to September. Provisional estimates of 2013 catches were 14,826 fish for Lingcod, 19,307 fish for all rockfish species, 27,583 fish for Pacific Halibut, 1,313 fish for North Pacific Spiny Dogfish, 172 fish for greenlings, 1,136 for all flatfish species, and 495 fish for other groundfish species.

Fisheries and Oceans Canada (DFO) has also implemented an internet survey (iRec) of people who hold a Tidal Waters Sport Fishing Licence to collect data on recreational fishing activity and catch in the tidal waters of British Columbia. The information collected will be used, in combination with data from other sources, to provide estimates of catch and effort in recreational fisheries. Random samples of people with Tidal Waters Sport Fishing Licences will be selected monthly. Selected licence holders will be asked to summarize all of their fishing activity and catch during that month.

The estimates from the iREC surveys won't be used for management purposes until two specific actions have been completed:

1.) Independent science review of the survey design, analysis methods and results to date.
2.) A review of iREC results against local knowledge in the recreational sector.

3. Joint-venture fisheries

There were no joint-venture fisheries conducted off British Columbia in 2013.

4. Foreign fisheries

There were no national or supplemental fisheries for Pacific Hake off British Columbia in 2013.

APPENDIX 2. SUMMARY OF BOTTOM TRAWL SURVEYS IN 2013

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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 rates are useful indicators 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. 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. Nonetheless, ageing structures and tissue samples were collected from Rougheye/ Blackspotted Rockfish in 2013.

The 2013 survey included locations in Barkley Sound that were surveyed by the CCGS Neocaligus in previous years. Groundfish staff have typically not participated in surveys on board the Neocaligus due to limited bunk space but were able to participate this year as the survey was on the W.E. Ricker.

The groundfish section routinely places two staff on board for the duration of the survey. Due to staffing shortages, only one groundfish staffer was on board for the Queen Charlotte Sound portion of the survey. This resulted in marked decrease in the number of biological samples that were collected as compared to previous years. A total of four different groundfish staff and one volunteer participated in the Multi-species Small Mesh Bottom Trawl Survey in 2013.

The 2013 survey was conducted onboard the W.E. Ricker and ran from May 2 to 26. A total of 200 tows were completed. The total catch weight of all species was 70,702 kg. The mean catch per tow was 353 kg, averaging 21 different species of fish and invertebrates in each. The most abundant fish species encountered was and Eulachon (*Thaleichthys pacificus*) followed by Arrowtooth Flounder (*Reinhardtius stomias*) and Pink Shrimp (*Pandalus jordani*). The number of tows where the species was captured, total catch weight, estimated biomass, and relative survey error for the top 25 species are shown in Table 1 and Table 2 for the West Coast Vancouver Island and Queen Charlotte Sound portions of the survey, respectively. Biological data were collected from a total of 21,019 individual fish from 36 different groundfish species (Table 3).

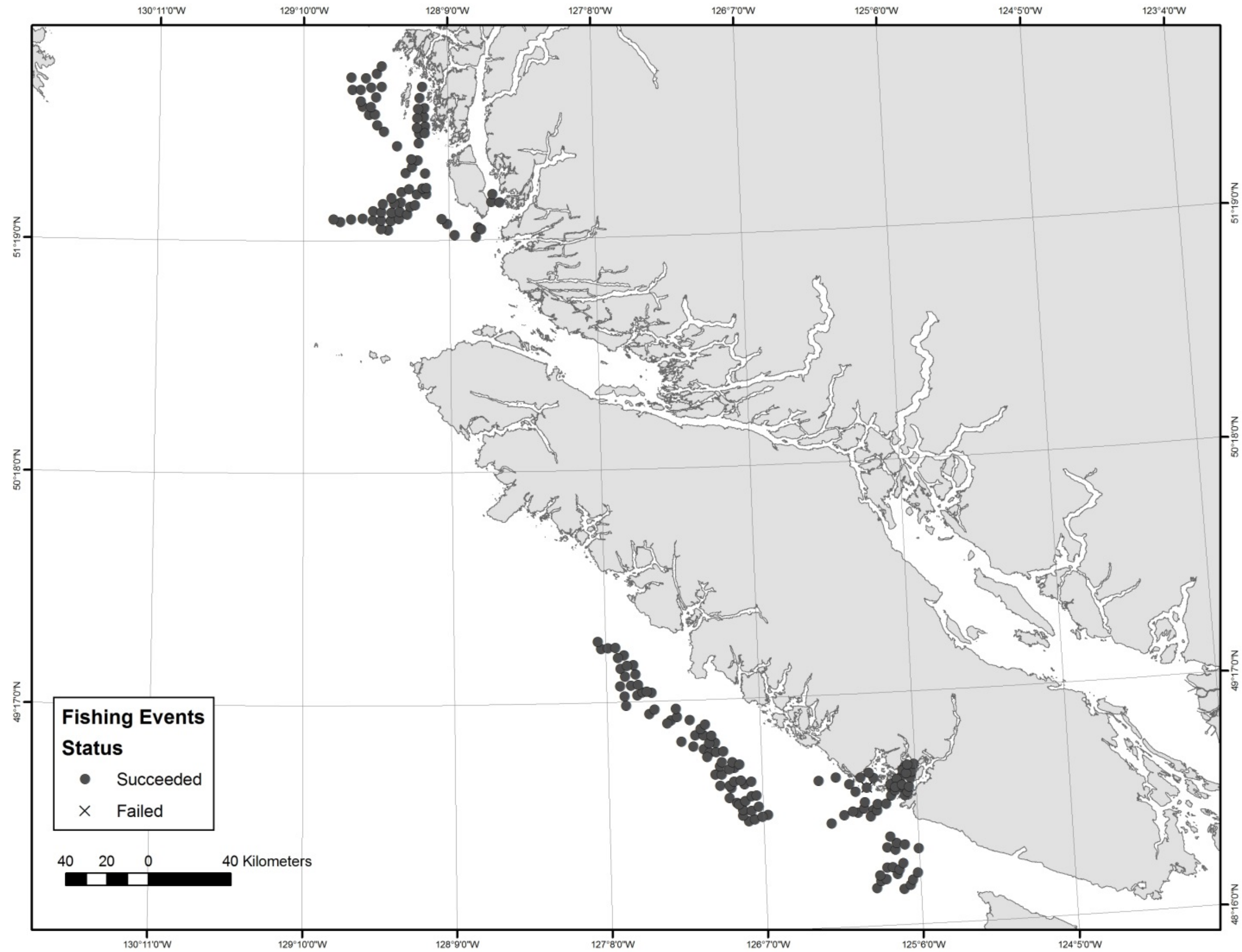

Figure 6. Barkley Sound, West Coast Vancouver Island and Eastern Queen Charlotte Sound set locations of the 2013 Multi-species Small Mesh Bottom Trawl Survey

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 2013 Multi-species Small Mesh Bottom Trawl Survey.

Species	Num. Tows	Catch (kg)	Biomass (t)	Rel. Error
Eulachon	61	4891	3355	0.13
Arrowtooth Flounder	71	3577	2314	0.14
Pacific Ocean Perch	10	1894	944	0.99
Pacific Cod	38	1250	804	0.49
North Pacific Spiny Dogfish	30	1174	1037	0.83
Rex Sole	71	822	594	0.08
Dover Sole	67	346	237	0.14
Flathead Sole	53	331	222	0.19
Slender Sole	71	220	150	0.09
Spotted Ratfish	55	132	89	0.13
Longnose Skate	36	122	87	0.2
Lingcod	28	113	88	0.19
Pacific Halibut	17	93	61	0.27
Redstripe Rockfish	6	91	55	0.7
Sablefish	21	90	49	0.36
Walleye Pollock	33	61	48	0.3
Greenstriped Rockfish	22	60	54	0.69
English Sole	20	44	30	0.3
Big Skate	1	44	23	1.02
Petrale Sole	27	40	29	0.18
Yellowtail Rockfish	16	38	22	0.25
Blackbelly Eelpout	49	32	19	0.18
Canary Rockfish	7	16	15	0.42
Sandpaper Skate	12	10	7	0.31
Pacific Herring	5	7	3	0.78

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 2013 Multi-species Small Mesh Bottom Trawl Survey.

Species	**Num. Tows**	**Catch (kg)**	**Biomass (t)**	**Rel. Error**
Arrowtooth Flounder	67	6310	3050	0.23
Eulachon	59	4274	1981	0.16
Flathead Sole	54	861	409	0.21
Dover Sole	61	592	280	0.18
Blackbelly Eelpout	51	475	205	0.24
North Pacific Spiny Dogfish	30	450	212	0.53
Spotted Ratfish	65	358	166	0.12
Rex Sole	64	280	127	0.17
Pacific Ocean Perch	34	230	112	0.49
Longnose Skate	32	193	93	0.27
Redbanded Rockfish	18	162	78	0.51
Slender Sole	54	161	75	0.2
Pacific Hake	9	148	79	0.6
Pacific Halibut	17	104	47	0.26
Yellowtail Rockfish	17	82	39	0.42
Big Skate	4	72	32	0.55
Walleye Pollock	26	63	26	0.31
Splitnose Rockfish	16	49	24	0.67
Silvergray Rockfish	8	34	16	0.51
Pacific Cod	10	33	14	0.39
Sablefish	20	30	13	0.32
Lingcod	7	29	14	0.43
English Sole	8	27	11	0.37
Petrale Sole	14	20	9	0.27
Sandpaper Skate	14	15	7	0.37

Table 3. Number of fish sampled for biological data during the 2013 Multi-species Small Mesh Bottom Trawl Survey showing the number of lengths anc age structures that were collected by species.

Species		**Lengths Collected**	**Age Structures Collected**
North Pacific Spiny Dogfish	*Squalus suckleyi*	255	0
Big Skate	*Raja binoculata*	22	0
Sandpaper Skate	*Bathyraja interrupta*	17	0
Longnose Skate	*Raja rhina*	255	0
Spotted Ratfish	*Hydrolagus colliei*	1059	0
American Shad	*Alosa sapidissima*	41	0
Eulachon	*Thaleichthys pacificus*	7388	0
Pacific Cod	*Gadus macrocephalus*	294	0
Pacific Hake	*Merluccius productus*	543	0
Pacific Tomcod	*Microgadus proximus*	58	0
Walleye Pollock	*Theragra chalcogramma*	1087	0
Blackbelly Eelpout	*Lycodes pacificus*	635	0
Rougheye Rockfish	*Sebastes aleutianus*	63	63
Pacific Ocean Perch	*Sebastes alutus*	168	0
Darkblotched Rockfish	*Sebastes crameri*	31	0
Splitnose Rockfish	*Sebastes diploproa*	76	0
Greenstriped Rockfish	*Sebastes elongatus*	132	0
Yellowtail Rockfish	*Sebastes flavidus*	48	0
Shortbelly Rockfish	*Sebastes jordani*	4	0
Redstripe Rockfish	*Sebastes proriger*	79	0
Pygmy Rockfish	*Sebastes wilsoni*	26	0
Sharpchin Rockfish	*Sebastes zacentrus*	51	0
Sablefish	*Anoplopoma fimbria*	107	0
Lingcod	*Ophiodon elongatus*	49	0
Blacktip Poacher	*Xeneretmus latifrons*	39	0
Pacific Sanddab	*Citharichthys sordidus*	228	0
Arrowtooth Flounder	*Reinhardtius stomias*	1771	0
Petrale Sole	*Eopsetta jordani*	245	0
Rex Sole	*Glyptocephalus zachirus*	1840	0
Flathead Sole	*Hippoglossoides elassodon*	1476	0
Pacific Halibut	*Hippoglossus stenolepis*	34	0
Southern Rock Sole	*Lepidopsetta bilineata*	81	0
Slender Sole	*Lyopsetta exilis*	1538	0
Dover Sole	*Microstomus pacificus*	662	0
English Sole	*Parophrys vetulus*	610	0
Sand Sole	*Psettichthys melanostictus*	7	0

1. 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 2013 the Hecate Strait and Queen Charlotte Sound surveys were conducted.

1.1. Hecate Strait Synoptic Bottom Trawl Survey

The Hecate Strait Multi-Species Synoptic Bottom Trawl Survey was conducted on the Canadian Coast Guard Ship W. E. Ricker between May 28 and June 23. We assessed a total of 195 blocks (Table 4). We conducted a total of 185 tows; 175 were successful survey sets and 10 were failures due to hang ups or insufficient bottom time. Note that some blocks are only successfully fished following more than one attempt.

A total of 12 different DFO staff and two volunteers participated in the survey.

The total catch weight of all species was 82,322 kg. The mean catch per tow was 450 kg, averaging 22 different species of fish and invertebrates in each. The most abundant fish species encountered were Arrowtooth Flounder (R*einhardtius stomias*), Spotted Ratfish (*Hyrolagus colliei*), English Sole (*Parophyrs vetulus*), Dover Sole (*Microstomus pacificus*) and Southern Rock Sole (*Lepidopsetta bilineata*). The number of tows where the species was captured, total catch weight, estimated biomass, and relative survey error for the top 25 species are shown in Table 5. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 30,672 individual fish of 68 different species (Table 6). Oceanographic data, including water temperature, depth, salinity, and dissolve oxygen were also recorded for most tows.

Table 4. 2013 Hecate Strait 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 - 70	0	7	0	74	0	83
70 - 130	0	7	1	42	0	50
130 - 220	0	3	0	43	0	46
220 - 500	0	0	0	16	1	16
Total	**0**	**17**	**3**	**175**	**2**	**195**

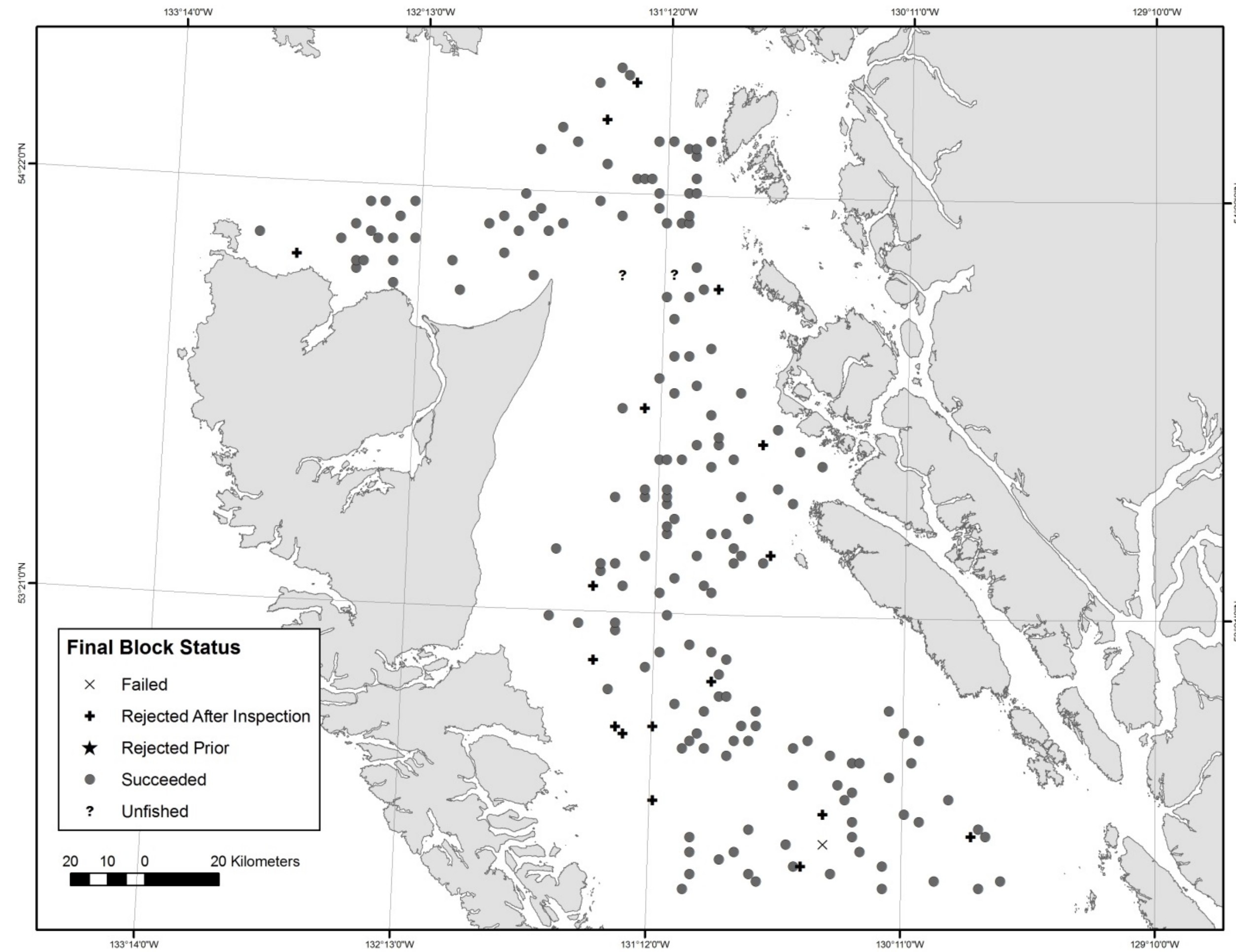

Figure 7. Final status of the allocated blocks for the 2013 Hecate Strait Multi-Species Synoptic Bottom Trawl Survey.

Table 5. Number of tows, catch weight, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the 2013 Hecate Strait Multi-Species Synoptic Bottom Trawl Survey.

Species	**Num. Tows**	**Catch (kg)**	**Biomass (t)**	**Rel. Error**
Arrowtooth Flounder	133	19336	14593	0.18
Spotted Ratfish	172	15507	16107	0.26
English Sole	113	8259	8402	0.19
Dover Sole	107	6199	4495	0.19
Southern Rock Sole	94	4049	4484	0.21
Rex Sole	116	3845	2709	0.16
Pacific Halibut	124	3577	3368	0.10
Pacific Cod	132	2624	2351	0.24
Walleye Pollock	101	2276	1853	0.24
North Pacific Spiny Dogfish	128	2089	1607	0.15
Pacific Ocean Perch	60	1251	792	0.32
Big Skate	38	1078	1167	0.21
Flathead Sole	61	856	568	0.30
Sand Sole	53	757	903	0.31
Silvergray Rockfish	47	592	356	0.22
Sablefish	58	566	529	0.30
Petrale Sole	79	547	429	0.17
Redstripe Rockfish	9	535	407	0.60
Quillback Rockfish	44	522	446	0.31
Yellowtail Rockfish	25	458	338	0.47
Pacific Sanddab	29	451	406	0.58
Shortspine Thornyhead	37	428	407	0.25
Redbanded Rockfish	42	400	319	0.19
Longnose Skate	37	326	259	0.19
Pacific Herring	65	315	350	0.20

Table 6. Number of fish sampled for biological data during the 2013 Hecate Strait Multi-Species Synoptic Bottom Trawl Survey showing the number of lengths and age structures that were collected by species.

Species		**Lengths Collected**	**Age Structures Collected**
North Pacific Spiny Dogfish	*Squalus suckleyi*	961	25
Aleutian Skate	*Bathyraja aleutica*	2	0
Big Skate	*Raja binoculata*	127	0
Sandpaper Skate	*Bathyraja interrupta*	16	0
Longnose Skate	*Raja rhina*	57	0
Spotted Ratfish	*Hydrolagus colliei*	3901	0
Pacific Herring	*Clupea pallasii*	889	0
Chinook Salmon	*Oncorhynchus tshawytscha*	2	0
Eulachon	*Thaleichthys pacificus*	802	0
Northern Smoothtongue	*Leuroglossus schmidti*	27	0
Pacific Cod	*Gadus macrocephalus*	1755	910
Pacific Tomcod	*Microgadus proximus*	439	0
Walleye Pollock	*Theragra chalcogramma*	1341	136
Black Eelpout	*Lycodes diapterus*	10	0
Blackbelly Eelpout	*Lycodes pacificus*	19	0
Northern Ronquil	*Ronquilus jordani*	3	0
Snake Prickleback	*Lumpenus sagitta*	23	0
Prowfish	*Zaprora silenus*	1	0
Pacific Sand Lance	*Ammodytes hexapterus*	592	0
Rougheye Rockfish	*Sebastes aleutianus*	44	44
Pacific Ocean Perch	*Sebastes alutus*	775	285
Redbanded Rockfish	*Sebastes babcocki*	272	217
Shortraker Rockfish	*Sebastes borealis*	1	1
Silvergray Rockfish	*Sebastes brevispinis*	335	79
Copper Rockfish	*Sebastes caurinus*	158	123
Darkblotched Rockfish	*Sebastes crameri*	5	0
Splitnose Rockfish	*Sebastes diploproa*	11	0
Greenstriped Rockfish	*Sebastes elongatus*	77	0
Puget Sound Rockfish	*Sebastes emphaeus*	34	34
Widow Rockfish	*Sebastes entomelas*	32	30
Yellowtail Rockfish	*Sebastes flavidus*	261	76
Quillback Rockfish	*Sebastes maliger*	397	272
Black Rockfish	*Sebastes melanops*	2	0
China Rockfish	*Sebastes nebulosus*	3	0
Tiger Rockfish	*Sebastes nigrocinctus*	1	0
Bocaccio	*Sebastes paucispinis*	3	3
Canary Rockfish	*Sebastes pinniger*	119	80
Redstripe Rockfish	*Sebastes proriger*	203	131
Yellowmouth Rockfish	*Sebastes reedi*	91	28
Yelloweye Rockfish	*Sebastes ruberrimus*	8	7
Harlequin Rockfish	*Sebastes variegatus*	2	0

Species		**Lengths Collected**	**Age Structures Collected**
Pygmy Rockfish	*Sebastes wilsoni*	8	0
Sharpchin Rockfish	*Sebastes zacentrus*	69	0
Shortspine Thornyhead	*Sebastolobus alascanus*	585	237
Sablefish	*Anoplopoma fimbria*	312	72
Kelp Greenling	*Hexagrammos decagrammus*	245	0
Lingcod	*Ophiodon elongatus*	52	0
Roughback Sculpin	*Chitonotus pugetensis*	23	0
Red Irish Lord	*Hemilepidotus hemilepidotus*	3	0
Bigmouth Sculpin	*Hemitripterus bolini*	4	0
Cabezon	*Scorpaenichthys marmoratus*	1	0
Sturgeon Poacher	*Podothecus accipenserinus*	39	0
Pacific Sanddab	*Citharichthys sordidus*	327	28
Speckled Sanddab	*Citharichthys stigmaeus*	4	0
Arrowtooth Flounder	*Reinhardtius stomias*	2800	835
Petrale Sole	*Eopsetta jordani*	538	371
Rex Sole	*Glyptocephalus zachirus*	2401	278
Flathead Sole	*Hippoglossoides elassodon*	808	170
Pacific Halibut	*Hippoglossus stenolepis*	649	0
Butter Sole	*Isopsetta isolepis*	665	75
Southern Rock Sole	*Lepidopsetta bilineata*	1939	802
Slender Sole	*Lyopsetta exilis*	202	0
Dover Sole	*Microstomus pacificus*	1712	708
English Sole	*Parophrys vetulus*	2421	815
Starry Flounder	*Platichthys stellatus*	67	25
Curlfin Sole	*Pleuronichthys decurrens*	192	47
Sand Sole	*Psettichthys melanostictus*	772	142
Schoolmaster Gonate Squid	*Berryteuthis magister*	33	0

1.2. Queen Charlotte Sound Multi-species Synoptic Bottom Trawl Survey

The Queen Charlotte Sound Multi-Species Synoptic Bottom Trawl Survey was conducted on the F/V Nordic Pearl between July 2 and 28. We conducted a total of 281 tows; 241 were successful and 40 were failures due to hang ups or insufficient bottom time. We assessed a total of 287 blocks (Table 7). Note that some blocks are only successfully fished following more than one attempt.

A total of three different DFO staff and four contractor science staff from Archipelago Marine Research participated in the survey.

The total catch weight of all species was 104,805 kg. The mean catch per tow was 387 kg, averaging 21 different species of fish and invertebrates in each. The most abundant fish species encountered were Silvergray Rockfish (*Sebastes brevispinis*), Arrowtooth Flounder (*Reinhardtius stomias*), Pacific Ocean Perch (*Sebastes alutus*), Redstripe Rockfish (*Sebastes proriger*), and Yellowtail Rockfish (*Sebastes flavidus*). The number of tows where the species was captured, total catch weight, estimated biomass, and relative survey error for the top 25 species are shown in Table 8. Biological data, including individual length, weight, sex, maturity, and age structure were collected from a total of 29,266 individual fish of 71 different species (Table 9). Oceanographic data, including water temperature, depth, salinity, and dissolve oxygen were also recorded for most tows.

Table 7. 2013 Queen Charlotte Sound 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.

Stratum	Rejected Prior	Rejected Inspected	Failed	Success	Not Fished	Total
1: South 50 to 125 m	0	4	4	32	0	40
2: South 125 to 200 m	0	2	5	66	0	73
3: South 200 to 330 m	0	4	2	29	0	35
4: South 330 to 500 m	0	0	0	10	0	10
5: North 50 to 125 m	0	3	0	9	0	12
6: North 125 to 200 m	0	8	7	46	0	61
7: North 200 to 330 m	0	2	2	44	0	48
8: North 330 to 500 m	0	1	2	5	0	8
Total	**0**	**24**	**22**	**241**	**0**	**287**

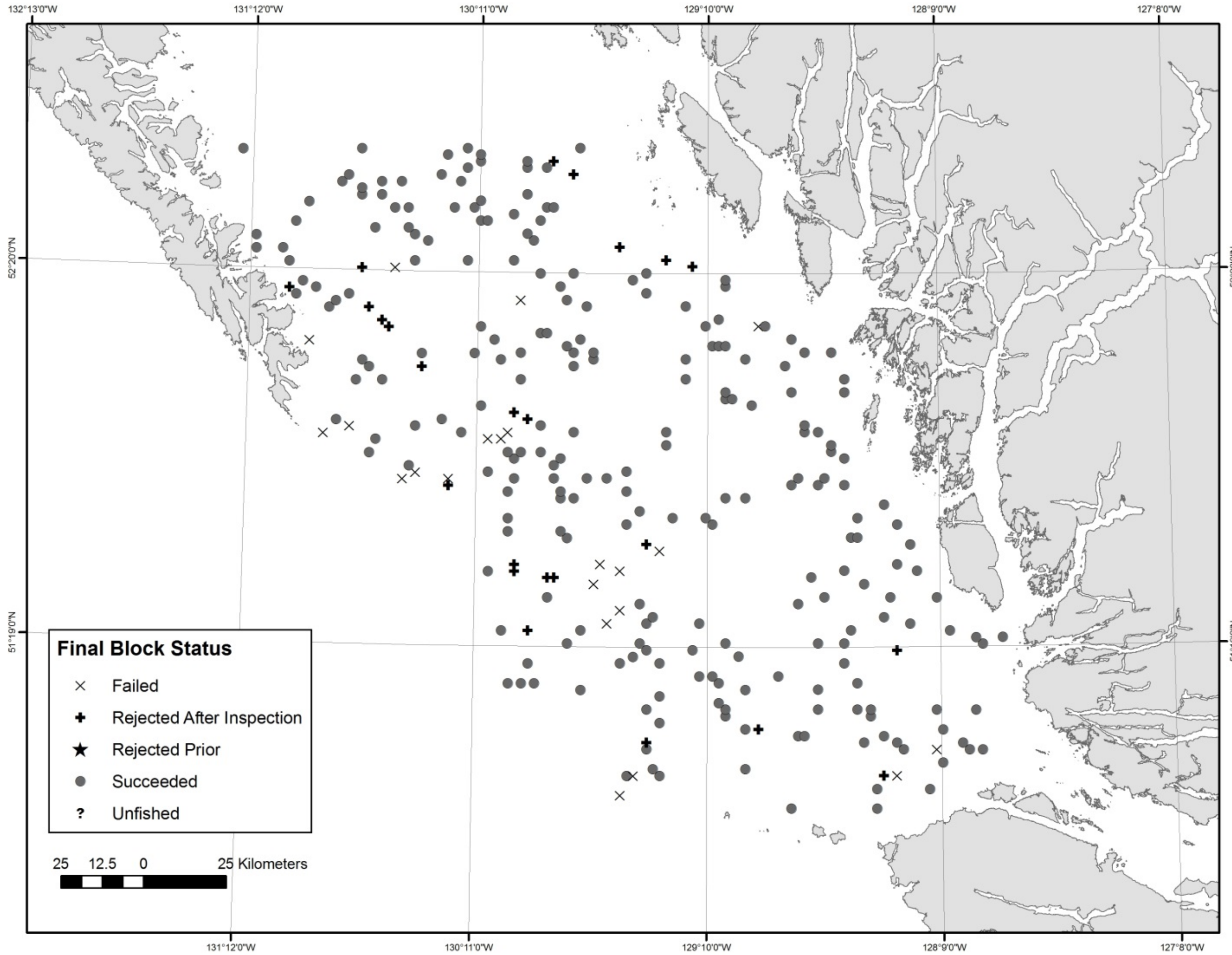

Figure 8. Final status of the allocated blocks for the 2013 Queen Charlotte Sound Multi-Species Synoptic Bottom Trawl Survey.

Table 8. Number of tows, catch weight, estimated biomass, and relative survey error for the top 25 species (by weight) captured in the 2013 Queen Charlotte Sound Multi-Species Synoptic Bottom Trawl Survey.

Species	**Num. Tows**	**Catch (kg)**	**Biomass (t)**	**Rel. Error**
Silvergray Rockfish	147	21377	14793	0.40
Arrowtooth Flounder	223	15071	11676	0.17
Pacific Ocean Perch	141	14846	11462	0.18
Redstripe Rockfish	61	3627	2958	0.37
North Pacific Spiny Dogfish	142	3388	5955	0.53
Rex Sole	211	2917	2288	0.12
Sharpchin Rockfish	101	2619	1751	0.31
Spotted Ratfish	201	2532	2616	0.35
Yellowtail Rockfish	38	2494	1695	0.51
Canary Rockfish	54	2451	2184	0.35
Dover Sole	166	2376	1823	0.11
Yellowmouth Rockfish	72	2036	1502	0.31
Walleye Pollock	110	1930	1687	0.26
Shortspine Thornyhead	90	1655	1400	0.14
Redbanded Rockfish	113	1395	950	0.14
Pacific Halibut	76	1289	1546	0.26
English Sole	70	1243	1376	0.29
Pacific Cod	135	1233	965	0.15
Splitnose Rockfish	47	1163	809	0.68
Pacific Hake	59	1120	805	0.30
Flathead Sole	94	1070	929	0.32
Rougheye Rockfish	59	1066	593	0.29
Sablefish	91	771	637	0.23
Southern Rock Sole	33	537	812	0.32
Petrale Sole	104	531	428	0.24

Table 9. Number of fish sampled for biological data during the 2013 Queen Charlotte Sound Multi-Species Synoptic Bottom Trawl Survey showing the number of lengths and age structures that were collected by species.

Species		**Lengths Collected**	**Age Structures Collected**
Brown Cat Shark	*Apristurus brunneus*	1	0
North Pacific Spiny Dogfish	*Squalus suckleyi*	345	44
Aleutian Skate	*Bathyraja aleutica*	3	0
Big Skate	*Raja binoculata*	7	0
Sandpaper Skate	*Bathyraja interrupta*	35	0
Longnose Skate	*Raja rhina*	117	0
Alaska Skate	*Bathyraja parmifera*	7	0
Spotted Ratfish	*Hydrolagus colliei*	2015	0
Pacific Herring	*Clupea pallasii*	16	0
Pink Salmon	*Oncorhynchus gorbuscha*	3	0
Chum Salmon	*Oncorhynchus keta*	1	0
Sockeye Salmon	*Oncorhynchus nerka*	1	0
Chinook Salmon	*Oncorhynchus tshawytscha*	1	0
Eulachon	*Thaleichthys pacificus*	582	0
Pacific Cod	*Gadus macrocephalus*	1040	616
Pacific Hake	*Merluccius productus*	177	100
Walleye Pollock	*Theragra chalcogramma*	882	256
Bigfin Eelpout	*Lycodes cortezianus*	11	0
Shortfin Eelpout	*Lycodes brevipes*	12	0
Black Eelpout	*Lycodes diapterus*	57	0
Blackbelly Eelpout	*Lycodes pacificus*	284	0
Wolf Eel	*Anarrhichthys ocellatus*	1	0
Rougheye Rockfish	*Sebastes aleutianus*	334	335
Pacific Ocean Perch	*Sebastes alutus*	2202	1725
Aurora Rockfish	*Sebastes aurora*	8	0
Redbanded Rockfish	*Sebastes babcocki*	902	662
Shortraker Rockfish	*Sebastes borealis*	17	17
Silvergray Rockfish	*Sebastes brevispinis*	1415	786
Copper Rockfish	*Sebastes caurinus*	2	0
Darkblotched Rockfish	*Sebastes crameri*	55	0
Splitnose Rockfish	*Sebastes diploproa*	307	134
Greenstriped Rockfish	*Sebastes elongatus*	627	93
Puget Sound Rockfish	*Sebastes emphaeus*	63	23
Widow Rockfish	*Sebastes entomelas*	55	21
Yellowtail Rockfish	*Sebastes flavidus*	210	134
Chilipepper	*Sebastes goodei*	3	0
Rosethorn Rockfish	*Sebastes helvomaculatus*	291	60
Shortbelly Rockfish	*Sebastes jordani*	3	0
Quillback Rockfish	*Sebastes maliger*	103	52
Vermilion Rockfish	*Sebastes miniatus*	4	0

Species		**Lengths Collected**	**Age Structures Collected**
China Rockfish	*Sebastes nebulosus*	5	0
Bocaccio	*Sebastes paucispinis*	34	34
Canary Rockfish	*Sebastes pinniger*	481	368
Redstripe Rockfish	*Sebastes proriger*	893	593
Yellowmouth Rockfish	*Sebastes reedi*	686	439
Yelloweye Rockfish	*Sebastes ruberrimus*	79	78
Stripetail Rockfish	*Sebastes saxicola*	1	0
Harlequin Rockfish	*Sebastes variegatus*	88	34
Pygmy Rockfish	*Sebastes wilsoni*	95	0
Sharpchin Rockfish	*Sebastes zacentrus*	1078	255
Shortspine Thornyhead	*Sebastolobus alascanus*	1696	908
Longspine Thornyhead	*Sebastolobus altivelis*	94	79
Sablefish	*Anoplopoma fimbria*	379	28
Kelp Greenling	*Hexagrammos decagrammus*	18	0
Lingcod	*Ophiodon elongatus*	141	70
Bigmouth Sculpin	*Hemitripterus bolini*	1	0
Threadfin Sculpin	*Icelinus filamentosus*	18	0
Sturgeon Poacher	*Podothecus accipenserinus*	13	0
Pacific Sanddab	*Citharichthys sordidus*	231	100
Arrowtooth Flounder	*Reinhardtius stomias*	3371	1433
Deepsea Sole	*Microstomus bathybius*	1	0
Petrale Sole	*Eopsetta jordani*	490	215
Rex Sole	*Glyptocephalus zachirus*	2247	921
Flathead Sole	*Hippoglossoides elassodon*	1201	256
Pacific Halibut	*Hippoglossus stenolepis*	233	0
Butter Sole	*Isopsetta isolepis*	1	0
Southern Rock Sole	*Lepidopsetta bilineata*	369	173
Slender Sole	*Lyopsetta exilis*	673	0
Dover Sole	*Microstomus pacificus*	1570	964
English Sole	*Parophrys vetulus*	825	659
Curlfin Sole	*Pleuronichthys decurrens*	55	0

APPENDIX 3. PARTIAL LIST OF GROUNDFISH RELATED REPORTS WITH 2013 PUBLICATION DATES.

PRIMARY

Forrest, R.E., McAllister, M.K., Martell, S.J.D., Walters, C.J. 2013. Modelling the effects of density-dependent mortality in juvenile red snapper caught as bycatch in Gulf of Mexico shrimp fisheries: implications for management. *Fisheries Research* 146: 102-120.

Mangel, M., MacCall, A.D., Brodziak, J., Dick, E.J., Forrest, R.E., Pourzand, R., and Ralston, S. 2013. A perspective on steepness and its implications for strategic fishery management and stock assessment. *Canadian Journal of Fisheries and Aquatic Sciences* 70, pg. 930-940.

Okamura, H., M. K. McAllister, M. Ichinokawa, L. Yamanaka, and K. Holt. Evaluation of the sensitivity of biological reference points to the spatio-temporal distribution of fishing effort when seasonal migrations are sex-specific. Fisheries Research (2013), http://dx.doi.org/10.1016/j.fishres.2013.10.022

Siegle, M.R., Taylor E.B., Miller K.M., Withler R.E., Yamanaka K.L. (2013) Subtle Population Genetic structure in Yelloweye Rockfish (Sebastes ruberrimus) is consistent with a major oceanographic division in British Columbia, Canada. PLoS ONE 8(8): e71083.

OTHER PUBLICATIONS

DFO (2013). Pacific Ocean Perch (*Sebastes alutus*) stock assessments for the west coast of Vancouver Island and the north and west coasts of Haida Gwaii, British Columbia. *DFO Canadian Science Advisory Secretariat, Scientific Advisory Report* **2013/038** 10p.

Edwards, A.M., Haigh, R., and Starr, P.J. 2014. Pacific Ocean Perch (*Sebastes alutus*) stock assessment for the north and west coasts of Haida Gwaii, British Columbia. *Canadian Science Advisory Secretariat, Research Document* **2013/092**: vi + 126 p.

Edwards, A.M., Haigh, R., and Starr, P.J. 2014. Pacific Ocean Perch (*Sebastes alutus*) stock assessment for the west coast of Vancouver Island, British Columbia *Canadian Science Advisory Secretariat, Research Document* **2013/093**: vi + 135 p.

Forrest, R.E., Rutherford, K.L, Lacko, L., Kronlund, A.R., Starr, P.J., McClelland, E.K. In press. Assessment of Pacific Cod (*Gadus macrocephalus*) for Hecate Strait (5CD) and Queen Charlotte Sound (5AB) in 2013. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/xxx.

King, J.R., Surry, A.M., Wyeth, M.R., Olsen, N., and Workman, G. 2013. Strait of Georgia groundfish bottom trawl survey, March 14 – 24, 2012. Can. Tech. Rep. Fish. Aquat. Sci. 3056: vii + 58 p.

JTC. 2013. Status of the Pacific hake (Whiting) stock in U.S. and Canadian Waters in 2013. Prepared for the Joint U.S.-Canada Pacific hake treaty process.

Methot, R., Workman, G., Prager, M., Forrest, R.E., Sampson, D. 2013. Joint U.S.-Canada Scientific Review Group Report. February 19-22, 2013, Vancouver, BC. Online: http://www.nwr.noaa.gov/publications/fishery_management/groundfish/whiting/draft_2013_srg_report-final.pdf

Stewart, I.J., Martell, S.J.D., Webster, R.A., Forrest, R.E., Ianelli, J., Leaman, B. 2013. Assessment review team meeting, October 24-26, 2012. International Pacific Halibut Commission Report of Assessment and Research Activities, 2012, 239-266.

APPENDIX 3. GROUNDFISH STAFF IN 2013

Greg Workman	Section Head
Schon Acheson	Technician, Pacific Hake, port sampling and surveys
Kristina Anderson	Technician, Sablefish and surveys (maternity leave until Jan 2015)
Karina Cooke	Technician, Database support and surveys, Inshore Rockfish
Andrew Edwards	Scientist, 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 (retired April 2014)
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. (retired August 2013)
Maria Surry	Technician, Elasmobranchs
Nathan Taylor	Program Head, Groundfish surveys, Shelf Rockfish, Pacific Hake stock assessment (Acting Section Head Pelagics since June 2013)
Malcolm Wyeth	Biologist, Groundfish surveys
Lynne Yamanaka	Program Head, Inshore rockfish research and stock assessment

2014 IPHC Research Report for TSC

Review of 2013 Projects and Proposals for 2014

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 2013, and the third section presents the preliminary staff research proposals for 2014 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 2013 the IPHC hired Sierra Summers (Administrative Assistant) and Chris Johnston (Age Technician). These are in addition to some standard turnover seen in both the port and sea sampling seasonal positions.

SECTION II:

Review of 2013- Project Summaries

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

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

<u>Assessment and stock identification</u>

Project 604.00: Monitoring juvenile halibut abundance via NMFS trawl surveys

Start Date: 1996
Priority: High

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 were deployed in the Bering Sea and Gulf of Alaska surveys.

Project 650.13: Archival tags: mounting protocols (OCA)

Priority: Medium

Start Date: 2009

Anticipated ending: 2014

Personnel: T. Loher

For 2013, the staff continued 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 have been given for all tags recovered. Thirty-nine fish were recovered as of Dec. 2013. Because of a subsequent decision to focus only on an external mount protocol, this project was redone in Area 3A in 2013 (as Project 2013-04 with an anticipated ending in 2015). The project was redone to fully evaluate external attachment as the results are needed to evaluate three potential tag attachment sites on the fish. The release was designed to occur from the surveys to reduce costs while still achieving a broad distribution of releases. During the 2013 survey, a total of 900 halibut were tagged using one of four different attachment methods. As of December 2013, twelve fish were recovered.

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 occurred in 2013, Lotek is continuing their work on our requirements and construction. Results from the 2009 and 2013 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 for 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 (to date 38 tags have been recovered which equates to a 5% recovery rate). 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 was 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. One tag was recovered (3% recovery rate) as of December 2013. 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.

Project 2013-03: Estimate of length/weight relationship and head/ice/slime adjustment (NEW) – Pilot Project

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 was collected in most sampled ports coastwide for part of the season. The goal is to collect data coastwide in sampled ports throughout the commercial 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 were tasked with collecting data at plants within their ports. 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 2013-06: SSA Expansion – California pilot (NEW)

Priority: Medium

Start: 2013

Anticipated Ending: currently planned for 2013 only

Personnel: C. Dykstra, survey team

The IPHC staff extended the assessment survey into the waters off northern California for the first time in 2013. In the past, the survey stopped at the Oregon/California border, which was traditionally the southern end of commercial fishing in past 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, indicated the potential for a larger share of the resource in this area than was assumed. Adding this area into the assessment required a measure of fish density, which was 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 survey expansion extended 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.

Biology

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 continued on determining if oocyte diameter is homogeneous within a single gonad.

Project 2012-01: Otolith increment analysis (New)

Priority: High

Start Date: 2013

Anticipated ending: 2015

Personnel: T. Loher, S. Wischniowski

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. Work in 2013 included 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.

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)

Our collaboration with the Alaska Department of Environmental Conservation (ADEC) continued in 2013, collecting halibut tissue samples 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 1,293 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.

Project 661.11: *Ichthyophonus* prevalence in halibut

Priority: Medium

Start Date: 2012

Anticipated ending: ongoing

Personnel: C. Dykstra, G. Williams, J. Gregg (USGS), P. Hershberger (USGS)

Ichthyophonus is a protozoan parasite from the class Mesomycetozoea, a highly diverse group of organisms having characteristics of both animals and fungi. It has been identified in many marine fish, and is considered a causative agent in herring fishery collapses world-wide and there is concern over its effects on the success of salmon spawning on major rivers such as the Yukon.

In 2011 the IPHC ran a small pilot project looking at *Ichthyophonus* prevalence in Pacific halibut in response to some initial test results from a 2010 USGS study which found high incidence rates in sport caught halibut in Cook Inlet, AK. The 2011 pilot took place in three geographically disparate areas (Oregon, Prince William Sound proper, and the northern Bering Sea). Results from this study found some of the highest incidence rates for any marine species in the Prince William Sound region (76.7% incidence), with lower, but still significant levels in Oregon (33.8%) and the northern Bering Sea (26.6%). USGS defines the Prince William Sound result as an epizootic event as the incidence rate is much higher than background rates seen in other halibut studies.

In 2012, sampling was expanded to collect tissue samples 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 (<50 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. For this reason, the IPHC staff and USGS researchers believe that future work should examine the effect of infection intensity on infection progression, tissue preferences (tropism), growth and survival. This type of work would be conducted on fish held in a controlled environment at the USGS lab at Marrowstone, WA. Field work in 2013 was limited to repeating collection of samples at the three sites initially surveyed in 2011 (and repeated in 2012) – Area 4D, Prince William Sound, and Oregon, with the objective of further describing the interannual variability of prevalence and infection over a broad spatial scale.

Other

Project 618.00: Undergraduate Internship

Start Date: 2002

Anticipated duration: Continuing

Personnel: L. Sadorus, other staff support as needed

The IPHC’s 2013 summer intern, Hesper Kohler, worked on a pilot study to determine if a data collection request by NMFS was feasible during the IPHC setline survey. Specifically, NMFS was interested in biological information from longnose and big skates. During the pilot, 110 skates were sampled in IPHC Regulatory Area 3A. Skates were brought on board, stunned, and sampled for total length, sex, and a maturity rating. In addition, a section of the vertebral column was removed from each sampled skate for aging. The pilot study included experimentation with the best means of sampling the skates and storing the vertebral samples. Sampling the skates on the halibut measuring cradle made sampling easiest and most efficient, decreasing sampling time to less than two minutes. Freezing was the preferred method of storing bertebra samples over icing or salting. By the end of the study, it was determined that skate age and maturity sampling could be added to the Commission's summer survey in most cases, without hindering the halibut sampling. However, the project should not be added to areas with five or more other special projects in order to maintain the integrity of data collection for each project and the halibut survey.

Remote Data Entry Development

In 2013, the IPHC worked on developing software applications for data entry of commercial and survey data into tablets with the intent of replacing the pencil and paper method currently used in both programs. IPHC's programmers created and are still developing two applications: eLogs and eSurvey.

The eLogs application was finalized for testing in the field and tablets were deployed with port samplers in Alaskan ports at the start of the commercial halibut season (March 2013). Port samplers are using Panasonic Toughpads on which the eLog application was installed. The intent is for samplers to enter fishing log data directly into the eLog application during skipper interviews. Testing is ongoing with an anticipated completion date of May or June 2014.

The eSurvey application was also developed to replace the paper data forms that are currently used on the survey. The eSurvey application is still in the development phase with the expectation that it will be ready for in-field testing during the 2014 IPHC survey season.

SECTION III:

Ongoing and Proposed for 2014

Research proposed by IPHC staff goes through an internal review process by a staff Science Board. This year, the Board met in early October to review staff proposals for 2014 research. For each proposal, the Board discussed the merits, objectives, design, and coherence with the Commission's research goals and objectives. The Principal 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.

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, with the resulting effects and impacts on the 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. Research into both areas is of high priority for the Commission and staff. In the following section, studies for 2014 will be presented which address both topics. Briefly, the IPHC staff recommends continuing the otolith increment study which was started in 2013, which would examine growth patterns during earlier time periods (project 664.11). 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 (projects 650.xx).

Based on the Science Board discussions and the topics previously outlined, the following sections describe the upcoming work by IPHC staff and also provide descriptions of recommended research studies for funding in FY2014.

OBJECTIVE 1: STOCK IDENTIFICATION, MONITORING AND ASSESSMENT

Research in this area focuses on stock identification, monitoring, assessment, forecasting, and incorporation of uncertainty in both data and processes into management advice. The staff seeks to understand the underlying Pacific halibut stock structure and the influence of age, size, and sex on movement as they relate to stock components. Additionally, monitoring occurs through the IPHC Port Sampling program (fishery removals), standardized setline stock assessment survey (fishery-independent stock indices), and trawl surveys (pre-recruits).

The most significant work is the annual stock assessment, which produces estimates of abundance based on a comprehensive suite of fishery-dependent and -independent variables. The assessment also forecasts short-term trends in the stock to support the IPHC decision-making process. Assessment staff also works at determining and reducing the level of uncertainty associated with stock assessments through advanced analytical techniques. Where needed, improved data collection or other studies are recommended.

For 2014, in addition to the annual assessment, the staff is proposing a field study to more fully characterize the selectivity of large halibut by examining hooking success for fish > 40 pounds. Additional detail is provided below.

Funded research - Proposed

Project 2014-02: Estimating hooking success for large halibut

Priority: Medium

Start: 2014

Anticipated Ending: 2014

Personnel: S. Kaimmer, I. Stewart

The study will observe hook attacks by halibut in the 110 to 150+ cm, i.e., 40-60 lb., range to estimate hooking success. Previous studies examining hooking success (2006 and 2007) estimated an increasing relationship between hooking success and fish size, but did not have enough observations on large fish (>100 cm; 20 lb.) to estimate whether this relationship might be dome shaped. Although the limited information available suggests an asymptotic curve, this is an important relationship for stock assessment modelling. Observing 50 attacks from halibut in the 110 to 150+ cm size range is expected to provide sufficient data to estimate the form of the relationship between hooking success and fish length for these larger fish. The study requires a suitable location from which captures of large halibut can be assured. IPHC stock assessment staff have placed a high priority on obtaining a more precise estimate of this relationship.

OBJECTIVE 2: HARVEST POLICY AND MANAGEMENT

Work to support this objective involves annual evaluations of IPHC's harvest policy with regard to the current stock dynamics and management goals. The staff develops stock projection procedures which incorporate a realistic range of alternative hypotheses about stock behavior, environmental influences, and fishing effects on stock abundance and halibut characteristics. The staff also provides harvest management advice to the Commission and user groups in a form which allows the consideration of uncertainty in the assessment and forecasting processes.

In 2013 the Commission approved the formation of a Management Strategy Advisory Board (MSAB) to oversee the Management Strategy Evaluation (MSE) process and to advise the Commission and Staff on the development and evaluation of candidate objectives and strategies for managing the fishery. The MSE process will help the Commission develop and thoroughly test alternative management procedures, prior to actually implementing any management changes for the fishery. A web site has been set up for all MSAB information and activities (http://www.iphc.info/msab).

The staff is not proposing any additional research for 2014 requiring separate funding. All work will be done within current staff work assignments.

OBJECTIVE 3: BIOLOGY, PHYSIOLOGY AND MIGRATION

Staff research within this objective seeks to collect and monitor primary biological characteristics of all sizes of halibut throughout the species' range. This includes directed studies but also involves incorporating studies monitoring the size at age of halibut within ongoing data programs wherever possible. IPHC also collaborates with other institutions and agencies to obtain biological and ecosystem information on halibut not otherwise available through IPHC programs and to incorporate that information into understanding and prediction of halibut population dynamics. Specific migration research objectives focus on the impacts of ontogenetic and seasonal movements on long-term yield, spatial distribution of spawning biomass, impact of fishing seasons on interceptions, and temporal variations in fish movement.
Research specific to halibut migration and movement was requested by the Commission in 2001 (Leaman et al., 2002). Dr. T. Loher of the IPHC staff has designed a tag study to provide information on seasonal migration of halibut that can provide input for discussing appropriate fishing seasons with four objectives. These objectives will be accomplished by quantifying, for the eastern Pacific halibut population, on regional bases:

1) the active spawning season for Pacific halibut, defined as the period over which eggs are released into the water column;

2) depth-specific spawning habitat, defined as the range of bottom depths over which halibut initiate active spawning behavior;

3) the fall and spring migratory periods, including estimates of the proportion of stock in a state of seasonal migration by date; and

4) where possible, timing of seasonal movement among regulatory areas, and the proportion of the spawning stock likely to be located out-of-area, by date.

Since 2009, the IPHC staff has been actively engaged in studies explicitly designed to establish protocols for the proposed work. This includes selection of appropriate tag type, tagging attachment and location protocols on the fish, and reliable, cost-effective tag technology. The ongoing studies outlined below support this work.

Also, in 2013 the IPHC embarked on an extensive set of studies to examine the recent decline in halibut size at age. The work encompasses several focused pieces of research, including those being conducted by IPHC staff and others in a collaborative study with the National Marine Fisheries Service (NMFS), the University of Washington (UW), and the Alaska Department of Fish and Game (ADF&G). Work will continue in 2014 as the decadal samples are identified and extracted from the archives, and aging/measuring of the growth increments begins.

The staff is also proposing a study of halibut movements within the southern Salish Sea (Puget Sound) in response to recent proposed hypotheses about the nature of the population in that region. There has been a suggestion that the fish in this region are isolated and may require unique management. A demonstration of the movement of halibut from inside and outside waters will address the hypotheses.

Funded Research - ongoing

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 2014, work will continue on determining the maximum precision for oocyte diameter measurements by oocyte maturation stage, 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: High

Start Date: 2009

Anticipated ending: 2014

Personnel: T. Loher

For 2014, 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. A subsequent decision to focus on an external tag led to an additional release of externally-tagged fish in 2013 (project 650.18).

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: High

Start Date: 2011

Anticipated ending: on hold until sufficient tags are developed/produced

Personnel: T. Loher, J. Nielsen (UAF Juneau)

Project 650.18: Archival tags: tag attachment protocols

Priority: High

Start Date: 2013

Anticipated ending: 2015

Personnel: T. Loher, J. Nielsen (UAF Juneau)

This study has the objective of refining an appropriate external tag protocol for the geomagnetic tagging. Recovery rates of archival tags affixed to halibut using four different external mounting protocols (three dart-and-tether configurations; wired to the operculum) are being tested in a field release of "dummy" archival tags. During the summer of 2013, 900 fish were tagged off northern Kodiak Island (Area 3A), with an equal number of fish tagged with each tag attachment type. Fish carrying a dart-and-tether tag were also tagged with a bright pink cheek tag, and rewards of either $200 or $100, depending on tag configuration, will be given for all tags recovered.

