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

## Forty Fifth Annual Meeting of the TSC

## May 3-4, 2005

## Parksville, British Columbia

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

**Compiled by the Pacific States Marine Fisheries Commission**

# History of TSC Meeting Locations, Hosts and Chairpersons

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

# TABLE OF CONTENTS

# A. Overview and Terms of Reference

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

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

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

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

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

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

# B. Executive Summary

The Technical Sub-Committee of the Canada/US Groundfish Committee (TSC) met May 3-4 in Parksville, B.C. Representatives from the Canadian Department of Fisheries and Oceans, NOAA Fisheries (National Marine Fisheries Service), International Pacific Halibut Commission, Pacific States Marine Fisheries Commission, the North Pacific Fishery Management Council, Southwest Fisheries Science Center, Alaska Department of Fish and Game, Washington Department of Fish and Wildlife, and Oregon Department of Fish and Wildlife attended. Rick Stanley of the Canadian Department of Fisheries and Oceans served as Chair, and Jonathan Martin and Janet Lochead of the Canadian Department of Fisheries and Oceans served as Secretaries.

During the 2005 meeting, the TSC exchanged information on research, stock assessment and management activities conducted during 2004 and work planned for 2005. The agency reports and TSC working group reports have been collated in the accompanying document. The report contains additional information that scientists and managers may find useful, including agency publication and staff lists.

# C. Minutes of the Technical Sub-Committee

## Forty-Sixth Annual Meeting of the Technical Sub-Committee
## May 3-4, 2005
## Parksville, British Columbia

**I. Call to Order** – Rick Stanley, Chair, called the meeting to order at 8:40am, May 3.

**II. Appointment Secretary** – Jonathan Martin and Janet Lochead

**III. Introduction** – Attendees introduced themselves:

| | |
|---|---|
| **Rick Stanley (TSC Chair)** | - Science Branch, DFO, Nanaimo |
| **Diana Trager** | - Fisheries Branch, DFO, Vancouver<br>Canadian Parent Committee Representative |
| **Stephen Phillips** | - Pacific States Marine Fish Commission, Portland<br>U.S. Parent Committee Representative |
| Dave Clausen | - Alaska Fisheries Science Center, NMFS, Auke Bay |
| Eric Coonradt | - Commercial Fisheries Division, ADFG, Sitka |
| Jane DiCosimo | - North Pacific Fisheries Management Council, Anchorage |
| John Field | - Southwest Fisheries Science Center, NMFS, La Jolla |
| Tracee Geernaert | - International Pacific Halibut Commission, Seattle |
| Janet Lochead | - Science Branch, DFO, Nanaimo |
| Tom Jagielo | - Marine Fish Science, WDFW, Montesano |
| Rob Kronlund | - Science Branch, DFO, Nanaimo |
| Shayne MacLellan | - Science Branch, DFO, Nanaimo |
| Patrick McDonald | - Northwest Fisheries Science Center, NMFS, Newport |
| Steve Parker | - Marine Resources Program, ODFW, Newport |
| Kate Rutherford | - Science Branch, DFO, Nanaimo |
| Michael Schirripa | - Northwest Fisheries Science Center, NMFS, Newport |
| Mark Wilkins | - Alaska Fisheries Science Center, NMFS, Seattle |
| Lynne Yamanaka | - Science Branch, DFO, Nanaimo |

**IV. Approval of 2004 Report** – A draft Report of the 2004 TSC meeting was presented to the group by S. Phillips. Members were asked to review the document and bring any changes to Stephen's attention. Approval was deferred until later.

**V. Approval of 2005 Agenda** – Under other topics – "Completion date for 2005 Report" was added.

# VI. Working Group Reports

## *A. Committee of Age Reading Experts (CARE)*

P. McDonald, CARE Chair, summarized the 2004 workshop. The agency report will be finalized for the next CARE meeting. With respect to the Manual CARE Subcommittee, the lingcod and pacific whiting ageing chapters are still in progress. The Moss Landing Marine Laboratory is now one of the participating agencies in CARE (as of last fall). There have been otolith exchanges between DFO and NWFSC with respect to Pacific Ocean perch and darkblotched rockfish. Pre-exchange samples of Dover sole have been submitted.

An interim workshop on sablefish ageing is planned to be part of the sablefish symposium. Chris Monk (ADFG) is coordinating this workshop and has sent out a list of tentative objectives for the workshop. She is awaiting feedback.

The PBS lab recently hosted two NWFSC staff (Newport Lab) to examine hake ageing.

TSC asked about the Dover sole annual workshop. They suggested rotating among species rather than being fixed on Dover sole every year. The consensus was to have one every year. S. MacLellan indicated that CARE was looking for support to plan and travel to meetings. It would take two to four people and not more than six people with two to three days being sufficient. (~US$5000/meeting). Newport (NWFSC) currently funds the Dover sole workshop. M. Schirripa will draft a recommendation to the Parent Committee (see XI.B)

## *B. Groundfish Trawl Survey Meeting*

R. Stanley noted that the annual Trawl Survey meeting was invaluable for Canada. Among the many benefits, Canadian surveys had modified tow length and introduced bottom sensors on advice and with assistance from U.S. scientists. M. Wilkins concurred with the Canadian viewpoint. The TSC noted that the hake acoustic survey has been a cooperative venture for 15-20 years and was a good example of survey cooperation.

## *C. Sablefish Working Group Report*

M. Schirripa noted there were previous sablefish symposia in 1983 and 1993. The proposed date for the next symposium is the week of January 8, 2007. The backup date is the week of January 15. These dates will be brought to the Steering Committee to finalize and the TSC will be updated at the 2006 meeting. S. Phillips suggested holding it at Sand Point in Seattle or another government facility to keep costs low. M. Schirripa suggested Newport because it would be easier for him to organize. A pre-symposium list of interested individuals was developed at the 2004 WGC. The plan is to prepare a NOAA technical report or Alaska Fisheries Bulletin publication of the proceedings.

# VII. Other Topics

## *A. IDFA – Interdepartmental Fisheries*

S. Phillips gave a brief overview. It does not look like funds will be available in the near future. T. Jagielo's funding from ODFA has been terminated.

## *B. Genetics and Stock Structure*

M. Wilkins commented that many agencies are increasing their focus on genetics studies. At the AFSC, Pacific Ocean perch and other rockfishes, as well as Atka mackerel, are receiving attention. T. Geernaert noted the IPHC is attempting to determine whether Bering Sea populations of halibut are isolated from those of the Gulf of Alaska (GOA). This work also involves otolith elemental work. There are some indications that the Aleutian chain may be isolated; research continues this year (fin clips).

## *C. WGC 2006 Update*

S. Parker commented that about six people meet monthly to plan the WGC 2006. The venue will be the Agate Beach Best Western in Newport, January 30 to February 3, 2006. The logo has been decided. The website is hosted by the IPHC. Deadlines for abstracts will be posted soon. September 20th is the deadline for suggesting themes/sessions. Abstracts will be accepted starting June 1. Socials are being planned; the banquet will be at the aquarium. The committee is investigating having a special bottling done at the Rogue Brewery. The hotel can only hold ~375, so registration may be held at 300. The committee is looking into web-based registration and payment. M. Schirripa enquired about publishing the papers. The TSC noted that the objective is to be informal to encourage emerging work. There is not a lot of time available to have any workshops. One may be appended at the end of the conference.

## *D. Data Acquisition*

T. Geernaert stated that the IPHC wishes to develop GIS applications, which integrate their spatial data with a data management system. IPHC is also still using pencil and paper in the field. They would like to host a workshop somewhere to look at new technology in the field and the integration of database management and data acquisition.

R. Stanley suggested a split between data acquisition and GIS and perhaps developing two workshops. This was followed by a discussion of the forms of the workshops. T. Geernaert offered to draft a resolution. L. Yamanaka asked about whether the 2004 Dave Somerton technical workshop (Quantitative Video) will be repeated. M. Wilkins said probably not.

The TSC then discussed a GIS workshop. M. Wilkins indicated there have been previous GIS-based workshops, but broader-scale than just fisheries. It would be useful to have a workshop focused only on groundfish work. L. Yamanaka expressed interest in the workshop, in particular with respect to multibeam/bottom type/habitat classification. There was a consensus that a Groundfish-GIS workshop would be useful. The recommendation to be drafted by Lynne Yamanaka (see XI. B).

## *E. Role of TSC*

M. Schirripa noted that certain agencies have questioned the utility of attending TSC meetings. "What would we tell someone when they ask why they should attend the meeting? Why should we go every year?" It has also been suggested that the WGC has replaced the need for the TSC. S. Phillips noted that workshops are a ground-up approach to get our voices heard and to bring forward important information. Symposia help but they provide different benefits. T. Jagielo noted that TSC is an agency-specific sit-down, question-answer format, unlike a general forum like WGC. TSC's usefulness is that it is agency-specific.

M. Schirripa questioned whether it should meet every second year. T. Jagielo commented that there is a lot of material to discuss each year, and it is also useful to brainstorm about needed workshops. Perhaps TSC's most valuable contribution is as a catalyst in creating working groups.

## VIII. 2005 Report

S. Phillips indicated that members need to complete their reports if they have not already. We require reports for 2004 and 2005 to be completed by June/July.

***Coffee Break – 10:14-10:30***
***J. DiCosimo joined by conference call. 10:30***

## IX. Other Topics

### *A. Marine Reserves*

J. DiCosimo reported that the North Pacific Council designated a large area within the Aleutian Islands as a marine reserve. They will be scheduling discussions about creating similar reserves in the Bering Sea in the next year. Information is available on the website; Jane has also arranged for documents to be distributed at the meeting.

J. Field reported that the NOAA Marine Protected Area Centre in the Santa Cruz lab has developed a technical working group to examine the effects that MPAs will have on science and assessment. Charlie Wall is the director. They met for the first time last October, and will be meeting every six months for the next few years. The next meeting is in June 2005. Additional information can be found on their website (http://mpa.gov/mpa_center/science_institute.html ).

L. Yamanaka reported that last fall,DFO completed consultations on proposed RCAs in B.C.'s outside waters to protect inshore rockfish. Approximately 15 percent of the inshore rockfish habitat on the outside is closed. Further consultations this summer and fall will lead to closing more areas in B.C.'s inside waters. The goal is to close 50 percent of rockfish habitat on the inside. The Rockfish Conservation Strategy was implemented in 2002 and has four main facets: reduced harvests, closed areas, improved stock assessment and monitoring.

S. Parker noted that for Oregon, essential fish habitat implementation is currently being reviewed in council. Implementation may occur soon for some small areas and these may be a research focus in the near future. Closures are being implemented by legislation.

## X. Review of Groundfish Research Assessment and Management

### *A. Agency Overviews*

#### 1. Alaska

E. Coonradt noted that SenateBbill 113, "Groundfish Rationalization", is being introduced in Alaska. It is intended to "end the race for fish". J. DiCosimo commented that an IFQ or cooperative fishery might be introduced in the Gulf of Alaska for Pacific cod.

#### 2. AFSC

M. Wilkins noted that the AFSC was establishing an infrastructure to handle "big-picture" research. They will establish a team to draw expertise from the various divisions in the center to build an infrastructure to handle ecosystem project activities. Ecosystem management is the focus. The new research trawler, the Oscar Dyson, is heading to Kodiak after sea trials.

D. Clausen commented that the Auke Bay Lab is conducting a procedure to hire a new director and that a new facility will replace the Auke Bay Lab. It will be called the Ted Stevens Marine Research Laboratory.

#### 3. Canada

D. Trager explained that the "Integrated Groundfish Fishery" plan is progressing in Canada. All groundfish fisheries will be moving to IQs with transferability of quota between the license groups. Fishers will be accountable for all retained and discarded catch with some form of 100 percent catch monitoring funded by the fleet. This year, 20 percent of the vessels will have electronic monitoring as a pilot program. R. Stanley will present a paper on this subject at the Wakefield Rockfish Symposium. This initiative is currently intended for the commercial fishery only.

L. Yamanaka summarized the reorganization within the Science Branch in DFO, Pacific Region. The Groundfish Section is now in the Marine Ecosystem and Aquaculture Division (MEAD). The research trawler the CCGS W. E. Ricker has a blown engine. Various repair options are being considered; existing plans for a replacement vessel are being fast-tracked.

#### 4. PSMFC

S. Phillips noted that the sea squirt, which has blanketed a lot of the scallop/bottom habitat on the east coast, is now found in Puget Sound.

#### 5. Washington

T. Jagielo noted that most groundfish research in Washington is focused on Puget Sound.

#### 6. Oregon

S. Parker commented that Oregon has launched a process to develop a new nearshore management strategy. This is being conducted with a federal grant to develop management plans for exploited species statewide. Public consultation is ongoing to prioritize species and areas and consider approaches. Consultation will be completed this summer with a proposed strategy and fishery plan finished in the fall. The State is assuming responsibility for habitat mapping, developing survey

techniques and general research, including monitoring sports and commercial landings data, for all nearshore fish species.

The trawl vessel buyout has been completed. The final impact is yet to be determined. There has been a shift in effort into the other fisheries. There is no estimate of how many people have actually left the fisheries. Scientific impact includes a reduced opportunity for sampling. Four vessels were donated to Oregon State University. Some catch histories were "bought out" with the vessels.

### 7. NWFSC

M. Schirripa commented on the change in stock assessment scheduling. Rather than one-half of the species every year, they have adopted an on-year/off-year assessment program. This has created a very busy year. They are having trouble finding reviewers. Most assessments are using Stock Synthesis Two (SSII), which now has capability for a full Bayesian approach. The template is available to anyone.

### 8. SWFSC

J. Field noted that the SWFSC is conducting six to seven assessments this round. At least three species may be "overfished" and are being assessed for the first time.

## *B. Multispecies Studies*

### 1. AFSC

M. Wilkins noted that they are going to start a mesopelagic index for the North Pacific during the annual return of the NOAA Freeman from Alaska. Now that the Oscar Dyson is coming online, it frees up some vessel days. They will conduct a pilot survey at the end of August. The plan is for a MOC net, fitted to a towed body, to conduct trawls at 250, 500, and 1000m although there is concern that the net will not be ready.

### 2. Oregon

S. Parker noted that Oregon has spent three to four years developing a selective flatfish trawl. It was implemented last year. The shelf flatfish fishery is now no longer constrained by rockfish bycatch. It also does not catch hake. Most of the semi-pelagic/demersal rockfish tend to escape except for darkblotched, rosethorn and greenstripe rockfish. The net does not do well below the scattering layer, or in deeper waters. In the dark, the fish tend to have more erratic responses, and thus be caught in the trawl.

S. Parker commented that he just returned from a NWFSC cruise. Using a bycatch reduction grant, Didson technology was used on a bottom trawl to observe fish behavior in the dark with promising results from 10 tows.

Oregon has been conducting a lot of work on barotrauma in rockfishes with reasonable success. Recompression seems to work. They built a cage with a video camera on one end. Black rockfish caught at 60-80m were brought to surface, then lowered and released from the cage at 80-90 feet, and filmed. Even when "blown-out" yelloweye rockfish seem to recover when recompressed.

### 3. SWFSC

J. Field noted that there have been discussions in the Multispecies Ecosystem Modeling group on the management of kill. They are considering the impacts of placing moratorium on the developing krill fisheries.

## *C. By Species (items mentioned for emphasis or were not included in the reports)*

### 1. Nearshore Rockfish

***Canada*:** L. Yamanaka noted that the Inshore Rockfish Group placed an observer on the IPHC setline survey and conducted a jig survey/longline survey in the Strait of Georgia. They attempted a submersible survey but were unsuccessful due to labor issues within DFO. They plan to try again in 2005. This survey will include staff from WDFG, ADFG, NMFS, University of Southern Florida, Parks Canada and the Pacific GeoScience Center (to do bottom profiling). In addition to rockfish enumeration, the project will try to delineate better habitat maps. Parks Canada will investigate flooded river valleys for evidence of civilization. Video footage will be used to ground truth multibeam classification.

COSEWIC (Committee on the Status of Endangered Species in Canada) has asked for status report on quillback, yelloweye, canary, and rougheye rockfish, and longspine thornyheads. DFO staff will be the principal authors of these papers. They are due in early September 2005.

***Oregon*:** S. Parker summarized a project, which looked at home range and use of space in black rockfish off the coast of Newport. The project was successful. It examined 18 square km of ocean covered with an ultrasonic receiver grid. Forty fish were tagged with transmitters, providing depth and position. Transmitters lasted about eight months.

***SWFSC***: J. Field noted that the cowcod submersible work underwent extensive review. Recent work suggested that there are two to three times as many cowcod in the conservation areas as indicated in earlier research. The State of California has moved to a new recreational data-collection system. The new system indicates lower estimates of recreational landing, so it is popular with the recreational fisheries. However, they are investigating weaknesses in the new system.

### 2. Shelf Rockfish

***Alaska***: E. Coonradt noted that the sport harvest of demersal shelf rockfish was included in the assessment this year. The recreational estimates of catch exceeded those for the commercial fishery (yelloweye, quillback, canary, china, and rosethorn rockfish). The numbers were based on landings, not estimates of "other" catch. It is likely that the discard mortality from recreational fishing is much higher.

***Canada***: R. Stanley commented that the decision as to whether to accept the "Threatened" designation for bocaccio is under review by the Ministers of Fisheries and Environment. Voluntary avoidance of trawlers has decreased catch by about two-thirds in the trawl fishery.

***NWFSC***: M. Schirripa reported that canary rockfish ageing is being examined with bomb radiocarbon methodology. It was not successful with darkblotched rockfish. It is joint work with the Moss Landing Marine Laboratory. The ageing symposium in Australia was 90 percent microchemistry papers.

***SWFSC***: J. Field reported that current projects at the center include an examination of shortbelly rockfish larval production. They are considering similar work on bocaccio in the Southern California Bight.

***Coffee 2:30-2:45 pm.***

**3. Slope Rockfish**

***Alaska***: E. Coonradt noted that the directed fishery for slope rockfish was closed years ago. It is now by-catch only.

***AFSC***: D. Clausen reported that Tony Gharrett just published a paper showing that there are two species of rougheye rockfish that are genetically distinct. Funding will be provided this year for Kitty Mecklenburg to look at morphological characteristics of the two reputed species. Genetic research is showing stock structure among Pacific Ocean perch in Alaska. Two cruises with the Delta submersible are planned to look at slope rockfish habitat and catchability of Pacific Ocean perch (trawl abundance vs. visual abundance). The center also plans to extend Steve Berkley's work on maternal effects on rockfish larval survival . For three or four years, opportunistic acoustic data has been collected survey charter vessels. A working group within the Center has been formed to standardize the way acoustic data is collected, calibrated, analyzed, and archived in a single center-owned database.

***Canada*:** R. Stanley commented that a high Canadian dollar and rising fuel prices have reduced the fishing pressure on thornyhead fishing in Canada.

***Oregon***: S. Parker noted in their maturity work on Pacific Ocean perch, that they have an extended adolescent phase where individuals abort the maturation process. This is an age effect and the proportion of its incidence reduces to zero by about age 18.

***NWFSC***: M. Schirripa commented that Center is conducting assessments for sablefish, Dover sole and both thornyheads species.

**4. Sablefish**

***Alaska***: E. Coonradt reported that PIT-tagging of sablefish in SE. Alaska has had mixed results. The sablefish successfully held the tags in their cheeks, however, many tags were not successfully recovered in the shore plants due to the "noise" level within the plant environment.

***AFSC***: D. Clausen reported that AFSC (Auke Bay) plans to update the sablefish migration model. Tory O'Connell (ADFG) will provide the ADFG data for the model. Organizers hope that Canadian tagging data can be incorporated into the model. Mike Sigler (AFSC) is the contact for that project.

***Canada***: L. Yamanaka reported that Bowie Seamount might soon be designated a Marine Protected Area, which would affect the sablefish commercial fishery. R. Kronlund asked U.S. representatives if there were issues with mercury levels in sablefish in the U.S. D. Clausen did not know of any reported problems. M. Schirripa enquired about sablefish aquaculture in Canada. R. Kronlund commented that sablefish aquaculture is still in its infancy in Canada. R. Stanley commented that there does not appear to be any lessening of DFO's role in aquaculture. There are an increasing number of inquiries by managers into the impact of aquaculture on wild groundfish populations.

## 5. Flatfish

***Canada***: L. Yamanaka reported that there is no flatfish research program planned for 2004 although a southern rock sole assessment is planned for the fall of 2005. Two new supertrawlers (40m and 65m) have been brought to B.C. from Europe. They plan to fish (and process) hake and Arrowtooth flounder for growing markets in China.

**NWFS*C*:** M. Schirripa reported that the Center is conducting an English sole mark recapture project. English sole, petrale sole, and starry flounder assessments were just completed. English and petrale sole assessments look favorable.

***SWFSC***: J. Field reported that the Center has completed a starry flounder assessment. Run-off from the Sacramento River appears to have a strong influence on starry flounder abundance.

## 6. Lingcod

***Canada*:** L. Yamanaka reported that a management framework model has been developed for Strait of Georgia lingcod. Bill de la Mare (Simon Fraser University) developed the formal model. It will be reviewed at PSARC in May 2005.

## 7. Pacific Whiting

***Canada***: L. Yamanaka commented that Steve Martel of the University of British Columbia is participating in the assessment. The hake research program in Canada is currently unfunded.

***NWFSC***: M. Schirripa reported that the joint hake survey between Canada and U.S. will be conducted again this year, as it was last year. Stomach collections will be performed this year. A manuscript on growth increments in hake otoliths related to environmental parameters will be published shortly.

## 8. Walleye Pollock

***AFSC*:** M. Wilkins reported that a light meter has been placed on survey nets to investigate how light intensity might affect the vertical distribution and hence its vulnerability fishing gear.

## 9. Dogfish and Skate

***AFSC***: D. Clausen reported that Gerry Hoff's PhD is looking at skate nursery areas in the Bering Sea and the Gulf of Alaska. He is trying to characterize these areas by species.

***Alaska*:** E. Coonradt commented that: Dean Courtenay and Vince Galluci are attempting to develop a stock assessment for sharks in Alaska. Dogfish spines have been requested and Cindy Trabuzio will be working on the ageing technique and reproductive biology for sharks. There has been some local tagging of pacific sleeper sharks just off the Auke Bay Lab.

***Canada*:** L. Yamanaka reported that a COSEWIC status report on elasmobranches is being completed under contract with DFO support. Ongoing work includes aging and tagging of big skates, and a longline survey for dogfish.

***NWFSC***: M. Schirripa commented that Josie Thompson (Age Growth and Maturity for the Longnose Skate) will be defending her thesis in about three or four weeks, and this information may be useful for stock assessment purposes. They are putting observers on dogfish boats to collect age samples.

## 10. Pacific Mackerel and Sardines

TSC decided to exclude mackerel and sardines issues from the meeting.

## 11. Other Species

***North Pacific Fisheries Management Council***: J. DiCosimo reported that the "Other species" in previous North Pacific management plans included sharks, skates, squids, sculpins and octopi. These were historically caught as by-catch only. Starting next year, TACs will be set for these species by area.

***AFSC***: D. Clausen reported that the Center tried to do an assessment on grenadiers in Alaska last year. There is a small new target fishery for giant grenadier off Kodiak Island ($0.09/lb for grenadier surimi). Estimated by-catch of giant grenadier is actually higher than the annual catch of sablefish.

## 12. Other Related Studies

***Surveys*:** R. Stanley summarized the groundfish-related surveys on the B.C. coast. These include biennial bottom trawl surveys (Hecate Strait, Queen Charlotte Sound, and West Coast of Vancouver Island), an annual sablefish trap survey, annual shrimp trawl surveys, annual offshore and biennial inshore hake acoustic surveys, the annual IPHC longline survey, a prototype inshore rockfish longline survey, Strait of Georgia hook-and-line survey for lingcod, a Strait of Georgia lingcod larval survey, and the Strait of Georgia lingcod YOY trawl survey. We are also developing a survey simulator to estimate survey precision and evaluate a survey's ability to track population abundance trends over time.

## 13. Other Items

***Role of TSC:*** S. Phillips noted that since the TSC was first formed, several things have changed (20- mile limit, Magnuson Act, etc.). Perhaps the role for TSC is task-based like supporting CARE, initiating survey workshops and symposia, and coordinating the sharing of survey information. These could be conducted in association with the WGC, but the agenda for that conference is too full. R. Stanley suggested that holding the TSC meeting in a more central location may be a way of increasing participation and reducing travel costs – perhaps Seattle. S. Parker emphasized that release of the minutes and annual reports should be more timely. This

would allow participants to summarize information for colleagues. M. Schirripa emphasized that the TSC should continue to be apolitical. R. Stanley suggested that the TSC should draft a one to two-page executive summary, which highlights the major topics and initiatives covered at the meeting. This could be given to everyone's supervisor within two/three weeks and then posted on the website. This idea was accepted and Rick (as Chair) offered to draft the summary.

***TSC Funding*:** M. Schirripa suggested that the TSC help fund workshops and symposiums, in addition to suggesting that they occur. S. Parker suggested looking into the Sea Grant funding. S. Phillips suggested looking into sport fish restoration funds. The TSC concluded that:

- The structure of the meeting will not change.
- The TSC should make better attempts to market/advertise itself.
- The TSC should focus on task-based items such as encouraging workshops and symposia and focus on the international coordination of projects. L. Yamanaka mentioned the importance of this especially with respect to the Species-at-Risk reports now being required.
- The TSC should meet on the same time frame.
- The TSC should use the same political structure.

## XI. Progress on 2004 Recommendations

### *A. From TSC to Itself*

1. TSC acknowledges notification by CARE of the differences observed when comparing ADFG Pollock ageing results to those of AFSC. TSC was advised by CARE that attempts to reconcile the differences in criteria were not successful at the 2004 meeting. TSC notes that resolution of the ageing discrepancies, if needed, will require direct focus by Pollock assessment staff.

   *No action required.*

2. No corrections were noted for the 2004 report.

### *B. TSC to Parent Committee*

1. The TSC notes that researchers at Moss Landing Marine Laboratories (MLML) conduct significant age validation work. Given the multinational and multi-agency membership and purpose of CARE, it would be beneficial to have a MLML representative as a regular member of CARE. The TSC requests that the Parent Committee write a letter to Dr. Gregor Cailliet at MLML explaining the history of CARE, the importance of MLML participation, and encourage regular attendance by MLML at the biennial CARE meeting.

   *MLML was invited and has accepted to be a participant in CARE.*

2. The TSC recommends that the Parent Committee support and endorse the continued effort toward planning the Third International Sablefish Symposium as discussed at the 2004 TSC meeting. Dr. Michael Schirripa is the Chair of working group. A letter of support

from the Parent Committee directed to the NWFSC/FRAM Division Chief (Dr. Elizabeth Clarke) could help facilitate this effort.

*This letter was drafted and sent. The symposium is planned for early 2006.*

3. TSC notes the ongoing annual inter-agency meetings, as well as data and information exchange, related to the design, execution, and analysis of bottom trawl surveys. TSC recommends the creation of a trans-boundary bottom trawl survey working group, to include representatives of the NMFS groups at the NWFSC and AFSC, and DFO, as well as any other interested party.

*This group has been for three consecutive years and is planning to meet in February 2006.*

4. The TSC discussed the request from CARE to support interim travel to hands-on-only, species-specific workshops between regularly scheduled biennial meetings. The TSC requests the Parent Committee consider seeking funds to accommodate this request.

*TSC was not able to obtain external funding for these meetings.*

### *C. TSC to CARE*

1. In response to CARE's request for guidance on the content of their "Summary of Age Structure Exchanges" table (refer to http://care.psmfc.org/structtable.htm ), the TSC recommends eliminating the summary statistics and adding hyperlinks to any reports pertinent to the exchange. The TSC also supports the CARE representative's suggestion of standardizing the format of age structure exchange reports.

*No action required.*

## XII. 2005 Recommendations

### *A. TSC to Parent Committee*

1. The TSC recommends to the Parent Committee that CARE consider annual ageing workshops on different species of concern on a rotational basis, modeled after the current annual Dover sole workshop held in Eureka, California. The objective of this recommendation is to disperse the "hands on" workshop effort over a wider range of species and to maintain inter-lab calibration on ages that are shared for stock assessments. It was estimated that a maximum of six scientists could be accommodated for an ageing lab exchange for two to three days.

***ACTION:*** *If accepted by theParent Committee, Tom Jagielo will carry this forward to the PFMC and NPFMC SSC to obtain a list of candidate species for this process. Rick Stanley will do the same with respect to PSARC. Michael Schirripa will present the recommendation to the CARE committee.*

## *B. TSC to Itself*

1. The TSC notes the resources required and the complexities of field data acquisition. These activities could be much improved through increased use of new and evolving technologies. The TSC recommends that the Parent Committee support the creation of a workshop on electronic data acquisition and database integration in the marine environment.

   Workshop topics could include:
   - Data collection technologies in use;
   - Evaluation of existing or other appropriate technologies concerning durability, ease of use, expansion capability, programming capabilities etc.;
   - How data collected with these technologies are integrated with existing data sets.

   ***ACTION:*** *Mark Wilkins will organize a steering committee to develop the workshop.*

2. The TSC notes that habitat research is being conducted by many agencies to support groundfish management as well as stock assessments. Developments in geographical information systems (GIS) have aided much of this research. The TSC recommends that a workshop be convened to present and discuss agency investigations into habitat assessment, the application of GIS tools and the incorporation of habitat information into stock assessments.

   ***ACTION:*** *Lynne Yamanaka will contact agencies and determine interest in the workshop and participation on a steering committee*

3. R. Stanley was appointed the 2005/2006 TSC Chair.

4. The next meeting will be held in Newport, Oregon.on May 2-3, 2006.

***The meeting was adjourned at 9:47am, May 4, 2005.***

# D. Parent Committee Minutes

## Forty-Seventh Annual Meeting of the Canada-US. Groundfish Committee

**(aka "Parent Committee")**

## I. Call to Order

Chair Diana Trager, DFO Canada, the Canadian representative, called the meeting to order at 12:25 pm, Wednesday, May 4, 2005. Mr. Stephen Phillips, PSMFC, represented the U.S. (for Randy Fisher, PSMFC). Also in attendance were Tom Jagielo (WDFW), Mark Wilkins (NMFS, AFSC Seattle), Dave Clausen (NMFS, AFSC, Auke Bay Lab), and Rick Stanley (DFO, Nanaimo, 2005 TSC Chair).

**II**. Stephen Phillips was appointed secretary for the meeting.

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

## IV. Adoption of May 2004 Parent Committee meeting minutes

The minutes were adopted as presented.

## V. Progress on 2004 Recommendations from TSC to Parent Committee

A. The TSC requested that the Parent Committee write a letter to Dr. Gregor Cailliet at MLML explaining the history of CARE, the importance of MLML participation, and encourage regular attendance by MLML at the biennial CARE meeting.
Status: *Completed.*

B. The TSC recommended that the Parent Committee support and endorse the continued effort towards planning the Third International Sablefish Symposium as discussed at the 2004 TSC meeting. Dr. Michael Schirripa is the working group chair of this effort. A letter of support from the Parent Committee directed to the NWFSC/FRAM Division Chief (Dr. Elizabeth Clarke) could help facilitate this effort.
Status: *Done, meeting progressing, Michael Schirripa lead.*

C. The TSC noted the ongoing annual inter-agency meetings, as well as data and information exchange, related to the design, execution, and analysis of bottom trawl surveys. The TSC recommended the creation of a trans-boundary bottom trawl survey working group, to include representatives of the NMFS groups at the NWFSC and AFSC, and DFO, as well as any other interested party.
Status: *This group has been meetings for three consecutive years and is planning to meet in February 2006. Participants have agreed that they should meet annually.*

## VI. Progress on 2004 Recommendations from Parent Committee to TSC

*None made***.**

## VII. Progress on 2004 Recommendations from Parent Committee to Itself

*None made.*

## VIII. 2005 Recommendations from the Parent Committee to the TSC

A. The TSC recommended to the Parent Committee that CARE consider annual ageing workshops on different species of concern on a rotational basis, modeled after the current annual Dover sole workshop held in Eureka, California. The objective of this recommendation is to disperse the "hands on" workshop effort over a wider range of species and to maintain inter-lab calibration on ages that are shared for stock assessments. It was estimated that a maximum of six scientists could be accommodated for an ageing lab exchange for two to three days.
Status**:** The Parent Committee concurs, and directs Tom Jagielo to carry this forward to the PFMC and NPFMC SSC to obtain a list of candidate species for this process. Rick Stanley will do the same with respect to PSARC. Michael Schirripa will present the recommendation to the CARE committee.

B. The Parent Committee recognizes the effort in the past year conducted by Michael Schirripa in the planning the Third International Sablefish Symposium, to be held in January 2007, tentatively in Seattle.
Status: The Parent Committee notes the importance of this conference.

## IX. Other Business

A. The Parent Committee thanks Rick Stanley for hosting and chairing this year's meeting, and Jonathan Martin and Janet Lochead recording minutes.

B. The Parent Committee thanks Lynn Yamanaka for hosting a dinner at her residence.

## X. Meeting Location

Steve Parker and Michael Schirripa will arrange the 2006 meeting, which will be held at Newport, Oregon on May 2-3.

**XI.** There being no further business, the meeting was adjourned at 1:00 pm.

# E. Agency Reports

**Report of the Technical Sub-Committee**
**of the**
**Canada-United States**
**Groundfish Committee**

**Agency Reports**

## Agency Reports

ALASKA FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE
FISHERIES AND OCEANS, CANADA
COMMITTEE OF AGE READING EXPERTS (CARE)
INTERNATIONAL PACIFIC HALIBUT COMMISSION (IPHC)
NORTHWEST FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE
SOUTHWEST FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE
STATE OF ALASKA – ALASKA DEPARTMENT OF FISH AND GAME
STATE OF OREGON – DEPARTMENT OF FISH AND GAME
STATE OF WASHINGTON – DEPARTMENT OF FISH ANDWILDLIFE

# Alaska Fisheries Science Center

# of the

# National Marine Fisheries Service

2005 Agency Report
to the
Technical Subcommittee
of the
Canada-US Groundfish Committee

May 2005

Compiled by
Mark Wilkins, Tom Wilderbuer, and David Clausen

# REVIEW OF AGENCY GROUNDFISH RESEARCH, ASSESSMENTS, AND MANAGEMENT IN 2004

## 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, and the Auke Bay Laboratory (ABL). The RACE and REFM Divisions are divided along regional or disciplinary lines into a number of tasks and subtasks. A change that is currently in transition is the conversion of the North Pacific Observer Program from a program within the REFM Division into a Division of its own. 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 three units are included as Appendices II, III, and IV.

### RACE DIVISION

In 2004, the primary activity of the Resource Assessment and Conservation Engineering (RACE) Division continued to be fishery-independent stock assessment surveys of important groundfish species of the northeast Pacific Ocean and Bering Sea. Regularly scheduled bottom trawl surveys in Alaskan waters include an annual survey of the crab and groundfish resources of the eastern Bering Sea shelf and biennial surveys of the Gulf of Alaska (odd years) and the Aleutian Islands and the upper continental slope of the eastern Bering Sea (even years).

Three major bottom trawl surveys of groundfish resources were conducted during the summer of 2004 by RACE Groundfish Assessment Program (GAP) scientists on the eastern Bering Sea shelf and upper slope and on the shelf in the Aleutian Islands. RACE scientists of the Habitat Research Team (HRT) also continued Groundfish habitat-related research.

The Midwater Assessment and Conservation Engineering (MACE) Program conducted echo integration-trawl (EIT) surveys of midwater pollock abundance in the Shelikof Strait and areas south and east of Kodiak Island in March and on the U.S. and Russian Bering Sea shelf during June and July of 2004. MACE scientists also continued research on how commercial fishing operations affect the distributional patterns of pollock.

The AFSC's new research vessel, the NOAA ship *Oscar Dyson*, arrived in Seattle on March 5 and is in the process of final fitting out. Sea trials will begin May 4 and it will depart for its homeport in Kodiak on May 19. Commissioning is set for May 28 and it will depart June 1 to begin its first mission – an EIT survey of the Gulf of Alaska. Intervessel calibrations are being planned between the *Dyson* and the *Miller Freeman*.

Several GAP scientists have retired this year. Harold (Skip) Zenger and Gary Walters have hung it up, and Eric Brown and Terry Sample are scheduled to leave around June 1. Dan Nichol is the acting team leader of the Eastern Bering Sea Team following Walters' retirement.

For more information on overall RACE Division programs, contact Division Director Dr. Gary Stauffer at (206)526-4170.

## REFM DIVISION

The research and activities of the Resource Ecology and Fisheries Management Division (REFM) are designed to respond to the needs of the National Marine Fisheries Service regarding the conservation and management of fishery resources within the US 200-mile Exclusive Economic Zone (EEZ) of the northeast Pacific Ocean and Bering Sea. Specifically, REFM's activities are organized under the Observer Program and the following tasks: Age and Growth Studies, Socioeconomic Assessments, Resource Ecology and Ecosystem Management, and Status of Stocks and Multispecies Assessment. (As mentioned in the Agency Overview section, the Observer Program is in the process of being converted to a Division of its own.) Scientists at AFSC assist in preparation of stock assessment documents for groundfish in the two management regions of Alaska (Bering Sea/Aleutian Islands and Gulf of Alaska, conduct research to improve the precision of these assessments, and provide management support through membership in regional groundfish management teams.

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

## AUKE BAY LABORATORY

The Auke Bay Laboratory (ABL), located in Juneau, Alaska, is a division of the NMFS Alaska Fisheries Science Center (AFSC). ABL's Groundfish Assessment Program is primarily involved with research and assessment of sablefish and rockfish in Alaska and with the study of fishing effects on the benthic habitat. In recent years, the Groundfish Program has also conducted research to study the interaction between Steller sea lions and prey/predators in Alaska. Presently, the program is staffed by 15 scientists, including 14 permanent employees and 1 term employee. Three previous members of the program staff left in 2004: Linc Freese retired, Patrick Malecha transferred to another program at ABL, and Leland Hulburt took a position with the state of Alaska. One addition to the program in 2004 was Dr. Kalei Shotwell, who was hired to work on groundfish habitat, especially rockfish. Four employees in other ABL programs have also been involved with research on groundfish in recent years.

In 2004, field and laboratory research, ABL's Groundfish Program, in cooperation with the AFSC's RACE Division, conducted the annual NMFS sablefish longline survey in Alaska. Other field and laboratory work by ABL included 1) continuation of a study that used a manned submersible and a remotely operated vehicle (ROV) to investigate distribution of deep-water corals in the Aleutian Islands; 2) a series of cruises in southeast Alaska to test the hypothesis

that sea lion prey diversity and seasonality are related to Steller sea lion population trends; 3) scuba diving studies of coral species in southeast Alaska to determine growth rates and effects of fishing on these taxa in Alaska; 4) continued juvenile sablefish studies, including routine tagging of juveniles and a special sonic tagging study of these fish; 5) a genetics study to determine species identification and stock structure of young-of-the-year rockfish from offshore waters of the Gulf of Alaska and eastern Bering Sea; 6) a tagging study of Pacific sleeper sharks in southeast Alaska; 7) a new study of spiny dogfish near Yakutat, Alaska, to collect information on movements and biology; 8) an additional new study that used an ROV to observe juvenile rockfish and their habitat near Sitka, Alaska; and 9) continuing habitat studies of groundfish in nearshore and estuarine areas of southeast Alaska.

Ongoing analytic activities involved management of ABL's sablefish tag database, analysis of sablefish logbook and observer data to determine fishery catch rates, and preparation of five annual status of stocks documents for Alaska groundfish: sablefish, Pacific ocean perch, northern rockfish, shortraker/rougheye rockfish and other slope rockfish, and pelagic shelf rockfish. Other analytic activities during the past year were: 1) an investigation of the performance of age-structured models for species that have high survey measurement errors, which used Gulf of Alaska Pacific ocean perch as a case example; 2) an analysis of shark bycatch in the Alaska groundfishery; 3) development of habitat maps for several important fishing grounds in the Gulf of Alaska; and 4) an analysis of data on grenadiers in Alaska to provide a synopsis of biological, fishery, and survey information for these fish. In addition, Groundfish Program staff spent considerable time working on analyses for the final draft of the Environmental Impact Statement (EIS) for essential fish habitat in Alaska.

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

## B. Multispecies Studies

### *1. Research*

**Bering Sea Crab/Groundfish Bottom Trawl Survey - RACE**

The annual crab-groundfish demersal trawl survey of the eastern Bering Sea shelf was conducted from June 1- July 25, 2004. A total of 403 stations were successfully sampled, covering nearly 500,000 $km^2$ from inner Bristol Bay to the shelf edge and from Unimak Pass to 62° N near St. Matthew Island. The chartered vessels F/V Aldebaran and F/V Arcturus were used for the 12th consecutive year. This also marked the 23rd survey of the 'standard' time series of consistent area, gear, and general sampling protocol.

Biomass estimates for major species indicated relatively little change from 2003, except for walleye pollock. Survey biomass estimates of walleye pollock, which showed a dramatic increase of 5 million to 8.5 million tons from 2002 to 2003, declined to 3.9 million tons in 2004.

The lack of winter ice cover in the eastern Bering Sea again contributed to a relatively high average bottom temperature of 3.4 °C.

Nineteen additional stations were sampled in inner Bristol Bay and along the Alaska Peninsula to continue our look at improving yellowfin sole biomass estimates. After the standard survey, one vessel proceeded to the area north of St. Mathew Island to collect biological information on opilio Tanner crab, butterfly sculpin, and marbled eelpout, species whose distributions may be shifting north due to warmer conditions. The other vessel conducted some exploratory work near the Pribilof Islands to determine whether measurable avoidance behaviors exist for walleye pollock in response to the vessel and/or bottom trawl.

For further information, contact Dan Nichol, (206) 526-4538.

**Aleutian Islands Biennial Groundfish Bottom Trawl Survey - RACE**

The third in the series of biennial bottom trawl surveys of Aleutian Islands region (AI) groundfish resources was conducted from June 1 through August 9, 2004. The full series of periodic AI surveys dates back to 1980 and, prior to establishing a biennial schedule in 2000, had been done on a triennial schedule. The primary objective of the survey is to provide a standardized time series of data to assess, describe, and monitor the distribution, abundance, and biological condition of Aleutian groundfish and invertebrate stocks. Secondary objectives are to collect environmental data and to collect biological specimens and data requested by scientists from the AFSC or other cooperating research groups.

The 70-day 2004 AI triennial survey area stretches over 900 nmi from the Islands of Four Mountains (170° W long.) to Stalemate Bank (170° E long.), including stations on Petrel Bank. In addition, the region between 165° and 170° W long. along the north side of the archipelago is included as the Southern Bering Sea subarea. Sampling was conducted aboard two chartered commercial trawlers, the *Sea Storm*, and the *Gladiator*. Of the 471 attempted standard survey

tows, 420 were successfully completed, ranging in depth from 26 m to 488 m.

Over the total survey area, the most abundant species in 2004 were, in order, Atka mackerel, Pacific ocean perch, walleye pollock, giant grenadier, northern rockfish, Pacific cod, and arrowtooth flounder. Increases in survey-wide estimated biomass since 2002 were observed for all of these species: Atka mackerel by 39% to 1,154,000 t, Pacific ocean perch by 24% to 579,000 t, pollock by 3% to 366,000 t, giant grenadier by 14% to 248,000 t, northern rockfish by 9% to 192,000 t, cod by 38% to 114,000 t, and arrowtooth flounder by 7% to 95,000 t. Results have been supplied to stock assessment authors for updating assessment reports for the North Pacific Fisheries Management Council.

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

**The Visual System of Northeast Pacific fishes: Its Importance in Survival and Recruitment**

This research project is designed to broaden our understanding of the physiological and behavioral functions of the visual system in Northeast Pacific fishes, particularly during the early life stages. Over the past three years, we have demonstrated in our lab that a variety of local marine fishes have extended visual sensitivity at very short wavelength during the larval stages of development. Behavioral experiments on the larvae of three of these species have demonstrated that these larvae have the visual capacity to feed effectively on zooplankton when illuminated with exclusively UV-A light. Additionally, many of the species investigated to date have shown an ontogenetic shift in spectral sensitivity from the larval to juvenile and adult stages. Therefore, what are the significance of short-wavelength vision in fish larvae and these visual shifts? In addition, when do these shifts occur in larvae that assume different life history strategies with ontogeny?

We are currently pursuing answers to these questions by emphasizing detailed studies into the visual sensitivity of marine fishes by using microspectrophotometric, histological, and behavioral study techniques. In order to build a visual ecology matrix for the region, seven groups/guilds of Northeast Pacific fishes that have recreational, commercial, and ecological significance are being studied. Investigations are focusing on visual system changes from the early larval to late larval stages of development and comparing these results to the visual systems of juveniles and adults for each group. The groups include: (1) greenlings, (2) rockfishes, (3) sculpins, (4) cods, (5) flatfishes, (6) forage fishes, and (7) wrymouths. A total of 52 different species are being used in this study.

For further information, please contact Lyle Britt, (206) 526-4501.

**Groundfish Systematics Program - RACE**

Several projects on the systematics of fishes of the North Pacific have been completed or were underway during 2004. The systematics of the dusky rockfish complex with the recognition of two species, *Sebastes variabilis* and *S. ciliatus*, was published (Orr and Blackburn, 2004), and research is continuing into the systematics of the rougheye rockfish complex (Orr and S. Hawkins).

Systematic research on skates, a collaboration of Orr, D. E. Stevenson, G. R. Hoff, and J. D. McEachran (Texas A&M University), has resulted in the description of a new species from the Aleutian Islands (Stevenson et al., 2004), a field guide to the skates of Alaska (Stevenson et al., draft), new skate records for Alaska (Stevenson and Orr, in press), and documentation of Fishery Observer progress in the identification of skates (as well as smelts and sculpins; Stevenson 2004). The description of a second new species from the Aleutian Islands is being prepared (Orr et al. 2004). Skate research is summarized in the 2005 AFSC Quarterly Report for Jan-Mar (Stevenson and Orr, 2005).

The new snailfish genus and species *Lopholiparis flerxi* was described (Orr, 2004), and a publication on new records of a snaifish and cuskeel from Alaska is in press (Orr et al., in press). A taxonomic revision of the snailfish genus *Allocareproctus* has been completed that includes the descriptions of four new species (Orr and M. S. Busby, in review), as well as a note on the reproduction of one of the new species (Busby, Orr, and D. M. Blood, in review). The description of two new species of *Careproctus* snailfishes is in preparation (Orr and K. P. Maslenikov, 2004) as well as a note describing underwater observations of *Careproctus* species (Reuter and Orr, 2004).

A taxonomic revision of the ronquil family Bathymasteridae is in press (Stevenson and Matarese, in press). Descriptions of new species of the eelpout genera *Bothrocara* and *Lycodes* have been submitted for publication (Stevenson and Anderson, in review; Stevenson and Orr, in review) and a revision of the genus *Bothrocara* is underway (Anderson, Stevenson, and G. Shinohara). The phylogenetics of *Hemilepidotus* sculpins is also being examined (Bass et al., 2004). Selected invertebrates are the subject of the research of Elaina Jorgensen, who is preparing a review and guide to the cephalopods of Alaska.

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

**Recruitment Processes**
*No report this year.*

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

**Fisheries Behavioral Ecology Program - RACE**

The Fisheries Behavioral Ecology Program conducts experimental research designed to understand the role that behavior plays in regulating distribution, abundance growth, and survival of fish species and their interactions with fishing methods and gear. The goal of the Program is to provide the critical information needed to improve survey techniques, to improve predictions of population abundance and survival, and to conserve populations of economically significant marine resource species and their habitats. Research conducted during 2004 continued under long-term research themes related to bycatch stress and basic studies in fish ecology relevant to the performance of fishing gear, definition of essential habitat, and recruitment processes.

***Experimental Bycatch Studies*** – Bycatch studies in the Fisheries Behavioral Ecology Program fall into two main categories: 1) the fate of fish which are discarded after their arrival on the deck, and 2) the fate of fish which escape trawl gear at depth through cod-end meshes. In studies related to discards, an attempt has been made to understand the key principles which control mortality; integrating analysis of injury, behavior and plasma constituents with observed mortality. Recent laboratory experiments conducted with sablefish and Pacific halibut have shown that capture and environmental stressors interact to produce physical injury, behavior impairment and mortality. Mortality can be immediate or delayed, resulting from infection and behavior impairment. High incidence of mortality in smaller fish indicates that the practice of highgrading in fisheries is counter-productive for stocks and should be restricted.

The magnitude of behavior impairment in discards and escapees was correlated with stressor intensity and was a good predictor of delayed mortality in fish that had sustained physical injury from capture. Fish with capture-induced behavior impairment are also probably more susceptible to predation after release and this is an additional source of delayed mortality that is not normally measured in field studies. Few methods are available for predicting delayed mortality in the field. Present research is concerned with developing field methods for quantifying delayed mortality based on measures of fish injury and behavior impairment that can be employed on fishing vessels.

***Performance of Fishing Gear*** –Capture of fish with baited fishing gear (e.g., longlines and traps) for both prosecution of a fishery and stock assessment depends upon feeding motivation, movement patterns, and sensory capabilities in the target species as well as the design of hooks, fish pots, and other gear. Several new papers were published in 2004 showing that environmental variables affect the catchability of fishery species on baited gear. One of these was a review article on fish feeding ecology which revealed that water temperature, light level, current velocity, and prey density are likely to have the most significant impacts on fish catchability and stock assessments. Experimental studies conducted in Newport showed that capture rates for Pacific halibut will be density-dependent in a non-linear function because of social facilitation in feeding motivation. Experiments are currently underway to test the effects of temperature on responsiveness to baits in halibut. Population sizes based upon baited gear surveys can be greatly underestimated in conditions where environmental variables reduce feeding motivation and/or locomotion.

High-frequency imaging sonar (DIDSON), sometimes called an acoustic camera, can now be used to observe fish behavior instead of traditional video camera systems. Some advantages of acoustic cameras over traditional cameras are that observations can be made in total darkness and the imaging range can be 10 m or greater. In 2004, acoustic and traditional cameras were used to observe the behavior of sablefish and Pacific halibut around fish pots and baited hooks in 400 m depth off the coast of Oregon. The short-term project revealed that the acoustic system is well adapted for observing fish in and around fishing gear and far superior to traditional cameras for improving the selectivity and efficiency of fishing gear.
Efficiency of trawl gear relies upon fish herding in response to the approaching gear. In flatfish trawls, the sweeps stimulate fish to move inward towards the mouth of the trawl, where they subsequently tire and fall back into the meshes. However, this herding response may rely upon fish being able to see and respond to the approaching gear. Recent laboratory studies

demonstrate that three flatfish species, northern rock sole, Pacific halibut and English sole, show differing behavioral responses to simulated trawl ground gear in the light vs dark. When fish can see the approaching gear, they lift off the bottom, but remain close to the bottom, and herd in advance of the approaching sweep. In darkness, the fish are more often struck by the gear, and when they did respond, typically rose into the water column, letting the gear pass beneath them. This suggests that the sweeps on bottom trawls may be relatively ineffective at stimulating herding behavior in flatfishes at night or at great depth, influencing catch rates. In 2005, these conclusions will be tested in the field using imaging sonar mounted on commercial and research trawls operated under light and dark conditions.