Project 664.11: Otolith increment study

Priority: High

Start Date: 2013

Anticipated ending: 2014

Personnel: B. Leaman, T. Loher, Ian Stewart, S. Martell, J. Forsberg

This research focuses on the decrease in size at age, and the desire to examine similar metrics in previous time periods of the halibut stock. The project is part of a broad-based study of changing size at age in halibut, involving food web and ecosystem drivers, bioenergetics, fisher effects, and analytic modeling. The study, in collaboration with NMFS, UW, and ADF&G, is partially funded by NPRB. Primary work by IPHC staff will include the use of the otolith archives to examine growth patterns and size at age in earlier time periods. Thus far, the IPHC staff has been examining the IPHC historical otolith collection for samples available for specific decadal time periods and ages. In addition, several otolith collections from more recent samples have been re-aged using the now-standard bake and burn (B&B) aging technique. The re-aging allows us to estimate the bias in the surface age readings. We intend to extend this study by looking at samples by decade, back to the 1920s. Stomach and relative abundance samples for halibut and co-occurring groundfish species were also collected for the larger project during the 2013 NMFS Gulf of Alaska survey.

Project 665.11: Estimate of length/weight relationship and head/ice/slime adjustment

Priority: High

Start: 2013

Anticipated Ending: open ended

Personnel: R. Webster, L. Erikson, K. MacTavish, H. Gilroy

The purpose of this study is to reexamine the relationship between fork length and net weight, including the estimation of adjustments necessary to convert head-on weight to net weight. The current length-net weight relationship was estimated in 1926. Using 1989 data, Clark (1992) re-estimated the relationship's parameters and found good agreement with the earlier curve. However, when Courcelles (2012) estimated the relationship data collected in 2011, she found significant differences between her estimated curve and that derived from the 1989 data, although inference was limited to a relatively small part of Area 3A and to the time of the setline survey. IPHC staff has always known that the relationship varies seasonally and likely regionally. If the relationship varies among regulatory areas, there may be systematic bias in regulatory area estimates of weight or WPUE derived from length measurements. Seasonal variation could affect weight estimates that are made from data collected during only a small part of the year. Therefore, we are collecting data coastwide throughout the season in order to estimate spatial and seasonal variation in the length to weight relationship. Data will be collected in 2014 from ports staffed with IPHC samplers throughout the fishing season. The goal is to determine whether seasonal or area-specific L-W relationships are warranted, or whether the effect of any variation can be incorporated via variation about the existing relationship.

The current relationship used by IPHC between fork length and net weight also includes adjustments for the weight of the head, and of ice and slime: gross landed weight (gutted, with head, ice and slime) 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. However, the industry standard for head, ice and slime deduction is a total of 12%. Therefore as a secondary goal, we also plan to collect data to provide direct estimates of adjustment factors to compare with the currently assumed values, and to assess variability in the weight of heads and ice and slime. To achieve this, we plan to record multiple weights on at least a subsample of fish.

In 2013, a pilot phase of the project was implemented that tested the equipment and methods at a selection of ports (Bellingham, Port Hardy, Prince Rupert, Petersburg, Sitka, Juneau, and Homer). The need to carefully test potential scales prior to full implementation, and the fact that the scales we used were far more expensive than those considered within the 2013 project budget, meant that the scope of the project in 2013 was more limited than initially proposed. In 2014, the project will be expanded to all ports with samplers. Sampling rates will be re-calculated based on the 2013 length distribution of market samples.

Funded Research - proposed

Project 2014-01: Archival tags: Salish Sea PAT tags

Priority: Low

Start: 2014

Anticipated Ending: 2015 (or 2016)

Personnel: T. Loher

This study is a test of several hypotheses regarding halibut movements within Area 2A. Specifically, that halibut found in the southern Salish Sea, i.e., Puget Sound, are an isolated stock component requiring management independent of the larger outer coast population. In this proposal, 14 halibut would be marked with PAT tags at four setline survey locations during the summer of 2014, either from a dedicated chartered vessel or in collaboration with tribal fishers. The tags would be programmed to pop up the following January. The study proposes to use refurbished PAT tags currently on hand with IPHC for deployment. An additional 12 would be deployed in the summer of 2015, unless inter-area migration is detected from the 2014 releases.

OBJECTIVE 4: ECOSYSTEM INTERACTIONS AND ENVIRONMENTAL INFLUENCES

Research on this objective seeks to advance the understanding of the ecological context for halibut, including predation and competition, as well as fishing and environmental effects on recruitment and distribution. This also includes understanding the relationship between environmental influences and halibut distribution and behavior. This is primarily accomplished with broad-scale monitoring programs, some of which can occur on IPHC research platforms. Additionally, IPHC seeks to share its environmental data set with other researchers and institutions. Collaborative research is sought out whenever possible.

IPHC is actively involved in a large-scale monitoring program from the setline assessment survey using water column profilers. The program is making environmental data available to other researchers through a public access portal with the Pacific Marine Environmental Laboratory (PMEL). Other monitoring is occurring from the survey platform, including an appraisal of contaminants in halibut and the prevalence of *Ichthyophonus*. These three programs are proposed to continue in 2014, and are discussed below.

Funded research - ongoing

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: Low

Start Date: 2002

Anticipated ending: Continuing

Personnel: C. Dykstra, B. Gerlach (ADEC)

The staff proposes to continue IPHC's collaboration with the Alaska Department of Environmental Conservation (ADEC) in 2014, collecting halibut tissue samples 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 2,088 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.

Project 661.11: *Ichthyophonus* prevalence in halibut

Priority: Low

Start Date: 2012

Anticipated ending: ongoing

Personnel: C. Dykstra, G. Williams, J. Gregg (USGS), P. Hershberger (USGS)

Ichthyophonus is a protozoan parasite from the class Mesomycetozoea, a highly diverse group of organisms having characteristics of both animals and fungi. It has been identified in many marine fish, and is considered a causative agent in herring fishery collapses world-wide and there is concern over its effects on the success of salmon spawning on major rivers such as the Yukon.

During 2011-2013, samples have been collected from halibut caught on the IPHC setline assessment survey over a broad geographic range, with a goal of describing the spatial and temporal distribution of *Ichthyophonus* prevalence. Limited sampling of small (<50 cm) halibut from the NMFS trawl survey recorded a very low prevalence rate of 2.4%, suggesting that infections establish after some ontogenetic shift in diet, habitat, or behavior. Sampling of larger, adult halibut have shown a wide range of rates, with Prince William Sound showing some of the highest observed in fish.

The prevalence of infection 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. For this reason, the IPHC staff and USGS researchers believe that future work should examine the effect of infection intensity on infection progression, tissue preferences (tropism), growth and survival. Work in 2014 will continue with the monitoring of the three original sites (OR, PWS, northern Bering Sea). Investigations will also be made into the logistics of conducting a controlled exposure/growth experiment at the USGS lab at Marrowstone, WA. Juvenile halibut would be randomly assigned to one of three treatment groups to assess the effect on halibut growth and survival. Costs would be shared between IPHC and USGS. A written manuscript describing results will be prepared by USGS and IPHC researchers.

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Northwest Fisheries Science Center

National Marine Fisheries Service

Agency Report to the Technical Subcommittee

of the Canada-U.S. Groundfish Committee

April 2014

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. Four divisions, Conservation Biology, Environmental and Fisheries Sciences, Fish Ecology, and Fishery Resource Analysis and Monitoring, conduct applied research to resolve problems that threaten marine resources or that deter their use. The Center's main facility and laboratories are located in Seattle. Other Center research facilities are located in Pasco, Big Beef Creek, Mukilteo, and Manchester, Washington; Newport, Hammond, and Clatskanie, Oregon; and Charleston, North Carolina.

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 2013, 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 and Fisheries Sciences Division conducts research to assess and reduce natural and human-caused impacts on environmental and human health, and to improve methods for fisheries restoration and production in conservation hatcheries and in aquaculture. Programs within this Division are focused on: aquaculture, ecotoxicology, environmental chemistry, environmental physiology, hatchery reform science, marine fish and shellfish biology and marine microbes and toxins. Environmental health and conservation research examine environmental conditions and the impacts of chemical contaminants, marine biotoxins, and pathogens on fishery resources, protected species, habitat quality, seafood safety, and human health. Fisheries restoration and aquaculture include research on the challenges associated with captive rearing, nutrition, reproduction, behavior, disease control, engineering, hatchery technology and larval/juvenile quality for protected, depleted and commercially valuable species.

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 focus is also on helping local agencies evaluate stream, river and watershed restoration efforts with a goal to recover listed salmon stocks.

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 impact on effective area swept of a survey trawl

Investigators: D.R. Bryan, K.L. Bosley, A.C. Hicks, M.A. Haltuch, and W.W. Wakefield

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 sweep to improve the understanding of survey and assessment results. The behavior of 632 flatfishes was recorded during four tows. More than 90% of fish were observed in a perpendicular orientation away from the sweeps indicating a herding response. There was no significant effect of fish length on fish orientation or whether it reacted or remained stationary during the observation. Only 1.3% of fish were observed escaping 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 distance that stationary fish were first observed reacting to the sweep was 36.6 cm (± 2.0 SE). Quantitative analysis indicates that flatfish herding occurs along trawl sweeps and the effective area swept is greater than the wing spread. Thus, the use of wing spread to calculate relative abundance estimates explains bias in stock assessment estimates of survey catchability that are greater than expected.

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

b) 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 δ15N between years. Depleted δ13C 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.

Bosley, K.L., T. Miller, R.D. Brodeur, K.M. Bosley, A. VanGaest and A. Elz. (In revision) Feeding ecology of juvenile rockfishes off Oregon and Washington based on stomach contents and stable isotopes. Mar. Biol.

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

c) 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

d) 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, the authors measured the ^{13}C and ^{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, indicating *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.

Field et al. (2014; Mar Ecol Prog Ser) comment on the authors' application of a Bayesian isotope-mixing model (SIAR) to examine the relative contribution of prey from different regions to *Dosidicus gigas* diet, and point out that the model violated assumptions of *D. gigas* feeding. The authors agreed in part with their position that use of SIAR for assessing contributions of sources from different regions for an omnivorous species may be unreliable. However, the results from the study and from the prevailing literature and data indicate that *D. gigas* collected in the Northern California Current (NCC) isotopically matched the NCC baseline and were isotopically distinct from prey resources in the Southern California Current. Field et al.'s (2014) comments on the distribution and abundance of *D. gigas* in the NCC missed results from the primary literature which show that *D. gigas* and their purported prey are predominantly distributed along the shelf-slope waters of the NCC, well within the offshore extent of the study. The discrepancy of not finding myctophids as significant sources to *D. gigas* diet may lie in the fact that isotope values of myctophids came from adults only, and that smaller conspecifics with lower relative $\delta^{15}N$ values would have shown a greater contribution from this trophic group. The conclusion reached of lower trophic level feeding by *D. gigas* relative to previous diet studies remains valid.

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

e) Calculating target spawning potential ratio rates for West Coast Elasmobranch species

Investigators: M. Dorn and V.V. Gertseva

The Pacific Fishery Management Council (PFMC) uses biological reference points to determine whether a stock is in an overfished state, and whether overfishing is occurring. The former is determined using estimated depletion level, which is the ratio of spawning stock output (number of eggs or embryos) in the fished condition, to the spawning output in the unfished condition. The latter is determined by a fishing mortality rate (F), expressed based on spawning potential ratio (SPR). This ratio is the number of eggs produced by an average recruit over its lifetime when the stock is fished divided by the same metric when the stock is unfished. The SPR is based on the principle that a certain proportion of fish need to survive to spawn and replenish the stock at a sustainable level.

The default proxy fishing mortality rate for spiny dogfish shark (*Squalus suckleyi*) used by the PFMC has been $F_{SPR45\%}$. However, the most recent assessment of this species conducted in 2011 predicts that fishing at this proxy rate will severely reduce the spawning output of spiny dogfish over the long term, due to the low productivity and other reproductive characteristics of the stock. The spiny dogfish Stock Assessment Review (STAR) Panel suggested that the PFMC's Scientific and Statistical Committee (SSC) consider the appropriateness of using the current proxy fishing mortality rate for spiny dogfish. The SSC agreed that the PFMC's F_{MSY} proxy of $F_{SPR45\%}$ may be too aggressive for spiny dogfish, and suggested a revision of the currently used target SPR value for this species, as well as other elasmobranches (sharks, skates, and rays) managed under the Groundfish Fishery Management Plan, since they share similar life history characteristics.

The appropriateness of using the current proxy fishing mortality rate for elasmobranches managed by the PFMC was evaluated using information reported in Zhou et al. (2012). They compiled fishing mortality reference point's data for more than 200 species and stocks worldwide that have been assessed with different methods and conducted a meta-analysis to link fishing mortality based reference points to natural mortality and other life history traits. The results indicated that $F_{SPR50\%}$ is a more appropriate proxy fishing mortality rate for elasmobranch species along the West Coast of the United States.

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

f) Spine-based ageing methods in the spiny dogfish shark, *Squalus suckleyi*: How they measure up

Investigators: I.G. Taylor, V. Gertseva and S.E. Matson

The second dorsal spine has historically been used for age determination in the spiny dogfish shark. The dorsal spines are located on the external surface of the body and are subjected to natural wear and breakage. Two methods have been developed to account for the worn portion of the spine and extrapolate the lost annuli. The authors compared the performance of these methods using a large data collection assembled from multiple sources, and evaluated their utility for stock assessment and management of the spiny dogfish shark *Squalus suckleyi* in the Northeast Pacific Ocean. Results showed that the two methods produced very different age estimates for older fish with worn spines. Both methods raised significant questions about some aspects of the age estimates produced, and further exploration of techniques to account for worn spine annuli is needed. It is therefore important to develop alternative methods for shark age determination, including those using stained vertebrae.

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

g) Assessing the quality of life history information in publicly available databases

Investigators: J.T. Thorson, J. Cope and W.S. 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 publicly available databases. The authors therefore developed a novel method based on a Bayesian errors-in-variables model that compared database entries with estimates from local experts, and illustrated 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) relative to values from regional experts in the United States, 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 maximum age, 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 bias and precision estimates be used in future errors-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.

For more information, please contact James Thorson at James.Thorson@noaa.gov or Jason Cope at Jason.Cope@noaa.gov

h) 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. NWFSC researchers are analyzing tissue samples taken from specimens captured during the survey to taxonomically separate vermilion rockfish and its cryptic twin, the sunset rockfish, to compare depth and distributional patterns between the two species. In addition, this research is developing separate life history parameters for each species including age at length, annual growth estimates, length-weight relationships, and age at maturity. This information can be combined with species-specific abundance indices using the methods described in Harms et al. (2010) to determine whether separate stock assessments for vermilion and sunset rockfish are warranted.

For more information, please contact John Harms at John.Harms@noaa.gov

i) A fishery-independent multi-species examination of recent population trends for key species of shelf rockfish (Genus: *Sebastes*) in Southern California

Investigators: A.C. Hicks, J.H. Harms, J.A Benante and R.M. Barnhart

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 121 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 annual 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

j) 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 55% 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 survey has prioritized the collection of ovary specimens to support research aimed at estimating size at maturity for vermilion rockfish, sunset rockfish, greenspotted rockfish, cowcod, and bocaccio. Efforts to collect video habitat information via the deployment of an underwater camera sled 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.

For more information, please contact John Harms at John.Harms@noaa.gov

k) Classification of benthic habitats in the Southern California Bight

Investigators: A. Chappell, R.M. Barnhart, J.H. Harms, J.A. Benante and C.E. Whitmire.

The Southern California Shelf Rockfish Hook and Line Survey uses rod and reel gear to sample hard bottom habitats within the Southern California Bight (SCB) that are not effectively sampled during trawl surveys. Information collected during the survey is used to generate abundance indices and estimate biological parameters to support stock assessments for demersal rockfishes (*Sebastes* spp.). The survey, initiated in 2004, is conducted annually aboard vessels chartered from the local sportfishing industry. The survey design consists of 121 fixed stations sampled annually spanning from Pt. Arguello (34.6° N) to the Mexican border (32.1° N) in a depth range of 37 – 229 m.

Benthic habitat observations are also collected during the survey via opportunistic deployment of a towed video sled consisting of a low-light analog color camera and a mini-DV recording system. Video is analyzed using established protocols to classify bottom type into major and minor substrata comprising eight habitat categories: mud, sand, pebble, cobble, boulder, continuous flat rock, diagonal rock ridge and vertical rock-pinnacle top. The primary objective is to compare the proportion of each habitat type within the survey's sampling frame relative to their composition in the SCB as a whole as determined by available habitat maps. To date, 73 sled dives have occurred producing informative footage during 43 dives representing 41 unique stations. Preliminary findings suggest some smaller hard-bottom habitat features may not be adequately resolved within available maps. If these features support significant abundances of fish and invertebrates, this may have implications for coastwide biomass estimates for these species. Longer term objectives include: incorporating habitat type as a covariate in population abundance models; identifying species and assemblage associations with specific habitat types; and ground-truthing habitat maps.

For more information, please contact Aaron Chappell at Aaron.Chappell@noaa.gov

l) Fishing Vessel-based Survey of Young-of-the-Year (YOY) Groundfishes along the Newport Hydrographic Line

Investigators: W. Wakefield, M. Yergey and L. Ciannelli

The Northwest Fisheries Science Center (NWFSC) Fishery Resource Analysis and Monitoring Division conducts a comprehensive groundfish bottom trawl survey encompassing the U.S. west coast between the borders with Canada and Mexico and water depths of 55 – 1280 m. This survey does an excellent job of quantifying adult fishes in the study area, but was not designed to quantitatively sample the young-of-the-year (YOY) life history stage. Limited research has been conducted on YOY groundfishes off Oregon since the pioneering work during the late 1970s and early 1980s. A recent Oregon Sea Grant funded project on the effects hypoxia on pelagic larval and benthic juvenile groundfishes has allowed for sampling in nearshore waters (30 – 80 m) during the summer months, but there has been no systematic seasonal sampling across the entire continental shelf since the early 1980s. In 2012 a project was initiated to conduct a fishing vessel-based survey of YOY groundfishes along the NH-Line synoptically with a separate and ongoing plankton/physical oceanography sampling program.

A 2-m wide by 0.5-m high video beam trawl system, equipped with a high-definition video system and scaling lasers is being used to collect fish samples as well as video of fish habitat and behavior. On board, scientists work with the fishing crew to collect fish from the trawl, measuring and returning the large juveniles and adults (anything greater than 150 mm SL), and freezing the juvenile and YOY groundfish. These frozen fish are brought back to the lab, where they are classified to lowest possible taxonomic group possible (usually species), measured, and weighed. These fish are then preserved to allow for future research that may look at the diets or growth rates. The video that is collected on each deployment of the beam trawl is also analyzed back in the laboratory, where each fish in the video is classified to the lowest possible taxonomic group possible, and their behavior is quantified. This information is then used to better understand how the behavior of these YOY fishes changes with a changing environment. A total of 90 tows have been conducted as a part of this project, with 34 in 2012, 56 in 2013. The fish samples collected from the first full year (July 2012 – July 2013) have been fully processed with fishes identified to lowest taxonomic level (species in most cases), and cataloged into our database (Fisheries Oceanography Information System or FOIS). Analysis of the data from the first complete year of sampling was recently presented at the 18th Western Groundfish Conference in Victoria, British Columbia in February 2014.

For more information, contact Waldo Wakefield at Waldo.Wakefield@noaa.gov or Matthew Yergey at MYergey@psmfc.org or Lorenzo Ciannelli at lciannel@coas.oregonstate.edu.

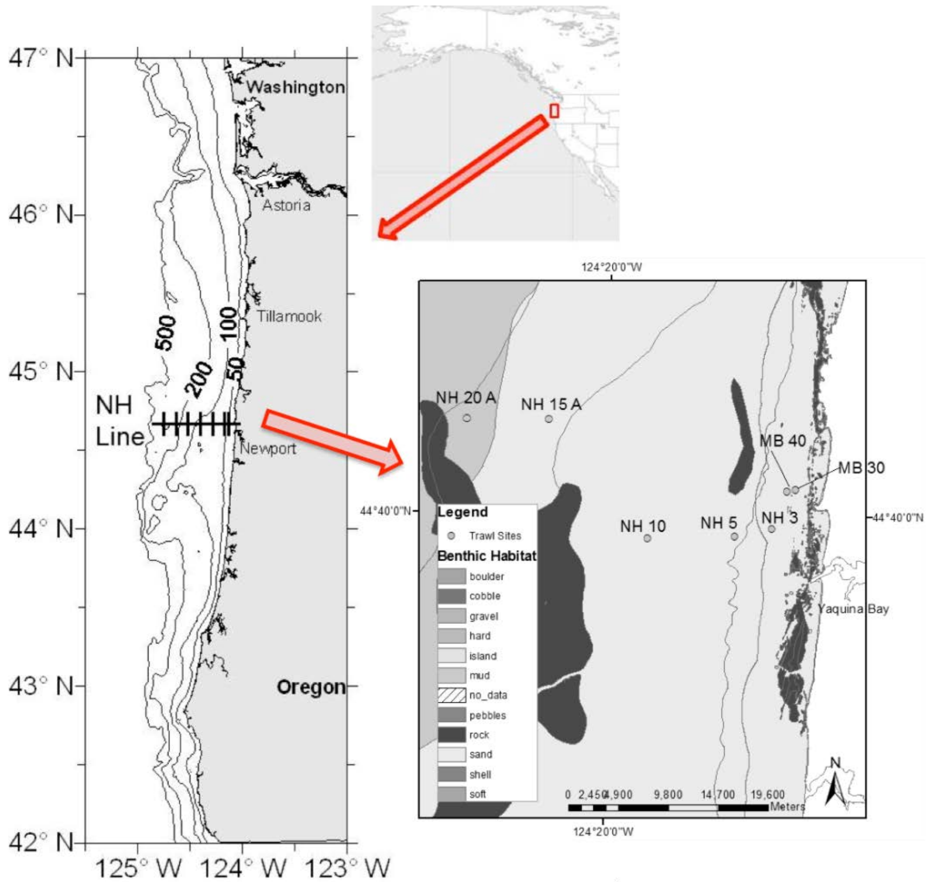

Figure 1. Hydrography/zooplankton/ichthyoplankton stations sampled along the Newport Hydrographic Line at biweekly intervals by the NWFSC Estuarine and Ocean Ecology Program (left). Detailed view of beam trawl stations off Moolack Beach and along the Newport Hydrographic Line.

Figure 2. NMFS and PSMFC researchers and the crew of the F/V Miss Yvonne look on during a deployment of the beam trawl system equipped with HD camera and scaling lasers. F/V Miss Yvonne, off Newport OR, July 30th 2012.

m) Impact of light on catch rate of four demersal fish species during the 2009 - 2010 U.S. west coast groundfish bottom trawl survey

Investigators: M. Bradburn and A.A. Keller

To determine the influence of light on catch of demersal fish, the relationship between near-bottom light levels, catch rates, and catch probability for four abundant groundfish species well represented in annual bottom trawl surveys on the U.S. west coast: arrowtooth flounder (*Atheresthes stomias*), greenstriped rockfish (*Sebastes elongatus*), longnose skate (*Raja rhina*), and Pacific hake (*Merluccius productus*) was examined. Relative downward irradiance was measured with net-mounted archival tags during annual trawl surveys along the U.S. west coast in 2009 and 2010. Near-bottom light levels were recorded for 818 hauls at depths less than 400 m. Significant linear relationships were observed between catch per unit effort (CPUE, kg ha^{-1}) and near-bottom light ($P < 0.05$). CPUE of arrowtooth flounder, longnose skate, and Pacific hake was negatively related to near-bottom light. For these species, CPUE decreased 16 - 22% per unit increase in log10 light ($\mu E\ m^{-2}\ s^{-1}$). CPUE of greenstriped rockfish increased 39% per unit increase in log10 light. Light, depth, and latitude explained 15 - 47% of the variance in

CPUE for the four species. Catch probability was significantly related to light, depth, latitude, and relative time of day ($P < 0.05$). For all species, catch probability varied inversely with light when depth was less than 200 m. At depths of 200 to 300 m, catch probability increased with light for arrowtooth flounder and greenstriped rockfish. Catch probability for Pacific hake decreased slightly at depths greater than 200 m while longnose skate was relatively unaffected by light at these depths. These relationships were used to explain the variability in catch rates for individual species within bottom trawl surveys. By influencing the density and distribution of these groundfish species, light can alter catch rates. Furthermore, possible herding of greenstriped rockfish, and trawl avoidance by arrowtooth flounder, Pacific hake, and longnose skate were suggested.

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n) Distribution of demersal fishes along the U.S. west coast (Canada to Mexico) in relation to spatial fishing closures (2003 – 2011)

Investigators: A.A. Keller, W.W. Wakefield, C.E. Whitmire, B.H. Horness, M.A. Bellman and K.L. Bosley

A temporally and spatially variable Rockfish Conservation Area (RCA) was established as a marine protected area along the U.S. west coast in 2002 to protect stocks of rockfishes (*Sebastes* spp.) by restricting commercial trawling in regions where depleted stocks were most abundant. Since the RCA falls within the region sampled annually by the Northwest Fisheries Science Center's West Coast Groundfish Bottom Trawl Survey (32º30′ – 48º10′ N Lat.), data collected from 2003 to 2011 were utilized to evaluate if establishment of the RCA influenced catch per unit effort (CPUE, kg ha^{-1}), species richness, and size distribution of demersal fishes. Catch and species richness were compared among three management areas (continuously closed, periodically closed, and open to commercial bottom trawling) using analysis of covariance models that account for variability due to area, year, and depth. The most appropriate models for catch (35 species treated individually and aggregated into six subgroups) and species richness were selected using Akaike's information criteria (AIC). All of the best fit models were highly significant ($P < 0.0001$), explaining 3 to 76% of the variation in catch and the majority (19 of 35) included both area and depth. For 27 species and five subgroups of demersal fishes, the mean CPUE (based on Tukey's multiple comparison test) was significantly greater within the area continuously closed to commercial bottom trawling relative to areas periodically closed or open. The most appropriate model for species richness included area and year and mean richness was greatest in the area continuously closed to commercial bottom trawling. Species-specific length composition distributions were calculated from subsampled individual lengths which were available for 31 species. Significant differences in length frequency distributions (Kolmogorov-Smirnov asymptotic test statistic, $P < 0.001$) were observed for these 31 demersal fish species, with a higher proportion of larger fish most often (~65%) present in areas continuously closed to commercial bottom trawling (20 of 31 species) relative to other areas. The data suggest that the RCA is an effective management tool for conserving not only rockfishes, but other demersal fish species. Although no increases in CPUE occurred over the time examined, both catch and species richness were greater in the closed portion of the RCA and a higher proportion of larger fish occurred within the RCA boundaries.

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o) A review of essential fish habitat (EFH) for Pacific coast groundfishes

A review of Essential Fish Habitat (EFH) for 91 species of Pacific coast groundfish was ongoing in 2013. The review of the key products developed for this study is 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/2013/05/25450/rfp-gf-efh-may2013/; online data catalog: http://efh-catalog.coas.oregonstate.edu/overview/). NMFS conducted an analysis of the information in the Phase I Report, and delivered a Synthesis Report to the Council in April 2013 (http://www.pcouncil.org/2013/05/25450/rfp-gf-efh-may2013/). During Phase II of the process, the Council solicited proposals to modify EFH and Habitat Areas of Particular Concern (HAPC). The Council accepted the EFHRC Phase 2 report, thus formally ending the Phase 2 process. Towards the next step in Phase 3 the Council requested that the Northwest and Southwest Fisheries Science Centers investigate the question of essential fish habitat effectiveness, accuracy, and completeness, and present their findings at the September 2014 Council meeting. At the September meeting, the Council is tentatively scheduled to initiate a fishery management plan amendment, including alternatives for refining elements of groundfish EFH as warranted by new information, the Science Center evaluation, and proposals received. 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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p) Evaluating sustainability of fisheries bycatch mortality for marine megafauna: a review of conservation reference points for data-limited populations

Investigators: J.E. Moore, K.A. Curtis, R.L. Lewison, P.W. Dillingham, Jason M. Cope, S.V. Fordham, S.S. Heppell, S.A. Pardo, C.A. Simpfendorfer, G.N. Tuck and S. Zhou

Fisheries bycatch threatens populations of marine megafauna such as marine mammals, turtles, seabirds, sharks and rays, but fisheries impacts on nontarget populations are often difficult to assess due to factors such as data limitation, poorly defined management objectives and lack of quantitative bycatch reduction targets. Limit reference points can be used to address these issues and thereby facilitate adoption and implementation of mitigation efforts. Reference points based on catch data and life history analysis can identify sustainability limits for bycatch with respect to defined population goals even when data are quite limited. This can expedite assessments for large numbers of species and enable prioritization of management actions based on mitigation urgency and efficacy. This paper reviews limit reference point estimators for marine megafauna bycatch, with the aim of highlighting their utility in fisheries management and promoting best practices for use. Different estimators share a common basic structure that can be flexibly applied to different contexts depending on species life history and available data types. Information on demographic vital rates and abundance is required; of these, abundance is the most data-dependent and thus most limiting factor for application. There are different approaches for handling management risk stemming from uncertainty in reference point and bycatch estimates. Risk tolerance can be incorporated explicitly into the reference point estimator itself, or probability distributions may be used to describe uncertainties in bycatch and reference point estimates, and risk tolerance may guide how those are factored into the management process. Either approach requires simulation-based performance testing such as management strategy evaluation to ensure that management objectives can be achieved. Factoring potential sources of bias into such evaluations is critical. This paper reviews the technical, operational, and political challenges to widespread application of reference points for management of marine megafauna bycatch, while emphasizing the importance of developing assessment frameworks that can facilitate sustainable fishing practices.

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q) Giants' shoulders 15 years later: lessons, challenges and guidelines in fisheries meta-analysis

Investigators: J.T. Thorson, J.M. Cope, K.M. Kleisner, J.F. Samhouri, A.O. Shelton and E.J. Ward

Meta-analysis has been an integral tool for fisheries researchers since the late 1990s. However, there remain few guidelines for the design, implementation or interpretation of meta-analyses in the field of fisheries. Here, the authors provide the necessary background for readers, authors and reviewers, including a brief history of the use of meta-analysis in fisheries, an overview of common model types and distinctions, and examples of different goals that can be achieved using meta-analysis. The primary challenges in implementing meta-analyses are outlined, including difficulties in discriminating between alternative hypotheses that can explain the data with equal plausibility, the importance of validating results using multiple lines of evidence, the trade-off between complexity and sample size and problems associated with the use of model output. For each of these challenges, suggestions are also provided, such as the use of propensity scores for dealing with selection bias and the use of covariates to control for confounding effects. These challenges are then illustrated with examples from diverse subfields of fisheries, including (i) the analysis of the stock–recruit relationship, (ii) fisheries management, rebuilding and population viability, (iii) habitat-specific vital rates, (iv) life-history theory and (v) the evaluation of marine reserves. We conclude with our reasons for believing that meta-analysis will continue to grow in importance for these and many other research goals in fisheries science and argue that standards of practice are therefore essential.

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r) Co-occurrence of bycatch and target species in the groundfish demersal trawl fishery of the U.S. west coast; with special consideration of rebuilding stocks

Investigators: E. Heery and J.M. Cope

Bycatch and resultant discard mortality are issues of global concern. The groundfish demersal trawl fishery on the west coast of the United States is a multispecies fishery with significant catch of target and nontarget species. These catches are of particular concern in regard to species that have previously been declared overfished and are currently rebuilding biomass back to target levels. To understand these interactions better, data from the West Coast Groundfish Observer Program were used in a series of cluster analyses to evaluate 3 questions: 1) Are there identifiable associations between species caught in the bottom trawl fishery; 2) Do species that are undergoing population rebuilding toward target biomass levels ("rebuilding species") cluster with targeted species in a consistent way; 3) Are the relationships between rebuilding bycatch species and target species more resolved at particular spatial scales or are relationships spatially consistent across the whole data set? Two strong species clusters emerged— a deepwater slope cluster and a shelf cluster—neither of which included rebuilding species. The likelihood of encountering rebuilding rockfish species is relatively low. To evaluate whether weak clustering of rebuilding rockfish was attributable to their low rate of occurrence, we specified null models of species occurrence. Results indicated that the ability to predict occurrence of rebuilding rockfish when target species were caught was low. Cluster analyses performed at a variety of spatial scales indicated that the most reliable clustering of rebuilding species was at the spatial scale of individual fishing ports. This finding underscores the value of spatially resolved data for fishery management.

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s) Resolving the 10-year rebuilding dilemma for U.S. fish stocks

Investigators: W.S. Patrick and J.M. Cope

Worldwide, a major goal of fisheries management is to maintain fish stocks at or above levels that produce maximum sustainable yields, and to rebuild overexploited stocks that can no longer support such yields. In the United States, rebuilding overexploited stocks is an especially contentious issue, where most stocks are mandated to rebuild in as short a time as possible, and in a time period not to exceed 10 years. Opponents of such mandates and related guidance, note that rebuilding requirements are arbitrary, and create discontinuities in the time and fishing effort allowed for stocks to rebuild due to differences in productivity. Proponents, however, highlight how these mandates and guidance were needed to curtail the continued overexploitation of these stocks by setting firm deadlines on rebuilding. Here the statements made by opponents and proponents of the 10-year rebuilding mandate were evaluate and related guidance provided to determine whether such points are technically accurate using a simple population dynamics model and a database of U.S. fish stocks to parameterize the model. Overall, the authors found several of the statements made about the rebuilding mandates and guidelines were not supported by the analyses (i.e., generation time of stocks correspond with productivity, guidelines are needed to prevent overfishing), while other statements were supported (i.e., most stocks can rebuild within five years, half of the U.S. stocks are susceptible to a 10-year moratorium, there is a discontinuity in rebuilding plans for short- and long-lived species, and the rebuilding framework increases transparency). Lastly, the authors offer a resolution to many of the issues surrounding this mandate and its implementation by recommending some constant fishing mortality (F) based frameworks, which meet the intent of 10-year rebuilding requirement while also providing more flexibility.

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t) A Bayesian approach to estimation of length-weight relationships in fishes

Investigators: R. Froese, J.T. Thorson and R.B. Reyes, Jr.

A Bayesian hierarchical approach is presented for the estimation of length-weight relationships (LWR) in fishes. In particular, estimates are provided for the LWR parameters, a and b, in general as well as by body shape. These priors and existing LWR studies were used to derive species-specific LWR parameters. In the case of data-poor species, the analysis includes LWR studies of closely related species with the same body shape. This approach yielded LWR parameter estimates with measures of uncertainty for practically all known 32,000 species of fishes. Provided is a large LWR data set extracted from www.fishbase.org, the source code of the respective analyses, and ready-to-use tools for practitioners. This is presented as an example of a self-learning online database where the addition of new studies improves the species-specific parameter estimates and where these parameter estimates inform the analysis of new data.

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u) Rigorous meta-analysis of life history correlations by simultaneously analyzing multiple population dynamics models

Investigators: J.T. Thorson, I. Taylor, I.J. Stewart and A.E. Punt

Correlations among life history parameters have been discussed in the ecological literature for over 50 years, but are often estimated while treating model estimates of demographic rates such as natural mortality (M) or individual growth (k) as ‘‘data.’’ This approach fails to propagate uncertainty appropriately because it ignores correlations in estimation errors between parameters within a species and differences in estimation error among species. An improved alternative is multi-species mixed-effects modeling, which we approximate using multivariate likelihood profiles in an approach that synthesizes information from several population dynamics models. Simulation modeling demonstrates that this approach has minimal bias, and that precision improves with increased number of species. As a case study, the authors demonstrate this approach by estimating M/k for 11 groundfish species off the U.S. West Coast using the data and functional forms on which pre-existing, peer-reviewed, population dynamics models are based. M/k is estimated to be 1.26 for Pacific rockfishes (*Sebastes* spp.), with a coefficient of variation of 76% for M given k. This represents the first-ever estimate of correlations among life history parameters for marine fishes using several age-structured population dynamics models, and it serves as a standard for future life history correlation studies. This approach can be modified to provide robust estimates of other life history parameters and correlations, and requires few changes to existing population dynamics models and software input files for both marine and terrestrial species. Specific results for Pacific rockfishes can be used as a Bayesian prior for estimating natural mortality in future fisheries management efforts. We therefore recommend that fish population dynamics models be compiled in a global database that can be used to simultaneously analyze observation-level data for many species in life history meta-analyses.

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v) 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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w) 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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x) 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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y) Improving ecosystem-based stock assessment and forecasting by using a hierarchical approach to link fish productivity to environmental drivers

Investigators: Tim Essington, Trevor Branch (UW), Melissa Haltuch, Anne Hollowed, Paul Spencer, and Nate Mantua (NMFS).

We investigated the hypothesis that synchronous recruitment is due to a shared susceptibility to environmental processes using stock-recruitment residuals for 52 marine fish stocks within three Northeast Pacific large marine ecosystems: the Eastern Bering Sea and Aleutian Islands (BSAI), Gulf of Alaska, and California Current. There was moderate coherence in terms of exceptionally strong and weak year classes and significant distributions of across stock correlation. Based on evidence of synchrony from these analyses, we used Bayesian hierarchical models to relate recruitment to environmental covariates for groups of stocks with similar susceptibility to environmental processes. There were consistent relationships among stocks to the covariates, especially within the Gulf of Alaska and California Current. The best Gulf of Alaska model included Northeast Pacific sea surface height data as predictors of recruitment, and was particularly strong for stocks dependent on cross-shelf transport during the pelagic larval phase for recruitment. In the California Current the best-fit model included San Francisco coastal sea level data as predictors, with higher recruitment for many stocks corresponding to anomalously high sea level the year before spawning and low sea level the year of spawning. The best BSAI model included several environmental variables as covariates and there was some consistent response across stocks to these variables. Future research may be able to utilize these across stock environmental influences, in conjunction with an understanding of ecological processes important across early life history stages at appropriate temporal and spatial scales, to improve identification of environmental drivers of recruitment.

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z) Fisheries management under climate and environmental uncertainty: control rules and performance simulation

Investigators: A.E. Punt, T. A'Mar, N.A. Bond, D.S. Butterworth, C.L. de Moor, J.A.A. De Oliveira, M.A. Haltuch, A.B. Hollowed and C. Szuwalski.

The ability of management strategies to achieve fishery management goals are impacted by environmental variation and, therefore, also by global climate change. Management strategies can be modified to use environmental data using the "dynamic B_0" concept, and changing the set of years used to define biomass reference points. Two approaches have been developed to apply management strategy evaluation to examine the impact of environmental variation on the performance of management strategies. The "mechanistic approach" estimates the relationship between the environment and elements of the population dynamics of the fished species and makes predictions for population trends using the outputs from global climate models. In contrast, the "empirical approach" examines possible broad scenarios without explicitly identifying mechanisms. Many reviewed studies have found that modifying management strategies to include environmental factors does not improve the ability to achieve management goals much, if at all, and only if the manner in which these factors drive the system is well known. As such, until the skill of stock projection models improves, it seems more appropriate to consider the implications of plausible broad forecasts related to how biological parameters may change in the future as a way to assess the robustness of management strategies, rather than attempting specific predictions per se.

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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 3.24s as of July 2013).

In 2013 Stock Synthesis was featured in the following publications as well as numerous publications reported below in section 10:

Cope, J.M. 2013. Implementing a statistical catch-at-age model (Stock Synthesis) as a tool for deriving overfishing limits in data-limited situations. Fisheries Research. 142: 3-14.

Taylor, I.G., Gerseva, V., Methot, R.D., Maunder, M.N. 2013. A stock-recruitment relationship based on pre-recruit survival, illustrated with application to spiny dogfish shark. Fisheries Research. 42: 15-21.

MacCall, A.D. 2013. Use of the delta method to evaluate the precision of assessments that fix parameter values. Fisheries Research. 42: 56-60.

MacCall, A.D., Teo, S.L.H. 2013. A hybrid stock synthesis- Virtual population analysis model of Pacific bluefin tuna. Fisheries Research. 142: 22-26.

Maunder, M.N., Punt, A.E. 2013. A review of integrated analysis in fisheries stock assessment. Fisheries Research. 42: 61-74.

Methot, R.D. Wetzel, C.R. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. Fisheries Research. 42: 86-99.

Punt, A.E., Maunder, M.N. 2013. Stock Synthesis: Advancing stock assessment application and research through the use of a general stock assessment computer program. Fisheries Research. 42: 1-2.

Stewart, I.J., Hicks, A.C., Taylor, I.G., Thorson, J.T., Wetzel, C., Kupschus, S. 2013. A comparison of stock assessment uncertainty estimates using maximum likelihood and Bayesian methods implemented with the same model framework. Fisheries Research. 42: 37-46.

Taylor, I.G., Methot, R.D. 2013. Hiding or dead? A computationally efficient model of selective fishing mortality. Fisheries Research. 42: 75-85.

Thorson, J.T., Stewart, I.J., Taylor, I.G., Punt, A.E. 2013. Using a recruitment-linked multispecies stock assessment model to estimate common trends in recruitment for US West Coast groundfishes. Marine Ecology Progress Series. 483: 245-256.

Wayte, S.E. 2013. Management implication of including a climate-induced recruitment shift in stock assessment for jackass morwong (*Nemadactylus macropterus*) in south-eastern Australia. Fisheries Research. 42: 47-55.

Whitten, A.R., Klaer, N.L., Tuck, G.N., Day, R.W. 2013. Accounting for cohort-specific variable growth in fisheries stock assessments: A case study from south-eastern Australia. Fisheries Research. 42: 27-36.

Additional papers that featured Stock synthesis:

Hurtado-Ferro, F., Punt, A.E., Hill, K.T. *in press*. Use of multiple selectivity patterns as a proxy for spatial structure. Fisheries Research.

Thorson, J.T., Taylor, I.G., Stewart, I., Punt, A.E. *in press*. Rigorous meta-analysis of life history correlation by simultaneously analyzing multiple population dynamics models. Ecological Applications.

Punt, A.E. Hurtado-Ferro, F., Whitten, A.R. *in press*. Model selection for selectivity in fisheries stock assessments. Fisheries Research.

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b) Stock Synthesis: a biological and statistical framework for fish stock assessment and fishery management

Investigators: R.D. 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.D. Methot

100 years after Rosa Lee (1912) showed that higher mortality on faster growing fish can alter length-at-age distributions in fish populations, a computationally-efficient and parsimonious method for modeling size-selective mortality within a commonly-used assessment model, Stock Synthesis, was developed. 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.D. Methot, and M. Maunder

Understanding the relationship between abundance of spawners and subsequent recruitment is one of the central issues in fisheries stock assessment. A new, pre-recruit survival based stock–recruitment model was developed 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, the authors 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. The results of the application of this new stock–recruitment model were compared 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 Development Workshop, Seattle, WA, December 10-12 2013

Investigator: R.D. Methot

A three day workshop was held to discuss Stock Synthesis. Topics ranging from: current available features including the R-SS interface and potential improvements, how best to use programmers for structured programming, steps to move towards an open source structure, wish list of features, and ease of use were discussed. Participants from research organizations and universities attended in person along with national and international participation through virtual attendance.

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f) Implementing a statistical catch-at-age model (Stock Synthesis) as a tool for deriving overfishing limits in data-limited situations

Investigator: J.M. Cope

Stock Synthesis (SS) is a likelihood-based statistical catch-at-age modeling environment allowing multiple data sources to be used to characterize population dynamics through time. While it is typically applied in data-rich circumstances, its suitability in data-limited situations is investigated in this work. Two "Simple Stock Synthesis" (SSS) approaches are outlined, each developed to mimic the Depletion-Based Stock Reduction Analysis (DB-SRA) estimation of overfishing limits (OFLs) currently applied to data-limited U.S. west coast groundfish species. SSS-MC uses Monte Carlo draws of natural mortality, steepness, and stock depletion and estimates initial recruitment, while SSS-MCMC estimates natural mortality, steepness, and initial recruitment while fitting to an artificial abundance survey representing stock depletion with an error distribution equivalent to the stock depletion prior used in DB-SRA. These approaches are applied to 45 species of unassessed groundfishes in the Pacific Fishery Management Council Groundfish Fishery Management Plan, and the OFL estimates are compared to corresponding DB-SRA estimates. Despite model structure and parameter specification differences, SSS led to results comparable to DB-SRA over a wide range of species and life histories. SSS models with sex-specific life history parameters and growth variability are also presented as examples of how the inherent flexibility of SS can be used to account for more uncertainty in derived quantities. SSS-MCMC, while exhibiting statistically undesirable traits due to the inclusion of the artificial survey, readily includes data-informed abundance surveys into an assessment framework consistent with more complex, data-informed assessments. Establishment of viable data-limited approaches in SS is a convenient first steps in "building-up" stock assessments towards fuller implementation in SS when additional data become available, while also providing a way to inform management in data-limited situations.

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

g) Applying catch-only (SSS) and catch-index (exSSS) methods in Stock Synthesis to northeast Pacific groundfishes

Investigators: J.M. Cope, J.T. Thorson and C.R. Wetzel

Recent applications of Stock Synthesis have reduced the stock assessment information to catch-only (Simple Stock Synthesis [SSS]) and catch and index (extended Simple Stock synthesis [exSSS]) models to provide information on sustainable catch levels and status. To further understand the behavior of these applications, the authors stripped down several data-heavy stock assessments into SSS and exSSS versions and compared biomass and depletion trajectories. These comparisons seek to understand general patterns of these approaches, including the level of estimated uncertainty and systematic behavior of derived quantities. The authors also applied an updated prior on depletion to theoretically improve performance and compared those results to previous implementations that assume a similar depletion prior for all stocks.

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

h) Stock assessment and management in data-limited situations

Investigator: J.M. Cope

A presentation given to an Indonesian delegation visiting the NWFSC highlighted the work being done in developing data-limited stock assessment methods and areas wherein collaboration could advance the development and application of this work.

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

i) The biology of fisheries stock assessments

Investigator: J.M. Cope

Stock assessments provide a critical link between science and management. The integrated nature of stock assessments means many different data types are used to present the best available scientific information for management use. This overview presents not only the inter-relationships of disparate data types typically used in U.S. west coast groundfishes stock assessments, but also the "life cycle" of an assessment: from family planning/birth (stock prioritization), early development (data and parameters), adolescence (stock assessment review), maturity (assessment application), senility/death (expire assessments), and reincarnation (alternative stock assessment approaches).

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

j) The (d)evolution of U.S. west coast groundfish assessments: from data-poor to data-less poor and back

Investigators: J.M. Cope, E.J. Dick and C.R. Wetzel

The 1982 groundfish fishery management plan (FMP), comprising 90+ species, ushered in the era of formal groundfish management for the Pacific Fishery Management Council. Early stock assessments were comprised of data summaries and stock reduction analysis. Synthetic approaches started being applied in the late 1980s and remain the predominant approach, though only about a third of managed stocks have ever applied such models. The reauthorization of the Magnuson-Stevens Act in 2006, requiring annual catch limits (ACLs), changes the emphasis from "data-rich" only to "data-poor" stock assessment development to include analyzing all species within an FMP. The authors present this "evolution" from full synthetic models back to deterministic modeling approaches. Two newer implementations of catch-only and catch-index methods were featured, Depletion-based- Stock Reduction Analysis (DB-SRA) and Simple Stock Synthesis (SSS) developed to meet these management needs, and applyied them to several groundfish stocks lacking current stock assessments. Simulation results also give insight into how each model performs under known conditions. The development of these models bridges scientific advice to management across different resource availability and management needs. It also highlights current deficiencies and the need for ongoing model development, including the use of approaches that do not need baseline information. While data-limited stock assessments, by definition, are inherently dealing with high parameter and data uncertainty, the results demonstrate such reasons are insufficient to disregard their utility. Management— and ultimately the resources and its users—can benefit from such applications.

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

k) A new role for effort dynamics in the theory of harvest populations and data-poor stock assessment

Investigators: J.T. Thorson, Minto, Coilin, C. Minte-Vera, K. Kleisner and C. Longo

Research shows that population status can be predicted using catch data, but there is little justification for why these predictions work or how they account for changes in fisheries management. The authors demonstrate that biomass can be reconstructed from catch data whenever fishing mortality follows predictable dynamics over time (called “effort dynamics”), and develop a state-space catch only model (SSCOM) for this purpose. Theoretical arguments and simulation modeling were used to demonstrate that SSCOM can, in some cases, estimate population status from catch data. Next, the authors use meta-analysis to estimate effort dynamics for U.S. West Coast groundfishes before and after fisheries management changes in the mid-1990s. They apply the SSCOM using meta-analytic results to data for eight assessed species and compare results with stock assessment and data-poor methods. Results indicate general agreement among all three methods. The authors conclude that effort dynamics provides a theoretical basis for using catch data to reconstruct biomass and has potential for conducting data-poor assessments. However, they still recommend that index and compositional data be collected to allow application of data-rich methods.

For more information, please contact James Thorson at James.Thorson@noaa.gov

l) A comparison of parametric, semi-parametric, and non-parametric approaches to selectivity in age-structured assessment models

Investigators: J.T. Thorson and I.G. Taylor

Integrated assessment models frequently track population abundance at age, and hence account for fishery removals using a function representing fishery selectivity at age. However, fishery selectivity may have an unusual shape that does not match any parametric function. For this reason, previous research has developed flexible ‘non-parametric’ models for selectivity that specify a penalty on changes in selectivity as a function of age. In this study, the authors describe an alternative ‘semi-parametric’ approach to selectivity, which specifies a penalty on differences between estimated selectivity at age and a pre-specified parametric model whose parameters are freely estimated, while also using cross-validation to select the magnitude of penalty in both semi- and non-parametric models. The authors then compare parametric, semi-parametric, and non-parametric models using simulated data and evaluate the bias and precision of estimated depletion and fishing intensity. Results show that semi- and non-parametric models result in little decrease in precision relative to the parametric model when the parametric model matches the true data-generating process, but that the semi- and non-parametric models have less bias and greater precision when the parametric function is misspecified. As expected, the semi-parametric model reverts to its pre-specified parametric form when age-composition sample size is low but performs similarly to the non-parametric model when sample size is high. Overall, results indicate few disadvantages to using the non-parametric model given the range of simulation scenarios explored, and that the semi-parametric model provides a selectivity specification that is intermediate between parametric and non-parametric forms.

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m) A comparison of stock assessment uncertainty estimates using maximum likelihood and Bayesian methods implemented with the same model framework

Investigators: I.J. Stewart, A.C. Hicks, I.G. Taylor, J.T. Thorson, C.R. Wetzel and S. Kupschus

Many fisheries stock assessment models are implemented specifically for likelihood-based estimation or for Bayesian inference (via full integration of the joint posterior distributions), but not all have appropriate structure for both statistical approaches. Bias correction of recruitment deviations, in particular, must be adjusted to achieve consistency in each case. Fisheries management often uses the two types of results similarly, setting future catch quotas based on expected values or posterior medians depending on which is available given time constraints. Using two recent examples from the U.S. west coast, Pacific hake and sablefish, both implemented in Stock Synthesis, the authors find that likelihood-based estimates of key management quantities, such as spawning biomass, corresponded well with posterior modes, but tend to be lower (on an absolute scale) than posterior median values and that the asymptotic approximation for uncertainty intervals based on the Hessian matrix tends to overestimate the likelihood of smaller stock sizes and underestimate that of larger stock sizes. This pattern may be caused by a basic asymmetry in most fisheries data-sets: the necessity of a minimum stock size to have generated the observed catch/time-series, but little information regarding the plausibility among much larger stock sizes. Where only one type of inference is available, this asymmetry may be important for management decision-making. Even if management takes explicit account of uncertainty, in some cases adding a precautionary buffer that scales with the relative uncertainty in point estimates, the differences in catch advice may turn out to be important and the relative reductions non-linear.

For more information, please contact James Thorson at Allan.Hicks@noaa.gov

n) Using a recruitment-linked multispecies stock assessment model to estimate common trends in recruitment for U.S. West Coast groundfishes

Investigators: J.T. Thorson, I.G. Taylor, I.J. Stewart and A.E. Punt

Recruitment is highly variable in marine fishes, and is often estimated using stock–recruit relationships that explain little of the observed variability in recruitment. Researchers have sought for decades to identify environmental indices that are associated with cohort strength, and often use stock assessment estimates of recruitment within secondary regressions to test hypothesized drivers of recruitment variability. This practice is statistically questionable because it fails to acknowledge differences in the precision of recruitment estimates among species and years, as well as covariance between recruitment estimates within a given species. We developed an alternative, statistically rigorous method to estimate an index of cohort strength that is shared among several species while accounting for each single-species stock–recruit relationship. This method simultaneously optimizes multiple stock assessment models with shared cohort strength parameters, while using observation-level fishery data for each species to propagate the precision and covariance of recruitment estimates. The method is demonstrated using data for 8 groundfish species off the U.S. West Coast for which recruitment is relatively well estimated: our model estimated high recruitment during 1990–1991 and 1999–2000, followed by anomalously low recruitment during 2002–2007. The impact of a shared index of cohort strength is demonstrated for 2 additional species with little information about recruitment, yelloweye *Sebastes ruberrimus* and blackgill *Sebastes melanostomus* rockfishes, where it decreases the coefficient of variation for recruitment estimates in the most recent modeled year by 40%. The method can be applied to other fishery management regions in the USA and elsewhere, and represents a rigorous method to estimate associations in cohort strength among species within a region.

o) A method for calculating a meta-analytical prior for the natural mortality rate using multiple life-history correlates

Investigator: O.S. Hamel

The natural mortality rate *M* is an extraordinarily difficult parameter to estimate for many fish species. The uncertainty associated with *M* translates into increased uncertainty in fishery stock assessments. Estimation of *M* within a stock assessment model is complicated by the confounding of this parameter with other life history and fishery parameters which are also uncertain and some of which are typically estimated within the model. Ageing error and variation in growth, which may not be fully modeled, can also affect estimation of *M*, as can assumptions, including the assumed form of the stock recruitment function (e.g., Beverton-Holt, Ricker) and the level of compensation (or steepness), which may be fixed (or limited by a prior) in the model. To avoid this difficulty, stock assessors often assume point estimates for M derived from meta-analytical relationships between *M* and more easily measured life history characteristics. However, these relationships depend upon estimates of *M* for a great number of species, and those estimates are also subject to errors and biases (as are, to a lesser extent, the other life history parameters). Therefore, at the very least, some measure of uncertainty should be calculated and used for evaluating uncertainty in stock assessments as well as in fishery management evaluations. Given error-free data on *M* and the covariate(s) for the meta-analysis, prediction intervals provide the appropriate measure of uncertainty in *M*. In contrast, if the relationship between the covariate(s) and *M* is exact and the only error is observation error in *M*, confidence intervals are appropriate. In this talk I will describe both types of intervals,

develop priors based upon multiple published meta-analyses of various life history correlates using the prediction interval calculation, and discuss some caveats and considerations when deciding which meta-analyses to use in developing priors.
This research was presented at the World Conference on Stock Assessment Methods for Sustainable Fisheries in Boston, MA in July, 2013. A manuscript has been submitted to the ICES Journal of Marine Science.