***Habitat Studies*** −A three-year field survey for juvenile flatfishes was completed in 2004. The surveys were conducted with a towed camera sled integrated with navigation and depth data to provide a spatially-explicit analysis of distribution and habitat association at several spatial scales, from 10's of kilometers to <1 meter. Spatially intensive surveys were conducted in three known nursery areas four times throughout the summer recruitment season. The video records are now being viewed for subsequent analysis using multivariate statistical approaches and GIS interpretation. Preliminary analyses for field data and laboratory experiments show that some juvenile flatfishes are associated with habitat structural complexity provided by shells, sponges, and other emergent biota and bedform structures. These are structures that can be removed or reduced by fishing activities.

During 2003 and 2004, field experiments were conducted to increase habitat complexity by adding shell to bare sand habitat in flatfish nursery grounds near Kodiak. Contrary to predictions, densities of age-0 yr rock sole declined in the enhanced tracts while densities of larger (age-2+ yr) rock sole increased. Subsequent laboratory studies revealed that confirmed that large rock sole demonstrate a stronger preference for emergent structure than age-0 rock sole. Furthermore, age-0 rock sole actively avoid a variety of large flatfish. This combination of field and laboratory experiments demonstrated two important considerations relative to fish habitat preference and definition of essential fish habitat. First, preferences for different types of habitat change with fish size or age. Second, a holistic understanding of habitat requires knowledge not only of fish response to structural components of habitat, but also relative to biotic components, such as the abundance of potential predators.

An Oregon State University (OSU) graduate student supported by the Fisheries Behavioral Ecology Program is conducting an experimental and comparative analysis of anti-predator behavior in three species of juvenile flatfish. It is now clear that behavioral characteristics are adapted to physical conditions present in the typical nursery habitats. For example, juvenile English sole, which occupy highly turbid estuarine nurseries, have greatly diminished anti-predator behaviors compared with Pacific halibut and rock sole which occupy clear coastal waters.

Another OSU graduate student conducted experiments addressing habitat utilization by young-of-year lingcod. Laboratory experiments indicated that newly settled lingcod show only slight preference for structurally complex habitats, such as rock rubble, shell and seagrass. However, preference for structurally complex habitats increases with fish size during the first summer until lingcod spend nearly all of their time in structurally complex refuge habitats. This increased

preference for habitat structure was confirmed in an acoustic tagging study carried out in Yaquina Bay, Oregon.

***Fish Behavior, Foraging and Growth —*** Seawater temperature can have a profound impact on fish growth, energy allocation, and behavior, all of which can affect variation in recruitment to a fishery. During 2004, an experiment was completed examining growth rates of northern rock sole across the range of temperatures likely encountered in the eastern Bering Sea. The results were combined with estimates of growth at three Kodiak nursery sites. Persistent differences in growth rate were observed among the sites that were not solely due to thermal regimes. In addition, there was a late summer decline in realized growth rates at all three sites, suggesting the possibility of prey limitation. Future work will evaluate the temporal stability of site-specific growth patterns observed in 2004.

Laboratory experiments were conducted to examine the effects of light level on the foraging efficiency of age-0 and age-1 northern rock sole. Light levels near $10^{-5}$ µmole photons $m^{-2}s^{-1}$ appear to be the threshold necessary for visual foraging. This threshold is similar to that previously observed in age-1 Pacific halibut. Field collections of northern rock sole were made through two day-night cycles off the Kodiak coast to examine the relationships between feeding periodicity and visual acuity.

Laboratory studies continue examining the effect of temperature on key predator-prey linkages of North Pacific food webs. In 2004, experiments were conducted to test halibut preying on walleye pollock. These studies examine the behavioral response of prey to temperature changes that may affect their vulnerability to predators as well as the capture ability of the predators. Preliminary observations indicate that pollock behavior is much less sensitive to temperature changes between 2 and 9$^{o}$C, compared to that of halibut. As a result, walleye pollock are most vulnerable to attacks from halibut predators at higher temperatures.

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

**Age and Growth Task - REFM**

The Age and Growth Program, of the REFM Division, serves as the Alaska Fisheries Science Center's ageing unit for groundfish species. The program consists of a biometrician, age validation researcher, IT/data specialist, and 11 age readers. Ages are usually determined from otoliths, but scales, finrays and vertebrae are sometimes used.

Data provided by the program are used in stock assessment modeling, which contributes to the estimation of the allowable catch of many commercially important groundfish species. These species include walleye pollock, Pacific cod, sablefish, Pacific Ocean perch, northern and dusky rockfishes, Atka mackerel, yellowfin sole, rock sole, rex sole, and misc. sole and rockfish species.

Research in the Age and Growth Program in 2004 has focused on the following areas:

1. Craig Kastelle is finalizing a draft of a paper on the radiometric age validation of the AFSC's walleye pollock surface/bb ageing method. Partial results on C-14 age validation of Pacific ocean perch is encouraging. Although some outliers exist, the method appears to generally support POP ageing criteria.
2. Charles Hutchinson has completed his MS degree (Dec. 2004) on "Using radioisotopes in the age determination of Shortraker rockfish(*Sebastes borealis*) and Canary rockfish (*Sebastes pinniger*)." The Age and Growth Program is investigating to what extent the otolith sectioning methods developed in this thesis is applicable to production age readings. Rockfishes such as shortraker, and shortspine thornyheads (*Sebastolobus alascanus*) continue to be a challenge to traditional ageing methods.
3. Jake Gregg (a former UW contract employee, now with the USGS) in collaboration with Delsa Anderl has nearly completed a draft manuscript that documents an innovative method of ageing Greenland turbot (*Reinhardtius hippoglossoides*) based on cutting and staining otoliths. This manuscript will soon be submitted for publication.
4. Chris Gburski continues the project of ageing Alaska skates (big skate, longnose skate, Aleutian skate and Bering skate) using vertebrae. We hope to draft a paper based on ages from this project.
5. The Age and Growth Program website has added some new offerings including a database covering the AFSC otolith collections, and a table describing the species currently being aged.
6. The Ageing Program has begun putting together materials that will eventually become an Ageing Manual for the species aged at the AFSC.

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

**Resource Ecology and Ecosystem Modeling - REFM**

Multispecies, foodweb, and ecosystem modeling and research are ongoing. Documents, symposia and workshop presentations, and a detailed program overview are available on the World Wide Web. These can be viewed from the Alaska Fisheries Science Center (AFSC) web site at: **http://www.afsc.noaa.gov/refm/reem/Default.htm**.

***Groundfish stomach sample collection and analysis*** – The Resource Ecology and Ecosystem Modeling Task continued regular collection of food habits information on key fish predators in the North Pacific. Collection of groundfish stomach samples is primarily through the RACE bottom trawl and echo-integration/trawl surveys. Additional samples that broaden our spatial and seasonal coverage are obtained through the Observer Program and through coordinated studies with other agencies.
In 2004, REEM experimented with performing detailed analysis of groundfish stomach contents at sea instead of returning preserved stomach samples to the laboratory for analysis. Personnel participating in the bottom trawl surveys of the Aleutian Islands and upper continental slope of the eastern Bering Sea were equipped with motion compensating scales (that measure to the nearest 0.5g) and other equipment to make this at-sea analysis feasible. The goal was to produce

data that retained the most important detailed aspects of laboratory analysis, such as identification of commercially important prey to the species level, while reducing the costs associated with buckets, chemicals, bags, storage, shipping and laboratory analysis. To accomplish this, the minimum identification standards were adjusted to require less detail, especially for small invertebrates. Prey that weren't identifiable at-sea to the minimum standard were preserved and returned to the laboratory. The reduction in sample size and detail in the data were small relative to the monetary savings. However, detailed stomach content analysis in the laboratory will still be necessary when addressing more complex ecological questions requiring identification of small invertebrate prey to finer taxonomic levels.

In 2004, REEM collected samples during bottom trawl surveys of the Aleutian Islands, Gulf of Alaska, and eastern Bering Sea regions. Observers also collected stomach samples during fishery operations from the eastern Bering Sea. In total, 4,051 stomachs were collected from the eastern Bering Sea, 116 from the Aleutian Islands, and 662 from the Gulf of Alaska. Laboratory analysis was conducted on 14,672 fish stomachs from the Bering Sea and 5,836 fish stomachs from the Gulf of Alaska and Aleutian Islands. At-sea analysis was conducted on 1,900 fish stomachs from the Bering Sea and 1,563 fish stomachs from the Gulf of Alaska. The REEM predator-prey database was updated with 62,243 records in 2004. Complete database details can be found at http://www.afsc.noaa.gov/refm/reem/data/Default.htm.

***Seabird - Fishery Interaction Research*** – Research on seabird-fishery interactions, and incorporating seabirds into ecosystems models being developed for the Bering Sea and Gulf of Alaska has continued. Strategies are in place to reduce bycatch through fishing gear improvements, standardized reporting, and education and outreach. Details can be found in the National Bycatch Strategy (http://www.nmfs.noaa.gov/bycatch_images/FINALstrategy.pdf), the National Plan of Action to reduce seabird bycatch in longline fisheries (http://www.fakr.noaa.gov/protectedresources/seabirds/npoa/npoa.pdf), and the Alaska Region webpage http://www.fakr.noaa.gov/protectedresources/seabirds.html).

Two field activities were implemented during May and June of 2004 which addressed areas of concern for seabird mortalities and the pelagic distribution of seabirds. The first was a special project for North Pacific groundfish observers. In their normal duties on commercial trawl vessels, observers record any seabirds recovered while sampling the catch. Observers have also recorded, in anecdotal notes, that seabird mortalities occur from interactions with the trawl main cables or trawl sonar cables. These interactions and mortalities are not recorded in a systematic way, so estimates cannot be made of this additional source of mortality. A pilot project was completed by four observers in January through March, 2004, to capture this information while not disrupting normal sampling duties. Based on comments from observers and other reviewers, project instructions were revised and most observers on trawl vessels will complete the work in the latter half of 2004.

Another project was implemented which will increase our understanding of seabird distribution and habitat use in pelagic waters of the Bering Sea and Aleutian Islands. Protocols for a stationary seabird survey had been developed by the Washington Sea Grant Program for use in

longline surveys carried out by the International Pacific Halibut Commission, Alaska Department of Fish and Game, and NOAA Fisheries. That project is in its third year and a data report of 2002 is available from Washington Sea Grant. The project has yielded valuable information on seabird distribution and relative abundance, so protocols were revised for use on trawl vessels and implemented on Alaska Fisheries Science Center summer research charters. Five vessels will complete three legs each, covering the Bering Sea shelf, Bering Sea slope, and Aleutian Islands. At each station, if weather permits, a seabird survey will be completed and numbers of birds by species or species groups within a specific distance from the vessel recorded. These data will add greatly to our increasing understanding of seabird distribution, abundance, and habitat use in these waters. Increased understanding of seabird distribution at-sea is important in devising management strategies for reducing fishery interactions with seabirds.

Collaboration with the fishing industry and the Washington Sea Grant Program continued to explore the use of mitigation measures to reduce seabird interactions with fishing gear. Cooperative Research funds were awarded to the Pollock Conservation Cooperative to investigate measures to reduce seabird interactions for trawl vessels. This preliminary work will lead to a rigorous field experiment, likely beginning in 2006. We also coordinated with the Observer Program to deploy staff to a longline vessel to work on vessel-specific bycatch reduction.

To assist with efforts to monitor seabird/trawl gear interactions, a pilot project was completed in 2002 that employed the use of electronic monitoring to view seabird interactions with trawl third wires. The results of this study are now available as: McElderry et al., 2004. Electronic monitoring of seabird interactions with trawl third-wire cables on trawl vessels – a pilot study. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-147, 39 p. This pilot study involved field testing of electronic monitoring (EM) systems on shoreside delivery and head and gut bottom trawl vessels conducting operations in the Bering Sea, U.S. Exclusive Economic Zone. EM systems, consisting of two closed circuit television cameras, GPS, hydraulic and winch sensors, and on-board data storage, were deployed on five fishing vessels for 14 fishing trips during a one-month period in the fall of 2002. Detailed analysis of about 200 hours of fishing imagery occurred, representing 20 shoreside delivery vessel fishing events and 32 head and gut fleet fishing events. Results from the study demonstrated effective monitoring of seabird interactions with trawl third-wire cables. The EM system provided imagery of sufficient quality to detect the presence, abundance, and general behavior of seabirds during most daylight fishing events, but it was not very useful for species identification. Although it was not possible to determine the cause of seabird third-wire entanglements, they were detectable, thus, EM would be suitable for monitoring the use and effectiveness of mitigation measures.
Interactions between commercial fishing vessels and scavenging seabirds have received increasing attention in recent years. Seabird-fishery studies in the North Pacific have focused almost exclusively on accidental entanglement of seabirds in fishing gear. However studies from the North Atlantic have demonstrated that fisheries discards and offal can positively affect seabird populations. In November, 2004 a new project was launched to take an ecosystem approach to seabird-fisheries interactions in Alaskan waters. The ultimate goal is to integrate

into population models for target seabird species both the positive and negative impacts of fisheries, and to integrate these effects across multiple fisheries. The first step in the process is to map the spatial and temporal availability of fisheries discards and offal to seabirds. Future steps will link food availability to estimated population level changes. The project is supported in part by a National Research Council postdoctoral fellowship.

***Models of Gulf of Alaska Oceanic Food Webs*** – The ocean basin of the Gulf of Alaska is an important habitat for the growth of Pacific salmon (*Oncorhynchus* spp.). Several North American and Asian salmon stocks put on up to 90% of their body weight through feeding in this region. In recent years there has been concern about the effects of long-term climate change on their growth, as both cold water temperatures and prey supply are critical to salmon obtaining sufficient body size for their return migrations. Further, competition for food might limit salmon body size during periods of high salmon abundance, as were present in the Gulf of Alaska throughout the 1980s and 1990s.

In an international collaboration through the North Pacific Marine Fisheries Organization (PICES), a food web model of the oceanic Alaskan gyre was developed which quantified the annual prey and predator budgets for several species of salmon such as pink salmon (*O. gorbuscha*; Figure 1). The modeling was expanded to a detailed seasonal exploration of factors influencing pink salmon growth, by coupling a bioenergetics model of individual pink salmon growth and seasonal feeding behavior based on data provided by the University of Washington High Seas Salmon Program to both the food web model and a seasonal nutrient-phytoplankton-zooplankton model.

The results suggest that the measured rates of pink salmon growth, especially their accelerated spring and summer growth prior to spawning, are not explained solely by seasonal zooplankton blooms (bottom-up control). While the zooplankton bloom is important, two additional factors are necessary to explain growth differences: (1) salmon switching their diet from zooplankton to more-nutritious squid as they grow; and (2) a decreasing energetic cost of foraging for salmon in the spring and summer. A possible reason for this second factor is the concentration of prey in surface waters, which occurs as heat input stratifies the pelagic water column in the summer, requiring salmon to search less water to find the same amount of food.

The next steps are to test these models with inputs of historical changes in bloom timing, water temperature, prey supply, and increases in salmon population numbers that have occurred along with measured climate changes. The hope is that such models will go beyond simple correlations in predicting the effects of future climate on salmon populations.

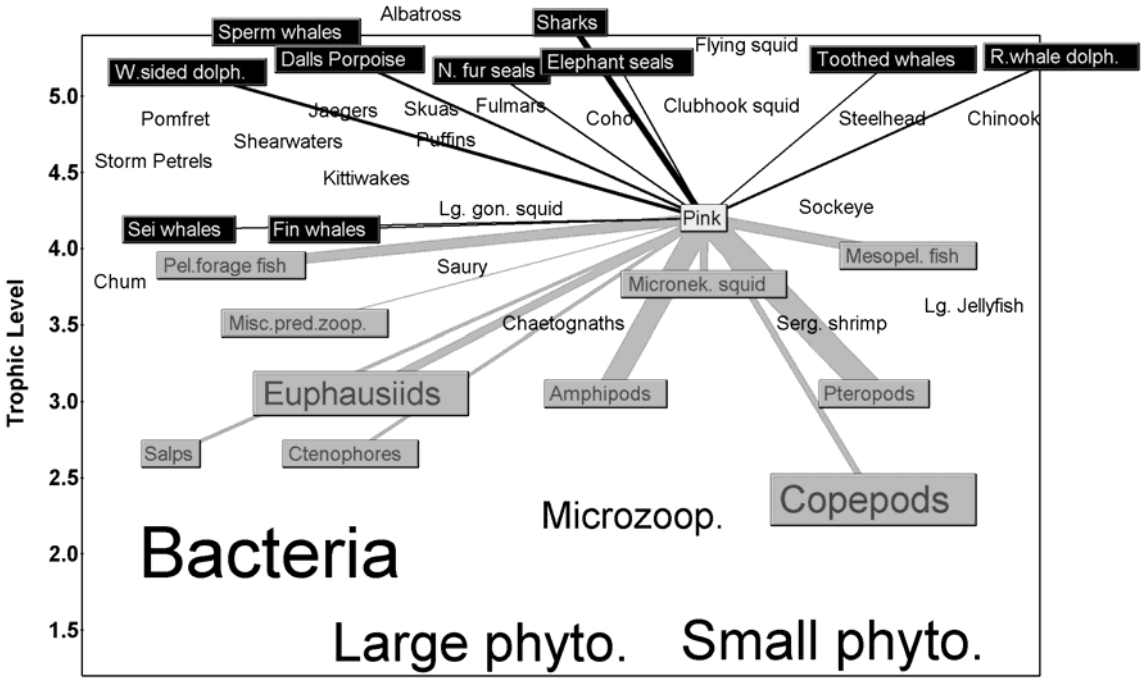



**Figure 1.** Food web of the oceanic Alaska gyre, emphasizing pink salmon. Prey of pink salmon are shown in grey; predators of pink salmon are shown in black. Line widths are proportional to the volume of flow (tons/year).

***Surplus Production in Marine Ecosystems*** – The question of the amount of "surplus" production available in marine ecosystems is a critical one for fisheries management. On one hand, catching a fish makes it unavailable to predators, and in a tightly connected ecosystem, there may be little overall energy surplus. On the other hand, the removal of large fish leads to younger and possibly more energy-efficient fish populations. While humans cannot control the interactions in an ecosystem, modeling these shifts of energy flow is an important step to understanding the overall yields that might be expected from ecosystems, especially if maintaining the health of top predators such as marine mammals is a management priority.

The energetic assumptions most commonly used in ecosystem models were reviewed, and the energetic implications of model predictions were explored. The biomass dynamics model Ecosim has a tendency to underestimate the dietary requirements of large, slow-growing, older fish in unfished ecosystems, and may therefore overestimate the biomasses of top predator populations that were supportable by ecosystems before fishing began. Some relatively simple bias correction formulas for Ecosim, based on the expanding the model to take life-history strategies into account using von Bertalanffy growth parameters, were derived, tested, and recommended.

***Testing the stability of the suitability coefficients from the eastern Bering Sea multispecies virtual population analysis*** −Suitability coefficients are important for the estimation of predation mortality *M2* in the multispecies virtual population analysis (MSVPA) and the multispecies forecasting (MSFOR) models. Testing the assumption of the stability of the suitability coefficients is important to assess the robustness of the predictions made with MSFOR. We used different statistical methods to partially test this assumption. The comparison of the estimates from two different sets of data suggested that sample sizes greater than 200 reduce the differences between the two types of estimates. In a second approach, we contrasted the residual variances of partial data sets with the results from the fit of a combined data set. Results suggested a small effect (~10.8 %) of variation in stomach contents among years on suitability estimates. The comparison of the fitted means of the suitability coefficients associated with each predator species suggest that only 13 of the 50 pair-wise contrasts were significantly different ($\alpha = 0.05$). In general, results suggested that the predator preferences and prey vulnerabilities remained stable over time. Therefore, MSFOR could be considered as a tool for providing advice to fisheries managers within a multispecies context.

***Incorporating predation interactions in a statistical catch-at-age model for a predator-prey system in the eastern Bering Sea*** − Multispecies virtual population analysis (MSVPA) has been used to model groundfish predation interactions in the eastern Bering Sea. This model incorporates predation mortality, M2, into the virtual population estimation process. However, this model framework lacks the statistical assumptions now commonly used in single-species assessment modeling in which statistical fitting of parameters is accomplished by considering how errors enter into the model and multiple data sources are used to estimate parameters. In this work, a two-species system (walleye pollock and Pacific cod) was derived to incorporate the predation equations from MSVPA into a multispecies statistical catch-at-age model (MSM). The MSM is a complex model that estimates population numbers and predation mortality based on catch-at-age data, relative indexes of abundance, predator annual ration and predator stomach contents using estimation procedures for the statistical part and the predation mortality. MSM statistically estimates population parameters such as numbers at age and fishing mortality rates using either an optimization algorithm (Newton-Raphson for example) or Bayesian methods and an internal algorithm for the estimation of the predation mortality.

Results suggest that the multispecies statistical model reproduced most of the suitability coefficients (Figure 2) and predation mortalities estimated by MSVPA and the adult population estimates from the single-species stock assessment. MSM also provides a measure of the uncertainty associated with these parameters, which is not available with the current MSVPA technology.

MSM is an important advancement in providing advice to fisheries managers because it incorporates the current tools used in stock assessment such as Bayesian methods and decision analysis into a multispecies context, helping to establish useful scenarios for management in the eastern Bering Sea. Future improvements to the model will include adding the full suite of groundfish predators presently modeled in the eastern Bering Sea MSVPA and incorporating stomach content data into the statistical estimation process.

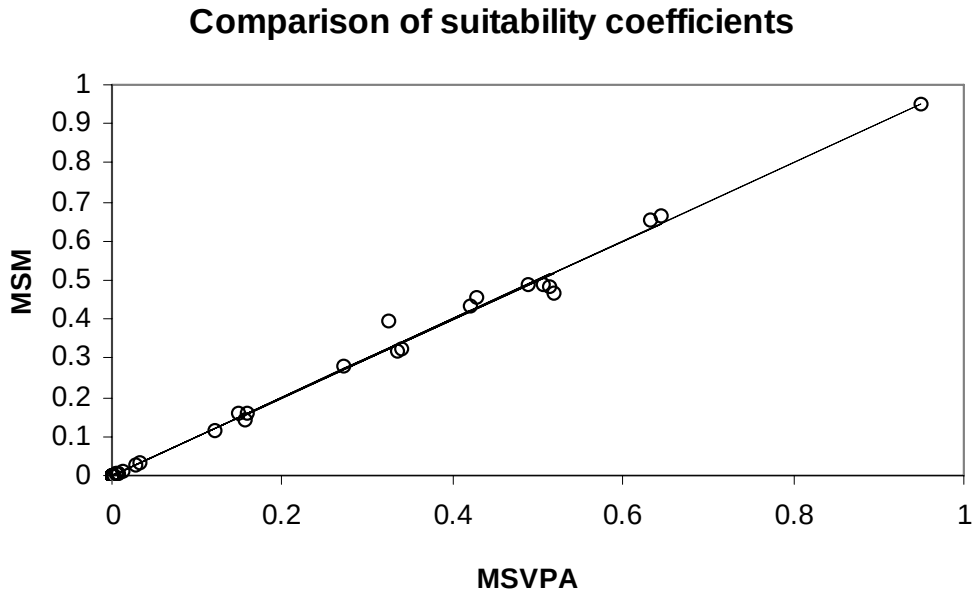



**Figure 2**. Comparison of estimates of average suitability coefficients for walleye pollock as predator from the multispecies virtual population analysis and the multispecies statistical model.

***Spatial distribution of walleye pollock in the eastern Bering Sea*** —The large biomass of walleye pollock in the EBS is supported by occasional recruitment of very large yearclasses. Hypotheses developed to link recruitment variability with climate and oceanographic conditions explain only a limited portion of the variability. Environment-recruitment relationships can be obscured by combining groups of fish with asynchronous population trajectories.

The distribution of yearclasses were examined from year to year based on age-specific catch-per-unit-effort from summer bottom trawl surveys of the EBS shelf from 1982 to 2004. The patterns in distribution of large yearclasses were easiest to discern because of their large signal-to-noise ratio. The distribution of the 78 and 89 yearclasses exhibited a high abundance in both the NW and SE regions of the EBS shelf, but the 82 and 84 yearclasses exhibited a high abundance only in the NW region (Figure 3). Consequently, the total number of adult walleye pollock in the NW and SE regions appears to fluctuate asynchronously. It is interesting that during the period from 1987 to 1990 when the 82 and 84 yearclasses were very abundant in the NW region, there did not appear to be any density-dependent shift into the SE region. Recognition of the spatial distribution of walleye pollock yearclasses within the EBS management area might enhance our ability to understand the relationship between environmental factors and recruitment.

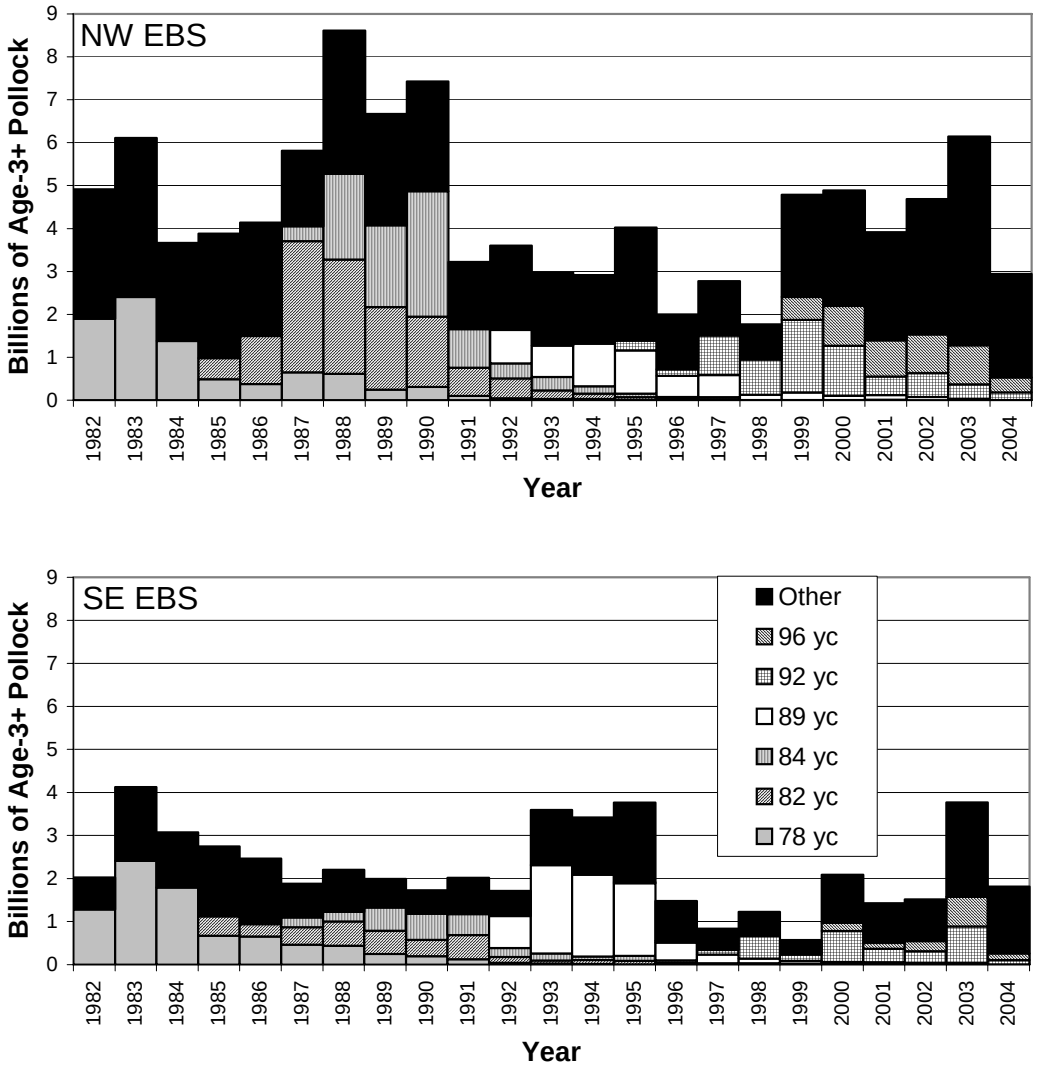



**Figure 3**. The number of walleye pollock, age-3 and older, in the NW and SE regions of the EBS shelf as found by the summer bottom trawl survey from 1982 through 2003. The contribution of large yearclasses (78, 82, 84, 89, 92, and 96) in each region are indicated in each year.

***Ecosystem Considerations for 2005*** −The Ecosystem Considerations Section for 2005 was completed as part of the Stock Assessment and Fishery Evaluation (SAFE) Reports that are annually provided to the North Pacific Fishery Management Council (NPFMC). A summary of the first draft was presented to the NPFMC groundfish plan teams September 17, 2004. The section content and format has changed slightly from last year and is comprised of 3 parts: the

Ecosystem Assessment, Ecosystem Status Indicators, and Ecosystem-Based Management indices and information.

The Ecosystem Assessment this year focuses on the historical responses of ecosystem components to climate regime shifts and provides expert judgment on the near-future state of the climate. This assessment was derived primarily from a PICES study group report providing advice to the U.S. on the effects of climate on fisheries. Based on basin-wide North Pacific climate-ocean indices, there appears to have been a major regime shift in 1977, a minor shift in 1989, and recent shift in 1998. For regimes, prior to 1977, the pattern of sea surface temperature spatial variability implied a west-east dipole. Since 1989, the pattern of spatial variability has been dominated by a second pattern of sea surface temperature variability, which implies a north-south dipole. In the Bering Sea (BS) and Gulf of Alaska (GOA), the major atmospheric shift of 1977 resulted in a change from a predominantly cold climate to a warmer maritime climate as part of the Pacific Decadal Oscillation (PDO). Responses of various physical and biological indices to the 1977 and 1989 regime shifts can be seen in newly created tables of time series anomalies in the Ecosystem Assessment. For example, after 1977, salmon catches increased in the BS and GOA, GOA shrimp survey CPUE decreased, and survival indices of some groundfish shifted. Given the variability in indices since 1998, there is some uncertainty about the level of productivity of the new regime; however, there is growing evidence that there are strong responses in the California Current ecosystem and weak evidence of responses in the GOA ecosystem. It is projected that the Bering Sea will most likely continue on its current warm trajectory, with biomass transitioning northward allowing pollock a larger domain at the expense of cold and ice-adapted species, rather than transitioning back to a cold regime. It is currently unclear if changes observed in the GOA after 1998 will persist. For example, shrimp CPUE in the north GOA increased from 1998 to 2001, but has since decreased again.

The next draft of the Ecosystem Assessment will include some information on ecosystem models that will be used to summarize possible future effects of climate and fishing on ecosystem structure and function. Currently, not all of the modeling tools are ready for use in projections; however, future development of modeling tools will enable scientists to provide advice on management strategies that are robust to a wide range of future ecosystem states. The assessment could be used to evaluate aggregate effects of groundfish fisheries on ecosystem and habitat and could result in advice regarding changes in aggregate catch levels (OY cap), species mix of the catch, and discard amounts. The assessment this year also provides a more analytical presentation of the historical trend and variation in key indicators in a graphical red/green indicator table that indicates direction and magnitude of indicator changes over time.

The Ecosystem Status Indicators section summarizes the historical trends and current status of physical, biological, and community, or ecosystem-level indices. New this year is the addition of status and trend information pertaining nutrients and productivity, age-0 pollock diet, distribution, and energy content in the Bering Sea, error bars on bottom trawl survey CPUE estimates of forage fish, HAPC, and miscellaneous species, a regime-shift analysis of recruit-per-spawning biomass anomalies, and a detailed summary of Alaska Native Traditional

Environmental Knowledge of climate regimes. Data gaps still include lower trophic levels, such as phytoplankton, and zooplankton information.

The Ecosystem-Based Management indices and information section contains updated indices that are intended to provide either early signals of direct human effects on ecosystem components or to provide evidence of the efficacy of previous management actions. Indices presented address four main goals of ecosystem-based management that the NPFMC proposed: maintain diversity, maintain and restore fish habitats, sustainability, and humans are part of the ecosystem.

Stock assessment scientists continued to use indicators from the Ecosystem Considerations section to assess ecosystem factors such as climate, predators, prey, and habitat that might affect a particular stock. Also, information regarding a particular fishery's catch, bycatch and temporal/spatial distribution was used to consider the possible impacts of that fishery on the ecosystem although updated non-target species catch data were not available this year. We are still in early stages of using this type of information in stock assessments. However, we anticipate the information could be used to modify allowable biological catch recommendations or spatial/distribution of the catch due to ecosystem concerns, or to target further research that would be needed to quantify ecosystem impacts.

For more information about REEM research, please contact Pat Livingston at (206)526-4172.

### Fish Distribution and Habitat in Southeast Alaska Estuaries – ABL

In 2004, the Auke Bay Laboratory continued classification and mapping of critical estuarine fish habitat. Sampling of fish and fish habitat was done in 12 Southeast Alaska and Prince William Sound estuaries. Estuaries selected for sampling had characteristics representative of the hydrographic and geomorphic diversity of the region. This data will be used to determine relative abundance and distribution of fishery resources in Alaska estuaries and to "ground-truth" and improve coastal mapping being done by State and Federal agencies throughout the region.

For more information, contact Mitch Lorenz at 907-789-6035.

## *2. Stock Assessment*

### Status of Stocks and Multispecies Assessment Task – REFM

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

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

Assessment scientists provided analytic assistance on many current fisheries management issues. These included: 1) identification and prioritization of research activities that may lead to improved groundfish stock assessments; 2) modeling of groundfish stock structure; 3) contribution to a comprehensive report on bycatch, utilization and discards; 4) helped to develop overfishing definitions for the NPFMC, 5) provided analysis of environmental impacts of the pollock and Atka mackerel fisheries on Stellar sea lions, and 6) worked with the NMFS Alaska Region to provide a supplemental environmental impact statement for the setting of TACs.

Research activities spanned a broad range of topics. Field studies initiated by staff members included the continuing development of a demersal rockfish trawl for improved stock assessment and hydroacoustic approaches for rockfish habitat determination. Significant research contributions on: 1) the examination of climatic effects on the recruitment of North Pacific groundfish species, 2) relationship of Bering Sea oceanography to pollock recruitment, 3) modeling the Pacific whiting fishery behavior, 4) analysis of the geographic and genetic variation in Atka mackerel in the Aleutian Islands, and 5) incorporation of predation in the Gulf of Alaska pollock assessment were presented at various symposia. In addition, staff members participated on nationwide NMFS committees for specifying a precautionary approach to fisheries management; used a Leslie depletion model to analyze Atka mackerel fishery CPUE data; investigated restratifying fisheries data along biological lines as opposed to traditional INPFC areas; worked with other fishery labs in developing and implementing a new stock assessment model, and continued the international cooperative analysis of Bering Sea pollock stocks with Russian scientists. Staff members also served on national and international steering committees of GLOBEC and PICES.

For further information, contact Dr. Anne Hollowed (206) 526-4223.

## *3. Management*

### North Pacific Groundfish Observer Program – REFM

The North Pacific Groundfish Observer Program is responsible for placement of observers on vessels fishing for groundfish species in the U.S. EEZ of the northeastern Pacific Ocean and Bering Sea. Observers collect data, which provide the basis for in-season management of the groundfish fisheries by NMFS, provide a means for evaluating and developing management strategies by the regional management council and NMFS, and are used in the stock assessment process. Observers play important roles in providing information that is critical to the U.S. fishing industry.

During 2004, no foreign vessels were allowed to catch or process fish in the U.S. EEZ off the coast of Alaska. The Observer Program trained and deployed 790 observers to 317 vessels and 21 shore plants in Alaska. These observers spent 36,624 days collecting data in 2004. The Program is responsible for defining the sampling duties and data collection methods used by observers, training of the observers prior to deployment, debriefing of observers upon their return, and editing and managing the resulting data. The catch data are provided to the Alaska Regional Office to assist in management decisions regarding the catches of groundfish and prohibited species. Data are also collected regarding the operations of the groundfish fishery.

For further information or if you have questions about the North Pacific Groundfish Observer Program, please contact Dr. William Karp (206)-526-4194.

**Economics and Social Science Research Program – REFM**

***Estimating the Cost of Steller Sea Lion Conservation Areas in the Pollock Fishery –*** Alan Haynie has been developing a model that values the economic impacts of the Steller Sea Lion Conservation Areas (SCA) upon the pollock fishery. In joint work with David Layton at the University of Washington, Alan has extended the standard economic model commonly used to predict site choice that allows one to better utilize available data and to evaluate the costs of closures such as the SCA. Their paper, entitled "Estimating the Economic Impact of the Steller Sea Lion Conservation Area: Developing and Applying New Methods for Evaluating Spatially Complex Area Closures" was presented at the International Institute of Fisheries Economics and Trade conference in Tokyo, Japan in 2004. Although the current model examines trip choices only in the summer season and focuses on catcher vessels, Alan is working to extend the model to the entire year and to include catcher-processors. In the future, these models can be extended to other species and for any closures for which spatially explicit catch information are available. They may also be used to better understand how the nature of fishing trips site choice may change when a fishery is rationalized.

***Measuring Fishing Capacity and Fishing Productivity in Groundfish Fisheries*** – Ron Felthoven and Catherine Morrison Paul (at the University of California, Davis) published a paper entitled "Multi-Output, Non-Frontier Primal Measures of Capacity and Capacity Utilization" in the *American Journal of Agricultural Economics*. This research developed and implemented an econometric approach for generating measures of fishing capacity and capacity utilization. In situations where regulatory, environmental, and resource conditions affect catch levels but are not independently identified in the data, the commonly used frontier-based capacity models may interpret such impacts as production inefficiency. However, if such inefficiencies are unlikely to be eliminated, the implied potential output increases may be unrealistic. In this paper the authors develop a multi-output, multi-input stochastic transformation function framework that permits various assumptions about how output composition may change when operating at full capacity. They apply the model to the surimi-capable catcher-processor vessels in the Alaskan pollock fishery.

Ron Felthoven, Terry Hiatt and Joe Terry published a paper entitled "Measuring Fishing Capacity and Utilization with Commonly Available Data: An Application to Alaskan Fisheries" in *Marine Fisheries Review*. Due to a lack of data on vessel costs, earnings, and input use, many of the capacity assessment models developed in the economics literature cannot be applied in groundfish fisheries. This incongruity between available data and model requirements underscores the need for developing applicable methodologies. This paper presents a means of assessing fishing capacity and utilization (for both vessels and fish stocks) with commonly available data, while avoiding some of the shortcomings associated with competing "frontier" approaches (such as data envelopment analysis). The authors apply the methodology to the catcher-vessels and catcher-processors operating in Alaska's federally managed fisheries in 2001 and the examine trends in fishing effort and participation since 1990.

Ron Felthoven and Catherine Morrison Paul (at the University of California, Davis) published a paper entitled "Directions for Productivity Measurement in Fisheries" in *Marine Policy.* Fisheries policy is often aimed at sustaining and improving economic performance, but the use of traditional productivity measurement to assess performance over time has been quite limited. In this paper the authors review the currently sparse literature on productivity in fisheries, and suggest ways to better account for many of the relevant issues unique to the industry and groundfish fisheries in particular. Specifically, we discuss the need to incorporate bycatch levels, to better account for environmental and stock fluctuations, and to relax some of the restrictive economic assumptions that have been imposed in the research to date. A methodological framework that may be used to incorporate these factors is proposed.

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

# C. By Species, By Agency

## *1. Pacific Cod*

### b. STOCK ASSESSMENT

***Bering Sea/Aleutians***

The present assessment is a substantial revision of last year's assessment, incorporating recent age and growth data and slope survey length data. The 2004 EBS shelf bottom trawl survey resulted in a biomass estimate of 597,000 t, nearly identical (down 1%) to the 2003 estimate and near the minimum for the 23 year time series (534,000 t). The Aleutian Islands and EBS slope also were surveyed in 2004. The stock assessment model estimates of abundance are much lower than last year's assessment due to the added age, growth, and length data. Estimated 2005 spawning biomass for the BSAI stock is 295,000 t, down about 32% from last year's estimate for 2004 and down about 21% from last year's *F40%* projection for 2005. The added data have reduced some of the uncertainties in the Pacific cod assessment. The stock assessment model

estimates of current total and spawning biomass are roughly half of the peak value for the time series which occurred in 1987.

The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, and that this stock therefore qualifies for management under tier 3. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 304,000 t, 0.36 and 0.43, respectively. Pacific cod qualify for management under sub-tier Ab@ of tier 3 because projected biomass for 2005 is about 3% below $B_{40\%}$. Fishing at an instantaneous rate of 0.35 is projected to result in a 2005 catch of 227,000 t, which is the maximum permissible ABC. However, the ABC recommended by the authors is 206,000 t based on an alternative approach that considers the tradeoff between average yield and variability in yield. This ABC results in a 2005 $F_{ABC}$ of 0.31 and is about 8 percent less than last year's estimate and down about 8percent from last year's $F_{ABC}$ projection for 2005. The overfishing level was determined from the tier 3b formula, where fishing at a rate of 0.42 gives a 2005 value of 265,000 t, down about 24 percent from the 2004 estimate. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

***Gulf of Alaska***

The stock assessment was updated with new fishery data but otherwise was specified as in last year's assessment. No new survey data is available from the Gulf of Alaska in 2004. The assessment model results estimate the 2005 spawning biomass at 91,700 t, down about 11% from last year's estimate for 2004. The estimated 2005 total age 3+ total biomass for this stock is 472,000 t, down about 2% from last year=s model estimate.

The recommended 2005 ABC for the GOA stock is 58,100 t (7% less than 2004) which is almost unchanged from last year=s projection for 2005. This harvest level corresponds to a fishing mortality rate of 0.24. The estimated 2005 overfishing level is 86,200 t, down about 15% from last year=s estimate for 2004 ($F_{OFL}$ = 0.36). The 2005 harvest is apportioned as follows: East 7%, Central GOA 57% and Western GOA 36%. The Pacific cod stock is not overfished and is not approaching an overfished condition.

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

## *3. Shelf Rockfish*

### b. STOCK ASSESSMENT

***Gulf of Alaska***

**Pelagic shelf rockfish - ABL**

The pelagic shelf rockfish assemblage is comprised of four species (dusky, dark, yellowtail, and widow rockfish) that inhabit waters of the continental shelf of the Gulf of Alaska and that are

thought to exhibit midwater, schooling behavior. At certain times, however, some of these fish are caught in bottom trawls. Dusky rockfish is by far the most abundant species in the group, and has been the target of an offshore bottom trawl fishery since the late 1980's. A major change in 2004 was the taxonomic separation of what was formerly one species, dusky rockfish, into two species: dusky rockfish (*Sebastes variabilis*) and dark rockfish (*Sebastes ciliatus*). Previously, these two varieties were referred to as "light dusky rockfish" and "dark dusky rockfish", respectively, and were both classified as *S. ciliatus*. Dark rockfish share an inshore reef or kelp environment with black rockfish, and these two species are often found together. Black rockfish in Alaska were placed under state jurisdiction in 1998, and now that dark rockfish have been recognized as a distinct species, a North Pacific Fishery Management Council Plan amendment has been proposed that would also transfer this latter species to state control.

An age-structured model was used for the first time in 2003 to determine biomass and ABC for dusky rockfish (*S. variabilis*), the predominant species in the assemblage. This model is a modified version of the northern rockfish model and was first developed in preliminary form in 2002. In 2004, a large quantity of new age data for dusky rockfish became available, which required some reconditioning of the model. The end result was increased overall model stability compared to the 2003 version. The model estimate of current total biomass for dusky rockfish is 58,519 mt, and recommended ABC for 2005 based on an $F_{40\%}$ harvest rate (0.120) is 4,060 mt. Exploitable biomass for the three other species in the assemblage (dark, yellowtail, and widow rockfish) is computed using their average biomass estimates for last three biennial trawl surveys in 1999, 2001, and 2003, which equal a total of 7,040 mt. Applying an F=0.75M=0.0675 rate to this value of exploitable biomass yields a recommended ABC of 497 mt. Therefore, for the pelagic shelf rockfish group as a whole, total biomass is 65,559 mt, and recommended ABC for 2005 in the Gulf of Alaska is 4,557 mt. This ABC is an increase of about 2% compared to the 2004 value.

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

## *4. Slope Rockfish*

### a. RESEARCH

#### *Gulf of Alaska*

**Species Identification of Young-of-the-Year Rockfish and Population Genetic Structure of Pacific Ocean Perch Collected in Offshore Waters of the Gulf of Alaska and Bering Sea**
Young-of-the-year (YOY) *Sebastes* rockfish were collected as "bycatch" during Auke Bay Laboratory (ABL) Ocean Carrying Capacity surveys of juvenile salmon in the Gulf of Alaska (GOA) in 1998, 2000–2003, and in the Bering Sea in 2002. The YOY rockfish were caught in rope trawls towed near the surface in offshore waters of both regions. These collections are significant because very little is known about the species identification, distribution, habitat, and genetic structure of YOY rockfish in Alaska.

A pilot study of species identification using morphological analysis by Dr. Arthur Kendall (retired from AFSC's RACE Division) and mitochondrial DNA (mtDNA) analysis by ABL scientists in cooperation with Dr. A.J. Gharrett of the University of Alaska Fairbanks (UAF),

revealed the majority of the rockfish are Pacific ocean perch (*S. alutus*; POP). Six other species were also identified: shortraker, rougheye, dusky, darkblotched, widow, and yellowmouth rockfish.

In 2003, about one-third of the collections were processed for further analysis. In 2004, the remaining collections were processed resulting in a total of 2,072 POP-type fish sampled for future population structure analysis using genetic methods. Of these, 559 were sampled for otoliths, 442 for stomach content analysis (by Dr. Nicola Hillgruber, UAF), and 55 for morphologic analysis (by Dr. Kendall). Also, mtDNA analysis was used to confirm species identification for a subset of POP-type fish (95% POP, 5% other rockfish species). An additional 377 fish (POP type and non-POP type) were sampled for ongoing morphologic and genetic species identification analyses.

Dr. A.J. Gharrett is taking the lead on determining the extent of POP genetic divergence between year-classes and between geographic locations using microsatellite DNA markers. He received North Pacific Research Board funding in 2004 for this work. For the species identification analysis, ABL scientists in cooperation with UAF conducted a genetic analysis using mtDNA variation (three more species were identified: redstripe, yelloweye, and sharpchin), which Dr. Kendall will supplement with a morphologic analysis. This may lead to developing morphologic methods for species identification of young-of-the-year rockfish. To verify that the rockfish in these collections are one year-class, i.e. young-of-the-year (as believed), the otoliths will be aged by the AFSC REFM Division.

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

**Observations of Juvenile Rockfish Using a Remote Operated Vehicle in Sitka Sound, Alaska - ABL**

A study was initiated in the summer of 2004 on the presence of juvenile slope rockfish in nearshore habitat of the outer coast of Southeast Alaska. A remote operated vehicle was deployed from a 21 ft open skiff working primarily in the waters of Sitka Sound on the west side of Baranof Island. Weather during the one week study period limited observations in the more exposed habitat, but juvenile rockfish were observed in many locations. Concentrations of small red rockfish ( <15 cm) were observed at a number of locations, primarily over complex bottom habitat in exposed locations. One unique location in a relatively sheltered habitat had a concentration of small red rockfish hovering over a dense meadow of crinoids (a fern-shaped echinoderm). Redstripe (*Sebastes proriger*) rockfish juveniles were caught over this meadow using small bait jigs. Rougheye (*S. aleutianus*) rockfish juveniles were also captured in the study area. Numerous adult shelf rockfish were observed during the study including observations of fish hiding in close association with sponges and other dense benthic fauna. In 2005 the study will focus on observations in more exposed locations and on improving capture methods of the small juveniles to allow species identification.

For more information, contact Jeff Fujioka at (907) 789-6026.

## b. STOCK ASSESSMENT

### *Bering Sea and Aleutian Islands*

**Pacific Ocean perch (POP)**

The 2004 assessment updated the previous assessment by including the 2004 Aleutian Islands survey results and the 2003 Aleutian Islands fishery age composition. The Aleutian Islands survey resulted in a biomass estimate of 579,000 t, a 23% increase over 2004 and the second highest estimate during the time-series. Stock assessment model results indicate that Pacific ocean perch total and spawning biomass were at low levels in the 1970s and increased to the present high and stable levels.

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 142,000 t, 0.048, and 0.058, respectively. Projected spawning biomass for 2005 is 133,000 t, placing POP in sub-tier Ab@ of Tier 3. The maximum $F_{ABC}$ value allowed under Tier 3b is computed as follows:

$F_{ABC} = F_{40\%} \square (B_{2004} / B_{40\%} - 0.05)/(1-0.05) = 0.048 \square (133{,}000/142{,}000 - 0.05)/0.95 = 0.045$

Projected harvesting at a fishing mortality rate of 0.045 gives a 2005 ABC of 14,600 t, which is the recommended ABC. ABCs are set regionally based on the biomass apportionment as follows: BS = 2,920 t, Eastern Aleutians (Area 541) = 3,210 t, Central Aleutians (Area 542) = 3,165 t, Western Aleutians (Area 543) = 5,305 t. The OFL fishing mortality rate is computed under Tier 3b as follows:

$F_{OFL} = F_{35\%} \square (B_{2004} / B_{40\%} - 0.05)/(1-0.05) = 0.058 \square (133{,}000/142{,}000 - 0.05)/0.95 = 0.054$

Projected harvesting at a fishing mortality rate of 0.054 gives a 2005 catch of 17,300 t, which is the authors and Plan Team's recommended OFL for the BSAI. The OFL for BSAI is not regionally apportioned. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

**Northern rockfish**

The 2004 assessment updates the previous assessment with the 2004 Aleutian Islands survey results, 2004 catch and the age composition for the 2000 and 2003 Aleutian Islands fisheries. The combined 2004 Bering Sea and Aleutian Islands survey estimate of 192,000 t was a 9% increase over the 2002 combined estimate. The stock assessment model indicates that the northern rockfish stock has steadily increased from 133,000 t in 1977 to 200,000 t in 2004.

Northern rockfish, which had previously been managed under Tier 5, are now managed under Tier 3 due to the availability of reliable estimates for $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ (45,900 t, 0.048, and 0.058 respectively). Since the female spawning biomass (66,600 t) is greater than $B_{40\%}$, sub-tier Aa@ would be applicable. Under Tier 3a, the maximum permissible ABC would be 8,260 t, which is the recommendation for the 2005 ABC. Under Tier 3a, the 2005 OFL would be 9,810 t for the Bering Sea/Aleutian Islands combined. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

**Shortraker/rougheye rockfish**
The 2004 Aleutian Islands survey biomass estimates for shortraker and rougheye rockfish are 33,257 t and 15,039 t, respectively. These estimates are of the same magnitude of other surveys conducted in the Aleutian Islands since 1991. The stock assessment model indicates that the rougheye rockfish resource has slowly declined to 12,000 t, about half of the biomass estimated for 1980, the initial year in the model. Similarly, shortraker rockfish are estimated to have declined 25% from the 1980 biomass of 35,000 t to the 2005 estimate of 26,500 t.

Although a stock assessment model has been developed for these species and provides more reliable estimates of biomass than the trawl surveys, species identification in the commercial catch remains a problem. Therefore, these species remain in Tier 5 for the present time.