For more information, please contact Owen Hamel at Owen.Hamel@noaa.gov.

p) Bootstrapping of sample sizes for length- or age-composition data used in stock assessments

Investigators: I.J. Stewart and O.S. Hamel

Integrated stock assessment models derive estimates of management quantities by fitting to indices of abundance and length and age compositions. For composition data, where a multinomial likelihood is often applied, weights are determined by input sample sizes, which can be an important contributor to model results. The authors used a generic bootstrap method, verified through simulation, to calculate year-specific maximum realized sample sizes from the observation error inherent in fishery biological data. Applying this method to length-composition observations for 47 groundfish species collected during a standardized trawl survey, the authors found maximum realized sample size to be related to both the number of hauls and individual fish sampled from those hauls. Sampling in excess of 20 fish from each haul produced little increase in most cases, with maximum realized sample size ranging from approximately 2-4 per haul sampled. Utilizing these maximum realized sample sizes as input values for stock assessment (analogous to minimum variance estimates), appropriately incorporates interannual variability, and may reduce over-emphasis on composition data. Results from this method can also help determine sampling targets.

A manuscript on this subject has been accepted at the Canadian Journal of Fisheries and Aquatic Sciences.

For more information, please contact Owen Hamel at Owen.Hamel@noaa.gov.

q) Biology, fisheries, assessment and management of Pacific hake (*Merluccius productus*)

Investigators: O. S. Hamel, P.H. Ressler, R. E. Thomas, D.A. Waldeck, A.C. Hicks, J.A. Holmes and G.W. Fleischer

Pacific hake (*Merluccius productus*), also known as Pacific whiting, is the most abundant commercial fish species in the California Current Large Marine Ecosystem (CCLME) and is an important part of the ecosystem as both predator and prey. A large migratory population occurs off California, Oregon, and Washington in United States waters and off British Columbia in Canadian waters. Smaller distinct non-migratory populations of Pacific hake occur in major inlets of the northeast Pacific Ocean, including the Strait of Georgia and Puget Sound. The coastal Pacific hake population has supported a fishery averaging 222 thousand tonnes per year since 1966. Coastal Pacific hake migrate to northern feeding areas in the summer and southern spawning areas in the winter. The extent of the northern migration and the distribution along the coast are related to the population age and size composition and to varying ocean-climatic conditions, which also influence growth and location of spawning aggregations. Pacific hake have a lifespan of around 20 years, reach maturity around age 4, and achieve an average asymptotic size of 53 cm.

Coastal Pacific hake are managed under the auspices of a treaty between the United States and Canada, and the two countries jointly conduct acoustic surveys of the resource, stock assessments, stock assessment reviews and management meetings. Prior to the treaty there were independent and competing stock assessments from the United States and Canada. The Hake Treaty established a default harvest policy, a fixed harvest allocation for each country, and a Joint Management Committee that determines the annual coastwide Total Allowable Catch based on the best available science, the treaty's default harvest policy, and input from industry advisors. Regulation and management of the individual fisheries continues to rest within each country.

The fishery is executed by four sectors in the United States: vessels that deliver to shore-based processors, vessels that deliver to at-sea processors (motherships), vessels that both catch and process at-sea (catcher-processors), and a tribal fishery. The Canadian fishery is prosecuted by vessels that deliver to shore-based processors, with a joint-venture mothership sector in some years. The Pacific hake fishery in the United States and Canada is jointly certified by the Marine Stewardship Council as a sustainable fishery. Pacific hake must be frozen or processed soon after harvest to achieve a marketable product. Currently, most Pacific hake is marketed as fillets or headed and gutted products, although previously a large portion of the harvest was turned into surimi. While none of these products demand a high price, the total revenue to the industry is in the tens of millions of U.S. dollars.

A chapter on this subject has been accepted at for publication in a new book Hakes: biology and exploitation.

For more information, please contact Owen Hamel at Owen.Hamel@noaa.gov.

r) Estimating process error in the assessment for Pacific hake and its effect on management decisions

Investigators: A.C. Hicks, N.G. Taylor, S.Cox, I.G. Taylor and C. Grandin

Pacific hake or whiting (*Merluccius productus*) is the largest groundfish fishery off of the West Coast of the United States and Canada with recent annual catches ranging from 177,000 to 363,000 metric tons. Large variability in recruitment characterizes this stock with strong year-classes often supporting the fishery for many years. The stock is jointly assessed and managed by the U.S and Canada under an international agreement, and the countries conduct a stock assessment annually to provide up-to-date estimates of the highly variable population. However, data are typically not available for age-1 hake resulting in a large amount of uncertainty in the prediction of incoming year classes and can be the cause of considerable angst when setting quotas for a fishery that begins catching significant numbers of age-2 hake. Recently, there has been concern that estimates of large year-classes are biased high when the cohort is young and there are few years of data to inform the strength of the cohort. Through simulation, we investigated the estimates of recruitment for strong, average, and weak cohorts under the current paradigm of data collection and assessment modeling. Under the ideal situations assumed in the simulations, recruitment estimates show a small bias which is reduced as the cohort ages and multiple observations are available. However, we attempt to explain why recent retrospective patterns in estimated recruitment from the actual stock assessment have occurred and if this is a pattern that we can expect to see in the future.

A poster of this research was presented at the World Conference on Stock Assessment Methods for Sustainable Fisheries in Boston, MA on July 17, 2013.

For more information, please contact Allan Hicks at Allan.Hicks@noaa.gov.

s) Random effect estimation of time-varying factors in Stock Synthesis

Investigators: J. T. Thorson, A.C. Hicks and R.D. Methot

Biological processes such as fishery selectivity, natural mortality, and somatic growth can vary over time, but it is challenging to estimate the magnitude of time-variation of demographic parameters in population dynamics models, particularly when using penalized likelihood estimation approaches. Random-effect approaches can estimate the variance, but are computationally infeasible or not implemented for many models and software packages. The authors show that existing models and software based on penalized-likelihood can be used to calculate the Laplace approximation to the marginal likelihood of parameters representing variability over time, and specifically demonstrate this approach via application to Stock Synthesis. Using North Sea cod and Pacific hake models as case studies, the authors show that this method has little bias in estimating variances for simulated data. It also provides a similar estimate of variability in hake recruitment (log-SD = 1.43) to that obtained from Markov chain Monte Carlo (MCMC) methods (log-SD = 1.68), and the method estimates a non-trivial magnitude (log-SD = 0.07) of variation in growth for North Sea cod. The authors conclude by discussing the generality of the proposed method and by recommending future research regarding its performance relative to MCMC, particularly when estimating multiple variances simultaneously.

Published in ICES Journal of Marine Science, January 9, 2014.

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C. By Species, by Agency

The PFMC currently operates under a biennial schedule for the development of stock assessments and management guidance. For all groundfish species except Pacific hake, stock assessments are scheduled for review only during odd-numbered years. A schedule for Stock Assessment Review (STAR) panels for full assessments of species conducted in 2013, along with the 2013 and 2014 Hake Scientific Review Group meetings, is shown in Table 1.

Table 1. Review Schedule for Full Groundfish Assessments.

STAR PANEL	STOCK	AUTHOR(S)	REVIEW PANEL DATES	STAR PANEL LOCATION
Hake SRG* Panel	Pacific hake/ whiting	Allan Hicks Nathan Taylor Chris Grandin Ian Taylor Sean Cox	February 19-22, 2013	Vancouver, British Columbia Canada
Hake SRG* Panel	Pacific hake/ whiting	Allan Hicks Nathan Taylor Chris Grandin Ian Taylor Sean Cox	February 18-21, 2014	Seattle, WA, USA
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
**Accepted for status determination but not for management (scale of population not accepted)
*** Not accepted for management or status determination at the STAR panel

1. Shelf Rockfish - West Coast

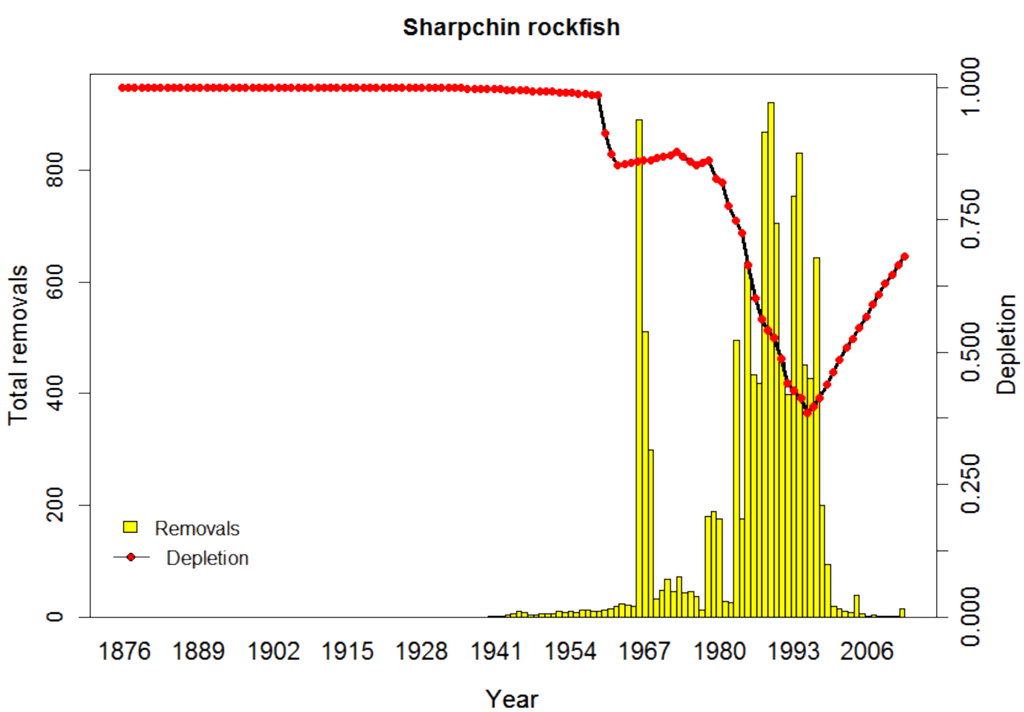
a) Stock Assessments

Full assessments of cowcod and data moderate rockfish species brown, china, copper, sharpchin, stripetail, and yellowtail were conducted in 2013. An update of the 2009 assessment of bocaccio and data reports on canary and yelloweye rockfish and Pacific ocean perch were also conducted in 2013.

Bocaccio: An update of the 2009 bocaccio assessment was conducted in 2013 by the SWFSC. The complete version of: Status of bocaccio, *Sebastes paucispinis*, in the Conception, Monterey and Eureka INPFC areas as evaluated for 2013 can be viewed online at:
http://www.pcouncil.org/wp-content/uploads/Bocaccio_2013_Assessment_Update..pdf
For more information on the bocaccio assessment, contact John Field at John.Field@noaa.gov

Brown, China, Copper, Sharpchin, Stripetail and Yellowtail rockfishes: Catch and index only assessments ("data-moderate" assessments) were performed for 5 groundfish species. Four of the five had sufficient information in the index data to advise catch levels and status determination (see Figure 3a and 3b below for assessment summaries for sharpchin and yellowtail rockfish). Stripetail rockfish had too much uncertainty in the scale of the population to inform catches, but could inform stock status enough to indicate the population was well above the target stock status.

A.



B.

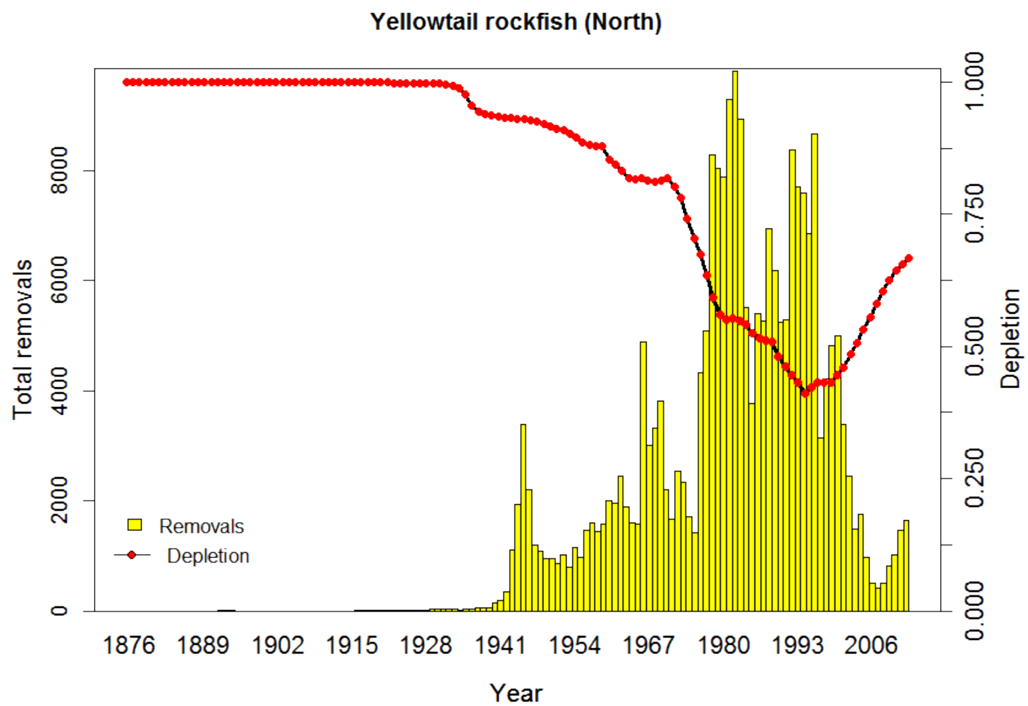


Figure 3. Time series of total removals (mt; bars) and estimated depletion (line) for A) sharpchin and B) yellowtail rockfish.

The data moderate assessment document for the brown, china, copper, sharpchin, stripetail (status only), and yellowtail rockfish can be found at: http://www.pcouncil.org/groundfish/stock-assessments/by-year/gf2013/.

For more information on the 2013 data-moderate rockfish assessments, contact Jason Cope at Jason.Cope@noaa.gov or E. J. Dick at Edward.Dick@noaa.gov.

Cowcod: The complete version of the 2013 stock assessment of cowcod, *Sebastes levis*, can be viewed online at: http://www.pcouncil.org/groundfish/stock-assessments/by-species/cowcod/
For more information on the cowcod assessment, contact E. J. Dick at Edward.Dick@noaa.gov

Canary rockfish: A data report showing that overfishing has not been occurring was conducted for canary rockfish in 2013. For more information on the canary rockfish data report, contact John Wallace at John.Wallace@noaa.gov

Yelloweye rockfish: A data report showing that overfishing has not been occurring was conducted for yelloweye rockfish in 2013. For more information on the yelloweye rockfish data report, contact John Wallace at John.Wallace@noaa.gov

2. Slope Rockfish

a) Stock assessments

Full assessments of aurora, darkblotched, and rougheye and blackspotted rockfish (the latter two as a complex), and a data report on Pacific ocean perch were conducted in 2013.

Aurora rockfish: This first full age-structured assessment for aurora rockfish (*Sebastes aurora*) reports the status of the species off the west coast of the United States. Aurora rockfish are a long-lived member of the rockfish family, with a life-span over 100 years while reaching lengths only in the mid-30 cm range. Aurora rockfish occur from the Queen Charlotte Islands (British Columbia, Canada) south to mid-Baja California (Mexico), but are most common in U.S. waters from northern Oregon to southern California. They are deep-dwelling, occurring from 200 to 700 meters, with the median depth increasing to the south. They are most abundant from 350 to 550 m in the north and 400 to 600 m in the south. While there are intermittent areas of greater and lesser abundance, the population appears continuous over the entire coast and there is no clear point for stock delineation. For the purposes of this assessment, the population of Aurora rockfish was treated as a single stock from the U.S.-Mexico border to the U.S.-Canada border.

Previous estimates of sustainable aurora rockfish removals (via catch-only methods) compared to actual removals indicated possibly elevated overfishing risks. The aurora base-case model provides an improved basis for evaluating the stock's exploitation history. Even so, the assessment relies upon a number of parameters estimated outside of the model. The natural mortality rate in the model is set equal to the median of the prior distribution based upon Hoenig's method relating natural mortality to longevity (Hoenig, 1983). The steepness of the Beverton-holt stock-recruitment relationship is set equal to the median of the meta-analytical prior used for the 2013 stock assessments.

The current model estimates that exploitation of aurora rockfish has been relatively low, with total catch estimated to have exceeded the current management harvest-rate limits in only 2 years, during the early peak in trawl catch (1990 and 1992). Recent levels of removals have remained moderate. There is very low risk that current removals are causing overfishing. Unfished spawning biomass (acting as a proxy for productions of eggs or larva) is estimated to be 2626 mt (95% CI: 1165-4087; CV = 28.4%) with spawning biomass at the beginning of 2013 estimated to be 1050 mt (95% CI: 466-1635; CV = 40.4%). The stock's status is estimated to be at 64% of the unfished level in 2013. Both scale and status are very sensitive to assumed natural mortality rates, though all plausible values of this parameter result in estimated current status above the biomass target ($B_{40\%}$).

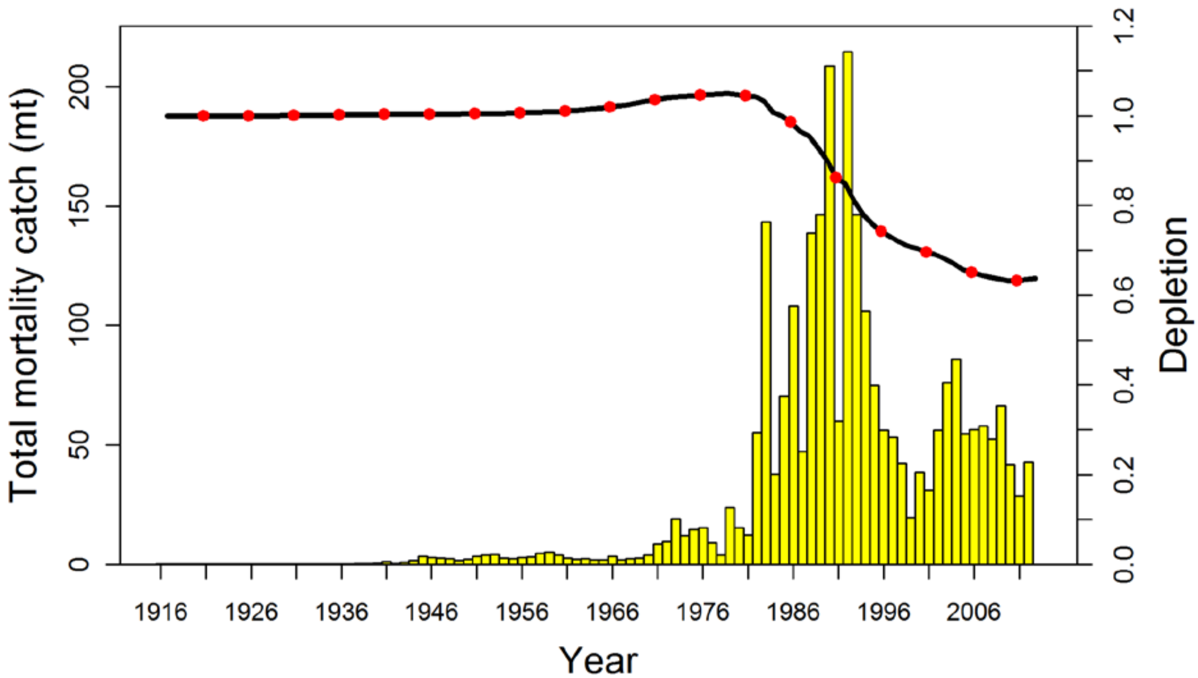


Figure 4. Total catch (mt; bars) and depletion (relative to average unexploited equilibrium level; line) for aurora rockfish, 1936-2013.

The complete version of "Stock assessment of aurora rockfish in 2013" can be found online at: http://www.pcouncil.org/wp-content/uploads/AURORA_Assessment_2013_Final.pdf

For more information on the aurora rockfish assessment, contact Owen Hamel at Owen.Hamel@noaa.gov

Darkblotched rockfish: Darkblotched rockfish (*Sebastes crameri*) in the Northeast Pacific Ocean occur from the southeastern Bering Sea and Aleutian Islands to near Santa Catalina Island in southern California. This species is most abundant from off British Columbia to Central California. Commercially important concentrations are found from the Canadian border through Northern California. This assessment focuses on the portion of the population that occurs in coastal waters of the western United States, off Washington, Oregon and California, the area bounded by the U.S.-Canada border on the north and U.S.-Mexico border on the south. The population within this area is treated as a single coastwide stock, due to the lack of biological and genetic data supporting the presence of multiple stocks.

Darkblotched rockfish has always been caught primarily with commercial trawl gear, as part of a complex of slope rockfish, which includes Pacific ocean perch (*Sebastes alutus*), splitnose rockfish (*Sebastes diploproa*), yellowmouth rockfish (*Sebastes reedi*), and sharpchin rockfish (*Sebastes zacentrus*). Catches taken with non-trawl gear over the years comprised less than 2% of the total coastwide domestic catch. This species has not been taken recreationally.

Catch of darkblotched rockfish first became significant in the mid-1940s when balloon trawl nets (efficient in taking rockfish) were introduced, and demand for rockfish increased due to World War II. The largest removals of the species occurred in the 1960s, when foreign trawl fleets from the former Soviet Union, Japan, Poland, Bulgaria and East Germany came to the Northeast Pacific Ocean to target large aggregations of Pacific ocean perch, a species that co-occurs with darkblotched rockfish. In 1966 the removals of darkblotched rockfish reached 4,220 metric tons. By the late-1960s, the foreign fleet had almost abandoned the fishery. Domestic landings of darkblotched rockfish rose again between the late-1970s and the late-1980s, peaking in 1987 with landings of 2,415 metric tons. Since the mid-1970s, a small amount of darkblotched rockfish has been also taken as bycatch in the at-sea Pacific hake fishery, with a maximum annual removal of 49 metric tons that occurred in 1995. In 2000, the species was declared overfished, and landings substantially decreased due to management regulations. This species is currently in under rebuilding. During the last decade the average landings of darkblotched rockfish made by the domestic trawl fishery was around 120 metric tons.

The first stock assessment of darkblotched rockfish was done in 1993 and stock assessments have been conducted frequently since then. This current assessment, conducted in 2013, shows that the stock of darkblotched rockfish off the continental U.S. Pacific Coast is currently at 36% of its unexploited level. This is above the overfished threshold of 25% of unexploited stock ($SB_{25\%}$), but below the management target of 40% of unfished spawning output ($SB_{40\%}$). Historically, the spawning output of darkblotched rockfish dropped below the $SB_{40\%}$ target for the first time in 1987, as a result of intense fishing by foreign and domestic fleets. It continued to decline and reached the level of 13% of its unfished output in 1999. Since 2000, when the stock was declared overfished, the spawning output was slowly increasing primarily due to management regulations instituted for the species.

The time series of total mortality catch (landings plus discards) and estimated depletion for darkblotched rockfish are presented in Figure 5.

The assessment model captures some uncertainty in estimated size and status of the stock through asymptotic confidence intervals estimated within the model. To further explore uncertainty associated with alternative model configurations and evaluate the responsiveness of model outputs to changes in key model assumptions, a variety of sensitivity runs were performed. A major source of uncertainty in the assessment is related to natural mortality, which was found to have a relatively large influence on the perception of current stock size. Female natural mortality in the assessment is fixed at the value estimated outside the model, based on other life history characteristics of the species, while male natural mortality is estimated within the model. Uncertainty from natural mortality is reported via alternate states of nature in the decision table, bracketing the base model results.

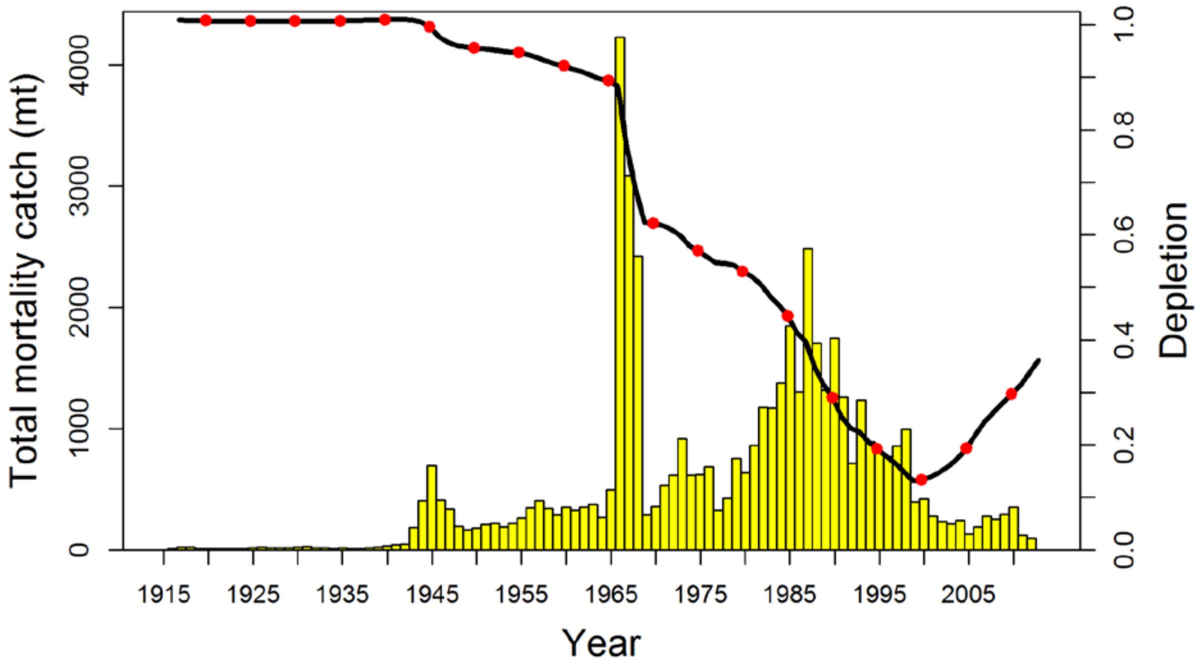


Figure 5. The time series of total mortality catch (bars) and estimated depletion (line) for darkblotched rockfish.

The complete version of "Status of the Darkblotched Rockfish Resource off the Continental U.S. Pacific Coast in 2013" can be found online at: http://www.pcouncil.org/wp-content/uploads/Darkblotched_2013_Assessment.pdf

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

Pacific ocean perch: A data report showing that overfishing has not been occurring was conducted for Pacific ocean perch in 2013. For more information on the Pacific ocean perch data report, contact John Wallace at John.Wallace@noaa.gov

Rougheye and blackspotted rockfishes: This is an assessment of rougheye rockfish (*Sebastes aleutianus*) that reside in the waters off California, Oregon, and Washington from the U.S.-Canada border in the north to the U.S.-Mexico border in the south. Rougheye rockfish are more common north of the California-Oregon border and are also harvested in waters off British Columbia and the Gulf of Alaska. Although catches north of the U.S.-Canada border were not included in this assessment, it is not certain if those populations contribute to the biomass of rougheye rockfish off of the U.S. West Coast possibly through adult migration and/or larval dispersion.

The depth and geographic distribution of blackspotted rockfish (*S. melanostictus*) overlaps with rougheye rockfish and it is very difficult to visually distinguish between the two species. It has only been from recent genetic studies in the early 2000's that two separate species have been identified and described. Consequently, the vast majority of data that are available include pooled contributions from both rougheye rockfish and blackspotted rockfish. Due to the difficulty in distinguishing these two species and the lack of historical separation of the species in all of the data, this assessment combines any data for blackspotted rockfish with rougheye rockfish and provides management advice for the two species combined. In this assessment, the term “rougheye rockfish” refers to rougheye and blackspotted rockfishes unless specified.

Rougheye rockfish are landed as part of the minor slope rockfish species complex. Because landings from the complex need not be sorted into component species for purposes of fish-ticket reporting, species composition sampling of this ‘market’ category is required to determine the amount of landed catch. The uncertainty in species composition is greater in past years, thus landings of rougheye rockfish are not well known further back in history.

This assessment was the first formal assessment model for rougheye rockfish on the U.S. West Coast and was conducted using the length- and age-structured model called Stock Synthesis (version 3.24o, pers. comm. Richard Methot, NMFS). The data used in the assessment model consisted of survey abundance indices, length compositions, discard data, and ages. Model-based biomass indices and length compositions were determined from three different surveys. Length data were also available from the fisheries in recent years. Discard data for the trawl and hook & line fisheries were available for 2002–2011 in the form of discarded biomass, length compositions, and average weights. No data were available to inform discarding practices of rougheye rockfish prior to 2002, although anecdotal information suggests little discarding occurred before trip limits were implemented in the 1990’s.

Although there are many types of recent data available for rougheye rockfish, which were used in this assessment, there is little information about steepness, natural mortality, and historical recruitment. Estimates of steepness are uncertain partly because the stock has not been fished to low levels. Uncertainty in natural mortality is common in many fish stock assessments and because length and age data are available only for recent years, there is little information to accurately estimate natural mortality, thus estimated spawning biomass is also uncertain. Finally, there is little information about the levels of historical recruitment mostly due to a lack of historical length or age data. This uncertainty was included in the predictions from this assessment.

The predicted spawning biomass from the base model generally showed a slight decline over the entire time series with a period of steeper decline during the 1980’s and 1990’s. Since 2000, the spawning biomass has stabilized and possibly increased because of reduced catches and above average recruitment in 1999. The 2013 spawning biomass relative to unfished equilibrium spawning biomass is above the target of 40% of unfished spawning biomass and there is a small probability that the stock has dropped below the 40% of unfished spawning biomass threshold in the last decade. Uncertainty in the estimated spawning biomass is high.

Exploitation rates on rougheye rockfish have exceeded *MSY* proxy target harvest rates during the 1980’s and 1990’s, and only slightly in the mid-2000’s. Exploitation rates decreased in the late 1990’s due to management restrictions, and have increased in recent years. Rougheye rockfish are managed as part of the minor slope rockfish complex, and there were species specific contributions to the OFL catch levels set for the complex in 2011 and 2012. However, catch is measured on the complex as a whole and rougheye landings exceeded the rougheye contributions to the ABC's for the complex in 2011 and 2012. In retrospect, recent landings are predicted to have been only slightly above proxy harvest target levels. Recent catch and levels of depletion are presented in Figure 6.

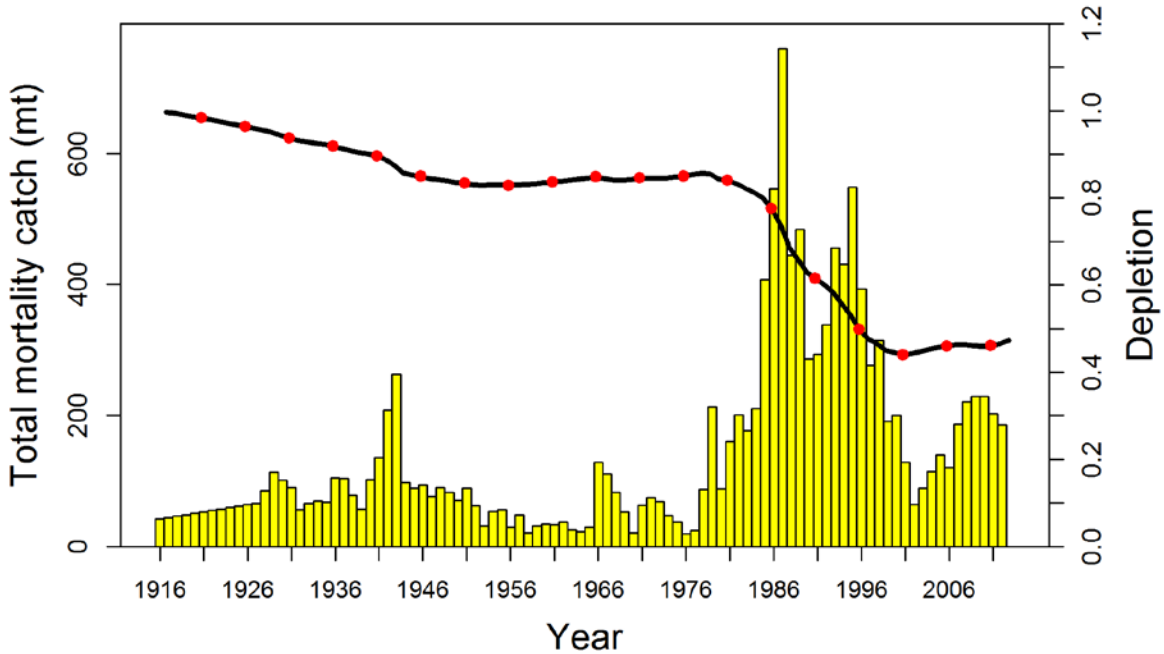


Figure 6. Total catch (mt; bars) and depletion (relative to average unexploited equilibrium level; line) for rougheye/blackspotted rockfish, 1916-2013.

The complete assessment, "The status of Rougheye Rockfish (*Sebastes aleutianus*) and Blackspotted Rockfish (*S. melanostictus*)" by Allan Hicks, Chantel, Wetzel, and John Harms can be found online at:
http://www.pcouncil.org/wp-content/uploads/Rougheye_and_Blackspotted_2013_Assessment.pdf

For more information on the rougheye and blackspotted rockfish assessment, contact Allan Hicks at Allan.Hicks@noaa.gov

3. Thornyheads

a) Stock Assessments

Full assessments of both shortspine and longspine thonyhead were conducted in 2013.

Longspine thornyhead: This assessment pertains to the longspine thornyhead (*Sebastolobus altivelis*) population located off the west coast of the continental USA, from the U.S.-Canada border in the north to the southern end of the Conception INPFC area (32.5° latitude). Longspine thornyheads have been reported from 200 meters (m) to as deep as 1,755 m, however survey and fishery data are only available down to 1,280 m. This resource is modeled as a single stock because genetic analyses do not indicate significant stock structure within this range. This is the same stock assumption made in the most recent assessment of longspine thornyhead in 2005 (Fay, 2005).

Landings of longspine were modeled as a single coast-wide fishery. Very small amounts of longspine thornyhead are caught using gears other than trawl; this catch was combined with the trawl catch. Recreational fishery landings of thornyheads were negligible, so only commercial landings were included in the model. No age information is available for longspine thornyhead, so none was included in this model. Fixed parameters used in this assessment included a natural mortality rate (M) of 0.11, and Beverton-Holt steepness (h) of 0.6. Fishery and survey selectivities were estimated as asymptotic, with the exception of the AFSC slope survey, which is dome shaped.

Total and spawning biomass of longspine thornyhead declined from the beginning of the modeled period, in 1964, until the late 1990s, with the rate of this decline being highest from the late 1980s until the mid to late-1990s due to peak catches during that period. Total biomass reached a low of 48,200 mt (compared to an unexploited level of 91,049 mt) in 1998, and spawning biomass reached a low of 18,184 mt (a depletion level of 46% of the unfished equilibrium level of 39,134). The stock, is currently only lightly exploited, and the current spawning biomass is estimated to be over 29,400 mt (a depletion of 75%), with a 95% confidence interval of 12,500 – 46,400 mt. Recent catch and depletion levels are presented in Figure 7.

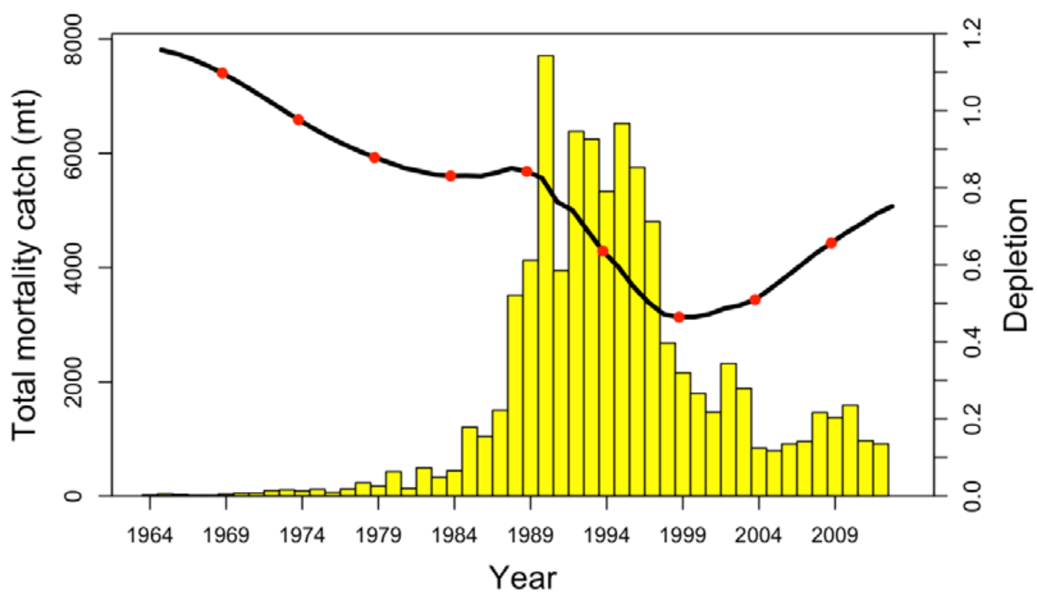


Figure 7. Total catch (mt; bars) and depletion (relative to average unexploited equilibrium level; line) for longspine thornyhead, 1964-2012.

The complete document, "Stock Assessment and Status of Longspine Thornyhead (*Sebastolobus altivelis*) off California, Oregon and Washington in 2013" can be viewed online at: www.pcouncil.org/wp-content/uploads/Longspine_Assessment_2013.pdf

For more information on the longspine thornyhead assessment, please contact Andi Stephens: Andi.Stephens@noaa.gov.

Shortspine Thornyhead: This assessment applies to shortspine thornyhead (*Sebastolobus alascanus*) off of the west coast of the United States from the U.S.-Canada border in the north to the U.S.-Mexico border in the south. Shortspine thornyheads have been reported as deep as 1,524 m, and this assessment applies to their full depth range although survey and fishery data are only available down to 1,280 m. This resource is modeled as a single stock because genetic analyses do not indicate significant stock structure within this range. This is the same stock assumption made in the most recent assessment of shortspine thornyhead in 2005 (Hamel, 2005).

Unfished equilibrium spawning biomass (B_0) is estimated to be 189,765 mt, with a 95% confidence interval of 57,435 – 322,095 mt. The B_0 estimate represents an increase from the 130,646 mt estimate for B_0 in the previous assessment although this previous estimate falls well within the uncertainty interval around the current estimate. Spawning biomass is estimated to have remained stable until the mid-1970s and then declined from the 1970s to about 80% in the 1990s, followed by a slower decline under the lower catch levels in the 2000s. The estimated spawning biomass in 2013 is 140,753 mt, which represents a stock status or "depletion" (represented as spawning biomass in 2013, B_{2013}, divided by B_0) of 74.2%. The depletion estimated for 2005 is 76.4%, which is higher than the 62.9% estimated for 2005 in the previous assessment. The standard deviation of the log of spawning biomass in 2013 is $\sigma = 0.45$, which is less than the 0.72 default minimum used in p^* adjustments to OFL values for Category 2 stock assessments.

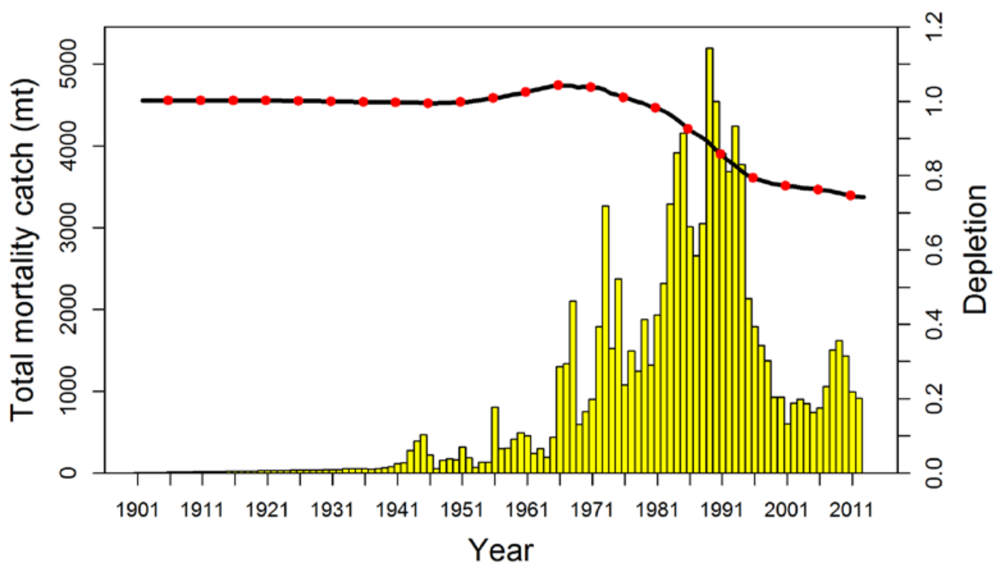


Figure 8. Total catch (mt; bars) and depletion (relative to average unexploited equilibrium level; line) for shortspine thornyhead, 1901–2012.

The complete document: "Stock Assessment of Shortspine Thornyhead in 2013" can be viewed online at: http://www.pcouncil.org/wp-content/uploads/Shortspine_2013 _Assessment.pdf

For more information on the shortspine thornyhead assessment, please contact Ian Taylor at Ian.Taylor@noaa.gov.

4. Sablefish

a) Stock Assessments

No sablefish assessment was conducted in 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

Full assessments of Pacific sanddab (accepted for status determination only) and petrale sole and data moderate assessments for English and rex soles were conducted in 2013.

Pacific sanddab: The 2013 assessment of Pacific sanddab can be found online at: http://www.pcouncil.org/wp-content/uploads/Sanddab_2013_Assessment.pdf

For more information on the Pacific sanddab assessment, contact Xi He at Xi.He@noaa.gov.

Petrale sole: This assessment reports the status of the petrale sole (*Eopsetta jordani*) resource off the coast of California, Oregon, and Washington using data through 2012. While petrale sole are modeled as a single stock, the spatial aspects of the coast-wide population are addressed through geographic separation of data sources/fleets where possible and consideration of residual patterns that may be a result of inherent stock structure. There is currently no genetic evidence suggesting distinct biological stocks of petrale sole off the U.S. coast. The limited tagging data available to describe adult movement suggests that petrale sole may have some homing ability for deepwater spawning sites but also have the ability to move long distances between spawning sites and seasonally.

The earliest catches of petrale sole are reported in 1876 in California and 1884 in Oregon. Recent annual catches during 1981–2012 range between about 700-3,000 mt (Figure 9). Petrale sole are almost exclusively caught by trawl fleets. Non-trawl gears contribute less than 2% of the catches. Based on the 2005 assessment, subsequent ACLs were reduced to 2499 mt. Following the 2009 assessment /ACLs were further reduced to 976 mt for 2011. Following the 2011 assessment ACLs were set at 1,160 and 2,592 for 2012 and 2013, respectively. From the inception of the fishery through the war years, the vast majority of catches occurred between March and October (the summer fishery), when the stock is dispersed over the continental shelf. The post-World War II period witnessed a steady decline in the amount and proportion of annual catches occurring during the summer months (March-October). Conversely, petrale catch during the winter season (November–February), when the fishery targets spawning aggregations, has exhibited a steadily increasing trend since the 1940's. Since the mid-1980s, catches during the winter months have been roughly equivalent to or exceeded catches throughout the remainder of the year. In 2009 catches of petrale sole began to be restricted due to declining stock size. However, stock increases observed during the 2011 assessment lead to less restricted catches during recent years.

Petrale sole were lightly exploited during the early 1900s but by the 1950s the fishery was well developed and showing clear signs of depletion and declines in catches and biomass (Figure 9). The rate of decline in spawning biomass accelerated through the 1930s–1970s reaching minimums generally around or below 10% of the unexploited levels during the 1980s and 1990s (Figure 9). The petrale sole spawning stock biomass is estimated to have increased slightly from the late 1990s, peaking in 2005, in response to above average recruitment (Figure 9). However, this increasing trend reversed between 2005 and 2010 and the stock has been declining, most likely due to strong year classes having passed through the fishery. Since 2010 the total biomass of the stock has increased slightly as a large 2007 recruitment appears to be moving into the population. While this increase was slight during 2011 because these fish were not yet fully mature the 2013 stock assessment has observed increases in spawning biomass as these fish have aged. The estimated relative depletion level in 2013 is 22% (~95% asymptotic interval: 15%-30%, ~ 75% interval based on the range of states of nature: 18-28%), corresponding to 7,233 mt (~95% asymptotic interval: 5,668–8,796 mt, states of nature interval: 6,800-7,846 mt) of female spawning biomass in the base model. The base model indicates that the spawning biomass has been below 25% of the unfished level since the mid-1950s.

Unfished spawning stock biomass was estimated to be 32,426 mt in the base case model. The target stock size ($SB_{25\%}$) is therefore 8,107 mt which gives a catch of 2,750 mt. Model estimates of spawning biomass at MSY and MSY yield are similar to those specified under the current harvest control rule. Maximum sustained yield (MSY) applying recent fishery selectivity and allocations was estimated in the assessment model at 2,732 mt, occurring at a spawning stock biomass of 8,739 mt (SPR = 0.25). Pacific coast flatfish, including Petrale sole, are considered overfished when the stock falls below 12.5% of unfished spawning biomass and rebuilt when it reaches 25% of unfished spawning biomass.

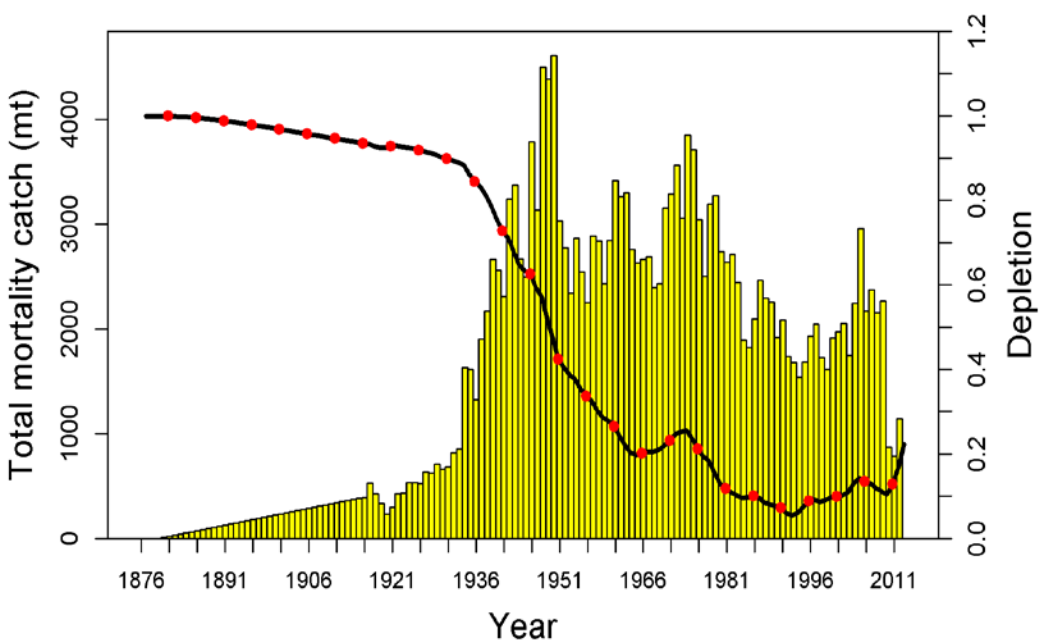


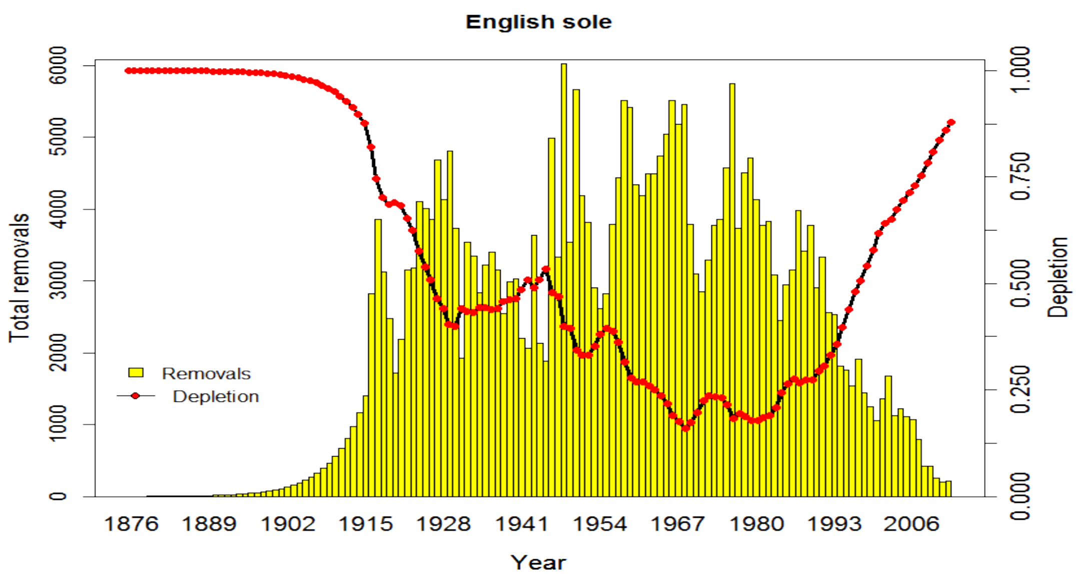
Figure 9. Time series of catch (mt; bars) and estimated depletion (line) for petrale sole.

The complete version of: Status of the U.S. petrale sole resource in 2012 can be viewed online at: http://www.pcouncil.org/groundfish/gfstocks.html

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

English and Rex Soles: Catch and index only assessments ("data-moderate" assessments) were performed for English sole and rex sole (see Figure 10a and 10b below for assessment summaries).

A.



B.

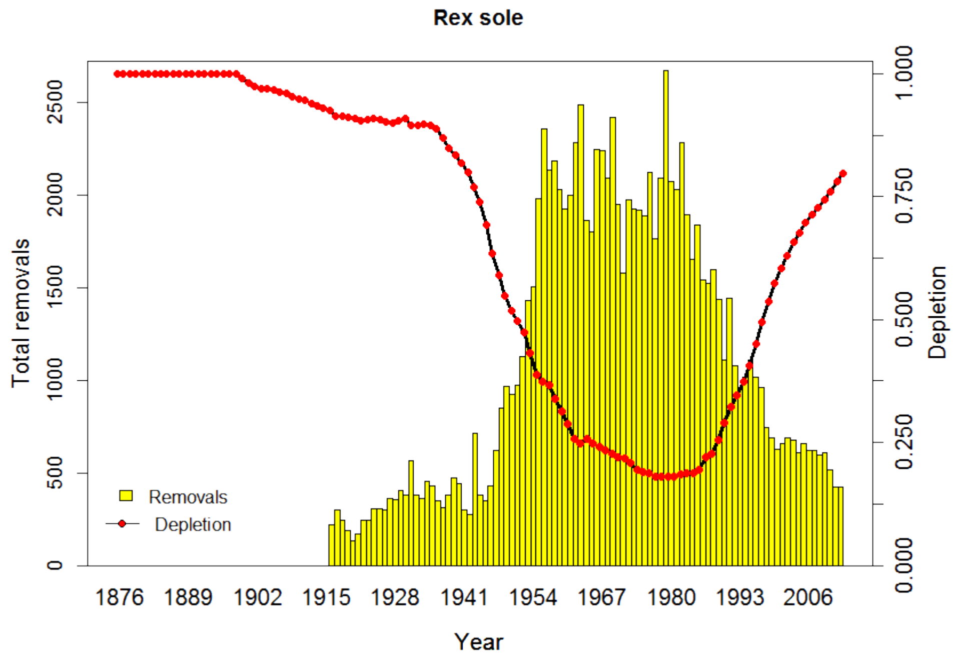


Figure 10. Time series of removals (mt; bars) and estimated depletion level (line) for catch for A) English sole and B) rex sole.

The data moderate assessment document for English and rex soles can be found at: http://www.pcouncil.org/groundfish/stock-assessments/by-year/gf2013/

For more information on the 2013 data-moderate assessments, contact Jason Cope at Jason.Cope@noaa.gov

6. Pacific Hake:

This stock assessment reported the collaborative efforts of the official U.S. and Canadian JTC members in accordance with the Agreement between the government of the United States and the government of Canada on Pacific hake/whiting. The assessment reported the status of the coastal Pacific Hake (or Pacific whiting, *Merluccius productus*) resource off the west coast of the United States and Canada. Coast-wide fishery landings of Pacific Hake averaged 222 thousand mt from 1966 to 2012, with a low of 90 thousand mt in 1980 and a peak of 363 thousand mt in 2005. Prior to 1966 the total removals were negligible relative to the modern fishery. Recent coast-wide landings from 2008–2012 have been above the long term average, at 243 thousand mt. Landings between 2001 and 2008 were predominantly comprised of fish from the very large 1999 year class, with the cumulative removal from that cohort exceeding 1.2 million mt. In 2012, U.S. fisheries caught mostly 2- and 4-year old fish from the 2008 and 2010 year classes, while the Canadian fisheries encountered older fish from the 2005 and 2006, and 2008 year classes. The Agreement between the United States and Canada establishes U.S. and Canadian shares of the coast-wide TAC at 73.88% and 26.12%.

Data were updated for the 2013 assessment with the addition of new ages into the 2011 age distribution, the addition of a new age distribution from the 2012 fishery and acoustic survey, and addition of the 2012 acoustic survey biomass estimate to the abundance index. The assessment used Bayesian methods to incorporate prior information on two key parameters (natural mortality, *M*, and steepness of the stock-recruit relationship, *h*) and integrated over parameter uncertainty to provide results that can be probabilistically interpreted. The exploration of uncertainty was not limited to parameter uncertainty as structural uncertainty was investigated through sensitivity analyses. Pacific hake displays the highest degree of recruitment variability of any west coast groundfish stock, resulting in large and rapid changes in stock biomass. This volatility, coupled with a dynamic fishery, which potentially targets strong cohorts resulting in time-varying selectivity, and little data to inform incoming recruitment until the cohort is age 2 or greater, will, in most circumstances, continue to result in highly uncertain estimates of current stock status and even less-certain projections of future stock trajectory. Uncertainty in this assessment is largely a function of the potentially large 2010 year class being observed once in the acoustic survey and twice in the fishery, although with low and uncertain selectivity. The supplemental acoustic survey performed in 2012 helped reduce the uncertainty of the strength of this year class, which is an expected result of increasing the survey frequency. However, with recruitment being a main source of uncertainty in the projections and the survey not quantifying hake until they are 2 years old, short term forecasts are very uncertain.

The base-case stock assessment model indicates that Pacific Hake female spawning biomass was below the 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 steadily 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 (a median female spawning biomass estimate of 1.34 million mt in the SS model) as the large 1999 year class matured. The stock is then estimated to have declined with the aging 1999 year class to a female spawning biomass time-series low of 0.42 million mt in 2009. This recent decline is similar to that estimated in the 2012 assessment, but at a slightly greater absolute value. The current (2013) median posterior spawning biomass is estimated to be 72.3% of the estimated unfished equilibrium level (*SB0*) with 95% posterior credibility intervals ranging from 34.7% to 159.7%. The estimate of 2013 female spawning biomass is 1.50 million mt, which is more than double the projected spawning biomass from the 2012 assessment (0.64 million mt). The difference in projected biomass is largely driven by increases in the estimated size of the 2008 and 2010 year classes.

Estimates of historical Pacific hake recruitment indicate very large year classes in 1980, 1984, 1999, and 2010. The U.S. fishery and acoustic age compositions both show the 2010 year class comprised a very large proportion of the observations in 2012. Uncertainty in estimated recruitments is substantial, especially for 2010, as indicated by the broad posterior intervals. The fishing intensity on the Pacific hake stock is estimated to have been below the $F_{40\%}$ target until 2007 and was substantially below the $F_{40\%}$ target in 2012. Although the official catch targets adopted by the U.S. and Canada have been exceeded only once in the last decade (2002), in retrospect the fishing intensity is estimated to have exceeded the target rate in three of the last five years. Recent catch and levels of depletion are presented in Figure 11.

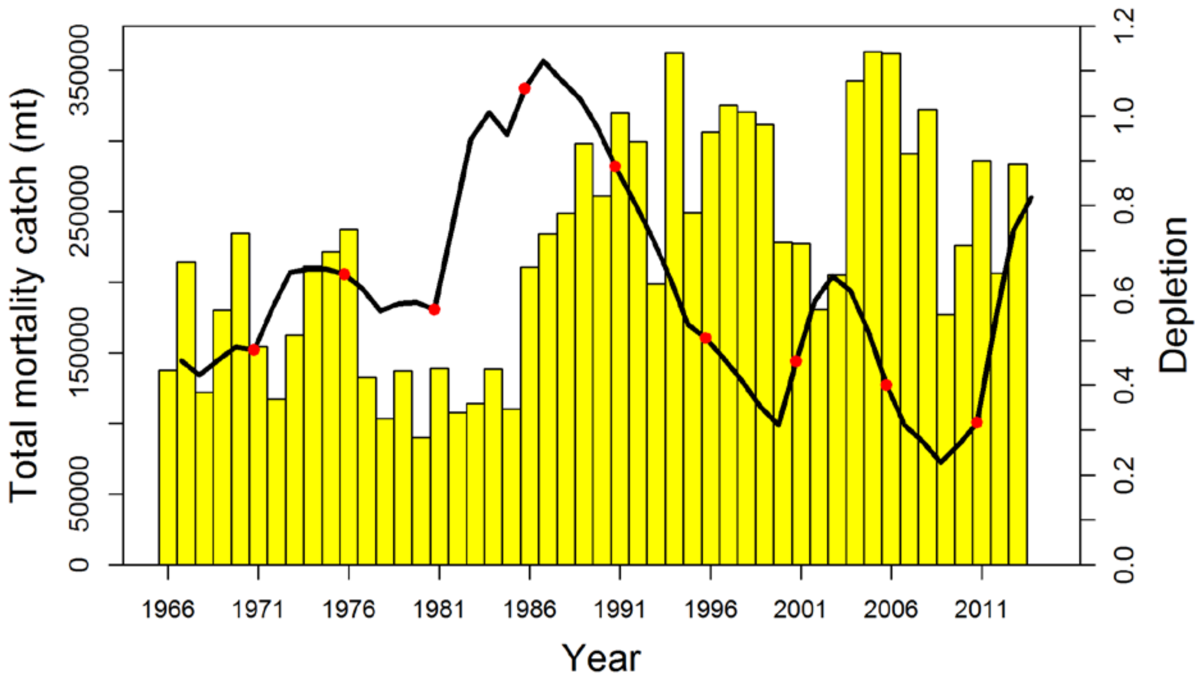


Figure 11. Total catch (mt; bars) and depletion (relative to average unexploited equilibrium level; line) for Pacific hake, 1966-2013.

The complete document: “Status of the Pacific hake (Whiting) stock in U.S. and Canadian Waters in 2013” can be viewed online at:
http://www.pcouncil.org/wp-content/uploads/Hake_2013_Assessment.pdf

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

7. Other species

No species in the ‘other’ category were assessed in 2013.

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 2013, the Active Tectonics and Seafloor Mapping Lab started to 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 U.S. 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 in the west coast groundfish and ocean shrimp trawl fisheries. In the past several years, these projects included: 1) Reducing Chinook salmon, eulachon, rockfish, and Pacific halibut bycatch in midwater and bottom trawl fisheries using BRDs, 2) Providing loaner video camera systems to the fishing industry, and 3) 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 concerns over catches of overfished rockfishes and Pacific halibut IBQ (Individual Bycatch Quota) allocated in the Pacific coast Groundfish Trawl Rationalization Catch Share Program. The trawl rationalization program, starting in January 2011, established formal Annual Catch Limits (ACLs) and individual catch share quotas. In addition to ACLs, fishing opportunities may also be limited by hard caps or IBQs for non-groundfish species (e.g., Chinook salmon, and Pacific halibut). Bycatch of overfished and prohibited 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.

a) Reducing and Rockfish Bycatch in the Pacific Hake Fishery

In 2011, the U.S. Pacific hake fishery began management under a catch share program (PFMC and NMFS, 2010). This program establishes annual catch limits (ACLs) and individual fishing quotas (IFQs) along with individual bycatch quotas for prohibited species. For many Pacific hake fishermen participating in this program, bycatch of rockfishes (i.e. darkblotched rockfish [*S. crameri*], widow rockfish [*S. entomelas*], canary rockfish [*S. pinniger*]) is a major concern because limited quota is available due to low spawning stock biomass for these species relative to the more abundant and productive Pacific hake stock. Individual fishermen could reach their quota for one of these "lower-quota" species before reaching their catch share quota of Pacific hake, thereby ending their fishing season with allowable harvest still left in the ocean unless additional quota can be leased or purchased from another quota share/permit holder. Acquiring additional quota, however, can be costly and/or difficult to obtain given certain circumstances (i.e. species needing quota coverage, amount of extra quota needed, time of year). This scenario occurred in 2011, 2012, and 2013. Developing techniques that reduce rockfish bycatch while retaining a high proportion of the targeted species in the U.S. Pacific hake fishery are increasingly important.

The Pacific States Marine Fisheries Commission (PSMFC), NOAA Fisheries Northwest Fisheries Science Center-Marine Habitat and Ecology group, and fishing industry conducted a collaborative workshop to develop a rockfish excluder for testing in the Pacific hake fishery during 2012. After an exchange of information and considerable discussion, the group came to a consensus that a flexible sorting grid excluder showed merit for reducing rockfish bycatch. Implementing recommendations made at the workshop, a pilot study was conducted in 2012 examining two (design-A and B) flexible sorting grid rockfish excluders. Results were relatively successful with one design (design-B) retaining a relatively high proportion of Pacific hake (>93% by weight) while reducing rockfish bycatch by 70%. Design-B, however, was only effective under slow-to-moderate fish volumes. Under moderate-to-high fish volumes this design tended to clog. Although design-B was ineffective under increased fish volumes, gear researchers and fishermen believed that the gear could be modified to improve its performance under higher catch levels and be effective at reducing rockfish bycatch while limiting Pacific hake loss. In 2013, we undertook a study to build on our recent findings and further examine flexible sorting grid excluders designed to reduce rockfish bycatch and evaluate its efficacy in the U.S. Pacific hake fishery.

The concept for the flexible sorting grid excluder tested is that fish smaller than the grid openings (i.e. Pacific hake) will pass through and move aft towards the codend, whereas fish larger than the grid openings (i.e. rockfishes) will be excluded. The excluder was constructed within a four-seam tube of netting that was 200 meshes deep (fore to aft) and 168 meshes in circumference, excluding meshes in each selvedge. The device was designed to be inserted between the intermediate section of the trawl and the packer/stuffing tube forward of the codend. The design utilizes two vertical panels (grids) of 7.62 x 8.89 cm (H x L) rectangular slot openings to crowd fish and direct large fish towards an upward-angled exit ramp. The vertical panels stand approximately 1.2 m in height and extend longitudinally down the tube of netting 175 meshes deep before connecting to the exit ramp. Over this distance the two panels gradually angle inward then straighten to create a narrow "hallway" that extends aft (Fig. 1). Within the "hallway" section of the excluder ropes with chaffing material wedged through them were installed to stimulate fish to interact with the vertical panels by creating a partial obstruction to fish moving aft. These ropes were positioned vertically (attached to the bottom and top panel of the tube of netting) and placed approximately every 15 meshes deep within the “hallway” section of the excluder. To reduce the potential of clogging under high fish volumes, three large rectangular sections 0.91 x 1.52 (H x L), referred to as “flex panels”, along each vertical sorting panel were created that were designed to swing open (such as a door would) to allow fish to move directly aft towards the codend if clogging was occurring. Strands of shock cord were placed vertically over the outside of the rectangular sections to keep them closed under slow-to-moderate fish volumes. These rectangular sections occurred every 1.52 m apart within the “hallway” section of the excluder. Escapement of Pacific hake and bycatch was quantified using a recapture net. The excluder and recapture net used in this study was manufactured by Foulweather Trawl, LLC.

Tests occurred off Oregon during 2013 aboard a commercial trawler. During this study, widow rockfish (*S. entomelas*) was the primary rockfish species caught. Their bycatch was reduced 26.2% by weight. The retention of Pacific hake was 92.7% by weight. Widow rockfish caught in the recapture net were statistically larger than widow rockfish retained in the trawl. Mean lengths of Pacific hake caught between the trawl and recapture net did not differ significantly. Estimated single haul catches of Pacific hake ranged from 40 to 100 mt. Catches producing over 90 mt of Pacific hake in haul durations less than 2.5 hours were made. However, under heavier fish volumes (when over 90 mt of Pacific hake were being caught in less than 45 minutes of towing) the excluder tended to clog. While further refinement of the excluder is needed for the gear to function under heavy fish volumes, this project has developed a bycatch reduction device that can assist Pacific hake fishermen reduce rockfish bycatch when fishing conditions are moderate-to-high.

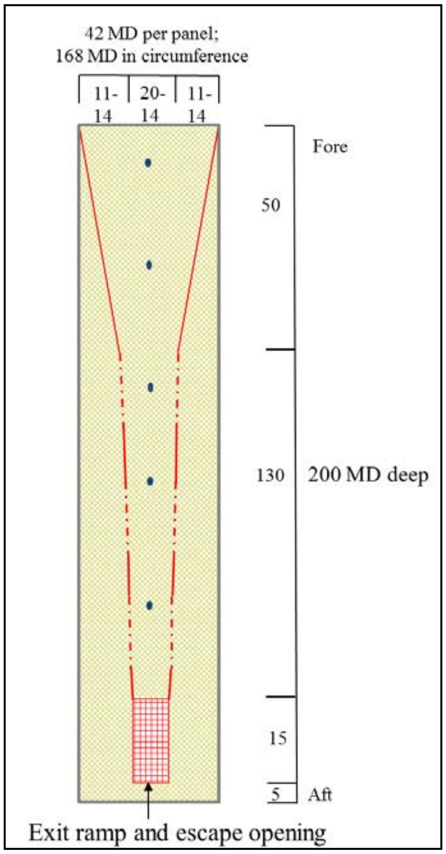


Figure 12. Top view diagram depicting the flexible sorting grid excluder tested. Solid red lines represent the vertical sorting panels; red dashed-dot-dash lines represent the "flex panels; the red grids represent the exit ramp and escape opening; the blue oval shapes represent the ropes with chaffing gear wedged through them; MD = diamond mesh. Note: this diagram is not drawn to scale.

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

b) Reducing Pacific halibut bycatch in bottom trawl fisheries

In 2011, the west coast LE groundfish trawl fishery started to be managed under a catch share program (PFMC and NMFS, 2010). This program established annual catch limits (ACLs) and individual fishing quotas (allocated by weight) along with individual bycatch quotas (IBQs) for prohibited species. For many fishermen participating in the bottom trawl component of this fishery, a major bycatch species of concern is Pacific halibut (*Hippoglossus stenolepis*), because limited IBQ is available. Individual fishermen could reach their Pacific halibut IBQ before reaching their groundfish catch share quotas, thereby ending their fishing season with allowable harvest still left in the ocean unless additional Pacific halibut bycatch quota can be leased or purchased from another quota share/permit holder. Acquiring additional quota, however, can be costly and/or difficult to obtain given certain circumstances (i.e. amount of quota needed, time of year). This scenario did occur both in 2011 and 2012. Reducing Pacific halibut bycatch would allow fishermen to more effectively utilize their catch share quotas and increase their net economic benefits. Under mandate of the International Pacific Halibut Commission (IPHC) trawl-caught Pacific halibut must be discarded at sea. Prior to the catch share program fishermen were not held individually accountable for discarding Pacific halibut. The implementation of a catch share program has created increased demand among fishermen to reduce bycatch and improve trawl selectivity. Since 2011, many fishermen have begun using BRDs to improve trawl selectivity; however, limited scientific evaluation of the devices being used is available to industry or management.

In 2013, we tested an industry-designed flexible sorting grid bycatch reduction device (BRD) that many fishermen felt showed promise in reducing Pacific halibut bycatch, while maintaining catch levels for several target species (Figure 13). Fish retention and escapement was quantified using a recapture net. Pacific halibut bycatch was reduced 83.7% by weight and 74.3% by numbers. Exclusion was highest for Pacific halibut longer than 80 cm. Retention of marketable-sized arrowtooth flounder, Dover sole, and petrale sole was 93.3%, 99.0%, and 96.9%, respectively. The percentage retained of marketable-sized shortspine thornyhead, and sablefish was 96.9% and 90.0%, respectively. Sablefish longer than 79 cm were caught in the recapture net in a higher proportion than in the trawl and accounted for nearly 50% of the 10.0% loss observed. Results demonstrated the capability of a flexible sorting grid BRD to reduce Pacific halibut bycatch, while maintaining catch levels for several target species. The scientific evaluation of this BRD will provide valuable information to the fishing industry and management.

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

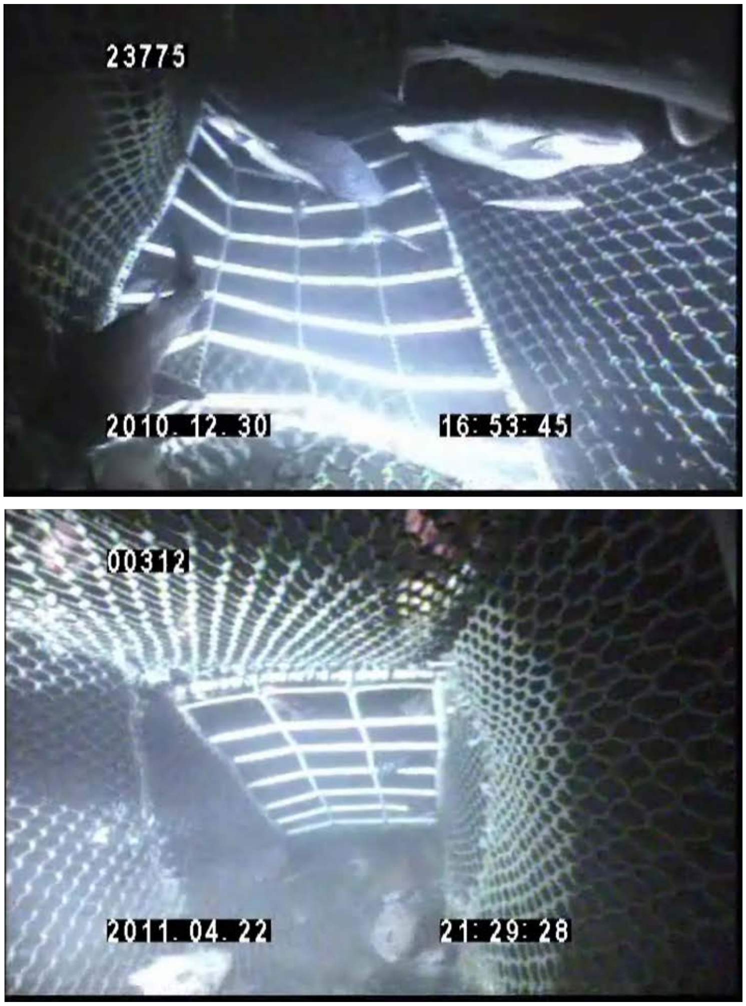


Figure 13. Video frame grabs showing flexible sorting grates developed by the fishing industry to reduce Pacific halibut bycatch in the groundfish bottom trawl fishery. Information gained from the videos was used to improve the performance of the grates.

c) 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 (Figure 14). These camera systems have been used extensively across the Pacific hake midwater trawl fishery, groundfish bottom trawl fishery, and the pink shrimp trawl fishery.

Figure 14. One of four autonomous direct observation video camera systems developed at the NWFSC.

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 2013, CAP aged more than 28,000 otoliths. About 15,500 were aged in the first half of the year, for inclusion in the 2013 assessments for petrale sole, darkblotched rockfish, aurora rockfish and rougheye rockfish. Throughout 2013, 8,700 hake otoliths were aged for use in the 2014 joint hake assessment with Canada. CAP also completed over 1,800 training age reads during the year. CAP continued the practice of recording otolith weights prior to breaking and burning, in support of research into alternative methods of age determination. They are also collaborating with a NW Center engineer in Seattle to explore alternative light-based means of counting annuli.

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 sixteenth annual bottom trawl resource survey for groundfish off the coasts of Washington, Oregon, and California. The objective of the 2013 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 2013 survey was reduced to a 3-vessel survey in 2013 because of insufficient funds to conduct a full 4-vessel survey. The survey was further reduced by the government shutdown (Oct. 1 – 17) which caused an early end to the survey on Sept. 30. We lost 18 sampling days and about 72 stations all south of Monterey Bay, CA due to the unanticipated furlough. The complete loss of one of the four vessels used to conduct the survey in 2013, due to budget cuts, created problems with the 2013 data that were exacerbated by the complete loss of the final portion of the survey in southern CA. In addition to having less data, the latitudinal terminus of the data for the second pass of the survey is in the middle of statistical areas (depth x latitude) used for analysis across years. Our assessment scientists have indicated this will complicate and reduce the usefulness of even the data that were collected during the second pass.

The NWFSC chartered commercial fishing vessels to conduct independent, replicate surveys using standardized trawl gear. Fishing vessels *Last straw*, *Noah's Ark* and *Excalibur* were contracted to survey the area from Cape Flattery, WA to the Mexico border in Southern California, beginning in the later part of May and continuing through October. Each charter was for a period of 11-12 weeks with the *Last Straw* and *Noah's Ark* surveying the coast during the initial survey period from May to July. The *Excalibur* planned to survey the coast during a second pass from mid-August to late October. However since the survey ended on Sept. 30th the period of the charter was shortened by several weeks. 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 for a 3-vessel survey consisted of 564 sampling locations.

In 2013, 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) Echinoderm adaptations to hypoxia across the Southern California continental margin - Scripps Institution of Oceanography, UC San Diego; 2) Maturity investigations for blackgill rockfish (*Sebastes melanostomus*) – Southwest Fisheries Science Center; 3) *Chionoecetes* spp. mitogenome comparative research - AFSC; 4) A study on the life history of the pygmy rockfish, *Sebastes wilsoni* - Marine Science Institute, University of California, Santa Barbara; 5) Record all sightings of basking sharks – Moss Landing Marine Laboratories; 6) Collections of eastern North Pacific softnose skates, Genus *Bathyraja* – Moss Landing Marine Laboratories; 7) Collection of any Pacific black dogfish, *Centroscyllium nigrum* – Moss Landing Marine Laboratories; 8) 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; 9) Collection of all unusual or unidentifiable sharks including small sleeper sharks, *Somniosus pacificus* and velvet dog shark (*Zameus squamulosus*) – Moss Landing Marine Laboratories; 10) Collection of any chimaera that is not *Hydrolagus colliei*, including: *Harriotta raleighana*, *Hydrolagus* spp. and *Hydrolagus trolli* – Moss Landing Marine Laboratories; 11) Collection of voucher specimens for multiple fish species – Northwest Fisheries Science Center; 12) Collection of vouncher specimens for multiple fish species – Oregon State University; 13) 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 2013 West Coast Groundfish Trawl Survey; and 8) Collection of ovaries from Pacific ocean perch, Pacific hake, aurora rockfish, lingcod, sablefish, shortspine thornyheads, Dover sole and canary rockfish to assess maturity; 9) maturity of tanner crabs.

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

b) Southern California shelf rockfish hook-and-line survey

In early Fall 2013, FRAM personnel conducted the 10th 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*), cowcod (*S. levis*), and the vermilion rockfish complex (e.g., *S. miniatus* and *S. crocotulus*) within the SCB.

The F/V *Aggressor* (Newport Beach, CA), F/V *Mirage* (Port Hueneme, CA), and F/V *Toronado* (Long Beach, CA) were each chartered for 9 days of at-sea research, with 13 biologists participating during the course of the survey. The three vessels sampled a total of 121 sites ranging from Point Arguello in the north to 9 Mile Bank and the U.S.-Mexico EEZ boundary in the south. Normally conducted aboard two chartered vessels, the addition of a third survey boat in 2013 was a response to internal and external peer reviews recommending additional research into the role the vessel platform plays in abundance modeling.

Approximately 3,471 sexed lengths and weights, 3,386 fin clips, and 3,280 otolith pairs were taken during the course of the entire survey representing 33 different species of fish and 1 invertebrate species. Several ancillary projects were also conducted during the course of the survey. Approximately 640 ovaries were collected from 11 different species to support the development of 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 an underwater video sled to capture visual observations for habitat analysis, species composition, and fish behavior studies.

For more information, please contact John Harms at John.Harms@noaa.gov

c) 2013 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 9 June 2013 to 27 August 2013, and by a Canadian team (DFO/Pacific region) on the CCGS *W.E. Ricker* from 22 August 2013 to 11 September 2013. 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 32.8°N (off San Diego) to 54.7°N (Dixon Entrance) with acoustic transects spaced 10 nm apart. Acoustic data were collected on the *Shimada* with an EK60 echosounder operating at frequencies of 18, 38, 70, 120, and 200 kHz, and on the *Ricker* with an EK60 echosounder operating at frequencies of 18, 38, and 120 kHz. The survey resulted in 134 transects with 5,536 nautical miles of acoustical transect that were used for the hake biomass estimate. Nine transects of 212 nautical miles in the Southern California Bight were used just for the sardine biomass estimate. Aggregations of adult (age 2+) Pacific hake were detected on 101 transects from just south of Morro Bay

(35.3°N), north along the U.S. and Canadian coast, in the Queen Charlotte Sound and Hecate Strait, and at the southwest tip of Haida Gwaii (known formerly as the Queen Charlotte Islands). Highest concentrations of Pacific hake were observed off the San Francisco Bay area, north of Cape Mendocino to Crescent City, and off the central Oregon coast. Hake sign was relatively light off the Washington coast and Vancouver Island. North of Vancouver Island, hake were quite sparse or absent, except for one aggregation in Hecate Strait near Banks Island. Midwater trawls equipped with a camera system 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 93 successful trawls (76 by the *Shimada* and 17 by the *Ricker*) resulted in a total hake catch of 19,249 kg (15,048 kg from the *Shimada* and 4,201 kg from the *Ricker*). The estimated total biomass of adult Pacific hake in 2013 was 2.423 million metric tons of which over 95% was from U.S. waters. The 2013 estimate represented an increase of over one million metric tons (75%) over the biomass estimate from 2012. Age-3 hake were dominant, amounting to 70% of the total survey-wide observed biomass and over 76% of observed numbers. The 2010 cohort was roughly seven times larger than the 2008 cohort.

For more information, please contact Larry Hufnagle at
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5. NOAA Program: Fisheries And The Environment (FATE)

a) 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 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.

For more information, contact Melissa Haltuch at Melissa.Haltuch@noaa.gov.

b) Incorporating climate driven growth variability into stock assessment models: a simulation-based decision table approach

Investigators: J. T. Thorson, A.E. Punt and V.V. Gertseva

Funding for this collaborative project between the Northwest Fisheries Science Center (NWFSC) and University of Washington is obtained from the NOAA Fisheries and the Environment (FATE) Program, for the period between 2013 and 2015. The motivation for this work is that biological characteristics of managed fishes are likely to vary with time due to environmental variability. Growth of splitnose and yelloweye rockfishes has been previously found to be highly correlated with several productivity indicators in the California Current Ecosystem, and time-series of climate-growth indices have been developed for these two species, using otolith band reading techniques. These indices, however, have not been used to inform stock assessments, due to a lack of guidance for when and how to incorporate indices of time-varying individual growth into an assessment model. This project will use a generic decision table approach to evaluate the effects of incorporating climate-driven time-varying growth into stock assessment models. Values in the decision table will represent management outcomes (i.e. lost yield and the probability of overfishing) and will be generated using simulation modeling, while existing data for splitnose and yelloweye rockfishes will be used to estimate the prior probability of time-varying growth. This simulation-based decision table approach will provide guidance on whether and how to include the environmental indices in future splitnose and yelloweye rockfish assessments. It could also be used generically to help evaluate the utility of including environmental data in stock assessment models. Funding for this project will support a Master's student.

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

6. Ecosystem Studies

a) 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 Phase II iteration of the California Current IEA, which covers up to 2012, 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 Phase II report is divided into sections that describe: (1) engagement with managers; (2) status and trends of drivers and pressures; (3) status and trends of key ecosystem components; (4) risk assessments for focal indicators to key pressures; and (5) scenario-based evaluation of management strategies, along with a series of visuals and detailed appendices. 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 fisheries and cetaceans; and the system-wide effects of the trawl fishery rationalization. The Phase II report of the California Current IEA is now available as a web document with downloadable chapters.

For more information, please contact Phil Levin at Phil.Levin@noaa.gov, or go to http://www.noaa.gov/iea/CCIEA-Report/index.html

b) Spatial, semi-parametric models improve estimates of species abundance and distribution

Investigators: A.O. Shelton, J.T. Thorson, E.J. Ward and B.E. Feist

Accurate estimates of abundance are imperative for successful conservation and management. Classical, stratified abundance estimators provide unbiased estimates of abundance but such estimators may be imprecise and impede assessment of population status and trend when the distribution of individuals is highly variable in space. Model-based procedures that account for important environmental covariates can improve overall precision, but frequently there is uncertainty about the contribution of particular environmental variables and a lack of information about variables that are important determinants of abundance. The authors develop a general semi-parametric mixture model that incorporates measured habitat variables and a non-parametric smoothing term to account for unmeasured variables. They contrast this spatial-habitat approach with two stratified abundance estimators and compare the three models using an intensively managed marine fish, darkblotched rockfish (*Sebastes crameri*). The authors show that the spatial habitat model yields more precise, biologically reasonable, and interpretable estimates of abundance than the classical methods. Results suggest that while design-based estimators are unbiased, they may exaggerate temporal variability of populations and strongly influence inference about population trend. Furthermore, when such estimates are used in broader meta-analyses such imprecision may affect the broader biological inference (e.g. the causes and consequences of the variability of populations).

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c) Predicting regional and coast-wide impacts of future fisheries development in the California Current

Investigators: K.N. Marshall, I.C. Kaplan and P.S. Levin

Growing human populations put increasing demands on marine ecosystems. Studies have demonstrated the importance of large biomass forage groups in model food webs, but small biomass contributors are often overlooked. Here, the authors predict the ecosystem effects of three potential future fisheries targeting functional groups that make up only a small proportion of total ecosystem biomass using the California Current Atlantis Model: deep demersal fish such as grenadier (*Albatrossia pectoralis* and *Coryphaenoides acrolepis*), nearshore fish such as white croaker (*Genyonemus lineatus*), and shortbelly rockfish (*Sebastes jordani*). Using a spatially explicit ecosystem model, fishing scenarios for these groups were explored that resulted in abundance levels of 75, 40, 25, and 0 percent of the status quo fishing scenario. The authors evaluated the effects on coast-wide biomass and describe variation in affected groups by region. Results indicate that developing fisheries on the proposed targets would have low coast-wide effects on other species. However, effects varied significantly within the ecosystem, with higher impacts concentrated in the central California region of the model. This work provides a framework for evaluating effects of new fisheries and suggests that regional effects should be evaluated within a larger management context.

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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, the authors 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, the 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) Non-fisheries pressures on groundfish essential fish habitat

Investigators: K.S. Andrews

There are numerous non-fisheries related pressures acting upon groundfish essential fish habitat (EFH) along the West Coast of the United States. The author presents an example of how some non-fisheries pressures can be analyzed in order to be incorporated into the management framework for West Coast groundfish EFH, and a synthesis of readily available information about threats in these marine areas. First, the author takes advantage of 16 spatially-explicit data layers available from Halpern et al. (2009) to quantify the intensity of non-fisheries pressures among various regions, depth strata, habitat substrate types, and spatial management boundaries related to West Coast groundfish EFH. From the 16 non-fisheries related pressures, the author identified seven that were most relevant to West Coast groundfish EFH and which had enough data to be useful for a coastwide analysis. Initially, these pressures along with two climate change pressures are individually reported. In order to summarize the distribution of non-fisheries pressures, all 16 non-fisheries pressures were into a "combined" pressures data layer.

Non-fisheries pressures were greatest in the Salish Sea sub-region, which is entirely in shelf habitat and is consequently highly exposed to numerous land-derived pressures. Among other sub-regions, offshore pressures were more intense in the north, while nearshore pressures were more intense in the south. For example, lower slope habitat was exposed to higher pressure intensity values in the northern sub-region, while shelf and upper slope habitat was exposed to higher pressure intensity values in the southern sub-region. There was little variation in the mean intensity of non-fisheries pressures across EFH conservation areas compared to other spatial management regions. This was likely because EFH conservation areas were located offshore and relatively unexposed to land-based pressures. Habitat areas of particular concern (HAPCs) were proportionately more exposed to high non-fisheries pressures than other spatial management areas, and this is generally true across other individual pressures.

Andrews, K.S. 2013. Non-fisheries pressures. Appendix 3.2 in National Marine Fisheries Service. Groundfish essential fish habitat synthesis: a report to the Pacific Fishery Management Council. NOAA NMFS Northwest Fisheries Science Center, Seattle, WA, April 2013. 107p.

For more information, please contact Kelly Andrews at Kelly.Andrews@noaa.gov.

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, the authors 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. The authors quantified the exposure of each species to each fleet type by multiplying the predicted mean cetacean density by the measured fishing fleet effort. They 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, results suggest there is opportunity for fisheries interactions with some cetacean species, particularly in the fixed gear fleets. These 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) The legacy of a crowded ocean: indicators, status, and trends of anthropogenic pressures in the California Current ecosystem

Investigators: K.S. Andrews, G.D. Williams, J.F. Samhouri, K.N. Marshall, V. Gertseva and P.S. Levin

As human population size and demand for seafood and other marine resources increase, the influence of human activities in the ocean (e.g., fishing and shipping activity) and on land (e.g., pollutants and runoff from industrial and agricultural activities) is increasingly critical to the management and conservation of marine resources. In order to make management decisions related to anthropogenic pressures on marine ecosystems, there is a need to understand the links between pressures and ecosystem components, and those linkages cannot be drawn unless there is information on how pressures have been changing over time. The authors developed indicators and time series of indicators for 22 anthropogenic pressures at the scale of the U.S. portion of the California Current ecosystem. Time series suggest that seven pressures have decreased and two have increased over the short term, while five pressures were above and two pressures were below long-term means. Cumulative indices of anthropogenic pressures suggest a slight decrease in pressures in the 2000's compared to the preceding few decades. Dynamic factor analysis revealed four common trends that sufficiently explained the temporal variation found among all anthropogenic pressures. Using this reduced set of time series will be useful when trying to determine whether links exist between individual or multiple pressures and various ecosystem components.

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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, the authors 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 understanding of species interactions and will improve the ability to predict changes in food web dynamics under various environmental and management scenarios.

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i) Spatial and seasonal variation in δ^{15}N and δ^{13}C values in a mesopredator shark, *Squalus suckleyi*, revealed through multi-tissue analyses.

Investigators: J.C.P. Reum and T.E. Essington

The authors used variance decomposition to explore the importance of body size, sex, location, and sampling period as predictors of intrapopulation variation in δ^{15}N and δ^{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 δ^{15}N and δ^{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.

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j) Comparing the movements of spiny dogfish *Squalus suckleyi* in the north Pacific with satellite and acoustic tracking technology

Investigators: C. Tribuzio and K.S. Andrews

Spiny dogfish (*Squalus suckleyi*) are a small species of shark, common in coastal waters of the eastern North Pacific Ocean. Previous tagging studies have shown that they have the potential to undertake large scale migration and that there are seasonal patterns to their movement. This study investigates movement on an even finer scale. The miniaturization of pop-off satellite archival tags (PSATs) has enabled smaller species to be tagged. Since 2009, 184 PSATs were deployed on spiny dogfish at locations across the Gulf of Alaska, British Columbia (Canada) and Puget Sound (Washington, USA) waters. To date, 145 tags have been recovered, with 31 still outstanding and the remainder failed to report. As well, 6 spiny dogfish were double tagged with acoustic tags and deployed in Puget Sound. Preliminary results such as pop-off location are already elucidating surprising movement patterns. While most spiny dogfish were tagged in the Gulf of Alaska, many fish moved as far south as southern California. Further, the fish that undertook the large scale migrations, tended to have a different daily movement pattern from those that remained. A great deal of analysis remains on this project, but early results are intriguing and suggest that spiny dogfish are more highly mobile than previously believed.

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k) Conceptual models and indicator selection process for Washington State's marine spatial planning process

Investigators: K.S. Andrews, C.J. Harvey and P.S. Levin

In March 2010, the Washington State legislature enacted a new state law on marine spatial planning (MSP; Substitute Senate Bill 6350). One of the primary objectives of this law was to develop a comprehensive marine management plan for the state's marine waters. The law stipulated that the "plan must include an ecosystem assessment that analyzes the health and status of Washington marine waters including key social, economic, and ecological characteristics. This assessment should seek to identify key threats to plan goals, analyze risk and management scenarios, and develop key ecosystem indicators." In support of Washington State's MSP process, this report develops a conceptual model and begins to develop corresponding ecosystem indicators that describe the important ecological components, oceanographic drivers, and human pressures in Washington State waters. The conceptual model serves as the basic framework for the development of ecosystem indicators and assessing the status and trends of key components of the ecosystem in Washington marine waters. In this report, we focused on non-human ecological components, oceanographic drivers and human pressures. Future research will focus on integrating social, economic and cultural characteristics into the conceptual model. The authors organized the conceptual model of Washington State waters according to major types of habitat found along and off the coast: rocky intertidal shores, sandy beaches, kelp forests, seafloor, and the pelagic zone. Key components of each habitat (e.g., focal species, predator-prey interactions, oceanographic drivers, and human pressures) were linked within each conceptual model based on reviews of the literature and expert opinions of how the ecological systems worked. The authors then used an evaluation framework to select and evaluate potential indicators that could be tracked for each of the key components of each habitat's conceptual model. This research will continue until a suite of indicators have been chosen that will characterize the status and trends of key components related to the socio-ecological conditions of Washington's marine waters.

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l) 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. The authors 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. Results suggest failing to account for the full extent of a fish's time overestimates the effectiveness of marine reserves.

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m) 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

Mean trophic level (MTL) is one of the most widely used indicators of marine ecosystem health. It usually represents the relative abundance of fished species across a spectrum of TLs. The reality, ubiquity, and causes of a general decline in the MTL of fisheries catch through time, and whether fisheries catch tracks ecosystem level changes, have engendered much attention. However, the consequences of such patterns for broader ecosystem structure and function remain virtually unexplored. Along the Pacific U.S. Coast, previous work has documented fluctuations and a slow increase in ecosystem MTL from 1977 to 2004. Here, the authors document a decline in the ecosystem MTL of groundfishes in the same ecosystem from 2003 to 2011, the proximate cause of which was a decrease in the biomass of higher TL groundfishes. Using a food web model, they illustrate how these shifts in ecosystem structure may have resulted in short term, positive responses by many lower TL 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 other higher TL species, such as salmon and seabirds. Although 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 TL indicators.

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n) Beta diversity of demersal fish assemblages in the north-eastern 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. The authors 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.

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o) Economic impacts of ocean acidification on California Current fisheries

Investigators: B. Wippel, K.N. Marshall, and I.C. Kaplan

Ocean acidification may restructure marine food webs by causing declines in calcifying species and the predators that feed on them. Here, the authors quantify economic effects of reduced catches of predators in the California Current stemming from erosion of their calcifying prey groups. Diet data were synthesized from the published literature to describe the vulnerability of commercially important species (Dungeness crab, Dover sole, Pacific whiting, and sablefish) to potential declines in echinoderms and mollusks. The authors then predicted potential losses of fisheries revenues due to loss of these prey species. They predict Dover sole is highly vulnerable because calcifiers comprise 40% of its diet. Ocean acidification could cost $690,000 - 2.76 million in lost fisheries. Costs would be disproportionately higher in Oregon, where most Dover sole are landed. This simple analysis is a first step in predicting economic costs of indirect effects of ocean acidification for fisheries along the West Coast.

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p) 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. The authors explored the impacts of CO_2 on growth, development, and survival of China rockfish (*Sebastes nebulosa*) larvae. Larvae were reared 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.

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q) Variability in rockfish (*Sebastes* spp.) fecundity: species contrasts, maternal size effects, and spatial differences

Investigators: S.G. Beyer, S.M. Sogard, C.J. Harvey and J.C. Field

Over 60 species of rockfish (*Sebastes* spp.) reside off the coast of California, many of which are economically important to both recreational and commercial fisheries. Rockfish are live-bearers with a diverse array of reproductive strategies. Understanding the reproductive potential of an exploited stock is critical to assessing the health and status of a fishery. The authors investigated the reproductive ecology of four rockfish species to examine species contrasts and to determine spatial and maternal-size effects on reproductive potential. Females were sampled during the winter parturition season (November through March) of 2009 through 2012. Maternal length and somatic weight were positively correlated with relative fecundity (larvae per g somatic weight) in all four species, indicating a disproportionately greater reproductive output by larger, older females. Fecundity estimates in chilipepper, *S. goodei*, and yellowtail rockfish, *S. flavidus*, varied regionally, but did not significantly differ over time within the years sampled (sample sizes for speckled, *S. ovalis*, and blackgill rockfish, *S. melanostomus*, were too small to allow spatiotemporal comparisons). Two reproductive strategies were evident as yellowtail and blackgill rockfish produced a relatively highly fecund, single brood of smaller-sized larvae annually, in contrast to chilipepper and speckled rockfish, which produced larger-sized larvae with lower fecundity. In some regions multiple broods were common, complicating estimates of annual fecundity for these two species. There was some evidence that 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).

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r) Anthropogenic drivers and pressures in the California Current integrated ecosystem assessment

Investigators: K.S. Andrews, G.D. Williams and V.V. Gertseva

This work is a part of the California Current Integrated Ecosystem Assessment (IEA). One of the goals of the IAE is to fully understand the web of interactions that links drivers and pressures to ecosystem-based management (EBM) components and to forecast how changing environmental conditions and management actions affect the status of EBM components.

As human population size and demand for seafood increases globally and within the California Current, numerous human activities in the ocean (e.g., fishing and shipping activity) and on land (e.g., pollutants and runoff from agricultural activities) need to be recognized and incorporated into management of marine resources. Because these pressures originate from human activities, there is a need to assess current and historic levels, as well as predict future levels of the pressure. Establishing specific target levels of a pressure (e.g., fisheries landings quotas or concentration of nitrogen in coastal waters) will allow managers to determine whether the current status and trend of the pressure is moving in the right direction or whether alternative management strategies may be needed. The authors identified and described primary groups of fisheries and non-fisheries related anthropogenic pressures that affect various components of the CCLME. They also evaluated various indicators that are best suited to capture the trends and variability of these pressures and provided time series data describing the status and trends of each pressure.

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7. Acoustic Modeling and Research

a) Calibration of a broadband acoustic system in nearfield (ASTWG funded research)

Conventional calibrations of narrowband systems involving one or more standard targets are normally conducted in the farfields of both the transducer and the calibration sphere. However, for a multibeam system that spans a wide angular range or a broadband system that spans a wide frequency range, the farfield requirement may not be satisfied easily. The effect and influence of the nearfield application have been discussed and analyzed by various investigators. To improve our ability to conduct calibration in the nearfield, researchers have accomplished a number of tasks related to this project:

- Built a laboratory pulse-echo system.

  The dimensions of the tank are 60 cm x 38 cm x 30 cm (shown in Fig. 15). The precision of the 3D positioning system is 0.01mm. The bandwidth of Pulser/Receiver system, manufactured by Panametrics, Inc, is more than 30 MHz, with output energy selectable from 12.5 µJ to 100 µJ. A digital oscilloscope (LaCroy Wave Runner) can provide 100 MHz maximum sampling rate.

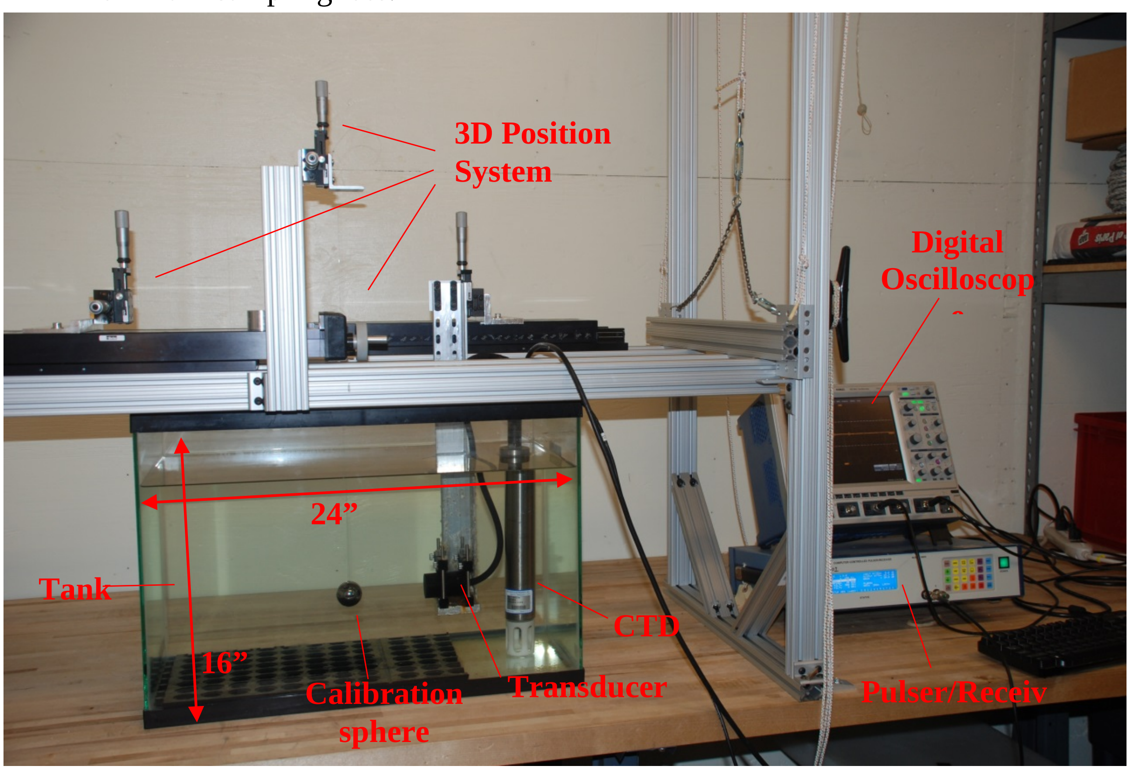

Figure 15. Photograph of the experiment tank, position system, and the pulse-echo system.

- Determination of the material properties of calibration spheres.

  The previous pre- and post- survey calibrations were all based on the TS of spheres calculated with the nominal material properties: density, and compressional and shear wave speeds. Using the built pulse-echo system, these parameters were measured and determined for all 38.1 mm WC spheres and the 25 mm WC sphere #1, including the one used in the hake acoustic survey in 2013 (WC38.1 #2, NWFSC) (Table 2). The authors also helped to measure the material properties for two spheres (20 mm and 22 mm) from our colleagues at the Institute of Marine Research (IMR), Norway. Utilizing the determination methods, one of the spheres was an unknown, but was determined to be stainless steel.

  In addition to these targets, nearfield measurements were made on the 1st 64 mm Cu sphere at a separation of 10 cm. The compressional speed was hardly changed from its nominal value and the shear wave speed was also only slightly different from its nominal value showing only about 0.10% variation from the mean.

Table 2. Experimentally determined material properties of the calibration spheres.

Sphere	Density ($g\ cm^{-3}$)	Compressional wave speed ($m\ s^{-1}$)	Shear wave speed ($m\ s^{-1}$)
WC25 #1, NWFSC	14.23 ± 0.02	6765.05 ± 4.06	3964.70 ± 5.37
WC38.1 #1, NWFSC	14.96 ± 0.01	6804.19 ± 4.90	4182.59 ± 6.69
WC38.1 #2, NWFSC	14.46 ± 0.01	6802.93 ± 4.74	4083.74 ± 2.53
WC38.1 #3, NWFSC	14.92 ± 0.01	6802.48 ± 4.66	4191.15 ± 4.17
WC20, IMR	14.96 ± 0.01	6800.63 ± 0.92	4187.71 ± 1.25
SS20, IMR	7.96 ± 0.01	5669.94 ± 21.71	2987.69 ± 2.24
Cu64 #1, NWFSC	8.93 ± 0.004	4760.01 ± 0.24	2282.02 ± 2.37

- Development of the theory, algorithms, and experimental protocols of near-field calibration for high frequency broadband transducers.

  The theory is based on the exact integral representations of acoustic radiation/reception by a circular disk (piston), and the exact backscattering by a solid elastic sphere with a spherical incident wave. The solutions are exact for both far-field and near-field applications, which allows a variety of better controlled acoustic scattering measurements to be conducted in the laboratory to determine the acoustic characteristics of marine species. The results from such scattering characteristics provide very useful information for spectral classification of marine animals. The data processing algorithms for broadband transducer calibration have been developed, including numerical evaluations of integral representation of the exact solution, spherical wave representation of the backscattering by a solid elastic sphere, and spectral processing and analysis of broadband signals. In addition, the protocols of conducting near-field calibration in a small aquarium have been developed, i.e. a capability of calibrating a broadband transducer with much less efforts and less time consuming.

- Determination of the calibration curves as a function of frequency.
  Total of five transducers have been calibrated, including four from the NWFSC and one out of three broadband transducers from Dr. Kelly Benoid-Bird (OSU). These five transducers have a frequency band covering several hundreds of kHz, all with center frequency around 500 kHz. The nominal bandwidths (manufacturer's specification sheet) are only less than 200 kHz, but with near-field calibration, a much wider usable bandwidth can be achieved since a higher signal-to-noise ratio (SNR) can be obtained in near-field. A representative calibration curve of the Transducer #1 from NWFSC as a function of frequency is shown in Fig. 16. The comparison of the theoretical predictions with the calibrated backscattering data using a WC25 sphere at different distances is provided in Fig. 17.

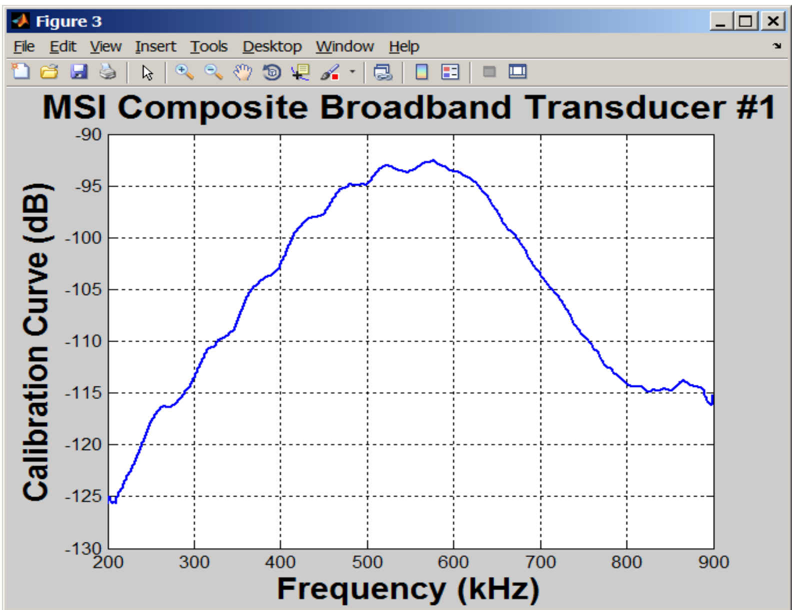

Figure 16. Calibration curve of the NWFSC Transducer #1 (MSI) as a function of frequency. The useable bandwidth is seen to be approximately from 300 kHz to 800 kHz.