$F_{ABC}$ is set at the maximum permissible level under Tier 5, which is 75% of M. Accepted values for M for these stocks are: rougheye rockfish--0.025, shortraker rockfish--0.030. The authors recommended a combined BSAI 2005 OFL and ABC for shortraker rockfish of 794 t and 596 t and a combined BSAI 2005 OFL and ABC for rougheye rockfish of 298 t and 223 t. The management of these small OFLs will be challenging. These species are not targeted but are harvested incidentally in numerous target fisheries. It is not possible to determine whether these species are overfished or whether they are approaching an overfished condition because they are managed under Tier 5.

**Other rockfish complex**
The BSAI AOther Rockfish complex formerly consisted of 28 *Sebastes* and *Sebastolobus* species, but now considers only the 8 species that have been caught at least once during AFSC research surveys or appeared in more than 1% of observed fishery hauls between 1990 and 2001. The updated assessment includes 2004 Aleutian Islands and Bering Sea survey biomass, catches in the EBS and AI, updated length frequency data and analyses of growth of light dusky rockfish and shortspine thornyheads. The authors recommend assigning a separate ABC and OFL to shortspine thornyheads and leaving the remaining 7 rockfish species within the other rockfish complex. This recommendation was based on the fact that shortshine thornyheads are the most abundant and valuable species in the complex and inhabit deeper regions of the shelf and slope than the others. The authors recommend using Tier 5 criteria to assign separate ABCs and OFLs in the EBS and AI for shortspine thornyheads (using the 5-year survey average for biomass and $M$=0.07), and using Tier 6 (average catch from 1998-2002) criteria for the remaining species in the AOther Rockfish complex.

The Tier 5ABCs and OFLs for thornyheads were based on biomass estimates that the Plan Team and the author considered reliable. However, biomass estimates for the remaining other rockfish did not appear to be reliable. The actual catches of the remaining other rockfish species have been much larger (by a factor of 6) than the OFLs would have been had this species group been managed under Tier 5 in 1992-2002. This, combined with the fact that the Aleutian Island area survey biomass estimates for this group have generally increased for the last 13 years, suggested that the biomass estimates for this group are unreliable. Using Tier 6 criteria for the remaining other rockfish resulted in an OFL that was similar to catches for 1999-2002. As with Tier 5, the Tier 6 OFL for this subgroup is inappropriate (i.e., it seemed unlikely that biomass would keep increasing for 13 years if catches had equaled or exceeded OFL on average). Therefore, thornyheads were not split from the other rockfish complex at this time.

For 2005, the ABCs and OFLs were set for the entire other rockfish complex, including thornyheads. $F_{ABC}$ was set at the maximum value allowable under Tier 5, which is 75% of $M$ (0.07), or 0.053. Multiplying this rate by the best estimates of other rockfish biomass yields 2005 ABCs of 809 t in the EBS and 590 t in the AI. OFL was set for the entire BSAI area, which under Tier 5 is calculated by multiplying the best estimate of total biomass for the area by $M$ (0.07), which yields an OFL of 1,870 t.

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

### *Gulf of Alaska*

**Pacific ocean perch**

Pacific ocean perch (POP), *Sebastes alutus*, is the dominant fish in the slope rockfish assemblage and has been extensively fished along its North American range since 1940. For 2005, Gulf of Alaska rockfish have been moved to a biennial stock assessment schedule to coincide with the biennial trawl survey. On alternate (even) years when the survey is not conducted we will present an executive summary with last year's harvest parameters and projection for this year, and this year's harvest parameters and projection for next year with updated catch information. There were no major changes in the 2004 model from 2003. There was a slight downward change in spawning biomass and a small upward change in ABC. This was due to the fishery selectivity curve being relatively steep. A larger year class moved into the fishery, so the exploitable biomass has increased slightly. However, the older fish that make up the bulk of the spawning biomass were on a slight downward trend, as indicated by last year's projection. Thus, a slightly larger ABC resulted, even though spawning biomass decreased slightly. For next year's full assessment, an age sample of 1,021 otoliths from the 2003 trawl survey and new survey biomass estimates for 2005 will be included. For the 2005 fishery, we recommended an ABC of 13,575 mt from the updated model. This ABC was similar to the 2004 ABC of 13,336 mt.

The recent Goodman report (2002) raised questions about the sustainability of harvest rates for rockfish. To partially answer this question, we adapted methods previously applied to walleye pollock to conduct a Bayesian spawner-recruit analysis for Gulf of Alaska Pacific ocean perch. The analysis presented as an appendix in the November 2004 Pacific ocean perch Stock Assessment and Fishery Evaluation Report (SAFE) examined what harvest rates would be optimum and those that would be conservative. The results of this analysis suggested that the optimum harvest rate is between *F26%* and *F28%* depending on the spawner-recruit relationship used. This appendix suggested that the current harvest rate of *F40%* for Gulf of Alaska Pacific ocean perch is sufficiently conservative.

Recently, there have been general concerns about age-distribution truncation in rockfish because fecundity and larval success for older rockfish may be much higher. In an appendix to the Pacific ocean perch SAFE, we presented a simple analysis applying previous data for black rockfish to Gulf of Alaska Pacific ocean perch, where we adjusted the maturity curve to reflect better larval survival from older mothers. This analysis shows a 3% decrease in spawning biomass and a 14% decrease in projected ABC. The results suggest that research similar to that

conducted on black rockfish regarding viability of progeny from older mothers should also be initiated for other rockfish such as Pacific ocean perch.

Suggestions by management councils have heightened interest in management strategy evaluation and better ways to capture the real uncertainty in projections of future spawning biomass and catches. In an appendix to the 2004 Pacific ocean perch SAFE, we presented three preliminary alternative methods of projecting the Gulf of Alaska Pacific ocean perch stock into the future and compared it to the standard method used by AFSC scientists. Allowing more realistic stochasticity into the projections resulted in both different average biomass trajectories and much greater uncertainty into the future.

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

**Performance of Modern Age-Structured Stock Assessments with High Survey Measurement Error**

AFSC bottom trawl surveys in Alaska have the daunting objective of obtaining biomass estimates for all major groundfish species. However, many species of rockfish (*Sebastes*) are patchily distributed and therefore are imprecisely estimated in these multispecies surveys, which are based on a stratified random design. This same general problem pervades the stock assessments of many fish species worldwide.

In this study, the stock assessment model for Pacific ocean perch (*Sebastes alutus*) in the Gulf of Alaska was used to explore the consequences of survey imprecision and other uncertainties in components of this type of model. The characteristics of the Pacific ocean perch assessment can be generalized to other long-lived, iteroparous fish species with uncertain survey biomass estimates. The results of the 2003 stock assessment model served as the "true" values, and simulated data sets were constructed in five experiments to answer the following questions: (1) What is the effect of measurement error in survey biomass estimates on stock assessment results? (2) What is the effect if the catchability coefficient changes over time from either gear changes or environmental changes? (3) Does adding an additional biomass index increase model precision? (4) How sensitive are model results to applying arbitrary weights to different data sources such as fishery length distributions and survey ages? (5) How sensitive are model results to prior distributions (a distribution representing prior knowledge about a parameter that influences estimation) imposed on key parameters?

These five simulation experiments yielded the following general answers to these questions: (1) High measurement error (coefficient of variation equal to 50%) rendered the stock assessment inaccurate and imprecise. (2) A catchability trend in the biomass index was undetectable and created a large bias in biomass and parameter estimates. (3) The addition of a second, more precise biomass index with a shorter time series improved performance of the model. Examples of an additional index could be a hydroacoustic index or a dedicated rockfish survey. (4) This type of assessment was robust to various data weightings, indicating that the stock assessment scientist could merely give each data source equal weight. (5) The prior distribution for natural mortality needed to be precisely specified, while the prior distributions for the catchability coefficient and recruitment variability could be relatively uninformative. Overall, the study showed that the high measurement error in the survey index (for species such as rockfish) can

render stock assessment intractable, data weighting was less important than expected, and prior distributions on parameters except natural mortality could be uninformative.

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

**Northern rockfish**

Northern rockfish is the second most abundant rockfish in the Gulf of Alaska. The year 2004 was the first year of the new biennial stock assessment schedule for the Gulf of Alaska, with new assessments made coinciding with the availability of new biennial bottom trawl survey biomass estimates. The new schedule allows stock assessment authors to make two year projections of acceptable biological catch (ABC) and overfishing limits (OFL) and allows stock assessment authors to update those two year projections during each annual stock assessment cycle. Because 2004 was the first year of the two year stock assessment schedule and a non-biennial survey year, the Gulf of Alaska northern rockfish assessment for 2004 was based upon the 2003 assessment model (the last year with a biennial survey biomass estimate) with updated catch. Based on the 2003 model with updated catch for 2004, the recommended 2005 ABC for Gulf of Alaska northern rockfish is 5,093 metric tons (mt). The 2005 ABC is approximately 5% higher than the 2004 ABC. A full assessment will be completed next year to coincide with the next available biennial survey biomass estimate.

For more information contact Dean Courtney at (907) 789-6626.

**Shortraker/rougheye and other slope rockfish**

A significant change occurred in 2004 concerning the assessment and management of shortraker and rougheye rockfish in the Gulf of Alaska. At its December meeting, the North Pacific Fishery Management Council decided to accept the recommendation of the Gulf of Alaska Plan Team to divide the shortraker/rougheye management group into its constituent species and establish separate ABCs for each species. The rationale for this decision was to protect shortraker rockfish from possible disproportionate harvest, as there was evidence that shortraker rockfish were being caught in amounts greater than their share of the ABC. Previously, the two species were always managed as a group, and individual ABCs for each species were combined to form an overall ABC.

As in previous years, the 2004 assessments for shortraker rockfish, rougheye rockfish, and other slope rockfish in the Gulf of Alaska were not based on modeling, but instead relied on biomass estimates provided by trawl surveys. Exploitable biomass for each of these three management categories was estimated by the average biomass in the three most recent biennial trawl surveys, excluding the estimated biomass in the 1-100 m stratum. The 1-100m depth stratum was removed from the estimate because most rockfish in this stratum are small juvenile fish, and thus are not considered exploitable. This results in an exploitable biomass of 32,723 mt for shortraker rockfish, 40,281 for rougheye rockfish and 89,455 mt for other slope rockfish. Applying a combination of F=M and F=0.75M rates (depending on the species) to these values of exploitable biomass results in recommended ABC's for 2005 of 753 mt for shortraker rockfish, 1,007 for rougheye rockfish, and 3,900 mt for other slope rockfish.

A preliminary age-structured model for rougheye rockfish was constructed in 2004. This model followed the general framework of the model used to describe Pacific ocean perch stock status in

the Gulf of Alaska, but added data acquired from the sablefish longline survey. The longline data include a relative abundance index and many fish lengths. Since rougheye have limited age data at this time, the additional biomass index and fish length data helped fit the model, allowing natural mortality and three different selectivity curves to be estimated. Substantially more age data for rougheye rockfish will likely become available in 2005, which should improve the model results. Therefore, we expect to use the model in 2005 to set the 2006 ABC for rougheye rockfish.

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

## *5. Thornyheads*

### b. STOCK ASSESSMENT

#### *Gulf of Alaska*

No new assessment was made for Gulf of Alaska thornyeads in 2004 since the biennial survey was not conducted in 2004. The 2003 assessment was used for 2004 management.

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

## *6. Sablefish*

### a. RESEARCH

***Bering Sea, Aleutian Islands, and Gulf of Alaska***

**Sablefish Longline Survey**

The AFSC has conducted an annual longline survey of sablefish and other groundfish in Alaska from 1987-2004. The survey is a joint effort involving two divisions of the AFSC: ABL and RACE. It replicates as closely as practical the Japan-U.S. cooperative longline survey conducted from 1978-94 and also samples gullies not sampled during the cooperative longline survey. In 2004, the twenty-seventh annual longline survey of the upper continental slope of the Gulf of Alaska was conducted, along with a similar survey of the eastern Aleutian Islands. One hundred-forty-eight longline hauls (sets) were completed between June 3, 2004 and September 1, 2004 by the chartered fishing vessel *Alaskan Leader*. Sixteen kilometers of groundline were set each day, containing 7,200 hooks baited with squid.

Sablefish (*Anoplopoma fimbria*) was the most frequently caught species, followed by giant grenadiers (*Albatrossia pectoralis*), Pacific cod (*Gadus macrocephalus*), and arrowtooth flounder (*Atheresthes stomias*). A total of 90,226 sablefish were caught during the survey compared to 86,617 in 2003. A total of 4,132 sablefish, 442 shortspine thornyhead (*Sebastolobus alascanus*), and 24 Greenland turbot (*Reinhardtius hippoglossoides*) were tagged and released during the survey. Electronic temperature-depth tags were surgically implanted in 23 Greenland turbot and 53 shortspine thornyhead. Four Greenland turbot tagged with electronic tags have been recovered by the fishery since tagging began in 2003. Length-weight data and otoliths were collected from 2,454 sablefish. Killer whales (*Orcinus orca*) took fish from the longline at four stations in the western Gulf of Alaska. Sperm whales *(Physeter macrocephalus*) were common near the vessel in the eastern Gulf, west Yakutat, and central Gulf regions and were observed taking fish from the line at several stations.

Several special projects were conducted during the 2004 longline survey. Uncommon corals caught on the line were collected for identification and sample preservation. Large tree coral *Primnoa sp.* specimens were collected for age determination studies. A seabird occurrence study was conducted for the third year. This study is being conducted during several different surveys and hopes to address where and when certain seabird species occur in Alaska waters. Fifty sablefish were collected throughout the Gulf of Alaska and Aleutian Islands and sent to the Alaska Department of Environmental Conservation for contaminants analysis. Giant grenadier specimens were collected in the central Gulf for maturity work and dogfish shark (*Squalus acanthias*) specimens were collected by a University of Alaska graduate student for maturity studies.

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

**Auke Bay Laboratory Sablefish Tag Recovery Program**
Processing tag recoveries and administration of the reward program continued during 2004. Total tags recovered for the year are expected to be around 600, which is about the same as the last two years. Four fish at liberty 26 years and four more at liberty 25 years were recovered in 2004. These fish were all released during the first two Japan – U.S. Cooperative Longline Surveys in 1978 and 1979.

Tagging continued on the 2004 sablefish longline survey, with 4,132 sablefish tagged and released. Database sablefish releases, including 289,485 adults and 33,754 juveniles, now total 323,239. There are 25,903 recoveries to date, including 23,974 tagged as adults and 1,929 tagged as juveniles.

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

**Archival Sablefish Tags**
Data from archival tags can provide information about fish behavior in the sea as well as the marine environmental conditions they experience. Sablefish were surgically implanted with archival tags during the 1998-2002 sablefish longline surveys. Two fish were tagged and released at each station from the eastern Aleutian Islands and eastern Bering Sea throughout the Gulf of Alaska to Dixon Entrance. The archival tag contains a computer chip that records depth and temperature for 1-1/2 to 2 years. A total of 603 sablefish were released and 71 have been recovered. Rewards of $200 or $500 are being offered to fishermen for the recovery of these tags, depending on the year of release. Based on the recovered tags, three daily movement patterns have been observed: random movement (irregular depth movements not related to time of day), diel vertical movement (greater depths during day and movement to shallower water at night), and reverse diel vertical movement (shallower depths during day and movement to deeper water at night). Ten to twenty tags are recovered each year. The results will be reported in a journal article when annual recovery rates diminish to small numbers.

For more information, contact Michael Sigler at (907) 789-6037.

**Juvenile Sablefish Studies**
Juvenile sablefish studies have been conducted by the Auke Bay Laboratory in Alaska since 1984 and were continued in 2004. A total of 194 juvenile sablefish (age 1+) were tagged with spaghetti tags and released during a cruise of the NOAA vessel *John N. Cobb* at St. John Baptist Bay near Sitka in May 2004. During the same cruise, 80 juvenile sablefish were implanted with electronic archival tags and 8 with electronic acoustic tags. This relatively small bay is the only known location in Alaska where juvenile sablefish have been consistently found.

The acoustic tags were programmed to transmit data on the temperature and depth experienced by the fish to acoustic receivers fixed on the bottom of St. John Baptist Bay. These receivers recorded the data and were retrieved by divers in September 2004. The data from the acoustic tags will provide information on juvenile sablefish behavior and habitat use in nearshore rearing

areas and on the timing and duration of emigration from nearshore rearing habitat to the more open waters of the Gulf of Alaska.

The electronic archival tags will provide information over a longer time period on juvenile sablefish behavior and habitat during their transition from nearshore rearing areas to the age at which they are intercepted by the fishery. These tags also record the temperatures and depths experienced by the fish and are designed for recovery in the commercial fishery when the fish are age 2+ or greater.

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

## b. STOCK ASSESSMENT

### *Bering Sea, Aleutian Islands, and Gulf of Alaska*

The 2004 sablefish assessment showed that sablefish abundance increased during the mid-1960's due to strong year classes from the 1960's. Abundance subsequently dropped during the 1970's due to heavy fishing; catches peaked at 53,080 mt in 1972. The population recovered due to exceptional year classes from the late 1970's; spawning abundance peaked again in 1987. The population then decreased as these exceptional year classes died off.

The longline survey abundance index decreased 5% from 2003 to 2004, which follows an 8% decrease from 2002 to 2003. These decreases follow recent increases, so that relative abundance in 2004 is 4% higher than in 2000. The fishery abundance index decreased 12% from 2002 to 2003 (the 2004 data are not available yet). The decrease follows recent increases, so that relative abundance in 2003 is 6% lower than in 2000. Spawning biomass is projected to decrease slightly (2%) from 2004 to 2005. Sablefish abundance is moderate; projected 2005 spawning biomass is 37% of unfished biomass. Abundance has increased from a low of 33% of unfished biomass during 1998 to 2000. The 1997 year class is an important part of the total biomass and is projected to account for 23% of 2005 spawning biomass. The 2000 year class likely is above average although more years of data are needed to confirm its strength. The 1998 year class, once expected to be strong, appears average.

The stock assessment authors recommended a 2005 ABC of 21,000 mt for the Bering Sea, Aleutian Islands, and Gulf of Alaska regions combined. The maximum permissible yield for 2005 from an adjusted $F_{40\%}$ strategy is 21,000 mt. The maximum permissible yield for 2005 represents a decrease (9%) from the 2004 ABC of 23,000 mt and is similar to the 2003 ABC of 20,900 mt. Spawning biomass is projected to decrease from 2004 to 2005 (2%). Spawning biomass currently is at 37% of the unfished level, but is projected to fall to 35% of the unfished level by 2007. Abundance is projected to fall because year classes following the strong 1997 year class are weaker than the 1997 year class. The maximum permissible ABC also is projected to decline to 19,900 mt in 2006 and 18,500 mt in 2007. A 2005 ABC of 21,000 mt was recommended by the NPFMC Groundfish Plan Teams and Science and Statistical Committee, and this was the 2005 ABC value accepted by the NPFMC at its December 2004 meeting.

For more information, contact Michael Sigler at (907) 789-6037 or Sandra Lowe at (206) 526-4230.

# 7. Flatfish

## b. Stock assessments

### *Bering Sea*

**Yellowfin sole**
The 2004 assessment incorporates the 2004 catch and survey information. This year's EBS bottom trawl survey resulted in a biomass estimate of 2,530,000 t, an increase of 13% from last year's survey. The stock assessment model indicates that the stock has been slowly declining over the past twenty years due to recruitment levels which are less than those which built the stock to high levels in the late 1960s and early 1970s. Survey age composition from the 2003 EBS bottom trawl resulted in the lowest estimates of 7 year old and younger fish in the entire time series of the trawl survey. This assessment features an estimate of the relationship between survey catchability and annual mean bottom water temperature and also estimates a Ricker form of the spawner recruit relationship within the model. Results indicate that catchability, averaged over 23 years, = 1.35.

Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, thereby qualifying yellowfin sole for management under Tier 3. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the assessment are 388,000 t, 0.11, and 0.14, respectively. Given that the projected 2005 spawning biomass of 494,000 t exceeds the estimate of $B_{40\%}$, ABC and overfishing recommendations for 2005 were calculated under sub-tier Aa@ of Tier 3. $F_{ABC}$ was set at the $F_{40\%}$ (0.11) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2005 ABC of 124,000 t.

The overfishing level was also determined from the Tier 3a formula, where an $F_{35\%}$ value of 0.14 gives a 2005 OFL of 148,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

In response to SSC recommendations, the authors analyzed stock-recruitment data to consider an alternative assignment of yellowfin sole harvest policy under Tier 1. The authors fit Ricker stock-recruitment curves to two different time-series of data (1954-1999 and 1978-1999) inside the model and obtained very different estimates of MSY and $F_{msy}$ depending on which time-series was utilized.. Concerns regarding the reliability of the stock-recruitment model fit to these data precluded their use to implement a Tier 1 harvest strategy at this time.

**Northern rock sole**
Changes to the input data for the 2004 assessment include addition of the 2003 fishery age composition, 2003 survey age composition, and 2004 trawl survey biomass point estimate and standard error. The 2004 bottom trawl survey resulted in a biomass estimate of 2,182,000 t, a 2% increase over last year=s estimate of 2,135,000 t. The assessment continued the investigation of catchability ($q$) began in 2002. As in last year=s assessment, a value of 1.4 obtained from a trawl Aherding@ experiment was used as the mean of a prior distribution on $q$.

The new assessment gives a *q* estimate of 1.51. Natural mortality was estimated as a free parameter (with q constrained as stated above0 giving the best fit at M = 0.16. M was fixed at 0.18 in past assessments. The biomass of rock sole is expected to decline over the next few years due to below average recruitment observed in the 1990s. The model estimates the 2004 biomass of rock sole at 1,370,000 t, a decline of 27% from the peak level observed in 1995.

Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, therefore this stock qualifies for management under Tier 3. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 205,000 t, 0.15, and 0.18, respectively. Given that the projected 2005 spawning biomass of 420,500 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2005 were calculated under sub-tier Aa@ of Tier 3. The recommended $F_{ABC}$ is at the $F_{40\%}$ (=0.15) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2005 ABC of 132,000 t.

The OFL was determined from the Tier 3a formula, where an $F_{35\%}$ value of 0.18 gives a 2005 OFL of 157,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

The authors responded to a request by the SSC to examine rock sole for possible management under Tier 1. In the case of rock sole, the time series of recruitment estimates from this assessment is 28 years. In the stock assessment model, a Ricker form of the stock-recruit relationship was fit to these data. Very different estimates of $F_{MSY}$ and $B_{MSY}$ were obtained depending on which years of data were included. Recent research indicates a decadal scale shift in atmospheric forcing, which may affect the recruitment of rock sole. Given these concerns, the authors plan to perform a simulation study to determine the appropriateness of applying a harvest strategy resulting from fitting the full time series for a fish stock experiencing temporal less productive reproductive potential due to changing oceanic conditions. Therefore, management under Tier 1 is not recommended at the present time.

**Flathead sole**

The latest assessment updated the previous by incorporating new catch, discard, survey biomass, length composition, and age composition data. The 2004 trawl survey biomass estimate of 617,000 t was about 16% higher than last year's estimate of 530,000 t. Survey biomass has been relatively stable over the past three years compared to the decrease observed from 1998-2000. The assessment again investigated the relationship between temperature anomalies and survey biomass anomalies whereby the survey catchability coefficient was modeled as a function of the temperature anomalies. This addition had an effect on survey biomass estimates since 1998, during which time temperature fluctuations were greater.

Model estimates of age 3+ biomass indicate that the stock has steadily declined from a peak of 942,000 t in 1993 to the 2004 level of 577,600 t, a decline of 39%. The decline is attributable to a reduction in recruitment during the 1990s relative to that observed in the 1980s. The stock remains lightly harvested and well above $B_{40\%}$.

The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, thereby qualifying it for management under Tier 3. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 113,800, 0.30, and 0.37, respectively. Given that the

projected 2005 spawning biomass of 198,000 t exceeds $B_{40\%}$, ABC and OFL recommendations for 2005 were calculated under sub-tier Aa@ of Tier 3 where $F_{ABC}$ is set at the $F_{40\%}$ (=0.30) level, the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2005 ABC of 58,500 t. The OFL was also determined from the Tier 3a formula, where an $F_{35\%}$ value of 0.37 gives a 2005 OFL of 70,200 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

At the request of the SSC, flathead sole productivity and estimation of $F_{MSY}$ were investigated by fitting both Ricker and Beverton-Holt spawner recruit models inside the stock assessment model. Both spawner-recruit models were fit to all the data (1976-2000) and to just the post 1988 data. Very different estimates of stock productivity resulted from this analysis depending on which data set was used (the stock was much more productive when all the data were included). Also, density dependent factors may be confounding the interpretation of the effect of the regime shift on stock productivity. Thus the results of the estimation of MSY and $F_{MSY}$ from the spawner-recruit models are not considered reliable at this time.

**Alaska plaice**

The 2004 assessment incorporated the 2004 shelf survey biomass estimate (488,000 t), 2004 catch data and the 2003 survey length and age composition data into the stock assessment model.. The survey biomass estimate was 4% higher than in 2003. The stock is estimated to be at a high and stable level with relatively stable recruitment since the 1970s. Catchability investigations do not indicate a temperature effect as shown for other shelf flatfish.

Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, therefore qualifying it for management under Tier 3. The updated point estimates are $B_{40\%}$ = 118,000 t, $F_{40\%}$ = 0.76, and $F_{35\%}$ = 1.06. Given that the projected 2005 spawning biomass of 203,000 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2005 were calculated under sub-tier Aa@ of Tier 3. Projected harvesting at the $F_{40\%}$ level gives a 2005 ABC of 189,000 t. The OFL was determined from the Tier 3a formula, where projected harvesting at $F_{35\%}$ gives a 2005 OFL of 237,000 t. Because the age at 50% selection in the fishery is 10.3, Alaska plaice has the potential to spawn twice before it is recruited to the fishery. Additionally, the high natural mortality of 0.25 indicates that the lifetime spawner per recruit potential is rapidly reducing at the ages of highest fishing selectivity. Recruitment has been stable from the late 1970s through present. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

The authors also analyzed stock-recruitment data to consider assessment of Alaska plaice under Tier 1. The authors fit both Ricker and Beverton-Holt stock recruitment curves using two different time series of data. The full time series (1979 B 2001) and the portion of the time series since the possible 1989 regime shift (1989-2001) were examined. Neither stock-recruitment curve fit the data well. Both curves imply that Alaska plaice is highly unproductive and that even a small fishery could not be maintained. Although the stock size may be decreasing somewhat, the authors do not feel that the estimates of productivity implied by these stock-recruitment relationships are accurate, and therefore conclude that management of Alaska plaice under Tier 1 is not advisable at this time.

**Other flatfish**

The other flatfish complex currently consists of Dover sole, rex sole, longhead dab, Sakhalin sole, starry flounder, and butter sole in the EBS and Dover sole, rex sole, starry flounder, butter sole, and English sole in the AI. Starry flounder, rex sole, and butter sole comprise the vast majority of the species landed. For example, Starry flounder and rex sole comprised 84% of the Aother flatfish@ catch in 2004. Because of insufficient information about these species, no model analyses are possible. The latest assessment incorporates 2004 total catch and discard, catch through 20 October 2004, and 2004 trawl survey information. The 2004 EBS bottom trawl survey resulted in biomass estimates of 127,600 t, an 29% increase from the estimate of 99,039 t in the 2003 survey. The biomass of these species in the Aleutian Islands is 14,980 t from the 2004 survey, the highest observed since 1983.

Other flatfish@ are classified as Tier 5 species complex with an assumed natural mortality rate of 0.2. $F_{ABC}$ was set at the 0.75 *M* level (=0.15), which is the maximum permissible level under Tier 5. Projected harvesting at the 0.75 *M* level gives a 2005 ABC of 21,400 t. The overfishing level was set with an $F_{OFL}$ value of 0.20, giving a 2005 OFL of 28,500 t. It is not possible to determine whether the other flatfish complex is overfished or approaching an overfished condition because it is managed under Tier 5.

**Greenland turbot**

The 2004 assessment model incorporated new catch and length frequency data from the fishery. It also included an aggregated longline survey index and updated trawl survey information on biomass and length frequency data. Biomass and size composition data were also included from the EBS slope survey. The stock assessment model indicates that this stock has continued to decline due to the reduced recruitment levels observed in the last 20 years relative to the strong recruitment observed in the 1970s. The stock is still above the $B_{40\%}$ reference level and is lightly harvested. Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock. Updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 51,600 t, 0.39, and 0.5, respectively. Projected spawning biomass for 2005 is 55,600 t.

Greenland turbot therefore qualify for management under Tier 3a. The maximum permissible value of $F_{ABC}$ under this tier translates into a 2005 catch of 15,500 t. The assessment authors= recommend setting the 2005 ABC at a value less than the maximum permissible. Using $F_{ABC}$ = 5-year average results in a 2005 ABC of 3,930 t corresponding to a full selection fishing mortality rate of 0.07. The proposed harvest is apportioned by area on the basis of relative survey biomass, giving an EBS ABC of 2,621 t and an AI ABC of 1,309 t. The OFL fishing mortality rate is computed under Tier 3a, $F_{OFL} = F_{35\%} = 0.5$, and translates into an overfishing level of 19,200 t.

**Arrowtooth flounder**

The present assessment continues to utilize catchability as a function of the annual average bottom temperature during the EBS shelf trawl survey and also uses the EBS shelf trawl survey sex ratios as prior information to estimate sex-specific population numbers at age. This year's EBS shelf bottom trawl survey resulted in a biomass estimate of 547,000 t, a 1% decrease relative to last year's estimate. A slope survey was also conducted in 2004 and resulted in an estimate of 68,600 t. Combined, the two surveys represent the highest biomass estimate for

arrowtooth flounder since the surveys began. The stock remains very lightly harvested with fish caught primarily as bycatch in other fisheries. Discarding occurs at a rate exceeding 50%.

Since more female arrowtooth flounder are caught in trawl surveys throughout Alaska compared to males, and because the oldest female fish have been determined to be older than the oldest males, it is assumed that there are different natural mortality values for each sex. With the female natural mortality rate fixed at 0.2, male natural mortality was profiled over a range of values to determine which value provided the best fit to all the observable population characteristics. The male natural mortality rate that provided the best fit was 0.32. With the stock assessment model configured in this way, the population biomass was estimated at 709,900 t. This is about 7% less than the peak value estimated for 1996. Thus the stock is in a high and stable condition, but declining slowly from the peak observed in 1996.

The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, thereby qualifying arrowtooth flounder for management under Tier 3. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 235,000 t, 0.26, and 0.33, respectively. Given that the projected 2005 spawning biomass of 505,000 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2005 were calculated under sub-tier Aa@ of Tier 3 by *se*tting $F_{ABC}$ (=0.26) which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2005 ABC of 108,000 t. The OFL fishing mortality rate under Tier 3a is $F_{35\%}$ (=0.33), or a 2005 OFL of 132,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

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

### *Gulf of Alaska*

Since no new survey information is available in the Gulf of Alaska, the 2003 assessment (reported last year) is used for management in 2005.

For further information, contact Jack Turnock (206) 526-6549.

## *10. Walleye Pollock*

### a. RESEARCH

#### *Echo Integration-Trawl Surveys*

#### Gulf of Alaska

**Winter echo integration-trawl surveys in Shelikof Strait and near Chirikof Island** –The MACE Program conducted echo integration-trawl (EIT) surveys of midwater walleye pollock in Shelikof Strait and the shelf break southeast of Chirikof Island between 25 March and 1 April 2004. Parallel transect designs were used in both areas surveyed. The Shelikof Strait sea valley was surveyed from about Cape Chiniak on the Alaska Peninsula to south of Chirikof Island

between 25-30 March using 7.5 nmi transect spacing. A survey of the shelf break southeast of Chirikof Island to near the mouth of Barnabas Trough was conducted between 31 March-1 April along 8-nmi spaced transects.

In Shelikof Strait, for the first time since 2000, significant amounts of adult pre-spawning pollock were detected between Cape Kuliak and Cape Kekurnoi, although in lower abundance than in the mid to late 1990s. Significant quantities of adult pollock were also detected off Middle Cape. Pollock in the densest fish aggregations had lengths ranging from about 35 to 40 cm FL (most likely the 1999 year class) with a few larger individuals. Lengths for midwater layers of sub-adult pollock that were observed on some transects ranged from about 30 to 40 cm FL. Younger fish (≤ 30 cm FL) were only prevalent in the southern portion of the survey area. The maturity composition of males longer than 40 cm was 1% immature, 1% developing, 68% pre-spawning, 29% spawning, and 1% spent. The maturity composition of females longer than 40 cm FL was 3% immature, 13% developing, 77% pre-spawning, 5% spawning, and 1% spent. Female pollock were estimated to be 50% mature at 34 cm FL. The mean gonado-somatic index (GSI) for pre-spawning females was 0.16, which was higher than in 2002 (0.12) or 2003 (0.11), but similar to mean GSIs from surveys between 1992 and 2001 (0.14-0.19). Water column (to 0.5-m off the seafloor) abundance estimates were 631 million pollock weighing 291 thousand tons (t) based on catch data from 15 trawl hauls and acoustic data from 659 nmi of survey transects.

Along the Chirikof Island shelf break, most echosign attributed to pollock formed layers between 275 to 500 m depth over bottom depths of 350 to 800 m. Most pollock were shorter than 50 cm FL, which differed from the 2002 and 2003 survey results when most fish were longer than 50 cm FL. No fish shorter than 35 cm FL were caught in this area. The maturity composition of males longer than 40 cm FL was 19% immature, 10% developing, 60% pre-spawning, 6% spawning, and 4% spent. The female maturity composition of fish longer than 40 cm FL was 0% immature, 65% developing, 32% pre-spawning, 2% spawning, and 1% spent. Female pollock were estimated to be 50% mature at a length of 48 cm FL. The average GSI for pre-spawning females was 0.18. Midwater abundance estimates were 45 million pollock weighing 30 thousand t based on catch data from 4 trawl hauls and 121 nmi of acoustic survey transects.

**Summer interaction study between commercial fishing and walleye pollock off East Kodiak** – The MACE Program conducted a field experiment off the east side of Kodiak Island from 13 August to 6 September 2004 to evaluate the effects of commercial fishing on the availability of walleye pollock as prey for endangered Steller sea lions. This effort was a continuation of work conducted during August in 2000, 2001, and 2002. Motivation for the study centered on the concern that factors during commercial fishing operations such as radiated vessel noise, trawling operations, and removal of fish could potentially disrupt pollock distributional patterns over time scales of days to weeks and space scales on the order of 10s of km. These disruptions in fish distribution could reduce sea lion foraging success. The study site consisted of two submarine troughs that served as treatment and control sites with commercial fishing allowed in one trough and prohibited in the other. Repeated acoustic survey passes were conducted over a period of several weeks before and during the fishery. Walleye pollock biomass, vertical distribution, and large-scale, geographical distribution were estimated for each pass in each trough.

Acoustic data were collected from 1930 nmi of survey transects. Most of the acoustic backscattering was attributed to either adult pollock or age-0 pollock with some capelin (*Mallotus villosus*). Adult pollock were distributed throughout Chiniak Trough. Adult pollock were distributed throughout the northern half of Barnabas Trough, as well as the eastern side of the southern half of the trough. Large, dense aggregations of age-0 pollock/capelin, which typically occurred higher in the water column than the adults, were observed throughout Chiniak Trough and in the northern portion of Barnabas Trough. Unlike the deeper dwelling adults, the age-0 pollock/capelin mix often extended beyond the edges of the troughs into shallower water.

Catch data were collected from 69 midwater and bottom trawl hauls, and 15 Methot trawls. Adult pollock size distributions were similar between the two troughs. Most fish were between 40 and 55 cm FL, and few fish were less than 30 cm FL. The modal length of age-0 pollock in both troughs was 7 cm standard length (SL).

Analyses of the 2004 data are underway. Preliminary findings suggest results similar to those in 2001 when no differences in estimates between the pre-fishery and fishery period could be attributed to fishing.

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

**Bering Sea**

**Summer echo integration-trawl survey on the U.S. and Russian Bering Sea shelf** – The MACE Program conducted an EIT survey of midwater walleye pollock in the U.S. and Russian Bering Sea shelf between 5 June and 1 August 2004. This was the first time since 1994 that permission was granted to survey in the Russian Exclusive Economic Zone (EEZ). The survey design consisted of 30 north-south transects spaced 20 nautical miles (nmi) apart over the Bering Sea shelf from Port Moller, Alaska, to Cape Navarin, Russia.

In the U.S. EEZ, water column (to 3 m off the seafloor) abundance estimates were 6.83 billion pollock weighing 3.31 million t based on catch data from 139 trawl hauls and acoustic data from 4980 nmi of survey transects. The biomass was slightly less than in 2002 (3.62 million t) but greater than in the previous five summer surveys starting in 1994 (2.31-3.29 million t). About 31% of the estimated biomass was east of 170°W and about 15% of this value was found inside the Steller sea lion Conservation Area (SCA). East of 170°W, the predominant length mode was 44 cm FL; relatively few juveniles were observed. Pollock abundance and size composition inside and outside the SCA were nearly identical. West of 170°W to the U.S.-Russia border, the predominant length mode was 39 cm FL. Densest aggregations were observed west and south of St. Matthew Island.

Population-at-age estimates from the EIT survey were based on the 2004 Bering Sea bottom trawl survey age data because ages from the EIT survey were not yet available. Pollock from the 2000, 1999, and 2001 year-classes made up most of the U.S. EEZ population. Four-year-old pollock (2000 year class) were estimated to number 2.9 billion and weigh 1.3 million t. This year class contributed about 42% and 40% of the total estimated numbers and biomass, respectively. The age-1 pollock estimate was the lowest since 1994. The age-2 pollock estimate was the second lowest since 1994. These preliminary age estimates will be updated with EIT age data.

In the Russian EEZ, between Cape Navarin and the U.S.-Russia border, water column (to 0.5 m off the seafloor) abundance estimates were 1.55 billion pollock weighing 0.40 million t based on catch data from 15 trawl hauls and acoustic data from 393 nmi of survey transects. The Russia EEZ biomass made up about 9% of the total estimate for the combined U.S.-Russia area surveyed in 2004. The predominant length mode was 31 cm FL and relatively few adult pollock larger than 40 cm FL were observed.

**Summer buoy trawl experiment** – As part of the 2004 Eastern Bering Sea Bottom Trawl survey, scientists from the MACE Program and the Groundfish Assessment Program conducted a collaborative experiment designed to evaluate the behavior of walleye pollock in response to cues from vessels engaged in trawling operations. The study was conducted aboard the chartered fishing vessel Aldebaran in the vicinity of Zhemchug Canyon (~58 30 N, 172 40 W) between 26 July and 6 August 2004. A free-drifting buoy equipped with a calibrated 38 kHz scientific echosounder was used to observe pollock abundance and vertical distribution as the Aldebaran towed an 83/112 Eastern bottom trawl past the buoy.

The acoustic buoy was deployed on 6 occasions, and the trawl was towed past the buoy a total of 24 times. The closest point of approach (CPA) between the vessel and buoy during the passes was 4 to 32 m. The majority of the pollock captured in trawl hauls were 40-50 cm FL.

Two primary types of pollock echosign were observed during the buoy deployments: the fish formed an on-bottom layer within 1-2 m of the bottom (carpet), or they formed more pelagic, dense schools within 20 m of the bottom (cherry balls). Initial analysis of echograms from the buoy indicates that the trawl warps as well as the trawl itself can be discerned on the echogram. These acoustic records will be analyzed to determine whether walleye pollock exhibited behavioral responses such as changes in vertical distribution when approached by the vessel and trawl.

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

**Assessing the effect of light intensity and light penetration on the availability of walleye pollock to the trawl and echo-integration surveys.**

A series of field measurements designed to test if light intensity affects the distribution and feeding of pollock were conducted by incorporating light measurements into existing trawl and acoustic surveys of pollock abundance in the eastern Bering Sea in 2004. The main goal of this research is to determine if surface light intensity and light penetration affect the vertical distribution of pollock and, thereby, their availability to bottom trawl and echo-integration surveys. Currently, these surveys are used as independent estimates of abundance, but our results may provide the means to integrate the results from these surveys and establish a relationship between light penetration and availability of walleye pollock to bottom trawls. If this relationship is established, it has the potential to reduce uncertainty in biomass estimates from the stock assessment model for pollock in the EBS and to increase our understanding of pollock stock dynamics in the EBS.

For more information, please contact Stan Kotwicki (206) 526-6614 or Alex De Robertis (206) 526-4789.

## b. STOCK ASSESSMENTS

### *Gulf of Alaska*

The age-structured model developed using AD Model Builder and used for GOA pollock assessments in 1999-2002 is fundamentally unchanged. This year's pollock assessment features the following new data: (1) total catch and age composition from the 2003 fishery; (2) biomass and age composition from the 2004 Shelikof Strait echo integration trawl (EIT) survey; (3) biomass and length composition from the 2004 ADF&G coastal trawl survey and age composition from the 2002 ADF&G survey. The 2003 NMFS bottom trawl survey biomass estimate increased 86% over a comparable area surveyed in 2001. The 2004 Shelikof Strait EIT survey biomass estimate increased 8% over the 2003 estimate. The 2004 ADF&G near shore survey biomass estimate increased 5 fold from 2003, primarily due to the 1999 year class.

The stock assessment authors evaluated five models: Model 1 estimated the NMFS trawl survey catchability; Model 2a fixed trawl survey catchability at 1.0 (similar to previous assessments) and estimated other catchabilities; Model 2b is configured as 2a, except for a temporary change to *F50%* in 2005 and 2006; Model 2c was similar to 2a, except that the 1999 year class was assumed to be average in abundance for yield projections (the authors' and Plan Team's 2004 ABC recommendation was based on this assumption as a precautionary measure); Model 3 was similar to 2a, except that the weights used to fit the model to the ADF&G survey time series were reduced; Model 4 was similar to 2a, except that the weights used to fit the model to the EIT survey time series were reduced.

There is concern regarding the apparent lack of strong recruitment since the 2000 year class, the lower than expected spawning biomass estimates for Shelikof Strait, and the projected decline in biomass after 2005. The authors recommended a temporary change to an adjusted $F_{50\%}$ harvest rate in 2005 and 2006 to stabilize yields over the short-term, reduce the rate of biomass decline, and at the same time address any residual concerns about the strength of the 1999 year class. While the Plan Team supported these motivating factors, they disagreed on the selection of an appropriate SPR rate, i.e., the selection of $F_{50\%}$ and the time frame under which to apply this rate. As a way to capture elements of pollock stock biomass uncertainty and risk aversion, the Plan Team used the average of the 2004 ABC of 65,660 mt and the projected 2005 yield from an adjusted $F_{40\%}$ harvest strategy (constant buffer) of 106,530 mt for a recommended 2005 pollock ABC of 86,100 mt for GOA waters west of 140 degrees W. longitude (Note that this ABC recommendation includes the 910 mt for Prince William Sound). This harvest level also coincides closely with Scenario 4 of the projections where the recent 5- year average fishing mortality is used. It was felt that a harvest level where the fishing mortality was held stable (rather than increasing) added an appropriate level of precaution.

Model 2a results produced an estimated 2005 spawning biomass of 213,200 mt, or 37% of unfished spawning biomass. The $B_{40\%}$ estimate is 229,100 mt. Because model estimated 2005 female spawning biomass is below $B_{40\%}$, Gulf of Alaska pollock are in Tier 3b. The projected

2005 age-3+ biomass estimate is 736,200 mt. The spawning biomass is projected to peak in 2005 and decline in following years due to the lack of significant recruitment since the 2000 year class. Markov Chain Monte Carlo analysis indicated the probability of the stock being below $B_{20\%}$ to be less than 1% in 2005 and subsequent years. The 2005 OFL under Tier 3b is 144,340 mt.

No new survey information is available for pollock east of 140 degrees W. longitude (Southeast Alaska). Southeast Alaska pollock are in Tier 5 and the ABC and OFL recommendations based on natural mortality (0.30) and the biomass from the 2003 survey remain the same.

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

***Eastern Bering Sea***

The Eastern Bering Sea Pollock resource remains at a high and stable level while sustaining average annual harvest levels greater than 1 million tons. The 2004 stock assessment incorporated new data from the 2004 EIT and bottom trawl surveys and from the 2004 fishery. The 2004 EIT survey estimated a biomass of 3,310,000 t, a decrease of 8% relative to the 2002 estimate. The 2004 bottom trawl survey estimated a biomass of 3,750,000 t, a decrease of 54% relative to the all-time high estimate obtained in 2003 but was within the range of the 1999-2002 estimates. The estimates of average weight at age from the fishery were revised with more recent measurements.

Six alternative models approaches were considered, all of which follow the statistical age-structured approach that has been used for the last several years. All of the models give point estimates of 2005 spawning biomass in the range 2,580,000 t to 3,310,000 t. A model (Model 4) which explicitly addressed the possibility that an environmental covariate (summer bottom temperature) had an effect on trawl survey catchability failed to find a statistically significant relationship. The assessment authors based their recommendations for 2005 on the reference model (Model 1), which is identical to last year=s model. The current assessment provides estimates of the biomass time series that are slightly lower than those provided in last year's assessment. Due to reduced levels of recruitment observed in the past 3 years, the stock is projected to decline to levels that were present in the early 1990s in the near future.

The SSC of the NPFMC has determined that reliable estimates of $B_{MSY}$ and the probability density function for $F_{MSY}$ exist for this stock, and that EBS walleye pollock therefore qualify for management under Tier 1. The senior assessment author continues to feel that the Tier 1 reference points are reliably estimated given the structure of the model. The updated estimate of $B_{MSY}$ from the present assessment is 2,230,000 t, compared to 2,470,000 t from last year's *NPFMC Bering Sea and Aleutian Islands SAFE assessment*. The projected spawning biomass for 2005 is 2,870,000 t, placing EBS walleye pollock in sub-tier Aa of Tier 1. As in last year's assessment, the maximum permissible ABC harvest rate was based on the ratio between MSY and the equilibrium age 3+ biomass corresponding to MSY. The harmonic mean of this ratio from this year's assessment is 0.233, identical to the value obtained in last year=s assessment. This ratio is multiplied by the geometric mean of the projected age 3+ biomass for 2005 (8,410,000 t) to obtain the maximum permissible ABC for 2005, which is 1,960,000 t. This ABC is about 3% higher than the 2005 yield corresponding to an *F40%* strategy, which is

1,900,000 t. In each of the last three years, the senior assessment author, Plan Team, and SSC all recommended setting ABC at the maximum permissible value. For 2005, the assessment authors recommended setting ABC at the $F_{40\%}$ level rather than at the maximum permissible value since the 2001, 2002, and 2003 year classes are all estimated to be well below average and that ABC recommendations for the near future are expected to be substantially lower than the 2005 recommendation.

The overfishing harvest ratio under Tier 1a is 0.250, the arithmetic mean of the ratio between MSY and the equilibrium age 3+ biomass corresponding to MSY. The product of this ratio and the geometric mean of the projected age 3+ biomass for 2005 (8,410,000 t) gives the overfishing level for 2005 of 2,100,000 t. The walleye pollock stock in the EBS is not overfished and is not approaching an overfished condition.

***Aleutian Islands***

In last year's assessment, preliminary explorations of several age-structured models were provided for the first time, all of which focused on the portion of the stock to the west of 174° W. In this year's assessment, five alternative age-structured models were developed and evaluated. The assessment focuses on two of those models, one of which (Model 1) uses data only from the portion of the stock to the west of 174° W, and the other of which (Model 1B) includes survey data from the entire Aleutian Islands management area. The time series of survey biomass estimates for the entire Aleutian Islands management area tends to show greater year-to-year consistency than the time series for the portion west of 174° W. For example, the 2002 and 2004 estimates for the entire Aleutian Islands management area are 175,283 t and 130,451 t, respectively, whereas the corresponding estimates for the portion west of 174° W are 121,915 t and 19,201 t, respectively. The model (1B) which used all the information was the model of choice for 2005.

If the SSC determined that the Aleutian pollock stock qualified for management under Tier 3 using Model 1B, the estimates of 2005 spawning biomass, *B40%*, and *F40%* would be 131,000 t, 77,000 t, and 0.35, respectively. However, the SSC used a precautionary approach for 2005 and 2006 and continued to use the Tier 5 harvest strategy for Aleutian Islands Pollock where $F_{ABC}$ is calculated as 0.75 * M. With M=0.3 the ABC harvest level is 29,400 t and the overfishing level is 39,100 t. As a Tier 5 stock, it would not be possible to determine whether Aleutian pollock is overfished or whether it is approaching an overfished condition.

***Bogoslof***

The 2003 hydroacoustic survey of the Bogoslof region resulted in a biomass estimate of 198,000 t. There was no survey of the Bogoslof region this year. Last year, the SSC determined that Bogoslof Pollock qualified for management under Tier 5. The maximum permissible ABC under Tier 5 is 75% of the product of the natural mortality rate (0.20) and biomass, giving a value of 29,700 t. The overfishing level under Tier 5 is the product of the natural mortality rate and biomass, giving an OFL of 39,600 t for 2005. As a Tier 5 stock, it is not possible to determine whether Bogoslof pollock is overfished or whether it is approaching an overfished condition.

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

## *11. Dogfish*

### a. RESEARCH

***NMFS Auke Bay Laboratory and University of Alaska Fairbanks Joint Research on Spiny Dogfish in the Gulf of Alaska***

In 2004, scientists from the NMFS Auke Bay Laboratory and the University of Alaska Fairbanks, School of Fisheries and Ocean Sciences (SFOS), Juneau Center, conducted a joint study on spiny dogfish in the Gulf of Alaska. Little is known about the life history or ecological role of spiny dogfish (*Squalus acanthias*) in the North Pacific despite the fact that they comprise a relatively large biomass in coastal northeast Pacific waters. The 2004 research was designed to collect critical information on life history, ecology, population dynamics, and fisheries bycatch for spiny dogfish in the Gulf of Alaska. One aspect of this research is to collect seasonal time series of life history and ecological information from spiny dogfish in several locations within the Gulf of Alaska. where they are commonly encountered as bycatch.

Spiny dogfish were captured for tagging and biological sampling from a chartered 30' sport-fishing boat in Yakutat Bay, Alaska. A total of 59 spiny dogfish were tagged and released. Electronic archival tags were surgically implanted in 37 spiny dogfish. A fluorescent pink disc tag with the words "reward for tag inside fish" was attached to the first dorsal fin of each electronically tagged spiny dogfish. The Auke Bay Laboratory is offering a $200 reward for return of the electronic archival tags. An additional 22 spiny dogfish were tagged with externally attached modified disc tags. The modified disc tags were uniquely numbered on one side and have the Auke Bay laboratory address printed on the other side. No tagged spiny dogfish have been recovered.

A total of 110 spiny dogfish, 96 females (80-110 cm) and 22 males (80-90 cm), were taken for biological sampling of age, maturity, and diet. Age will be determined from dorsal spines. Maturity and diet were examined on the boat. Most (80%) of the spiny dogfish examined were immature. One female was pregnant with 8 very young embryos. Most stomachs were empty, but the few items found suggest that spiny dogfish in the Yakutat region are opportunistic predators with a high incidence of invertebrates. Items found in stomachs in order of incidence of occurrence included several species of jellyfish, razor clams, shrimp/krill, and unidentified forage fish species.