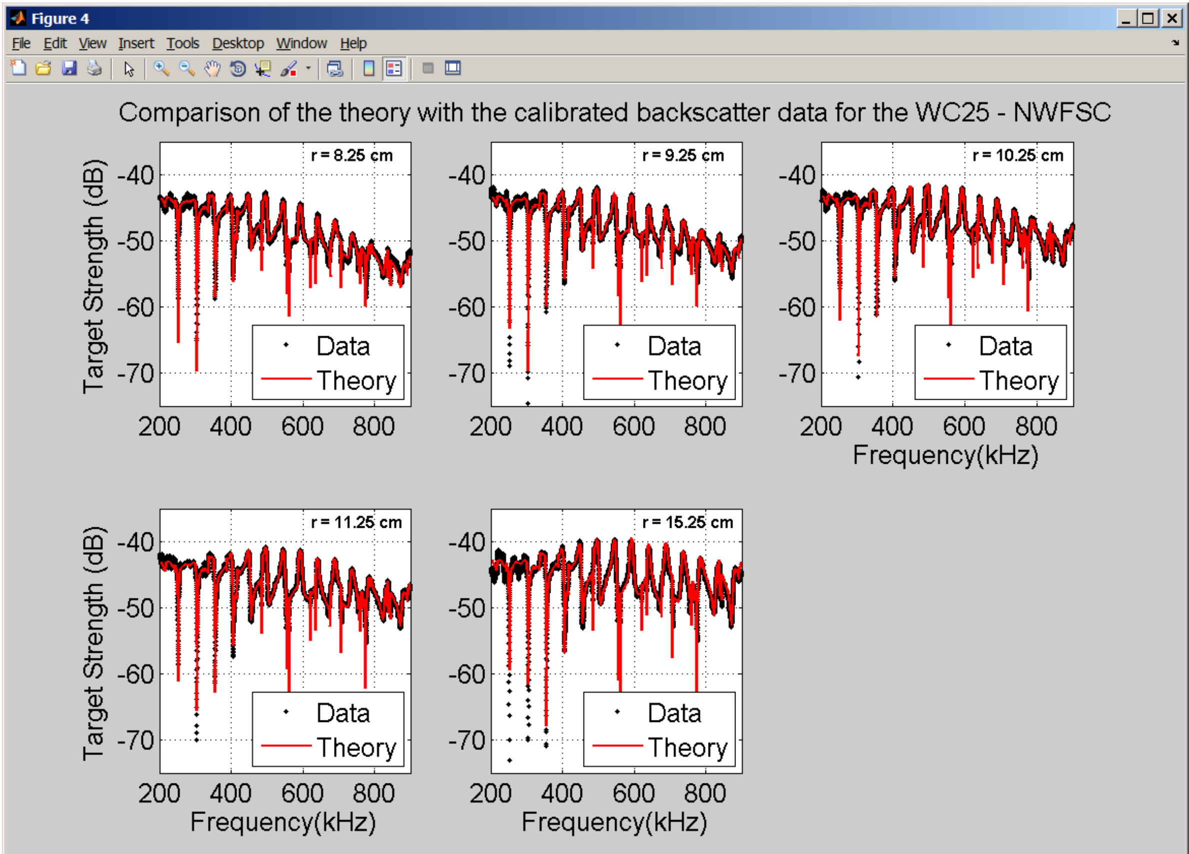

Figure 17. Comparison of the theoretical predictions with the calibrated backscattering data using a WC25 sphere at five different distances, 8.25 cm, 9.25 cm, 10.25 cm, 11.25 cm, and 15.25 cm, respectively.

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8. Advance Technologies

a) Pilot study utilizing a Wave Glider towed echo-sounder system for fisheries acoustic surveys (ASTWG funded research)

The primary goal of the project is to accelerate the transition of NOAA National Marine Fishery Service (NMFS) fishery acoustic assessments from their current operational dependence on manned survey vessels to a more strategic mix of ships and Autonomous Lagrangian Platforms and Sensors (ALPS). The Liquid Robotics Incorporated (LRI) SV3 Wave Glider (WG) is probably the most suitable ALPS system currently available for fulfilling NMFS's scientific and operational needs in this area. During 2013, the authors conducted two case studies to test feasibility of using the vehicle and towbody equipped with 38- and 120-kHz transducers for acoustic surveys.

I. Case Study I: The first case was to test the upgraded WG-TES system in Monterey Bay, CA in July 2013 (Fig. 18).

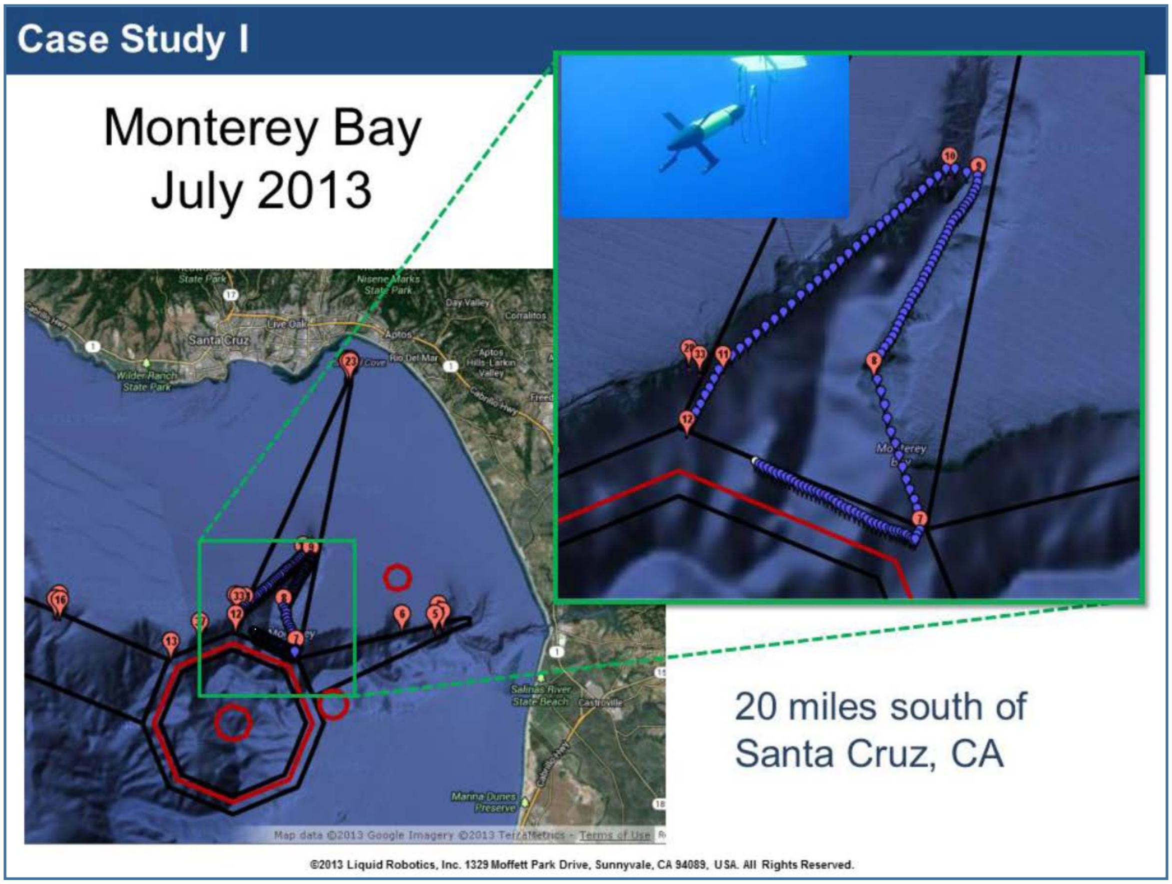

Figure 18. Test area for case I showing the tracks for the WG-TES system on day 2 of the deployment (courtesy of Liquid Robotics, Inc.).

This was a two-day mission with the following tests completed:

- WG upgrades
  - – new impedance matched cables.
- Power Consumption
  - – Reduced the power consumption by about 10%.
- Communication
  - – Transferred the snippets (low-resolution echo integration report and status report) via satellite in real time.
- Reliability Test
  - – Power on/off reliability (hardware)
  - – Platform stability
  - – WGMS interface/control
- Sonar Data Validation
  - – Same sonar configuration as the real deployment in July-Aug., 2013
  - – Acoustic signal validation
  - – Noise floor validation

The collected low-resolution and high resolution data are shown in Fig. 19. Clearly the two aggregations, one is a fish aggregation (most likely myctophids with air-filled swimbladders), and the other is fluid-like zooplankton (most likely euphausiids).

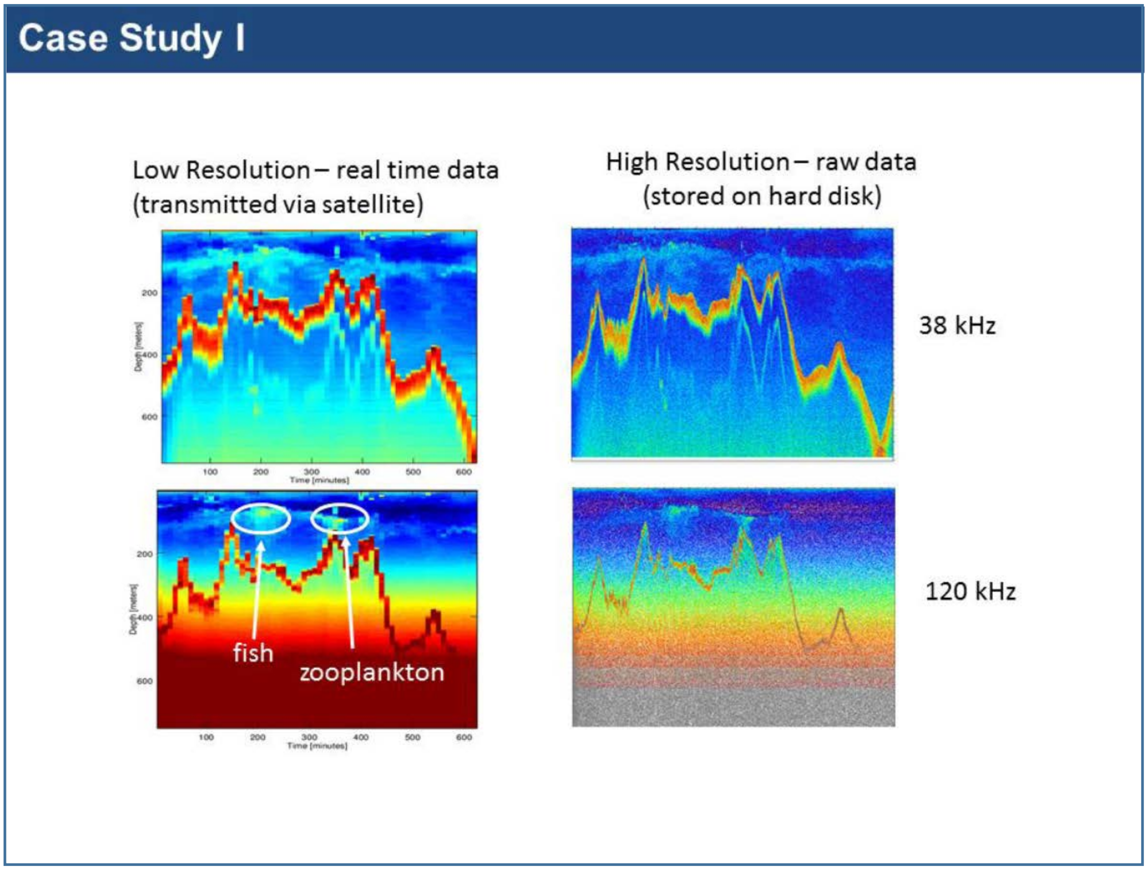

Figure 19. Low and high resolution acoustic data collected in case study I, where fish and zooplankton (euphausiids) could be identified based on their frequency responses.

II. Case Study II: For this case study, the WG-TES system was successfully deployed off the NOAA Ship FSV *Bell Shimada* once and other smaller vessels off the Oregon and Washington coasts (Fig. 20).

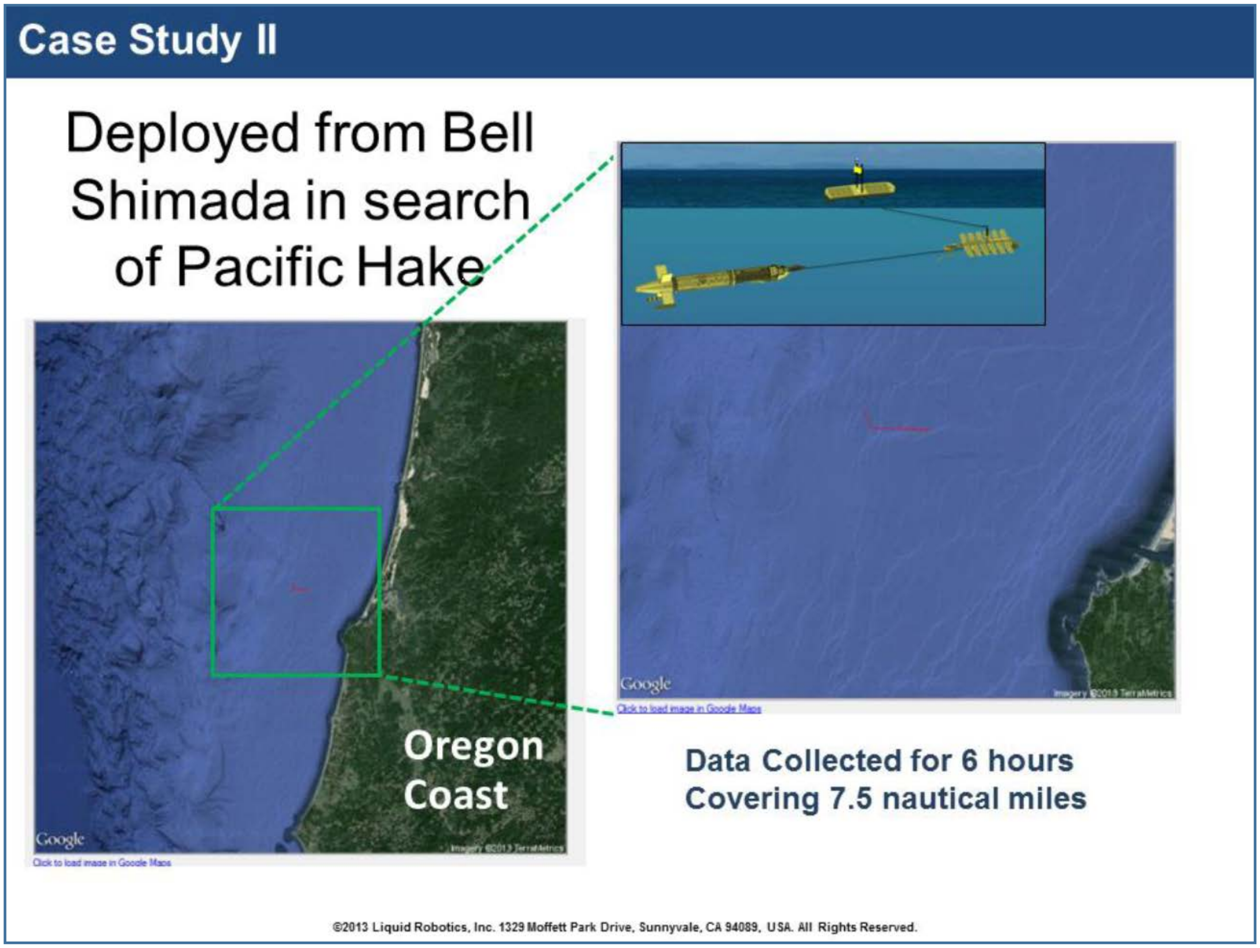

Figure 20. Study area for case II where the WG-TES system was successfully deployed in a region surveyed during the 2013 Joint sardine and Pacific hake acoustic survey. The rectangular box shows the region for the first deployment on July 27, 2013 off the FSV *Bell Shimada* (courtesy of Liquid Robotics, Inc.).

The two deployments, off the FSV *Bell Shimada* and a smaller OSU research vessel were successful but communication between the WG and the towfish failed under rougher sea conditions. After modifications of the electronics, the third deployment was near La Push, Washington on Aug. 31, 2014. The system worked well for more than a week until the towfish was lost on Sept. 7, 2014. The exact reason why it was lost could not be determined but there were some indications that the towfish might have been caught up for a short time and then the tow cable broke. Despite the loss of the towfish, acoustic raw data was collected from the second deployment off Coos Bay, OR shown in Figure 21. Multiple aggregations shown on 120 kHz echograms are clearly identifiable on both low-resolution and high resolution data and are most likely due to echoes from fluid-like zooplankton (euphausiids).

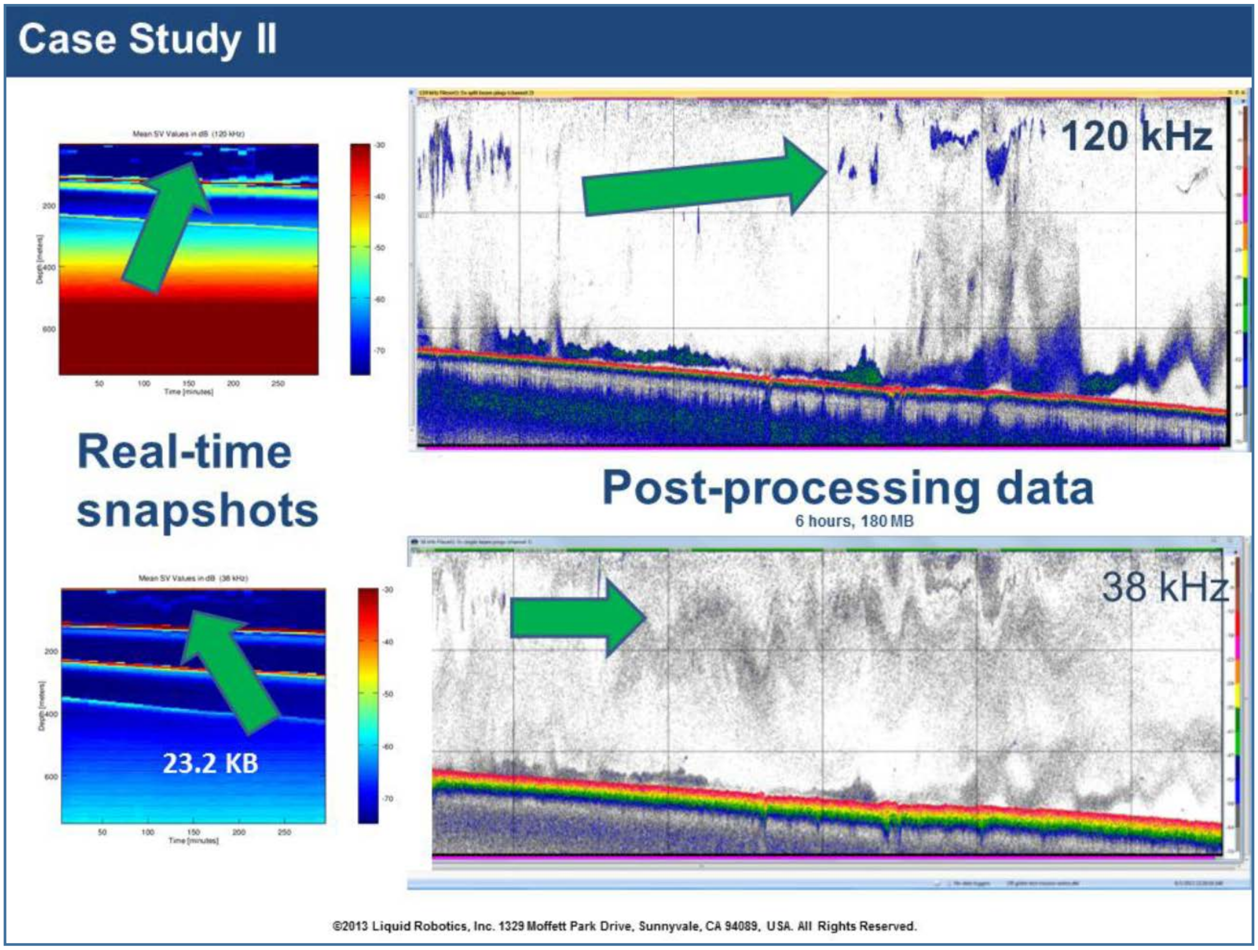

Figure 21. Low and high resolution echograms from 38- and 120-kHz echosounders collected during case study II, showing multiple zooplankton aggregations in the water column as well as near the bottom. The left column shows the low-resolution (raw) data while the right column provides the high-resolution acoustic echograms (courtesy of Liquid Robotics, Inc.).

Although the mission was not completely successful, it provided important guidance for future development: (a) the WG-TES system can be successfully deployed from both the small vessels and NOAA FSVs like *Bell Shimada*; (b) revisions are needed to avoid the loss of the towbody; and (c) more reduction in power consumption is desirable to conduct a more efficient survey.

Based on work completed during the past two years, the integrated WG-TES system is capable of collecting high quality multi-frequency acoustic data and transmitting snippets of low-resolution echo-integration data in real-time. We have submitted a proposal to NOAA-NOS-IOOS for the FY2014 Marine Sensor and Other Advanced Observing Technologies Transition Project. The title of our proposal is "Coastal Ocean Wave Glider Investigations for Rapid Low-Cost Surveys to Monitor, Assess, and Map Marine Fishery Resources and Ecosystems of the US Exclusive Economic Zone". It is a 3-year proposal collaborative proposal led by Dr. Greene (Cornell University) involving scientists from NOAA fisheries NWFSC and SWFSC, and PMEL, MBARI. We have been invited to submit a full proposal.

For more information, please contact Larry Hufnagle at lawrence.c.hufnagle@noaa.gov.

b) The implications of spatially varying catchability on bottom trawl surveys of fish abundance: a proposed solution involving underwater vehicles

Investigators: J. Thorson, M.E Clarke, I.J. Stewart, and A.E. 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, the authors use simulation modeling to evaluate the abundance trends arising from bottom trawl sampling given density-dependent habitat selection and spatially varying catchability. The authors first demonstrate that relative abundance indices in this case will generally be biased measures of changes in population abundance. They 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. In conclusion, the authors recommend future research that could test the assumptions under which combined sampling is a feasible solution to spatially varying catchability.

For more information, please contact James Thorson at James.Thorson@noaa.gov

9. Observer Data Collection and Analysis

The FRAM West Coast Groundfish Observer Program (WCGOP) continued collecting fishery-dependent data during 2013 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 3. Number of observers that were deployed by the WCGOP in 2013

2013	
Number of catch share observers	**87**
Number of non-catch share observers	**22**
Number of ASHOP Observers	**35**

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 4 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 4. 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	69	18	25	18	14
Number of trips*	1,227	122	943	46	72
Number of Sea days*	4,857		2,082	627	1,424**
Number of Observers	87				35

*Includes trips and/or sea days where no fishing activity occurred.
**Includes both Lead and Second observers
Note: Totals as of 2/14/2014. 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.
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

b) 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 1,450 sea days in the non-catch share fisheries in 2013 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 5. Non-Catch Share sea day summary by fisheries/sectors:

NCS Sea Days	
FISHERY DESCRIPTION	SEA DAYS*
CA Yellowtail EFP	6
CA Halibut	33
CA Nearshore	174
CA Pink Shrimp	42
Limited Entry Sablefish	222
Limited Entry Zero Tier	145
OR Blue/Black Rockfish	55
OR Blue/Black Rockfish Nearshore	170
OR Pink Shrimp	417
WA Pink Shrimp	124
WC Open Access Fixed Gear	62

*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. The 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

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NMFS Southwest Fisheries Science Center

Draft Agency Report to the Technical Subcommittee

of the Canada-U.S. Groundfish Committee

April 2014

Edited by Xi He and John Field

With contributions from John Hyde,
Susan Sogard, Andrew Thompson, Cindy Thomson, 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 Acting Director Dale Sweetnam). 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 Dr. Toby Garfield 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

B1. Swimming capabilities of early life stages of rockfish

Investigators: Neosha Kashef (UCSC) and Susan Sogard (FED, SWFSC)

Understanding the mechanisms that affect larval dispersal is critical to management of marine populations. Rockfishes (*Sebastes* spp.) do not settle to benthic habitats immediately after metamorphosis, but instead remain in the water column for weeks to months. Movements of larvae and pelagic juveniles during their months at sea are largely unknown. It is traditionally thought that young rockfishes are planktonic, moving at the mercy of ocean currents, but this assumption is unverified. In this study swimming capabilities (critical speed) of larval and pelagic juvenile stages of six rockfish species (blue (*S. mystinus*), yellowtail (*S. flavidus*), brown (S. *auriculatus*), kelp (*S. atrovirens*), gopher (*S. carnatus*), and splitnose (S. *diploproa*)) are evaluated to determine their ability to behaviorally influence dispersal. Rockfish larvae have critical speeds of 0.5 – 1.8 cm s^{-1} (1-3 body lengths per second (bl s^{-1})) at parturition, whereas newly settled juveniles are capable of swimming 8.6 – 53.5 cm s^{-1} (5-9 bl s^{-1}). Swimming ability increases throughout ontogeny and postflexion rockfishes can swim faster than mean current speeds in waters off central California. Critical speeds for *Sebastes* spp. are substantially lower than those for larvae and juveniles of tropical species at similar body sizes. Rockfishes, however, have comparable swimming speeds to some tropical species at settlement, as rockfishes settle at larger sizes. The increasing ability of rockfishes to outswim currents during their pelagic phase, acting as nekton rather than plankton, may promote individual survival as well as enhance retention and long-distance dispersal – and thus swimming has important implications for population connectivity and sustainability.

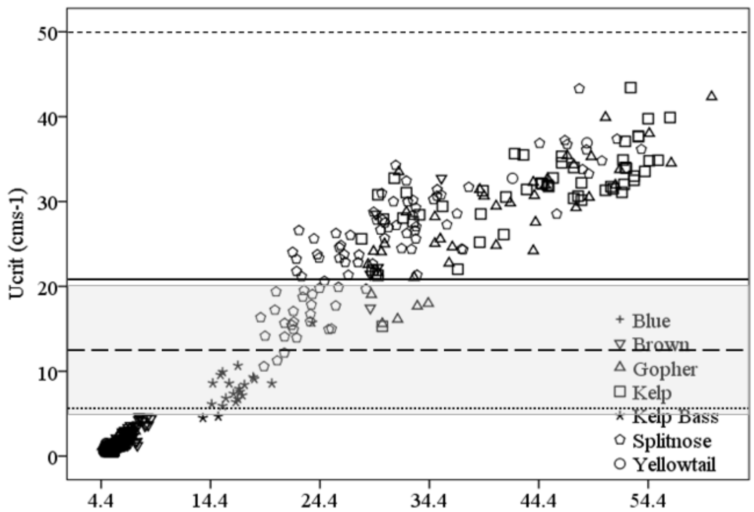

Figure B1. Relationship between absolute critical swimming speed (U_{crit}) and total length (TL) of *Sebastes* spp. throughout ontogeny from parturition to settlement. The shaded area represents current speeds between 5 and 20 cm s^{-1}, reported for Monterey Bay surface circulation by Breaker & Broenkow (1994) and the grey dashed line represents 50 cm s^{-1}, a typical speed for an upwelling jet (Largier *et al*. 1993, Rosenfeld et al. 1994, Kaplan et al. 2009). The dotted line represents a 3-week mean alongshore current speed at Terrace Point, CA (5.9 cm s^{-1}), the bold dashed line represents the 95-percentile for 33-hr filtered data (12.8 cm s^{-1}) and the solid line is the 95-percentile for 2-minute data (20.4 cm s^{-1}) (Kashef *et al*., 2014).

B2. Maternal influence on timing of parturition, fecundity, and larval quality in three shelf rockfishes (*Sebastes* spp.)

Investigators: David Stafford (UCSC) and Susan Sogard (FED, SWFSC)

Differences in maternal investment and reproductive timing can have important consequences for offspring survival. Prior studies on nearshore rockfishes have shown significant effects of maternal age and size on timing of parturition, fecundity, and larval quality, offering advantages to population persistence of maintaining age diversity in rockfish populations. In this study, reproduction in chilipepper, *Sebastes goodei*, widow rockfish, *Sebastes entomelas* and yellowtail rockfish, *Sebastes flavidus* was examined to determine whether age- and size-related effects on maternal investment and reproductive timing are exhibited in deeper-dwelling species of this genus. Parturition dates were derived from fine-scale staging of pre-parturition embryos from gravid females. Measurements of embryonic energy reserves (oil globule and yolk), indicators of condition, were used to estimate depletion rates and test for maternal age- and size-effects on larval quality. For widow and yellowtail rockfish, larger or older rockfish gave birth earlier in the parturition season than younger, smaller fishes. Maternal factors of weight, length or age were positively correlated to absolute and relative (weight-specific) fecundity in all species. A trade-off was observed between egg size and fecundity among species, with chilipepper displaying larger egg size and lower fecundity relative to widow and yellowtail rockfish. Embryonic reserves were weakly but significantly related to age only in chilipepper, with embryos from larger, older mothers having larger oil globules. Since strength of maternal effects varies among *Sebastes* species, information on maternal influence can assist managers in identifying species most likely to benefit from the protection of age structure afforded by marine reserves or other fisheries regulations.

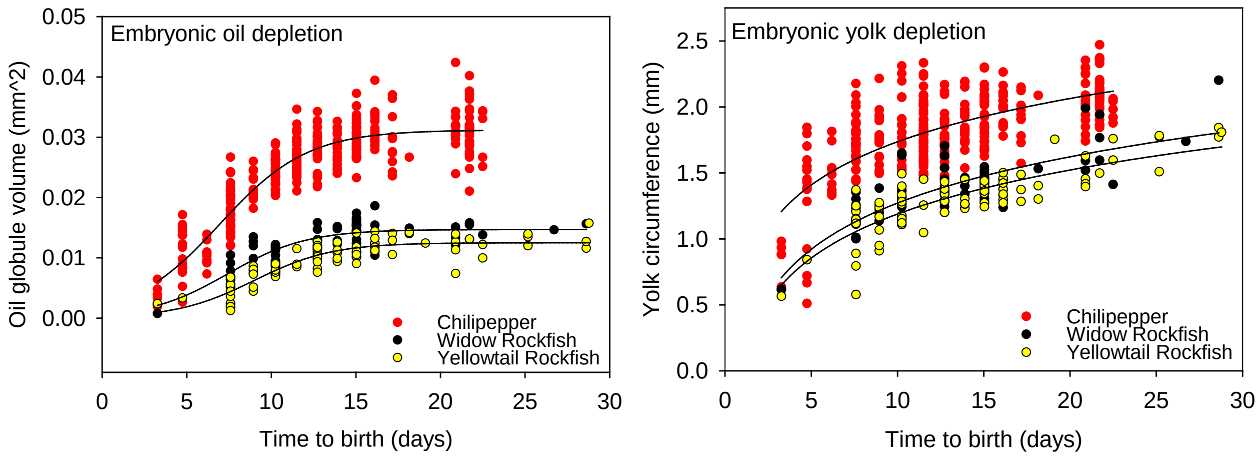

Figure B2. Energy reserve depletion of oil globule (left) and yolk (right) during embryogenesis of chilipepper, widow, and yellowtail rockfish. Each three species displayed a sigmoidal trend in depletion of oil reserves and a logarithmic depletion of yolk (Stafford *et al*., in press).

B3. Ecosystem indicators for the Central California Coast, May-June 2013

Investigators: John Field and Keith Sakuma, Fisheries Ecology Division, SWFSC

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. A recent manuscript by Ralston *et al*. (2013) describes the results from the first 28 years of the survey with respect to young-of-the-year (YOY) abundance in the core area. Standardized catch rate time series for ten species were developed from delta-GLM models that include main effects for year, station, and calendar date. The results show that interannual fluctuations of all ten species are strongly coherent but highly variable, demonstrating both high- and low-frequency components. A similarly coherent result is observed in the size composition of fish, with large fish associated with elevated catch rates. A comparison of PC1 from the juvenile rockfish abundance trends with recruitments from five rockfish stock assessments shows that the results compare favorably, but perhaps not as robustly as would be ideal, to the stock assessment estimates of year class strength. An examination of oceanographic factors associated with year-to-year variability indicates that sea level anomalies in the months preceding the survey are best correlated with high recruitment. Specifically, equatorward anomalies in the alongshore flow field in early winter are associated with elevated survival, while poleward anomalies (often associated with El Nino events) are associated with poor recruitment.

As the Ralston manuscript only included trends through 2010, we have updated that figure to reflect recruitment trends through 2013 (Figure B3). Most of the period since 2010 has been associated with higher productivity for the species and assemblages that tend to do better with cool, high productivity and high transport conditions, including juvenile rockfish, market squid and krill. In particular, the 2013 survey was associated with extremely high rockfish catches throughout both the core area and the expanded survey region, with the highest overall juvenile rockfish catches in the time series. Catches of more regularly encountered YOY groundfish, such as Pacific hake, were also at high (albeit, not record) levels (see Wells *et al*. 2013 for trends in other forage species). These observations were consistent with high reported catches of YOY rockfish and other groundfish in power plant impingement surveys, from scuba divers conducting a range of scuba surveys, and from commercial and recreational fishermen. Other papers report on the relationship between fronts and juvenile rockfish catches (Sakuma *et al*. 2013), on the anomalous coastwide distribution of YOY rockfish during the mid-2000s (Ralston and Stewart 2012) and on the relationships between YOY rockfish, YOY flatfish and other micronekton abundance and seabird productivity in central California (Santora *et al*. 2013).

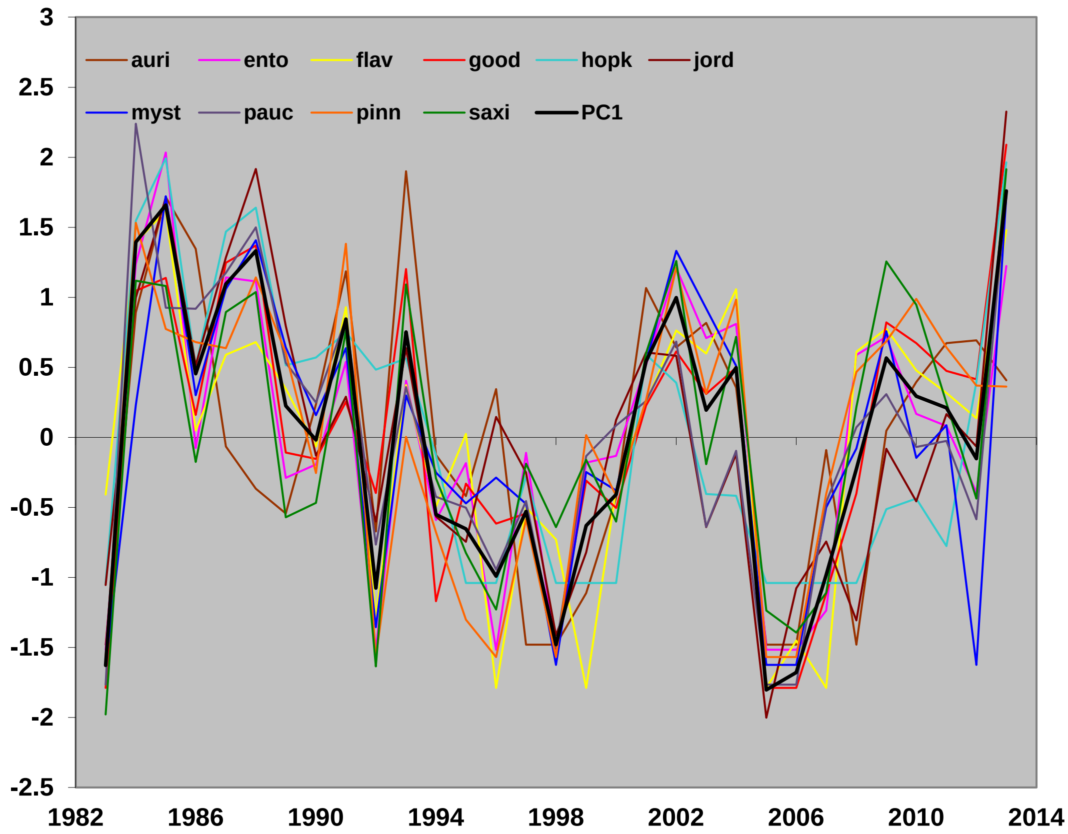

Figure B3: Standardized anomalies from Delta-GLM year effects for the ten most abundant rockfish (Sebastes) species in the Central California region (updated from Ralston *et al*. 2013)

B4. Research on larval rockfish at the SWFSC

Over the past year (2013-14) the Ichthyoplankton Ecology and Molecular Ecology labs within the Fisheries Resources Division in La Jolla continued to conduct molecular identification on larval rockfishes collected from CalCOFI cruises. The overall aim of this research is to develop a species-specific larval rockfish time-series and then use this data to evaluate how spawning patterns of different rockfishes responded to environmental factors and the presence of rockfish conservation areas in Southern California between 1997 and the present. Methodologically, the project involves sorting rockfishes (which can mostly only be identified to the genus level based on morphology) from ethanol-preserved plankton samples, sequencing mitochondrial DNA from individual larvae and matching larval sequences to those from adults that have previously been identified to species. We are initially focusing on winter CalCOFI cruises because rockfish larvae are more abundant in this relative to other seasons. During the past year we sorted larva from winter cruises in 2002-2005 and 2011 and genetically identified all 445 larvae from 2005 cruise. Twenty-eight species were found in winter 2005 (Figure B4a). We are currently in the process of identifying larvae from the winter 2011 cruise and are preparing a manuscript evaluating how rockfish assemblage structure changes spatially within Southern California based on relatively coarse-scale CalCOFI and fine-scale Cowcod Conservation Area (CCA; Figure B4b) sampling in 2005 (larvae from the 2005 CCA cruise were all genetically identified in 2012). In addition, we received funding from NOAA's Fisheries and the Environment program to work on this project; this award should accelerate greatly the rates of production and analysis of the rockfish genetic data.

In addition to the molecular identification-based research, we have continued updating larval fish identifications from historic CalCOFI surveys to current taxonomic standards. We currently have completed all surveys from 1966 to 2011, and are working on samples collected during 1965 in addition to completing processing of 2012 and 2013 samples. This provides to date a nearly 50-year time-series of larval abundances of the rockfish species visually identifiable as larvae (*Sebastes aurora, S. diploproa, S. goodei, S. jordani, S. levis, S. paucispinis*).

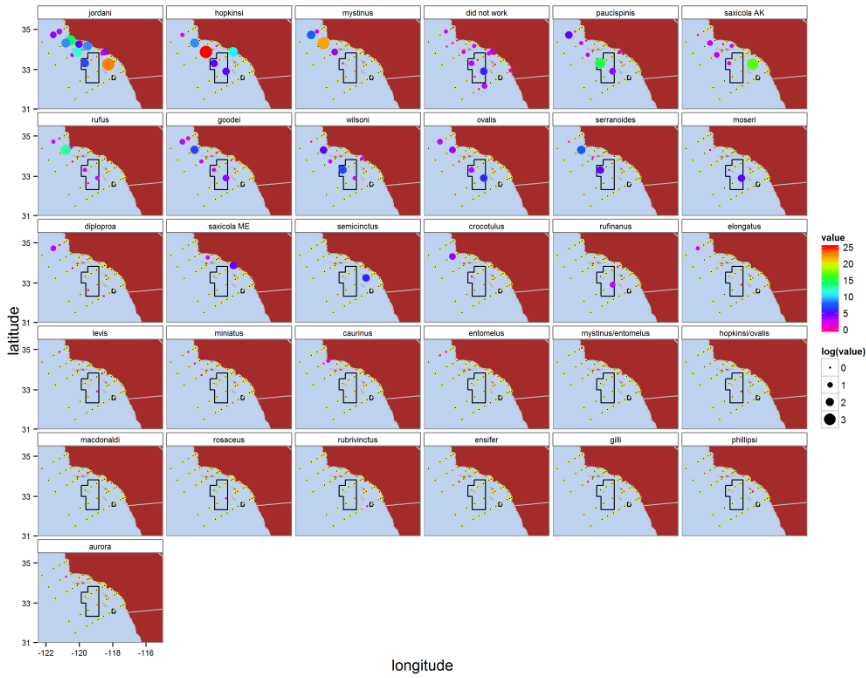

Figure B4a. Abundance of 28 species of rockfish larvae from the 2005 winter CalCOFI cruise. Species are ordered by their total abundance from all survey locations. Black outlines depicts the location of the Cowcod Conservation Areas within the Southern California Bight. Yellow circles depict locations where samples were collected. The size and color of circles corresponds to the abundance of each species.

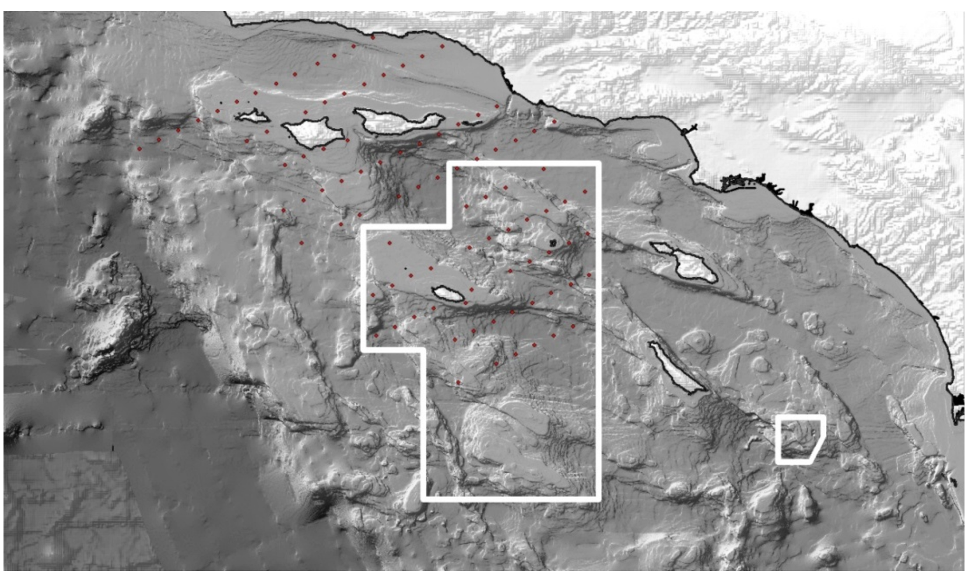

Figure B4b. Location of the 95 stations sampled within and around the western CCA during winter 2005.

C. BY SPECIES, BY AGENCY

C1. Nearshore rockfish stock assessments

Assessment scientists at the SWFSC contributed to the first "data-moderate" STAR panel held by the PFMC, resulting in approval of assessments for brown, China, and copper rockfishes (Cope et al. 2013). The data-moderate assessments improve upon catch-based estimators of sustainable yield that were previously applied to these stocks by incorporating indices of abundance to inform estimates of stock status. Stock status was found to vary by geographical region, but no stock was below the minimum stock size threshold.

C2. Shelf Rockfish

C2.a. Rockfish barotrauma and behavior research at SWFSC Lo Jolla Lab

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, multiple oxygen as well as temperature & depth loggers are deployed between 80an 200m 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 FY14/15 we will deploy 40 tags on bocaccio (*S. paucispinis*) and 15 on cowcod (*S. levis*). A subset of these fish will be fitted with dissolved oxygen sensor tags to monitor fine-scale oxygen preferences. The survival estimates from our FY12/13 project are currently being considered by the management council for incorporation into management decisions. However, as sample size is still somewhat low there is a need to gather more data to refine these estimates 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.

C2.b. Stock assessments

FED staffs conducted stock assessments for cowcod (*S. levis*) and bocaccio (*S. paucispinis*) in 2013.
A full stock assessment for cowcod (*Sebastes levis*) was conducted using a Bayesian extension of Depletion-Based Stock Reduction Analysis (DB-SRA). Four new indices of relative abundance were added to the assessment to infer recent trends in abundance and estimate overall stock productivity. The final cowcod model suggests that biomass has been increasing over the past decade, is currently near 34% of the unfished level, and is likely to rebuild within approximately the next ten years (Dick and MacCall 2013)

An update of the 2011 stock assessment of the bocaccio rockfish was conducted in 2013 (Field *et al*., 2013). The update included updated fishery and survey data from 2011 and 2012. It shows increasing trend of the stock biomass in recent years, with stock depletions changed from 24.9 percent in 2011 to 31.4 percent in 2013. Since the last full stock assessment was conducted in 2009, it is expected that a full assessment will be conducted in 2015. FED staffs started a new study to determine if otoliths from bocaccio rockfish can be used for estimating ages and growth in 2013, as no ageing data have been available to the past assessments of this species. The study shows promising results of otolith ageing for bocaccio, which will provide important data series for future assessments of this species.

C3. Flatfish stock assessments

A stock assessment of Pacific sanddab (*Citharichthys sordidus*) was conducted in 2013, and was reviewed by a STAR Panel (He *et al*., 2013). Because it was a first time that this species was assessed, extensive data collections and retrievals and laboratory works were conducted. This included field works on collecting samples for reproductive biology, and laboratory works on determining fecundity and maturity. Over 12,000 otoliths were examined to determine growth and ages of the species. The assessment model predicts that the spawning biomass was 96 percent of the unfished level at the start of 2013, well above the target biomass for flatfish stocks of 25 percent. However, there are major inconsistences between the estimates of biomass from the triennial and NWFSC surveys and the estimates of biomass from the assessment, with the assessment inferring that catchability for the surveys is substantially larger than 1. The SSC recommends that the assessment not be used for deciding harvest specifications. However, the information included in the assessment document is sufficient to conclude that the stock is well above the B_{SMY} proxy of 25 percent of the unfished level.

Research into the reproductive ecology of Pacific sanddabs has been ongoing since 2012 to support assessment activities. Pacific sanddab were collected between March 2012 and February 2014 from the Monterey Bay, and the reproductive cycle has been described based on visual, as well as more thorough histological, examination. Subsamples of ovarian tissue were collected to estimate batch fecundity, and a complimentary aquarium study demonstrated the biological capabilities for reproduction and provided samples for time-specific histological indicators of spawning. The current estimates of length at maturity were found to be considerably smaller than historical estimates. These and other results will be presented at the 2014 Flatfish Symposium in Seattle, WA.

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STATE OF ALASKA
GROUNDFISH FISHERIES

ASSOCIATED INVESTIGATIONS IN 2013

Prepared for the Fifty-fourth 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. Kenneth J. Goldman, Kristen Green, Lee Hulbert, Mike Jaenicke, Kevin McNeel, Scott Meyer, Jan Rumble, Elisa Russ, Gail Smith, Mark Stichert, and Carrie Worton

April 2014

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 2013

AGENDA ITEM VII.

REVIEW OF AGENCY GROUNDFISH RESEARCH, STOCK ASSESSMENT, AND MANAGEMENT

A. Agency Overview

1. Description of the State of Alaska commercial groundfish fishery program:

The Alaska Department of Fish and Game (ADF&G) has jurisdiction over all commercial groundfish fisheries within the internal waters of the state and to three miles offshore along the outer coast. A provision in the federal Gulf of Alaska (GOA) Groundfish Fishery Management Plan (FMP) gives the State of Alaska limited management authority for demersal shelf rockfish (DSR) in federal waters east of 140º W. longitude. The North Pacific Fisheries Management Council (Council) 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 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 (EEZ) equidistant line boundary in Dixon Entrance north and westward to 144º 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 Council Gulf of Alaska Groundfish Plan Team and produces the annual stock assessment for DSR for consideration by the Council.

Project activities center around fisheries monitoring, resource assessment, and in-season management of the groundfish resources. In-season management decisions are based on data collected from the fisheries and resource assessment surveys. Primary tasks include fish ticket collection, editing, and data entry for both state and federally-managed fisheries; dockside sampling of sablefish, lingcod, Pacific cod, and rockfish landings; and logbook collection and data entry. Four resource assessment surveys were conducted during 2013. The R/V *Medeia*, home ported in 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 and age reading coordinator, a groundfish fish ticket processing and data analysis position, two marine research biologists, one GIS analyst, five to six seasonal technicians, and one seasonal commercial catch sampler who also serves as the primary groundfish age reader. An assistant area management biologist and a seasonal commercial catch sampler are also located in Cordova, a seasonal catch sampler in Seward, and regional support is in Anchorage. The regional groundfish management biologist serves as a member of the Council's Gulf of Alaska Groundfish Plan Team and the research project leader serves on the Council Non-Target Species Committee and as a member of the Kasitsna Bay Lab Science Board. The age reading coordinator is the current Chair of the Committee of Age Reading Experts (CARE), a Working Group of the Technical Subcommittee (TSC). 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, walleye, 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 interviews and biological data collections from commercial groundfish landings; and a number of research projects. In addition, the Westward Region has a member on the Council 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 the collection, 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 are 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 personnel, 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 personnel 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 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. Age determination is 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 Council, 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, Council 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 Council 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 Council 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 Council, 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 2013 ADF&G AKFIN personnel processed 16,629 groundfish fish tickets, collected 24,734 groundfish biological samples and measured 20,462 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 personnel 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 2013

ADF&G Region	
1 - Southeast	3,303
2 - Central	2,584
4 - Westward; Kodiak, AK Pen.	9,563
4 - Westward; BSAI	1,179
Total	16,629

Groundfish Biological Data Collection - Calendar Year 2013

ADF&G Region	AWL Samples Collected	Age Estimates Produced by Regional Personnel	Age Estimates Produced by the Age Determination Unit
1 - Southeast	6,836	none	3,496

2 - Central	10,956	4,332	1,137
4 - Westward	6,942	5,470	none
Total	24,734	9,802	4,633

Interagency 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. Data are transferred annually to the Commercial Fisheries Entry Commission, where additional license and value information is merged with all fish ticket records. Once completed, the data are provided to the Alaska Fisheries Information Network (AKFIN) support center.

Beginning in 2001, the agencies tasked with commercial fisheries management in Alaska (ADF&G, NMFS, IPHC) began development of 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 are 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 tendered salmon fishery fleet by the end of the 2015 season. Statewide shellfish and herring fisheries will be addressed in 2015, as well.

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 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 2013, the IERS recorded more than 87,413 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 vessel operators.

Within the confines of confidentiality agreements, raw data are distributed to the State of Alaska Commercial Fisheries Entry Commission (CFEC) annually. Raw groundfish data are distributed 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 Council 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 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 ADF&G's statewide age reading program at the Age Determination Unit (ADU) in the Mark, Tag, and Age Laboratory continued to provide age data to regional managers in 2013. Age structures from 8,335 specimens (representing nine groundfish species) were received from statewide commercial and survey harvest sampling efforts. A total of 3,662 groundfish age data were distributed to managers, which included data from samples received in previous years, but processed in 2013. Sablefish is the most prominent species aged by ADU, but due to training constraints and staff turnover, only 706 ages were distributed statewide this year. Quality of age data is routinely assessed through precision testing of at least 15% of each sample along with the addition of a new error checking routine called the "Data Filter" (see below). This processes resulted in 1,445 additional age estimates. Also, 4,710 groundfish age estimates were produced through training and calibration procedures. Throughout 2013, ADU age readers evaluated approximately 10,736 groundfish specimens as part of production protocols.

All age structures received by the ADU are measured for length, height, and weight. Measurement data are used to assess potential errors arising from specimen handling, data entry, species misidentifications, and as part of age data quality assessments. A total of 7,648 age structures (representing 7,623 specimens) were measured in 2013.

Approximately 30% of funding for this project was provided by AKFIN. The majority of funding (70%) was provided by the State of Alaska. The ADU employed five people throughout 2013 for approximately 48 work months to age groundfish and invertebrates; process samples; enter data; maintain sample archives; measure samples; and complete other support tasks.

Continued efforts were made to increase objective information (age structure measurements and age validation) that served to strengthen the foundation of pattern interpretation for all species. One of these projects, called the "Data Filter", was initiated in 2013 and uses objective age structure weight to identify possible data errors and age data quality. The current model has established age structure weight ranges for each age class. The Data Filter compares the dimensions of each specimen to the prediction intervals of the measurement and highlights specimens that are not within expected ranges. Specimens falling outside the expected range are aged again by the original reader (without knowledge of their previous age estimate) to identify possible age or data entry errors. This process has been initiated for sablefish. Other projects in 2013 included research on using the thickness of age structures to benefit morphometric and age modeling, and evaluations regarding the impact of drying time, temperature, and humidity on age structure morphology to insure measurement protocols are producing accurate and consistent data.

A paperless entry protocol was initiated to allow direct entry of age data into the Oracle database to increase efficiency, preserve resources, and minimize transcription errors. The ADU continued to develop and improve protocols for managing data and tracking samples through the Oracle database and web-based interfaces to facilitate use by fishery managers and age readers.

The ADU continued to participate in CARE, a Working Group of the TSC, throughout 2013. Two age readers attended the 2013 meeting hosted at the Alaska Fisheries Science Center in Seattle, WA. During the meeting, representatives from the ADF&G, Department of Fisheries and Oceans Canada (DFO), PSMFC, and the National Marine Fisheries Service Alaska Fisheries Science Center (AFSC) completed an exchange of 24 known-age sablefish and compared pattern interpretation. The ADU also initiated and completed a structure exchange of 25 specimens with DFO and the Washington Department of Fish & Wildlife (WDFW) to compare pattern interpretations and different processing techniques. Both exchanges resulted in annotated images of age structures to document the exchanges (Contact Kevin McNeel).

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 that 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 coordinates a data collection program for halibut and groundfish in conjunction with a regionwide Chinook salmon harvest studies project. The project leader, the project biometrician, and the project research analyst are based in Juneau. A total of 25 technicians worked at the major ports in the Southeast region, where they interviewed anglers and charter operators and collected data from sport harvests of halibut and groundfish while also collecting data on sport harvests of salmon. Data collected on groundfish were limited to rockfish lengths and species composition; halibut length; lingcod length and sex; and sablefish length. No otoliths or other age structures were collected. Data summaries were provided to the Alaska BOF, other ADF&G staff, the public, and a variety of other agencies such as the Council, IPHC and NMFS.

The Regional Management Coordinator and Area Management Biologists in Yakutat, Haines, Sitka, Juneau, Petersburg, Craig, and Ketchikan are responsible for groundfish management in those local areas. The demersal shelf rockfish and lingcod sport fisheries are managed under the direction of the Demersal Shelf Rockfish Delegation of Authority and Provisions for Management (5 AAC 47.065) and the Lingcod Delegation of Authority and Provisions for Management (5 AAC 47.060) for allocations set by the Alaska Board of Fish.

b. Southcentral Region Sport Fish

The **Southcentral Region** groundfish staff consisted of two Regional Management Biologists as well as Area Management Biologists and assistants for the following areas: (1) PWS and the North Gulf areas, (2) Lower Cook Inlet, and (3) Kodiak, Alaska Peninsula, and the Aleutian Islands. In addition, a region-wide harvest assessment project was based in the Homer office, consisting of a project leader, project assistant, and six technicians. The research project biometrician was located in Anchorage. Ongoing assessment of sport harvest and fishery characteristics at major ports throughout the region is the primary activity. Data were collected from harvested halibut, rockfishes, lingcod, sharks, sablefish, and cod, 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 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 were forwarded to the IPHC for age reading.