A second sampling effort was conducted in offshore waters as part of the annual sablefish longline survey aboard the chartered longline vessel *Alaskan Leader*. Spiny dogfish caught as bycatch were sampled during Leg 5 of the survey, from August 9-19, 2004, covering stations between Cordova and Kodiak, AK. A total of 137 spiny dogfish, 85 females (70-112 cm) and 52 males (67–95 cm) were taken for biological sampling of age, maturity, and diet. Maturity was assessed onboard. None of the adult females sampled were pregnant. Stomach contents were preserved for further detailed examination. Initial examination of the stomachs suggests a different diet from that seen in the Yakutat Bay samples, but with invertebrates still being the

dominant type. Krill was by far the most common food item (by incidence of occurrence), followed by shrimp, octopus, crab and jellyfish.

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

## *13. Other Species*

### a. RESEARCH

***Pacific Sleeper Shark Acoustic Tagging in Upper Chatham Strait, Southeast Alaska***

Pacific sleeper sharks (*Somniosus pacificus*) are a deepwater shark of the North Pacific Ocean. Little information is available for Pacific sleeper sharks, although they are considered common in boreal and temperate regions of shelf and slope waters of the North Pacific. This study deployed acoustic transmitting tags on Pacific sleeper sharks in the upper Chatham Strait region of Southeast Alaska. The recovery of temperature, depth, and location data from the electronic tags will aid in the identification of Pacific sleeper shark habitat utilization and distribution in Southeast Alaska and identify the potential for interactions between Pacific sleeper sharks and other species in this region.

In 2004, 24 acoustic transmitting tags were surgically implanted on Pacific sleeper sharks in Chatham Strait. The acoustic tags periodically transmit temperature, depth, and movement for up to 1 km, and can transmit data for up to one year. Data from the acoustic tags were recovered with hydrophones deployed from a charter vessel. A total of 13 Pacific sleeper sharks were acoustically relocated within 60 nautical miles of the release location. Tagged sharks were tracked at depths of up to 500 m, traveled approximately 6 km per day, and exhibited vertical migrations off the bottom.

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

### *Grenadiers in Alaska*

The Auke Bay Laboratory in collaboration with the AFSC Resource Ecology and Fishery Management Division (REFM) completed a preliminary analysis of data on grenadiers in Alaska to provide a synopsis of biological, fishery, and survey information for these fish. This was in response to requests from North Pacific Fishery Management Council (NPFMC) staff and from NPFMC Management Plan Teams for more information on non-target species in the Alaska groundfishery. At least seven species of grenadier are known to occur in Alaskan waters, but only three are commonly found at depths shallow enough to be encountered in commercial fishing operations or in fishery surveys: giant grenadier (*Albatrossia pectoralis*), Pacific grenadier (*Coryphaenoides acrolepis*), and popeye grenadier (*Coryphaenoides cinereus*). Of these three species, only giant grenadier appears to warrant management concern at present. Survey information indicates that giant grenadier are the most abundant fish on the continental slope at depths 400-1,000 m in all surveyed areas of Alaska except the eastern Gulf of Alaska. As such, they have a significant role in the slope ecosystem and are important predators in this habitat. Although there is no directed fishery for giant grenadiers in Alaska, substantial numbers are taken as bycatch and discarded in the sablefish and Greenland turbot longline fisheries. Estimated annual catches of giant grenadier in Alaska may have ranged between 13,000 mt and 21,000 mt in the years 1997-2001. The large biomass of giant grenadier in Alaska may be able to support this level of catch, but the reported longevity and slow growth of this species makes it susceptible to overfishing. Furthermore, a high proportion of the catch is likely female because mostly female giant grenadier live at the depths where the commercial fishery operates. Disproportionate removal of females by the fishery could put stocks of giant grenadier at greater risk. One possible mitigating factor that may protect giant grenadier from overfishing is that a substantial portion of its population may inhabit depths >1,000 m, where they are currently safe from fishing pressure. These deep waters could act as a *de facto* reserve to replenish giant grenadier removed by the fishery in shallower water. Future plans are to conduct additional analyses of fishery and survey data for giant grenadier, as well as biological studies, to better determine the life history and population dynamics of this species.

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

### *Investigations of a Skate Nursery Area in the Eastern Bering Sea - RACE*

Skates utilize designated nursery grounds for egg case deposition and subsequent embryo development. Virtually nothing is known about the nursery grounds for skate species from Alaskan waters. This study attempts to characterize two skate nurseries in the eastern Bering Sea with a focus on skate biology and ecology. Specifically the projects goals and objectives are to:

* Determine nursery locations and area of use
* Determine skate species using the nursery areas
* Estimate annual production for each nursery area
* Determine reproductive cycles for skates in the nursery areas
* Determine embryo developmental and hatching duration
* Estimate predation rate on skate eggs and juvenile skates
* Describe habitat structure and biotic associations within skate nursery areas

Skate nursery habitat locations and area of use were determined during a 10 day charter aboard the F/V *Ocean Explorer* from July 27-August 5, 2004. An 83-112 eastern Bering Sea bottom trawl was used as the sampling tool to sample benthic fauna and egg cases in each nursery. An adaptive sampling scheme was employed to determine the spatial heterogeneity and the extended area of use for each site. Samples of collected eggs from each trawl were measured and staged for developmental state. Reproductive state and stomach contents of all species of skates were collected, as well as stomach contents of the main piscivorous species in the nurseries.

During the July 2004 research cruise, three nursery areas were located in the southern eastern Bering Sea. A site was located for the Alaska skate *Bathyraja parmifera,* the Aleutian skate *B. aleutica*, and the Bering skate *B. interrupta*. Each nursery area was characterized by containing dense masses of viable skates eggs and mature adults of each species. Total nursery area for each species appears to be relatively small (10's of nm) and distributed over homogeneous bottom types and depths.

Each site contained significant heterogeneity as to developmental state and egg densities across the nursery. Skates eggs were in all states of development within each site, however they were relatively homogeneous as to developmental state for a given trawl sampling location. Skates appear to alternate patches within the nursery for egg deposition during each cycle. Based on seasonal sampling egg development time to hatching may be as long as 12-16 months.

Adults skates sampled at each site were generally in reproductive state and actively producing and depositing egg cases or in otherwise mature reproductive state. Reproductive cycles are protracted lasting from January through September. Although general high and low reproductive activities at each nursery site was evident, a few actively reproducing skates were present throughout the year.

Predation on egg cases occurred during the early developmental stages most likely by predatory snail species. Predation on newly hatched skates was observed in two species, Pacific cod and Pacific halibut.

For further information, contact Gerald R. Hoff, (206) 526-4580.

## b. STOCK ASSESSMENT

### *Shark Bycatch in Alaskan Waters*

A stock assessment report was written for the North Pacific Fishery Management Council (NPFMC) Plan Teams that summarized available information on shark incidental catch, abundance trends and distribution, and independently estimated life history parameters in the Gulf of Alaska (GOA), Eastern Bering Sea (EBS), and Aleutian Islands (AI). Since the late 1990's, the NPFMC's Scientific and Statistical Committee (SSC) has suggested that sharks, along with skates and many rockfishes, warrant particular concern because of their late maturity, low productivity, long life spans, and low reproductive rates. The SSC has noted that these life history characteristics make these species especially vulnerable to overfishing and that they should be evaluated separately to ensure appropriate conservation and protection within the

current management system. A Non-Target Species Committee of the NPFMC is currently working on developing appropriate conservation actions for non-target species and species complexes, including sharks, within the current Fisheries Management Plan (FMP) framework. The shark assessment report is intended to provide guidance.

Incidental catches of sharks were estimated from NMFS Alaska Regional Office data for 1997–2004 and from NMFS North Pacific Observer Program data. Survey data on sharks were available from NMFS AFSC bottom trawls in the GOA (1984–2003), EBS shelf (1975–2004), EBS slope (historical 1979-1991, and new time series 2002, 2004), and AI (1979–2002); International Pacific Halibut Commission longline surveys in the GOA and Prince William Sound (1994-2003); and ADF&G sablefish longline surveys in Prince William Sound (1996-2003). Reported total incidental catches of Other Species have been relatively small in the GOA (averaging less than 3% of total catch from 1977-1998) and in the EBS/AI (approximately 1.5% of total catch in 2001). From 1997–2001, shark catches composed from 19% to 32% and from 1.3% to 2.5% of estimated Other Species total catches in the GOA and EBS/AI respectively. In the GOA, spiny dogfish composed 42% of total shark catch, Pacific sleeper sharks 25%, unidentified sharks 26%, and salmon sharks 6%. Blue sharks, sixgill sharks, and brown cat sharks were rarely identified in catches. In the EBS/AI, Pacific sleeper sharks composed 78% of total shark catch, unidentified sharks 17%, salmon shark 3.7%, and spiny dogfish 1.5%.

There are currently no directed commercial fisheries for shark species in federally or state managed waters of the GOA or EBS/AI, and most incidentally captured sharks are not retained. Spiny dogfish are allowed as retained bycatch in some NMFS and ADF&G managed fisheries, and salmon sharks are targeted in some ADF&G managed sport fisheries. Incidental catches of shark species in the GOA and EBS/AI fisheries have been very small compared to catch rates of target species. Preliminary comparisons of incidental catch estimates with available biomass estimates suggest that current levels of incidental catches are low relative to available biomass for spiny dogfish and Pacific sleeper sharks in the GOA and for Pacific sleeper sharks in the EBS/AI. There is also an increasing trend in bottom trawl survey biomass estimates (used here as an index of relative abundance) for Pacific sleeper sharks and perhaps for spiny dogfish in the GOA. Salmon sharks are rarely captured in the GOA or EBS/AI in either the fishery or the bottom trawl surveys. Spiny dogfish are rarely captured in the EBS/AI in either the fishery or the bottom trawl surveys. Other shark species are rarely captured, and incidental catches of these other species are not likely to play a significant role in their stock structure because catches were small and generally occurred near the edge of their ranges.

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

# D. OTHER RELATED STUDIES

## *Survey Strategies for Assessment of Bering Sea Forage Species*

This project will apply a suite of survey techniques to assess distribution, species composition, and diet of forage species from nearshore to continental slope habitats. Sample results will be used to identify strengths and constraints of single and integrated approaches in an effort to optimize habitat-specific surveys. This information does not exist because standard research

surveys by the Alaska Fisheries Science Center do not target many forage species. Capelin, eulachon, Pacific herring, Pacific sandfish, Pacific sand lance, and other ecologically important species are commonly found in nearshore environments to feed or spawn. Nearshore areas provide crucial nursery habitat for the juvenile life stages of many fish species such as Pacific cod, walleye pollock, and flatfish and rockfish species. The shelf region is used as a feeding area and migratory corridor for many of these same species. Myctophids, bathylagids, and squids are commonly found on the continental shelf and slope and are important in the diet of many apex predators. Lack of information on forage species composition, distribution, and movements hinders our understanding of the ecological role of forage species in the Bering Sea. This lack of understanding hinders efforts to conserve forage species and to enhance the recovery of declining marine mammal populations such as Steller sea lions. This project will examine distributions, abundances, food web relationships, and test survey technologies used to assess forage species in the Bering Sea. Fieldwork is planned for 8-22 June 2005 near Akutan, Akun, and Unimak Islands to 100-km offshore. This project is funded by the North Pacific Research Board. Cooperators on the project besides the Auke Bay Laboratory are the University of Alaska, University of Washington, Louisiana State University, and the NOAA Environmental Technology Laboratory.

For more information, contact Michael Sigler at (907) 789-6037.

## *Effects of Fishing on Sea Floor Habitat*

### Deep-Sea Coral Distribution and Habitat in the Aleutian Islands

In the Aleutian Islands, two studies were completed in summer 2004 on the distribution and habitat of deep-sea corals and the biological communities associated with these corals. The first study used the manned submersible *Delta* in June and July, whereas the second study in late July used the RV *Roger Revelle* as a support vessel for the remotely operated vehicle (ROV) *Jason II*.

The *Delta* was used to complete the second and final phase of a project to assess Aleutian Island coral habitat in waters less than 365 m deep. (This was the maximum depth the submersible could operate). The North Pacific Research Board and the Alaska Fisheries Science Center funded this component of the study. Scientists visited 10 sites and collected video of the seafloor on 23 strip transects. Previously undocumented beds of sponges, predominantly demosponges, were documented on an additional 6 dives. Over 150 coral specimens were collected for molecular and morphological taxonomic identification and for studies on reproduction. More than 100 sponge specimens were also collected, and 5 of the first 10 specimens analyzed microscopically confirmed that they are species new to science.

In July 2004, the RV *Roger Revelle* departed Dutch Harbor, Alaska with a team of biologists, fisheries scientists, and geologists to study deep-sea coral habitat in the central Aleutian Islands. The team used the ROV *Jason II* (Woods Hole Oceanographic Institute) to document coral and sponge habitat in deeper water down to 3,000 m. NOAA's Undersea Research Program funded the cruise, and this was the final component of a comprehensive study initiated in 2003 and funded by NOAA Fisheries and the North Pacific Research Board.

Dives were made with the ROV *Jason II* at ten sites in the Central Aleutian Islands ranging at depths from 131 m to 2,948 m. Video footage of the seafloor was collected along strip transects ranging from 13.2 to 2.4 km in length. Corals and sponges were widely distributed at the study sites with an apparent change in density, diversity, and species composition at a depth of approximately 1,400 m. Samples were collected at stations along transects and included 260 corals, 45 sponges, 165 miscellaneous invertebrates, and 82 rocks. Preliminary results indicate that representatives from all seven coral families known to occur in the North Pacific were collected and that several of the collected sponges represent species new to science.

Ultimately, the goal of all this research is to construct a model to predict the distribution and density of coral habitat throughout the Aleutian Islands based on depth, substrate type, habitat type, oceanographic parameters, and geological features. Fishing effort and predicted coral habitat distribution data will be entered into a geographical information system to create maps showing areas of coral habitat and fishery interaction. The scientific goals of this work are to study the zoogeography, ecology, and life history aspects of deep-water corals. This information will directly assist fishery managers in developing methods to minimize fishing interactions with coral habitat in the Aleutian Islands and should provide them with a powerful tool to conserve coral habitat in this region.

For more information, contact Robert Stone at (907) 789-6031 or Jon Heifetz at (907) 789-6054.

**Growth and Recruitment of an Alaskan Shallow-Water Gorgonian**

At least 45 species of gorgonian corals inhabit Alaskan waters. Specimens of all but one species have been found incidentally entangled in fishing gear (e.g., hook and line, longlines, trawls, crab pots, and fish traps) and detached from the seafloor. Several species attain large size and provide habitat in the form of structure and refuge for species of demersal fish and invertebrates. The effects of coral habitat alteration on benthic communities are unknown, but may be substantial due to the reported longevity and slow growth rates of cold-water corals. The North Pacific Fishery Management Council recently approved areal closures to protect areas where gorgonian corals are abundant. A five-year study to examine the growth and recruitment of *Calcigorgia spiculifera*, a shallow-water gorgonian, was established by the Auke Bay Laboratory in 1999 to provide insights into gorgonian growth rates, validate radiometric aging techniques, and elucidate the effects of fishing activities on coral habitat.

Computer image analysis tools were used to measure the linear length of colony branches from digitized video images collected by scuba diving on tagged specimens. Length of a branch was measured along the medial axis from the point opposite its origin. This method provides a permanent record of colony morphometry. Highly accurate measurements are possible with proper colony orientation with respect to the calibration grid and parallel alignment of the camera lens with the grid.

Thirty-seven colonies were tagged at 2 sites in southeastern Alaska in July 1999 and thirty colonies were tagged at a third site in 2001. Growth rate measured during the first year were variable for branches from the same colony and also between colonies. Mean branch growth rate at both sites ranged from -1.82 to 14.83 mm $yr^{-1}$ in 2000 and -0.80 to 9.7 mm $yr^{-1}$ in 2001. Growth rates (2000 mean =5.81 mm $yr^{-1}$, sd =4.99, 2001 mean =2.95 mm $yr^{-1}$, sd =2.66)

measured during both years were generally much lower than those reported for other gorgonians worldwide, including Alaskan *Primnoa*, a deep-water species. Recruitment of new colonies had not occurred at either study site for a minimum of several years indicating that recruitment in this species, at least at our study sites, is a rare sporadic event.
The slow growth rates measured so far in this study, although preliminary, are noteworthy because shallow-water corals are widely believed to have faster growth rates and shorter life spans than deep-water corals. Additionally, recruitment appears to be a rare, sporadic event. Shallow-water gorgonian communities may therefore exhibit slow recovery rates from sea floor perturbations. This study concluded during July 2004 and growth measurements collected during the five-year study are currently being analyzed.

For more information, contact Robert Stone at (907) 789-6031.

**Exploration of Shallow Water Thickets of the Red Tree Coral (Primnoa sp.) in Glacier Bay, Alaska**

In 2004, scientists from the Auke Bay Laboratory and the U.S. Geological Survey conducted reconnaissance scuba diving in Muir Inlet, Glacier Bay in response to a sighting of red tree coral (*Primnoa* sp.) in shallow water (20 m). Red tree coral is a large, structure-providing gorgonian that forms dense thickets in the North Pacific Ocean. *Primnoa* thickets provide important structural habitat to many species of demersal fish, including juvenile rockfish (*Sebastes* sp.). *Primnoa* is fragile and quite vulnerable to fishing activities that use bottom-contact gear and is believed to be long-lived and slow growing. The presence of *Primnoa* colonies in shallow water areas provided scuba divers with an invaluable opportunity to study the ecology and growth rate of this important gorgonian *in situ*. Colonies were found at six locations in Muir Inlet and were more than 1 m in length at several locations. Colonies were found at depths ranging between 11 and 35 m and these observations represent a shallow water depth range extension for the genus. Scientists believe that shallow water areas in the glacial fiords support *Primnoa* thickets because the oceanographic conditions (low temperature, high salinity, and low ambient light levels) there are uniquely similar to those found in their typical depth range (> 150 m depth). This phenomenon is known as “deep-water emergence”.

The deglaciation record in Glacier Bay has been meticulously recorded during the past 130 years and this timeline will provide scientists with an invaluable opportunity to validate indirect methods previously used to age *Primnoa*. Information on the growth of this species will provide insights into the ability of this coral to recover from disturbance and its ability to recolonize areas established to mitigate the effects of fishing activities. In 2005, scientists will explore *Primnoa* distribution in the West Arm of Glacier Bay where oceanographic conditions differ somewhat from those in Muir Inlet and where deglaciation has occurred at a different rate.

For more information, contact Robert Stone at (907) 789-6031.

**Habitat Evaluation of Major Fishing Grounds**

The Sustainable Fisheries Act of 1996 was passed to attain long-term protection of essential fish habitat, and it specifically requires that NMFS minimize adverse impacts to essential fish habitat by fisheries that it manages. While considerable legal and administrative effort has been

expended to meet the requirements of the Act, there has been little effort to observe the habitat where ongoing fisheries occur. NMFS has limited knowledge of bottom habitat where major fisheries occur. Any regulatory measures adopted to minimize impacts without the knowledge of whether or where vulnerable habitat is at risk may be ineffective or unnecessarily restrictive. This study, initiated by the Auke Bay Laboratory in 2001 on the Portlock Bank area of the central Gulf of Alaska, is an effort to attain such knowledge.

During 2002 and 2003, the study was expanded to include additional areas. High-resolution echosounder data were collected by the RV *Davidson* on the Pamplona Spur and south Yakutat Valley areas of the eastern Gulf of Alaska and in the vicinity of Albatross Bank in the central Gulf. The areas mapped by echosounder were 162 $km^2$ of Pamplona Spur in depths of 120 m to 940 m, 372 $km^2$ of the Yakutat Valley in depths of 190 m to 1,045 m, and 340 $km^2$ of Albatross Bank in depths of 20 to 810 m. These mapped areas were also in the vicinity of extensive bottom trawl and longline fisheries for groundfish. Video data of the bottom previously were collected in some of the mapped areas from the manned submersible *Delta*. The objective of the 2002 and 2003 study was similar to that of the 2001 study (i.e., characterize bottom habitat in or near heavily fished grounds) and also to compare these findings to those obtained from the 2001 survey of Portlock Bank. Habitat maps based on interpretation of the bathymetry and backscatter have been completed.

For more information, contact Jon Heifetz at (907) 789-6054 or Kalei Shotwell at (907) 789-6056.

**RACE Habitat Research Team**

Research by the RACE Division Habitat Research Team addresses Congressional mandates to describe and identify essential fish habitat (EFH) of federally managed species in Alaska. In practice, systematic trawl survey data are used to designate EFH as those areas supporting the highest relative abundance. This presumes that density data reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value. Subsequent characterization of these areas requires systematic mapping of the relevant biotic and abiotic variables. In general, environmental data are lacking and a substantial effort is devoted to the identification of suitable variables and the development of tools for mapping them over large areas. The HRT also investigate activities with potentially adverse effects on EFH, such as bottom trawling.

# 2004 HRT Field and Laboratory Research

***Determining the value of habitat to juvenile rockfish in the Aleutian Islands*** – This study assesses the value of Aleutian Islands habitat to juvenile Pacific ocean perch (POP) by examining abundance, condition and growth in five study areas. The initial phase of habitat mapping was completed during a research cruise from 28 May - 9 June 2004. Video transects and sediment samples were completed on a cruise from 13-24 August 2004. Each of five study areas surrounding the Islands of Four Mountains was mapped using a towed side scan sonar (100/500 kHz) and a multibeam system (100 kHz), to collect bathymetry and backscatter data.

In total, 25 $km^2$ were mapped using side scan sonar, and multibeam data were collected over almost twice that area. Video and sediment samples were collected to groundtruth the acoustic data. Preliminary results indicate the seabed at each area varied widely, from bare sand fields to rocky ledges, ridges and pinnacles. Sponge and coral were the dominant epibenthic invertebrates observed in the video and trawl collections. Juvenile POP were collected from 4 of the 5 study areas for laboratory analyses. Sponge and coral were observed at most sites where juvenile POP were collected. During the fall and winter of 2004-05 sediment samples, zooplankton, and fish collections were analyzed in the laboratory, and data analyses will follow.

***Bogoslof Island mapping and colonization*** – Colonization of benthic invertebrates at hard-bottom sites on Bogoslof Volcano is being studied to provide estimates of recovery rates from benthic fishing activities. Bogoslof provides a natural laboratory for this work because lava and tephra from historical eruptions (since 1796) have resurfaced different areas of the shallow seafloor around the island. The results will help managers define an upper bound on recovery time. The project involves three separate stages of research: mapping the seafloor, matching seafloor areas to specific eruptions (dates), and conducting an ROV census of benthic invertebrates within seafloor areas of known ages. The first phase of the project was completed in July 2004 when the seafloor surrounding Bogoslof (20-750 m depths) was successfully mapped with a multibeam echosounder. When funding is available, ROV transects will be conducted to selectively age the substrate and census the invertebrates.

***Long-range fisheries sidescan sonar R&D*** – The broad scope of the EFH mandate requires an efficient process for identifying and mapping habitat. Although biological data are readily available from fishery-independent surveys, the availability of environmental data is much more limited. Existing data consist of temperature profiles and derived depth measurements gathered during RACE Division bottom trawl surveys. Although research indicates surficial sediments affect the distribution and abundance of many groundfish species, direct sampling with benthic grabs and remote sensing with multibeam echosounders are prohibitively expensive over large areas. This research project will investigate the utility of acoustic backscatter for EFH characterization, while comparing the cost-benefit of various sonar systems. Performance of each system will be based on the degree of statistical correlation between normalized backscatter and fish density. An interferometric side scan sonar (455 kHz), two hull-mounted multibeam echosounders (50 kHz, 100 kHz), a 38 kHz bridge sounder, and a Long Range Fishery Sonar (LRFS) will be evaluated. The LRFS currently being manufactured is a towed system capable of very broad coverage at somewhat reduced resolution. A fiber-optic interface for the LRFS and a towed video package was assembled and tested in 2004. A 21 day Bering Sea cruise aboard NOAA ship FAIRWEATHER is scheduled for summer 2006.

# 2004 HRT Analysis Activities

***EFH EIS revision*** – HRT participated in responses to a review comments on the Alaska EFH EIS by the Council of Independent Experts.

***Short-term trawling effects and recovery monitoring in the eastern Bering Sea*** – This ongoing multi-year study is a process-oriented investigation of short-term effects and recovery using a BACI experimental design. The study area is located within the Crab and Halibut Protection Zone 1 closed area in Bristol Bay. During a 35-day cruise in 2001, 6 pairs of predesignated 10-mi long research corridors were sampled before and after a trawling disturbance with commercial gear (NETS 91/140 Aleutian cod combination). The experimental and control corridors were also surveyed before and after trawling using a Klein 5410 side scan sonar system. A quantitative evaluation of possible changes in sediment characteristics and bedforms before and after trawling is underway.

***Evaluating single beam echosounders for synoptic seabed classification*** – Nearly 8 million digitized echo returns from the seafloor were simultaneously collected at two frequencies (38 and 120 kHz) along a 9,000 nm trackline in the eastern Bering Sea (EBS) during a 1999 hydroacoustic fishery survey on the *R/V Miller Freeman*. Collaborative research with QTC has resulted in a fully-automated objective classification process involving a new application of the Bayesian Information Criterion (BIC). Data have also been processed using standard QTC methods. An optimal classification scheme for the EBS shelf has been identified (14 distinct classes of bottom types for 38 kHz data) and these results have been merged with 23 years of RACE trawl survey data from the EBS shelf (1982-2004). Statistical analyses are being conducted to examine the degree to which acoustic variability corresponds to environmental features that influence the distribution and abundance of groundfish and benthic invertebrates.

***Distribution of juvenile Pacific ocean perch in the Aleutian Islands*** – The objective of this research was to identify juvenile POP habitat using data from trawl surveys conducted by NMFS. Analyses were carried out to evaluate the POP CPUE relationship to depth, temperature, and sponge and coral CPUE. A principal component analysis indicated that sponge and coral CPUE were tightly linked, and depth and temperature were negatively correlated. The survey data indicate that juvenile POP were present at depths from 76 to 225 m. Juvenile POP CPUE increased with depth from 76 to 140 m, and decreased with increasing temperature from 3 to 5.5ºC. Juvenile POP CPUE also increased with increasing sponge and coral catch rates. A statistical model predicting juvenile CPUE at stations where POP were caught explained 34% of the CPUE variability using bottom temperature, depth, and combined sponge and coral CPUE. Juvenile POP were most abundant at sites in the western Aleutians (beyond 170º W longitude), on large underwater banks (Stalemate and Petrel banks), and in passes between islands where currents are strong and production may be higher than surrounding areas. These results suggest sponge and coral have an important role in the early life history of juvenile POP.

***Distribution of flathead sole by habitat in the Bering Sea*** – This study developed a robust method for modeling and predicting habitat use by a commercially harvested groundfish species

based on biological and physical variables. Models for eastern Bering Sea flathead sole were based on predicted ecological relationships for 1998-2000 trawl survey data, and the best fitting model was successfully tested on 2001-2002 data. Flathead sole CPUE had a curvilinear relationship with depth, peaking at 140 m, a proportional relationship with bottom water temperature, a positive curvilinear relationship with invertebrate sheltering organisms (anemones, corals, sponges, etc.), a negative relationship with increasing proportion of mud in the sediment, and an asymptotic relationship with prey abundance. The predicted CPUE was highly correlated ($r = 0.79$) to the observations (1998-2000) and the model accurately predicted CPUE ($r = 0.76$) in the test data set (2001-2002). Residual plots of the model fits from each year suggest the model tended to under-predict observed CPUE in the southern region of the Bering Sea shelf, while over-predicting observed CPUE in the northern shelf in 1998-2000, suggesting possible regional differences not accounted for in the model. This method of developing a habitat-based abundance model can be used to examine the consequences of fishing activity (e.g. reduction in sheltering organisms), changes in temperature (e.g. climate effects), interaction between variables, and can be modified to incorporate new variables as more information is developed about a species.

***Reconnaissance mapping with side scan sonar*** – A reconnaissance of Bristol Bay seafloor habitats was undertaken in 2002 using a high-resolution 455 kHz side scan sonar (Klein 5410). The reconnaissance effort was centered on an 800 $mi^2$ area of central Bristol Bay that has never been surveyed by NOAA hydrographers. A 150 m swath of bathymetric data and imagery were collected along survey lines totaling nearly 600 linear miles. In addition to providing spatial context for the ongoing trawl impact study in Bristol Bay (cited elsewhere in this document), the survey also intersected 18 RACE Division trawl survey stations and followed 78 mi of seabed previously classified using a *QTC View* single beam acoustic system. Imagery was systematically groundtruthed using an underwater video camera and van Veen grab samples. Thirteen distinct acoustic classes were identified using statistical methods (*QTC Sideview*), while a geologist identified seven major bottom types: (1) degraded bedforms, (2) hummocky seabed, (3) mixed sediments, (4) sand lenses, (5) smooth seabed, (6) sand ribbons, and (7) sand waves, with subdivisions loosely based on scale and shape of features, acoustic reflectivity, and presence or absence of walrus feeding tracks. There was general agreement between the methods, albeit with important differences. The statistical classification did not seem to identify the differing scales of bedforms identified by the geologist, nor did it distinguish between sand waves and sand ribbons. On the other hand, the statistical classification used information at the scale of the acoustical wavelength (~3 mm) that may not have been considered by the geologist. Research is continuing.

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

**Studies on Sea Lion/Groundfish Interactions**

***Seasonality of Prey Availability in Regions of Contrasting Steller Sea Lion Abundance Trends*** – The Auke Bay Laboratory (ABL) began research in 2001 to test the hypothesis that Steller sea lion prey diversity and seasonality are related to Steller sea lion population trends. The decline in the western population of Steller sea lions may be due to decreased prey availability; this decrease may be exacerbated by fishery removals of prey in sea lion habitat. Area-specific diet diversity and population change of Steller sea lions also appear to be related, with faster declines

in areas of lower diet diversity (Merrick et al. 1997). Steller sea lions also may switch diet seasonally, as different prey become more available. The purpose of this set of studies is to test the hypothesis that sea lion prey diversity and seasonality are related to Steller sea lion population trends. The approach is to measure Steller sea lion prey, prey quality (energy density), and predator abundance and fishery removals near selected rookeries and haul-outs, emphasizing seasonal measurements conducted during critical life stages of Steller sea lions. Two regional trend areas, southeast (SE) Alaska and the Kodiak area, are being compared. Study haul-outs and rookeries were selected based on year-round accessibility; simultaneous sampling of sea lion abundance, distribution, and diet (scats) is occurring by other cooperating agencies. The University of Alaska currently is conducting a seasonal study on Kodiak Island, an area where Steller sea lion abundance is declining. The ABL is studying sites in SE Alaska, where Steller sea lion abundance has been slowly increasing. In SE Alaska, ABL is cooperating with the Alaska Department of Fish and Game, the University of Alaska, and the University of British Columbia. This study also is being coordinated with the existing University of Alaska study on Kodiak Island.

For ABL's SE Alaska study, three study sites were selected where Steller sea lions are known to visit in relatively large numbers: 1) Benjamin Island, north of Juneau, 2) the Brothers Islands in Frederick Sound, and 3) Berners Bay, north of Juneau. Field work began in March 2001. Prey abundance at each site was determined by echo-integration and midwater trawling, and sea lion scat was collected from the haul-outs to infer diet. Fish were also collected for proximate and free fatty acid analysis. These studies were completed in May 2004. Results from the Berners Bay study were published this year. Analysis and manuscript preparation is ongoing and some manuscripts have been submitted for review and publication.

A study of the "Daily predictability of prey available to free-ranging Steller sea lions" began in November 2004 and is planned for completion in April 2005. This study is an outgrowth of the SE Alaska prey study which was conducted from March 2001 to May 2004. Steller sea lions, like many air-breathing vertebrates that forage at sea, face physiological and energetic constraints in acquiring prey that may be ephemerally available in time and patchily distributed in a three-dimensional water space. Given the large volume of water that potentially can be searched, the ability of sea lions to predict the distribution of prey in space and time will have direct fitness consequences; sea lions can reduce costly random search time by concentrating foraging efforts in areas that are known to support high densities of prey. Our study examines the quantity and distribution of prey species on a daily and weekly basis to test whether 1) forage species distributions are predictable on a daily or weekly time scale; and 2) areas that have the most predictable prey resources are also those used most often by foraging sea lions. This research will provide information on the relationship between the distribution and abundance of fish relative to the effort of sea lions to find and utilize these prey resources.

For more information, contact Michael Sigler at (907) 789-6037.

**Prey Availability Near Two Steller Sea Lion Haulouts in Southeast Alaska**

To better understand the declining abundance of Steller sea lions (SSL) in central and western Alaska, we examined the seasonal availability of SSL prey in southeast Alaska, where SSL abundance is increasing. From 2001-2004, we identified prey in nearshore waters <100 m deep near two SSL haulouts, Benjamin Island and The Brothers Islands, in summer and winter. Benjamin Island, a seasonal haulout, is used by up to 800 SSLs, and The Brothers Islands, a year-round haulout, is used by up to 1,500 SSLs. Available prey species were inventoried by beach seine, jig, and ROV within 7 km of each haulout.

Catch and number of prey species available to SSLs were greater in summer than in winter at both haulouts, and greater at The Brothers Islands than at Benjamin Island. Total catch by seining and jigging at both haulouts for all sampling periods was 201,331 fish and 559 fish, respectively; 58 species were identified in summer and 44 species in winter. Seine catches for both locations were dominated by young-of-the-year walleye pollock, Pacific herring, and Pacific sand lance in summer, and salmon fry, armorhead sculpin, and rock sole in winter. Jig catches were dominated by armorhead sculpin, Pacific cod, and rockfish in summer and winter.

Most fish captured by seining were juveniles (median FL $\leq$ 80 mm) and likely too small to be targeted by SSLs, whereas most fish captured by jigging (median FL $\geq$ 249 mm) were large enough to be consumed by SSLs. Thirty-four species that we captured have been identified in SSL scat at either haulout. Availability of prey close to SSL haulouts could contribute to overall diet diversity and provide a source of food that may reduce foraging effort in summer. Less available prey in winter, however, may force SSLs to travel farther from haulouts to forage.

For further information, contact John Thedinga at 907-789-6025.

## E. Other Items

### *GIS Resources*

No notable new developments, though some projects are in the works.
For more information, contact Jan Benson (206) 526-4183.

**APPENDIX I -** Alaska Fisheries Science Center Groundfish Publications - 2004 and In Press
(AFSC authors in bold text)


ASAHIDA, T., **A. K. GRAY**, and A. J. GHARRETT.
2004. Use of microsatellite locus flanking regions for phylogenetic analysis? A preliminary study of *Sebastes* subgenera. Environ. Biol. Fishes 69:461-470.

AU, W.L., J.K.B. FORD, **J.K. HORNE**, and K.A. ALLMAN.
2004. Echolocation signals of free-ranging killer whales (*Orcinus orca*) and modeling of foraging for chinook salmon (*Oncorhynchus tshawytscha*). Journal of the Acoustical Society of America 115: 901-909.

**AYDIN, K. Y.**
2004. Age structure of functional response? Reconciling the energetics of surplus production between single-species models and ECOSIM. Afr. J. Mar. Sci. 26:289-301.

**BAILEY, K. M., A. B. HOLLOWED**, and W. S. WOOSTER.
2004. Complexity in marine fisheries dynamics and climate interactions in the northeast Pacific Ocean, p. 147-152. In N. C. Stenseth, G. Ottersen, J. W. Hurrel, and A. Belgrano. (editors), Marine Ecosystems and Climate Variation. Oxford Univ. Press.

BARRON, M. G., **R. HEINTZ**, and **S. D. RICE**.
2004. Relative potency of PAHs and heterocycles as aryl hydrocarbon receptor agonists in fish. Mar. Environ. Res. 58:95-100.

BARRON, M. G., **M. G. CARLS, R. A. HEINTZ**, and **S. D. RICE**.
2004. Evaluation of fish early life-stage toxicity models of chronic embryonic exposures to complex polycyclic aromatic hydrocarbon mixtures. Toxicol. Sci. 78:60-67.

BUCKEL, J. A., and **A. W. STONER**.
2004. Negative effects of increasing group size on foraging in two piscivorous predators. J. Exp. Mar. Biol. Ecol. 307:183-196.

BUCKLAND, S. T., D. R. ANDERSON, K. P. BURNHAM, **J. L. LAAKE**, D. L. BORCHERS, and L. THOMAS.
2004. Advanced Distance Sampling. Oxford University Press, Oxford. 416 p.

**CANINO, M. F.**, and P. BENTZEN.
2004. Evidence for positive selection at the pantophysin (Pan I) locus in walleye pollock, *Theragra chalcogramma*. Mol. Biol. Evol. 21:1391-1400.

**CARLS, M. G., P. M. HARRIS, and S. D. RICE.**
2004. Restoration of oiled mussel beds in Prince William Sound, Alaska. Mar. Environ. Res. 57:359-376.

**CARLS, M. G., L. G. HOLLAND, J. W. SHORT, R. A. HEINTZ, and S. D. RICE**.

2004. Monitoring polynuclear aromatic hydrocarbons in aqueous environments with passive low-density polyethylene membrane devices. Environ. Toxicol. Chemist. 23(6):1416-1424.

**CARLS, M. G., S. D. RICE**, G. D. MARTY, and D. K. NAYDAN.
2004. Pink salmon spawning habitat is recovering a decade after the Exxon Valdez oil spill. Trans. Am. Fish. Soc. 133:834-844.

CIANNELLI, L., R. D. BRODEUR, and **J. M. NAPP**.
2004. Foraging impact on zooplankton by age-0 walleye pollock (*Theragra chalcogramma*) around a front in the southeast Bering Sea. Mar. Biol. 144:515-526.

CIANNELLI, L., **B. W. ROBSON**, R. C. FRANCIS, **K. AYDIN**, and R. D. BRODEUR.
2004. Boundaries of open marine ecosystems: an application to the Pribilof Archipelago, southeast Bering Sea. Ecol. Appl. 14(3):942-953.

CIANNELLI, L., K. S. CHAN, **K. M. BAILEY**, and N. C. STENSETH.
2004. Non-additive effects of environmental variables on the survival of a large marine fish population. Ecology 85:3418-3427.

**DAVIS, M. W.**, and S. J. PARKER.
2004. Fish size and exposure to air: Potential effects on behavioral impairment and mortality rates in discarded sablefish. North Am. J. Fish. Manage. 24:518-524.

**DeMASTER, D.** (chair), **R. ANGLISS**, J. COCHRANE, P. MACE, R. MERRICK, M. MILLER, S. RUMSEY, B. TAYLOR, **G. THOMPSON**, and R. WAPLES.
2004. Recommendations to NOAA Fisheries: ESA Listing Criteria by the Quantitative Working Group, 10 June 2004. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-67, 85 p. Online. (.pdf, 756KB ).

DIEFENBACH, D. R., and **J. L. LAAKE**.
2004. Spatio-temporal and demographic variation in the harvest of black bears: Implications for population estimation. J. Wildl. Manage. 68:947-959.

FELTHO**VEN, R. G.,** and C. MORRISON PAUL.
2004. Multi-output, nonfrontier measures of capacity and capacity utilization. Am. J. Agric. Econ. 86(3): 619-633.

FITZGERALD, J. R., S. R. THORROLD, **K. M. BAILEY, A. L. BROWN**, and K. P. SEVERIN.
2004. Elemental signatures in otoliths of larval walleye pollock (*Theragra chalcogramma*) from the northeast Pacific Ocean. Fish. Bull., U.S. 102:604–616. Online. (.pdf, 370KB).

**FOWLER, C. W.**, and R. J. M. CRAWFORD.
2004. Systemic management of fisheries in space and time: tradeoffs, complexity, ecosystems, sustainability. Biosphere Conservation 6(1):25-42.

**FOWLER, C. W.**, and L. HOBBS.

2004. Is Humanity Sustainable? Pp. 450-462. In M. S. Marx (editor), Human Dilemmas. Copley, Acton, Massachusetts.

GAO, Y., S. H. JONER, R. A. SVEC, and **K. L. WEINBERG**.
2004. Stable isotopic comparison in otoliths of juvenile sablefish (*Anoplopoma fimbria*) from waters off the Washington and Oregon coast. Fish. Res. 68:351-360.

GAUTHIER, S. and **J.K. HORNE**.
2004. Acoustic characteristics of forage fish species in the Gulf of Alaska and Bering Sea. Canadian Journal of Aquatic and Fishery Science 61: 1839-1850.

GAUTHIER, S. and **J.K. HORNE**.
2004. Potential acoustic discrimination of boreal fish assemblages. ICES Journal of Marine Science 61: 836-845.

GUIEB, R.A., P.A. JUMARS, and **R.F.L. SELF**.
2004. Adhesive-based selection by a tentacle-feeding polychaete for particle size, shape and bacterial coating in silt and sand. J. Mar. Res., 62:261-282.

**GUTTORMSEN, M.A., C.D. WILSON, and S. STIENESSEN.**
2004. Results of the February and March 2003 Echo integration-trawl surveys of walleye pollock in Shelikof Strait, Alaska. In: Stock Assessment and Fishery Evaluation Report for the 2003 Gulf of Alaska Groundfish Fishery, Prepared by the Gulf of Alaska Groundfish Plan Team, North Pacific Fishery Management Council, P.O. Box 103136, Anchorage, AK 99510.

HAMANN, I.M., G.W. BOEHLERT, and **C.D. WILSON**.
2004. Effects of steep topography on the flow and stratification near Palmyra Atoll. Ocean Dynamics 54: 460-473.

HAZEN, E.L. and **J.K. HORNE**.
2004. Comparing modeled and measured target strength variability of walleye pollock, *Theragra chalcogramma*. ICES Journal of Marine Science 61: 363-377.

**HOBBS, L., and C. W. FOWLER**.
2004. Complexity of Factors Involved in Human Population Growth. Environ. Health Perspect. 112(13): A726-A727.

**HURST, T. P.**
2004. Temperature and state-dependence of feeding and gastric evacuation in juvenile Pacific halibut. J. Fish. Biol. 65:157-169.

**HURST, T. P.**, K. A. McKOWN, and D. O. CONOVER.
2004. Interannual and long term variation in the nearshore fish community of the mesohaline Hudson River estuary. Estuaries 27:659-669.

ITO, S-I., M. J. KISHI, Y. KURITA, Y. OOZEKI, Y. YAMANAKA, **B. A. MEGREY**, and F. E. WERNER.

2004. Initial design for a fish bioenergetics model of Pacific saury coupled to a lower trophic ecosystem model. Fish. Oceanogr. 13 (Suppl. 1):111-124.

JURADO-MOLINA, J., **P. A. LIVINGSTON**, and V. F. GALLUCI.
2004. Sensitivity analysis of the multispecies virtual population analysis model parameterized for a system of trophically-linked species from the eastern Bering Sea. Ciencias Marinas 30:285-296.

KEITH, D. A., M. A. McCARTHY, H. REGAN, T. REGAN, C. BOWLES, C. DRILL, C. CRAIG, B. PELLOW, M. A. BURGMAN, L. L. MASTER, M. RUCKELSHAUS, B. MACKENZIE, S. J. ANDELMAN, and **P. R. WADE**.
2004. Protocols for listing threatened species can forecast extinction. Ecol. Letters 7:1101-1108.

**LAUTH, R. R., J. IANELLI**, and W. W. WAKEFIELD.
2004. Estimating the size selectivity and catching efficiency of a survey bottom trawl for thornyheads, *Sebastolobus* spp. using a towed video camera sled. Fish. Res. 70:27-37.

**LAUTH, R. R.,** W. W. WAKEFIELD, and **K. SMITH**.
2004. Estimating the density of thornyheads, *Sebastolobus* spp., using a towed video camera sled. Fish. Res. 70:39-48.

**LOGERWELL, E. A., and C. D. WILSON.**
2004. Species discrimination of fish using frequency-dependent acoustic backscatter. ICES J. Mar. Sci. 61(6):1004-1013.

MACKLIN, S. A., and **B. A. MEGREY**.
2004. The North Pacific Ecosystem Metadatabase. PICES Press, Vol. 12, No. 2, p. 32-35.

MATALA, A. P., **A. K. GRAY**, A. J. GHARRETT, and M. S. LOVE.
2004. Microsatellite variation indicates population genetic structure of bocaccio. North Am. J. Fish. Manage. 24:1189-1202.

MATALA, A. P., **A. K. GRAY, J. HEIFETZ**, and A. J. GHARRETT.
2004. Population structure of Alaska shortraker rockfish, *Sebastes borealis*, inferred from microsatellite variation. Environ. Biol. Fishes 69:201-210.

McELDERRY, H., J. SCHRADER, D. MCCULLOUGH, J. ILLINGWORTH, **S. FITZGERALD, and S. DAVIS**.
2004. Electronic monitoring of seabird interactions with trawl third-wire cables on trawl vessels - a pilot study, U.S. Dep Commer., NOAA Tech. Memo., NMFS-AFSC-147, 39 p. Online. (.pdf, 1.06MB).

**MOLES, A.**
2004. Parasites of juvenile yellowfin sole and rock sole in southeast Alaska. Northwest Sci. 78(4):339-343.

MORGAN, C.A., **A. DE ROBERTIS**, and R. ZABEL.
(In press) Columbia River plume fronts: I Hydrography, zooplankton distribution, and community composition. Marine Ecology Progress Series.

MORRISON PAUL, C. J., and **R. G. FELTHOVEN**.
2004. Directions for productivity measurement in fisheries. Marine Policy 28 (2004): 161-169.

O'REILLY, P. T., **M. F. CANINO, K. M. BAILEY**, and P. BENTZEN.
2004. Inverse relationship between FST and microsatellite polymorphism in the marine fish, walleye pollock (*Theragra chalcogramma*): Implications for resolving weak population structure. Mol. Ecol. 13:1799-1814.

**ORR, J. W.**
2004. *Lopholiparis flerxi*, a new genus and species of snailfish (Scorpaeniformes: Liparidae) from the Aleutian Islands, Alaska. Copeia 2004:551-555.

**ORR, J. W.**, and J. E. BLACKBURN.
2004. The dusky rockfishes (Teleostei: Scorpaeniformes) of the North Pacific Ocean: resurrection of *Sebastes variabilis* (Pallas, 1814) and a redescription of *Sebastes ciliatus* (Tilesius, 1813). Fish. Bull., U.S. 102:328-348. Online. (.pdf, 569KB).

PARK, W., **M. STURDEVANT, J. ORSI, A. WERTHEIMER, E. FERGUSSON, W. HEARD**, and T. SHIRLEY.
2004. Interannual abundance patterns of copepods during an ENSO event in Icy Strait, southeastern Alaska. ICES J. Mar. Sci. 61:464-477.

PEARSON, D. E., and **F. R. SHAW**.
2004. Sources of age determination errors for sablefish (*Anoplopoma fimbria*). Fish. Bull., U.S. 102:127-141. Online. (.pdf, 283KB).

PIKITCH, E. K., C. SANTORA, E. A. BABCOCK, A. BAKUM, R. BONFIL, D. O. CONOVER, P. DAYTON, P. DOUKAKIS, D. FLUHARTY, B. HENEMAN, E. D. HOUDE, J. LINK, **P. A. LIVINGSTON**, M. MANGEL, M. K. McALLISTER, J. POPE, and K. J. SAINSBURY.
2004. Ecosystem-based fishery management. Science 305:346-347.

PRESTON, J.M, A.C. CHRISTNEY, W.T. COLLINS, **R.A. MCCONNAUGHEY and S.E. SYRJALA**.
2004. Considerations in large-scale acoustic seabed characterization for mapping benthic habitats. ICES CM 2004/T:13, 8 p.

**ROOPER, C. N.**, D. R. GUNDERSON, and D. A. ARMSTRONG.
2004. Application of the concentration hypothesis to English sole in nursery estuaries and potential contribution to coastal fisheries. Estuaries 27:102-111.

**RYER, C. H.**
2004. Laboratory evidence for behavioural impairment of fish escaping trawls: a review. ICES J. Mar. Sci. 61:1157-1164.

**RYER, C.H.**
2004. Comparison of genetically based anti-predator behaviour in hatchery and wild coho fry from a coastal Oregon river: interpreting a negative result. J. Fish Biol. 65:1413-1418.

**RYER, C. H., M. L. OTTMAR, and E. A. STURM.**
2004. Behavioral impairment after escape from trawl codends may not be limited to fragile fish species. Fish. Res. 66:261-269.

**RYER, C. H., A. W. STONER, and R. H. TITGEN.**
2004. Behavioral mechanisms underlying the refuge value of benthic habitat structure for two flatfishes with differing anti-predator strategies. Mar. Ecol. Prog. Ser. 268:231-243.

**SHELDEN, K. E. W., and D. P. DeMASTER.**
2004. Guidelines for developing status-determining criteria. Endangered Species Update 21:119-123.

**SHORT, J. W., M. R. LINDEBERG, P. M. HARRIS, J. M. MASELKO, J. J. PELLA, and S. D. RICE.**
2004. Estimate of oil persisting on beaches of Prince William Sound, 12 years after the Exxon Valdez oil spill. Environ. Sci. Technol. (1):19-25.

**SIGLER, M. F.,** J. N. WOMBLE, and J. J. VOLLENWEIDER.
2004. Availability to Steller sea lions (*Eumetopias jubatus*) of a seasonal prey resource: a prespawning aggregation of eulachon (*Thaleichthys pacificus*). Can. J. Fish. Aquat. Sci. 61:1475-1484.

**SMITH, K. R., D. A. SOMERTON, and D. G. NICHOL.**
2004. Distribution and biology of prowfish (*Zaprora silenus*) in the northeast Pacific. Fish. Bull., U.S. 102:168-178. Online. (.pdf, 344KB).

**SOGARD, S. M., and M. L. SPENCER.**
2004. Energy allocation in juvenile sablefish: Effects of temperature, ration, and body size. J. Fish. Biol. 64:726-738.

**SOMERTON, D. A.**
2004. Do Pacific cod (*Gadus macrocephalus*) and walleye pollock (*Theregra chalcogramma*) [sic] lack a herding response to the doors, bridles, and mudclouds of survey trawls? ICES J. Mar. Sci. 61:1186-1189.

**STARK, J. W.**
2004. A comparison of the maturation and growth of female flathead sole in the central Gulf of Alaska and south-eastern Bering Sea. J. Fish Biol. 64:876-889.

**STEVENSON, D. E.**
2004. Identification of skates, sculpins, and smelts by observers in North Pacific groundfish fisheries (2002-2003). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-142, 67 p. Online (.pdf, 4.0MB).

**STEVENSON, D. E., J. W. ORR, G. R. HOFF**, and J. D. MCEACHRAN.
2004. *Bathyraja mariposa*, a new species of skate (Rajidae: Arhynchobatinae) from the Aleutian Islands. Copeia 2004:305-314.

**STONER, A. W.**
2004. Effects of environmental variables on fish feeding ecology: Implications for the performance of baited fishing gear and stock assessment. J. Fish Biol. 65:1445-1471.

**STONER, A. W., and M. L. OTTMAR.**
2004. Fish density and size alter Pacific halibut feeding: implications for stock assessment. J. Fish. Biol. 64:1712-1724.

**STONER, A. W., and E. A. STURM.**
2004. Temperature and hunger mediate sablefish (*Anoplopoma fimbria*) feeding motivation: implications for stock assessment. Can. J. Fish. Aquat. Sci. 61:238-246.