Southcentral Region staff is responsible for management of groundfish fisheries in state and federal waters. The lack of stock assessment information for state-managed species has prevented 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. Stock status is evaluated by examining times series data on age, size, and sex composition. The lack of stock assessments, coupled with increasing effort and harvest in several groundfish sport fisheries, accentuate the need for developing comprehensive management plans and harvest strategies.

Typical duties included providing sport halibut harvest statistics to IPHC and Council, 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** discontinued the cod-tagging program in 2011 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, with seven recovered in 2013. 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 2013.

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 Council recently established sector allocations for the federal Central Gulf of Alaska (CGOA) Pacific cod fisheries. The Council'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 Council. Current GHLs are set at 25% of the Central Gulf ABC apportioned between the Kodiak, Chignik and Cook Inlet Areas and 25% of the Eastern Gulf ABC for the Prince William Sound Area. Historically 25% of the Western Gulf ABC was reserved for the South Alaska Peninsula Area. In October 2013, the BOF increased the South Alaska Peninsula Area ABC apportionment from 25% to 30% of the Western Gulf Pacific cod ABC.

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 of the acceptable biological catch (ABC) of Pacific cod as established by the Council 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 accrue toward the GHL, while harvest in state waters east of 175° W long and west of 178° W long are initially 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 remains 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 reopens 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.

In October 2013, the BOF created a state-waters Pacific cod fishery management plan in waters of the Bering Sea near Dutch Harbor. The Dutch Harbor Pacific cod season is open to vessels 58 feet or less OAL using pot gear, with a limit of 60 pots. The season opens seven days after the federal Bering Sea – Aleutian Islands pot/longline sector's season closure, and may close and re-open as needed to coordinate with federal fishery openings. The fishery was not opened to jig gear because the federal jig season typically occurs year-round

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). The Southcentral Region creel sampling program also collects data on cod catch by stat area (on a vessel-trip basis), and lengths of sport-caught Pacific cod. 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 (CI)** and longline gear the dominant gear in recent **Prince William Sound (PWS)** fisheries. Pot gear is still the dominant gear during the state-waters season in CI, however, parallel season Pacific cod harvest by longline gear in CI in 2012 was nearly three times that of pot gear in 2012. Overall Pacific cod harvest during the 2013 parallel season from the Cook Inlet Area decreased slightly and harvest from PWS Area nearly doubled compared to 2012. However, parallel season harvest from both areas was back to levels similar to 2000, and comparable to 2012, which showed a marked increase 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 23% of the harvest, pot gear took 77%, and longline gear took less than 1%. Trawl and pot gear were used only during the A season and only longline gear was used 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, 17% 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 2013 totaled 354 mt.

The 2013 GHLs for the state-waters Pacific cod seasons in the Cook Inlet and Prince William Sound Areas of the **Central** Region were 1,848 mt and 808 mt, respectively. Harvest from the Cook Inlet Area state-waters Pacific cod fishery totaled 1,249 mt and the Prince William Sound Area harvest totaled 578 mt. In 2013, GHLs were not achieved and there was no harvest by jig gear due to the parallel season remaining open for the entire year. In 2014, 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 2013 South Alaska Peninsula Area state-waters Pacific cod GHL was 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 2013 Pacific cod GHLs were 6,161 mt in the Kodiak Area, 4,312 mt in the Chignik Area and 7,070 mt in the South Alaska Peninsula Area. Total state-waters Pacific cod catch in the Kodiak, Chignik and South Alaska Peninsula was 3,298 mt, 3,951 mt and 7,069 mt respectively. In the Aleutian Islands District state-waters Pacific cod GHL is based on three 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 4,792 mt. The Dutch Harbor state-waters Pacific cod GHL is based on three percent of the annual BSAI Pacific cod ABC and is open to pot gear only.

Estimates of the 2013 recreational harvest of Pacific cod are not yet available from the statewide harvest survey, but the 2012 estimates were 10,877 fish in **Southeast** and 31,050 fish in **Southcentral Alaska**. The average estimated annual harvests for the prior five-year period (2007-2011) were 10,400 fish in **Southeast** Alaska and 22,747 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*, (thornyhead) 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 fishery 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 2013 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 1,680 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. No biological samples of yelloweye rockfish were collected from the internal waters fishery.

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 2013. 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 2013 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 resulted in additional sampling opportunity. However, with only 20 landings in 2013, sampling opportunity was limited and 221 samples were collected from the fishery. An additional 130 pelagic shelf, 2,118 demersal shelf, and 725 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 research trawl surveys (Contact Elisa Russ).

2013 was an off year for seafloor mapping in **Central Region**. Plans were made for a collaborative seafloor mapping project with the USGS for summer 2014. A large section of seafloor from Cape Cleare to Junken Bank was chosen for multibeam mapping. USGS is interested in this area for surveying geologic faults for understanding earthquake and tsunami hazards while for Central Region, this area represents important DSR and lingcod habitat. The R/V Solstice will be used for the survey with Central Region covering the vessel cost and USGS covering all the data acquisition and processing cost (Contact Mike Byerly or Dr. Kenneth Goldman).

The **Westward Region** continued port sampling of several commercial rockfish species and Pacific cod in 2013. 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 2013 season. Pacific cod otolith aging is ongoing.

The **Westward Region** also continued to conduct hydroacoustic surveys of black and dark rockfish in the Northeast, Eastside, and Afognak districts of the Kodiak Management Area in 2013 in an effort to generate biomass estimates for both black and dark rockfish. Data are currently being analyzed. Surveys of the Eastside and Southeast districts in the Kodiak Management Area will continue in 2014 (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 port. Primary species harvested in Southeast Alaska included yelloweye, black, copper, and quillback rockfish. Approximately 10,255 rockfish were sampled from the sport harvests at Ketchikan, Craig, Klawock, Wrangell, Petersburg, Juneau, Sitka, Gustavus, Elfin Cove, and Yakutat in 2013 (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 port. The 2013 total sample size from the sport harvests at Seward, Valdez, Whittier, Kodiak, and Homer was 5,066 rockfish (Contact Barbi Failor).

The Division of Sport Fish continued research in Prince William Sound on survival of rockfish following recompression. In 2013, dark, dusky, and silvergray rockfish were caught using sport fishing gear over a range of depths, and held for two days at capture depths of at least 35 m to evaluate survival. All held fish survived, which is consistent with results from other studies indicating high survival for yelloweye and quillback rockfish in Prince William Sound and for other species in the Pacific Northwest (Contact Mike Thalhauser).

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 from the submersible 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 and 2013, we collaborated with the Central Region staff to conduct an ROV surveys in the CSEO and SSEO management areas. Yelloweye rockfish, lingcod, and halibut total lengths were measured using the stereo camera imaging software (SeaGIS, Ltd). Yelloweye density analyses for CSEO in 2012 were 752 fish/km^2 (CV=14%) and 986 fish/km^2 (CV=22%) in 2103 in SSEO. An ROV survey is planned in EYKT in 2014. 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 bordered by land masses, deep fjords, and/or expanses of deeper soft substrates. An ROV survey was conducted in August 2013 to estimate the abundance and biomass of DSR in Harris Bay, Aialik Bay, and along Chiswell Ridge. Chiswell Ridge is the first area in Central Region to be resurveyed, having been surveyed earlier in 2005. Work on the new stereoscopic Gigabit Ethernet camera system continued. This system is anticipated to be operational for the 2014 survey season (Contact Mike Byerly or Dr. Kenneth 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 Northeast, Eastside, and Afognak districts of the Kodiak 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 five-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 2014 ABC for DSR was 274 mt, which resulted in an allocation of 224 mt to commercial fisheries and 43 mt to sport fisheries (after a deduction of seven mt for the subsistence fishery) (Green et al. 2013). 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 estimate bycatch rate by depth and apply this to the commercial catch to estimate DSR bycatch. In 2012 and 2013, 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 because six years of DSR full retention landings were 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 8.1 mt in 2013. Shortspine thornyhead, shortraker rockfish, rougheye rockfish and redbanded rockfish may be taken as bycatch only (no directed fishing). A total of 67.6 mt of slope and thornyhead rockfish were landed in NSEI and SSEI during 2013, similar to 69 mt in 2012 (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 2013, 64 mt of black rockfish were harvested from five sections in the Kodiak Area. GHLs were attained in four sections. Harvest in the Chignik and South Alaska Peninsula Management areas remain confidential. In 2013, 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 2013 season, the entire **Southeast Alaska** region's sport bag and possession limit for pelagic rockfish was five fish per day, 10 in possession. The non-pelagic rockfish regulations were set as follows:

<u>Southeast Alaska Outside Waters</u>: 1) resident bag limit was two fish, only one of which could be a yelloweye; four fish in possession, of which no more than two could be yelloweye; all non-pelagic rockfish caught must be retained until the bag limit is reached; 2) nonresident bag limit was two fish, only one of which could be a yelloweye, four fish in possession, of which no more than one could be yelloweye; and an annual limit of one yelloweye rockfish; all non-pelagic rockfish caught must be retained until the bag limit is reached.

<u>Southeast Alaska Inside Waters</u>: 1) resident bag limit was three fish, only one of which could be a yelloweye; six fish in possession, of which no more than two could be yelloweye; all non-pelagic rockfish caught must be retained until the bag limit is reached; 2) nonresident bag limit was two fish, only one of which could be a yelloweye, four fish in possession, of which no more than two could be yelloweye; and an annual limit of two yelloweye rockfish; all non-pelagic rockfish caught must be retained until the bag limit is reached.

For the entire Southeast Alaska region, charter operators and crewmembers could not retain non-pelagic rockfish while clients were on board the vessel. In addition, anglers fishing from charter vessels were required to release non-pelagic rockfish to the depth of capture or at least 100 feet, whichever is shallower, using a deepwater release device. Charter vessels were required to have at least one functional deep water release device on board and available for inspection (Contact Bob Chadwick).

Rockfish regulations in **Southcentral Alaska** have been designed to discourage targeting of rockfish yet allow and mandate retention of incidental harvest. As in Southeast Alaska, bag limits are more restrictive for non-pelagic species to account for their lower natural mortality rates. The open season for rockfish was year-round in all areas. 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 in Prince William Sound 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 2013. Effort in the directed black rockfish fishery was low with three vessels participating. In the black rockfish fishery, 2.6 mt were harvested in 2013. The directed DSR fishery in 2013 in outside waters was opened in EYKT, CSEO, and SSEO for a total harvest of 129.5 mt. There was also a directed DSR fishery in internal waters in 2013 (SSEI and NSEI); the total harvest in SSEI and NSEI combined was 15 mt.

The total amount of all rockfish species and thornyheads taken as bycatch in all commercial fisheries conducted east of 140^0 W Longitude in 2013 in state and federal water was 436 mt. DSR bycatch made in conjunction with the IFQ halibut fishery in outside as well as internal waters contributed 86.7 mt toward this total.

In the **Central Region**, total rockfish harvest in 2013 was just under 100 mt. The 2013 Cook Inlet Area directed rockfish fishery opened July 1 and closed December 31 with a harvest of 16.7 mt of pelagic shelf rockfish. Total rockfish harvest in the Cook Inlet Area including bycatch to longline, pot and jig fisheries was 32 mt. Total rockfish harvest for the PWS Area bycatch-only fishery was 67.7 mt from pot, trawl, and longline fisheries. This included a 13.3 mt incidental catch of rockfish from the walleye pollock trawl fishery and a 53.8 mt incidental harvest of demersal and slope rockfish primarily from the sablefish, Pacific cod, and halibut longline fisheries.

Overall **sport harvest** (guided and unguided) is estimated primarily through the Statewide Harvest Survey (SWHS). Charter vessel logbooks provide reported harvest for the 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 estimates are for the general category of “rockfish” (all species combined), and the charter vessel logbooks require reporting of rockfish harvest in three categories - pelagic, yelloweye, and other non-pelagics. Recreational rockfish harvest is typically estimated in numbers of fish. Estimates of the 2013 harvest are not yet available from the SWHS, but the 2012 estimates for all species combined were 128,422 fish in Southeast and 101,161 fish in Southcentral Alaska. The average estimated annual harvest for the prior five-year period (2007-2011) was 104,402 rockfish in Southeast Alaska and 109,299 fish in Southcentral Alaska.

3. Sablefish

a. Research
In 2013, 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). Fishery CPUE for 2013 has not yet been calculated. The cost of these surveys is offset by the sale of the fish landed, but in 2013 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 30%. The department plans to allow permit holders to harvest their PQS aboard the 2014 survey as well.

In the SSEI stock assessment, analyses revealed a decline in the overall longline survey and CPUE index (round lb/hook) from 2012 (0.76) to 2013 (0.60). There is a high proportion of immature fish in the fishery (>60% in 2012 and 2013) and in the survey (>76%) in 2012 and 2013. In 2013, the survey was redesigned to expand survey station coverage in Dixon Entrance as well as increase the minimum spacing between survey stations. The Dixon Entrance area 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.

Since 2012, ADF&G has conducted our mark/recapture study in NSEI on the ADF&G *R/V Medeia*. In May and June 2013, 7,961 fish were marked and released in NSEI over the course of the pot tagging survey. Over the 23 day survey, 34 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. No pot tagging survey is planned for May 2014 due to budget reductions (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 and 2013 using pot longline gear. There were 1,203 and 318 fish tagged in 2011 and 2013, respectively. CPUE was very low in 2013 with an average of 0.60 fish per pot. To date, 241 fish have been recaptured from the 2011 survey and 22 were captured from the 2013 survey. From the 2011 tagged releases, 79% were recaptured within PWS and 19% outside in the GOA with the remainder of unknown location. Due to funding issues, no PWS sablefish tagging survey is planned for March, 2014.

Long-term goals include obtaining funding to pursue more sablefish tagging and working towards tag-recapture analysis potentially in combination with an age-structured model (Contact Mike Byerly or Dr. Kenneth Goldman).

Skipper interviews and port sampling occurred in Cordova, Whittier, 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 finclips. The 2013 recommended ABC of 1,207,282 round pounds was calculated by applying 2012 fishery mortality at age (based on a harvest rate of 7.8% using the $F_{50\%}$ biological reference point (BRP)) to the 2013 forecast of total biomass at age and summing across all ages. The 2013 ABC is a 4% increase from the 2012 ABC (1,160,674 round pounds), which was also based on the $F_{50\%}$ BRP (the harvest rate was 7.5% for 2012). 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 GHLs. In the Cook Inlet Area there is a state-managed open access sablefish fishery with a separate GHL.

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 78 permit holders eligible to fish in 2013 in NSEI and 23 permit holders eligible to fish in SSEI.

The SSEI quota was set at 265 mt for 2013.

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.

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 ABC in the federal CGOA. The 2013 fishery GHL was 29.9 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 PWS fishery GHL is set at 110 mt, which is the midpoint of the harvest range set by a habitat-based estimate. PWS 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. In 2009, new season dates were also 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 sole **Westward Region** sablefish fishery occurs in the Aleutian Islands. The GHL for the Aleutian Islands is set at 5% of the combined Bering Sea and Aleutian Islands 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 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. In 2013, the BOF changed the season opening and closing dates to revert back to coinciding with the federal IFQ season.

The Southeast Alaska **sport fishery** for sablefish was regulated for the first time in 2009. Sport limits in 2013 were four fish of any size per day, four in possession, with an annual limit of eight fish applied to nonresidents only. In 2013 a total of 348 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 2013, with no bag, possession, or size limits. Port samplers in Southcentral Alaska measured one sablefish from the sport harvest, again suggesting relatively small harvests.

d. Fisheries

In the **Southeast Region** the 2013 NSEI sablefish fishery opened August 15 and closed November 15. The 78 permit holders landed a total of 440.6 mt of sablefish. The fishery is managed by equal quota share; each permit holder was allowed 5.8 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 2013 CPUE has not yet been calculated. The 2013 SSEI sablefish fishery opened June 1 and closed November 15. Twenty-two permit holders landed a total of 229.3 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 was relatively stable in 2013 relative to 2012 (0.33 lb/hook in both years)) (Contact Kristen Green).

In the **Central Region** the 2013 open access sablefish fishery in the Cook Inlet North Gulf District opened at noon July 15 and was open through the remainder of the calendar year. Eight vessels participated and the 2013 sablefish harvest for the Cook Inlet Area was 19.2 mt, the lowest harvest since a GHL was first established in 1997 and also the first year that the GHL (29.9 mt) was not fully utilized. The 2013 PWS harvest totaled 70.5 mt and was the lowest harvest on record and 24% lower than the 2012 harvest although the GHL has remained fixed (Contact Jan Rumble).

Within the **Westward Region**, only the Aleutian Islands have sufficient habitat to support mature sablefish populations of enough 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 2013 Aleutian Island fishery opened on May 15. Additional requirements for the fishery include registration and logbook requirements. The GHL was set at 200 mt for the state fishery. The harvest from the 2013 Aleutian Islands sablefish fishery was 103 mt. The season remained open until the November 7 closure date (Contact Heather Fitch).

The most recent sablefish recreational harvest estimates from the SWHS are for 2012. The estimated harvest was 11,798 fish in Southeast Alaska and 5,902 fish in Southcentral Alaska. SWHS estimates are suspected to be biased high due to misidentification and misreporting. Sablefish are not commonly taken by anglers, and relatively high catches were reported from some areas where sablefish are rarely or never observed by creel survey crews. Charter logbooks indicated guided harvests of 5,184 sablefish in Southeast Alaska and 442 sablefish in Southcentral Alaska in 2012 (Contact Bob Chadwick).

4. Flatfish

a. Research
There was no research on flatfish during 2013.

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, however in 2013, a vessel applied for a Commissioner's permit to participate in the fishery, and made a single flatfish landing, however this landing information is confidential. 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 commissioner's permits to harvest flatfish were issued in **Central Region** during 2013.

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 2013 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 1,150 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 2013 (Contact Dr. Kenneth 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. In 2013, new management measures were implemented to set the PWS pollock GHL at 2.5% of the federal Gulf of Alaska ABC. 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 trawl fishing has occurred in the Cook Inlet Area since 2004. In Central Region, pollock is also retained as bycatch to other directed groundfish fisheries, primarily Pacific cod (Contact Jan Rumble).

d. Fisheries

The 2013 **Prince William Sound** fishery opened on January 20 with a GHL of 2,827 mt. The Hinchinbrook section closed by emergency order at 4:00 p.m. January 22 while the Knight Island and Bainbridge sections closed by emergency order at 12:00 midnight February 3. Total pollock harvest for all sections combined was 2,843 mt. Total bycatch during the PWS pollock fishery was 51.4 mt, 1.8 percent of the GHL and was dominated by squid at 37.4 mt. In the Cook Inlet Area, pollock harvested in 2013 as bycatch to other fisheries (mainly Pacific cod jig fishery) was 21.5 mt, the highest harvest since the last directed fishery was conducted in 2004 (Contact Jan Rumble).

6. Sharks

a. Research

In 2009, **Central Region** Commercial Fisheries Division began tagging all sharks with spaghetti-type external tags, but discontinued that work after the 2012 field season. A recent collaboration between ADF&G and NOAA/NMFS staff resulted in the publication of a paper strongly indicating that salmon sharks have a biennial reproductive cycle and a gestation period of no longer than 10 months (Conrath et al. 2014). A research project on the reproductive biology of salmon sharks via blood hormone concentrations, which was initiated in the summer of 2010, continues with the goal of providing more precise information on the timing and frequency of reproductive activity. Another research project examining the energetics of salmon sharks was initiated in the summer of 2012, which includes the concurrent application of temperature/depth transmitters and accelerometers (Contact Dr. Kenneth 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. No salmon sharks were reported harvested by any interviewed anglers in 2013. Nine spiny dogfish were reported harvested in over 3,300 angler-days of effort. Two length measurements were obtained from spiny dogfish in 2013. 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. Kenneth 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 was set by the maximum allowable retention amount in regulation at 20% of the round weight of the directed species on board a vessel. Additionally, 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 sharks continued to be low in 2013.

d. Fisheries
No applications for permits to target spiny dogfish in Cook Inlet were received in 2013. In 2013, no spiny dogfish were harvested as bycatch in the Cook Inlet Area and only 0.1 mt were harvested in the PWS Area.

Recreational shark harvest in 2012 (the most recent year for which estimates are available) was estimated at 69 sharks of all species in Southeast Alaska and 132 sharks in Southcentral Alaska. The precision of these estimates is low; the Southeast estimate has a CV of 54% and the Southcentral estimate has a CV of 47%. 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 2012 reported charter harvest from logbooks was 11 salmon sharks in Southeast Alaska and 10 salmon sharks in Southcentral Alaska.

7. Lingcod

a. Research
Since 1996, 9,189 lingcod have been tagged and 477 fish recovered in Southeast Region. Opportunistic tagging of four lingcod in the vicinity of Sitka occurred during 2013. Length, sex

and tagging location are recorded for all tagged fish. Dockside sampling of lingcod caught in the commercial fishery continued in 2013 in Sitka and Yakutat with over 1,571 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 365 lingcod samples collected and 77% 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).

In the **Westward Region**, no directed lingcod effort occurred during 2013. All lingcod were harvested incidental to other federal and state managed groundfish fisheries. The 2013 harvest totaled 106 mt in the Kodiak Area and 19 mt in the Chignik Area.

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 2013 included Juneau, Sitka, Craig/Klawock, Wrangell, Petersburg, Gustavus, Elfin Cove, Yakutat, and Ketchikan. Length and sex data were collected from 1,707 lingcod in 2013, 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 1,004 lingcod were sampled from sport harvest at Seward, Valdez, Whittier, Kodiak, and Homer in 2013. 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 analyses were conducted for 2013.

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 bordered by land masses, deep fjords, and/or expanses of deeper soft substrates. An ROV survey was conducted in August 2013 to estimate the abundance and biomass DSR in Harris Bay, Aialik Bay and along Chiswell Ridge. Chiswell Ridge is the first area in Central Region to be resurveyed, having been surveyed earlier in 2005. Work on the new stereoscopic Gigabit Ethernet camera system continued. This system is anticipated to be operational for the 2014 survey season (Contact Mike Byerly or Dr. Kenneth 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**, sport harvests of lingcod are incorporated into a regionwide lingcod management plan. This plan 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.

The sport fishery lingcod season for 2013 was May 16-November 30. Charter vessel operators and crew members were prohibited from retaining lingcod while guiding clients. For resident anglers, the limits regionwide were one fish per day and two in possession, and there was no size limit. For nonresidents, however, additional regulations were in place to keep harvest from exceeding allocations enacted by the Alaska Board of Fisheries. Nonresidents were allowed one fish daily and one in possession. In the Yakutat and Southern Southeast districts, nonresidents were allowed to harvest fish 30-45 inches in length, or fish 55 inches and greater in length. In the Northern Southeast District, nonresidents were only allowed to harvest fish that were 30-35 inches in total length, or fish 55 inches and greater in length. In all areas, nonresidents were limited to two lingcod annually, only one of which could be 55 inches or greater in length. In addition, the Pinnacles area near Sitka has been closed to sport fishing year-round for all groundfish since 1997 (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 2013 were two 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 115.5 mt of lingcod in 2013. An additional 72.7 mt was landed as bycatch in halibut and other groundfish fisheries and 8.5 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 2013, the Cook Inlet GHL was 24 mt and the PWS GHL was 15 mt. Lingcod harvests in 2013 totaled 5.4 mt in Cook Inlet and 13.8 mt in PWS. Approximately 73% of the lingcod harvest in Cook Inlet resulted from directed jig effort. In PWS, approximately 87% 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 on August 31 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 2013. 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 from the statewide mail survey for 2012 (the most recent year available) were 12,717 lingcod in Southeast Alaska and 20,389 lingcod in Southcentral Alaska. The average estimated annual harvest for the prior five-year period (2007-2011) was 10,714 fish in Southeast Alaska and 24,379 fish in Southcentral Alaska.

8. Other species

In 1997 the BOF approved 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 thereafter. 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 2013 the bycatch harvest of combined big and longnose skates was 107.8 mt in the PWS Area and 51.4 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, three Aleutian skate, and 112 sandpaper skate tagged (Contact Dr. Kenneth 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 Council. 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** currently houses all data in an MS Access database format. Queries are complete for calculating CPUE, abundance, and biomass estimates from most surveys. All data are additionally captured in a GIS for spatial analysis.

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	37	2	17	107	2	128
2011	31	41	<1	16	112	2	130
2012	21	26	<1	18	116	4	139
2013	25	27	<1	14	115	2	132

2. Marine Reserves

In September of 1997 the ADF&G submitted proposals to both the BOF and the Council 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 Council approved of the reserve at their June 1998 meeting. The Council 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.adfg.alaska.gov/index.cfm?adfg=CommercialByFisheryGroundfish.groundfishmaps
(Contact Cathy Tide)

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	67	67	closed	127	117	15	0	closed
2013	66	84	closed	129	87	4	1	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 2013, 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 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 Fisheries 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 I, Southeast Region, Groundfish Home Page:
http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareasoutheast.groundfish

Region II, Central Region, Groundfish Pages:
http://www.adfg.alaska.gov/index.cfm?adfg=fishingcommercialbyarea.southcentral

Westward Region, Groundfish Pages:
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.groundfishmap
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APPENDIX I. ALASKA DEPARTMENT OF FISH AND GAME PERMANENT FULL-TIME GROUNDFISH STAFF DURING 2013.

COMMERCIAL FISHERIES DIVISION

HEADQUARTERS, P.O. Box 25526, Juneau, Alaska 99802-5526

Chief, Computer Services Kathleen Jones (907) 465-4753	Age Determination Unit Kevin McNeel Box 115526 Juneau, AK 99811 (907) 465-3054	Elandings Program Coordinator II Gail Smith (907) 465-6157
Alaska Fisheries Information Network (AKFIN) Program Coordinator Lee Hulbert (907) 465-6109		

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Project Biometrician Kray Van Kirk Box 240020 Douglas, AK 99824-0020 (907) 465-4216	Fishery Biologist I Aaron Baldwin Box 240020 Douglas, AK 99824-0020 (907) 465-3896	Fishery Technician IV Kamala Carroll 304 Lake St. Rm. 103 Sitka, AK 99835 (907) 747-6688
Research Analyst II Martina Kallenberger Box 240020 Douglas, AK 99824-0020 (907) 465-4209	Fishery Technician IV Jennifer Dupree P.O. Box 667 Petersburg, AK 99833-0667 (907) 772-5231	Fishery Technician III Jessica Acker 304 Lake St. Rm. 103 Sitka, AK 99835 (907) 747-6831

CENTRAL REGION

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Fish Ticket Processing and Data Analyst Chris Russ 3298 Douglas Place, Homer, AK 99603-7942 (907) 235-8191	Fishery Biologist Mike Byerly 3298 Douglas Place Homer, AK 99603-7942 (907) 235-8191	PWS Management Biologist Maria Wessell PO Box 669 Cordova, AK 99574-0669 (907) 424-3212
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WESTWARD REGION

Shellfish/Groundfish Biologist Wayne Donaldson 351 Research Ct Kodiak, AK 99615-6399 (907) 486-1840	Area Management Biologist Mark Stichert 351 Research Ct., Kodiak, AK 99615-6399 (907) 486-1840	Groundfish Research Biologist Carrie Worton 351 Research Ct Kodiak, AK 99615-6399 (907) 486-1849
Groundfish Sampling Coordinator Kally Spalinger 351 Research Ct Kodiak, AK 99615 (907) 486-1840	Assistant Area Management Biologist Trent Hartill 351 Research Ct Kodiak, AK 99615 (907) 486-1840	Area Management Biologist Heather Fitch P.O. Box 920587 Dutch Harbor, AK 99692 (907) 581-1239
Assistant Groundfish Research Biologist Philip Tschersich 351 Research Ct Kodiak, AK 99615-6399 (907) 486-1871	Assistant Area Management Biologist VACANT P.O. Box 920587 Dutch Harbor, AK 99692 (907) 581-1239	

SPORT FISH DIVISION

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SOUTHEAST REGION

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Sitka Area Management Biologist Troy Tydingco 304 Lake St., Room 103 Sitka, AK 99835-7563 (907) 747-5355	Petersburg/Wrangell Area Mgmt. Biologist Douglas Fleming P.O. Box 667 Petersburg, AK 99833-0667 (907) 772-5231	Prince of Wales Area Management Biologist Vacant P.O. Box 682 Craig, AK 99921 (907) 826-2498
Ketchikan Area Mgmt. Biologist Kelly Piazza 2030 Sea Level Drive, Ste 205 Ketchikan, AK 99901 (907) 225-2859	Biometrician Sarah Power Division of Sport Fish-RTS PO Box 110024 Juneau, AK 99811-0024 (907) 465-1192	

SOUTHCENTRAL REGION

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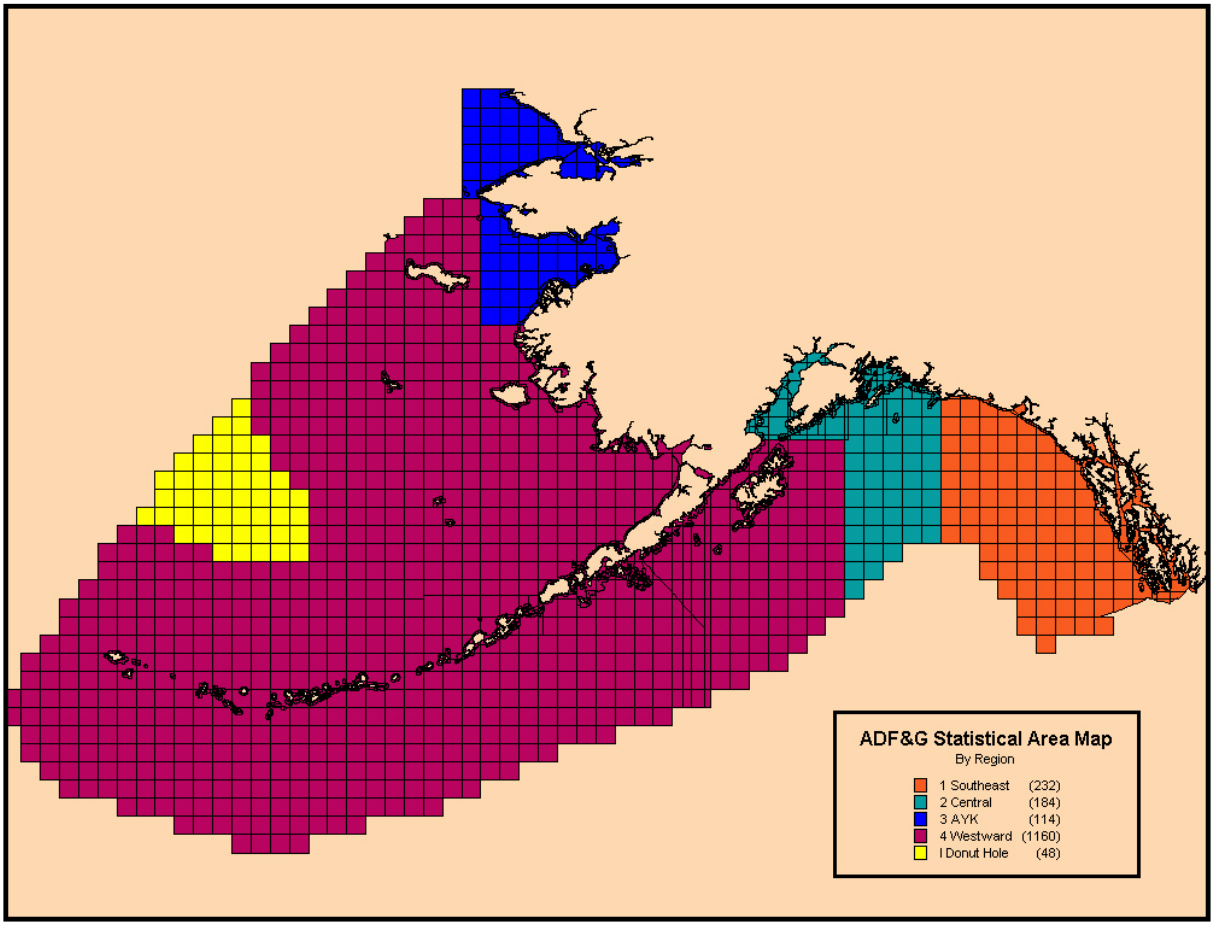
PWS Assistant Area Biol. Mike Thalhauser 333 Raspberry Road Anchorage, AK 99518-1599 (907) 267-2186	Biometrician Adam Craig Division of Sport Fish-RTS 333 Raspberry Road Anchorage, AK 99518-1599 (907) 267-2272	



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

Species	Location	Year	Sample size	Tissues
	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
	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

Species	Location	Year	Sample size	Tissues
	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
	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 Department of Fish and Wildlife
Agency Report
to the
Technical Subcommittee
of the
Canada-United States Groundfish Committee

April 2014

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A. AGENCY OVERVIEW

Within the California Department of Fish and Wildlife (CDFW), the Marine Region is responsible for protecting and managing California's marine resources under the authority of laws and regulations created by the State Legislature, the California Fish and Game Commission (CFGC) and the Pacific Fishery Management Council (Council). The Marine Region is unique in the CDFW because of its dual responsibility for both policy and operational issues within the State's marine jurisdiction (0 – 3 miles). It was created to improve marine resources management by incorporating fisheries and habitat programs, environmental review and water quality monitoring into a single organizational unit. In addition, it was specifically designed to be more effective, inclusive, comprehensive and collaborative in marine management activities.

The Marine Region has adopted an approach that takes a broad perspective relative to resource issues and management. This ecosystem approach considers the values of entire biological communities and habitats, as well as the needs of communities, while to ensure a healthy marine environment and sustainable fisheries. The Marine Region employs approximately 250 permanent and seasonal staff that provide technical expertise and policy recommendations to the CDFW, CFGC, Council, and other agencies or entities involved with the management, protection, and utilization of finfish, shellfish, invertebrates, and plants in California's ocean waters.

In 2013, Legislature changed the name of the Department of Fish and Game to the Department of Fish and Wildlife to better reflect the many non-game issues under its jurisdiction. Also in 2013, the Regional Manager for the Marine Region, Ms. Marija Vojkovich retired after more than 30 years of state service. The new Regional Manager is Dr. Craig Shuman, former Marine Advisor to the CFGC.

Contributed by Traci Larinto (Traci.Larinto@wildlife.ca.gov)

B. MULTISPECIES STUDIES

1. Research and Monitoring

(a) *Commercial Fishery Monitoring*

Statistical and biological data from landings are continually collected and routinely analyzed by CDFW staff to provide current information on groundfish fisheries and the status of the stocks. California's primary commercial landings database is housed in CDFW's Commercial Fisheries Information System. Outside funding also enables California fishery data to be routinely incorporated into regional databases such as Pacific Coast Fisheries Information Network.

Commercial sampling occurs at local fish markets where samplers determine species composition of the different market categories, measure and weigh fish and take otoliths for future ageing studies/projects. Market categories recorded on the landing receipt may be single species (e.g., bocaccio, *Sebastes paucispinis*) or species groups (e.g., group slope rockfish). Samplers need to determine the species composition so that landings of market categories can be split into individual species for management purposes. Table 1 lists the commercial groundfish landings for 2012 and 2013 along with the number of lengths and otoliths taken by samplers.

Contributed by Traci Larinto (Traci.Larinto@wildlife.ca.gov)

Table 1. Commercial groundfish landings (metric tons) and samples taken in 2012 and 2013.

Market category[1]	2012 m tons	2012 Lengths	2012 Otoliths	2013 m tons[2]	2013 Lengths	2013 Otoliths
Rockfish:						
Chilipepper rockfish	236	1280	349	322	1136	412
Blackgill rockfish	127	1360	322	72	682	197
Group slope rockfish	102			21		
Bank rockfish	11	367	63	52	412	136
Black rockfish	24	695	44	36	590	1
Brown rockfish	26	203		28	101	
Gopher rockfish	23	420		23	343	
Vermilion rockfish	18	170	6	22	238	2
Splitnose rockfish	20	655	93	14	373	202
Bocaccio rockfish	12	356	75	16	433	25
Grass rockfish	12	305		13	143	
Black-and-yellow rockfish	11	289		10	238	
Copper rockfish	6	73	1	7	47	
Darkblotched rockfish	7	1042	426	4	540	168
Blue rockfish	4	791	6	5	482	
Widow rockfish	2	145	186	6	255	89
Aurora rockfish	2	1459	744	5	734	348
Yellowtail rockfish	1	162	28	5	218	12
Group shelf rockfish	2			3		
Redbanded rockfish	4	198	92	0[4]	171	100
Group red rockfish	2			2		
China rockfish	2	13		1	8	
Greenspotted rockfish	1	102	13	2	13	3
Treefish	2	37		1	23	
Quillback rockfish	2	15	4	1	13	
Canary rockfish	1	167		2	310	149
Olive rockfish	1	31	6	1	24	
Kelp rockfish	1	2		1	23	
Starry rockfish	0	10		1	23	
Unspecified rockfish	1			0		
Flag rockfish	0	14		0	7	
Rosy rockfish	0	14		0	17	
Speckled rockfish	0	1		0		
Rosethorn rockfish	0	113	30	0	8	3
Cowcod	0	46	8	0	24	19
Greenblotched rockfish	0	15	1	0	10	
Squarespot rockfish	0			0		
Pacific ocean perch	0	56	45	0	37	31
Greenstriped rockfish	0	8		0	40	24
Group bolina rockfish	0			0		
Group nearshore rockfish	0			0		
Mexican rockfish	0	1	1	0	9	8
Rockfish (continued)						
Group rosefish rockfish	0			0		
Pinkrose rockfish	0			0	82	
Group small rockfish	0			0		

Table 1. Commercial groundfish landings (metric tons) and samples taken in 2012 and 2013.

	2012			2013		
Market category[1]	m tons	Lengths	Otoliths	m tons[2]	Lengths	Otoliths
Shortbelly rockfish	0	9		0		
Honeycomb rockfish	0	2		0		
Group bocaccio/chilipepper rockfish	0			--[4]		
Pink rockfish	0	6	1	0	11	1
Bronzespotted rockfish	0			--		
Yelloweye rockfish	0	1		0	3	1
Stripetail rockfish	0	26	13	0	55	17
Swordspine rockfish	--			0		
Group gopher rockfish	--			0		
Copper (whitebelly) rockfish	--			0		
Group deeper nearshore rockfish	--			0		
Group canary/vermilion rockfish	--			0		
Blackspotted rockfish[3]	--	11	12	7		6
Freckled rockfish[3]	--	1		--		
Rougheye rockfish[3]	--	35	24	--	36	19
Shortraker rockfish[3]	--	3	1	--	1	
Yellowmouth rockfish[3]	--	1		--		
Sharpchin rockfish[3]	--			--	4	4
Silvergrey rockfish[3]	--			--	1	1
Tiger rockfish[3]	--			--	1	
Skates:						
Longnose skate	174	1196		148	948	
Unspecified skate	31	5		17	5	
Big skate	4	43		20	207	
California skate	1	2		0	1	
Black skate[3]	--	4		--		
Sandpaper skate[3]	--	4		--		
Roundfish:						
Sablefish	1627	6893	980	1364	5887	836
Longspine thornyhead	502	4876	41	652	4617	
Shortspine thornyhead	411	4304	120	427	4082	
Unspecified grenadier	99	177		83	325	60
Lingcod	48	230		64	459	
Cabezon	31	247		29	102	
California sheephead	28	6		28	45	
Kelp greenling	5	47		5	38	
Pacific whiting	4	79		4	153	
California scorpionfish	4	1		3	244	
Unspecified thornyhead	1			6		
Spotted ratfish	0			0		
Pacific tomcod	0			0		
Pacific cod	0			0		
Pacific grenadier[3]	--	38		--	39	
Rock greenling	--	1		3		
Sharks:						
Lepoard shark	2			1		
Soupfin shark	1			1		
Spiny dogfish	1	3		1		
Flatfish						
Dover sole	2150	2428	980	2218	2557	757
Petrale sole	222	2224	154	47	3683	143
California halibut	171	34		182	27	
Arrowtooth flounder	99	982	169	118	862	44

Table 1. Commercial groundfish landings (metric tons) and samples taken in 2012 and 2013.

Market category[1]	2012 m tons	2012 Lengths	2012 Otoliths	2013 m tons[2]	2013 Lengths	2013 Otoliths
Unidentified sanddab	59			95		
Rex sole	48	2046	172	45	2289	37
English sole	23	877	32	49	1508	148
Sand sole	18	410		15	498	
Starry flounder	5	154		5	221	
Rock sole	4	141		4	93	12
Pacific sanddab	0	585	5	2	1379	
Curlfin sole	0			0	19	
Butter sole	0			0		
Bigmouth sole	--	1		--	2	
Deepsea sole[3]	--	145	4	--	13	
Fantail sole	--	2		--	14	
Hornyhead turbot	--			--	72	
Slender sole	--	9	8	--		
Spotted turbot	--	7		--	9	
Diamond turbot	--			--	2	

Notes:

1. Market categories can be either single species (e.g., lingcod, blue rockfish) or group categories (e.g., unspecified sole, group slope rockfish). In some instances, there were no landings reported for a species, yet lengths and otoliths were collected. These landings were likely reported in a group market category (e.g., fantail sole were probably listed as unspecified sole on the landing receipt).
2. Landings for 2013 are preliminary.
3. There are no market categories for these species, so these fish were landed under a group market category (e.g., unspecified sole, group shelf rockfish)
4. Zero (0) indicates that less than 1 metric ton was caught; blank indicates no catch was recorded

Source: California Commercial Fisheries Information System (landings) and California Cooperative Groundfish Survey (sample data).

(b) *Recreational Fishery Monitoring*

The California Recreational Fisheries Survey (CRFS) was initiated in January 2004 to provide catch and effort estimates for marine recreational finfish fisheries. The CRFS generates monthly estimates of total recreational catch for four modes of fishing [beach/bank, man-made structures, commercial passenger fishing vessels (CPFVs), and private and rental boats] for six geographic districts along California’s 1000 plus miles of coast. The data are used to inform stock assessors and by state and federal regulators to craft regulations to protect fish stocks and provide recreational fishing opportunities. The sampling data and estimates are available on the Recreational Fisheries Information Network website.

The CRFS is a multi-part survey which uses field sampling, a telephone survey of licensed anglers, and CPFV logs (activity records for each trip). Throughout 2013, over 70 CRFS samplers gathered recreational fishing effort and catch data statewide. The CRFS samplers interviewed nearly 61,000 anglers at more than 500 sites, and examined and identified about 223,000 fish, the contractor for the licensed angler telephone survey completed 26,000 interviews, and CDFW received and processed more than 30,000 CPFV logs that were all used in the estimation process. The high sampling levels have contributed to greater accuracy and precision in estimating catch and effort, especially for overfished species.

The Council adopted provisions for adjusting the mortality rates for rockfish released with a descending device in the recreational fishery. The CRFS collected species-specific data on the use of descending devices in 2013. These data will be applied retrospectively to the harvest estimates of canary rockfish (*Sebastes pinniger*), cowcod (*S. levis*) and yelloweye rockfish (*S. ruberrimus*).

In addition to producing monthly catch and effort estimates, the CRFS provides weekly estimates of cowcod and yelloweye encounters. Recreational anglers are prohibited from retaining cowcod and yelloweye rockfish, and both species have low harvest guidelines. This close in-season monitoring helps to ensure that California stays within the harvest guidelines.

Please visit the CRFS website for more information.

Contributed by Connie Ryan (Connie.Ryan@Wildlife.ca.gov)

(c) *Inseason Monitoring*

Commercial fishery

The CFGC has authority under state law to manage nearshore species (as defined by the state's Marine Life Management Act and the Nearshore Fisheries Management Act). The CFGC has given CDFW the authority to take action as a routine management measure to close the recreational and/or commercial sectors of the cabezon, California sheephead, and greenling fisheries upon projected attainment of their respective established optimum yields and fishery allocations. The CDFW also has authority to make inseason trip limit adjustments to the commercial fisheries for cabezon, California sheephead and greenlings.

Inseason monitoring is used to track landings against statewide total allowable catches, statewide and/or regional allocations and trip limits. Staff conduct inseason monitoring of California commercial nearshore species landings in the areas north and south of 40°10' North Latitude near Cape Mendocino. This work is done in conjunction with inseason monitoring, management and regulatory tasks conducted by the Council. Weekly tallies of landing receipts are used for inseason monitoring.

In 2012 and 2013, no inseason changes were made for cabezon, California sheephead and greenlings. The last time the CFGC had to take inseason action was in 2008. Fewer participants and increased trip limits for some species has allowed the fishery to continue unchanged.

In 2012, inseason trip limit changes were made for federal sablefish, shelf rockfish complex and bocaccio. In 2013, inseason trip limit changes were made for federal sablefish, shortspine thornyhead, shelf rockfish complex, bocaccio, and deeper nearshore rockfish complex. These changes kept the catch within the allowable harvest.

Contributed by Traci Larinto (Traci.Larinto@wildlife.ca.gov)

Recreational fishery

The CFGC has given the CDFW additional authority to take inseason action to modify management measures or close the recreational fishery for groundfish if harvests are projected to exceed or be well below federally-established harvest guidelines. Inseason monitoring of California recreational groundfish species catch is conducted by CDFW biologists utilizing a mathematical model that includes projected catch based on previous years' data as well as current catch rates obtained weekly from CRFS staff. Recreational catch monitoring of yelloweye rockfish, a species that significantly constrains the recreational catch of all rockfish, is available on CDFW's Inseason Tracking website.

In 2012, inseason management action was taken to modify the depth in the Southern Groundfish Management Area (Figure 1), allowing fishing in waters 50 fathoms or less (previously 60 fathoms or less). In 2013, no inseason management actions were taken and the take of yelloweye rockfish in the recreational fishery was less than half the harvest limit. The CFGC has not had to take inseason action for the recreational fishery since 2008, due in part to modifying management areas and seasonal closures to better reduce the take of yelloweye rockfish.

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2. Management

(a) *2012 & 2013 State Management Measures Affecting Groundfish*

Commercial fishery

In 2011, at the federal level, new methodologies were approved for use in determining allowable harvest amounts for data poor stocks. These methodologies were applied to kelp greenling and resulted in a significantly higher harvest limit of 121,900 pounds, more than 3 times the previous harvest limit of 37,600 pounds, was adopted by the Council. The CFGC adopted regulations increasing the total allowable catch (TAC) for greenlings to 121,900 pounds, and increased the commercial allocation from 3,400 pounds to 55,400 pounds. Along with the increased TAC, the CFGC increased the commercial greenling trip limits (Table 2).

Figure 1. Recreational groundfish management areas for 2013-14.

Table 2. Greenling commercial trip limit changes in 2012, effective May 1, 2012.

	Old trip limits (pounds)	New trip limits (pounds)
January-February	25	150
March-April (closed)[1]	25	150
May-June	25	200
July-August	25	200
September-October	25	200
November-December	25	150

Notes:
1 Since the fishery is closed, the actual trip limits are zero pounds.

Recreational fishery

As a result of the increased TAC for greenlings, the CFGC increased the recreational allocation from 34,200 to 66,500 pounds, and removed the 2-fish sub-bag limit for greenlings within the 10-fish RCG (rockfish, cabezon, greenling) daily bag limit.

In December 2012, the CFGC adopted regulations for the 2013-2014 recreational groundfish fishery to make them consistent with proposed federal regulations. The changes included:

- Increased the number of bocaccio from 2 to 3 fish within the 10-fish RCG bag limit.
- Removed the minimum size limit for bocaccio.
- Removed the minimum fillet length for bocaccio.
- Allow retention of shelf species in the Cowcod Conservation Area (CCA) in waters 20 fathoms or less.
- Adjusted the seasons according to Figure 2.

Figure 2. Season structure and depth constraints for the California recreational groundfish fishery proposed for 2013 and 2014, as recommended by the Council in June 2012.

Management area	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Northern	Closed				May 15 – October 31, < 20 fm						Closed	
Mendocino	Closed				May 15-Sept 2, 2013, < 20 fm May 15-Sept 1, 2014, < 20 fm				Closed			
San Francisco	Closed					June 1 – December 31, < 30 fm						
Central	Closed				May 1 – December 31, < 40 fm							
Southern	Closed		March 1 – December 31, < 50 fm									
CCA	Closed		March 1 – December 31, < 20 fm									

Note: See Figure 1 for groundfish management area boundaries.

Contributed by Traci Larinto (Traci.Larinto@wildlife.ca.gov)

(b) *Nearshore Management*

In 2002, the CFGC adopted California's Nearshore Fishery Management Plan (FMP) for 19 species [black (*Sebastes melanops*), black-and-yellow (*S. chrysomelas*), blue (*S. mystinus*), brown (*S. auriculatus*), calico (*S. dalli*), China (*S. nebulosus*), copper (*S. caurinus*), gopher (*S. carnatus*), grass (*S. rastrelliger*), kelp (*S. atrovirens*), olive (*S. serranoides*), quillback (*S. maliger*), and treefish (*S. serriceps*) rockfishes; cabezon (*Scorpaenichthys marmoratus*); kelp (*Hexagrammos decagrammus*) and rock greenlings (*H. lagocephalus*); California scorpionfish (*Scorpeana guttata*); California sheephead (*Semicossyphus pulcher*); and monkeyface prickleback (*Cebidichthys violaceus*)]. All but California sheephead, rock greenling and monkeyface prickleback are also included in the Council's federal Groundfish FMP. The Nearshore FMP is based on a framework management approach that gives the CFGC a comprehensive management strategy to prevent overfishing, rebuild depressed stocks, ensure conservation, promote habitat protection and provide for non-consumptive uses.

The CFGC adopted seasonal closures, total allowable catch, and trip limits for cabezon, kelp greenling, and California sheephead. Additionally, the CFGC provided CDFW with authority to close any of these fisheries upon attainment of the total allowable catch. Seasonal closures coincide with federal groundfish closures in waters off the state of California. In 2013, the only management changes to nearshore species are discussed above.

Contributed by Traci Larinto (Traci.Larinto@wildlife.ca.gov)

(c) *Restricted Access for Nearshore Fisheries*

The State of California began a restricted access program for the commercial nearshore fishery in 2003. The Nearshore Fishery Permit is required to take the following 10 shallow nearshore species: black-and-yellow, China, gopher, grass and kelp rockfishes, kelp and rock greenlings, California scorpionfish, California sheephead, and cabezon. These species can be taken with hook-and-line or dip net gears only; trap gear can be used with a trap endorsement. The Nearshore Fishery Permit program was set up on a regional basis with four regions: North Coast Region (Oregon border to 40°10' North Latitude near Cape Mendocino), North-Central Coast Region (40°10' North Latitude to Point Año Nuevo), South-Central Coast Region (Point Año Nuevo to Point Conception), and South Coast Region (Point Conception to the U.S./Mexico border). Nearshore Fishery Permit holders may only take these nearshore species within the region on the permit. Both transferable and non-transferable Nearshore Fishery Permits are issued.

A permit capacity goal was set for each nearshore region: 14 for the North Coast Region, 9 for the North-Central Coast Region, 20 for the South-Central Coast Region, and 18 for the South Coast Region. Until a region reaches its capacity goal, permits can only be transferred on a two for one basis, whereby two permits are purchased, one is retired and the other is used to fish. When the program began in 2003, a total of 220 permits were issued. In 2013, the number of permits had decreased to 157. The number of permits has been reduced 29 percent due to 2-for-1 permit transfers and attrition. Despite this, the number of permits still exceeds the capacity goal for each region.

The Nearshore Fishery Bycatch Permit program, which was started in 2003, authorizes the take, possession, and landing of shallow nearshore species by vessels using only trawl or entangling nets (gill and trammel nets). Thirteen Nearshore Fishery Bycatch Permits were issued in 2013, a 50 percent reduction in the number of permits issued in 2003.

A Deeper Nearshore Species Fishery Permit program was also implemented in 2003. This permit allows the take of the following eight species of deeper nearshore rockfishes: black, blue, brown, calico, copper, olive, quillback and treefish. The permit is non-transferable, because there is no capacity goal for the fishery. Permit holders are not restricted by gear and may catch and land these species anywhere in the state where commercial fishing is allowed. A total of 294 permits were issued in 2003; the number of permits issued decreased to 191 in 2013, a 35 percent reduction in permits.

Contributed by Traci Larinto (Traci.Larinto@Wildlife.ca.gov)

C. BY SPECIES

1. Pacific Whiting

There have been no directed Pacific whiting (*Merluccius productus*) trips in California since the inception of the Trawl Individual Quota (TIQ) program. Pacific whiting quota share holders are fishing in other states or trading their whiting shares for other groundfish.

Contributed by Traci Larinto (Traci.Larinto@Wildlife.ca.gov)

2. Chilipepper Rockfish

Exempted fishing permits (EFP) have been granted by the Council in recent years to study the use of different gears in both commercial and recreational groundfish fisheries. One EFP was granted to commercial fishermen to study a method of commercial troll long line fishing to target chilipepper rockfish (*Sebastes goodei*) inside Rockfish Conservation Areas (RCAs). The RCAs, which are currently closed to groundfish fishing, were designed to protect overfished rockfish species such as yelloweye and canary rockfish. The inability to target healthy groundfish stocks (e.g., chilipepper rockfish) within the RCAs has resulted in underutilization of many groundfish species. The goal of this study is to determine whether alternate fishing strategies (i.e., troll long line) can provide additional fishing opportunities for commercial fisheries inside the RCAs while avoiding overfished stocks. At this time, no fishing has occurred under this EFP, although plans are underway to fish in the winter and early spring 2014.

Contributed by Joanna Grebel (Joanna.Grebel@Wildlife.ca.gov)

3. Yellowtail rockfish

A second EFP was granted to commercial fishermen to study a method of commercial jig fishing to determine whether it is possible to target yellowtail rockfish (*Sebastes flavidus*) inside the RCAs while avoiding overfished rockfish species. The goal of this study is to determine if alternate fishing strategies can provide additional fishing opportunities for the commercial fishery in the RCAs while avoiding overfished stocks. Preliminary data from five trips taken in 2013 indicate that the catch was comprised of primarily yellowtail and widow rockfish (*S. entomelas*) (57 and 30 percent of total catch, respectively). Catch of overfished species was minimal (bocaccio, canary, and yelloweye rockfish catch was 6.5, 1.4, 0.5 percent of total catch, respectively). The remainder (4.6 percent) was a combination of shelf rockfish and other species. Fishing ceased when the participants came close to their yelloweye rockfish set aside (22 pounds). Additional trips are planned for 2014.

Contributed by Joanna Grebel (Joanna.Grebel@Wildlife.ca.gov)

4. Copper rockfish

Copper rockfish is one of the 19 nearshore finfish species in California's Nearshore FMP. Successful implementation of the Nearshore FMP requires filling data gaps on essential fishery information which is lacking. For copper rockfish, there is limited information available on age and growth in California waters. The CDFW's Groundfish Ecosystem Research and Management Project initiated a study to estimate age and growth parameters of copper rockfish in California for use in future stock assessments.

Biological sample data (i.e., otoliths) from commercial, recreational and research sectors collected over the last 4 decades (1970s to present) have been compiled, with over 1200 otoliths collected. A random sub-sample of 465 otoliths representing all available size classes and sexes was selected for ageing purposes. Within the sub-set, females (n = 181) ranged from 150 mm to 565 mm total length. Males (n = 140) ranged from 168 mm to

554 mm total length. Samples where sex was unavailable (n = 144) ranged from 79 mm to 542 mm total length.

This study is still in progress. Although ages have been estimated for some samples, estimates of growth parameters have not been completed. Once ages have been estimated for the initial 476 otoliths, additional samples can be added if necessary to reduce uncertainty in growth parameters.

Contributed by Caroline Mcknight (Caroline.Mcknight@Wildlife.ca.gov)

D. OTHER RELATED ACTIVITIES AND STUDIES

1. Implementation of the Marine Life Protection Act

Overview: The Marine Life Protection Act (MLPA), passed by the California State Legislature, mandates the State to redesign, manage, and evaluate an improved MPA network to, among other things, protect marine life and habitats, marine ecosystems, and marine natural heritage[13]. Prior to the passage of the MLPA in 1999, there were 63 existing MPAs that were primarily established in an ad hoc manner, mostly small and considered ineffective (covering 2.7 percent of state waters, with less than 0.25 percent in no-take MPAs). For the purposes of MPA planning from 2004 – 2012, the State was split into five planning regions that included four coastal regions and the San Francisco Bay. By the end of 2012, the MPA planning processes for all four coastal regions were completed[14] (Figure 3). California's redesigned statewide MPA network includes 124 MPAs (119 MPAs and five state marine recreational management areas). There are also 15 special closures (Table 3). California's redesigned coastal MPA network covers approximately 852 sq mi of state waters or about 16 percent, and approximately 9.4 percent of which in no-take MPAs (Figure 4).

[13] California Fish and Game Code, Sections 2850-2863.

[14] Options for an MPA planning process in the fifth and final region, the San Francisco Bay, have been developed for consideration subsequent to completion of a water supply and ecosystem plan for the Sacramento-San Joaquin River Delta. For more information, visit http://www.dfg.ca.gov/marine/mpa/sanfranciscobay.asp.

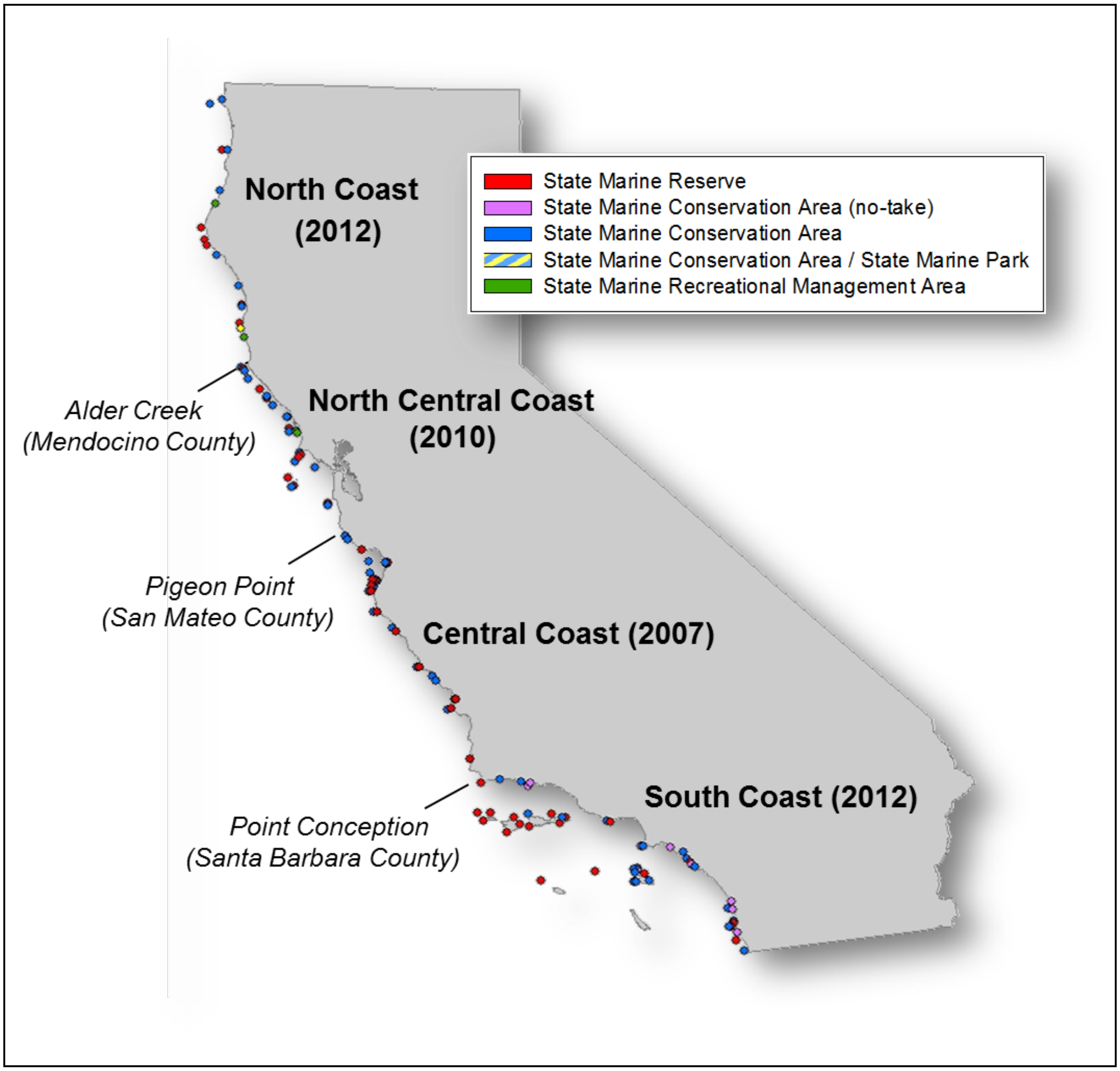

Figure 3. Locations for each MPA in California's redesigned coastal MPA network, the four MLPA coastal planning regions, and year in which each regional MPA network took effect.

(a) *Description of the MPA Classification System Used in California*

There are different classifications used in California's MPA network, including three MPA designations, one additional marine managed area designation, and special closures:

- State Marine Reserve (SMR): Prohibits all take and consumptive use (commercial and recreational, living or geologic). Permitted research, and non-consumptive uses may be allowed.
- State Marine Conservation Area (SMCA): May allow select recreational and commercial harvest to continue. Access for research and non-consumptive uses is encouraged.

- State Marine Park[15] (SMP): Prohibits commercial take but may allow select recreational harvest to continue. Access for research and non-consumptive use is encouraged.
- State Marine Recreational Management Area (SMRMA): Provides subtidal protection equivalent to an SMPA, while still allowing legal waterfowl hunting to continue.
- Special closures: A geographically specific area that prohibits human entry. Special closures are generally smaller in size than MPAs and are designed to seasonally protect breeding seabird and marine mammal populations from human disturbance.

Table 3. Summary statistics for California's redesigned coastal MPA network.

Designations	**Count**	**Area (sq mi) in All Coastal State Waters**	**Percent of All Coastal State Waters**
SMR	48	463.23	8.76%
SMCA (no-take)	10	33.60	0.64%
SMCA	60	344.50	6.52%
SMCA/SMP[16]	1	6.26	0.12%
SMRMA	5	4.43	0.08%
Special Closures	15	3.25	0.06%
Total[17]	**124**	**852.02**	**16.12%**

[15] In the MPA planning process, SMPs were designated as SMCAs designed with the intent to match an SMP in allowed regulations, goals and objectives. They can only be formally adopted as an SMP by the California State Park and Recreation Commission in a separate action which takes the MPA designation intent into account. After the State Park Commission adopts the SMP, then the area will have dual designation in statute as both an SMCA and SMP.

[16] The California Fish and Game Commission designated Cambria SMCA, which was subsequently also adopted as Cambria SMP by the State Park Commission (August 2010) with the same boundaries and no change to regulations. Therefore, this MPA has dual designations, as reflected in the table.

[17] Statewide totals include all MPAs effective in the north coast, north central coast, central coast, and south coast regions, and do not include special closures or existing MPAs in the San Francisco Bay.

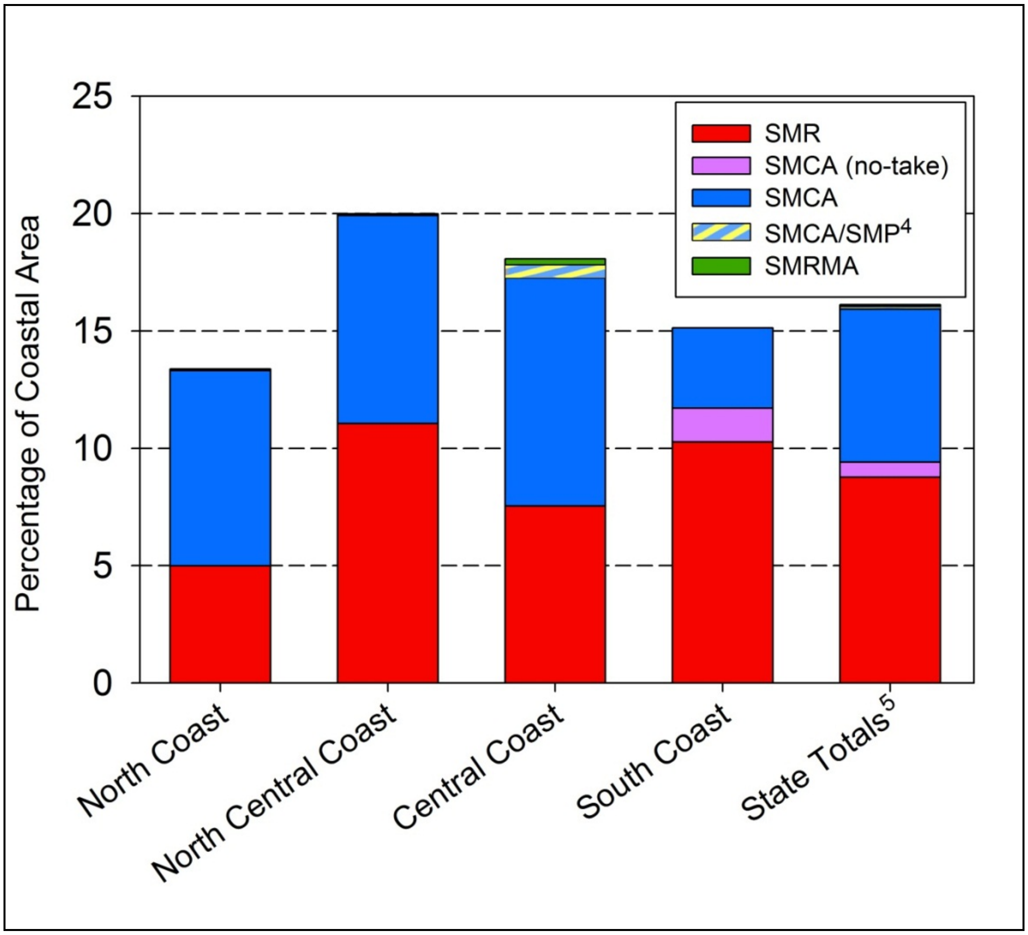

Figure 4. Percentage of each of the four California coastal regions and total state waters[5] within MPAs by designation type.

2. <u>California MPA Monitoring and Research Activities</u>

Overview: CDFW is currently focused on implementing, monitoring, and managing California's MPA network relative to the MLPA goals and requirements, and other relevant California legislation such as the Marine Life Management Act. Provisions of the MLPA require monitoring and research to facilitate adaptive management. CDFW works with key partners to provide oversight on all aspects of MPA monitoring to inform adaptive management. For example, CDFW collaborates with the MPA Monitoring Enterprise (MPA ME) – a program of the California Ocean Science Trust (OST), the California Ocean Protection Council (OPC), and California Sea Grant (CASG) to develop regional MPA baseline monitoring programs and 5-year MPA monitoring and management reviews, as recommended in the MLPA Master Plan. Baseline programs are designed to establish an ecological and socioeconomic benchmark against which future MPA performance can be measured, and to assess whether there are any initial changes resulting from MPA implementation in one to two years after the MPAs take effect.

CDFW also works with partners, academic institutions, and others to coordinate data collection related to marine life, habitats, and commercial and recreational activities that occur both inside and outside MPAs, and to develop cost-effective long-term MPA monitoring programs. In addition, CDFW continues to explore MPA effects on California's marine fisheries, and conduct field investigations such as remotely operated vehicle projects. Please visit the MPA Research and Monitoring Activities website for more information.

(a) *Regional MPA Monitoring Activities:*

Central Coast: A network of 29 MPAs (including 28 MPAs and one SMRMA), covering approximately 207 sq mi of state waters or about 18 percent of the central coast region, went into effect in September 2007.

- The Central Coast MPA Baseline Monitoring Program was launched in 2007 to assess baseline ecological and socioeconomic conditions of the central coast regional MPA network. The baseline program supported five projects to conduct collaborative fisheries sampling, surveys of kelp forests, nearshore fish populations, rocky intertidal habitats and deep-water habitats, as well as collect socioeconomic data. Data collection and analyses for the baseline program were completed in 2012.
- A three-day public symposium was held in 2013 to present results from the baseline program, discuss perspectives on MLPA implementation, and provide a forum for local researchers to share results from their own research. Together, OST and CDFW produced a summary report sharing the baseline program monitoring results, titled *State of the California Central Coast: Results from Baseline Monitoring of Marine Protected Areas 2007-2012*. Along with proceedings from the State of the California Central Coast Symposium, this information was provided to the CDFW and CFGC to inform their 5-year management recommendations delivered in late 2013.
- Results from the baseline program will help planning and implementation of a continued MPA monitoring program, which is a collaborative effort by MPA ME, CDFW, and OPC. A related project currently underway by MPA ME, in partnership with CDFW, is to update the Central Coast MPA Monitoring Plan to reflect baseline monitoring results, apply the statewide MPA monitoring framework, and ensure consistency with existing regional MPA monitoring plans. This project is underway and will continue through 2014.

North Central Coast: A network of 25 MPAs (including 22 MPAs and three SMRMAs) and six special closures, covering approximately 763 sq mi of state waters or about 20 percent of the north central coast region, went into effect in May 2010.

- Following a collaborative process with stakeholders and scientists, MPA ME in partnership with CDFW, completed the North Central Coast MPA Monitoring Plan in late 2009. The monitoring plan was adopted by the Commission in 2010. As with other regional MPA monitoring plans, the North Central Coast MPA Monitoring Plan will be updated near the 5-year MPA monitoring and management reviews to reflect baseline program results.
- The North Central Coast MPA Baseline Monitoring Program was launched in 2010 to assess baseline ecological and socioeconomic conditions of the central coast regional MPA network. The baseline program encompasses 11 projects selected to monitor a broad range of habitats from sandy beaches, rocky reefs, and kelp forests to the deep waters around the Farallon Islands, and examine patterns of ocean currents across the

whole region. Data were also collected on human activities including commercial and recreational fishing, beach use, and boating activities. Data collection and analyses are nearing completion.

- In April 2014, MPA ME in partnership with CDFW, OPC, and CASG, and in collaboration with the baseline program Principal Investigators, produced a summary report based on peer-reviewed technical reports, titled the California North Central Coast: Marine Protected Area Baseline Monitoring Summary Report, 2010-2013. This is the first in a series of reports that will share monitoring highlights and next steps. The OST, CDFW, and the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) are also collaborating to explore ways to integrate data across baseline monitoring projects and with data from other programs in the region. This data integration and synthesis will culminate in a State of the Region Report in 2015.

South Coast: A network of 50 MPAs (including 13 previously established in 2003 at the northern Channel Islands that were retained without change) and two special closures, covering approximately 2,351 sq mi of state waters or about 15 percent of the south coast region, went into effect in January 2012.

- The South Coast MPA Monitoring Plan was completed in 2011, and adopted by the Commission that same year.
- The South Coast MPA Baseline Monitoring Program was launched in 2011. The baseline program includes 10 projects to monitor a broad suite of habitats including rocky shores, sandy beaches, shallow subtidal, subtidal rocky reefs, and deep water habitats. Additional projects include assessing seabird and lobster populations, patterns of human uses, and an integrative project to facilitate collaboration and data comparability among the other baseline program projects. Baseline program projects began data collection in mid-2011. As with other baseline programs, reports of their findings will undergo peer review, scheduled for late 2014 and publicly available in 2015.

North Coast: A network of 20 MPAs (including 19 MPAs and one SMRMA), along with seven special closures covering approximately 137 sq mi of state waters or about 13 percent of the north coast region, went into effect in December 2012.

- The North Coast MPA Baseline Program was launched in March 2014. Eleven projects were selected for funding to monitor habitats including kelp forests, rocky shores, and beaches as well as commercially and recreationally important fish populations and seabirds. Projects will also document human uses, socioeconomic dimensions of MPAs, and examine patterns of ocean currents across the whole region. The north coast is also the first baseline program in California to incorporate traditional ecological knowledge, which will be shared as part of understanding the historical and current ocean conditions in the region. Data collection will begin in mid-2014.

(b) *MPAs and Fisheries Integration:* It is expected that California's MPA network will result in various biological, ecological, and socioeconomic effects that may have broad implications for fisheries. Consequently, it is important to understand how this network of MPAs affects California's fishery resources, and how fisheries may respond to the network.

However, the efficacy of MPAs in terms of both their design and fisheries-based elements remains largely untested, especially on the scale of California's MPA network. The CDFW convened a MPAs and Fisheries Integration Workshop in 2011 to elicit input from scientists representing a wide range of disciplines on the utility and practicality of using a redesigned statewide network of MPAs to inform fisheries management, and produced a workshop proceedings report. CDFW continues to build on the results of prior workshops and discussions, as well as complementary CDFW programs such as the Nearshore FMP, Abalone Recovery and Management Plan, and Spiny Lobster Fishery Management Plan (currently in development), to explore internally and with partners how MPA monitoring information may be used to inform California fisheries management.

(c) *Remotely Operated Vehicle (ROV) MPA Monitoring:* Since 1999, the CDFW and its partners have performed visual surveys of fish, invertebrates, and habitat in California's MPAs. The objective of these surveys is to establish baseline conditions inside and outside MPAs and to examine initial changes in size and density of fished species after MPA implementation. The CDFW program coordinates surveys with other studies funded through the MPA baseline monitoring programs as well as other projects and partners providing information for fisheries management. To date, extensive surveys have been completed in the Channel Islands (2003 – 2009), central coast region (2007 – 2009), and north central coast region (2009 – 2011). The CDFW will be performing ROV surveys in in the north coast and south coast MPAs in 2014 and the central coast MPAs in 2015.

3. Other Relevant California MPA Activities and Resources

Overview: Complementary to MPA implementation, monitoring, research, and management activities, CDFW maintains a Geographic Information System (GIS) lab, an MPA mobile website, an interactive marine and coastal data viewer, and identifies additional opportunities such as linking California's MPAs to the national system of MPAs.

(a) *Geographic Information System:* The CDFW's Marine Region GIS unit specializes in providing GIS marine and coastal data to support California marine science and management, such as spatial data related to California's coastline, bathymetry, fisheries, natural resources, and seafloor characteristics. Please visit the Marine Region GIS downloads website for more information.

(b) *MPA Mobile Website:* In 2011, the CDFW unveiled a MPA mobile website allowing anglers, divers and other ocean users to look up current information about restricted areas and boundaries from land-based computers, smartphones, tablets and other portable Internet-enabled devices. Please visit mobile MPA website for more information.

(c) *Interactive Marine and Coastal Data Viewer:* CDFW's marine and coastal data viewer, MarineBIOS, offers an interactive map for referencing relevant marine resource planning data, including boundaries and regulations of California's MPAs, marine habitats, geographic references, and points of interest.

(d) *Linking California's MPAs to the National System of MPAs:* The National MPA Center, established in 2000 by Executive Order 13158, is an active partnership between the National Oceanic and Atmospheric Administration and the Department of Interior, designed to develop and implement a national system of MPAs. The National MPA Center receives nominations by other federal, state, tribal and local governments for inclusion into a comprehensive nationwide listing of MPAs. Nominated MPAs must meet specific criteria for inclusion in the national MPA network. All of California's protected areas (including 119 MPAs, five SMRMAs, and 15 special closures) have been nominated and accepted into the national system of MPAs managed by the National MPA Center.

Please visit California's MPAs website for more information on California's system of MPAs.

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APPENDIX 1:

2013 CALIFORNIA GROUNDFISH COMMERCIAL FISHERY REVIEW

The 2013 California commercial groundfish harvest (Table 4) was approximately 6540 metric tons, with an ex-vessel value of $17.4 million. Total harvest increased 4 percent compared to 2012; due primarily to increased catches of Petrale sole (*Eopsetta jordani*), English sole (*Parophrys vetulus*), sanddabs (*Citharichthys spp.*) chilipepper rockfish, bocaccio, arrowtooth flounder (*Atheresthes stomias*) and thornyheads (*Sebastalobus spp.*). Pacific whiting landings totaled 1741 metric tons in 2003, dropping to 5 metric tons in 2011 before decreasing to 4 metric tons in 2012 and 2013. The first year of the trawl individual quota program was 2011 and fishermen were given individual quotas for some groundfish species, including Pacific whiting. California fishermen traded their Pacific whiting shares for other species, primarily sablefish (*Anoplopoma fimbria*), in 2011 which accounted for the large increased in value ($24.6 million). Groundfish revenue decreased 37 percent in 2013 compared to 2011, as sablefish landings decreased 43 percent.

In 2013, 77 percent of the groundfish landed were taken by bottom and mid-water trawl gear, an increase from the 64 percent observed in 2011. Line and trap gears were the second and third most common gear types in 2013 at 19 and 3 percent, respectively; both gears saw decreased use compared to 2011 (26 and 10 percent, respectively). Gill and trammel net landings were minimal, accounting for less that 0.3 percent of the groundfish catch.

Dover sole, sablefish, thornyheads and Petrale sole dominated California's 2013 groundfish harvest, making up approximately 79 percent of the state's landings (78 percent of groundfish revenue). Petrale sole landings in 2011 were less than half the landings in 2003 as harvest levels were reduced to allow the stock to rebuild. Since 2011, Petrale sole landings have been on an increasing trend, going from 174 metric tons to 470 metric tons (2011 and 2013, respectively) as the stock rebuilds. Landings of sanddabs (all species combined) declined dramatically between 2003 and 2013 going from 1294 metric tons to 97 metric tons; however, recently, landings are again on the upswing going 51 to 97 metric tons between 2011 and 2013. Sablefish landings declined going from 2406 metric tons in 2011 to 1364 metric tons in 2013 as the ex-vessel price declined (average price $3.32 and $2.66, respectively) due to declining demand.

Contributed by Traci Larinto (Traci.Larinto@Wildlife.ca.gov)

Table 4. California commercial groundfish landings (metric tons) for 2011-2013.

		2011	2012	2013[1]	2003	Percent change between 2003 and 2013
ROUNDFISH	Cabezon	32	31	29	40	-27.4
	California sheephead	31	28	28	49	-43.9
	Grenadiers	87	99	83	165	-49.6
	Kelp greenling	2	5	5	5	10.0
	Lingcod	33	48	64	52	21.9
	Monkeyface prickleback	0[2]	0	0	0	0.0
	Pacific cod	--[2]	--	0	1	-99.5
	Pacific whiting	5	4	4	1741	-99.8
	Ratfish	0	0	0	--	--
	Rock greenling	0	0	0	--	--
	Sablefish	2406	1627	1364	1621	-15.8
FLATFISH	Arrowtooth flounder	86	99	118	43	171.8
	Butter sole	--	0	0	--	--
	Curlfin turbot	0	0	0	0	0.0
	Dover sole	2412	2150	2218	3259	-32.0
	English sole	19	23	49	131	-62.8
	Pacific sanddab	4	0	2	0	1944.0
	Petrale sole	174	222	470	380	23.6
	Rex sole	68	48	45	259	-82.5
	Rock sole	2	4	4	15	-73.9
	Sand sole	13	18	15	37	-58.2
	Starry flounder	7	5	5	29	-81.0
	Unspecified sanddabs	47	59	95	612	-84.5
	Unspecified sole	13	14	17	10	78.6
SHARKS AND SKATES	Big skate	0	4	20	0	49581.1
	California skate	0	1	0	--	--
	Leopard shark	2	2	1	8	-86.3
	Longnose skate[3]	171	174	148	--	--
	Soupfin shark	2	1	1	20	-93.9
	Spiny dogfish	1	1	1	11	-91.2
	Unspecified skate	30	31	17	125	-86.4
ROCKFISH	*Shallow nearshore*					
	California scorpionfish	5	4	3	5	-48.2
	Black-and-yellow rockfish	12	11	10	8	39.3
	China rockfish	2	2	1	2	-9.3
	Gopher rockfish	30	23	23	13	74.4
	Grass rockfish	12	12	13	14	-7.3
	Kelp rockfish	1	1	1	1	-16.1
	Misc. shallow nearshore rockfish[4]	0	0	0	2	-98.5
Deeper nearshore						
	Black rockfish	27	24	36	58	-38.7
	Blue rockfish	7	4	5	8	-29.7
	Brown rockfish	29	26	28	20	40.0
	Copper rockfish	4	6	7	3	118.6
	Olive rockfish	1	1	1	1	69.1

Table 4. California commercial groundfish landings (metric tons) for 2011-2013.

	2011	2012	2013[1]	2003	Percent change between 2003 and 2013
Deeper nearshore (continued)					
Quillback rockfish	1	2	1	2	-65.2
Treefish	2	2	1	1	57.5
Misc. deeper nearshore rockfish[4]	0	0	0	2	-98.9
Shelf					
Bocaccio	8	12	16	1	2529.0
Chilipepper rockfish	293	236	322	18	1729.4
Greenspotted rockfish	1	1	2	0	435.0
Vermilion rockfish	17	18	22	6	265.9
Widow rockfish	1	2	6	5	23.6
Yellowtail rockfish	1	1	5	2	106.8
Misc. shelf rockfish[4]	2	5	6	174	-96.4
Slope					
Aurora rockfish	2	2	5	2	208.8
Bank rockfish	6	11	52	72	-28.6
Blackgill rockfish	126	127	72	179	-59.9
Darkblotched rockfish	3	7	4	6	-30.4
Splitnose rockfish	10	20	14	23	-39.2
Misc.slope rockfish[4]	60	108	24	72	-67.3
Unspecified rockfish[5]	0	1	0	10	-97.1
Longspine thornyhead	461	502	652	845	-22.9
Shortspine thornyhead	460	411	427	390	9.5
Unspecified thornyheads[5]	1	1	6	59	-90.2
TOTAL	**7234**	**6281**	**6569**	**10616**	**-38.1**

Notes:

1. Landings data for 2013 are preliminary.
2. Zero (0) indicates that less than 1 metric ton was landed; -- indicates no landings occurred.
3. Longnose skate market category was added in 2009. Prior to that, longnose skates were included in the unspecified skate category.
4. Misc.rockfish contain both group market categories (e.g., group shelf rockfish) and single species market categories for species with landings less than one ton per year (e.g., greenstriped rockfish) and are a minor component of the commercial catch.
5. Unspecified rockfish and unspecified thornyhead market categories were discontinued in 2001.

Source: California Commercial Fisheries Information System.

APPENDIX 2:

2013 CALIFORNIA GROUNDFISH RECREATIONAL FISHERY REVIEW

The 2013 California recreational fishery caught approximately 2314 metric tons of groundfish and nearshore species (Table 5), according to estimates generated by the Recreational Fisheries Information Network (RecFIN) that are based on data collected by California Recreational Fisheries Survey (CRFS) samplers using both sampler examined catch and fish observed discarded dead. Recreational groundfish catch in 2013 was almost 20 percent higher than in 2012 and was due to increased catch of lingcod (*Ophiodon elongatus*) and rockfishes. In 2013, lingcod catch continued to increase as did rockfish catch (35 and17 percent, respectively, compared to 2012) due to longer fishing seasons in most regions. Changes to the sampling protocol instituted in 2004 prevent a direct comparison between 2003 and 2013 recreational catch. However, given that the recreational fishery has seen increased restrictions since 2001, much like the commercial fishery, the overall catch is likely considerably lower.

Rockfishes made up 71 percent of the recreational groundfish and state nearshore species catch in 2013, down slightly from 2012 (73 percent). The slight decline can be attributed to the large increase in lingcod catch in 2013. The same thing happened in 2012—increased lingcod and decreased rockfish catches compared to 2011. That rockfish make up the majority of the recreational groundfish catch is not surprising given that anglers most commonly reported bottomfish as the target species when asked by CRFS samplers. Deeper nearshore rockfish accounted for 42 percent of the rockfish catch in 2013 followed by shelf and shallow nearshore (33 and 12, percent respectively); slope rockfish were rarely encountered due to the fact that fishing has been closed in deeper depths for a number of years. Black, vermilion, and bocaccio were the most frequently caught rockfish in 2013, followed by blue, copper and brown rockfishes. California scorpionfish, a closely related species in southern California, accounted for 7 percent of the rockfish catch in 2013. Of the non-rockfish groundfish, lingcod was most frequently caught (19 percent) in 2013. Lingcod was followed by sanddabs (all species combined), California sheephead (not a groundfish species, but a state nearshore species) and cabezon (4, 3 and 2 percent, respectively).

Contributed by Traci Larinto (Traci.Larinto@Wildlife.ca.gov)

Table 5. California recreational groundfish catch[1] (metric tons) for 2012-2013.

	2012	**2013[2]**		**2012**	**2013[2]**
Flatfish					
Butter sole	--[3]	0.0[3]	Rock sole	1.2	0.7
Dover sole	--	--	Sand sole	2.9	1.0
English sole	0.0	0.0	Starry flounder	0.9	0.9
Pacific sanddab	65.9	85.7	Unspecified sanddabs	1.9	5.6
Petrale sole	0.7	1.1	**Flatfish total**	**73.6**	**95.1**
Rockfish					
Shallow nearshore			*Shelf (continued)*		
Black and yellow rockfish	5.5	5.8	Flag rockfish	14.1	14.2
California scorpionfish	116.3	112.0	Greenspotted rockfish	17.8	11.1
China rockfish	13.8	10.0	Greenstriped rockfish	1.2	1.3
Gopher rockfish	52.4	41.2	Halfbanded rockfish	3.9	3.3
Grass rockfish	20.8	9.8	Honeycomb rockfish	6.2	9.2
Kelp rockfish	19.1	19.2	Rosy rockfish	5.6	5.5
Deeper nearshore			Speckled rockfish	9.6	15.5
Black rockfish	210.4	362.6	Squarespot rockfish	4.4	16.6
Blue rockfish	51.8	106.2	Starry rockfish	23.4	24.0
Brown rockfish	70.3	81.7	Vermilion rockfish	219.5	210.7
Calico rockfish	5.1	0.9	Widow rockfish	5.2	17.8
Copper rockfish	79.9	98.8	Yellowtail rockfish	53.5	55.9
Olive rockfish	31.6	20.3	Misc. shelf rockfish[4]	17.1	16.5
Quillback rockfish	6.3	2.9	*Slope*		
Treefish	11.0	13.1	Bank rockfish	0.6	0.3
Shelf			Redbanded rockfish	0.1	--
Bocaccio	124.7	130.8	*Unspecified rockfish*	160.0	215.0
Chilipepper rockfish	7.7	7.3	**Rockfish total**	**1368.7**	**1639.4**
Roundfish					
Cabezon	43.3	39.3	Pacific whiting	0.1	0.0
California sheephead	43.0	61.3	Rock greenling	10.1	0.7
Kelp greenling	12.9	13.7	Sablefish	0.0	0.1
Lingcod	281.4	433.1	Unspecified greenlings	0.0	--
Monkeyface prickleback	6.2	2.2	**Roundfish total**	**396.9**	**550.4**
Sharks and skates					
Big skate	0.1	6.6	Soupfin shark	0.4	0.6
California skate	0.0	0.3	Spiny dogfish	2.8	7.0
Leopard shark	35.3	14.0	Unspecified skates	--	0.0
Longnose skate	--	0.0	**Sharks and skates total**	**38.6**	**28.6**
			GRAND TOTAL	**1878**	**2314**

Notes:

1. Recreational catch includes sampler examined catch and observed discarded dead catch.
2. Catch data for 2013 are preliminary.
3. Zero (0.0) indicates that less than 1 metric ton was caught; -- indicates no catch was recorded.
4. Misc. shelf rockfish combines species for which there was less than 1 metric ton caught per year.

Source: Pacific Recreational Fisheries Information Network (RecFIN).

OREGON DEPARTMENT OF FISH AND WILDLIFE

2014 AGENCY REPORT
PREPARED FOR THE 29-30 APRIL 2014 MEETING OF THE TECHNICAL SUB-COMMITTEE OF THE CANADA-UNITED STATES GROUNDFISH COMMITTEE

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Oregon Department of Fish and Wildlife
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April 2014
OREGON DEPARTMENT OF FISH AND WILDLIFE

A. AGENCY OVERVIEW – MARINE RESOURCES PROGRAM

MRP Program Manager:	Dr. Caren Braby
Resource Management and Assessment:	Dave Fox
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The Marine Resources Program (MRP) is within the Oregon Department of Fish and Wildlife (ODFW) and has jurisdiction over marine fish, wildlife and habitat issues 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 $8.75 million, with about 77% 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 23% 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 2013. Starting in November 2005, major ports were sampled year-round and minor ports for peak summer-fall season. We continue to estimate catch during un-sampled 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 un-sampled periods. This was the result of a review of the ORBS program and funded through the National Marine Recreational Information Program (MRIP). The results of that overwinter sampling are still being analyzed. 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 2013. 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, 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 (see Section B.2).

Beginning in 2003, the recreational harvest of several groundfish species is monitored in-season for catch limit tracking purposes. Pre-season in 2013, the cabezon season was modified to July 1 through December 31. This allowed the cabezon season to proceed with no in-season actions being necessary for the first time in many years. 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 are 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 followed by Pacific City. Other ODFW management activities in 2013 include participation in the U.S. West Coast Recreational Fish International Network (RecFIN) process, data analysis, public outreach and education, and public input processes to discuss changes to the management of groundfish and Pacific halibut fisheries for 2014.

Starting in July 2005, sampling of the shore and estuary fishery was discontinued due to a lack of funding. While salmon dominate estuary boat landings by weight, 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. 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. Development of a Relational Database for Sport Groundfish State Observer Data

In 2013, MRP staff collaborated with National Marine Fisheries Service - Southwest Fishery Science Center scientists to develop a fully relational database for ODFW's Sport Groundfish Onboard Sampling Program. Beginning as a pilot program in 2001, from April through October, a portion of sport charter vessels were sampled using ride-along state observers for species composition, discard rates and sizes, location, depth and catch per angler (catch per unit effort or CPUE). The program became permanent in 2003. The program surveys the charter boat fleet targeting groundfish from seven of Oregon's major ports. Through 2012, observers have collected spatially-explicit catch and discard records for 12,377 fishing locations during 997 observed trips. Lengths of discarded fish caught by observed anglers are also recorded to monitor discards. Development of the database included quality control methods applied to data through 2012. Data from the new Access database are available by permission from ODFW. Information on the sampling program and the new database's development can be found in a NOAA technical memorandum (Monk et al. 2013).

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3. “No Floaters: Release At-Depth” Barotrauma Outreach Campaign

To reduce bycatch mortality of overfished rockfish species in the sport fisheries, ODFW conducted a large-scale outreach campaign in 2013 with the goal of increasing descending device usage among sport anglers. The effort, branded “No Floaters: Release At-Depth”, distributed over 5,000 descending devices to all charter vessel owners and to the majority of sport boat owners who had previously targeted groundfish or halibut. In addition, several thousand stickers bearing an emblem of the brand (Figure 1) were distributed with the goal of making rockfish conservation an innate aspect of fishing culture. The outreach campaign appeared to be highly successful. Prior to the campaign, fewer than 40% of anglers used the devices. After the campaign, the percentage of users increased to greater than 80%. The remaining 20% of non-users were surveyed to determine if and how they could be persuaded to use a descending device. Nearly all (~99%) said that they could be persuaded (for a variety of reasons), and the most common response (47%) was a need for visual proof rockfish surviving after being released with descending devices. In response, videos are being produced that show fish successfully swimming away after release with a device. Since the results of this outreach campaign appeared to be successful, the methods may provide a useful template for other descending device outreach campaigns or conservation based outreach campaigns, in general.

Figure 1: Picture of sticker provided to anglers as part of the “No Floaters” outreach campaign.

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4. 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 in-season adjustments of the commercial nearshore fishery (Section B.5), which is conducted in state waters, and for participation in the Pacific Fisheries Information Network (PacFIN). Species composition sampling of rockfish and biological sampling of commercially landed finfish continued in 2013 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.

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5. Oregon's Commercial Nearshore Fishery

The commercial nearshore fishery in Oregon became a limited-entry permit-based program in 2004, following the development of the open access nearshore fishery in the late 1990's. The commercial nearshore fishery exclusively targets groundfish, including black rockfish, blue rockfish (*S. mystinus*), cabezon, kelp greenling and an "other nearshore rockfish" complex, and is primarily composed of small vessels (< 10 meters) fishing in waters less than 30 fathoms. Major gear types include hook-and-line, longline and fish pots. Fish landed in the commercial nearshore fishery supply mainly the live fish market, but also fresh markets as well, along the entire Oregon coast. Landings are regulated through two-month trip limits, minimum size limits and annual harvest caps for each species or species complex. Weekly updates on landings allow MRP staff to more effectively manage in-season.

Landings in the 2012 commercial nearshore fishery, along with logbook compliance, are detailed in the 2012 Commercial Nearshore Fishery Summary (Rodomsky et al. 2013). Overall, the majority of active permit holders are located on the southern Oregon coast, resulting in most of the catch consistently landed in southern Oregon ports, including Port Orford, Gold Beach and Brookings. Black and blue rockfish continued to comprise the majority of landings by weight in 2012. In-season management changes in 2012 included changes to two-month trip limits for black and blue rockfish, cabezon and kelp greenling.

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6. Continuation of Marine Fish Ageing Project at MRP

During 2013, age estimates for black rockfish were provided to recreational, commercial and Marine Reserve programs. A total of 2,757 black rockfish ages were produced, and an additional 517 test ages were made during the year. In addition to the black rockfish, age estimates were made of 505 blue rockfish (103 tested) for a concurrent maturity study.

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7. Rockfish Maturity Studies

ODFW 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. Analysis was initiated on both copper and solid-type blue rockfish in 2013; however, work has not been completed on either species and will continue into 2014.

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8. Movement of Rockfishes Using Acoustic Telemetry

ODFW investigated whether holding yelloweye rockfish in delayed-release cages after tagging with internal and external acoustic tags would increase survival and facilitate a VPS-based movement study at Stonewall Bank, Oregon. All of the seven fish survived four days of cage confinement and various time periods following release. A few fish from both tagging methods survived long enough to provide some information on movements. However, these data indicated a larger scale of movement than expected on this large rocky reef, exceeding the VPS grid dimensions. One externally-tagged fish was re-sited with a baited video lander. This fish appeared to be in good condition, displayed behavior that was similar to the untagged fish observed at the same site and showed no adverse effects from tagging. The findings of a prior rockfish movements study at Cape Perpetua was also published in 2013 (Rankin et al. 2013).

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9. Development and Testing of a Video Lander for Studying Demersal Fishes on Nearshore Rocky Reefs

ODFW continued developing and testing a video lander as a survey tool for rocky reef fishes. Progress in 2013 included the development and testing of a baited, stereo-video high-definition lander system and a systematic evaluation of the effect of bait on fish counts and sizes. Bait increased the counts of many demersal fish species, as well as their "measurability" with the stereo-video system by bringing them closer to the cameras. Some species were seemingly unaffected by the presence of bait. A manuscript describing the lander system and the study results has been accepted (Hannah and Blume, in press).

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10. Reducing Eulachon Entrainment at the Footrope of a Shrimp Trawl

A third year of testing of footropes designed to reduce trawl entrainment of eulachon in shrimp trawls was completed in 2013. The study concluded that reduction of eulachon can be achieved via footrope modifications; however, shrimp catches are reduced by similar amounts with all of the tested designs. A report describing these study results is available at:

http://www.dfw.state.or.us/MRP/publications/#Research (Hannah and Jones 2013).

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11. Discard Mortality of Hook-and-Line-Caught Rockfish with Barotrauma

Additional cage-survival experiments in 2013 on yelloweye and canary rockfish were conducted, extending prior work at capture depths less than 64 meters (m) out to capture depths of up to 174 m. As capture depth increased beyond about 84 m, 48-hour survival of canary rockfish fell to about 25%, while yelloweye rockfish survival remained high. A manuscript describing the results from this study has been accepted (Hannah et al., in press).

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12. Marine Reserves in Oregon

Status of sites

Harvest prohibitions took effect on January 1, 2014 for two new marine reserves at Cascade Head and Cape Perpetua, bringing the total number of implemented no-take reserves in state waters to four. Harvest prohibitions at a fifth and final marine reserve site at Cape Falcon will begin on January 1, 2016, as mandated by Senate Bill 1510 passed by the 2012 Oregon Legislature.

Site management plans have been completed and are currently being implemented for the Redfish Rocks and Otter Rock Marine Reserves. Development of site management plans for the Cape Perpetua and Cascade Head sites is currently underway, with assistance from local communities. Management plans outline site-specific strategies for outreach, reporting on monitoring activities and results, ways to improve compliance and enforcement, opportunities for community and public engagement and for addressing site specific management issues. The plans also highlight local community interests, priorities, and projects for the marine reserve site.

Monitoring Program

In 2013, ODFW continued collection of baseline ecological data in Cascade Head and Cape Perpetua Marine Reserves. These data were collected by ODFW staff in collaboration with partners at Oregon State University and the Oregon Coast Aquarium. Local fishing vessels were contracted when feasible to serve as research platforms.

Survey Design: Monitoring data were collected inside the no-take marine reserves and outside the reserves in control sites, hereafter referred to as comparison areas. Comparison areas were selected based on similar depths, habitats, oceanographic conditions and fishing pressure as the associated marine reserve. Unlike the reserve however, comparison areas remain open to fishing. Long-term monitoring of the marine community will be conducted identically in both the reserve and comparison areas to discern changes due to environmental variation from changes caused by marine reserve protection. Baseline data establishes a starting point, from which future changes will be monitored in both the reserve and comparison areas through time. To detect reserve effects, the analyses will focus on comparing the magnitude of temporal change from the baseline data for response variables such as fish and invertebrate diversity, size and abundance.

Monitoring Conducted: The ecological monitoring program focuses on three techniques to collect data: (1) underwater video surveys, (2) subtidal SCUBA surveys, and (3) fishery-independent hook-and-line surveys. In addition, temperature, salinity and dissolved oxygen are measured to track oceanographic metrics that could influence nearshore community composition. Five local fishing vessels (including both charter and commercial vessels) were contracted in 2013 to assist with monitoring efforts. In 2013, 82 stationary video surveys (approximately four minutes in duration) were completed at the Cascade Head site in rocky reef habitats, from which fish and invertebrate community composition was quantified. A towed video sled was used to survey soft bottom habitats and associated communities in the Cape Perpetua and Cascade Head marine reserve sites. Eight tows were completed in 2013 (surveying approximately 8 kilometers (km) of habitat) at Cape Perpetua, and 31 tows were completed at Cascade Head (surveying approximately 31 km of habitat). A remotely operated vehicle (ROV) equipped with high definition video was used to survey deep rocky reef communities in the Cascade Head site (approximately 10 km of reef habitat surveyed). Subtidal SCUBA surveys quantifying the seaweed, invertebrate and fish communities were initiated in the Cascade Head site in 2013, involving the training of an Oregon-based cadre of volunteer scientific divers. Both the training and surveys are ongoing. Lastly, hook-and-line surveys were completed in Cascade Head and Cape Perpetua sites as part of the baseline sampling effort. The third year of hook-and-line survey monitoring was completed in the Redfish Rocks site, in accord with long-term monitoring plans.

In 2013, hook-and-line surveys involved 75 volunteer anglers, 26 survey days and over 384 total angler hours. Over 3000 fishes representing 27 nearshore species were caught, weighed and total length recorded. From this data, CPUE, size frequency distribution and mean length per species was determined and compared for differences between the marine reserve and comparison area. Data from the underwater video surveys is currently being reviewed for fish and invertebrate diversity and abundance, as well as relationship of these organisms to spatially-explicit features of the habitat. These results will be compiled with 2012 sampling results in a monitoring report anticipated for April 2015. Baseline survey summaries for Redfish Rocks and Otter Rock Marine Reserves (2010-2011) can be found in a monitoring report completed in March 2014.

More information, including copies of monitoring plans and reports, is available on the Oregon Marine Reserves website at www.oregonocean.info/marinereserves.

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13. 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 ROV during September and October of 2012. The objective was to conduct the first visual survey of these recently mapped rocky reef areas. The video from this survey was 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: Scott Marion (541) 867-0300 ext. 262 (Scott.R.Marion@state.or.us)

14. Ocean and Estuary Shoreline Habitat Mapping
MRP staff are currently working on a project to map and classify 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. Aerial image interpretation and mapping, has been completed for 80% complete as of 2013. Staff obtained a grant to complete the final 20% in 2014. The aerial photography is viewable at http://www.coastalatlas.net/shorezone/.

Contact: Dave Fox (541) 867-0300 ext. 228 (David.S.Fox@state.or.us)

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 the fishery, such as effort distribution and regulations. The need to independently estimate exploitation rates and population abundances for black rockfish off Oregon prompted the development of a mark-recapture program using passive integrated transponder (PIT) tags. 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 2013, PIT tags (12 millimeters (mm) by two mm) were inserted in 2,767 black rockfish over 21 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 using a descender device and released at depth. The total number of black rockfish ≥ 32 cm tagged since the project began in 2002 is now 38,578. Carcasses of black rockfish are counted and electronically scanned for tags year-round upon being landed by recreational fishers on the central coast. During the study recovery year (July 1, 2012 to June 30, 2013), 51,921 black rockfish were landed in Newport and 77.12% were scanned for tags. Likewise in Depoe Bay, 35,478 black rockfish were landed and 50.29% were scanned for tags. In 2012/2013, 402 tags were recovered, all in Newport. Tags were recovered from all twelve tagging cohort years. Estimates of annual exploitation rate derived from this project vary from 3.15% to 4.93% and are less than expected assessment values of approximately 5%. The annual exploitation rate in 2011/2012 was 3.15%. Exploitation rates for 2012/2013 will be available in 2014. Annual population estimates of black rockfish in the program area range from 1.17 to 1.89 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.

In early 2014, due to the lack of federal funding, tagging operations for this project has been terminated. Tag recovery collection will continue through at least the end of June 2014. Because these tags will last for decades within the population, it may be possible to recover tags in the future and use this data to make further estimates if there is adequate funding and staff to continue scanning black rockfish carcasses and analyzing data. The 2013 annual progress report for this project summarizes the data collected during the past 12 years (Krutzikowsky et al. 2014).

Contact: D. Wolfe Wagman (541) 867-0300 ext. 289 (David.W.Wagman@state.or.us), Greg Krutzikowsky (541) 867-0300 ext. 248 (Greg.Krutzikowsky@state.or.us)

2. 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. In 2013, ODFW continued to fill in data gaps on the growth and maturity of kelp greenling in Oregon waters. Efforts to collect fish through fishing, beach seining, and trapping yielded 74 kelp greenling ≤27 cm. Nine fish were collected in Siletz Bay, four from Alsea Bay and 61 from Yaquina Bay on the central Oregon coast. Fish ranged from 6.9 to 27.0 cm with weights from 2.8 to 251.6 grams (g). Otoliths were collected from all fish. Thirty-five of the 74 fish (47%) were females from which ovary samples were collected. Ovary weights ranged from 0.0015 to 0.4678 g. Maturity of female fish has been determined by ODFW staff and is now being validated by NOAA NWFSC staff. A total of 86 juvenile kelp greenling samples have now been collected. Additional sampling efforts are anticipated to continue in 2014.

Contact: Greg Krutzikowsky (541) 867-0300 ext. 248 (Greg.Krutzikowsky@state.or.us), Brett Rodomsky (541) 867-0300 ext. 291 (Brett.T.Rodomsky@state.or.us)

D. PUBLICATIONS

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Rodomsky, B.T., G.K. Krutzikowsky, and R.C. Ireland. 2013. 2012 Commercial Nearshore Fishery Summary. Marine Resources Program Publications: Finfish Reports. http://www.dfw.state.or.us/MRP/publications/docs/2012_Commercial_Nearshore_Fishery_Summary.pdf.

E. PROJECTS PLANNED FOR YEAR 2014

1. Maturity Studies

Maturity data for solid-type blue rockfish and copper rockfish will be finalized and summarized during 2014.

Contact: Bob Hannah, (bob.w.hannah@state.or.us)

2. Testing a Video Lander for Surveying Rocky Reefs

Work planned for 2014 includes an evaluation of how light color (orange-filtered versus white) and how ambient light levels influence avoidance of the video lander by various demersal fish species.

Contact: Bob Hannah, (bob.w.hannah@state.or.us), Matthew Blume (matthew.blume@state.or.us)

3. Eulachon Bycatch Reduction Studies

In a cooperative study with Mark Lomeli of PSMFC, ODFW will be testing whether Lindgren-Pitman lights can be used to increase the exclusion efficiency of rigid-grate bycatch reduction devices for eulachon.

Contact: Bob Hannah (bob.w.hannah@state.or.us), Steve Jones (steve.a.jones@state.or.us)

4. Discard Mortality of Rockfishes

ODFW will be investigating several aspects of the health of yelloweye rockfish that have experienced capture-related barotrauma. One experiment will utilize an on-bottom observation cage to evaluate the post-recompression behavior of yelloweye rockfish. An additional experiment will employ longer term holding and veterinarian-led necropsies of yelloweye rockfish that have experienced, and recovered or died from capture-related barotrauma.

Contact: Bob Hannah (bob.w.hannah@state.or.us), Polly Rankin (polly.s.rankin@state.or.us)

5. Nearshore Video Lander and CTD Survey

In 2014, ODFW will use a video lander and a Seabird CTD to study habitat characteristics and demersal fish populations on nearshore rocky reefs. The study area will range from Cape Foulweather to Alsea Bay, and offshore to about 30 fathoms. Approximately 200 individual video lander drops are planned, with 200 associated CTD casts. Observations of seabirds and marine mammals will also be collected during this survey.

Contact: Greg Krutzikowsky (Greg.Krutzikowsky@state.or.us), Brett Rodomsky (Brett.T.Rodomsky@state.or.us)

6. Marine Finfish Ageing

Ageing of commercially and recreationally captured black rockfish otoliths will continue in 2014. Ageing of recreationally caught kelp greenling (approximately 1,000 otoliths) will resume this year. Ageing female copper rockfish otoliths were completed in early 2014 (260 ages with an additional 52 tests).

Contact: Lisa Kautzi (Lisa.A.Kautzi@state.or.us)

Washington Contribution to the 2014 Meeting of the Technical Sub-Committee (TSC) of the Canada-US Groundfish Committee

April 29th-30th, 2013

Edited by:
Dayv Lowry

Contributions by:
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Robert Pacunski
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Larry LeClair
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Washington Department of Fish and Wildlife
April 2014

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 include Dayv Lowry, Robert Pacunski, Larry LeClair, Kurt Stick, Jen Blaine, 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. Taylor Frierson, Casey Wilkinson, and Amanda Philips joined the team in February of 2014 and serve as primary staff for ongoing surveys at U.S. Navy Facilities (see below). Unit tasks are primarily supported by supplemental funds from the Washington State Legislature for the recovery of Puget Sound bottomfish populations, and secondarily by a suite of collaborative external grants. 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, in 2013 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. After the proposed critical habitat designation posted in the Federal Register in October, MFS staff coordinated the Department's critical review of technical documents. In general, the areas proposed for listing were identified using very simple criteria, which appeared to work reasonably well for adults but not for juveniles. MFS staff are currently in negotiations with NOAA to groundtruth the validity of these criteria using visual survey techniques, including SCUBA and remotely operated vehicles (ROVs).