**Von SZALAY, P. G.**
2004. The effect of improved footrope contact measurements on trawl area swept estimates. Fish. Res. 69:389-398.

**WEINBERG, K. L., R. S. OTTO, and D. A. SOMERTON.**
2004. Capture probability of a survey trawl for red king crab (*Paralithodes camtschaticus*). Fish. Bull., U.S. 102:740–749. Online. (.pdf, 534KB).

**WILLIAMS, K.**, N. PAPANIKOS, R.P. PHELPS, and J.D. SHARDO.
2004. Development, growth, and yolk utilization of hatchery-reared red snapper *Lutjanus campechanus* larvae. Marine Ecology Progress Series, Vol 275: 231-239.

**WILSON, C.D.** and G.W. BOEHLERT. 2004. Ocean currents and resident micronekton at a seamount in the central North Pacific. J. Mar. Systems 50:39-60.

**WING, B. L.**, and D. R. BARNARD.
2004. A field guide to Alaskan corals, U.S. Dep Commer., NOAA Tech. Memo., NMFS-AFSC-146, 67 p. Online. (.pdf 2.6MB).

**YANG, M-S.**

2004. Diet changes of Pacific cod (*Gadus macrocephalus*) in Pavlof Bay associated with climate changes in the Gulf of Alaska between 1980 and 1995. Fish. Bull., U.S. 102:400-405. Online. (.pdf, 292KB).

**ZENGER, H. H. JR.**
2004. Data report: 2002 Aleutian Islands bottom trawl survey, U.S. Dep Commer., NOAA Tech. Memo., NMFS-AFSC-143, 247 p. Online. (.pdf, 16.5MB).

## *Publications to Date in 2005:*

**ABOOKIRE, A. A.,** and J. F. PIATT.
2005. Oceanographic conditions structure forage fish into lipid-rich and lipid-poor communities in lower Cook Inlet, Alaska. Mar. Ecol. Prog. Ser. 287:229-240.

**ABOOKIRE, A. A., and C. S. ROSE.**
2005. Modifications to a plumb staff beam trawl for sampling uneven, complex habitats. Fish. Res. 71:247-254.

AMES, R. T., G. H. WILLIAMS, and **S. M. FITZGERALD**.
2005. Using digital video monitoring systems in fisheries: Application for monitoring compliance of seabird avoidance devices and seabird mortality in Pacific halibut longline fisheries. U.S. Dep. Commer., NOAA Tech. Memo., NMFS-AFSC-152, 93 p. Online. (.pdf, 2.21 MB).

**BAILEY, K. M.**, H. NAKATA, and H. W. van der VEER.
2005. The planktonic stages of flatfish: physical and biological interactions in transport processes, p. 94-119. In R. N. Gibson (editor). Flatfishes: Biology and Exploitation. Blackwell Publishing, Oxford.

BORNHOLD, B.D., C.V. JAY, **R.A. MCCONNAUGHEY**, G. RATHWELL, K. RHYNAS and W. COLLINS.
2005. Walrus foraging marks on the seafloor in Bristol Bay, Alaska – a reconnaissance survey. Geo-Marine Letters (in press).

**BUSBY, M. S.**
2005. An unusual macrourid larva (Gadiformes) from San Juan Island, Washington, USA. Ichthyol. Res. 52:86-89.

**COOPER, D. W.**, K. E. PEARSON, and D. R. GUNDERSON.
2005. Fecundity of shortspine thornyhead (*Sebastolobus alascanus*) and longspine thornyhead (*S. altivelis*) (Scorpaenidae) from the northeastern Pacific Ocean, determined by stereological and gravimetric techniques. Fish. Bull., U.S. 103:15–22. Online. (.pdf, 291KB).

**DAVIS, M. W.**
2005. Behaviour impairment in captured and released sablefish: ecological consequences and possible substitute measures for delayed discard mortality. J. Fish. Biol. 66:254-265.

**DAVIS, M.W.** and C.B. SCHRECK.
2005. Responses by Pacific halibut to air exposure: lack of correspondence among plasma constituents and mortality. Trans. Amer. Fish. Soc. (in press)

**DE ROBERTIS A.,** MORGAN C.A., SCHABETSBERGER R.A., ZABEL R.A., BRODEUR R.D., EMMETT R.L., KNIGHT C.M., KRUTZIKOWSKY G.K., CASILLAS E.

(*In press*) Columbia River plume fronts: II Distribution, abundance and feeding ecology of juvenile salmon. Marine Ecology Progress Series.

**DEW, C.B** and **R.A. MCCONNAUGHEY**.
(*In press*). Did bottom trawling in Bristol Bay's red king crab brood-stock refuge contribute to the collapse of Alaska's most valuable fishery? Ecol. Applic. 15(3)

**FOWLER, C. W.**
2005. Sustainability, health, and the human population. EcoHealth 2:58-69.

**HURST, T.P., M.L. SPENCER, S.M. SOGARD and A.W. STONER.**
(*In press*). Compensatory growth, energy storage and behavior of juvenile Pacific halibut *Hippoglossus stenolepis* following a thermally induced growth reduction. Mar. Ecol. Prog. Ser.

**IANELLI, J.**
2005. Assessment and fisheries management of eastern Bering Sea pollock: Is sustainability luck? Bull. Mar. Sci. 76:321-335.

KOTWICKI, S., T. W. BUCKLEY, T. HONKALEHTO and G. WALTERS.
(*In press*) Variation in the distribution of walleye pollock (*Theragra chalcogramma*) with temperature and implications for seasonal migration. Fish.Bull.

LAZRUS, H., and **J. SEPEZ**.
2005. The NOAA Fisheries Alaska native traditional knowledge database. Practicing Anthropology 27(1):33-37.

**LEW, D. K.**, and D. M. LARSON.
2005. Valuing recreation and amenities at San Diego County beaches. Coastal Manage. 33(1):71-86.

**LIVINGSTON, P. A., K. AYDIN, J. BOLDT, J. IANELLI, and J. JURADO-MOLINA.**
2005. A framework for ecosystem impacts assessment using an indicator approach. ICES J. Mar. Sci. 62:592-597.

**LOGERWELL, E. A.**, and L. E. SCHAUFLER.
2005. New data on proximate composition and energy density of Steller sea lion (*Eumetopias jubatus*) prey fills seasonal and geographic gaps in existing information. Aquat. Mammals 31(1):62-82.

**MCCONNAUGHEY, R.A., S.E. SYRJALA** and **C.B. DEW**.
(*In press*). Effects of chronic bottom trawling on the size structure of soft-bottom benthic invertebrates. Pages xxx-xxx in P. W. Barnes and J. P. Thomas, editors. Benthic habitats and the effects of fishing. American Fisheries Society, Symposium 41, Bethesda, Maryland.

**ORR, J. W., E. S SINCLAIR**, and W. W WALKER.
(*In press*). *Bassozetus zenkevitchi* (Ophidiidae: Teleostei) and *Paraliparis paucidens* (Liparidae: Teleostei): new records for Alaska from the Bering Sea. Northwestern Naturalist.

**PELLA, J., and M. MASUDA.**
2005. Classical discriminant analysis, classification of individuals, and source population composition of mixtures, p. 517-552. In S. Cadrin, K. Friedland, and J. Waldman (editors), Stock Identification Methods: Applications in Fishery Science. Elsevier Academic Press.

**ROBERSON, N. E., D. K. KIMURA**, D. R. GUNDERSON, and A. M. SHIMADA.
2005. Indirect validation of the age-reading method for Pacific cod (*Gadus macrocephalus*) using otoliths from marked and recaptured fish. Fish. Bull., U.S. 103:153–160. Online. (.pdf, 212KB).

**ROOPER, C. N., M. ZIMMERMANN, and P. D. SPENCER.**
2005. Using ecologically based relationships to predict distribution of flathead sole *Hippoglossoides elassodon* in the eastern Bering Sea. Mar. Ecol. Prog. Ser. 290:251-262.

**SEPEZ, J.**
2005. Introduction to traditional environmental knowledge in federal natural resource management agencies. Practicing Anthropology 27(1):2-5.

**SPENCER, M.L., A.W. STONER, C.H. RYER** and J.E. MUNK.
(*In press*). Use of a towed camera sled for estimating abundance and habitat characteristics of juvenile flatfishes: comparison with beam trawl and diver transects. Estuar. Coastal Shelf Sci.

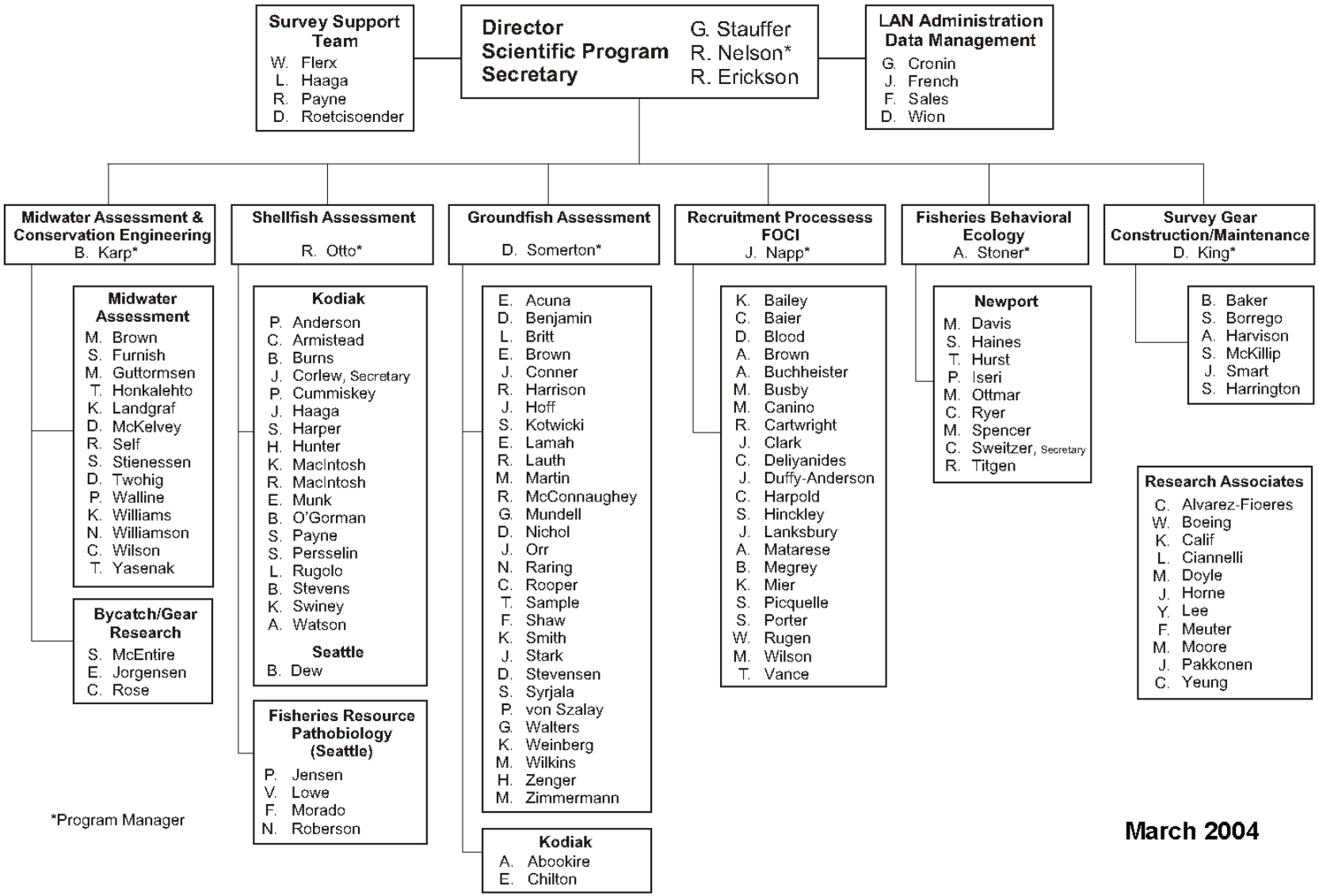
**STEVENSON, D. E., and A. MATARESE.**
**(***In press*). The ronquils: a review of the North Pacific fish family Bathymasteridae (Actinopterygii: Perciformes: Zoarcoidei). Proc. Biol. Soc. Wash.

**STEVENSON, D. E., and J. W. ORR.**
(*In press*). New records of two deepwater skate species from the eastern Bering Sea. Northwestern Naturalist.

SWARTZMAN, G., B. HICKEY, P.M. KOSRO, and **C.D. WILSON**.
2005. Core undercurrent and equatorward surface currents in the Pacific Eastern boundary current in summer 1995 and 1998 and their relationship to the distribution of euphausiids. Deep-Sea Res. II. 52: 73-88.

**WILSON, M. T., A. L. BROWN, and K. L. MIER.**
2005. Geographic variation among age-0 walleye pollock (*Theragra chalcogramma*): Evidence of mesoscale variation in nursery quality? Fish. Bull., U.S. 103:207-218. Online. (.pdf, 472KB).

## APPENDIX II.--RESOURCE ASSESSMENT AND CONSERVATION ENGINEERING DIVISION ORGANIZATION CHART 2003




*Program Manager

**March 2004**

# APPENDIX III.--RESOURCE ECOLOGY AND FISHERIES MANAGEMENT DIVISION

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

| **Administrative Support** | **Age Determination Unit** | **Status of Stocks and Multispecies Modeling** | **Resource Ecology and Ecosystems Modeling** | **Socio-Economic Assessment** |
|---|---|---|---|---|
| Ito, Daniel -- NEPA coordinator | Kimura, Dan -- Supervisor | Hollowed, Anne -- Supervisor | Aydin, Kerim BActing Supervisor | Felthoven, Ron -- Leader |
| Goiney, Bernie | Anderl, Delsa | Conners, Liz | Buckley, Troy | Haynie, Alan |
| | Benson, Irina | Dorn, Martin | Derrah, Christopher | Hiatt, Terry |
| | Gburski, Chris | Greig, Angie | Lang, Geoffrey | Lew, Dan |
| | Goetz, Betty | Gaichas, Sarah | Yang, Mei-Sun | Sepez, Jennifer |
| | Hutchinson, Charles | Ianelli, James | | Seung, Chang |
| | Johnston, Chris | Logerwell, Libby | | |
| | Kastelle, Craig | Lowe, Sandra | | |
| | Foy, Dan | Munro, Peter | | |
| | Kautzi, Lisa | Pearce, Julie | | |
| | Shockley, Wes | Spencer, Paul | | |
| | Short, Jonathan | Thompson, Grant | | |
| | Piston, Charlses | Turnock, Jack | | |
| | Brogan, John | Stockhousen, Buck | | |
| | | Wilderbuer, Thomas | | |
| | | Neidetcher, Sandi | | |
| | | McDermott, Susanne | | |

| **ADP** |
|---|
| Blaisdell, Mark |
| Wennberg, Sherrie |

Revised April 2005

## **APPENDIX IV -** Auke Bay Laboratory Groundfish Assessment Program Staff

| **Name** | **Duties** |
|---|---|
| Phil Rigby | Program Manager |
| Dave Clausen | Rockfish, Gulf of Alaska Groundfish |
| Dean Courtney | Rockfish, Sharks, Stock Assessment |
| Dave Csepp | Sea Lion Prey/Predation |
| Jeff Fujioka | Sablefish, Rockfish, Stock Assessment, Effects of Fishing |
| Dana Hanselman | Rockfish, Stock Assessment |
| Jon Heifetz | Effects of Fishing, Rockfish, Sablefish, Stock Assessment |
| John Karinen | Gulf of Alaska Groundfish |
| Mitch Lorenz | Essential Fish Habitat |
| Chris Lunsford | Rockfish, Sablefish, Stock Assessment, Longline Survey |
| Nancy Maloney | Sablefish Tag Database, Longline Survey, and Seamounts |
| Tom Rutecki | Sablefish, Webmaster |
| Kalei Shotwell | Groundfish Habitat |
| Mike Sigler | Sablefish, Stock Assessment, Sea Lion Prey/Predation |
| Robert Stone | Seafloor Ecology, Effects of Fishing, Coral and Sponge Life History |

**Other ABL Staff Working on Groundfish**

| | |
|---|---|
| Scott Johnson | Essential Fish Habitat, Sea Lion Prey |
| John Thedinga | Essential Fish Habitat, Sea Lion Prey |
| Bruce Wing | Groundfish Early Life History, Corals |
| Christine Kondzela | Rockfish Genetics |

# CANADA

## British Columbia Groundfish Fisheries and Their Investigations in 2004

**May 2005**

**Prepared for the 46th Annual Meeting of the Technical Sub-Committee of the Canada-United States Groundfish Committee**
**May 2-4, 2005.**
**Parksville,**
**British Columbia, Canada**

**Compiled by**

**K. L. Yamanaka**
**Fisheries and Oceans Canada**
**Science Branch**
**Pacific Biological Station**
**Nanaimo, British Columbia**
**V9T 6N7**

# REVIEW OF AGENCY GROUNDFISH RESEARCH, STOCK ASSESSMENT, AND MANAGEMENT

## A. Agency Overview

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

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

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

Section Heads within the Marine Ecosystems & Aquaculture Division are:

| | |
|---|---|
| Groundfish | Mr. Jeff Fargo |
| Shellfish | Mr. Jim Boutillier |
| Pelagics | Mr. Jake Schweigert |
| Conservation Biology | Mr. Jim Boutillier |
| Applied Technologies | Mr. Ken Cooke |
| Fish Health and Parasitology | Dr. Susan Bower |
| Aquaculture and Environmental Research | (West Van Lab) |

Groundfish research and stock assessments are conducted primarily in the Groundfish Section and groundfish ageing and acoustics work is conducted in the Applied Technology Section. The Canadian Coast Guard operates DFO research vessels. These vessels include the *W.E. Ricker*, *J.P. Tully* and *Neocaligus.*

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

Trawl, sablefish (trap and hook-and-line), and halibut (hook-and-line) fisheries continue to be managed with Individual Vessel Quotas (IVQ). IVQ's 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. Specific management issues are addressed below when appropriate. Management plans can be viewed on the website http://www-ops2.pac.dfo-mpo.gc.ca/xnet/content/MPLANS/MPlans.htm

Managers are currently engaging industry in discussions to address issues associated with groundfish conservation and management of the commercial fishery. In particular, DFO and the various fishery sectors (geartypes) are working towards an integrated fishery plan.

## B. Multispecies or Ecosystem Models

No update is currently available

## C. By Species

### *1. Pacific Cod*

**Stock Assessment**

The available commercial fishery and research survey data for Pacific cod stocks in Hecate Strait (5CD) and Queen Charlotte Sound (5AB) were assembled and reviewed in a stock assessment presented in January, 2005. Results from a 3-year survey designed specifically to monitor Pacific cod abundance in Hecate Strait during a period of stock recovery were included. A delay-difference stock production model was used to synthesize these data. There are clear indications that the Hecate Strait population has increased in abundance and biomass since an historic low in 2001. The reduction in TAC for this stock which was introduced in the 2001/02 fishing year resulted in a decrease in exploitation rate which has contributed to the increase in stock size. However, the population has not yet recovered to the long term average biomass and continued increases may be desirable. A candidate stock biomass limit reference point is proposed based on the previous minimum biomass from which the stock had recovered. This was the stock biomass in 1971. Catch forecasts were calculated for a wide range of TAC in 2005/06. The results are presented as probabilities of specific performance measures being met or exceeded. Attention is drawn to the probability of biomass increase and the probability of the biomass being greater than the biomass in 1971. We were unable to produce an analytical assessment of the Queen Charlotte Sound population.

### *2a. Rockfish – Offshore*

**Research Programs**

No survey targeting slope rockfish occurred in 2004.

**Stock Assessment**

We prepared a major stock assessment document on longspine thornyhead *Sebastolobus altivelis* in 2004 (Schnute et al. 2004). The report presents an analysis of the biomass survey, conducted annually in 2001-2003 off the west coast of Vancouver Island (WCVI), in the context of a

coastwide longspine thornyhead fishery that began in 1996 and extended northward from WCVI into two northern regions, Tidemarks and Rennell (Fig.1).

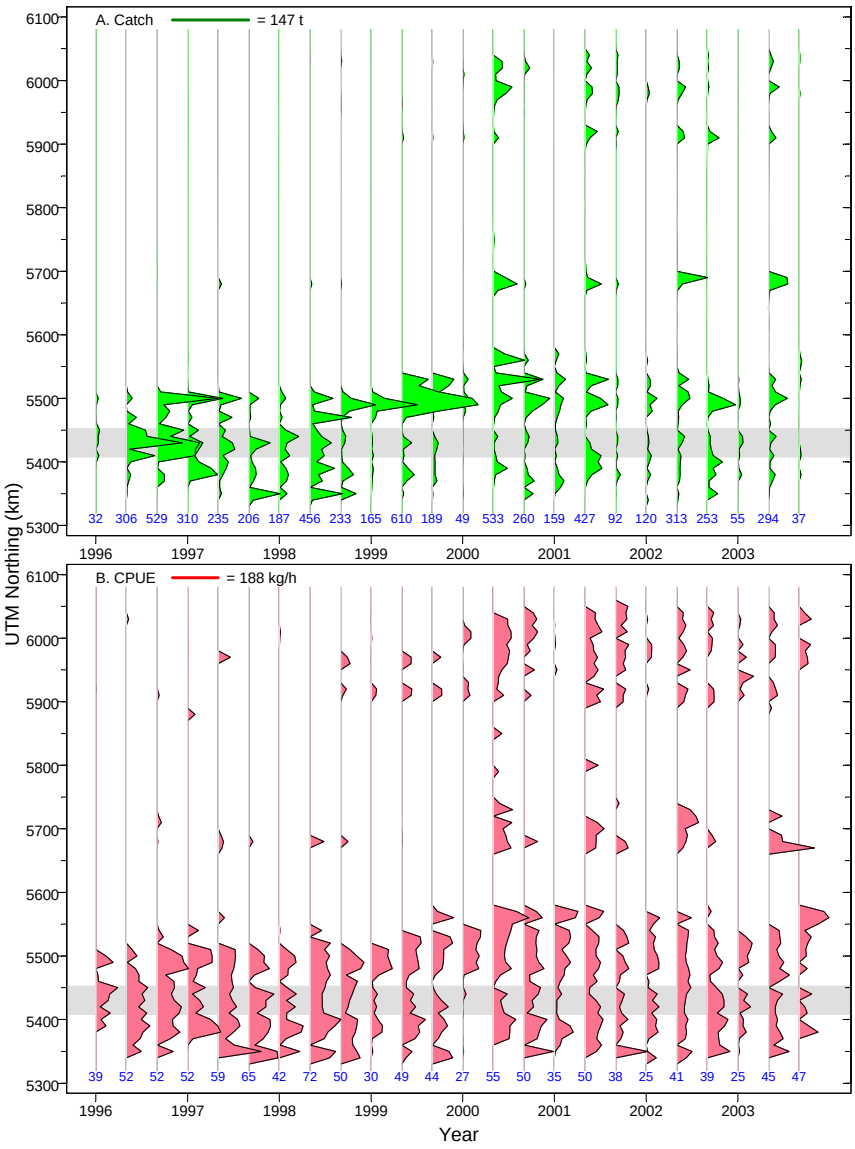



**Figure 1.** Latitudinal spread of catch and CPUE over time along the BC coast using 10-km UTM northing intervals and 4-month periods. All tows catching longspine thornyhead are used to summarize catch. CPUE is calculated using bottom trawl tows deeper than 500 m by vessels with an onboard observer. Total catch and mean CPUE are indicated for each 4-month period. The genesis of the fishery started in an area off WCVI known locally as "Beginner's Ledge" (grey band).

In the WCVI region, the survey appears to index longspine thornyhead biomass well, achieves coefficients of variation near 10%, and indicates no significant biomass change in the period 2001-2003 (Fig.2). Because the survey has limited coverage in space and time, we compare this analysis with similar analyses of commercial catch per unit effort (CPUE) data in WCVI (Fig.2) and the two northern regions, where no surveys exist.

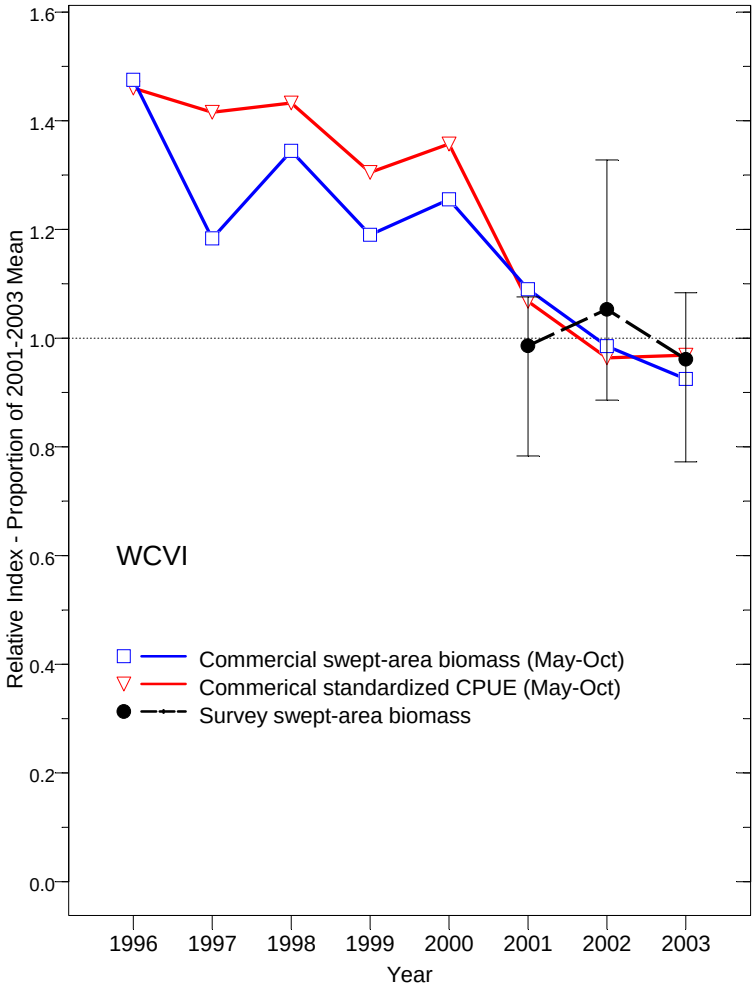



**Figure 2.** Comparison of annual abundance indices for the WCVI region: commercial vs. survey indices, each standardized to its 2001-2003 mean. Survey indices show bootstrapped 95% confidence intervals.

We present an integrated framework of three mathematical models for making these comparisons: (i) swept-area biomass estimates, (ii) standardized catch rates with fixed effects for various factors (Fig.3), and (iii) swept-area biomass estimates with standardized vessel effects. All commercial indices for the three regions show downward trends since the inception of the fishery, with the largest decline in the Rennell Sound area. The magnitude of decline depends on the model chosen for analysis. If these trends in the commercial data reflect real declines in population biomass, current removals of longspine thornyhead may not be sustainable. We conclude with recommendations for planning future surveys, integrating data from surveys and commercial fisheries, planning future reductions in the commercial fishery, and improving the basic biological information available for this species.

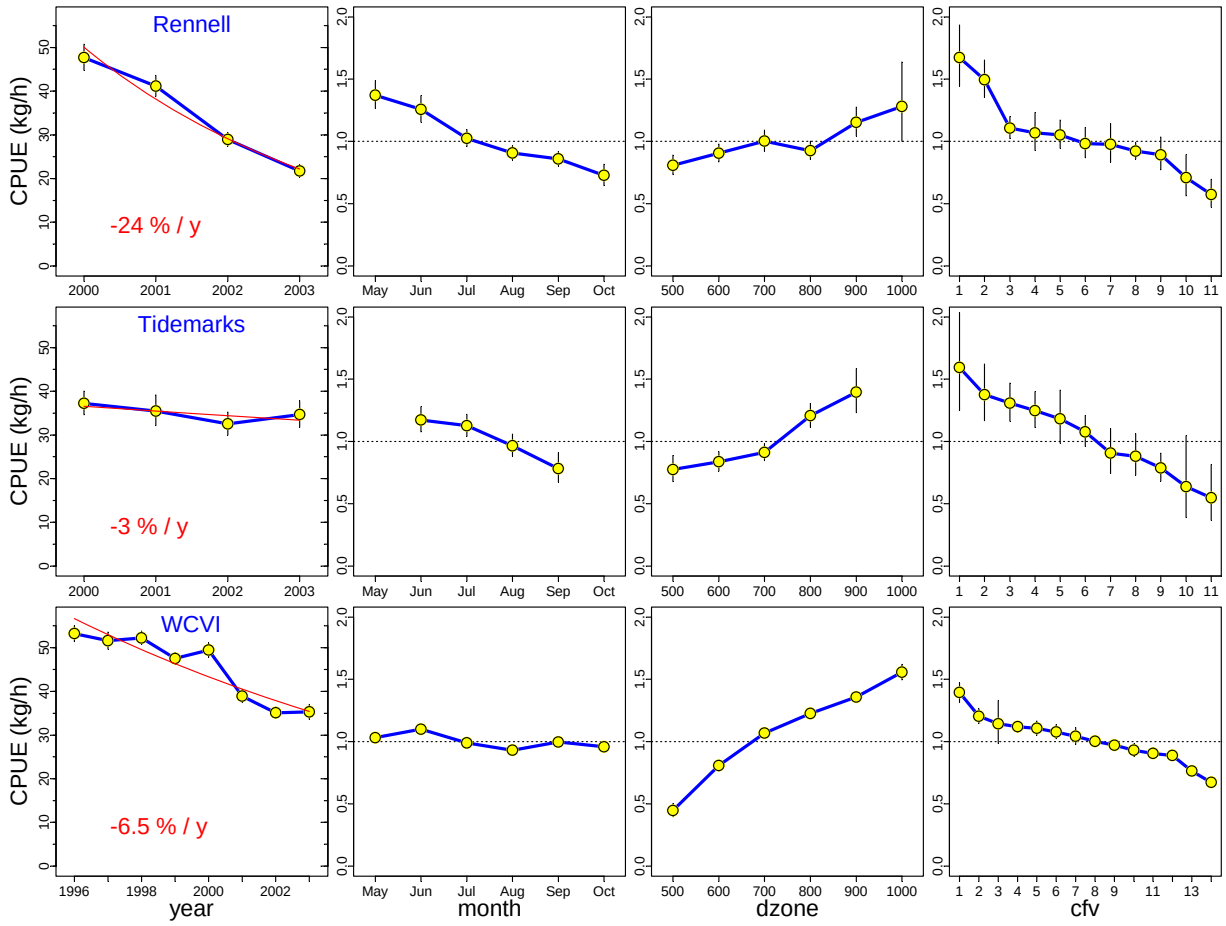



**Figure 3. .** Commercial longspine thornyhead CPUE U (kg $h^{-1}$) as $\log_2 U$ in three management regions (Rennell, Tidemarks, WCVI) along the BC coast – year as $2^{\mu+\alpha_i}$, month as $2^{\beta_j}$, depth zone (100-m intervals) as $2^{\gamma_k}$, and vessel (cfv) as $2^{\delta_l}$. Vertical error bars indicate 95% confidence limits. Red lines in column 1 show the back-transformed linear fit through $\alpha_i$; implies an annual loss of 24, 3, and 6.5 % · $y^{-1}$ in each of the three regions, respectively.

iii Research activities for 2005

There is a proposed 2005 survey for the west coast of Vancouver Island that will include the slope community (to depths of 1,500m). Additionally, an ongoing Tanner crab survey will provide an opportunity to collect biological samples of deepwater fish such as longspine thornyhead *Sebastolobus altivelis*.

The third year of the Queen Charlotte Sound synoptic survey will continue in 2005, targeting the 5AB (central BC coast) region between 50 and 500m. This includes a fair amount of slope rockfish habitat, especially that of Pacific ocean perch *Sebastes alutus*.

## *2b. Rockfish – Shelf*

### Research Programs in 2004

There was no new directed work on any shelf rockfish species in 2004. Staff efforts were directed at the multiple species bottom trawl surveys (see below). Work continues on yellowtail genetics study with Washington Department of Fish and Wildlife and a paper (Stanley and Kronlund 2005) on the biology of silvergray rockfish. Staff also played a consultative role in a U.S. widow rockfish acoustic project being conducted by the NWFSC and the U.S. trawl fishery.

### Stock Assessments in 2004

Staff developed an Allowable Harm Assessment (AHA) for bocaccio (*Sebastes paucispinis*) in B.C. waters (Stanley and Starr 2004). If a species is listed in Canada, then an AHA is required as background for developing a permit basis for harvesting, should harvesting be allowed. A decision on the proposed designation is expected by mid-2005.

The current status and recovery definition for bocaccio is ambiguous as shown in Figure 1. A shrimp trawl research index conducted off the west of Vancouver Island since 1975 is consistent with other information to indicate that abundance is currently low in comparison with the early 1980's. The early 1970's information, which is only available in this one time series, tends to indicate an earlier low period of abundance. Thus the current status of bocaccio can be viewed either relative to an averaged abundance or relative to the earliest period in the available time series. The same ambiguity affects any recovery strategy which has to define a recovery target.

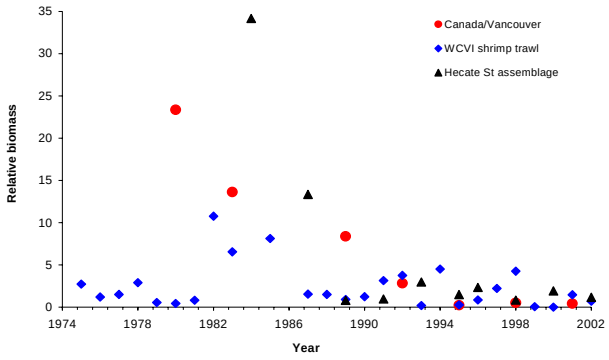



Figure 1 Comparison of the three available sets of trawl survey data for bocaccio in Canadian waters: a) NMFS survey for the Canada/Vancouver region; b) WCVI shrimp trawl survey; c) Hecate St. Assemblage bottom trawl survey. All survey indices have been standardized relative to the geometric mean of the 1989, 1995 and 1998 indices, the only years of overlap in these surveys.

The AHA proposed that the time series be viewed as having various stages; one example is provided in Fig 2.

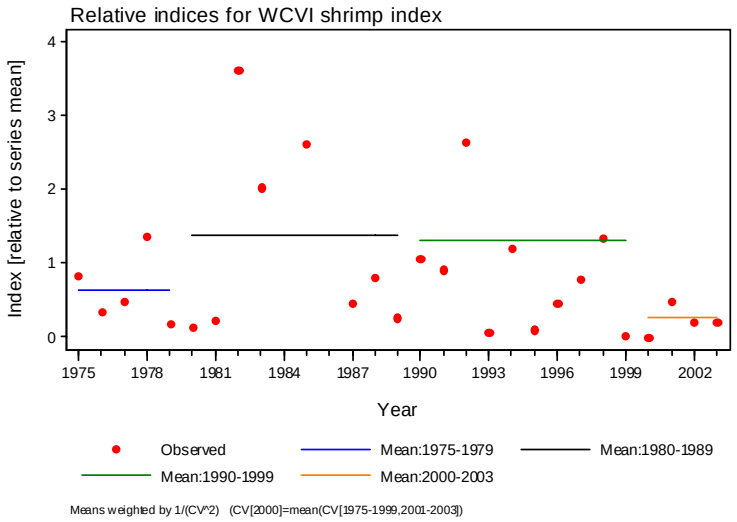



Figure 2. Four step function for the WCVI shrimp survey index, plotted relative to the mean 1975-79 survey estimates, weighted by the inverse of the $CV^2$ for each survey. The mean CV for the entire series (0.653) was used for the 2000 index because $CV_{2000}$=0.

### Research Activities Planned for 2005

Staff will continue participate in the conduct and analysis of bottom trawl surveys. There are no plans for directed research work on shelf rockfish for 2005.

### Stock Assessment Activities for 2005

Staff will be preparing a Status Report in 2005 on canary rockfish for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

## *2c. Rockfish – Inshore*

### Research Programs in 2004

Funded jointly by the Pacific Halibut Management Association (PHMA) and the Canadian Sablefish Association (CSA), an observer was deployed to collect biological samples and hook-by-hook catch data, during the International Pacific Halibut Commission (IPHC) Area 2B setline survey conducted from May to August 2004. Redbanded (*S. babcocki*) and yelloweye rockfishes were the dominant rockfish species taken on the survey. Preliminary simulation results from 2003 indicate that if an annual catch rate index is collected, it will be useful to track abundance trends for yelloweye rockfish by 2009. The PHMA and CSA also funded a technician in the Pacific Biological Station's Ageing lab, for six months, to assist in ageing the backlog of yelloweye rockfish ageing samples.

A repeat of the depth stratified (41 – 70 m and 71 – 100 m) random design survey conducted in 2003 was conducted in the Strait of Georgia (PFMC 4B), Statistical Areas 12 and 13 during August and September 2004. Fourteen species of rockfishes were encountered on the survey. Quillback and yelloweye rockfishes were again the dominant rockfish in the catch. Other commercial species caught included spiny dogfish, Pacific cod, sablefish, Pacific halibut and lingcod. A total of 4176 fish were sampled on the survey, including 658 rockfish. A strong 1985 year class is evident in the quillback age frequency data from both 2003 and 2004..

Jig research surveys were conducted in Statistical Area 12 (PFMC 4B) during June 2004. One hundred and one fishing sets were completed in 10 index sites. Preliminary data show continued declines in quillback rockfish catch per unit of effort from 1986-88 and 1992. A strong 1985 year class of quillback rockfish contributed 25% to the catch in 1992 (7 yr) and accounts for 11% of the catch in 2004 (19 yr.)

In collaboration with Dr. Sean Cox from Simon Fraser University, research on a genetic tagging experiment is continuing in a Rockfish Conservation Area (RCA) in the Strait of Georgia (PFMC 4B). Habitat maps have been developed by the Pacific GeoScience Centre (PGC) of Natural Resources Canada (NRCAN) and genetic tags were deployed in 5 study sites. Estimates of population size within the study sites are then extrapolated using the habitat maps.

**Stock Assessment**

No stock assessments were conducted in 2004. A stock assessment framework document was prepared for PSARC in May 2004 which summarizes all research activity conducted on inshore rockfish.

**Management Actions for 2004**

During 2003, the rockfish sustainability team worked with stakeholders through various advisory processes, publicly held workshops and the Department's consultation website to modify and improve 89 Rockfish Conservation Areas (RCAs). These 89 RCAs were then implemented for the 2004 fishing year. RCAs are used as a management tool to protect rockfish and fishing activities that are likely to catch rockfish are prohibited.
http://www-comm.pac.dfo-mpo.gc.ca/pages/consultations/fisheriesmgmt/rockfish/default_e.htm

**Research Activities Planned for 2005**

Further development of a rockfish conservation areas (RCAs) strategy is planned and will involve the investigation of a spatial model based on multibeam bathymetric and backscatter data to identify habitat areas. Rockfish habitat areas, identified through the model, will be overlain with all available fishery data to assess the potential of using these to site additional RCAs.

A submersible survey using visual methods to assess rockfish abundance is planned for May 9 to 24, 2005 in the Queen Charlotte Islands. This survey is designed to develop habitat assessment methodology and assess stock status for inshore rockfish. Rockfish density estimates by habitat type may be expanded using habitat maps to a biomass estimate over an area much larger than that surveyed by submersible. Habitat maps are being developed with the PGC using multibeam backscatter, bottom grab and seismic data. The submersible project is a joint project with the Washington Department of Fish and Game.

DFO will continue to coordinate and compile the hook-by-hook catch composition and rockfish biological sample collection on the IPHC setline survey in 2005. The cost of the contracted observer and additional vessel costs are borne by the halibut industry.

The longline survey in the Strait of Georgia (PFMC 4B) is planned for August 10th to September 6th, 2005 and will be conducted Statistical Areas 14 to 20 within the Strait of Georgia Management Region 4B.

## *3. Sablefish*

No report available.

## *4. Flatfish*

No program in 2004.

## *5. Pacific Hake*

On March 10, 2005, the US Pacific Fishery Management Council met to set the US total allowable catch (TAC) for the 2005 Pacific hake fishery based on analysis of data including the 2004 fishery. Although Canada and the US adopted a new treaty for the joint management of this shared resource in 2003, the treaty has not yet entered-into force as the treaty has yet to be ratified by the US Congress. The treaty seeks to have the catch-sharing provisions informally applied in 2005, as they were in 2004.

In advance of the Council meeting, a new stock assessment had been prepared jointly by Canadian and US scientists. The new stock assessment was an update of the 2004 assessment that included additional data for catch, catch-at-age and juvenile pre-recruit abundance in 2004 but otherwise used the same model configuration as in 2004. As was the case last year, the major source of uncertainty was the value of the catchability coefficient (q) for the acoustic survey. Both the 2004 assessment and the 2005 update provided two scenarios for the stock size and catch projections based on two alternative models (q=1.0 and q=0.6). Both were identified as equally likely, and decision tables were generated for both models. The Council then adopted a TAC which corresponded to the US's treaty share of a coast-wide TAC derived from the q=1.0 model.

## *6. Elasmobranchs*

**Research Programs in 2004**

An examination of potential age determination methods for big skate was completed (*Raja binoculata*) and submitted for publication. Vertebral centra sectioned longitudinally, immersed in ethanol, stained with crystal violet and enhanced with a thin layer of mineral oil produced the best results. Age compositions were produced and growth curves estimated. The method appears appropriate for age determination of big skate and the production of growth rates and productivity

for input into ecosystem models. The method was also utilized on centra of longnose skate with good results.

A tag/recapture program to examine stock discreteness of Big skate was initiated in 2003.This program was continued in 2004. Approximately 4300 big skate were tagged and released, bringing the total number of skates tagged and released to 7800 fish. As of November 2004, 452 skates were recaptured.

In November 2004, a longline survey for spiny dogfish was conducted in the Strait of Georgia. The objectives of the survey were: 1) compare catch rates of spiny dogfish between 'J' hook and circle hook gear; 2) collect biological data at 7 sites, 4 depths including age structures; and 3) compare catch rates of dogfish to previous surveys.

**Stock Assessment in 2004.**

No assessments were conducted on BC elasmobranches. COSEWIC status reports on blue sharks, shortfin mako, and basking sharks were prepared and will be submitted in early 2005.

**Management**

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

Recent increases in directed catch of skate prompted management to examine options for the 2002/2003 and subsequent fishing years. This resulted in a catch "cap" of 850 t on Hecate Strait big skate in 2002/03, which was continued in 2004/05.

**Research Activities Planned for 2005.**

1. Continue tagging program for big skate.
2. Conduct longline survey for spiny dogfish in Strait of Georgia.
3. Refine age determination methodology for spiny dogfish.
4. Prepare COSEWIC reports on spiny dogfish, big skate, longnose skate, sandpaper skate, six-gill shark, brown cat shark, soupfin shark.

## *7. Lingcod*

**Research Programs in 2004**

Lingcod abundance surveys were initiated in the Strait of Georgia in 2004: hook and line for juveniles and adults, bottom trawl for young of year, and dive survey for juvenile and adults. Community dive surveys for lingcod and rockfish densities, coupled with egg mass surveys sponsored by DFO were initiated.

**Stock Assessment**

***Offshore*** – No assessment was conducted on offshore lingcod stocks in 2003.

***Inshore*** – No assessment was conducted on Strait of Georgia lingcod stocks in 2004. A Management Framework was developed for the Strait of Georgia lingcod population which identified rebuilding targets and timeframes for this severely depressed stock. It is likely that recreational fishing will resume in 2005.

**Research Activities Planned for 2005**

Lingcod abundance surveys will be continued in the Strait of Georgia in 2005. A new survey on larval fish distribution throughout the Strait of Georgia will take place in April. This research is in collaboration with oceanographers at the Institute of Ocean Sciences and its objective are to investigate the distribution of larval fishes (including lingcod) in relation to circulation patterns; and to link those distribution patterns to subsequent area recruitment. Research will focus on integrating lingcod abundance surveys to ROV research conducted by the inshore rockfish program with the objective of developing biomass estimates for the Strait of Georgia lingcod population.

# D. Other Related Studies

## *1. Statistics and Sampling*

**Database Work in 2004**

Principal statistics and sampling activities in 2004 included the ongoing population of the groundfish biological database (GFBio). This database now includes about 6.5 million specimens. Data entry activities continue to concentrate on input of current port sampling and observer biological data and recent research cruises. When time is available, the database is backfilled with research cruise data collected before 1997. This past year involved a considerable effort in the entry of historic port samples, with backfilling complete to 1954.

Approximately 10% of a person year is involved with data uploads of the trawl observer data and providing catch data summaries. The groundfish trawl fishery continues to be covered by 100% dockside and virtually 100% observer coverage. These observers also provided 502 length/sex/age samples and 314 length samples in 2004. Port samplers provided an additional 189 samples, 168 samples with ageing structures (length/sex/age/weight) and 21 without structures (length/sex/weight).

Hook-and-line and sablefish trap landings have 100% dockside validation. Observer coverage in the hook-and-line fishery was initiated in 2000 and continues to provide about 5-15% coverage.

Staff also prepared a draft report on a General Groundfish Survey Strategy for groundfish (under revisions) as well as began work on a draft report on a General Groundfish Sampling Strategy.

They also assisted in an analysis of the potential benefits of introducing Individual Quotas in the west coast U.S. trawl fishery (Branch et al., in press).

**Field Work in 2004**

Staff participated on various bottom trawl surveys as well as operating as port samplers (1.8 person-years) in the Vancouver and Prince Rupert areas

**Proposed Field Work for 2005**

Port sampling will continue in 2005, as will staff participation in the bottom trawl surveys, a submarine survey of inshore rockfish, and the coastwide acoustic survey of hake.

**Proposed Catch Monitoring Research an Development in 2005**

Staff will be participating in research pertaining to designing the Electronic monitoring system in the hook and line fisheries. Specific studies will examine the capability to measure fish from video footage, and the sample size needed during dockside monitoring to estimate mean size in landed species. An accurate estimate of mean size is required to estimate piece count from the larger unloadings. Part of the audit tracking of accurate monitoring will depend on a comparison of piece count in the fisher logbooks with piece count in the unloading.

The proposed use of EM is part of a large information system that will be developed in 2005. This system is required to support the information and data flow requirements of the Integrated Groundfish Fishery plan. The 2005 pilot is designed to develop and beta-test a catch monitoring system that will be fully implemented for April 1 of 2007. The key elements of the system are:

1) full accountability for all catches (retained and discarded);
2) updates of individual fishers' catch histories within 24-hours of unloading;
3) the ability of the system to collate data from multiple providers (multiple contractors) at the same time.

Staff from the statistics section of groundfish are providing the stock assessment and research advice during design and implementation of the system.

## APPENDIX 1. REVIEW OF CANADIAN GROUNDFISH FISHERIES

### 1. Commercial Fisheries

All catch figures for 2004 are preliminary. Canadian domestic trawl landings of groundfish (excluding halibut) in 2004 were 104,750 t, a decrease of 5% from the 2003 catch. This decrease was mainly accounted for by the decrease in landings of Pacific hake. The major species in the trawl landings were Pacific hake (62%), Pacific ocean perch (6%), turbot (5%), yellowtail rockfish (4%). Principal areas of trawl production were 3C (58%), 4B (11%), 5B (9%) and 3D (6%).

Canadian landings of groundfish caught by gear other than trawl in 2004 totalled 8,816 t. Landings by trap and longline gear accounted for 2,682 t, approximately 83% by trap gear and 17% by longline gear. Sablefish accounted for more than 99% of the landed amount. Landings of species other than sablefish by longline, handline and troll gear accounted for 6,134 t (72% dogfish, 13% rockfish and 12% lingcod).

### 2. Recreational Fisheries

Each year, the Fisheries Management Branch of DFO conducts creel surveys of the recreational angling fishery in the Strait of Georgia. Principal target species are chinook and coho salmon. In 2004, these surveys covered the months of May to October. Provisional estimates of 2004 catches, landings and discards, for this 6-month period were 18,207 fish for lingcod, 28,363 fish for all rockfish species, 1,899 fish for halibut, 10,930 fish for flatfish, 26,303 fish for dogfish, 4,551 fish for greenlings and 421 fish for cabezon.

### 3. Joint-Venture Fisheries

In 2004, 38 Canadian catcher vessels delivered Pacific hake and incidental species to 11 processing vessels in cooperative fishing arrangements. This fishery took place off the southwest coast of Vancouver Island (Area 3C). A total of 58,892 t of Pacific hake was processed by 11 Russian vessels. The quotas and catches are outlined below:

| Nation | Species | Quota (t) | Catch (t) |
|---|---|---|---|
| Poland | Hake | 50,000 | 58,892 |
| | Pollock | incidental | 44 |
| | Rockfish | incidental | 89 |
| | Other | incidental | 757 |

## 4. Foreign Fisheries

There were no national or supplemental fisheries for Pacific hake off southwest Vancouver Island (Area 3C) in 2004.

## APPENDIX 2. GROUNDFISH RELATED REPORTS PUBLISHED BY IN 2004/05.

### 1. Primary Publications


Beamish, R.J., Schnute, J.T., Cass, A.J., Neville, C.M., and Sweeting, R.M. 2004. The influence of climate on the stock and recruitment of pink and sockeye salmon in British Columbia, Canada. Transactions of the American Fisheries Society 133: 1396–1412.

Branch, T. A, K. Rutherford, and R. Hilborn. 2005. Replacing trip limits with individual transferable quotas: implications for discarding. Marine Policy. (in press).

Haigh, R. and J. T. Schnute. 2003. The longspine thornyhead fishery along the west coast of Vancouver Island, British Columbia, Canada: portrait of a developing fishery. North American Journal of Fisheries Management. 23: 120-140.

McFarlane, G. A., J. R. King. 2003. Migration dynamics of Spiny dogfish (*Squalus acanthias).* In the North Pacific Ocean. Fish. Bull. 101: 358-367.

King, J. R., and G. A. McFarlane. 2003. Marine fish life history strategies: applications to fishery management. Fish. Man. and Ecology 10:249-264.

King, J.R. and R.E. Withler. 2005. Male nest site fidelity and female serial polyandry in lingcod (*Ophiodon elongatus*, Hexagrammidae). Mol. Ecol. 14(2): 653-660.

Schnute, J. T. 2003. Designing fishery models: a personal adventure. Natural Resource Modeling 16: 393-413.

Schnute, J. T. and R. Haigh. 2003. A simulation model for designing groundfish trawl surveys. Canadian Journal of Fisheries and Aquatic Sciences. 60: 640-656.

Sinclair, A.F., and Crawford, W.R. 2005. Incorporating an environmental stock-recruitment relationship in the assessment of Pacific cod (Gadus macrocephalus). Fish. Ocean. 41: 138-150.

Withler, R.E., King, J.R., Marliave, J.B. Beaith, B., Li, S., Supernault, K.J. and K.M. Miller. 2004. Polygamous mating and high levels of genetic variation in lingcod, *Ophiodon elongatus*, of the Strait of Georgia, British Columbia. Env. Bio. Fish. 69: 345-357.