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. The RRT met in person four times in 2013 with efforts focused on developing the downlisting and delisting criteria for ESA rockfish. Several presentations were given to the RRT by outside scientists to provide

additional information for guiding the RRTs recovery planning efforts. A draft plan is expected to go out for public review by the summer of 2014.

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. At present the group is waiting to hold additional meetings until the results of the public review of the ESA Rockfish Recovery Plan are available.

c. 2010 San Juan Archipelago ROV Survey Report: Stereology

Based on the success of habitat-stratified ROV 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 but, due to departure of the lead statistician for the project as well as competing program and project demands, the final report has been delayed. Redrafting of the report is currently underway and completion is expected by fall of 2014. A presentation was delivered at the Western Groundfish Conference in Victoria, B.C. in February of 2014 by Lowry comparing the results of this study with the results from the habitat-stratified survey of 2008.

d. 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.

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 field portion of the survey concluded on April 4th, 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. The final station breakdown by strata was 47 morning (24%), 110 day (56%), and 38 evening (20%). Review of recordings made during the survey is ongoing, with approximately 78% of transect videos having been reviewed at least once. Our current timeline for completion (including second reviews) is May of 2014.

Based on the stations reviewed to date, sand and mud have been the dominant substrates encountered. In contrast, rock and boulder substrates represent only a small portion of the habitat segments viewed. Excluding unidentified small fish, the dominant taxa encountered thus far have been unidentified eelpouts, unidentified flatfish, unidentified gadids, spotted ratfish, blackfin 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, with this number split almost evenly between hard (boulder/rock/cobble) and soft (sand/mud) bottoms. The only other rockfishes seen thus far include twenty-three Puget Sound rockfish, five copper rockfish, two splitnose rockfish, one greenstriped rockfish, one black rockfish, one brown rockfish, one yelloweye rockfish, one unidentified red rockfish, and 174 unidentified rockfish (many presumed to be a combination of redstripe rockfish and Puget Sound rockfish). Hexagrammids observed include 96 kelp greenling, 13 lingcod, two whitespotted greenling, and three unidentified hexagrammids.

e. Continued investigation of the 2006 Recruitment Event of Young-of-the-Year Rockfishes in Puget Sound

As originally 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. MFS 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. Due to shifting priorities and lack of available resources, juvenile rockfish index sites were not surveyed in 2012 or 2013 but may be again in 2014.

f. Bottom Trawl Surveys of Puget Sound

Since 1987, WDFW has conducted bottom trawl surveys in Puget Sound that have proven invaluable as a fisheries-independent indicator of population abundance for fishes living on unconsolidated habitats. These surveys have been conducted at irregular intervals and at different scales since 1987. Early surveys between 1987 and 1991 were synoptic surveys of the entire Puget Sound, later were stratified, random surveys focusing on individual sub-basins, and 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 19 survey days in 2013 we occupied 42 stations and conducted 84 bottom trawls (Figure 1). Due to concerns for endangered Chinook salmon in 2013, NOAA restricted the survey from operating in the shallowest depth zone (30-120 feet), eliminating nine stations (18 trawls) from the 2013 survey frame. An estimated 70,000 individual fish among 80 species/taxa weighing 14 mt were collected. By weight, spotted ratfish constituted 42% of the catch, followed by English sole at 11%. 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 20% of the catch by weight (1% to 3% per species). Pacific cod were nearly four times more abundant in 2013 than in 2012, accounting for nearly 3% of the total catch. The size distribution of Pacific cod in 2013 was slightly greater than in 2012, measuring from 25 to 78 cm, but the average size of 44 cm in 2013 was 10 cm smaller than in 2012. Similar to 2012, most Pacific 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. One ESA-listed yelloweye rockfish was recorded in the catch, weighing 0.7 kg and measured 35 cm in total length. This specimen was dead upon capture thus age structures and genetic samples were collected in accordance with the Section 10 permit for the trawl survey.

g. 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 2012-13 ROV survey of Puget Sound. Due to a lack of MSF staff, and commitments to other projects, no monitoring activities were conducted at no-take refuges in 2013. A systematic evaluation of the data collected between 2000 and 2010 has begun and six sites have been identified as having data of sufficient quality and quantity to merit stand-alone evaluations of reserve efficacy. Over the next six months LeClair and Blaine

will be drafting a report on this six sites that includes, as an appendix, data from other sites surveyed during the evaluation period for which data collection was more sparse.

h. 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 two 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 in 2012. 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.

A report detailing the preliminary findings of the surveys at NBK Bremerton and NBK Keyport was accepted by the US Navy in October, 2013. In late 2013 WDFW signed a Cooperative Agreement with the Navy to continue surveys at NBK Bremerton and NBK Keyport, and to initiate new surveys for threatened and endangered (T and E) species at three additional installations; NAS Whidbey Island, Naval Magazine Indian Island, and Naval Submarine Base – Bangor. These surveys are expected to include scuba diving, ROV, hook-and-line, and acoustic components to establish baseline densities and distributions of T and E fishes at each installation. Funds from the Navy contract were used to hire a supervisory biologist and two technicians to assist with the conducting the surveys and analyzing the collected data. In preparation for these surveys, WDFW purchased a Biosonics DTX scientific echosounder (120 kHz) for conducting the acoustic portion of the project and sent MFS staff Lowry, Pacunski, Blaine, and Lindquist to a three-day training class to learn to use the hardware and software components of the new system.

i. TSC-sponsored Visual Survey Tools Workshop

In 2012 the TSC, spurred by suggestions from ADFG's Kristen Green and DFO's Lynne Yamanaka, began planning a coast-wide "hands-on" workshop for management entities utilizing visual survey tools, such as SCUBA, ROVs, AUVs, and drop cameras. WDFW membership on the organizing committee for this event switched from Tsou to Lowry early in the process and numerous organizational meetings were held leading up to the event April 8th and 9th, 2014. A full briefing on the meeting will be provided to the TSC at this meeting but, in short, representatives from 10 agencies/institutes and three NOAA Centers attended the two-day workshop, which focused on planning, designing, and conducting visual surveys as well as video review and data analysis. A proceedings document will be generated in the next few months that contains the results of a pre-workshop survey of participants, detailed discussion points, and project profiles for each group attending the workshop. A shared Dropbox folder was generated as part of the workshop to encourage distribution of grey literature employing visual survey techniques. A mailing list was also generated and discussions are in progress to create a managed list serve, blog, or other communication tool for interested parties to address shared concerns on an ongoing basis.

j. High-resolution modeling of fish habitat associations, and predictive models

In collaboration with the SeaDoc Society and Tombolo Laboratories MFS staff are working to integrate high-resolution multibeam bathymetry data from the San Juan Islands with fish occurrence data obtained from ROV and drop camera surveys over five years. H. Gary Greene, a geologist, has spent several years mapping and typing benthic habitats in the San Juans. Leveraging visual survey work conducted by WDFW that overlaps these focal areas, a unique opportunity has arisen to groundtruth Dr. Greene's bottom typing and to use benthic terrain modeler in ArcGIS to evaluate the occurrence of fish species over particular bottom types. Work is currently in the pilot stage, but a cooperative agreement is in development that would see the pilot completed by the end of 2014 and pave the way for a Puget Sound-wide model that could be used to evaluate rockfish critical habitat designations recently made by NOAA.

k. Derelict gear reporting, response, and removal grant funding

Marine fish mortality associated with derelict fishing gear has been identified as a threat to diverse species around the world. In Puget Sound, removal of derelict fishing nets has been the focus of a concerted effort by the Northwest Straits Foundations since 2002. In late 2013 the Washington State Legislature granted $3.5 million to the Foundation to "complete" removal of all known legacy fishing nets. A portion of this money was set aside for WDFW to assist with planning of removal efforts and evaluation of the final results.

In 2012 a reporting hotline was developed, and a rapid response and removal team was formed, to prevent the accumulation of additional fishing nets. Because these nets are a direct threat to ESA-listed rockfish, in 2014 WDFW and the Foundation were able to obtain Section 6 funding to continue hotline service and ensure support for the response team. Combined with the legislative grant money mentioned above, this funding source allows the WDFW and Foundation to remove old nets, stay informed about newly lost nets, and remove new nets to minimize/eliminate this threat to rockfish, and the ecosystem at large.

l. Participation in Conferences and Workshops

In 2013-14 staff of the Puget Sound MFS Unit presented at, and/or arranged symposia at, several regional scientific meetings, and education/outreach events as indicated below.

- Seattle Aquarium Lightning Talk – Discover Science Days, Nov. 6, 2013. Presenter: Robert Pacunski.
- WDFW Science Division Annual Meeting, Dec. 9, 2013. Presenter: Dayv Lowry.
- Tacoma area Gyro Club monthly meeting, Dec. 10, 2013. Presenter: Dayv Lowry.
- Seattle Aquarium Discover Science Days, Nov. 9-10, 2013. Presenters: Dayv Lowry, Robert Pacunski, Jen Blaine, Lisa Hillier, Andrea Hennings.
- Marker Buoy Dive Club, Jan. 2, 2014. Presenter: Robert Pacunski.
- Western Groundfish Conference, Feb. 10-14, 2014. Presenters: Robert Pacunski and Dayv Lowry with collaborators Jen Blaine and Lisa Hillier.
- First Annual Northeast Pacific Shark Symposium, Mar. 22, 2014. Presenter: Dayv Lowry.
- TSC Visual Survey Tools Workshop, Apr. 8-9, 2014. Co-organizer: Dayv Lowry. Presenters: Dayv Lowry and Robert Pacunski.

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*)

a. Annual Herring Assessment in Puget Sound

Annual herring spawning biomass was estimated in Washington in 2013 using spawn deposition surveys. WDFW staff based in the Mill Creek, La Conner, and Port Townsend offices conduct these assessment surveys of all known herring stocks in Washington's inside waters annually. Stock assessment activities for the 2014 spawning season are in progress.

The herring spawning biomass estimate for all Puget Sound stocks combined in 2013 is 7,332 tons (see table below). The cumulative total is a decrease from the 2012 total of 8,517 tons and less than the mean cumulative total for the previous ten year (2003-2012) period of 12,491 tons.

The combined spawning biomass of south/central Puget Sound (including Hood Canal) herring stocks in 2013 of 4,991 tons is a decrease from 2012, when the cumulative spawning biomass for this region was 5,846 tons. Spawning biomass for this region in 2013 was again dominated by the Quilcene Bay and Holmes Harbor stocks. Spawning abundance for these two stocks has been relatively high in recent years. A number of other stocks in the region that historically have been relatively large, are at low levels of abundance, particularly the Port Orchard-Port Madison and Quartermaster Harbor stocks. Spawning activity was again documented in Seattle's Elliot Bay in 2013, a repeat of the initial observation in 2012.

Cumulative biomass of north Puget Sound stocks in 2013, excluding the Cherry Point stock, is similar to recent years. The spawning biomass of the Cherry Point stock in 2013 was a decrease from 2012 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 also decreased in 2013, with an estimated spawning biomass of 71 tons.

PUGET SOUND HERRING SPAWNING BIOMASS ESTIMATES (SHORT TONS) BY STOCK AND REGION, 2004-2013

						YEAR				
	2013	**2012**	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**
Squaxin Pass	554	589	565	750	817	1025	557	755	436	828
Purdy	260	135	711	500	125	496				
Wollochet Bay	10	31	21	50	359	45	35	27	67	52
Quartermaster Harbor	157	108	96	143	843	491	441	987	756	727
Elliot Bay	214	290								
Port Orchard-Port Madison	184	217	123	350	1755	1186	1589	2112	1958	700
South Hood Canal	199	264	156	150	156	223	70	244	210	176
Quilcene Bay	2072	2626	4443	2012	3064	2531	2372	2530	1125	2342
Port Gamble	273	404	1464	433	1064	208	826	774	1372	1257
Kilisut Harbor	0	0	0	0	0	0	24	54	170	184
Port Susan	29	61	138	152	251	345	643	321	157	429
Holmes Harbor	585	678	3003	673	1045	686	572	1297	498	673
Skagit Bay	454	443	469	500	1027	1342	1236	2826	1169	1245
South-Central Puget Sound Total	4991	5846	11189	5713	10506	8578	8365	11927	7918	8613
Fidalgo Bay	100	89	119	103	15	156	159	323	231	339
Samish/Portage Bay	693	430	387	640	320	409	348	412	218	351
Int. San Juan Is.	0	5	0	17	0	60	33	285	41	67
N.W. San Juan Is.	0	0	0	0	0	0	0	0	0	0
Semiahmoo Bay	569	879	1605	1000	990	662	1124	1277	870	629
Cherry Point	908	1120	1301	774	1341	1352	2169	2216	2010	1734
North Puget Sound Total	2270	2523	3412	2534	2666	2639	3833	4513	3370	3120
Discovery Bay	0	105	0	26	205	248	42	1325	33	252
Dungeness/Sequim Bay	71	43	104	75	46	69	34	0	0	22
Strait of Juan de Fuca Total	71	148	104	101	251	317	76	1325	33	274
Puget Sound Total	7332	8517	14705	8348	13423	11534	12274	17765	11321	12007

b. Unique Herring Spawning and Pending Genetic Research

In late April of 2012 a WDFW field technician (Roy Clark) observed 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. In 2013 the fish returned again, and appeared to occupy a larger area of the Seattle waterfront (though access was limited in 2012 due to tides). A genetic study based on eggs collected in 2012 was complicated by low DNA amplification, but eggs and fin clips were collected in 2013. Analysis of these samples in expected by the end of August 2014.

c. Herring and smelt population-level genetic studies

Several genetic studies have been conducted on Pacific herring in Puget Sound over the last 20 years. While numerous populations have been sampled, there remain several populations that have never been included in these analyses, as well as a few populations for which poorly resolved genetic relationships still exist. In 2014, Working with the Department of Ecology and the Port Gamble Jamestown S'klallam Tribe, WDFW began collecting fin clips from spawning adults of six populations throughout Puget Sound: Port Gamble, Elliot Bay, Purdy/Henderson Inlet, Cherry Point, Squaxin Island, and Quilcene Bay. Together this suite of populations represents the three known genetically distinct populations of herring in Puget Sound, several "unresolved" stocks, and two populations that have never been genetically evaluated. The project will continue into 2015 with results expected in June of 2015.

In 2011 the WDFW, in collaboration with the USGS, conducted a preliminary study of surf smelt genetic relationships throughout Puget Sound. The results of this study indicated that a single panmictic stock of this species ranges throughout the Sound and into southern British Columbia. Samples used in this study were eggs, and sample size was low. As an extension of this work, the WDFW has been collecting fin clips from beach seine-caught smelt at eight locations throughout Puget Sound. Funding is currently limited for analysis, but pending legislative money may be used to support completion of this project and support interpretation of the genetic data obtained.

d. PSEMP's Forage Fish and Food Webs Working Group

The Puget Sound Ecosystem Monitoring Program (PSEMP) is a multientity consortium that supports several topic-specific standing workgroups. In 2013, PSEMP added a Forage Fish and Food Webs working group, which evolved from a less formal regional forage fish research group that had been hosting seminars and meetings since 2010. As a formalized group, this entity now includes individuals who work not only on forage fish but also the relationships among forage species and other biological components of the Puget Sound ecosystem. In their new advisory capacity to PSEMP the workgroup was able to make several recommendations for the future of forage fish and food web research in Washington state, which were combined with recommendations from other workgroups to develop a strategic scientific work plan for the Puget Sound Partnership.

e. Puget Sound Institute's Forage Fish Study Panel

From August 24-29th, 2013 the University of Washington, Tacoma's Puget Sound Institute hosted an inaugural workshop for its Forage Fish Study Panel. This panel is intended to draw on local and regional expertise on forage fish biology and ecology to evaluate existing data gaps and propose novel research approaches that can be instituted given existing resources. The panel will also write collaborative grants to seek support for additional novel work. After hearing two days of testimony from local forage fish scientists and enthusiasts, the Panel considered the available information and developed a list of priority projects to conduct in the next two year. This list was integrated with the Forage Fish and Food Web Working Group recommendations mentioned above to inform the Puget Sound Partnership's science plan, and has also led to several active projects addressing forage fish population dynamics, predation upon forage fish, and the effects of nearshore habitat loss on spawning potential.

f. Participation in Conferences and Workshops

In 2013-14 staff of the Puget Sound MFS Unit presented at, and/or arranged symposia at, several regional scientific meetings, and education/outreach events as indicated below.

Puget Sound Institute's Forage Fish Workgroup Kick-off Workshop, Aug. 24-29, 2013. Co-organizer, Presenter, and Panel Member: Dayv Lowry.

Salish Sea Ecosystem Conference, Apr. 30th-May 2nd, 2014. Session co-organizer: Dayv Lowry. Presenter: Dayv Lowry, Adam Lindquist, Kurt Stick.

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, Colin Jones, 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)*

a. 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

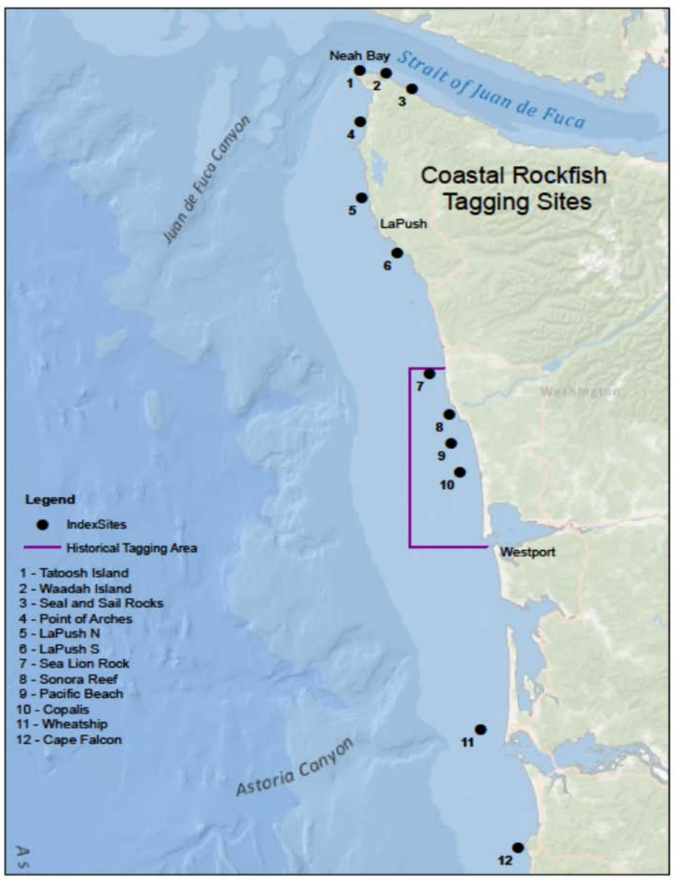

Table 1. Tagging Statistics

	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**

b. 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.)

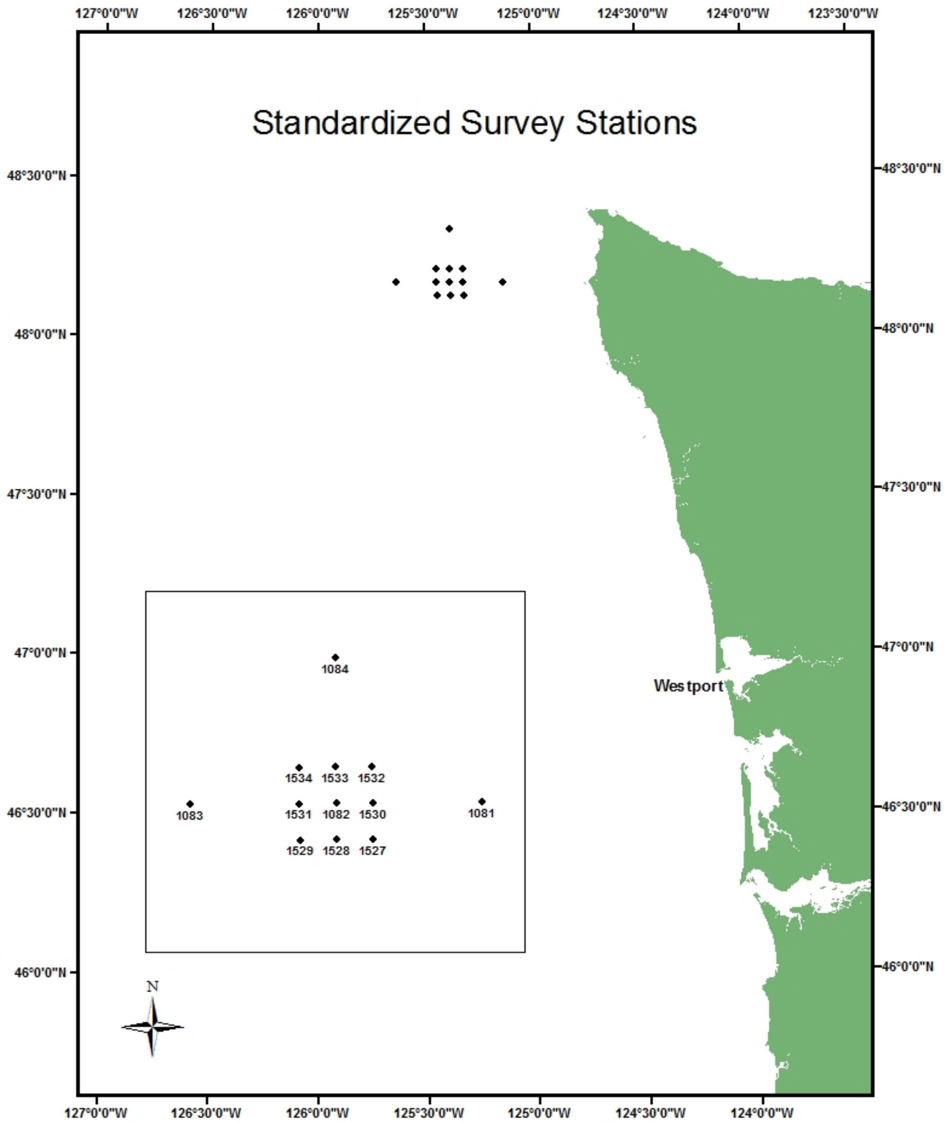

Figure 9. Standardized Survey Stations

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

Species Name	Total Caught	Average Weight (kg)	Total Weight (kg)	Percent of Catch by Weight	Percent of Catch by Number	Number Caught by Station 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													

c. 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*)

d. 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 an 11-month survey (Oct. 2012 to Sep. 2013), of beaches in an effort to document seasonal and spatial patterns of spawning ground usage by surf smelt. 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 included 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. Beaches were then divided into 1000-ft sampling units. Ten percent of potential beach segments were selected for sampling monthly (84 segments/month), without replacement, for each month. The plan was to utilize the obtained data to develop an occupancy model, allowing extrapolation of spatiotemporal patterns to the remainder of the sampling universe. Insufficient detections of eggs occurred, however, and an additional year of survey effort is needed before this model can be fully parameterized. Fieldwork for the second season of this study is ongoing.

A report was published in the WDFW Technical Report series coving the first year of sampling:.

Langness M., P. Dionne, E. Dilworth, and D. Lowry. 2014. Summary of coastal intertidal forage fish spawning surveys: October 2012 – September 2013. Washington Department of Fish and Wildlife, Fish Program Report Number FPA 14-01.

f. 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.

Committee of Age-Reading Experts

2013 Committee Report

Prepared for the Fifty-fifth Annual Meeting of the

Technical Subcommittee of the Canada-USA Groundfish Committee

April 29 – 30, 2014

Prepared by
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CARE 2013 Report to the Technical Subcommittee

Of the Canada-USA Groundfish Committee

A. CARE Overview

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

2. **Report Period**
   This report covers the work period of January 1, 2013 through December 31, 2013. This reporting period includes information from the Executive Summary prepared by outgoing Chair Sandra Rosenfield. Current officers elected at April 2013 meeting are:
   Chair - Elisa Russ (ADF&G)
   Vice-Chair - Chris Gburski (AFSC)
   Secretary - Lance Sullivan (NWFSC)

3. **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.
   a. **Overview:** The most recent biennial CARE workshop was held April 16-18, 2013 at the NOAA Alaska Fisheries Science Center (AFSC), Sand Point facility in Seattle, WA, and hosted by Delsa Anderl and the Age and Growth AFSC staff. The meeting was attended by 37 CARE members (Table 1) from participating agencies ADF&G (5), AFSC (12), CDFO (3), IPHC (4), NMFS – Auke Bay (1), NWFSC (6), ODFW (1), and WDFW (5). Also present was Theresa Tsou, WDFW, and member of TSC. The next CARE workshop in 2015 will be held prior to the TSC meeting at the AFSC in Seattle, WA.

   b. **Business Session Highlights:**
      i. **Scientific presentations:**
         Four PowerPoint presentations were given:
         - *The Spiny Issue of Ageing Spiny Dogfish: Historical Dogma vs. New Methods* by Cindy A. Tribuzio, AFSC – Auke Bay.
         - *Age validation using stable oxygen isotopes ($\delta^{18}O$) signatures in otoliths*: Comparison of secondary ion mass spectrometry and micro milling/continuous flow isotope ratio mass spectrometry, by Dr. Thomas Helser, AFSC - Seattle.
         - *A new bomb-radiocarbon reference curve for the Bering Sea, and age validations for two species, northern rockfish and yellowfin sole* by Craig Kastelle, AFSC - Seattle.
         - *The Potential Long Term Effects of Otolith Storage in Glycerin* by Sandra Rosenfield, WDFW.

ii. Agency Reports:

ADF&G -all sites (Elisa Russ, Kevin McNeel, Willy Dunne), WDFW (Lance Campbell and Jennifer Topping), AFSC (Tom Helser), ODFW (Lisa Kautzi), NWFSC (Patrick McDonald), IPHC (Joan Forsberg) and CDFO (Darlene Gillespie) provided reports summarizing and updating agency activities, staffing, organization, new species and projects. Important to note was the retiring of Kris Munk (ADF&G) and Shayne MacLellan (CDFO). NWFSC purchased elevating desks for all their employees that comply with ergonomic standards.

iii. Discussion Topics

There were six discussion topics of new business.

a) Symposiums/Conferences:

1. International Otolith Symposium, Spain, October 20-24, 2014: Members were encouraged to attend. Lance Campbell (WDFW), Craig Kastelle (AFSC), and Darlene Gillespie (CDFO) all expressed an interest to attend pending funding approval. Darlene said she has possession of the poster that was made for the last IOS symposium and if she is not able to attend she will relinquish it to another member who could attend. There was also mention of the 'Age Validation Conference' co-sponsored by Allen Andrews (NOAA-PIFSC) which coincides with the IOS.
    - As of April 2014, Helser and Allen Andrews (NOAA-PIFSC) confirmed to attend. Helser willing to represent CARE.
    - The CARE poster will be presented.
2. Helser presented at the 2012 American Marine Science Symposium meeting (AMSS) in Anchorage on age validation of skates.

b) Charter:

There was discussion about the Charter and if there was a need to continue the Charter Committee or disband it. Members decided that it should continue and three new members joined. Additional information to include timelines for the CARE Chair regarding TSC meetings, TSC reports, and examples of oral reports given to TSC was discussed. Include a time table reference for scheduling the bi-annual meetings, draft agendas as well as promoting and encouraging the CARE sub-committees were also discussed. Timelines will be added for the Vice Chair and Secretary as appropriate. These outlines will be presented to CARE for approval in 2015. Included in CARE to CARE recommendations.

c) Age Determination Manual:

There was discussion on whether potential differences in age determination within species, between stocks, should be included in the manual. Members concurred that there are regional differences depending on where specimens were collected, particularly in the Gulf of Alaska as move south to north, and ADF&G staff noted that certain species collected further north (PWS, North Gulf) can be easier to age than those collected in Southeast, which often present with a "noisier" pattern; although age determination criterion does not change based on sample location. Stock location is included on the website for age structure exchanges. The CARE Manual Committee will consider how to incorporate this information, in regards to age determination, into the manual and further discuss at the next CARE meeting.

c) Archived Structures:

CARE discussed where and how to add spreadsheets containing Archived Structures information from member agencies to the website. Jon Short (AFSC) suggested we add a link to the existing Species Information table. Members agreed this would be a temporary fix until the website is updated to accommodate a different arrangement.

d) Forum:

The CARE forum is an online place where members and other interested age readers can have discussion. The usefulness of the Forum was addressed. Nikki Atkins (NWFSC) reported that it's rarely used by our members. However, she has had three requests for new accounts from otolith age readers from other states in the US and abroad. It was decided that as CARE's reputation expands the Forum will encourage outside contacts and the Forum requires little effort to maintain. Also, with sequesters and budget constraints, it may still prove useful in the future for emergency communication purposes. Members agree the Forum should continue.

e) Effects of long-term storage of otoliths in glycerin:

The Focus of CARE for 2013 was the effect of otoliths stored long term in glycerin. Sandra Rosenfield (WDFW) presented a PowerPoint presentation of observations of otoliths stored in glycerin since 1970. Samples from 1970 - 1985 were stored in vials with the otoliths separated by paper disks and then filled with a liquid media of 30% ethanol and water or 30% glycerin, water and pinch of thymol. At the time there was no preference as to which media was used. The vials once filled were dipped in paraffin to prevent evaporation. Over the years, the samples in ethanol and water did evaporate, but there was no long term effect on the ability to age the otoliths. The glycerin, water and thymol samples did not evaporate. The otoliths, when removed from the vial, appeared translucent and seeped glycerin for days. 5% of otoliths were etched on the surface with a powdery residue. When broken and burnt, 60% showed a cloudy band on the outer edge concealing 5 to 15 annuli. Members were asked to fill out a survey on procedures used for otoliths storage. The results showed two other agencies having issues with glycerin when used for long term storage of otoliths. Shayne McLellan (CDFO) noted hake stored from the 1970's were recently aged using the break and burn method and they also revealed a milky white band on the outer edge. The white edge was very apparent, though CDFO could age around or see through the "milky white edge." MacLellan also stated that small sablefish otoliths (stored long term in glycerin) had a white powdery film all over them and they removed them from the glycerin media and now store them dry. Joan Forsberg (IPHC) noted their juvenile halibut otoliths stored in glycerin had become pliable and coated with a white film. They also removed the otoliths from the glycerin media, rinsed them in water and then stored them dry. Forsberg was concerned because they no longer age halibut otoliths using the surface method; they recently changed to baking and breaking. She said their archives go back to 1914 and everything is stored in glycerin. Forsberg is going to age the halibut using the break and bake method and report back to CARE in 2015. The members discussed potential causes attributing to the otoliths' deterioration, potential issues for age validation, and concern for the otoliths' integrity if they remain in glycerin. AFSC archives all of their otoliths in glycerin because of fire regulations. They are also going to age their otoliths and report to CARE in 2015. The findings from this report and information from IPHC and AFSC will collectively be considered when a recommendation is made to the manual committee regarding the use of glycerin as a storage media.

iv. Hands-on Session Highlights and Discussion:

a) Hands-On Age Reading at Microscopes:

A total of 27 readers reviewed 10 species during the hands-on workshop. Members aged sardines, geoduck, black rockfish, blue rockfish, rougheye rockfish, hake, yelloweye rockfish, redbanded rockfish, Pacific cod, and shortraker rockfish. All the species aged, participating members, and agencies are listed in Table 2.

b) Dogfish mini workshop:

A dogfish mini workshop led by Cindy Tribuzio (AFSC, Auke Bay) convened on Wednesday, April 17. The spiny dogfish ageing manual from the NPRB study (April, 2013-draft) *Methods for the preparation of spines and vertebrae and an overview of age structure reading* was first discussed. Age structures were processed by Cal Blood for a reference collection to calibrate ages across agencies, and were aged by all attending age readers and inter-reader ageing results were compared including precision (CV) by Tribuzio. Live images for vertebrae were viewed and growth patterns and age assignments were discussed. After group agreement on an age, the consensus age was recorded. Participating members and agencies: Nikki Atkins, Tyler Johnson (NWFSC), Beth Matta, Chris Gburski (AFSC), Sandra Rosenfield, Jennifer Topping (WDFW), Willy Dunne (ADF&G) Vanessa Hodes (CDFO) and Cal Blood (independent contractor).

B. CARE Subcommittee (Working Group) Reports

There were four active working groups that reported at the 2013 CARE workshop.

1. **CARE Manual/Glossary Committee** – Betty Kamikawa (NWFSC) resigned as lead and responsibilities were assumed by Elisa Russ (ADF&G - Homer) in March 2013. The other members of the manual working group include: Barbara Campbell (CDFO) [not present at the 2013 meeting] and Betty Goetz (AFSC). New members of the manual working group that joined during the 2013 CARE meeting are Willy Dunne (ADF&G), Lisa Kautzi (ODFW), and April Rebert (ADF&G).

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

At the 2013 CARE meeting, the CARE manual was updated with three new sections that were reviewed in 2012/13 by the CARE membership:

1) Age Determination of Pacific Halibut section submitted by J. Forsberg (IPHC),
2) Quality Assurance/ Quality Control (QA/QC) section submitted by B. Campbell, and
3) updated Accuracy and Precision section (including validation methods) submitted by Craig Kastelle (AFSC).

Two additional sections that were completed and reviewed by both the manual working group and the membership were 4) Age Determination of Lingcod Otoliths, and 5) Thin Sectioning Method.

These final two sections have not been incorporated into the CARE Manual because clarification was needed on how to proceed. Decisions regarding these sections were made at the 2013 CARE meeting as follows. The draft for Age Determination of Lingcod Otoliths was submitted by Kris Munk (ADF&G – Juneau, retired), and initial review was completed in 2013, however, there are new terms in the section that need to be clarified and/or added to the glossary and due to K. Munk's retirement prior to the April 2013 CARE meeting, final review of the lingcod otolith section and glossary will be conducted with other members that interpret lingcod otoliths, then submitted for approval to the membership with intended incorporation into the manual at the 2015 CARE meeting. Charles Hutchinson (AFSC) submitted the short section on Thin Sectioning Methods, and the working group needed to determine how to incorporate it into the manual in relation to the existing and fairly comprehensive existing Rockfish Ageing Thin Sectioning information, and it was decided to edit the draft and include in the General Ageing Procedures section, and then edit the Rockfish section to avoid redundancy.

The ambitious list of additional sections to be drafted and submitted for approval for the 2015 CARE meeting are a short section on Ergonomics (initial draft begun at 2013 CARE meeting), Baked Otolith Methods (to be included under General Ageing Procedures), review and update Rockfish Ageing Procedures, and Acknowledgements section (to replace current documentation sections at the beginning of the manual describing participants and contributors), as well as a new section on Walleye Pollock age determination and a revision to the Sablefish Ageing Procedures section. After review and approval by the Manual Working Group, all revisions will be submitted to the full CARE membership for final review and approval followed by incorporation into the CARE manual. Recommendations are included in CARE to CARE 2013.

2. CARE Website Committee – Jon Short (AFSC) Chair and webmaster, Nikki Atkins (NWFSC)

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

In 2013, J. Short updated the CARE website with 2012 production numbers, 2012 age structure exchanges, and the 2013 CARE meeting approved minutes. In early 2014, J. Short added 2013 age structure exchanges to the website. N. Atkins continued to maintain the CARE Forum in 2013 (link on website) and also posted Excel spreadsheets (including two macros) to assist in QA/QC and determining bias (including statistics APE, CV, % agreement).

3. Charter Committee – Elisa Russ (ADF&G), Betty Goetz (AFSC)

The Charter, initiated in 2000, provides a framework in which the original intent of CARE may continue. It also familiarizes 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.

Kris Munk retired and thereby resigned as lead of the working group. The committee had been reconvened in 2008, after being previously disbanded, to make updates to the CARE Charter, many of which were completed. The committee was not active in 2012. At the 2013 CARE meeting, E. Russ volunteered to lead the group. Tasks to be completed for the 2015 CARE meeting are to review the Charter and recommendations from 2011 CARE: 1) Define working groups, 2) Specify work and reporting obligations, 3) Suggest time limits, and 4) Add new members or disband the charter committee after the 2015 meeting, once updates are completed and approved by the CARE membership.

4. **Sablefish ad hoc Working Group** - Delsa Anderl (AFSC) was appointed as chair after Shayne MacLellan (CDFO) retired and stepped down. The other current committee members are:, Tom Helser (AFSC), Lisa Kautzi (ODFW), Darlene Gillespie (CDFO), Patrick McDonald (NWFSC), Kevin McNeel (ADFG), John Brogan (AFSC), and new member April Rebert (ADF&G).

   The sablefish working group convened, reviewed and discussed results of sablefish exchanges. In addition to extensive exchanges during the 2008-13 of up to 100 samples from each region, the working group also completed age structure exchanges, initiated in 2012, of known age sablefish (n=24) with participating agencies ADF&G, CDFO, PSMFC, and AFSC prior to the 2013 CARE meeting. These exchanges helped identify patterns with slow growth for otoliths younger than age 5 years which contributed to difficulties with calibration. The sablefish working group made a recommendation to revise the Sablefish Ageing Procedures section of the CARE manual that will be submitted to the manual committee by December 2014 for incorporation into the CARE manual at the 2015 meeting.

C. Age Structure Exchanges

Age structure exchanges occur periodically 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. There was one age structure exchange initiated in 2013 on geoduck clams between ADF&G and CDFO. Species exchanged were sablefish and sardines. In 2014, five exchanges have been initiated to date on rougheye rockfish, Pacific spiny dogfish, lingcod, big skate, and longnose skates. In 2013, an effort was made to retrieve missing CASE (CARE Age Structure Exchange) invoices which were then appended to the website. Age structure exchanges initiated and completed 2012-2013 are listed in Table 3.

D. Recommendations C.A.R.E. ~TSC

In 2013 recommendations were made by CARE to CARE, TSC to CARE, and CARE to TSC. Some recommendations may take more than one cycle to complete. This list contains recommendations that are still pending or provide background for those made by CARE/TSC in response to prior recommendations.

1. **2013 Recommendations**

   1.1. CARE to CARE

   1.1.1. CARE recommends the manual working group post archived editions of the CARE Manual on the website with a link to the year of publication.

   1.1.2. CARE recommends the Manual/Glossary Committee continue revision and expansion of the C.A.R.E. Manual on Generalized Age Determination (CARE Manual) as described here. Finalize the draft on Lingcod Otolith Ageing and incorporate into the CARE Manual by June 1, 2013. Edit the draft for the updated Thin Sectioning Method and include in the General

Ageing Procedures section in the manual to reference all age structures (otolith, vertebrae, and fin rays) and then edit the Rockfish Ageing Thin Section Method section to avoid redundancy. Write a section to be included in General Ageing Procedures describing baking otoliths and collaborate with other agencies that utilize that method for rockfish. Additionally, revise the remaining sections of the Rockfish Ageing Procedures section and move some information to the Otolith Ageing Procedures section where appropriate (e.g. microscope equipment information). Write a short section on Ergonomics and include with general information on equipment. Draft a new section on Walleye Pollock Ageing Procedures with collaboration with other agencies that age pollock. Revise the Sablefish Ageing Procedures section. Additionally, CARE recommends removing the documentation sections at the beginning of the manual (describing participants and contributors) because the documentation is incomplete, and then add an Acknowledgements section at the end of the document listing contributors to the manual. However, in order to maintain the CARE Manual as a historical reference, it is also recommended to post the old version(s) of the CARE Manual (when new versions are produced) to the website with links referencing their year of publication. The Thin Sectioning, Baked Otolith methods, updated Rockfish Ageing Procedures, Ergonomics, and Acknowledgments sections are assigned and to be submitted to the lead of the Manual Working Group (Elisa Russ) by October 2013, and the Walleye Pollock and sablefish sections are to be submitted by December 2014. After review and approval by the Manual Working Group, all revisions will be submitted to the full CARE membership for final review and approval followed by incorporation into the CARE Manual.

1.1.3. CARE recommends that the Forum continue.

1.1.4. CARE recommends the Website committee load a new version of Joomla for the CARE website or one of the other popular CMS, such as WordPress or Drupal. Future planned updates to the website include creating consistent capitalization on Species Info page, update agency production numbers, and add a webpage for age structure inventories.

1.1.5. Propose further study of otoliths stored long term in glycerin-thymol, from IPHC and AFSC, after several agencies observed otolith degradation from long-term storage in glycerin-thymol. At the next CARE, their observations regarding the media of glycerin-thymol combined with reports from 2013 will collectively result in a recommendation to the manual committee in 2015.

1.1.6. Charter Working Group: The charter will be expanded to include timelines for reports and meetings for possible additions to the charter pending CARE membership approval.

1.2. CARE to TSC

1.2.1. At the 2013 CARE meeting, the manual working group drafted a section on Ergonomics for inclusion in the CARE Manual on Generalized Age Determination. It is important that agency leaders recognize the health risks associated with age reading and equipment options that may be available to mitigate these risks.

1.3. TSC to CARE

1.3.1. 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).

2. 2012 Recommendations

2.1 TSC to CARE

2.1.1. The TSC thanks CARE for their continued good work and would like to acknowledge their continued work to support the online posting of otolith archives by member agencies in light of their many other work pressures.

3. 2011 Recommendations

3.1. CARE to TSC

2.1.1. 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, the 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 would consult their agencies regarding the TSC recommendation and will formulate a reply by year end.

3.2. 2011 TSC to CARE Recommendations:

3.2.1. *"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. "*

1. *To clarify for CARE, TSC's 2010 information request includes the following by species:*

   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.*

3.2.2. 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?"*

3.2.3. 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."

3.3. 2011 CARE reply to TSC:

3.3.1. 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.

3.4. 2011 CARE to CARE:

3.4.1. Website Committee: CARE recommends the website committee update 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.

3.4.2. Manual Working Group: CARE recommends the manual working group 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.

3.4.3. 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.

3.4.4. CARE recommends that the 2013 agenda address the effects of long-term storage of otoliths in glycerin.

4. 2010 Recommendations

4.1. TSC to CARE

4.1.1. 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.

Note: Complete minutes of 2013 CARE compiled by Chris Gburski (AFSC), outgoing secretary, are available online at:
http://care.psmfc.org/docs/minutes_13.pdf

Table 1. Attendees of the 2013 CARE Workshop, April 16-18 2013, Seattle, Washington, U.S.A.

Last name	First name	Agency	Location	Country	Email
Dunne	Willy	ADF&G	Homer	USA	willy.dunne@alaska.gov
McNeel	Kevin	ADF&G	Juneau	USA	kevin.mcneel@alaska.gov
Pollak	Andrew	ADF&G	Homer	USA	andrew.pollak@alaska.gov
Rebert	April	ADF&G	Juneau	USA	April.Rebert@alaska.gov
Russ	Elisa	ADF&G	Homer	USA	elisa.russ@alaska.gov
Anderl	Delsa	AFSC	Seattle	USA	delsa.anderl@noaa.gov
Brogan	John	AFSC	Seattle	USA	john.brogan@noaa.gov
Colman	Jamie	AFSC	Seattle	USA	jamie.colman@noaa.gov
Gburski	Chris	AFSC	Seattle	USA	christopher.gburski@noaa.gov
Goetz	Betty	AFSC	Seattle	USA	betty.goetz@noaa.gov
Helser	Tom	AFSC	Seattle	USA	thomas.helser@noaa.gov
Hutchinson	Charles	AFSC	Seattle	USA	charles.hutchinson@noaa.gov
Johnston	Chris	AFSC	Seattle	USA	chris.johnston@noaa.gov
Kastelle	Craig	AFSC	Seattle	USA	craig.kastelle@noaa.gov
Matta	Beth	AFSC	Seattle	USA	beth.matta@noaa.gov
Piston	Charlie	AFSC	Seattle	USA	charlie.piston@noaa.gov
Short	Jon	AFSC	Seattle	USA	jon.short@noaa.gov
Gillespie	Darlene	CDFO	Nanaimo	Canada	darlene.gillespie@dfo-mpo.gc.ca
Hodes	Vanessa	CDFO	Nanaimo	Canada	vanessa.hodes@dfo-mpo.gc.ca
Hudson	Mary-Jane	CDFO	Nanaimo	Canada	mary-jane.hudson@dfo-mpo.gc.ca
Blood	Cal	IPHC-Retired-Contractor	Seattle	USA	calvin.blood@frontier.com
Forsberg	Joan	IPHC	Seattle	USA	joan@iphc.int
Gibbs	Linda	IPHC	Seattle	USA	lindagibbs17@gmail.com
Tobin	Robert	IPHC	Seattle	USA	robert@iphc.washington.edu
Tribuzio	Cindy	NMFS-Auke Bay	Juneau	USA	cindy.tribuzio@noaa.gov
Atkins	Nikki	NWFSC	Newport	USA	nikki.atkins@noaa.gov
Higgins	Brooke	NWFSC	Newport	USA	brooke.higgins@noaa.gov
Johnson	Tyler	NWFSC	Newport	USA	tjohnson@psmfc.org
McDonald	Patrick	NWFSC	Newport	USA	patrick.mcdonald@noaa.gov
Sullivan	Lance	NWFSC	Newport	USA	lance.sullivan@noaa.gov
Whiteside	Cassandra	NWFSC	Newport	USA	cassandra.whiteside@noaa.gov
Kautzi	Lisa	ODFW	Newport	USA	lisa.a.kautzi@state.or.us
Campbell	Lance	WDFW	Olympia	USA	lance.campbell@dfw.wa.gov
Claiborne	Andrew	WDFW	Olympia	USA	andrew.claiborne@dfw.wa.gov
Rosenfield	Sandy	WDFW	Olympia	USA	greenthumb51@hughes.net
Topping	Jennifer	WDFW	Olympia	USA	toppijat@dfw.wa.gov
Tsou	Tien-Shui	WDFW	Olympia	USA	tien-shui.tsou@dfw.wa.gov

Table 2. 2013 CARE Hands-On "Scope Time" Session – Species Aged, Participants, and Agency.

Species	Participants	Agency	Comments
Sardine	Jennifer topping	WDFW	Sample exchange
	Vanessa Hodes	CDFO	
Sardine	Sandra Rosenfield	WDFW	Sample exchange
	Vanessa Hodes	CDFO	
Pacific cod	Chris Johnston	AFSC	Calibration
	Elisa Russ	ADF&G	
	Andy Pollak	ADF&G	
	Delsa Anderl	AFSC	
Yelloweye	Elisa Russ	ADF&G	Calibration
	Andy Pollak	ADF&G	
Shortraker	Charles Hutchinson	AFSC	
	Jeremy Harris	UW	
Rougheye	Betty Goetz	AFSC	Calibration
	Lance Sullivan	NWFSC	
	Cassie Whiteside	NWFSC	
	Charles Hutchinson	AFSC	
	Mary Jane Hudson	CDFO	
Redbanded	Betty Goetz	AFSC	Calibration
	Lance Sullivan	NWFSC	
	Cassie Whiteside	NWFSC	
	Charles Hutchinson	AFSC	
	Mary Jane Hudson	CDFO	
Black rockfish	Elisa Russ	ADF&G	Calibration
	Andy Pollak	ADF&G	
	Willy Dunne	ADF&G	
	Mary Jane Hudson	CDFO	
Geoduck	Darlene Gillespie	CDFO	Calibration
	April Rebert	ADF&G	
	Kevin McNeel	ADF&G	
Geoduck	Darlene Gillespie	CDFO	Calibration
	April Rebert	ADF&G	
Dogfish	Patrick McDonald	NWFSC	Spines
	Chris Gburski	AFSC	
	Vanessa Hodes	CDFO	
	Beth Matta	AFSC	
Dogfish	Cindy Tribuzio	NMFS-Juneau	Vertebrae
	Patrick McDonald	NWFSC	Training

	Chris Gburski	AFSC	
	Vanessa Hodes	CDFO	
	Beth Matta	AFSC	
	Sandra Rosenfield	WDFW	
	Jennifer topping	WDFW	
	Willy Dunne	ADF&G	
	Cal Blood	contractor	
Blue rockfish	Jennifer topping	WDFW	Cross training
	Lisa Kautzi	ODFW	
Black rockfish	Sandra Rosenfield	WDFW	Cross training
	Lisa Kautzi	ODFW	
Hake	Mary Jane Hudson	CDFO	
	Darlene Gillespie	CDFO	

Table 3. CARE age structure exchanges initiated/completed 2012-2013.

Exchange ID No.	Exchange Year	Species	Stock	Originating Agency	Coordinator	Coordinator (s)
13-001	2013	Geoduck	SE Alaska	ADF&G-Juneau	A. Rebert	CDFO, WDFW
12-003	2012	Sardine	Mixed	WDFW	S. Rosenfield	CDFO
12-002	2012	Sardine	British Columbia	CDFO	V. Hodes	WDFW
12-001	2012	Sablefish	Astoria, OR	ADF&G	Munk	AFSC, NWFSC

Figure 1: Attendees of the 2013 CARE Workshop, April 16-18 2013, Group Photo and Hands-On "Scope" Time Session Participants.

APPENDIX-I

Seventeenth Biennial Meeting of the
Committee of Age Reading Experts

C.A.R.E. Agenda
Canada – US Groundfish Committee
April 16 – 18, 2013
AFSC, Sand Point, Seattle, WA, USA
Traynor Room

<u>Tuesday April 16, 2013 (8:30 am - 4:30 pm)</u>

I. Welcome and Opening Statements (8:30 – 9:15)

A. Call to Order (Sandra Rosenfield, CARE Chair)
B. Host Statements
  1. Opening statements (Theresa Tsou and Thomas Helser)
  2. Host information (Delsa Anderl)
C. Introductions
  1. Round-table introductions (name, agency, location)
  2. Attendance, address, phone, email
D. Approval of the 2013 agenda
E. CARE to CARE recommendations from 2011
  1. Review the usefulness of the Forum
  2. Update website version from 1.12 to 1.5
  3. Review the method and validation in Species Info on the website (for updates and changes contact Jon Short)
  4. Update the manual to include:
    a. Sections on Halibut
    b. QA/QC
    c. Draft a hake section, skate section and ergonomics section
    d. Lingcod otoliths added to the lingcod finray section,
    e. Updated rockfish section to include thin sections and baked otolith
  5. Age validation section reviewed for updates and revisions

II. Working Group Reports / Activity Since CARE 2011 (9:15 - 10:00)

A. 2012 TSC Meeting (Sandra Rosenfield)
B. Age structure exchanges (Elisa Russ)
C. CARE Manual (Elisa Russ)
D. Website (Jon Short)

E. Forum (Nikki Atkins)
F. Sablefish (Delsa Anderl)

Break (10:00-10:15)

III. Agency Overviews and Updates (10:15-11:00)

*No PowerPoint; 5 minute updates (staffing, organizational, new species/projects, etc.)

A. CDFG
B. SWFSC
C. CDFO (Darlene Gillespie)
D. IPHC (Joan Forsberg)
E. ODFW (Lisa Kautzi)
F. AFSC (Tom Helser)
G. NWFSC (Patrick McDonald)
H. WDFW (Lance Campbell and Jennifer Topping)
I. ADF&G (Elisa Russ, Kevin McNeel, Willy Dunne)

IV. Topics for Discussion / New Business (11:00-12:00)

A. Otolith Symposium 2014 and other symposiums
B. Conferences since 2011
C. Charter: "The purpose is to familiarize new CARE members with the function of CARE and the responsibilities of its officers and members. The committee is responsible for facilitating changes and updates to the Charter." Kris Munk suggested:
  1. Define working groups
  2. Work and reporting obligations
  3. Suggest time limits
  4. Add new members or disband the committee
D. Should the Manual include potential differences between stocks within species?
E. Archive structures added to the website:
  1. Location on the CARE website
  2. Agency contacts
  3. Link to other websites (AFSC)
F. Species Info on the website - needs Agency updates
G. Additional topics
H. Non-agenda items

Lunch (12:00-1:00)

V. Scientific PowerPoint Presentations (1:00 – 2:00pm)

A. The Spiny Issue of Ageing Spiny Dogfish (Cindy Tribuzio)
B. A new bomb-radiocarbon reference curve for the Bering Sea (Craig Kastelle)
C. High resolution δ^{18}O sampling of otoliths for age validation – a comparison using micromilling/continuous flow mass spectrometry and secondary ion mass spectrometry (Thomas Helser)

VI. Work Shop Focus (2:00 – 2:30)
   A. Longtime storage of otolith in glycerin using WDFW's samples from the 1970s (Sandra Rosenfield)
   B. Discussion

Break (2:30-2:45)

VII. Working groups & Hands-On Workshop (2:45 – 4:30 pm)
   A. Working groups:
      1. Meet and formulate written recommendations
      2. Prepare the recommendations electronically (to be presented Thursday morning)
   B. Hands-on scope work
      1. Sign up for scope station space and time

Wednesday April 17, 2013 (8:30 am - 4:30 pm)

I. Working groups & Hands on Workshop Continued
   A. Dogfish working group (Room 2079)
   B. Working Groups
   C. Hands-on Workshop

Thursday April 18, 2013 (8:30 am – 12:00 noon)

I. Recommendations (8:30 – 9:00)
   A. 2013 CARE to TSC
   B. 2013 CARE to CARE

II. Concluding CARE business (9:00 -10:00)
   A. Administration nominations
   B. Schedule and location of 2015 meeting

III. Working groups & Hands on Workshop (10:00 – 12:00 noon)
   A. Working Groups
   B. Hands-on Workshop

IV. Adjourn (12:00 noon)