### 2. Other Publications


Boers, N.M., Haigh, R., and Schnute, J.T. 2004. PBS Mapping 2: developer's guide. Canadian Technical Report of Fisheries and Aquatic Sciences 2550, 38 p.

Choromanski, E.M., J. Fargo, G.D. Workman, and K.Mathias. 2004. Multispecies trawl survey of Hecate Strait, *F/V Viking Storm*, June 10 – 28, 2002. Can Data Rep. Fish. Aquat.Sci. 1124:81p.

Haggarty, D.R. and J.R. King. 2005. Hook and Line Survey of Lingcod (Ophiodon elongatus) and Rockfish (Sebastes spp.) in Northern Strait of Georgia (Statistical Areas 13, 14, 15 and 16) June 14-July 9, 2004. Can. Tech. Rep. Fish. Aquat. Sci. *In press.*

Haggarty, D.R., King, J.R., Surry, A.M. and K.M. Mathias. 2005. Bottom Trawl Survey of Young-of-the-Year Lingcod (Ophiodon elongates) in the Strait of Georgia by the R/V Neocaligus, July 12 – 23, 2004. Can. Tech. Rep. Fish. Aquat. Sci. *In press.*

Haggarty, D.R. and J.R. King. 2004. Hook and Line Survey of Lingcod (*Ophiodon elongatus*) and Rockfish (*Sebastes* spp.) Stocks in Southern Strait of Georgia (Statistical Areas 17, 18, 19) October 2003. Can. Tech. Rep. Fish. Aquat. Sci. 2533.

Haist, V, A. R. Kronlund, and M. R. Wyeth. 2004. Sablefish (*Anoplopoma fimbria*) in British Columbia, Canada: Stock Assessment for 2003 and Advice to Managers for 2004. PSARC Working Paper G2004-01.

King, J.R. and D.R. Haggarty. 2004. Lingcod Egg Mass and Reef Fish Density SCUBA Survey in the Strait of Georgia, February 17 - March 3, 2004. Can. Data Rep. Fish. Aquat. Sci. 1147.

King, J.R. and D.R. Haggarty. 2004. An Examination of Recapture Rates of Lingcod as a Potential Source of Bias in Recreational Catch Per Unit Effort (CPUE) Indices. Can. Man. Rep. Fish. Aquat. Sci. 2670.

King, J.R., McFarlane, G.A., Beamish, R.J. and C.J. Low. 2004. Factors Influencing the Abundance and Distribution of Lingcod Egg Masses in the Nearshore Waters Adjacent to the West Coast of Vancouver Island During January 17 - March 15, 1979. Can. Tech. Rep. Fish. Aquat. Sci. 2557.

Lochead, J.L. and Yamanaka, K.L. 2004. A New Longline Survey to Index Inshore Rockfish (*Sebastes spp.*): Summary Report on the Pilot Survey Conducted in Statistical Areas 12 and 13, August 17 – September 6, 2003. Can. Tech. Rep. Fish. Aquat. Sci. 2567: 59 p.

Martin, J.C. and Yamanaka, K.L. 2004. Survey of inshore rockfish populations, habitat and demographics in the southern Strait of Georgia using a towed video system. Can. Tech. Rep. Fish. Aquat. Sci. 2566: 52 p.

Schnute, J.T., Boers, N.M., and Haigh, R. 2004. PBS Mapping 2: user's guide. Canadian Technical Report of Fisheries and Aquatic Sciences 2549, 126 p.

Schnute, J., Haigh, R., Krishka, B., Sinclair, A., and Starr, P. 2004. The British Columbia longspine thornyhead fishery: analysis of survey and commercial data (1996-2003). Canadian Science Advisory Secretariat, Research Document 2004/059, 75 p.

Sinclair, A.F. and P.J. Starr. 2005. Assessment of Pacific Cod in Hecate Strait (5CD) and Queen Charlotte Sound (5AB), January, 2005. Canadian Science Advisory Secretariat Research Document. in press.

Stanley, R. D. and P. Starr. 2004. Scientific advice for input to the Allowable Harm Assessment for Bocaccio. Canadian Science Advisory Secretariat Research Document 2004/098.

Stanley, R., Starr, P., Olsen, N., and Haigh, R. 2004. Summary of results of the 2003 Queen Charlotte Sound bottom trawl survey. Canadian Science Advisory Secretariat, Research Document, 2004/028, 50 p.

Yamanaka, K.L., L.C. Lacko, J.K. Lochead, J. Martin, R. Haigh, C. Grandin and K. West. 2004. Stock Assessment Framework For Inshore Rockfish. Canadian Science Advisory Secretariat Research Document 2004/068 63p.

Yamanaka, K.L., Lochead J. L. and Dykstra, C. 2004. Summary of non-halibut catch from the Standardized Stock Assessment Survey conducted by the International Pacific Halibut Commission in British Columbia from May 27 to August 11, 2003. Can. Tech. Rep. Fish Aquat. Sci. 2535 53p.

## APPENDIX 3. GROUNDFISH STAFF IN 2004

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


# Committee of Age-Reading Experts

# 2005 Committee Report

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

**May 3 – 4, 2005**

**Prepared by**

**Patrick J. McDonald**
**2004-2006 CARE, chairperson**
**Pacific States Marine Fisheries Commission**
**2032 SE OSU Drive**
**Newport, OR 97365**

# CARE 2005 Report
# to the Technical Sub-Committee of the
# Canada-USA Groundfish Committee

## A. CARE Overview, 2004-2005

### *History*

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

1. The date for the next biennial CARE Workshop/conference to be held in 2006 has not been finalized. Final dates will be set to ensure the meeting is held before the 2006 TSC meeting.

2. The draft minutes from the April 20-22, 2004 CARE Workshop/conference are included in this report (Appendix I). These draft Minutes were sent out to CARE members and any comments/revisions will be updated and the minutes will be approved by members at the April 2006 CARE Workshop/conference.

## B. CARE Working Group Reports

1. Manual/Glossary Subcommittee- Shayne MacLellan (chair, report contributor), Betty Goetz, Kristen Munk, Bob Mikus

    a. The lingcod and Pacific whiting ageing chapters are still in the process of being finalized.

        (1) Lingcod: Author John Sneva (WDFW).
        (2) Pacific whiting: An edited rough draft has been sent to the Canada Dept of Fisheries and Oceans for review and comments. Authors Patrick McDonald (NOAA Fisheries-NWFSC) and Shayne MacLellan (CDFO).

    b. A Dover sole ageing chapter is also being written for addition into the CARE manual. An initial rough draft has been sent out to Dover sole age readers and the Manual/Glossary Subcommittee chair for review. Author: Lisa Lysak (NOAA Fisheries-NWFSC).
    c. The statistical analysis/tools chapter is still being worked through. Michael Shirripa is lead draft writer for this chapter.
    d. No new updates to the glossary.

2. Web Page Subcommittee- Jon Short (chair), Delsa Anderl, Brenda Erwin

a. The Age-Structure Exchange table on the CARE web site does not currently have updates beyond 2002.
b. Age structure images have yet to be forthcoming for incorporation into Ageing Methodology page.
c. The 2004 minutes from the CARE meeting will be sent to the Web Page Subcommittee upon approval at the next meeting.
d. Updates were forwarded to the Web Page Subcommittee chair regarding the acceptance of Moss Landing Marine Laboratory as an official member of CARE. Direction was given to update the participating agencies list and to archive the member offer letter.
e. The CARE web site is available at: http://www.psmfc.org/care/CARE_Pub/index.htm.

3. Charter Subcommittee – Shayne MacLellan, Kristen Munk, Betty Goetz, Bob Mikus

a. No new updates to the CARE Charter.

## C. Agency Structure Exchanges

There are no new updates to the CARE Age Structure exchange table beyond that provided in the last CARE report to TSC (see 2004 report, Appendix IV).

## D. Interim Workshop Updates

1. Sablefish: These interim or supplemental hands on workshops were discussed at 2004 CARE and TSC. This workshop is planned to coincide with the 2006 Sablefish symposium. Kris Munk offered to be coordinator between labs for the ageing workshop at the 2004 CARE meeting and has sent out an initial agenda to participating labs at ADFG, CDFO, NOAA Fisheries-AFSC and NOAA Fisheries-NWFSC.
2. Pacific hake and Pacific Ocean perch: Two Participants from the NOAA Fisheries-NWFSC traveled to CDFO to work on P. hake ageing issues and to address difficult interpretations of Pacific Ocean perch growth patterns.
3. Dover sole: The annual Dover sole workshop was held in Eureka, CA on April 26-27, 2005.

## E. CARE Workshop Business

### *Status of 2004 Recommendations from TSC to CARE*

**Recommendation** – TSC recommends eliminating the summary statistics and adding hyperlinks to any reports pertinent to the exchange. The TSC also supports the CARE representative's suggestion of standardizing the format of age structure exchange reports.

**Update** – These recommendations will be presented to CARE members at the 2006 CARE Meeting.

# CARE MEETING MINUTES

## APRIL 20-22, 2004

**OPENING REMARKS**
Delsa Anderl , chair of CARE 2002-2004, opened the meeting at 8:30 am, April 20, 2004, at the NOAA-Fisheries Sandpoint facility, Seattle, Washington. She welcomed everyone to the workshop, passed out copies of the agenda and last meeting's minutes, and proceeded to the introductions.

**INTRODUCTIONS**
Participants introduced themselves and stated the agency represented:

| | |
|---|---|
| Philip Cowan | ADFG-Homer |
| Jeremy Botz | ADFG-Juneau |
| Brit Constantine | ADFG-Juneau |
| Kristen Munk | ADFG-Juneau |
| Joan Brodie | ADFG-Kodiak |
| Barbara Campbell | CDFO |
| Shayne MacLellan | CDFO |
| Cal Blood | IPHC |
| Joan Forsberg | IPHC |
| Linda Gibbs | IPHC |
| Robert Tobin | IPHC |
| Stephen Wischniowski | IPHC |
| Delsa Anderl | NOAA-Fisheries-AFSC |
| Irina Benson | NOAA-Fisheries-AFSC |
| John Brogan | NOAA-Fisheries-AFSC |
| Dan Foy | NOAA-Fisheries-AFSC |
| Christopher Gburski | NOAA-Fisheries-AFSC |
| Betty Goetz | NOAA-Fisheries-AFSC |
| Charles Hutchinson | NOAA-Fisheries-AFSC |
| Chris Johnston | NOAA-Fisheries-AFSC |
| Craig Kastelle | NOAA-Fisheries-AFSC |
| Lisa Kautzi | NOAA-Fisheries-AFSC |
| Dan Kimura | NOAA-Fisheries-AFSC |
| Charlie Piston | NOAA-Fisheries-AFSC |
| Wesley Shockley | NOAA-Fisheries-AFSC |
| Jon Short | NOAA-Fisheries-AFSC |
| Susan Coccetti | NOAA-Fisheries-NWFSC |
| Lisa Lysak | NOAA-Fisheries-NWFSC |
| Patrick McDonald | NOAA-Fisheries-NWFSC |

| | |
|---|---|
| Jennifer Menkel | NOAA-Fisheries-NWFSC |
| Omar Rodriguez | NOAA-Fisheries-NWFSC |
| Michael Schirripa | NOAA-Fisheries-NWFSC |
| Bob Mikus | ODFW |
| Sandra Rosenfield | WDFW |
| John Sneva | WDFW |
| Jennifer Topping | WDFW |

**MEETINGS**
Anderl updated everyone on upcoming meetings:

Technical Sub-Committee (TSC) – May 4,5 – Whidbey Island
Dover sole workshop – May 16
Third International Symposium on Fish Otolith Research and Application – July 11-16 – Australia
Sablefish workshop – 2005 – Schirripa (lead)

**APPROVAL OF AGENDA**
All participants approved the 2004 agenda proposed by the chair (Appendix 1). Some changes were noted for the presentations.

**APPROVAL OF 2002 MEETING MINUTES**
All participants approved the 2002 meeting minutes.

**UPDATES**
The CARE addressee mail list was passed around for any revisions.

***Summary of age reading methods*** –The labs provided updates prior to the meeting. Discussion ensued regarding what production numbers to put in the table. It was decided that we should use the number of fish aged over the 2 year period. This would be updated on the website. The "stock" column will be changed to "area". It would also be advantageous to add a new column: "number of people/species". We discussed whether or not to eliminate the "capability" column or to define the terminology in the column. Further discussion and any decision on this was tabled until Thursday.

***Standards*** – It was decided that the new software standard is OFFICE 2000: Word, Excel, and Access.

**WORKING GROUP REPORTS**
***Manual/Glossary*** – MacLellan presented the new cover produced by Wischniowski. It was suggested that the title be lighter, more contrast for the text, delete "2004", and correct one formula. Wischniowski said he would attempt to have the cover revisions by Thursday. The addition of hake to the manual is in process, and a draft of lingcod ageing via dorsal fin ray cross sections is complete. Both should be finalized in a few months. Munk stated that "biannual" should be "biennial" in the text.

***Charter*** – Anderl thanked Goetz, Mikus, and Munk for their good work on finalizing the Charter. Anderl initiated discussion regarding a paper where the main author didn't allow review by the co-authors of the ageing protocols used. It was suggested that we add language to the Charter, under Membership Responsibilities, that states that authors should extend the courtesy of reviewing ageing methodologies to those whose age estimates are used. Goetz said she would propose specific language for further discussion on Thursday.

***Website*** – Anderl expressed concern with the structure exchange table. The TSC response regarding the addition of statistics was not definitive.

***Structure exchanges*** – McDonald reported the following exchanges and participants:

| | |
|---|---|
| Hake: | CDFO & ODFW |
| Sablefish: | ODFW & NOAA-Fisheries AFSC |
| Walleye Pollock: | ADFG-Juneau & NOAA-Fisheries AFSC |
| Darkblotch rockfish: | ODFW & NOAA-Fisheries AFSC |

Any additional exchanges would be reported on Thursday.

Morning Break at 10 a.m. to 10:20 a.m.

## AGE & GROWTH LAB OVERVIEW AND UPDATE BY AGENCY

***ADFG*** – Munk reported for their three lab locations at Juneau (central), Homer, and Kodiak. The Juneau lab has statewide responsibilities. The Homer and Kodiak labs have part-time agers. They have added one new ager and one new technician. Munk mentioned the funding constraints they are under, noting that groundfish ageing funding was up a little and that they had received rockfish ageing funds from NOAA through 2008. New ageing priorities have resulted in ageing fewer flatfish. Specific projects of note were looking at lingcod growth differences between regions, and partial validation in an age range via bomb radiocarbon dating for shortspine thornyhead.

***CDFO*** – MacClellan reported that their lab (Nanaimo) produces about 13,000 groundfish age estimates annually, and also ages for 30,000 herring, 5,000 shellfish, and 98,000 salmon (B.C. and Yukon). There are nine people on staff, with 6.5 FTEs doing production ageing. They have developed a new database for all species that is user friendly, accessible to users, and can be used as a tracking system. Phase 1 of the database system initially included just salmon; Phase 2 is better and captures all ways of age notation. All information from the age data sheets are recorded in the database. MacClellan noted their lack of prioritization, no standard sample sizes, and their desire to do more quality control and research. Managers have proposed the lab age 160,000 fish per year, while she stated that they can only age about 125,000 per year. They re-read 10%-20% for precision estimates.

***CDFG*** – Erwin was not able to attend this year.

***IPHC*** – Forsberg reported that they age about 28,000 sport and commercial halibut annually, with 5 agers. In 2003, they began utilizing the break and bake technique using a toaster oven which works better for younger fish. This technique was adopted after a 2002 study that compared

surface and break and bake age estimates. The lab is now using Trebiens for storing their otoliths. Their database now includes an age estimate, and alternate age estimate, an age range, plus 8 edge-type codes. They have been investigating bomb radiocarbon dating for otoliths that have been stored in glycerin and elemental analysis of otoliths. They have found out that the break and bake technique works better on otoliths that have been stored in glycerin.

***NOAA-Fisheries-AFSC*** – Goetz reported that their lab has 11 primary agers. The lab has been experimenting with the break and bake technique, noting that it is species-specific and doesn't work well for rockfish. They have added sculpins and greenlings to their list of fish to age, and will work on capelin and short-spine thornyheads in the future. The lab's priorities are set by their working group. Current research projects are radiometric and bomb radiocarbon age validation (Kastelle) and shortraker rockfish ageing (Hutchinson). New research projects planned are crab and whale ageing. The lab is under contract to provide age estimates for turbot and skate (vertebrae).

***NOAA-Fisheries-NWFSC*** – McDonald reported they have 6 agers, with another to be added shortly. He noted that PSMFC is in charge, with the priorities being set by the NWFSC. Current research projects are bomb radiocarbon age validation and annulus measurements for hake. The lab has become more research oriented.

***ODFW*** – Mikus reported that he is the primary ager with regional biologists ageing sport fish part-time. He assists in ageing Dover sole and near shore species, as well as ageing otoliths from marine mammal scats.

***WDFW*** – Sneva reported that they have two full-time groundfish ages. The lab has recently added sardines and spiny dogfish to their list of species they age.

## SIMILARITIES AND DIFFERENCES BETWEEN AGENCIES/LABS

Participants discussed differences in databases, precision statistics, and age reading sheets. All labs use the standard January 1 birthday, with the exception of sardines (June 1) and English sole (CDFO). Anderl led a discussion on edge-type data, noting that it works good for Atka mackerel, but poor for sablefish. Goetz said that Pollock show different edge-types on good growth years than on normal growth years. Munk's lab uses no edge-type code. She thought edge interpretation was most difficult for June-August sampled fish. Regarding establishing a protocol for resolving differences between labs in ageing criteria for the same species, Blood suggested that we should just acknowledge the differences and that the use of exchanges would reveal if there were problems. MacClellan said that the basic criteria must be the same, even though there are pattern differences between stocks. Schirripa noted to be aware of true criteria differences between stocks. We tabled further discussion until after lunch or Thursday.

Lunch Break at noon to 1 p.m.

## ERGONOMICS

Discussion revolved around which labs had ergonomic scopes and work stations. Goetz said that ergonomic scopes/work stations usually are not purchased until medical problems arise. Goetz said that the key to avoiding medical problems is educating oneself on proper posture and exercises, as well as having an adjustable chair, a properly positioned scope on a table at the right height. The major scope manufacturers have new ergonomic scopes incorporating low positioned focusing knobs and adjustable binocular tube angle and height. A Leica ergonomic head with bellows costs about $4,000. Some of the women members discussed the hardships of doing scope work while they were pregnant.

## RECOMMENDATIONS
## 2003 TSC TO CARE RECOMMENDATIONS

TSC recommended that we incorporate 2 to 4 hours of presentations in our meeting. Eight presentations were scheduled for the 2004 meeting.

TSC suggested we note limitations and caveats to exchange table statistics. We discussed adding a percent agreement column, but questioned what to do when you have 3 or more readers. Participants noted that the reasons for exchanges are many. We discussed a possible recommendation to TSC: what does TSC want in the exchange table?

TSC recommended that there should be a standard number of structures per exchange. Participants felt that this number should be reasonable and determined after consulting with the stock assessment biologist involved with that species.

## 2002 CARE TO CARE RECOMMENDATIONS

These were the recommendations and actions taken:

A draft of the charter should be presented to the membership by May 31, 2002. *Completed.*

Update cover of Aging Manual with CARE logo. *Completed with edits*.

Produce a table defining capability terms and updates for each agency-species by May 31, 2002. *This item was tabled.*

Include new technologies and/or aging related discussion to New Business for future Care workshops. We discussed the use of vertebrae for aging. Schirripa said utilizing new structures should be need based. Troublesome species are candidates for looking at new structures. Add age data, both blank and examples to the web page. *This will be done*.

Add the following new sections to the CARE manual:

Thin sectioning – *We are not quite ready to do this yet.*

Lingcod – *The first draft of thin-sectioning/aging this species is complete.*
Pacific Whiting – *McDonald's report with DFO pictures will be used*.
Data sheets – *Blank and example versions will be included*.

Add pictures to the website. *Anderl is working on this*.

Add a breakdown of numbers/species aged per year by agency to the website. *This will be done*.

Discuss ergonomic issues as part of New Business with a possible demonstration. *Completed at this year's workshop.*

## ELECTION OF 2004-2006 OFFICERS

| | |
|---|---|
| Chair: | Patrick McDonald |
| Vice Chair: | Kristen Munk |
| Secretary: | Joan Brodie |

All officers were elected unanimously.

## PRESENTATIONS

***Proposed new CARE website – Jon Short***
Short presented the pages to be included, noting that the first page needs a new look. Blood said that it needs to be updated periodically. Rodriguez suggested that other workshops and exchanges might be included. Kastelle suggested that abstracts and new publications be included. Short mentioned that currently he doesn't have web access to make changes.

***Otometrics – Kristen Munk***
The collection of dimensional and physical attributes of otoliths is part of the "basic data" and can be used to support age data. Munk discussed the measurements of "otolith index" and "otolith calcium investment index".

***Research projects at CDFO – Shayne MacClellan***
Most of the research has been with Pacific cod and sablefish. For Pacific cod, their goals were to determine the best structure for aging and to verify annuli on young fish. They looked at bake and break otoliths, otolith thin sections, and dorsal fin ray cross sections, concluding that the fin sections produced consistently clearer annuli and that annulus measurement criteria worked better for the fin rays. They will look at older fish next. For sablefish, they used young, "known age" fish and looked at break and burn otoliths and thin sections (only two sections needed). Annuli clarity was better for the break and burn method. They will be looking at age 2 to 5 tagged fish next.

Afternoon Break at 3:00 p.m. to 3:20 p.m.

***Ageing skate species using vertebrae – Chris Gburski***
Chris showed examples of whole and thin sectioned vertebrae, with age estimates up to 19. He described the preparation methods and said he would be looking at staining methods and trying caudal spines in the future.

***Challenges of determining ageing criteria for the Greenland turbot – Jake Gregg***
Otoliths of this species are very convoluted and fragile. Surface age estimates have revealed poor precision in past studies, with better precision for break and burn otoliths. His study examined half section (stained) and surface age estimates from one particular area of the otolith. Two readers aged the samples three times. Older fish stained section estimates were more precise than the surface estimates. There was no precision difference with the younger fish. He noted that a 76 cm male with a surface age of 14 had a sectioned age of 35. This species needs age validation.

***Age validation of canary rockfish using bomb radio carbon dating – Jennifer Menkel***
Jennifer described the basics of this methodology, noting that it is usually accurate within one to three years. The sample is taken from the first year core and she utilized reference curves from halibut and Atlantic haddock. Two sampling designs were employed. Conclusions were that parallelism was not rejected, there is a consistent ageing error bias of 2-3 years, and the assumptions of this validation method can be quantitatively tested.

***Walleye pollock radiometric age validation – Craig Kastelle***
Craig described this methodology which utilized the lead/radium ratio. The pollock fishery is the largest in the North Pacific, hence the need for age validation. His study was to validate the age reading criteria of the ADFG lab and the AFSC lab. He used age 3-8 otoliths, with 40 sampled from each age group. The results so far indicate that the AFSC lab criteria were most correct. There was a bias of about 2 years, mainly due to core problems and a biased radiometric standard.

***Sample size to measure bias between two age determinations – Michael Schirripa***
Michael used simulations on data sets of Pacific Ocean perch (long-lived) and hake (short-lived). He noted that what we are looking for is the Type II error. The simulations revealed that a sample size of 100-200 was adequate for hake and that 200-300 were adequate for POP. He reiterated that this is an absolute number, not a percentage.

Meeting was adjourned for the day at 5:00 p.m.

## Wednesday, April 21, 2004

Scope work from 8:00 a.m. – 5:00 p.m. at scheduled work stations.

We had three working group reviews prior to the morning break:

**Sablefish ageing** – In preparation for the upcoming TSC initiated international sablefish workshop.
**Pacific cod ageing** – Specifically on the determination of the first three annuli.
**Walleye Pollock ageing** – Specifically to document differences in ageing criteria.

Morning Break at 10:00 a.m. to 10:20 a.m.

We had two working group reviews prior to lunch:

**Pacific hake ageing**

**Shortspine thornyhead ageing** – Specifically to collaborate on developing ageing criteria.

Lunch from 12:00 p.m. to 1:15 p.m.

Hutchinson demonstrated his thin section preparations using Pacific cod and sablefish otoliths throughout the afternoon.

Afternoon Break 3:00 p.m. to 3:20 p.m.

We continued with collaborative scope work and discussions.

Meeting was adjourned for the day at 5:00 p.m.

## Thursday, April 22, 2004

***Wrap-up Group Session:***

Anderl expressed her thanks to the members for their contributions to this workshop.

We looked at the possible changes to the logo for the manual. We tabled the decision until later this morning.

The exchange table was passed out to the members for discussion of possible changes. We discussed adding more rows to accommodate individual readers and reader statistics? We discussed a possible recommendation to TSC, asking them if they want more detail or leave it as is. One suggestion was to include a disclaimer statement (with notes on who to contact) at the end of the table. The Vice Chair would review this.

Anderl noted that AFSC members have historically been in charge of the shirt and mugs sales and that this is no small endeavor. We decided that this duty will now be on a rotating agency basis.

We discussed possibly adding a "capability" column to the Summary of Age Reading Methods table. Anderl said she would check on possible definitions.

Goetz moved to add the following bullet item under Member Responsibilities in the CARE Charter:

"A member agency that drafts written materials which characterize the methodologies and/or protocols of other agencies with intent for

distribution and/or publication, are encouraged to allow the agencies involved to review and comment on the final draft prior to distribution."

The motion was seconded and passed unanimously. MacClellan emphasized that freedom of interaction is important in CARE.

It was moved, seconded, and passed unanimously to accept the CARE Charter as amended.

We decided, at least for now, to leave the number of structures for exchanges as is.

## 2004 RECOMMENDATIONS FROM CARE TO CARE:

1. CARE members are encouraged to hold workshops/calibration sessions as needed to address specific age reading issues.
2. Draft a chapter on statistics to include in the CARE manual.

## 2004 RECOMMENDATIONS FROM CARE TO TSC:

1. CARE recommends that TSC and its participating agencies support additional hands-on only workshops to address species specific age reading issues.
2. CARE recommends to TSC that Appendix B (CARE Charter) be included in the 2004 CARE to TSC report.

Logo cover changes to the manual were adopted

Morning Break at 10:00 a.m. to 10:20 a.m.

We continued with microscope collaborative work and discussions.

Lunch Break at 12:00 p.m. to 1:15 p.m.

Continuation of microscope collaborative work and discussions.

Meeting was adjourned for the day at 3:30 p.m.

**End of 2004 CARE workshop**

# IPHC Research Program:

# Review of 2004 Projects and Proposals for 2005

**The International Pacific Halibut Commission Staff**

**January 18, 2005**

## *Introduction*

This document reviews research conducted by the IPHC staff in the past year and proposed for the upcoming year. The report is divided into two sections, with the first section reviewing the status of research projects conducted 2004. The second section presents the staff research proposals for 2005. Information is provided on when each project was initiated, the anticipated completion date, the annual cost, a description of the costs, and the purpose of the project. This report does not include ongoing staff tasks such as data collection and processing that are necessary for the management of the fishery.

Research projects are organized into three funding categories that reflect availability and source of research funds. Limited research requiring cash outlay is possible under the basic $2.407 million (as of 2004) government appropriations, although a number of programs can be conducted using only the staff resources that are supported by the appropriations. The three funding categories are:

**Funded Research:** Necessary research projects of high priority that can only be conducted with revenues generated by survey fishing in 2005, and/or carry-over from 2004;

1) **Contract and Grants:** Agreements with other parties to conduct specific research. In this case, contracts and grants are shown for projects where the IPHC staff is the principle investigator; and

2) **Research conducted with internal funding:** Necessary research projects of high priority that can be conducted under the basic $2.407 million budget.

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

i) Improving the annual stock assessment and quota recommendations;

ii) Developing information on current management issues; and

iii) Adding to knowledge of the biology and life history of halibut.

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

## *SECTION I:*
## *REVIEW OF RESEARCH CONDUCTED IN 2004*

Research conducted by the IPHC staff during 2004 covered a myriad of subjects, from the coast-wide PIT tagging project, archival tags, collection of tissue and otolith samples, to issues that bear on the stock assessment. Most of the projects were conducted as part of the normal staff duties, with no additional funding required outside of staff salaries. Funding for projects outside of staff salaries came from supplemental funding, and these projects are outlined below.

### *Funded Research in 2004*

The staff completed several projects during 2004, but most of the work was on long-term projects which will continue past 2004. Substantial time was applied to the PIT tagging project, which included releasing tags from the assessment survey vessels in Areas 2B and 3A to provide information for estimating annual survival. Releases totaled 3,086 in Area 2B and 20,351 in Area 3A, for an overall total of 23,427 tags. As in 2003, the 2004 tags were released in proportion to abundance by fishing an additional three skates on each survey station.

The dockside detection program by IPHC Scan Samplers continued in 2004. This past year marked the first full season of scanning by samplers in eight Alaskan and four B.C. ports. Additionally, IPHC received state and tribal assistance in scanning efforts in nine west coast ports. Through 31 October, over 31 million pounds (45% of total landings) have been scanned. The number of recovered tags totals 386 from the 2003 primary experiment, 35 from the 2004 releases, and 198 from the September 2003 double tag experiment (2,662 PIT tags released). The latter project was conducted to confirm the PIT tag shedding rates observed during earlier holding experiments in Seward.

The otolith elemental project (project 620) continued in 2004 with the additional collection of age 1 and 2-yr old halibut from the Sitka/Shelikof Bay area in August. Juvenile halibut from the Bering Sea were obtained from the NMFS trawl survey to assess temporal stability of elemental signatures within nursery habitats. Temporal stability must be understood in order to establish future sampling designs. Lab work at the Woods Hole Oceanographic Institute (WHOI) on age-2 halibut suggests that otolith elemental signatures can be used to successfully distinguish and classify individuals within general geographic regions (southeast Bering versus west-Central Gulf), with 75-80% accuracy. Additional lab work will add more physical variables (oxygen and carbon isotope ratios) to the existing statistical model, hopefully increasing the accuracy of these classifications.

Studies on the genetic population structure moved forward in 2004 with tissue samples collected on charters in January-February, 2004, at spawning locations near Queen Charlotte Island, Portlock Bank, and Pribilof Canyon. These collections were made to address the question of whether or not the Bering Sea is reproductively isolated from the Gulf. As a portion of this work, a preliminary population analysis was conducted comparing Adak and St. Paul Island to

Newport, Oregon. The results were intriguing, suggesting potential reproductive isolation in the western Aleutians. However, sample sizes were low, so a more thorough analysis is warranted. Thus, ~1500 tissue samples were collected from 18 sites during the 2003 setline survey and port sampling program. These sites will be re-sampled in 2005 in order to examine temporal stability in genetic signatures.

During the 2004 summer setline survey, 12 PSATs were deployed at each of two Aleutian Islands: Atka and Attu (Project 622). These tags are programmed to release from the fish and report their location and data during mid-February 2005. The goal of the project is the identification of potential spawning areas utilized by Area 4B fish.

In 2003, preliminary histological work on the female gonads was initiated (Project 636). Based on the results, staff developed a sampling design and collection protocols for the 2004 surveys. During the 2004 winter and summer surveys, female gonads from three different regions, in each stage of development, were collected. Three different histological subsamples have been prepared and we are presently standardizing the sample sites on the gonad for the final slide preparation. We have collected nearly 240 gonad pairs and will be analyzing multiple sites from each sample.

Project 638, investigating whether species richness and evenness (i.e., species diversity) is correlated with bottom temperature and depth, got underway in 2004. Historical data from several survey regions in British Columbia and Alaska were examined and data from a directed field experiment were analyzed. Survey vessels in selected regions deployed temperature and depth recorders on each skate of gear in 2004. In addition, electronic monitoring equipment was installed on one vessel to record a sequential tally of all catch for each station (hook by hook data). A video analyst reviewed the video data, determining the numbers and species encountered. On the remaining vessels, Archipelago Marine Research (AMR) field staff recorded hook by hook data in-season. The final analysis will examine the spatial distribution and relative abundance of species relative to the temperature and depth profiles.

IPHC also continued working collaboratively with the Alaska Department of Environmental Conservation (ADEC) to collect halibut tissue samples on the assessment surveys for analysis of heavy metal and organic pollutant loading. In 2003, the principal results from the 2002 collection led the Alaska Division of Public Health to conclude that the concentrations of heavy metals in Alaskan Pacific halibut are not a public health concern. In 2004 the first results regarding organic pollutants (PCB's, pesticides) were released demonstrating that halibut had the lowest concentrations of the five species (including salmon and sablefish) examined. 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. Sampling continued in 2004 with a targeted collection of 60 samples (30 from fish weighing between 20 – 40 lbs. and 30 from fish weighing between 40 – 100 lbs.) from each of three regions (SE Alaska, Shumagin Islands, and the Aleutian Islands) during the setline survey. Results will be published as they become available.

As in past years, IPHC placed staff on the 2004 NMFS Bering Sea trawl survey (Project 604) to collect fishery-independent data for stock assessment. Trawl data are particularly useful because they include large numbers of juveniles (ages 3-7 yr) that do not appear in large numbers in the setline survey. Otoliths have been collected on the NMFS surveys since 1996 and provide relevant age information. These data are expanded to estimates of relative abundance and age/size composition by IPHC area.

Use of the water column profiler on selected assessment survey vessels continued in 2004 (Project 610). This work began in 2001, with the successful deployment of a SeaBird SBE-19 water column profiler. The program has been conducted on board six vessels fishing selected areas since 2001. Only one profiler was used in 2004, due to a lack of external funding. The work is in collaboration with the Pacific Marine Environmental Lab (PMEL).

Finally, IPHC hired one intern (project 618) and one graduate student (Project 607) in 2004. Mr. Christopher Clarke (University of Victoria, BC) worked May-August on a project examining prior hooking injuries, which also gave him an opportunity to spend time on a survey vessel collecting data. Mr. Rob Ames (Royal Roads University, Victoria, BC) conducted graduate work on the potential for using video monitoring systems for enumerating the hook by hook catch on the stock assessment survey vessels. He will be completing his Master's degree requirements this winter.

## *2004 Contract Research*

Since 2002, IPHC port samplers in BC have interviewed skippers about the bycatch of other species during halibut fishing (Project 376). These data were entered into the IPHC log database tables. The latitude/longitude location was converted using Geographical Information Systems (GIS) to DFO statistical areas and vessels were assigned a unique identifier to maintain the confidentiality of the vessels. In 2003, the 2002 bycatch catch and discard information from the logbooks was summarized and electronically provided to DFO. (The data provided had a skipper's signature acknowledging that IPHC would provide the information to DFO.) The 2003 and 2004 data will similarly be provided to DFO with additional bycatch landing weights collected by port samplers at the time of the log interview. This information may assist DFO with validation of the log data.

IPHC and NMFS Auke Bay Lab (ABL) have a sablefish data collection program (Project 628). The program was reviewed and modified in 2003/2004 to meet the IPHC confidentiality policy and to encompass all vessels rather than just vessels greater than 60 feet. Under a Statement of Work, NMFS contracted IPHC staff to interview the IFQ fishers to review and collect the sablefish information in addition to the halibut information. Data are entered by IPHC staff with an electronic summary provided to the NMFS ABL scientists. Vessels are assigned a unique code in the summarized data to preserve confidentiality.

Staff continued in 2004 a study with the Central Bering Sea Fishermen's Association (CBSFA) examining the effects of oceanographic conditions on halibut catches and CPUE (Project 629). The objective of the project is to see if temporal trends in CPUE can be isolated and correlated with changing water temperature. With the cooperation of local fishers and funding from the CBSFA, IPHC began deploying temperature loggers on longline gear during fishery operations in 2002. A total of five vessels participated, providing temperature observations from just over 100 longline sets. In 2003, with funding from an external granting agency (NPRB), the study was expanded to include 11 vessels, providing data from just over 250 sets. While the 2004 data have not yet been processed, the 2002-03 data clearly demonstrate seasonal temperature patterns in the region, short-term temperature variability, and interannual variability in daily maximum temperatures.

# 2004 Research Publications

IPHC staff noted in **Bold** type.


**Chen, D.G.** 2004. Bias and bias correction in fish recruitment prediction. N. Am. J. Fish. Mgmt, 24:724-730.

**Chen, D.G.**, Xie, Y., Mulligan, T.J. and MacLennan, D.N. 2004. Optimal partition of effort between observations of fish density and migration speed for a riverine hydro-acoustic duration-in-beam sampling method. Fish. Res., 67:275-282.

**Clark, W.G.** In press. Nonparametric estimates of age misclassification from paired readings. Can. J. Fish. Aquat. Sci.

**Clark, W. G.** and **Hare, S. R.** 2004. A conditional constant catch policy for managing the Pacific halibut fishery. N. Am. J. Fish. Mgmt 24: 106-113.

deBruin, J-P, Gosden, R.G., Finch, C.E., and **Leaman, B.M.** 2004. Ovarian aging in two species of long-lived rockfish, *Sebastes aleutianus* and *S. alutus*. Biol. Reprod. 71(4):1036-1042.

**Kaimmer, S. M.** 2004. 1998 gear and bait experiments. Int. Pac. Halibut Comm., Technical Report 48. 36 p.

**Kong, T.M., Gilroy, H.L.,** and **Leickly, R.C.** 2004. Definition of IPHC statistical areas. Int. Pac. Halibut Comm., Technical Report 49. 72 p.

Piner, K.R. and **Wischniowski, S.G.** 2004. Pacific halibut chronology of bomb radiocarbon in otoliths from 1944 to 1981 and a validation of ageing methods. J. Fish Biol., 64:1060-1071

## *Section II:*
## *Research Proposed for 2005*

Projects proposed for 2005 consist of a continuation of several projects currently underway and four new projects. PIT tag recovery efforts will continue in 2005 with the scan sampling program. No changes are planned for port coverage or duration of sampling. Planning for this activity is based on a March 1 – November 15 season.

For other continuing projects, staff is proposing continuing the otolith elemental fingerprinting (OEF) work (Project 620). Repeat sampling of our southeast Alaska nursery sites in 2005 will complete a 3-year time series from this region. Laboratory analysis of accumulated samples will continue during FY 2005, and samples collected from southeast Alaska will be analyzed during winter 2005-06.

The study of the population genetic structure (Project 622) is also proposed to continue in 2005. The samples collected in 2004 will be subjected to genetic testing during winter-spring 2005 by Dr. Lorenz Hauser (UW Marine Molecular Biology Laboratory), screening for allele frequencies in a suite of nuclear microsatellites that were isolated in Pacific halibut in 2003. Eighteen sites sampled during the 2003 setline survey and port sampling program will be re-sampled in 2005 in order to examine temporal stability in genetic signatures; analysis is likely to occur in 2006.

PSAT work will also continue in 2005, with the expected pop-up in May of the 2004 releases (Project 622). In addition, staff is proposing to releases PSATs in Areas 2B, 2C, 3A and 3B from the 2005 assessment surveys, with the tags programmed to pop-up in late spring 2006 (Project 640). The goal of this new set of releases is to gain information on winter migration timing of fish in these areas.

The species richness project (#638) will conclude in 2005, with completion of the video analysis and thesis.

The gonad staging/histology project (#636) will continue in 2005 with analysis of the 2004 samples and microscopy work. No additional sampling is expected.

Staff will also continue with several long-standing projects in 2005. These include placing staff on the NMFS trawl surveys (#604), data collections with water column profilers on the assessment surveys (#610), and the undergraduate internship program (#618). The otolith marginal increment analysis (#626) is expected to be completed in 2005. Finally, the investigation of sleeper shark population structure and development of an aging technique (#630) will focus on lab work and genetic testing of samples.

Four new projects are proposed for 2005. Another summer release of PSATs was described earlier (Project 640). The staff is also proposing to enhance the water column profiler with an additional measuring device to monitor dissolved oxygen (DO). It is believed that low levels of

DO contribute to localized reductions in abundance of many fish species. Staff would like to add the additional hardware to the profiler and monitor DO for correlations with halibut CPUE. Finally, the staff is proposing a major gear experiment (Project 641) to examine the effect of hook spacing and size on halibut catch rates. Previous experiments on these factors were conducted many years ago on J hooks, and the conclusions from that study are likely not applicable to the current circle hooks and spacings used by the IQ fisheries in Alaska and Canada. Additional details on these projects can be found later in the document.

Projects conducted under contract to other agencies will be continued in 2005. IPHC port samplers in Alaska will collect sablefish logbook data for the NMFS Auke Bay lab, and port samplers in Canada will collect data on the bycatch of other species for DFO. Finally, Project 629, examining the water temperature gradients around the Pribilof Islands and the effect on the catch and distribution of halibut, will continue with another year of data collection by local fishermen during 2005.

# Funded Research

## Project 413: Pit tagging study: Third year of tag recovery and scanning

Cost**:** $ 405,520
Start Date: 2003
Anticipated ending: 2006
Personnel: Williams, Kaimmer, Geernaert, Chen, Clark, Blood, Forsberg, Dykstra, Van Wormer, Soderlund, Ranta, sea samplers, scan samplers.

The staff is planning on continuing with PIT (Passive Integrated Transponder) tag scanning in 2005. In 2004, scanning occurred in eight Alaskan and four B.C. ports, the latter under contract with AMR. Additionally, IPHC received state and tribal assistance in scanning efforts in nine west coast ports. No changes are planned on coverage or sampling levels in 2005. Scanning is expected to continue through 2007.

Scan samplers also conduct experiments with Stock Assessment survey offloads which seek to a) confirm their ability to accurately count the number of fish in their scan sample by comparing their counts on survey offloads to counts made by vessel samplers, and b) test their ability to find tags by scanning the survey offloads looking for halibut that have been seeded with PIT tags. These experiments were started in 2003, continued in 2004, and are a standard part of the scan sampler duties.

Project costs are expected to increase moderately in FY2005, primarily due to (a) higher salaries for returning samplers, (b) taking on scanner repair costs which were covered by warranty up to now, (c) anticipated increase in contract with AMR for sampling BC, and (c) new leases for GSA vehicles needed for sampler transportation in selected ports.

## Project 604: NMFS trawl survey: At-sea data collection and data base management

Cost: $ 19,507
Start Date: 1996
Anticipated ending: Continuing
Personnel: Sadorus, Ranta, Clark

A series of NMFS trawl survey data on halibut, parallel to our setline data, is extremely valuable to IPHC as a second fishery-independent data source for stock assessment. Trawl data are particularly useful because they include large numbers of juveniles (ages 3-7 yr) that do not appear in large numbers in the setline survey. Otoliths have been collected on the NMFS surveys since 1996 and provide relevant age information. These data are incorporated into a

copy of the NMFS haul data, expanded to estimates of relative abundance and age/size composition by IPHC area (NMFS calculates estimates by INPFC area), and stored in a database at IPHC. Project cost entail personnel and travel.

## Project 610: Water column profiler project

Cost: $ 1,000
Start date: 2000
Anticipated ending: Continuing
Personnel: Hare, Loher, Stabeno (NMFS PMEL)

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

## Project 618: Undergraduate Internships

Cost: $ 25,816 (two interns)
Start Date: 2002
Anticipated duration: Continuing
Personnel: Sadorus, Van Wormer, Chen, Vienneau, other staff support as needed

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

## Project 620: Analysis of spatial recruitment dynamics in Pacific halibut using otolith elemental fingerprints (OEF): Phase 2

Cost: $ 36,669
Start Date: 2002
Anticipated Ending: Continuing
Personnel: Loher, Wischniowski, temporary staff

Preliminary lab results using age-2 halibut suggest that otolith elemental signatures can be used to successfully distinguish and classify individuals within general geographic regions (southeast Bering versus west-Central Gulf), with 75-80% accuracy. Additional lab work will add more physical variables (oxygen and carbon isotope ratios) to the existing statistical model, hopefully increasing the accuracy of these classifications. This will complete Phase I of the project, which was simply a "proof of concept". The second phase of the project will seek to establish appropriate protocols and sampling sites so that a coastwide nursery "otolith element map" can be developed. Due to contingency budgets during fiscal year 2004, the scope of fieldwork was reduced relative to our original intent, and no new sites were visited. However, additional samples were obtained from the NMFS Bering Sea trawl survey, and samples were collected by IPHC from southeast Alaska to assess temporal stability of elemental signatures within nursery habitats. Temporal stability must be understood in order to establish future sampling designs. Repeat sampling of our southeast Alaska nursery sites in 2005 will complete a 3-year time series from this region. Laboratory analysis of accumulated samples will continue during FY 2005, and samples collected from southeast Alaska will be analyzed during winter 2005-06.

## Project 621: Genetic population structure of Pacific halibut assessed via nuclear microsatellite diversity

Cost: $ 28,600
Start: 2002
Anticipated Ending: 2005
Personnel: Loher, L. Hauser (UW-MMBL), other staff

Tissue collections were made during winter charters in 2004, at spawning locations near Queen Charlotte Island, Portlock Bank, and Pribilof Canyon. Male and female halibut were sampled at all sites, resulting in sample sizes of 157-200 mature fish per site. These collections were made to address the question of whether or not the Bering Sea is reproductively isolated from the Gulf. Samples will be subjected to genetic testing during winter-spring 2005 by Dr. Lorenz Hauser (UW - Marine Molecular Biology Laboratory), screening for allele frequencies in a suite of nuclear microsatellites that were isolated in Pacific halibut in 2003. The results of the initial screening have been submitted as an IPHC internal report; publication is expected this winter. As a portion of that work, a preliminary population analysis was conducted comparing Adak and St. Paul Island to Newport, Oregon. The results were intriguing, suggesting potential reproductive isolation in the Aleutians. However, sample sizes were low and results tenuous, so a more thorough analysis is warranted. Thus, ~1500 tissue samples were collected from 18 sites during the 2003 setline survey and port sampling program. These sites will be re-sampled in 2005 in order to examine temporal stability in genetic signatures; the present budget does not include future analysis of these samples.

## Project 622: Pop-up, satellite-transmitting archival tags (PSATs) to study halibut movements

Cost: $8,200
Start: 2002
Anticipated Ending: Continuing
Personnel: Loher, A. Seitz (UAF), sea samplers

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

During the 2004 summer setline survey, 12 PSTATs were deployed at each of two Aleutian Islands: Atka and Attu. These tags are programmed to release from the fish and report their location and data during mid-February 2005. Costs for 2005 are for the expected satellite transmission fees when the 2004 releases pop to the surface and begin transmitting.

## Project 626: Otolith marginal increment analysis

Cost: $ 500
Star Date: 1999
Anticipated ending: 2005
Personnel: Blood, Wischniowski, Forsberg

This project has the objective of improving reliability of the age determination for Pacific halibut. Timing of annulus formation was first studied in the 1930s by Dunlop. Recent research on halibut age validation suggests Dunlop's early results were incomplete. Timing of annulus formation is critical to assigning accurate age and prevents smearing of strong year classes over weak ones. Collected otoliths will be used to note the timing of deposition of annual growth rings. The variability in this timing by area and sex will also be examined. Data collection occurred in 1999-2001, with otolith processing currently ongoing. Analysis will occur in late 2005. Project costs consist of lab supplies.

## Project 630: Sleeper shark investigations

Cost: $ 5,006
Start Date: 2003
Anticipated ending: 2005
Personnel: Wischniowski, Williams

During 2003, the Pacific sleeper shark (*Somniosus pacificus*) age determination program collected enough samples to begin the pilot study. Historical ageing studies on this species have

been plagued by the lack of visible microstructure within the centra of the vertebrae. An attempt will be made to expose any growth increments by way of an etching and staining experiment. All materials and structures required for this experiment have been collected, or purchased. Lab work began in winter of 2004.

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

Mitochondrial DNA polymorphisms will be used as the initial genetic marker system to investigate population differentiation among the three sampling locations. We will initially attempt amplification using primers located within the proline tRNA and 12S rRNA regions of the mitochondria. These primers have been used to examine population genetic structure across a similar geographic range in blacktip sharks and yielded sufficient information to differentiate among nurseries of this species. Statistical analysis will be by way of and AMOVA probabilities of haplotype homogeneity across sampling sites. As the name suggests, Analysis of Molecular Variance (AMOVA) is a method for studying molecular variation within a species.

## Project 636: Analysis of gonad staging on IPHC setline surveys (Histology)

Cost: $ 19,595
Start: 2004
Anticipated Ending: 2005
Personnel: Geernaert, Leaman (other staff as needed)

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

understood. We would like to re-evaluate our classification criteria and examine the stages and gonadal tissue development more closely.

In 2003, preliminary histological work on the female gonads was initiated. We developed a sampling design and collection protocols for the 2004 surveys. In 2004, during winter and summer surveys, female gonads from three different regions, in each stage of development, were collected. Three different histological subsamples have been prepared and we are presently standardizing the sample sites on the gonad for the final slide preparation. We have collected nearly 240 gonad pairs and will be analyzing multiple sites from each sample in 2005.

## Project 638: Associating environmental variables with species richness and evenness: A case study

Cost: $ 30,734
Start: 2004
Anticipated ending: 2005
Personnel: Van Wormer, Leaman (other staff as needed)

The study will investigate whether species richness and evenness (i.e., species diversity) is correlated with bottom temperature and depth. Historical data from the stock assessment survey (SSA) and data from a directed field experiment will be analyzed. The SSA charter regions investigated include Goose Island, St. James, and Charlotte in British Columbia as well as 4A Edge, 4D Edge, and Attu in Alaska. During the 2004 SSA, vessels were chosen to deploy temperature and depth recorders on each skate of gear. In addition, electronic monitoring equipment was installed on one vessel to record a sequential tally of all catch for each station (hook by hook data). A video analyst determined the numbers and species encountered. On the remaining vessels, Archipelago Marine Research (AMR) field staff recorded hook by hook data in season. Project costs in 2005 are for the video analyst and equipment rental from AMR. The final analysis will examine the spatial distribution and relative abundance of species relative to the temperature and depth profiles.

## Project 639: Dissolved oxygen monitoring on setline surveys

Cost: $ 6,500
Start Date: 2005
Anticipated ending: 2005
Personnel: Sadorus, Hare, Survey team

In 2000, the IPHC purchased a water column profiler to record measurements of conductivity, temperature, and depth at various stations in the IPHC setline surveys. The idea was to gain a better understanding of halibut habitat, and to contribute to the larger oceanographic picture that multiple agencies were working to build. Understanding of oceanographic conditions can lead to

a better understanding of the factors driving growth and recruitment of fish populations. An obvious addition to this data set is the collection of dissolved oxygen measurements at a time of year when primary and secondary production is peaking (i.e. summer). By revisiting the same stations over several years, it will be possible to identify variations in time and space related to this parameter.

In relation to halibut per se, being a deep water species, halibut may possibly exist routinely near the low oxygen threshold, but that also may mean that small variations in oxygen could cause variations in distribution and/or health. Over the long term, it may be possible to construct a profile of oceanographic ranges of which halibut are tolerant. Gathering this information may also lead to some new ways of thinking about existing problems. During a staff discussion, it was pointed out that low DO may be, for instance, the stressor that has remained elusive in identifying why fish turn chalky.

While it's possible we may see some correlation to specific halibut issues as pointed out in the previous paragraph, this proposal's justification is primarily based on the larger picture gathering of basic oceanographic data. DO recording is a cheap addition to the SeaBird unit already deployed.

## Project 640: Summer PSAT tagging: Areas 2B, 2C, 3A and 3B releases

Cost: $ 176,640
Start Date: 2005
Anticipated ending: 2006
Personnel: Loher, sea samplers

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

The project proposes to tag 48 fish in Areas 2B, 2C, 3A and 3B during the 2005 setline survey. The study entails tagging six fish at each of eight general locations: lower Queen Charlotte Sound and northern Queen Charlottes in Area 2B, western Baranof-Chichagof Islands (Area 2C), Yakutat and central and western Area 3A, and Semidi and Sanak Islands in Area 3B. Tags will be programmed to pop-up during the last week of May, 2006.

## Project 641: Hook spacing and size impacts on length selectivity and CPUE

Cost: $ 208,735
Start: 2005
Anticipated ending: 2005
Personnel: Leaman, Gilroy, Chen, Clark, Survey team

The adoption of IQ management for halibut and sablefish, together with coincident seasons for these species, has resulted in an increased amount of mixed-target or combination fishing for both halibut and sablefish in Alaska. The optimum gear for the two species is quite different, with sablefish gear using smaller 13/0 or 14/0 hooks and short 36-48" spacing, while optimum gear for halibut may be larger 16/0 hooks with 15-18' spacing. IPHC assessments make corrections for hook spacing relative to the IPHC standard 1800-ft 100-hook skate. However, the adjustment is based on a relationship developed in the 1970s from spacing experiments using J-hooks. No adjustment of CPUE for hook size is made. There is concern that smaller hooks may affect size selectivity, hence CPUE. This study will address potential differences in CPUE and size selectivity of selected combinations of hook size and spacing in the commercial fishery relative to the configuration of the standard IPHC survey skate. The project will consist of a one-month charter in Area 3A. Two sea samplers will be required to staff the vessel. The experiment will be a randomized block design, with two factors, hook size and hook spacing. The four levels of hook size will be 13/0 – 16/0 hooks (alternate designations are hook sizes 6 – 3). The four spacing levels will be 18, 12, 9, and 3.5 feet. The individual treatments from the 4 x 4 treatment matrix will be assigned randomly within strings.

## Project 642: Preliminary assessment of mercury incidence in Pacific halibut

Cost: $ 200
Start Date: 2002
Anticipated ending: Continuing
Personnel: Dykstra, Alaska Department of Environmental Conservation (ADEC)

For the last few years, health officials and media have raised the profile of pollutant contamination in fish (methyl mercury, PCB's, pesticides). Since 2002, the IPHC has been working collaboratively with the Alaska Department of Environmental Conservation (ADEC) to collect halibut tissue samples to be analyzed for heavy metal and organic pollutant loading. In 2003 the principal results from the 2002 collection led the Alaska Division of Public Health to conclude that the concentrations of heavy metals in Alaskan Pacific halibut are not a public health concern. In 2004 the first results regarding organic pollutants (PCB's, pesticides) were released demonstrating that halibut had the lowest concentrations of the five species (including salmon and sablefish) examined. The 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.

Sampling continued in 2004 with a targeted collection of 60 samples (30 from fish weighing between 20–40 lbs. and 30 from fish weighing between 40–100 lbs.) from each of three regions (SE Alaska, Shumagin Islands, and the Aleutian Islands) during the setline survey. Results will be published as they become available.

ADEC has expressed interest in further assessments of contaminant occurrence in halibut in 2005.

# Other 2005 Research – Contracts and Grants

## Project 375: NMFS port sampling grant

Cost: Staff salaries
Revenue: $ 125,311
Start Date: FY2002
Anticipated ending: Continuing
Personnel: Gilroy, Larsen, Hutton

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

## Project 376: Area 2B expanded logbook program

Cost: Staff salaries
Contract Amount: $ 16,320 (estimated, based on survey bycatch revenues)
Start Date: 2002
Anticipated ending: Continuing
Personnel: Geernaert, Gilroy

IPHC expanded the B.C. port sampler's tasks to include interviewing skippers and edit information on the bycatch of other species during halibut fishing. These data were entered into the IPHC log database tables. The latitude/longitude location was converted using Geographical Information Systems (GIS) to DFO statistical areas and vessels were assigned a unique identifier to maintain the confidentiality of the vessels. In 2004, the 2003 bycatch catch and discard information from the logbooks and bycatch landed weight information was summarized and provided electronically to DFO. The data provided had a skipper's signature acknowledging that IPHC would provide the information to DFO. The 2004 data included additional bycatch landing weights collected by port samplers at the time of the log interview to assist DFO with validation of the log data.

## Project 628: NMFS catcher vessel logbook and sablefish data collection

Cost: Staff salaries
Contract Amount: $ 46,700 (new contract in 2004 which includes implementation costs)
Start Date: 1999
Anticipated ending: Continuing
Personnel: Hutton, Gilroy, Taheri, port samplers

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

## Project 629: Correlating catch trends and variable oceanographic conditions in a local coastal fishery (Area 4C)

Cost: Staff salaries
Contract Amount: $27,300
Start Date: 2003
Anticipated ending: 2005
Personnel: Loher, Central Bering Sea Fishermen's Association, port sampler

For many western Alaska communities, halibut represents a major component of the local economy, and any substantial reduction in abundance or catchability can have large consequences. Over the past four years, catches in Area 4C have demonstrated a marked decline, with the local fishery unable to meet the established quotas. The 2003 combined CDQ and IFQ allocations were set at 2.03 million pounds, but the total harvest was only about 0.89 millions pounds, or less than 45% of allowable catch. This was the largest harvest shortfall in the last 10 years, and a cause of considerable concern that might represent substantial local depletion. If true, it follows that the region's fish must be relatively faithful to the Pribilof shallows and may not mix substantially with fish elsewhere in the southeast Bering Sea. Alternatively, changes in CPUE may simply reflect changes in movement patterns of fish near the islands. Halibut are known to spend the winter in deep shelf-edge waters to the south and west of the Pribilof Islands in order to spawn, and move into shallow waters of the southeast Bering Sea shelf east of the Pribilofs for summer feeding. The 4C fishery is seasonal: fish typically move into the waters around the islands in late June, and depart at the onset of winter. We hypothesize that the timing of these migrations, and hence the general characteristics of the fishery, may be governed to some degree by temperature patterns. Regional ocean conditions can vary considerably from year-to-year, thus lower CPUE might also represent reduced residence time within the shallows due altered bottom conditions, or use of different migratory pathways to move from the shelf-edge to the shallows and back.

During the course of this project, catch data from the 4C fishery will be analyzed to attempt to isolate temporal trends in CPUE and attempt to determine whether trends correlate with changing water temperature. With the cooperation of local fishers and funding from the CBSFA, the IPHC began deploying temperature-loggers on longline gear during normal fishery operations in 2002. A total of five vessels participated in 2002, providing temperature observations from just over 100 longline sets. In 2003, with funding from an external granting agency (NPRB), the study was expanded to include 11 vessels, providing data from just over 250 sets. The study is ongoing at present, with vessels just ending their season and returning data for analyses. While the 2004 data have not yet been processed, the 2002-03 data clearly demonstrate seasonal temperature patterns in the region, short-term temperature variability, and interannual variability in daily maximum temperatures. We plan to continue monitoring local conditions in future years, and correlation with catch trends is scheduled to begin this winter.

## Project 375: Seabird data repository

Contract Amount: $ 14,000 (maximum)
Start Date: 2005
Anticipated ending: Continuing
Personnel: Van Wormer, Geernaert

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

# Research Conducted With Internal Funding

## *1. Seabird occurrence project*

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

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

## *2. Estimates of bycatch on the setline surveys in Area 2B*

Cost: Staff Salaries
Start Date: 2003
Anticipated ending: Continuing
Personnel: Dykstra, Survey Team, and DFO personnel

Rockfish bycatch in the halibut fishery can be a constraint in conducting halibut fishing in some areas. In 2004, IPHC worked with DFO to allow a third biologist on IPHC survey vessels to sample rockfish and sablefish bycatch. The program was funded by industry (Canadian Sablefish Association and Pacific Halibut Management Authority). Data collected included hook by hook information, otoliths, maturities, and lengths for rockfish and sablefish.

## *3. Amphipod distribution and predation on survey halibut*

Cost: Staff Salaries
Start Date: 2004
Anticipated ending: 2005
Personnel: Leaman, Van Wormer, Soderlund

The project intends to document the occurrence and virulence of attacks by predatory amphipods on halibut caught on IPHC surveys and, by inference, the commercial fishery. The commercial industry suffers annual losses of product due to amphipod predation and must adjust its fishing locations and practices in response to predation. Harvester discussions indicate that predation sites are both known and ephemeral, and the virulence may vary interannually at a given site.

The specific identity of the amphipods has not been established and it is probable that more than one species is involved. Harvesters are interested in both documentation of predation areas for avoidance, as well as gaining an understanding of the dynamics of the species at given sites, i.e., are there cycles of abundance that respond to other factors. Data were collected on all stations during the 2004 stock assessment survey as part of standard protocol, recording incidence of sand flea predation, and the extent and virulence of the predation. Analysis is expected to occur in the spring, 2005.

## *4. Review of port sampling, 1994 to present*

Cost: Staff salaries
Start Date: 2002 (Deferred in 2004)
Anticipated ending: 2006
Personnel: Hutton

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

## *5. Development of a cooperative interagency electronic fishery information collection and management program in Alaska*

Cost: Staff salaries
Start Date: 2002
Anticipated ending: 2006
Personnel: Gilroy, Vienneau, Hutton, Kong

IPHC, ADF&G, and NMFS staffs are involved in the development of a cooperative interagency electronic fishery information collection and management program in Alaska. For halibut, the system could be used to jointly report quota share and fish ticket landing information. In 2004, the Agency Directors met to review a Draft Memorandum of Understanding (MOU) describing the framework and program structure necessary for meeting agency recording and reporting requirements. The MOU was prepared by the steering committee and is still under review by the individual agencies. Additionally, the interagency steering committee worked with Pacific States Marine Fisheries Commission (PSMFC) to complete a Request for Proposal for design and implement for the electronic reporting system. A contractor was hired in July 2004. In August, a two-day meeting was held involving agency users and experts on landing reports to provide feedback on the project. By late 2004, design and programming was initiated with a goal for completion in June 2005. The Bering Sea/Aleutian Island (BSAI) rationalized crab fishery should by using this system in August 2006 with the remaining BSAI crab, groundfish, and halibut fisheries using it starting in January 2006.

## *6. The 2004 stock assessment*

Cost: Staff salaries
Start Date: 1926
Anticipated ending: Ongoing
Personnel: Clark, Hare, Chen

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

## *7. Development of IPHC harvest policy*

Cost: Staff salaries
Start Date: 2001
Anticipated ending: Continuing
Personnel: Hare, Clark

Staff quota recommendations are calculated by applying a judiciously chosen harvest rate to an estimate of present exploitable biomass. The constant harvest rate policy was developed on the basis of its performance over a long time horizon and with the explicit goal of avoiding reaching the minimum stock sizes seen in the 1930s and 1970s. In 2003 the staff proposed a conditional constant catch policy under which total removals would be capped at a chosen ceiling level at high biomass levels, while a constant harvest rate policy would continue to be employed at low and intermediate stock levels. The Commission did not adopt the proposed policy at the 2004 annual meeting, and a staff/industry workshop on harvest policy alternatives in September 2004 showed general satisfaction with the present policy, as mediated in practice by the judgement exercised by the Director in developing staff recommendations and by the Commission in finally setting catch limits. Some elements of the proposed policy - an explicit lower limit on spawning biomass and a threshold below which the harvest rate will be reduced - will be added to the constant harvest rate policy. The staff will continue to evaluate the constant harvest rate policy. In particular, we will recalculate the optimum harvest rate itself in light of our present understanding of stock dynamics and new information on commercial length-specific selectivity coming from the PIT tag experiment.

## *8. Development of a formal medium-term recruitment forecast*

Cost: Staff salaries
Start Date: 2002
Anticipated ending: Ongoing
Personnel: Hare, Clark, Chen

Confidence in projected safe harvest levels over the medium term requires confidence in projections of expected recruitment over the next 1-7 years. Industry and stakeholders also have great interest in the IPHC recruitment predictions. A number of new methods of predicting

recruitment have been developed over the past few years. The goal of this project is to create a forum for assembling and describing these models and evaluate them in a formal time series analysis framework. It is expected that an official IPHC best guess recruitment forecast will be produced along with associated confidence bounds. This project was deferred in 2004.

## *9. Estimation of halibut abundance from mark-recapture data*

Cost: Staff salaries (analysis only)
Start Date: 2001
Anticipated ending: Ongoing for several years at least
Personnel: Chen, Clark, Leaman

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

During 2004 work was completed on a detailed simulation of the experiment to investigate the behavior of the proposed estimation methods. Preliminary analysis of the 2004 recovery data (estimation of selectivity schedules, harvest rates, and migration rates) was also done in 2004 and will continue in 2005 and later.

## *10. Density-dependent and independent control of halibut growth and recruitment*

Cost: Staff salaries, some travel
Start Date: 1998
Anticipated ending: Ongoing
Personnel: Hare, Clark, Loher

The specific mechanisms driving the observed interdecadal trends in halibut growth and recruitment remain largely unexplained though more specific hypotheses have been developed in the past two years. Work towards better understanding whether density-dependent (intra- or inter-specific) or density-independent factors are responsible continues and remains the core research focus of the fisheries oceanography project. In keeping with the NOAA movement towards ecosystem considerations in fisheries management, we will attempt to derive a framework whereby the results of fisheries oceanography investigations can provide useful input for management purposes, such as determining safe harvest levels or forecasting near-term recruitment. Part of this project includes maintenance of the near bottom "Ocean Bottom Properties" database, first assembled in 1997 (and described in the 1997 RARA) and maintained

and updated as additional data become available. This database has proven to be extremely useful to researchers around the north Pacific.

# Northwest Fisheries Science Center

# National Marine Fisheries Service


# 2004 Agency Report to the Technical Subcommittee

# of the Canada-U.S. Groundfish Committee

**April 2005**

# Review of Agency Groundfish Research, Assessments, and Management

## A. Agency Overview

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

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

FRAM consists of a multi-disciplinary team with expertise in fishery biology and ecology, stock assessment, mathematical modeling, statistics, computer science, and field sampling techniques. Members of this program are stationed at both the NWFSC in Seattle and in Newport, Oregon. 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 multispecies fisheries; design programs to provide information on the extent and characteristics of bycatch in commercial fisheries, as they look at methods to reduce fisheries bycatch; characterize essential habitats for key groundfish species; investigate the design, feasibility, function, and value of marine protected areas; and employ advanced technologies for new assessment.

During 2004, the FRAMD continued to: implement a West Coast observer program; build a survey program that will conduct West Coast groundfish hydroacoustic and trawl surveys previously conducted by the AFSC; and further augment its stock assessment, economics, and ecosystem research. Significant progress continues in all programs.

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

**The Conservation Biology Division** is responsible for characterizing the major components of biodiversity in living marine resources, using the latest genetic and quantitative methods. It also

has responsibility for identifying factors that pose risks to these components and the mechanisms that limit natural productivity. The Division's multi-disciplinary approach draws on expertise in the fields of population genetics, population dynamics, and ecology.

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

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

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

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

## B. Multispecies Studies

### *1) Stock Assessment*

**Stock Assessment Workshops.** Two comprehensive workshops were convened during 2004 to enable the delivery of the stock assessments and ensure that the demanding schedule yields the best possible science for groundfish management. The first workshop focused on data sources used in stock assessments, including data typically used as well as data that hold potential to be used in future assessments. The second workshop focused on modeling innovations and needs and included discussions on calculating uncertainty in stock assessments. A third workshop was held in June in Santa Cruz, California to discuss and review recreational fishery datasets and analytical methods used to calculate catch-per-unit-effort (CPUE). Workshop participants included stock assessment authors, members of the Pacific Fishery Management Council's Scientific and Statistical Committee, regional data experts, international stock assessment experts, and the public.

For more information, contact Stacy Miller at Stacey.Miller@noaa.gov, (206) 860-3480.

**Bayesian Hierarchical Meta-Analysis of Rockfish Life History Parameters**. While nearly 80 species of rockfish in the genus *Sebastes* in the Eastern Pacific Ocean are currently managed under the Pacific Fishery Management Council's Groundfish Management Plan, only a small fraction have been quantitatively assessed for stock status; seven major species are currently depleted including canary (*S. pinniger*), bocaccio (*S. paucispinis*), widow (*S. entomelas*), Pacific ocean

perch (*S. alutus*), cowcod (*S. levis*), yelloweye (*S. ruberrimus*) and darkblotched rockfish (*S. crameri*). For the vast majority of rockfish species, determining stock status remains elusive because of limited biological and population dynamics information. Owing to the fact that many of these species share common life histories, population dynamics and responses to exploitation, we initiated research using meta-analytic approaches for quantitative synthesis of information from both data-poor and data-rich species to explore and elucidate patterns in life history variability. This research will provide the foundation for development of a life history-based assessment model for data-poor species and will contribute additional information for those assessments already conducted.

Thus far our efforts have centered on growth of rockfish. We modeled somatic growth of 46 *Sebastes* species in the Eastern Pacific Ocean using Bayesian hierarchical meta-analysis to estimate parameters, investigate growth variability among species and elucidate meaningful biological covariates. Growth of species in the genus *Sebastes* varied by more than 300% in terms of maximum attainable size ($L_\infty$; 12 cm to 80 cm) and by more than 88% in terms of instantaneous growth rates ($K$; 0.008 $yr^{-1}$ to 0.08 $yr^{-1}$). Results from this method also confirm the theoretical, but often untested, view that growth parameters $L_\infty$ and $K$ are negatively correlated among species of fish; Bayesian credibility intervals ranged from –0.2 to –0.7 with the posterior median of –0.4. The Bayesian hierarchical growth model showed less variability in growth parameters and lower correlations among parameters than those from standard techniques used in population ecology. This suggests that the absolute value of the correlation between $L_\infty$ and $K$ may be lower than the general perception in the ecological literature, where values in the range of -0.8 to -0.9 are often [reported | hypothesized]. Size at 50% maturity was correlated positively with asymptotic size and negatively with $K$. Depth showed little predictive power for any growth parameters.

Future efforts will involve augmenting otolith collections for some of the minor rockfish species based on the sampling platform and procedures already being utilized as part of the FRAMD shelf/slope survey. While otolith collections of these data-limited species is our initial priority, we propose future expansion of sampling to include gonad material for staging maturity at a time when meaningful biological/ecological groups of rockfish have been established. Species and sample requirements for proposed collection of rockfish age-structures are given in the table below; only twelve commonly encountered species (not included in the table) currently have sufficient age and growth samples for this type of analysis.

As the inventory of rockfish otoliths accumulates, additional funding will be sought to support a graduate stipend or other position working closely with the aging lab to validate and establish aging techniques for age determination. Likewise funding will be sought to develop and establish maturity staging techniques when future gonad collections begin. Both aspects of this research will include collaboration with experienced researchers at the SWFSC and AKFC to optimize efficiency in developing methods where species have not been extensively aged in the past.

As available growth information for data-poor rockfish increases, these data will be pooled with our already extensive data base for the more common rockfish. The pooled data will be analyzed using Bayesian hierarchical meta-analysis to model the life history processes, their variability, and to explore biological and environmental covariates among a coherent set of species within this single genus. More detailed analysis and modeling can be done using incremental otolith analysis

to elucidate coherent correlations among groups of species and environmental covariates. Overall, we seek a unified quantitative approach which integrates all relevant life history parameters and ecological relationships to better understand the response of *Sebastes* species assemblages to exploitation. This research fosters preparation for an inevitable increase in the number of rockfish stock assessments likely to be performed in the future.

For more information, contact Tom Helser at Thomas.Helser@noaa.gov, (206) 860-3481 or Ian Stewart at Ian.Stewart@noaa.gov, (206) 860-3456.

## C. By Species, by Agency

### *1. Shelf Rockfish*

**WEST COAST**

**a) Research**

**Mathematical Modeling and Statistical Methodology for Bomb Radiocarbon Ageing Validation.** The use of the radiocarbon signal from atmospheric testing of nuclear weapons in the middle of the twentieth century has emerged, over the past decade, as a reliable method for ageing validation. Under-ageing is of particular concern for stock assessments in that, through biased age compositions, stock assessments can be overly optimistic about the productivity of a species. The bomb radiocarbon method uses measured radiocarbon levels in otolith cores to validate the annulus counts determined by break and burn or other ageing methodologies. In 2004, we developed a mathematical model to describe the increase in radiocarbon in otolith cores and in coral and are currently developing a statistical method to rigorously compare reference radiocarbon data sets to each other and to compare test data sets to reference data sets. This work, in preliminary form, was presented in July 2004 at the Third International Otolith Conference in Townsville, Australia.

We applied this method to canary rockfish by selecting and coring otoliths for radiocarbon analysis. To test two assumptions of the method, two sampling designs were used. A sampling design that controls for age-dependent ageing error allowed for testing the assumption of parallelism of the standardized rates of bomb radiocarbon increase for the validation and reference time series. A second sampling design that produces a linear relationship between the estimated age and birth year allowed for testing the assumption of ageing error consistency. Neither assumption was shown to be statistically invalid. Using the combined data sets, the similarity of the timing of increase in 14C levels in the canary otolith cores and the reference time series indicated that the canary rockfish ages determined using the break and burn method are reasonably precise, though with an average underaging bias of 2-3 years. This work was presented in July 2004 at the Third International Otolith Conference in Townsville, Australia. A manuscript describing this work is currently in press in The Canadian Journal of Fisheries and Aquatic Sciences.

We have also applied this method to darkblotched rockfish and will be using the methodology under development for final analysis of the data. Two different annulus count ageing methodologies are compared for darkblotched rockfish. Preliminary Pacific Ocean Perch otoliths were selected and cored and we are currently awaiting lab results.

For more information, contact Owen Hamel at Owen.Hamel@noaa.gov, (206) 860-3481 or John Wallace at John.Wallace@noaa.gov, (206) 860-3456.

**A Model-based Approach for Developing Biomass Indices from Multi-vessel Surveys**. Recent efforts have focused on developing biomass indices for slope species caught in the NMFS continental slope surveys. The primary objectives are to: (1) determine a post-stratification frame based on biological for each species or species groups and, (2) apply a model-based approach to estimate biomass and variances for inclusion in Stock Synthesis. Thus far we have analyzed 11 slope species using a generalized linear mixed model analysis. Specifically, we employ a generalized linear mixed model (GLMM) that treats year and spatial cell as fixed effects while treating vessel as a random effect is used to examine fishing power among chartered industry-based vessels and a research trawler, the *FRV Miller Freeman*, for bottom trawl surveys on the upper continental slope of U.S. West coast. A Bernoulli distribution is used to model the probability of a non-zero haul and the gamma, log-normal or inverse Gaussian error distribution was used to model the non-zero catch rates, depending on the specific species. The use of vessel as a random effect allows the data for the various vessels to be combined and a single continuous time-series of biomass indices to be developed, for some species in which vessel effect was nominal. Generally, the GLMMs fit the data reasonably well for all 11 species. As such treating vessel as a random effect is a reasonable approach to developing abundance indices.

For more information, contact Tom Helser at Thomas.Helser@noaa.gov, (206) 860-3481.

## *2. Sablefish*

**WEST COAST**

**a) Research**

Plans are being made to convene the Third International Sablefish Symposium. Dr. Michael Schirripa organized a meeting during the 2004 Western Groundfish Conference to determine interest level and to formulate a participant list. To start the meeting, Dr. Schirripa read the Original Task Statement, from the Technical Subcommittee of the Groundfish Committee directing him and Dr. Rick Stanley to provide terms of reference and oversight in the development of a sablefish-working group. The working group should consider survey methods, feasibility of survey calibration, tagging programs, ageing techniques, and the exchange of other data when drafting terms of reference for the sablefish workshop.

Dr. Schirripa then provided a brief statement on the background of sablefish symposia held in 1983 and 1993 that brought together scientists and managers to share information, data, and discuss future needs. The Proceedings of the International Sablefish Symposium, March 29-31, 1983, held at the University of Alaska with symposium coordinator Brenda R. Melteff, was published as Alaska Sea Grant Report 83-8. Mark E. Wilkins and Mark W. Saunders edited the Biology and management of sablefish, *Anoplopoma fimbria*, papers from the International Symposium on the Biology and Management of Sablefish, held in Seattle, Washington, 13-15 April 1993. It was published as NOAA Technical Report NMFS 130, June 1997 (275 pgs.).

Dr. Schirripa then read the current meeting objectives, passed around a sign-up sheet for participants to provide name and address. He then asked participants to introduce themselves and provide a brief background statement of their interest in sablefish. Following the round of introductions, Michael opened the floor for discussion that centered on the need for and format of a Sablefish Symposium to be held in the near future.

The idea of a symposium and attaching it to the next Groundfish Conference (GFC) was suggested to be too compact a schedule. The possible attaching of just a symposium, a workshop or presented papers together with a series of sablefish workshops makes attaching to the next GFC quite difficult to schedule. Assuming that 25 papers might be presented, it would be difficult for the symposium attendees to keep alert and focused after a week at the GFC. Reversing the order would make GFC attendance difficult. There was definite interest in both presented papers and workshops that would allow sablefish researchers and managers to communicate. Workshops will permit more discussion and collaborative interactions. Papers will provide the mechanisms for efficient communication of recent results. The format of presented papers was discussed and it was suggested that there should be more time for presentations and discussion of presented material in full detail. Structure of the Symposium and workshops were discussed briefly. It was suggested that invited papers could be used to present the range and structure of sessions and, in so doing, provide natural leads into workshops. A suggestion was made that workshop attendance be mandatory but there was concern raised that this might not be effective. It was suggested that workshops should be summarized and leaders should be provided with time at the end of the Symposium to present an overview of the discussions and results of workshops to the full audience of attendees. Such structure would assist in the display of the current knowledge, state of the art and construction of framework for future collaborations. Finally, the idea of publishing the proceedings was widely supported. While another Sea Grant Program or NOAA Technical

publication was discussed, the attendees appear to favor a blind peer-reviewed journal process. While the blind peer-review process is quite difficult to manage, several attendees argued that it would be great if it could be done. The "Alaska Fishery Research Bulletin" journal is one possible outlet. Other journal publishers should be contacted to explore possible alternative outlets.

A steering committee was developed that will be made up of the following: Michael Schirripa (NWFSC), Dave Carlile (ADFG), Tom Hurst (AFAC), Rob Kronlund (DFO), Dave Clausen (AFSC), and Chris Lunsford (AFSC).

It was agreed that the steering committee would first review and then send the results of this meeting (minutes and an initial symposium/workshop program structure outline) to all interested parties for input. This document will provide information on possible cities, locations, and venues for holding the meeting. It was recognized that to make the meeting most useful and successful requires early advertisement so that folks are able to get support for attendance and keep their calendars open. A timeline for meeting planning and implementation will be developed.

For more information, contact Michael Schirripa at Michael.Schirripa@noaa.gov, (541) 867-0536.

## *3) Pacific Hake*

**WEST COAST**

**a) Research**

**US-Canada Hake/Whiting**. A joint US-Canadian Pacific hake research cruise was conducted aboard the CCGS W.E. RICKER from September 14-20, 2004. The area of operation was the Barkley Sound, and La Perouse and Swiftsure banks off southern Vancouver Island, British Columbia. Lead scientists were Ken Cooke, DFO, Pacific Biological Station, Nanaimo and Guy Fleischer, NMFS, NWFSC, Seattle. Additional scientists in attendance were Robert Kieser (DFO), Greg Workman (DFO), Patrick Ressler (NOAA), Steve de Blois (NOAA), Ken Foote (WHOI), and Mark Henderson (UW).

The goals of this cruise were primarily two-fold. The first was to calibrate the W.E. RICKER EK500 and NMFS EK60 38kHz acoustic systems prior to conducting additional survey operations. System performance measurements included on-axis target strength and integration measures of a standard calibration sphere at approximately 30m range for each acoustic system, recording of internal performance values for the EK60 system, LOBE beam pattern measurements for each acoustic system, on-axis target strength measures at 5, 10, 20, and 30m ranges with the EK60 system, and on-axis target strength measures at small (~3cm) incremental ranges over a fixed distance (~30cm) at ranges of 5, 10, 20, and 30m to evaluate sampling rate of the EK60 system. The second goal was to collect Pacific hake target strength (TS) measures by exploration of selected study site to locate daytime aggregations of hake and other species, daytime trawl sampling to identify species composition of aggregations and of single target layers, continuous acoustic observation over a 12-18h period of selected targets to monitor diel distribution patterns and to record changes in behavior, night time trawl sampling to identify species composition of single target layers, night time surface trawling to collect fresh Pacific hake samples for observation of intake swim bladder structure and preservation of samples for modeling, biosampling of trawl catches to provide meristics on selected targets, and profiling temperature and salinity at selected sites to calculate speed of sound in water.

All aspects of the program were completed on schedule and were highly successful. Mayne Bay is a suitable calibration site that provides adequate ranges for target suspension, good shelter and excellent holding ground. Our three TS study sites were selected based on daytime exploratory surveys and discussions with members of the commercial hake fleet working in the area. Continuous acoustic observations maintained over 12-18h periods in each of the study sites provided excellent records of species distribution patterns and diel changes in behavior. We were able to monitor hake aggregations and maintain target detections throughout the sampling period.

Trawl operations were particularly successful and provided excellent quantity and quality samples for meristic measurements of Pacific hake and other species. The two surface tows conducted were uniquely successful in capturing near-surface hake samples usable for assessment of swim bladder structure and measurement for use in acoustic backscatter models.

All Pacific hake TS data are currently being analyzed and initial results are to be presented at the special symposium entitled "Recent Advances in Hydroacoustic Assessment of Fish Populations in Marine and Riverine Environments" as part of the American Fisheries Society 135th Annual Meeting in Anchorage, Alaska, September 11-15, 2005.

For more information, contact Guy Fleischer at Guy.Fleischer@noaa.gov, (206) 860-3289.

**b) Stock Assessment**

The Pacific hake stock assessment has been developed in the spirit of a treaty signed in November 2003 between the U.S. and Canada for the sharing of this trans-boundary resource. Under this agreement, not yet ratified by Congress, the stock assessment is to be reviewed by a Scientific Review Group (SRG), appointed by both parties. The Review Group meeting was held in Seattle, WA at the Northwest Fisheries Science Center, during Feb 2-4, 2005. While this report forms the basis for scientific advice to managers, final advice on appropriate yield is deferred to Canadian DFO managers by the PSARC Groundfish Sub-committee and the PSARC Steering Committee and to the U.S. Pacific Fisheries Management Council by the Groundfish Management Team.

The coastal population of Pacific hake (*Merluccius productus*, also called Pacific whiting) is distributed off the west coast of North America from 25° N. to 51° N. latitude and was assessed using an age-structured assessment model. The U.S. and Canadian fisheries were treated as distinct fisheries. The primary indicator of stock abundance is the acoustic survey, and a midwater trawl juvenile survey provides an indicator of recruitment. New data in this assessment included only updated catch at age through 2004 and recruitment indices from the Santa Cruz juvenile survey in 2004. The US/Canadian acoustic survey, which is the primary index of hake abundance, was last conducted in summer of 2003, but another is planned for the summer of 2005. As in last year's assessment, uncertainty in model results is represented by a range of biomass. The lower biomass end of the range is based upon the conventional assumption that the acoustic survey catchability coefficient, $q$=1.0, while the higher end of the range represents the $q$=0.6 assumption.

**Status of Stock.** The hake stock in 2004 was estimated to range from 2.5 to 4.0 million mt (age 3+ biomass) for the $q$=1.0 and $q$=0.6 model scenarios, respectively. Stock biomass increased to a historical high in 1987 due to exceptionally large 1980 and 1984 year classes, then declined as these year classes passed through the population and were replaced by more moderate year

classes. Stock size stabilized briefly between 1995-1997, but then declined continuously to its lowest point in 2001. Since 2001, stock biomass has increased substantially as the strong 1999 year class has entered the population. The mature female biomass in 2004 was estimated to range from 50% to 55% ($q$=1.0 and $q$=0.6) of an unfished stock. Thus the stock can be considered to be rebuilt to the target level of abundance

**Pacific hake (whiting) catch and stock status table (catches in thousands of metric tons, biomass in millions of metric tons and Age 2 recruits in billions of fish):**

| Year | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| U.S. landings | 253 | 178 | 213 | 233 | 233 | 225 | 208 | 182 | 132 | 144 | 211 |
| Canadian | 106 | 70 | 93 | 92 | 89 | 87 | 22 | 54 | 51 | 62 | 124 |
| Total | 359 | 248 | 306 | 325 | 321 | 312 | 230 | 236 | 183 | 206 | 335 |
| ABC | 325 | 223 | 265 | 290 | 290 | 290 | 290 | 238 | 208 | 235 | 514 |
| Model (q=1.0) | | | | | | | | | | | |
| Age 3+ stock | 2.8 | 2.2 | 2.1 | 2.1 | 1.8 | 1.5 | 1.4 | 1.3 | 2.9 | 2.7 | 2.5 |
| Female mature | 1.5 | 1.2 | 1.1 | 1.0 | 0.9 | 0.8 | 0.7 | 0.7 | 1.2 | 1.3 | 1.2 |
| Age 2 recruits | 0.33 | 1.71 | 1.72 | 0.90 | 0.85 | 0.55 | 0.93 | 5.34 | 0.53 | 0.72 | 0.34 |
| Total F | 0.24 | 0.22 | 0.27 | 0.26 | 0.30 | 0.36 | 0.29 | 0.34 | 0.19 | 0.20 | 0.32 |
| Depletion level | 58% | 47% | 42% | 41% | 36% | 30% | 28% | 29% | 46% | 51% | 50% |
| Exploitation rate | 12.6 | 11.4 | 14.9 | 15.4 | 17.5 | 20.9 | 16.8 | 18.5 | 6.5% | 7.6% | 13.2 |
| Model (q=0.6) | | | | | | | | | | | |
| Age 3+ stock | 4.2 | 3.3 | 3.1 | 3.1 | 2.7 | 2.3 | 2.2 | 2.1 | 4.5 | 4.3 | 4.0 |
| Female mature | 2.2 | 1.8 | 1.6 | 1.6 | 1.4 | 1.2 | 1.2 | 1.2 | 1.9 | 2.1 | 2.0 |
| Age 2 recruits | 0.39 | 2.03 | 2.05 | 1.13 | 1.10 | 0.74 | 1.37 | 7.60 | 0.72 | 0.89 | 0.51 |
| Total F | 0.18 | 0.16 | 0.19 | 0.19 | 0.22 | 0.25 | 0.18 | 0.20 | 0.11 | 0.11 | 0.17 |
| Depletion level | 60% | 50% | 44% | 43% | 38% | 33% | 32% | 34% | 52% | 57% | 55% |
| Exploitation rate | 9.4% | 8.2% | 10.8 | 11.2 | 12.6 | 14.3 | 11.0 | 11.8 | 4.4% | 5.1% | 8.7% |

The coastwide ABC and OY for 2005 are estimated to be 364,000 mt and 598,000 mt ($q$=1.0 and $q$=0.6) based upon a F40% harvest rate and 302,000 mt and 483,300 mt ($q$=1.0 and $q$=0.6) based upon the F45% harvest rate. With biomass above 40% unfished biomass level, the 40:10 OY adjustment would not be applied. Projections beyond 2005 are for a decline in stock biomass and ABC-OY as the 1999 year class passes through its age of peak abundance. At this time there is no evidence of sufficiently large recruitments after 1999 to maintain the stock at a high abundance level. Preliminary results from pre-recruit surveys suggest a larger than average 2003 year-class, but this remains unconfirmed until the 2005 acoustic survey. As such, spawning stock biomass is projected to again decline within the precautionary zone (25% - 40% unfished) by 2006-2007.

For more information, contact Thomas Helser at Thomas.Helser@noaa.gov, (206) 302-2435.

## *4) Estimates of Pacific Halibut Bycatch and Mortality in IPHC Area 2A in 2003*

**WEST COAST**

**a) Research**

The estimate of Pacific halibut bycatch and mortality in the bottom trawl fishery was updated through the calendar year 2003. The estimate of halibut bycatch and mortality in the bottom trawl fishery is based upon the method developed in the report for 1999 (Wallace, 2000). The 2003

analysis uses halibut bycatch rates observed from 01 September 2002 thru 31 August 2003 in the West Coast Groundfish Observer Program. These rates are stratified by season, depth, latitude, and level of arrowtooth flounder catch, then multiplied by the amount of trawl effort in each stratum determined from Oregon and Washington trawl logbooks in 2003. Estimated halibut bycatch and mortality in other gear types was not updated for 2003.

For more information, contact John Wallace at John.Wallace@noaa.gov, (206) 860-3456.

### *5) Flatfish*

**WEST COAST**

**a) Research**

**Defining Plausible Migration Rates Based on Historical Tagging Data: A Bayesian Mark-recapture Model Applied to English Sole.** A generalized Bayesian mark-recapture model was developed to assess movement rates from historical groundfish tagging studies off the west coast of North America. With this approach, substantial parameter uncertainty including tag loss and reporting rates can be integrated out by sampling from the joint posterior distribution for all model parameters. Probabilistic statements can then be made regarding plausible movement rates, conditioned on the hypotheses considered.

This model was applied to English sole (*Parophrys vetulus*), a commercially valuable species with a large amount of historical tagging data not analyzed previously in aggregate. Tag recoveries from coastal waters were modeled by spatial area and movement hypotheses including annual, semi-annual and monthly latitudinal movement were compared using Bayes factors. English sole showed greater movement rates toward the south than toward the north over all hypotheses considered. Although simple hypotheses favored increased movement in the fall, just prior to the spawning season, the best approximating model included small movement rates of 2% per month to the north and 4% per month to the south. Posterior distributions of movement rate parameters are reported for the best models at each level of hypothesis complexity. These parameter distributions and model comparisons can guide managers and stock assessment scientists in selecting the spatial and temporal complexity of future analyses. The Bayesian framework could be easily generalized for application to similar species or more data-rich examples.

For more information, contact Ian Stewart at Ian.Stewart@noaa.gov, (206) 302-2447.

## D. Other Related Studies

### *1. Age, Growth and Maturity for the Longnose Skate, Raja rhina, along the U.S. West Coast*

**Thesis title:** Age, growth and maturity for the longnose skate (*Raja rhina*) along the U.S. West Coast

**Finished collection of monthly samples in November 2004.** The source of all samples was groundfish trawlers catches landed in Newport. In total, I collected samples for 10 different months of the year, and had a total of 235 monthly samples. The data taken for each sample

included: total length, width, weight, sex, maturity status, age structures, and measurements of the reproductive organs. For females: relative width of largest ova, oviducal gland width, uterus width and presence of egg case; for males: clasper length, clasper calcification, seminal vesicle width, and presence of seminal vesicle coiling.

Prepared all vertebral centra for ageing at least once (which required cleaning, mounting, thin sectioning, staining, slide mounting, sanding and polishing). Of all 561 samples collected in total (from the 2003 survey plus the monthly samples), only 10 age structures were missing.

Conducted a double read study with Wade Smith, a Research Associate at the Pacific Shark Research Center at Moss Landing Marine Lab. The initial double read sample (n = 98) was read twice by each of us. This first double read study showed significant bias between the two readers. Results showed a plus bias for me, or possibly a negative bias for Mr. Smith. Due to the large amount of bias in the results, we met to review and compare our ageing techniques a second time (we also did this before the double read study was conducted). We are conducting a second double read study with an entirely new set of samples in order to see if we can reduce this significant difference between readers.

Re-prepared about 100 vertebral centra samples with poor clarity ratings, and estimated age for all 550 samples at least once, though about 200-250 have been aged at least twice if not three times, but these were initial reads, which will not be used in the final analysis.

For further information, contact Josie Thompson at Josie.Thompson@noaa.gov, (541) 867-0520.

## *2. At-Sea Hake Observer Program*

The At-Sea Hake Observer Program continued to deploy observers to collect total catch and species composition data in the at-sea hake fishery on both motherships and catcher-processors. The fishery takes place in waters off the Washington and Oregon coasts. A class of 27 observers was briefed May 5-7. All vessels participating in the 2004 fishery carried two observers each, and fished between May 15th and mid-November. Observers collected species composition samples from 99% of all hauls.

The observer program is run entirely by NWFSC FRAMD staff. However, as all of these vessels also participate in Alaska fisheries, they already have the North Pacific Groundfish Observer Program (NPGOP) observer data transmission system (ATLAS) on board. The data collection protocols followed by the hake observers are similar to those utilized by the North Pacific Groundfish Observer Program. Therefore, because of the assistance provided by the NPGOP, the collected data is stored in the AFSC's NORPac database and the observers use the same gear issued to observers deployed in the North Pacific.

The goals of the program are to collect:
1. Total catch data,
2. Species composition of the catch, and
3. Biological samples of hake, rockfish bycatch, prohibited species and protected species.

The Northwest Regional Office uses the observer catch data for in-season management of the at-sea hake fishery. In addition, stock assessment scientists use the collected hake biological samples for use in hake assessments.

For more information, contact Vanessa Tuttle at Vanessa.Tuttle@noaa.gov, (206) 860-3479.

## *3. Bycatch Modeling*

In 2001, a model was developed within FRAM for purposes of projecting groundfish trawl catch of target species, and associated bycatch of several groundfish species that have been listed as overfished and are subject to rebuilding plans. During 2004, data collected from the trawl fleet during the second year of observation by the WCGOP were incorporated into the model. Bycatch rates were calculated for species under rebuilding plans, relative to the retention of target species. These rates were then applied to projected target species landings within the model in order to estimate the bycatch mortality associated with management scenarios. Additionally, discard rates for major target species, derived from the observer data, were used to expand model projections of landed catch for those species up to total mortality estimates.

For more information, contact Dr. Jim Hastie at Jim.Hastie@noaa.gov, (206) 860-3412.

## *4. Cooperative Ageing Unit*

The NWFSC continued its collaborative effort with Pacific States Marine Fisheries Commission to maintain the Cooperative Ageing Program (CAP), located at the NWFSC Berry Fisher Building in Newport, Oregon. Much of 2004 was devoted to producing ages in support of seven stock assessments conducted by the NWFSC. These species include Pacific hake, sablefish, Pacific ocean perch, canary rockfish, darkblotched rockfish, and Dover sole. In 2004 the NWFSC trawl survey expanded its otolith sampling to rockfish species that have not yet been assessed, but are part of the Pacific Fisheries Management Council's Fisheries Management Plan. Future work will focus on cross training between readers, expanding the number of species the age examines, as well as investigating thin sectioning as means to reduce variance in age estimates.

In addition to the supplying assessment ages, scientists with the CAP contributed several scientific presentations, either oral or poster. These included:

- Age validation of canary rockfish using bomb radiocarbon dating. Jennifer L. Menkel.
- Identity crisis(?): determining the level of blackgill rockfish otolith contamination in darkblotched rockfish otolith collections for years 2000, 2001, and 2002. Jennifer L. Menkel.
- Difficulty in age determination between Pacific hake (*Merluccius productus*), Pacific ocean perch (*Sebastes alutus*), and sablefish (*Anoplopoma fimbria*). Susan K. Coccetti.
- Using marginal increment analysis to validate the periodicity of annulus formation in Dover sole, *Microstomus pacificus*. Lisa M. Lysak

- Environmental variations effect on growth in Pacific hake (*Merlussius productus*). Omar Rodriguez.

For more information, contact Dr. Michael Schirripa at Michael.Schirripa@noaa.gov, (541) 867-0536.

## *5. Cooperative Resource Surveys*

**WEST COAST**

**a) Slope and Shelf Groundfish Survey**

The NWFSC conducted its seventh annual bottom trawl resource survey for groundfish off the coasts of Washington, Oregon, and California. The objective of the 2004 survey was to provide information on the distribution and relative abundance of demersal species within this region at depths from 30 to 700 fathoms. Other biological information necessary to assess the status of groundfish stocks (e.g. length, weight, sex and age structures) was collected throughout the survey period.

The NWFSC chartered commercial fishing vessels to conduct independent, replicate surveys using standardized trawl gear. Fishing vessels *Ms. Julie, Excalibur* and *B.J. Thomas* were contracted to survey the area from Cape Flattery, Washington to the Mexican border in Southern California, beginning in the later part of May and continuing through the third week of October. Each vessel was chartered for eight weeks with the *Ms Julie* surveying the coast during the initial pass from May to July. The *Excalibur* and *B.J. Thomas*, operating in tandem, surveyed the coast during the second pass from mid-August to late October. The survey followed a stratified random sampling scheme with 15-minute tows at randomly selected depths. The depth strata were: shallow (30-100 fms), middle (100-300 fms), and deep (300-700 fms). The sample design consisted of 540 sampling locations, with 200 on the shelf (30-100 fms) and 340 on the slope (100-700 fms). Each of the three vessels occupied a different subset of 180 cell sites.

In 2004, we also continued to utilize the FSCS data collection system with updated software applications, and wireless networking. Newly 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.

For more information, contact Aimee Keller at Aimee.Keller@noaa.gov, (206) 860-3460.

**WEST COAST**

**b) Triennial Survey**

In 2004, the NWFSC conducted the $10^{th}$ in a series of triennial surveys that were previously undertaken by the Alaskan Fisheries Science Center (AFSC). The National Marine Fisheries Service instituted this series in 1977 to supplement commercial data used in assessments of groundfish resources off the U.S. West Coast. The objective of the NWFSC triennial survey was to extend the pre-existing West Coast triennial survey series, historically conducted by the AFSC. The survey covered the area between Point Conception, California and Cape Flattery, Washington between depths of 30 and 275 fm. The 2004 triennial survey provided information on the distribution and relative abundance of demersal species within this region. Other biological

information necessary to assess the status of groundfish stocks (e.g. length, weight, sex and age structures) was collected throughout the survey period.

The NWFSC chartered commercial fishing vessels to conduct independent, replicate surveys using standardized trawl gear. Fishing vessels *Morning Star* and *Vesteraalen* were contracted to survey the area in tandem beginning in the later part of May and continuing through the end of July. The survey followed a combined fixed and random sampling design with over 380 30-minute tows successfully completed. Sampling density was similar throughout three depth strata: 30-100, 101-200, and 201-275 fm. Stations were located randomly along fixed tracklines at the rate of one station per four nmi of linear distance in the shallow stratum and one station every five nmi of linear distance in the two deeper strata. Tracklines were spaced at 10 nmi intervals.

During the triennial survey, we also utilized the FSCS data collection system, wireless networking, and NOAA national bottom trawl protocols throughout the survey. A series of special research projects were undertaken in cooperation with other NOAA groups and various Universities. The data collected provide a measure of the changes in relative abundance, distribution, and condition of groundfish stocks over time, which is of interest to fisheries managers, fishers and concerned citizens.

For more information, contact Aimee Keller at Aimee.Keller@noaa.gov, (206) 860-3460.

## *6. Economics Research Program*

During 2004, the NWFSC economics program focused on providing economic analyses related to developing and implementing of fisheries management regimes that comply with the Sustainable Fisheries Act (SFA). The program also provided technical support for the National Marine Fisheries Service's Northwest Region office and the Pacific Fishery Management Council. The program also addresses requirements of the Regulatory Flexibility Act, including community impact analyses of proposed and alternative management options. During 2004, the NWFSC continued developing plans to collect data that will be used to estimate the economic value of recreational groundfish, salmon, and halibut fishing off Oregon and Washington. Data collection will begin in 2005. Also during 2004, preparations continued for a new survey to collect cost and earnings information from several components of the commercial fishing fleet operating off the Pacific Coast. A major focus of this effort will be the groundfish trawl fleet. Collection of data will begin during the summer of 2005. Results are expected to improve the ability to quantify the status of, and changes to, the economic health of the trawl fleet. These data will provide an important benchmark, revealing conditions existing prior to the implementation of a permit buyback in late 2003.

For more information, contact Dr. Todd Lee at Todd.Lee@noaa.gov, (206) 302-2436.

## *7. Fish/Habitat Associations*

Over the past decade, a number of regional interdisciplinary groups have come together to apply innovative approaches to the study of fish habitats. The formation of these interdisciplinary groups was a bottom-up phenomenon encouraged by technological advances and funded and facilitated by NOAA's National Undersea Research Program and parallel support in Canada. In general, these groups have linked the fields of marine geology and fisheries science to study the habitat ecology of commercially-important species of fish.

The NWFSC FRAM Division has formed an interdisciplinary team with the Southwest Fisheries Science Center Santa Cruz Lab, Pacific Marine Environmental Laboratory, Oregon State University, Washington State University-Vancouver, and a host of other government, academic, and private institutions. Heceta Bank, Oregon has been the focus for this group's research, although recently the team has expanded the geographic boundaries to include a larger portion of the shelf break off central Oregon.

Heceta Bank is the largest of the heavily fished rocky banks on the outer continental shelf off Oregon. Since the late 1980s this bank has been a primary focus of groundfish habitat investigations. The first phase (1987-90) used submersible transects to establish relationships between seafloor habitats and the distribution of rockfish (genus *Sebastes*) and other populations of demersal fishes and epibenthic invertebrates. A second phase began after a comprehensive multibeam survey was completed in 1998. The data from the 1980s submersible dives were retrofitted onto the multibeam grid using GIS techniques and extrapolated to broader areas of the bank using the new imagery. This work was completed in the spring of 2000 (OSU Masters Thesis completed by Nicole Nasby, and manuscript published in 2002 in Fishery Bulletin, Nasby et al., Fish. Bull., 100:739-751). The third phase of the study represents an on-going NOAA NURP program with additional support from NOAA's Office of Ocean Exploration to conduct an interdisciplinary and comprehensive study of the Bank's habitats using state-of-the-art survey strategies, instrumentation, and data analysis.

The project focuses on the following questions:

1. At what scales are there quantifiable relationships between groundfish populations and morphology/texture?
2. What are the factors that control these relationships?
3. What changes have occurred in the fish populations and habitat after a decade? and
4. What is the likelihood of the existence of natural refugia on the Bank?

During the summers of 2000 and 2001, a diverse team of marine geologists, fisheries scientists, invertebrate biologists and ecologists, conservation biologists, commercial fisherman and educators participated in two cruises at Heceta Bank aboard the R/V Ronald Brown with the ROPOS remotely operated vehicle (ROV) and two-person submersible Delta (in 2000 only). The ROV and submersible were used to explore and intensively sample five of the original six transect stations in addition to extensive transects over new areas identified on the seafloor imagery.

ROPOS completed twenty-one line transects, covering ~150 km of distance, to assess fish, invertebrate and habitat relationships and to ground-truth the multi-beam topography and backscatter imagery data collected in 1998. The NWFSC FRAM Division and the Heceta Bank

Project's research team completed the extraction of all of the fish and invertebrate counts from the extensive ROPOS ROV video in 2003 and 2004. Habitat associations, the distribution of habitat types, and habitat-specific densities were determined for non-schooling species of demersal fishes for all primary habitat types observed. Preliminary results from this study show: (1) Juvenile rockfish dominated the observed fish assemblages in rock ridge and boulder habitats with densities of ~1350 fish/ha. Cobble habitats were dominated by sharpchin rockfish (~2000 fish/ha) and fish densities in mud habitats were the lowest of all habitats with observed counts of flatfish (~400 fish/ha) and greenstriped rockfish (45 fish/ha) comprising the largest portion of those assemblages. Results from this project were presented at the 2004 Western Groundfish Project. An overview of the Heceta Bank Project is now in pressin"Benthic habitats and the effects of fishing" an American Fisheries Society Symposium volume (Wakefield et al. in press).

In a related effort, four demersal fish habitats were mapped across the entire extent of the multi-beam imagery collected in 1998 (OSU Masters Thesis completed by Curt E. Whitmire, and manuscript submitted for publication in the soon to be published "GeoHab" volume).

For more information, contact Waldo Wakefield at Waldo.Wakefield@noaa.gov, (541) 867-0542 or Julia Clemons at Julia.Clemons@noaa.gov, (541) 867-0539.

## *8. Fishery-independent Estimates of Density, Size Selectivity and Catch Efficiency of a Survey Bottom Trawl for Thornyheads*

Through a collaboration between the NWFSC and AFSC a pair of papers were recently published estimating the size selectivity and catching efficiency of a survey bottom trawl for thornyheads, *Sebastolobus* spp., as well as providing a fishery-independent estimate their density based on direct counts from a towed video camera sled.

A video camera sled was used to obtain an independent estimate of the density of *Sebastolobus* spp. (thornyheads) at three different depths (450, 750, and 1150 m) within a given space and time. Camera sled video footage was processed using an oblique grid plane and line transect methods. Thornyheads were randomly distributed across the seafloor within the sampling area, and variation in the dispersion over increasing spatial scales (10–1280 m) and depths was not significant. Thornyhead density estimates were derived using the program Distance. Densities ranged from 344 to 1005 thornyheads km−2 and CVs from 10 to 18%. Underlying assumptions necessary for obtaining unbiased density estimates using a camera sled and line transect sampling are discussed, including a methodology to account for fish movement in response to the camera sled. (Lauth et al. 2004a).

Data from a video camera sled and research survey trawl were used to estimate size-specific trawl selectivity for *Sebastolobus* spp. Sizes from the camera sled video were extracted using an oblique grid plane and image analysis software. Thornyhead mean densities were 3–5 times higher with the camera sled than the survey trawl. Experimental selectivity patterns failed to conform to traditional parametric selectivity functions so a new non-parametric model was derived. The estimates of catchability for 20–25 cm thornyheads were 0.25–0.75. Catchability estimates for thornyheads larger than 30 cm were much lower (<0.10). A reason for low catchability at larger sizes remains unclear but may be a size-dependent interaction with the trawl,

an artifact caused by low sample size of large fish in the study area, an unresolved bias in the video measurement system, or any combination of these factors. (Lauth et al. 2004b)

For more information, contact Waldo Wakefield at Waldo.Wakefield@noaa.gov, (541) 867-0542 or Robert Lauth at Bob.Lauth@noaa.gov, (206) 526-4121.

## *9. Bycatch Reduction: Fish Behavior During Interactions with Bottom Trawls*

This project, initiated in 2004 will use conventional underwater video and a state-of-the-art ultrasonic camera (DIDSON or dual frequency identification sonar) to document and categorize fish behavior during the sequence of capture in bottom trawls with an emphasis on a selective flatfish trawl – an experimental net being used in West Coast groundfish fisheries. The selective flatfish trawl has been shown to maintain the catch rate of flatfish while allowing larger and more mobile species (e.g., rockfishes, shortspine thornyhead and hake) to escape by swimming above the headrope. Several complementary biochemical studies are being conducted to evaluate burst swimming capabilities in selected groundfish species. This work is a collaboration between the NWFSC, Oregon Department of Fish and Wildlife, Alaska Fisheries Science Center and University of South Florida.

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

## *10. Science for Ecosystem-based Management Initiative*

### a) Using Leslie matrices to identify essential fish habitat.

NMFS is required by statute to identify and protect habitat areas of particular concern (HAPCs)—subsets of EFH that are especially ecologically important, sensitive to human-induced environmental degradation, stressed by development activities, and/or rare. The degree to which fish successfully complete their lives is determined by the rates that individuals move through their life cycle. By creating a matrix of estimates of birth, growth, maturation, fertility and mortality rates for each life history stage it is possible to translate events happening to individuals to the dynamics of the population. Using elasticity analysis one can then estimate which life stages contribute most to the growth rate of the population, and thus determine which life history stages should be the focus of conservation. Once critical life stages are identified, the next task is to determine what habitats are important to those life stages. In particular, we need to know how changes (i.e. degradation or restoration) in habitat affect vital rates. Using these estimates of habitat effects on vital rates, one can model how different management actions that target specific habitats will affect populations. Thus, this set of models will ask the question, how much habitat (of different types) does one need to have in order to meet a management goal?

For more information, contact Phil Levin at Phil.Levin@noaa.gov, (206) 860-3473.

### b) Risk analysis of West Coast groundfishes.

Many populations of marine fish have declined steeply over the last several decades. On the other hand, many populations have increased or remained stable. We are conducting a standardized assessment of risks faced by groundfish on the continental shelf of the U.S. Pacific coast. Using

the same techniques of population viability analysis that have been used on Pacific salmon (as well as numerous other at-risk terrestrial and marine species), we are estimating population growth rates and the probability of reaching various conservation or management benchmarks (e.g. probability of 90% decline in 100 years, probability of rebuilding in 100 years, etc.). Additional analyses will illuminate what life history attributes are associated with high risk species. Our goal is to develop this work into a "partial" assessment technique for a number of currently unassessed species.

For more information, contact Phil Levin at Phil.Levin@noaa.gov, (206) 860-3473.

**c) Impacts of fishing on marine community structure.**

Using food web models, we are examining a range of marine communities, varying in species richness, productivity, and fishing intensity, to determine how fishing has affected community structure and some basic ecosystem parameters. Our initial work suggests that incompatibilities exist between managing for sustainable fisheries versus managing for the health of coast ecosystems—2 of the missions of the NMFS. We are developing indices of "ecologically sustainable yield" based not on single-species fish population dynamics, but on systemic dynamics and NMFS ecosystem goals.

For more information, contact Phil Levin at Phil.Levin@noaa.gov, (206) 860-3473.

**d) Spatial and temporal scale effects of climate variability on groundfish assemblages.**

Groundfish species on the West Coast experience different temperatures, upwelling patterns, and other climate-related variables on many spatial and temporal scales. Variability of these factors is driven by forces such as north-south gradients, large- and small-scale currents, large-scale climate events (e.g., El Niño, Pacific Decadal Oscillation), and interactions between these forces. We will examine time series of climate patterns over a 25-year period and West Coast shelf trawl survey data over the same time series to determine if there are ecologically meaningful associations between climate patterns and abundances of particular species or species assemblages of groundfish. Such information will provide some idea of how climate has contributed to population trends of many groundfish species, particularly the sharp decline in many species of *Sebastes*.

For more information, contact Phil Levin at Phil.Levin@noaa.gov, (206) 860-3473.

**e) Community composition of coastal shelf rockfish communities.**

In conjunction with the previous agenda item, we will use data from the West Coast shelf trawl surveys to identify rockfish that are most likely to coexist in predictable community assemblages in different regions. We will use statistical methods such as principal components analysis or its non-parametric analogs to determine which species tend to coexist, and under what conditions those groups are likely to be found. We can further determine if those assemblages constitute guilds, based on ecological information derived from the literature, and examine how small-scale guild population dynamics behave. For example, rather than using traditional single species stock-recruit relationships, we can see if the stock size of a guild of species influences the recruitment of that guild, or of individual species within the guild. Such information would greatly benefit managers who are interested in multi-species or community-level fisheries management plans, as opposed to single-species plans.

For more information, contact Phil Levin at Phil.Levin@noaa.gov, (206) 860-3473.

**f) Groundfish bioenergetics.**

Bioenergetics models have proven an excellent tool in estimating the energetic demands of fishes, and thereby better understanding the amount of prey required by fish populations. Bioenergetics models are also useful for explaining fish growth trajectories as they relate to prey quality, temperature, fish size, and species- and sex-specific differences. We developed bioenergetics models for *Sebastes* species, and used these models to examine various issues such as per capita prey demand of different species, the influence of temperature anomalies (e.g., PDO shifts, El Niño) on fish growth and reproductive potential, and habitat-specific prey allocation across different life history stages of rockfish (that is, do adult and juvenile rockfish share common habitats and common prey, and if so, do the predatory demands of one age group constrain the success of the other?).

For more information, contact Chris Harvey at Chris.Harvey@noaa.gov, (206) 860-3228.

**g) Fish movement and MPA design**.

Rational design of networks of MPAs requires an understanding of the relationship between the spatial extent of a reserve, home ranges of fish, and the distribution of resources. As a result, understanding movement patterns of fishes is of central importance to measuring MPA effectiveness. In part, this is due to two potentially conflicting objectives of MPAs: (1) to conserve a breeding stock adult movement out of MPAs should be minimal, but (2) to augment local fisheries, some flux outside the MPAs to harvested areas is desirable. However, very little is known about the short-term movement of most economically and ecologically important temperate fish species. Here, we propose (1) to determine the degree to which habitat structure and food resources affect movement by rockfishes, and (2) to apply these data to models that can ascertain effectiveness of existing MPAs and develop guidelines for designing future MPAs. Our approach involves first documenting the movement of rockfishes on rocky reefs using sonic telemetry. We will then use the information gathered during the empirical phase of our project to model MPA effectiveness as a function of fish motility and habitat structure food availability.

For more information, contact Phil Levin at Phil.Levin@noaa.gov, (206) 860-3473.

**h) Development of a spatially-explicit ecosystem model to examine effects of fisheries management alternatives in the Northern California Current.**

Decision analysis is intimately associated with the analysis of uncertainty: given uncertainty about future behavior of a system, what policies are most robust over the full suite of alternative future conditions? Classic fisheries science, which relies on single-species population models, has been criticized by some as inadequate for fisheries decision analysis because it considers one possible effect of fisheries policy (i.e., fishing affects abundance and age structure which, in turn, affects yield). In contrast, ecosystem-based management recognizes a broader suite of system responses, and explicitly recognizes that fish stocks respond to underlying yet unpredictable ecosystem dynamics (e.g., irreducible uncertainties) and that fishing itself can induce ecosystem changes. Thus, decision analysis frameworks ideally explore responses of populations to fishing under alternative scenarios of ecosystem forcing and fishing-mediated ecosystem change.

Do we presently have the tools to predict all elements of marine ecosystems? Absolutely not, and it is exceedingly unlikely that such a case will ever arise. Do we presently have the tools to identify potential ecosystem responses and behaviors? Fortunately, we have considerable and expanding expertise. Our knowledge of food web processes in marine ecosystems continues to grow, building a strong conceptual framework of the types of food web relationships that are common, rare, and most importantly, dangerous in the context of fisheries management. What is presently lacking, however, is an integrated modeling framework that can be used to (1) synthesize this information; (2) analyze possible ecosystem responses; and (3) identify key processes that govern ecosystem condition.

We are developing such a modeling framework for the Northern California Current Ecosystem (NCCE). Our approach explicitly estimates the ecosystem and population-level consequences of various fisheries management alternatives in the face of a varying environment. ATLANTIS, a modeling approach developed by CSIRO scientists in Australia, achieves the crucial goal of integrating physical, chemical, ecological, and fisheries dynamics in a three-dimensional, spatially explicit domain. In ATLANTIS, marine ecosystem dynamics are represented by spatially-explicit sub-models that simulate hydrographic processes (light- and temperature-driven fluxes of water and nutrients), biogeochemical factors driving primary production, food web relations among functional groups, and the model represents key exploited species at the level of detail necessary to evaluate direct effects of fishing. The ATLANTIS model is thus ideally suited for ecosystem-based decision analysis.

The overarching goal of this project is to develop a model that allows users to examine the effects of large-scale management efforts against a backdrop of environmental variability resulting from climate events, seasonal changes, oceanographic dynamics, food web interactions, and fisheries. To achieve this goal, we are (1) collating data for the processes and functional groups included in the model; (2) defining the spatial structure of the NCCE; and (3) simulating behavior of the NCCE under alternate fisheries management policies and environmental regimes

For more information, contact Phil Levin at Phil.Levin@noaa.gov, (206) 860-3473.

## *11. Sea-Truthing Modern Geophysical and Historic Geologic Data: Working Towards Establishing a Natural Disturbance Mosaic on the Pacific Northwest Margin.*

A damped gravity corer and seafloor imaging system has been developed as part of a cooperative research project between Oregon State University oceanographers (Rob Wheatcroft, Clare Reimers and Tony D'Andrea) and a NWFSC FRAM Division scientist (Waldo Wakefield). This coring device has been designed to be deployed from commercial fishing vessels as part of a collaborative research program. OSUSSS is a new system that combines a hydraulically damped gravity corer and a video/digital still camera system. The corer collects high quality (i.e., sediment and pore-water intact) cores in coarse sand to mud, thereby permitting quantitative enumeration of benthic macroinvertebrates and high-resolution sediment properties, whereas the digital still camera yields data on epibenthic megafauna and seafloor structure (e.g., ripples, mounds, etc.). The OSUSSS will be used in projects to groundtruth the evolving database and

GIS for Oregon and Washington habitats. It will also be used in new projects to examine the environmental effects of fishing. Following is a summary of accomplishments in 2003.

During a two-week period in October 2004, researchers from OSU/COAS conducted a successful cruise using the OSUSSS off central Oregon aboard the R/V Wecoma. The cruise was highly successful with the recovery of over 80 gravity cores across a broad depth range from the nearshore to the shelf break.

Cara Fritz, OSU COAS Ph.D., student, working with Rob Wheatcroft and Waldo Wakefield, is working on her dissertation project to develop a natural vs. anthropogenic disturbance mosaic for the Pacific Northwest as part of her effort to provide insight into the impacts of trawling on benthic habitats. Preliminary findings from this work were presented as a poster at the Western Groundfish Conference in 2004.

For more information, contact Rob Wheatcroft at raw@coas.oregonstate.edu, (541) 737-3891 or Waldo Wakefield at Waldo.Wakefield@noaa.gov, (541) 867-0542.

## *12) Stable Isotope and Dietary Studies of Demersal Fishes Off of Oregon and Washington.*

The combination of stable isotope studies with the analysis of feeding habits presents an effective tool for characterizing some of the dynamics of exploited marine ecosystems on both a species and a trophodynamic basis. This area of research began in earnest during the Ocean Exploration cruise to Astoria Canyon in 2001, when tissue samples from several species of rockfish were collected along with a suite of potential prey items to look at tropic relationships in and around the Canyon (Bosley et al. 2004). This study specifically looked at several commercially-important rockfish species, and the findings indicated a significant amount of direct predation on other rockfish species was occurring. With this information, we expanded the research to include much of Washington and Oregon. During the summers of 2003 and 2004, NOAA Fisheries conducted trawl surveys of demersal species inhabiting the continental shelf waters along the U.S. West coast. Tissue samples for isotopic analysis, and stomachs for characterizing feeding habits, were collected from several rockfish species to try to assess the degree of competition between species and trophic relationships. With yearly changes in harvest limits, for instance, it is possible that we may be able to track changes in trophodynamics through continued, long-term studies such as these.

The new information from 2003 and 2004 is currently being analyzed and preliminary information was presented in 2004 at the Quantitative Ecosystems Indicators in Fisheries Management meeting in Paris, France.

In addition to scientists from the NWFSC (Bosley, Brodeur and Wakefield), this research has included collaborations with two graduate students, Keri York (Washington State University, Vancouver) and Todd Miller (Oregon State University), as well as scientists from the NEFSC Ecosystems Branch, Sandy Hook, N.J., the SEFSC, Long Beach, Calif., and the United States Coast Guard Academy, Groton, CT (e.g., Witting et al. 2004).

For more information, contact Keith Bosley at Keith.Bosley@noaa.gov, (541) 867-0506 or Richard D. Brodeur at Rick.Brodeur@noaa.gov or Waldo Wakefield at Waldo.Wakefield@noaa.gov, (541) 867-0542.

## *13) West Coast Essential Fish Habitat: Geologic and Geophysical Bottom Character Database and GIS for U.S. West Coast Groundfish.*

The database and GIS project for West Coast Essential Fish Habitat is a joint effort between Chris Goldfinger, Chris Romsos, Rondi Robison, Randall Milstein, and Beth Myers from the College of Oceanic and Atmospheric Sciences at Oregon State University, and Waldo Wakefield of the NWFSC FRAM Division.

The goal of this program, begun in 2001, was to create and use a comprehensive, helpful and easily accessible, multi-layered GIS database and associated CD-ROM-based products for groundfish habitat assessment in the Pacific Northwest. The database for Oregon and Washington has been linked to an integrated habitat database for California (Gary Greene at Moss Landing Marine Laboratories and Mary Yoklavich at SWFSC Santa Cruz). For the first time, marine researchers working along the U.S. West Coast have an integrated map of structural habitat for the entire region (San Diego, CA to Cape Flattery, WA). In addition, the combined GIS database for California, Oregon and Washington is being used in the current Essential Fish Habitat Environmental Impact Statement for West Coast groundfish.

Version 1.0 of the maps for Oregon and Washington were completed in 2003. This release is entitled "Active Tectonics and Seafloor Mapping Laboratory Publication 02-01: Interim Seafloor Lithology Maps for Oregon and Washington Version 1.0". The interim habitat maps are now in use at the Northwest Fisheries Science Center. Investigators there are beginning to integrate fisheries data and benthic habitat data to look for associations, and to assess the state of existing benthic habitat data in terms of future needs.

The following section describes the basic elements incorporated in the initial version of the habitat maps:

The interim map captures the essential habitat classifications to be found offshore Oregon and Washington, but due to time constraints, lacks ground-truthing, cross checking, and some of the components of rock prediction. Since delivery of the interim maps, work has continued in 2003 and 2004 on a second iteration of the habitat maps (Version 2) that will include detailed grain size mapping, fully cross-checked and ground-truthed rock prediction mapping, similar cross-checking, ground-truthing of lithologic data to resolve conflicts between datasets, and removal of artifacts. Version 2 will also include additional oil industry core samples from archives of the Minerals Management Service, as well as much more comprehensive interpretation of the sidescan datasets, quantitative classifications of bathymetry data, and will include significant new multi-beam/backscatter datasets collected in 2002, 2003 and 2004. In particular, under separate funding, 4 days of high-resolution multi-beam mapping aboard the R/V Thomas Thompson was conducted off Oregon (collaboration with NOAA's Pacific Marine Environmental Laboratory) and in Southern California with an additional 5 days of mapping in Southern California. Interpretation of these data will be included in the Version 2 release. Additional multi-beam and backscatter data collected by NOAA on the Washington margin have also been interpreted and incorporated into

bathymetry grids, and into the interpreted habitat layers for Version 2. Another significant task underway at present is the use of extensive submersible and ROV video data for ground-truthing the maps. These data are being used to verify and or modify the existing layers, and are particularly useful for calibrating the interpretation of sidescan datasets. Virtually all observational data are co-located with sidescan surveys, which were conducted for use during the dives. Background on the mapping project for surficial geological habitats of the Oregon and Washington continental margin can be found in Romsos (2004).

For more information, contact Waldo Wakefield at Waldo.Wakefield@noaa.gov, (541) 867-0542 or Chris Goldfinger at gold@coas.oregonstate.edu.

## *14) West Coast Groundfish Observer Program.*

The West Coast Groundfish Observer Program began deploying observers in the summer of 2001. During 2003, the program continued to successfully deploy observers on commercial west coast groundfish vessels. The program is a cooperative agreement between NOAA Fisheries and Pacific States Marine Fisheries Commission (PSMFC). PSFMC has contracted the Seattle-based observer company, Alaskan Observers Inc., to provide qualified, bachelor degreed biologists to be trained as observers. Currently, there are 43 active observers stationed in ports along the coast from San Diego, California to Bellingham, Washington.

The goals of the program continue to be:
1. Estimation of total catch,
2. Estimation of total discarded catch,
3. Species composition of discarded catch,
4. Collection of biological information, and
5. Provide a timely and efficient system for collection, storage, analysis and communication of collected data.

The program deploys observers on the bottom trawl fleet, the limited entry fixed gear fleet, open access fixed gear fleets that target groundfish, and ancillary fleets such as prawn and shrimp vessels. In addition to collecting the above information, observers also collect fishing effort data including position, depth and gear used. The data is recorded on weatherproof forms and entered into a NMFS-designed database. The observer is debriefed and the data goes through a number of quality controls before it is released for summarization and analysis.

During 2004, the program summarized and performed final data quality checks to prepare the data collected from the third observation year of the groundfish bottom trawl fleet (September 2003–August 2004), the fourth observation year of the sablefish endorsed fixed gear fleet (April 2004–October 2004) and two observation years of the non-endorsed fixed gear fleet (August 2002–September 2004) for analysis. The results were presented in three reports and made available on-line early this year at: http://www.nwfsc.noaa.gov/research/divisions/fram/Observer/. The results were incorporated into a bycatch model for management use.

In addition, the program aided CDF&G with data collection for the selective flatfish net EFP. The program also expanded coverage in the Oregon nearshore and pink shrimp fleets while

maintaining coverage of these fleets in California. Coverage of the groundfish bottom trawl and fixed gear fleets will continue into 2005.

The program also investigated the use of electronic monitoring systems rather than observers to monitor overall catch in the shore-based hake fishery. Program staff worked with a contractor to deploy systems aboard all active hake vessels, collect GPS, winch sensor, hydraulic pressure and video images during fishing and process the images for incidences of non-retention. The use of this technology is promising to monitor discards in this fleet. Further work with this technology on the hake fleet is planned for 2005.

For more information, contact Jonathan Cusick at Jonathan.Cusick@noaa.gov, (206) 302-2413.

## Appendix 1. Reports and Publications


Andrews, K. S., T. W. Anderson. 2004. Habitat-dependent recruitment of two temperate reef fishes at multiple spatial scales. Marine Ecology-Progress Series 277:231-244.

Bosley, K. L., W. Lavelle, R. D. Brodeur, W. W. Wakefield, R. L. Emmett, E. T. Baker, K. M. Rehmke. 2004. Feeding relationships among pelagic and benthic communities in relation to the hydrodynamics of Astoria Submarine Canyon, Oregon, USA. Journal of Marine Systems 50:21-37.

Foote, K. J., D. Chu, T. R. Hammar, K. C. Baldwin, L. A. Mayer, L. C. Hufnagle, Jr., J. M. Jech. Protocols for calibrating multibeam sonar. The Journal of the Acoustical Society of America, in press.

Jech, J. M., K. G. Foote, D. Chu, L. C. Hufnagle, Jr. Comparing two 38-kHz scientific echo sounders. ICES Journal of Marine Science, accepted with revisions.

Lauth, R. R., W. W. Wakefield, K. Smith. 2004a. Estimating the density of thornyheads, *Sebastolobus* spp., using a towed video camera sled. Fisheries Research 70:39-48.

Lauth, R. R., J. Ianelli, W. W. Wakefield. 2004b. Estimating the size selectivity and catching efficiency of a survey bottom trawl for thornyheads, *Sebastolobus* spp., using a towed video camera sled. Fisheries Research 70:27-37.

Levin, P., B. E. Kochin. 2004. Publication of marine conservation papers: is conservation biology too dry? Conservation Biology 18:1160-1162.

Romsos, C. G. 2004. Mapping surficial geological habitats of the Oregon continental margin using integrated interpretive and GIS techniques. Master's thesis. Oregon State University, Corvallis.

Tolimieri, N., P. Levin. 2004. Differences in responses of chinook salmon to climate shifts: implications for conservation. Environmental Biology of Fishes 70:155-167.

Wakefield, W. W., C. E. Whitmire, J. E. R. Clemons, B. N. Tissot. In press. Fish habitat studies: combining high-resolution geological and biological data. *In* P. W. Barnes and J. P. Thomas, editors. Benthic habitats and the effects of fishing. American Fisheries Society, Symposium 41, Bethesda, Maryland.

Witting, D. A., R. C. Chambers, K. L. Bosley, S. C. Wainright. 2005. Experimental evaluation of ontogenetic diet transitions in summer flounder, Paralichthys dentatus, using stable isotopes as diet tracers. Canadian Journal of Fisheries and Aquatic Sciences 61: 2069-2084.

# NMFS Southwest Fisheries Science Center

# Agency Report to the Technical Subcommittee of the Canada-U.S. Groundfish Committee

**May, 2005**

With contributions from Anne Allen, Alec MacCall, Janet Mason, and Frank Schwing, compiled by John Field

# 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, as well as a number of international fisheries commissions and conventions. The Deputy Director of the SWFSC is Dr. Norman Bartoo, and the Science Director is Dr. William Fox. A considerable amount of expertise on groundfish research, assessment, and management resides within all three SWFSC laboratories, and all have supported the essential needs of the NMFS and the PFMC for groundfish (and other west coast federally managed species) for over 25 years. Laboratory scientists from the Santa Cruz Lab have been members of the PFMC's Groundfish Management Team (GMT) every year since its inception in 1977, and scientists from all three labs are regular and active members of the PFMC's Scientific and Statistical Committee (SSC) and other management teams and advisory bodies.

The Center is headquartered in La Jolla, which hosts three divisions that conduct research on a wide range of Pacific and Antarctic fish, marine mammals, sea turtles, and marine habitats; the Antarctic Ecosystem Research Division (led by Dr. Rennie Holt) , the Protected Resources Division (led by Dr. Stephen Reilly), and the Fisheries Resources Division (led by Dr. Roger Hewitt). The Fisheries Resources Division conducts research on groundfish, large pelagic fishes (tunas, billfish and sharks), and small coastal pelagic fishes (anchovy, sardine and mackerel), and is the primary source of groundfish-related research in the La Jolla Laboratory. The La Jolla laboratory is also the primary source of federal support for the California Cooperative Oceanic and Fishery Investigations surveys that have taken place along most of the California coast since 1951, conducting integrated research on the physical, chemical and biological makeup of the California Current. Researchers at the La Jolla lab have primary responsibility for ichthyoplankton collections, studies of species abundance and distribution (including responses to climate variability), systematics, and the application of early life history information to stock assessments.

The Santa Cruz Laboratory (SCL), directed by Dr. Churchill Grimes, relocated from Tiburon, California in December 2000. The lab is comprised of two primary research branches, the Fisheries Branch (led by Dr. Peter Adams) leads research in salmon population analysis, economics, groundfish analysis, and fishery oceanography, and the Ecology branch (led by Dr. Susan Sogard) which leads research into early life history, salmon ocean and estuarine ecology, habitat ecology, and molecular ecology. Of the teams most directly involved in groundfish research, Dr. Alec MacCall leads the groundfish analysis team, Dr. Steve Ralston leads the fishery oceanography team, Ms. Mary Yoklavich leads the habitat ecology team, and Dr. Susan Sogard leads the early life history team. Specific objectives of Santa Cruz Lab groundfish programs include collecting and developing information useful in assessing and managing groundfish stocks (including both fishery-dependent and fishery-independent information, ecological and oceanographic studies), conducting stock assessments to provide a basis for harvest management decisions for the PFMC, disseminate information, research findings and associated advice to the fishery management community, and provide professional services (many of which fall in the above categories) at all levels, including inter-agency, national and international working groups. Cooperative relationships also include the National Marine Protected Area Center Science Institute (housed at the lab), and the Center for Stock Assessment Research (CSTAR), a partnership with the University of California Santa Cruz.

[5]The Pacific Fisheries Environmental Laboratory (PFEL), directed by Dr. Franklin Schwing, is located in Pacific Grove. The PFEL 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 PFEL 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. PFEL also contributes oceanographic expertise to the groundfish programs within the SWFSC, particularly at the Santa Cruz Lab. This includes planning surveys and sampling strategies, conducting analyses of oceanographic data in the context of characterizing groundfish habitat and its spatial and temporal variability, and cooperating in the development and testing of environmental and biological indices that can be useful in preparing stock assessments.

# B. MULTISPECIES STUDIES

## *1. Research*

**Icthyoplankton Surveys**

The CalCOFI ichthyoplankton time series has been used to study distribution and abundance changes of many fish species in relation to climate and ecosystem change in the California Current region. CalCOFI data have been used in recent assessments of bocaccio and cowcod rockfishes, and can provide fishery-independent time series information for many other groundfish species. Since 2002 CalCOFI stations off central California, last routinely sampled in 1984, have been re-occupied during the winter and spring cruises in order to provide improved geographic coverage during the principal reproductive season for Pacific sardine and groundfish species including rockfishes, greenlings, cabezon, and various flatfishes. Similar surveys include the Southern California Nearshore Ichthyoplankton survey (ongoing), the Cowcod Conservation Area high resolution ichthyoplankton and oceanographic surveys (2002-2005) and the Marine Ecological Reserves survey (1998-1999).

**Juvenile Surveys**

Since 1983 the Groundfish Analysis Team of the SCL has used the NOAA R/V David Starr Jordan to conduct an annual survey of the distribution and abundance of pelagic juvenile rockfishes. The goal of the survey is to provide an information base for forecasting future recruitment to rockfish and other groundfish fisheries, particularly as rockfish and other species (such as Pacific hake) exhibit extreme variability in recruitment. A number of west coast groundfish stock assessments (e.g., Pacific whiting, widow rockfish, chilipepper rockfish) have used this pelagic juvenile index to estimate recruitment strength of year classes. An improvement in rockfish reproductive success, following the extended period of poor survival that occurred during the mid-1990s and the likely 1999 regime shift, appears obvious from the results of this survey. Although the abundance of juvenile rockfish was low in 2003 (as is normal for El Nino conditions), in 2004 they rebounded to values that are generally above their long-term means (Figure 1). In 2004 the geographic coverage of the pelagic juvenile rockfish mid-water trawl

survey was expanded substantially, with the addition of new sample lines off of southern and northern California, from San Clemente Island to Point Delgada. This increased the effective latitudinal range of the survey from 180 to 800 km, representing a four-fold increase in coverage. The survey's expansion was made possible due to an increased allocation of shiptime, and changing from a design-based estimation scheme to a model-based GLM that includes year, station, and calendar date effects. In addition, for the last three years Groundfish Analysis staff have coordinated survey sampling efforts with the Pacific Whiting Conservation Cooperative (funded by the NWFSC).

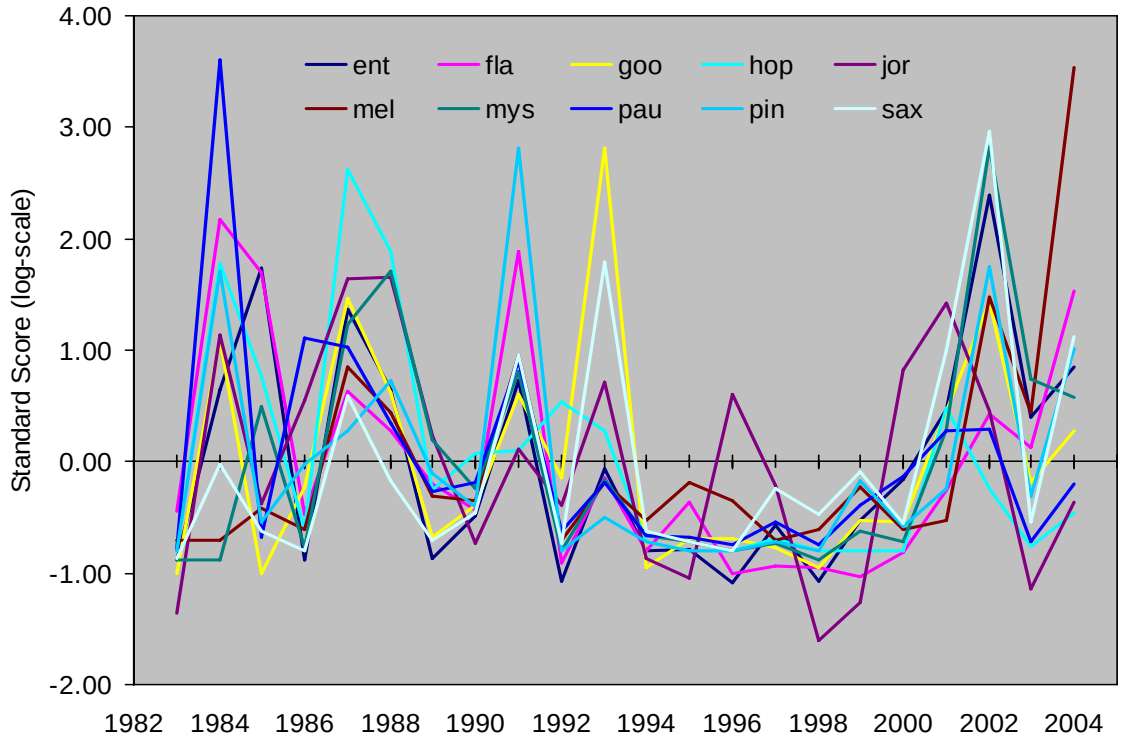



**Figure 1**: Time series of pelagic juvenile rockfish abundance in the SCL midwater trawl survey (results here are unadjusted for interannual differences in age composition).

**Adult Surveys**
In an effort to obtain a comprehensive understanding of the central California groundfish community and groundfish ecology, the Santa Cruz Lab has used Stock Assessment Improvement Program (SAIP) funding to continue the groundfish ecology surveys that began in late 2001. Cooperative research funding of the survey has allowed full monthly coverage for three consecutive years. The survey utilizes chartered commercial trawl and longline vessels using standardized gear, and typically operates over a wide range of depths throughout the Monterey Bay region. The primary objectives of the survey are to obtain detailed seasonal information on annual cycles, including species location and co-occurrence, maturation, and age validation. One potentially serious problem was identified early in these efforts, wherein it was noted that blackgill rockfish can easily be mistaken as darkblotched rockfish (an overfished stock) in fisheries samples. Additionally, evidence of multiple spawning has been documented in several species of rockfish, having previously been documented only for bocaccio. Tagging studies of nearshore species and skates has continued, including the deployment and monitoring of acoustic tags in gopher rockfish. The SCL molecular ecology and genetics team is also colleting tissue samples from rockfish and other species from this survey to evaluate population structure in a number of species. Finally, elasmobranch specimens have been provided to researchers at the Moss Landing Marine Laboratory, where studies of growth, maturity and food habits are ongoing.

**Ecosystem Research**
Santa Cruz Lab personnel have also been involved in ecosystem modeling, through participation in a National Center for Ecological Analysis and Synthesis (NCEAS) working group on ecosystem modeling and management, presentation of preliminary model results to the PFMC SSC and at national and international forum, and have publications forthcoming based on dynamic simulations of the Northern California Current ecosystem. Additionally, Santa Cruz Lab personnel were involved with a PICES Study Group investigating Fisheries and Ecosystem Responses to Recent Regime Shifts (FERRRS), which reported to the U.S. Government in October 2004. Santa Cruz Lab personnel analyzed multivariate long-term patterns of variability in ocean conditions by integrating the likelihood response surface over all possible two-wavelet deterministic models. The result identifies new patterns of potential regime shifts in the northeastern Pacific. Results were presented to the PICES FERRRS Study Group, and are being prepared for publication

**2. Stock Assessment Support**
Both the La Jolla and the Santa Cruz Lab regularly produce stock assessments of groundfish for the PFMC (recent groundfish assessments are described in more detail in the species summaries), and support stock assessment science through the maintenance of data systems and the development of new analytical techniques. The SCL works closely with the California Department of Fish and Game (CDFG) to coordinate port sampling efforts and to maintain the CALCOM database, which serves as the source of the data feeds provided to PacFIN by the State of California. The system provides port sampling biologists with Internet access to the database, so that monitoring data is entered directly in real time. Recently completed efforts included new expansions of landings and port sampling information that eliminate aggregate species and "unknown" categories. Although the resulting estimates are similar to older estimates for major species, they have improved the information content of estimates for minor species, several of which are being assessed for the first time in 2005.

Through our liaison with CDFG the SCL also recently acquired a massive amount of historical California landings data on microfiche and original paper. These records include high quality landings receipts from 1969- to the present (75,000 pages, good quality), landings receipts 1950-1968 from paper output (85,000 pages, poor quality), species landings summaries 1931-1949 by 10-minute block origin (9,000 pages, poor quality), and San Francisco area trawler catch and effort by block from 1924-1939 (on paper, 3 boxes). These data have immense value for stock assessment and habitat evaluation (e.g., EFH) purposes. CDFG recently relocated electronic records of the 1969-present data, which should ultimately extend the PacFIN database back to 1969, which is being enthusiastically received by the assessment community. The earlier data (landings receipts 1950-1968) are also especially valuable, and would extend the PacFIN database back to 1950. However, the poor image quality prevents use of optical character recognition (OCR), so the data must be keyed by hand. The SCL is currently trying to obtain cost estimates and looking for alternative funding sources for this effort, which will likely exceed $100,000.

The SCL has also developed a flexible computing package to do GLM analyses incorporating several delta-distributions, a variety of diagnostics, and jackknife estimation of precision, and has offered to contribute this package to the NMFS Stock Assessment Toolbox. Similarly, SCL scientists developed an AIC-based diagnostic methodology for identifying appropriate probability distributions for use in GLM analyses, as diagnostics recommended in existing literature were often shown to be insufficient. Finally, the SCL maintains an otolith archive representing nearly 400,000 roundfish, rockfish and flatfish collected over the past 40 years. These samples are used for stock assessment (including several first-time assessments being conducted in 2005), as well as for biological research. These archived otoliths may offer opportunities for distinguishing between the newly-discovered "species" of vermilion rockfish in historical landings, based on morphological or size-at-age differences, and perhaps genetic analysis of residual tissues. Recently, samples from these archives have been used by for age determinations of long-lived rockfish using bomb radiocarbon.

# C. BY SPECIES, BY AGENCY

## 2. Nearshore Rockfish

### *i. Research*

The SCL Early Life History Team conducts ecological research applicable to understanding factors driving population regulation during early larval and juvenile stages in rockfish and other species. Recent research has included studies of nearshore rockfish species to assess variability in the fitness characteristics of individual larval rockfish and determine sources of variability, such as the initial size of larvae at parturition, bioenergetic condition as indexed by oil reserves, initial swimming capabilities, growth rates and mortality. One clear tradeoff identified thus far is that species that release larvae early in winter (such as black and blue rockfish), have relatively small larvae that are well provisioned with oil reserves. By contrast, larvae of late spring spawners (such as gopher and kelp rockfish) have minimal oil reserves but are larger in body size. These strategies are potentially explained as an adaptive response to oceanographic conditions; larvae released in early winter may require high lipid stores to allow survival under poor or sporadic feeding conditions, whereas larvae released during the upwelling season may have a more reliable prey base but more vulnerability to predators or other threats (which would be mitigated by improved swimming capabilities). Laboratory experiments have also been used to test the

hypothesis that older females producing larvae that grow and survive better than larvae from younger mothers. Prior studies have demonstrated that this is true for black rockfish, and preliminary results suggest that this is also true for blue rockfish, another winter spawner, but results are less distinctive for spring and summer spawners.

### ii. Assessment

Personnel at the SCL 2003 assessed black rockfish, and the stock appears to be in relatively healthy condition. The SCL provided technical advice for a California sheephead stock assessment in 2004; although not a Council-managed species, sheephead interacts with the southern California groundfish fishery. Sheephead is a hermaphroditic species, and although current fishing intensity is near 50% SPR for females, male SPR may be closer to 10%.

Two assessments for nearshore rockfish initiated in 2004 are approaching completion for the 2005 PFMC biennial management cycle; gopher rockfish (led by CDFG, with participation by SCL), and kelp greenling (led by Jason Cope, UW, with participation from the SCL. Preliminary results from the gopher rockfish assessment suggest that this stock is well above target biomass levels.

## 3. Shelf Rockfish

### *i. Research*

The genetics program at the La Jolla Laboratory has developed many genetic markers for groundfish, is working to determine stock structure and dispersal distances, and helps with the design of MPA networks. Recently, the program has been attempting to resolve the discovery of many new cryptic species pairs that will greatly impede valid stock assessments until we can resolve the issue. Examples include rougheye, Pacific Ocean perch, dusky, vermillion, and stripetail rockfish. The laboratory also houses a collection of over 20,000 groundfish tissue samples, which includes virtually all extant rockfish species and DNA extracted from museum specimens. In addition, SWFSC Genetics has pioneered the development of automated molecular ID of eggs and larvae from RFLPs to Multiplex PCR and finally gene arrays. Presently they have a 20+ species gene array that covers most species encountered in the CalCOFI grid. One new molecular genetic species identification method uses DNA-specific probes and optical detection to identify larval rockfish samples to species in real-time (hours, not months), at sea (Figure 2). This method improves our observations by allowing for real-time adaptive sampling, and gives us a better understanding of the early life history of overfished rockfish stocks.

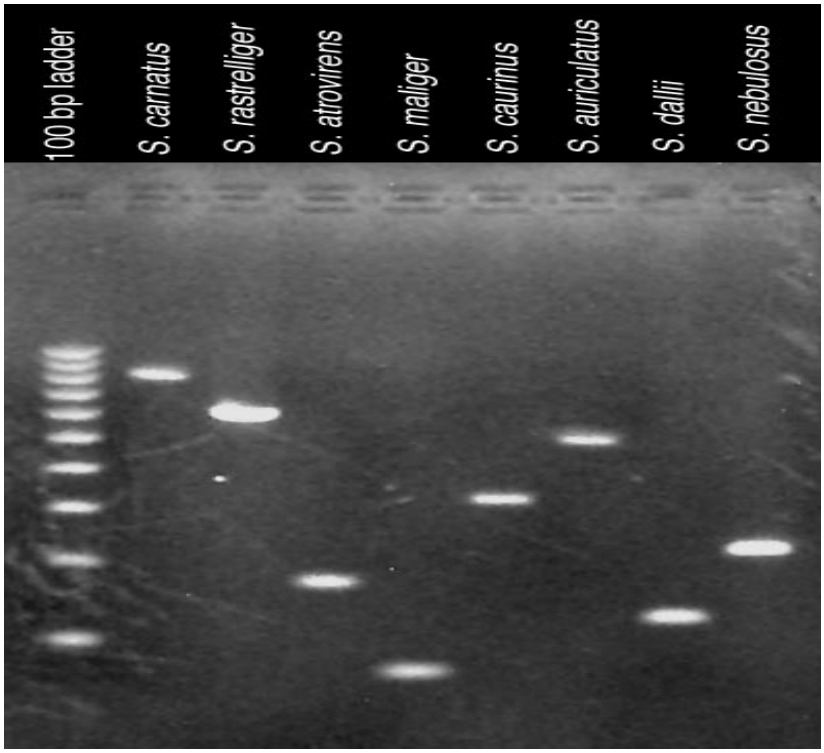



**Figure 2.** Agarose minigel of *Sebastes* (pteropodus) identification PCR

In cooperation with the NWFSC, the La Jolla Lab FRD has developed statistical techniques for analysis of bomb radiocarbon data and have completed several projects to assess ageing error of black and canary rockfish, using bomb radiocarbon and stable isotopes (papers submitted in 2004). Currently these methods are being applied to other rockfish species.

Following publication of the shortbelly rockfish larval production paper (Ralston et al. 2003), the Santa Cruz and La Jolla Labs are cooperatively developing a study in to estimate the spawning biomass of bocaccio in the southern California Bight. This study will utilize growth, maturity, and fecundity information data obtained from sampling female bocaccio at the Ensenada fish market, coupled with CalCOFI and CCA enhanced ichthyoplankton sampling of bocaccio larvae. Results of the analysis should compliment the stock assessment of bocaccio that will be conducted in the coming year. Preliminary results indicate that in southern California larger/older females release larvae at least twice during the spawning season.

Finally, results from an analysis of spatial patterns of recruitment variability based on port-specific catch at age data showed broad spatial coherence in rockfish recruitment events for winter-spawning shelf rockfish (chilipepper, widow, and yellowtail) along the US and Canadian west coast, which will help to alleviate concerns about the more restricted spatial scale of the juvenile recruit survey in prior years.

### *ii. Assessments*

The La Jolla laboratory is currently the lead for the ongoing (2005) cowcod stock assessment. Past assessments included the first cowcod assessment in 1999, and assessments of blackgill and cabezon. The Santa Cruz Lab habitat ecology team has led the development of a new fishery independent survey method for cowcod, using direct observations from an occupied submersible. The study surveyed demersal juvenile and adult cowcod using a one-sided line-transect method and direct visual observations made during dives in an occupied research submersible (Delta). The survey was conducted over eight major offshore rocky banks inside the two newly established Cowcod Conservation Areas (CCAs) off of southern California, all of which are longtime recreational and commercial fishing sites. A review of this survey method for cowcod was hosted by the La Jolla Fisheries Research Division (FRD) in December 2004, with the intent of advising the cowcod stock assessment team on how to use the new information. The draft assessment of cowcod has been completed and will be presented May 9-13, 2005 in Long Beach at the regional office, where the direct observation survey results will be considered further.

In 2003 Bocaccio was re-assessed by the SCL following a 2002 assessment that found that bocaccio were at an extremely low population size (<10% historical abundance), and had led to very restrictive groundfish management in California (as well as a petition for ESA listing). Anecdotal evidence of a strong 1999 year class was poorly supported by the data in 2002, but was prominent in the 2003 assessment, resulting in an increased estimate of productivity in 2003. Bocaccio is scheduled for an "update" assessment in 2005, work on this assessment is currently ongoing. The 2003 assessment also included the application of a newly developed a method for recreational CPUE estimation which draws inferences regarding fishing locations from the mix of species that is caught, allowing non-relevant fishing trips to be excluded from the analysis (Figure 3).

Widow rockfish was also assessed in 2003, and found to be at slightly under 25% of the historical SPR. This stock will be assessed again in 2005, although the assessment is scheduled as an update, the use of a new Bayesian one-tailed prior on steepness may merit a full review. Although genetic evidence suggests that Vermillion rockfish may in fact be two distinct species, the California stock is being assessed for the first time in 2005. Preliminary results so far suggest the stock is at or above target biomass levels. Rebuilding plans for both widow and bocaccio (as well as cowcod) were developed in 2003, and will be reevaluated in 2005. Steve Ralston and Alec MacCall are also actively engaged in the development of options for establishing quantitative criteria for assessing the progress towards rebuilding for the PFMC. Additionally, an assessment of shortbelly rockfish, an unexploited stock, is currently in progress. As this stock might be considered the equivalent of a "control" rockfish population, the results of this assessment should be informative with regard to the understanding the potential causes and consequences of natural population variability on exploited rockfish populations throughout the California Current.

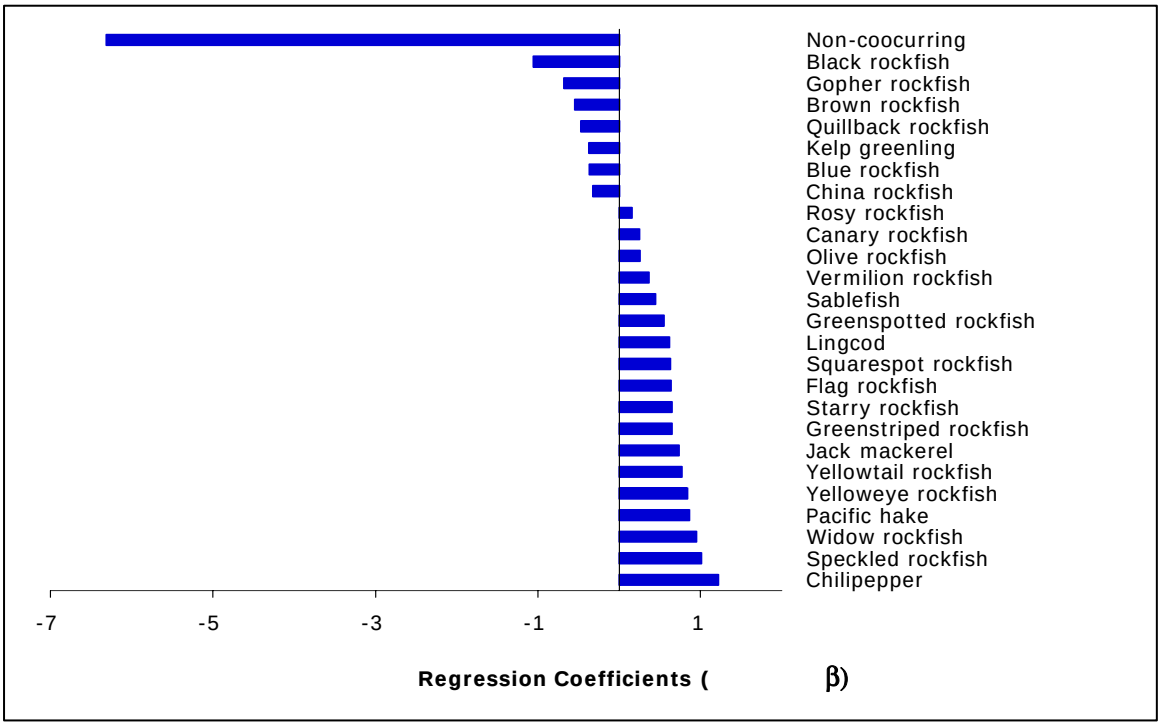



**Figure 3:** Species-based subsetting classifies each trip by probability of encountering target, as target switching is a major problem in interpreting recreational CPUE.

## 6. Sablefish

### *i. Research*

Publication of a study initiated jointly by SCL and AFSC researchers reviewed substantial complications in the ageing of sablefish, based on otoliths retrieved from fish that had been injected with oxytetracycline (OTC) and subsequently been at liberty for known durations. The findings suggest that some improvements could be achieved by detailed knowledge of growth characteristics of different morphological types.

## 7. Flatfish

### *i. Research*

A paper on the growth and life history of sand sole is in preparation. Maturity, growth, and life history studies of starry flounder, rex sole and sanddabs are also ongoing, based primarily on data and specimens collected in the Central California Cooperative Groundfish Ecology Survey.

### *ii. Assessment*

A stock assessment for starry flounder was initiated in 2004 and recently underwent STAR panel review. The final assessment is in preparation. This was the first assessment ever for starry flounder, and results suggest that although the stock is currently near target levels, biomass levels of the southern stock have recently been close to (or below) overfished levels, largely in response to environmental factors. In particular, recruitment for the southern stock appears to be strongly linked with streamflow to San Francisco Bay

## D. OTHER RELATED STUDIES

### 1. Acoustical/Optical Survey of Rockfish Habitat and Abundance

The La Jolla Center Advanced Sampling Technologies and In-Situ Survey groups are currently using three technologies combined with industry partnership to form a novel, non-lethal survey method for overfished stocks and to better survey rockfish off the California coast. Multi-beam sonar measurements are used for habitat characterization, multi-frequency echosounder measurements are used for mapping rockfish aggregations and facilitating remote species identification, and ROV video observations are used to validate the acoustical habitat classification and species identification.

In the past year, rockfish and their habitats were mapped using this technique at ten different locations. Rockfish at one of these sites, the Forty-three Fathom Spot (Fig. 1), were monitored for site fidelity, diel vertical migratory behavior, and temporal variations in biomass on inter-hourly, daily, weekly, and monthly scales. Also at this location, the frequency specific sound scatter from six different rockfish species were measured in-situ and as a function of water depth. These target strength data will ultimately be used to acoustically discriminate animal taxa, and to scale the total acoustic energy scattered from rockfish to estimate their biomass density. Other work includes the use of an instrumented small craft for efficient routine monitoring, the use of an Autonomous Underwater Vehicle (AUV) for species identification, and the use of instrumented buoys for characterization of environmental factors.

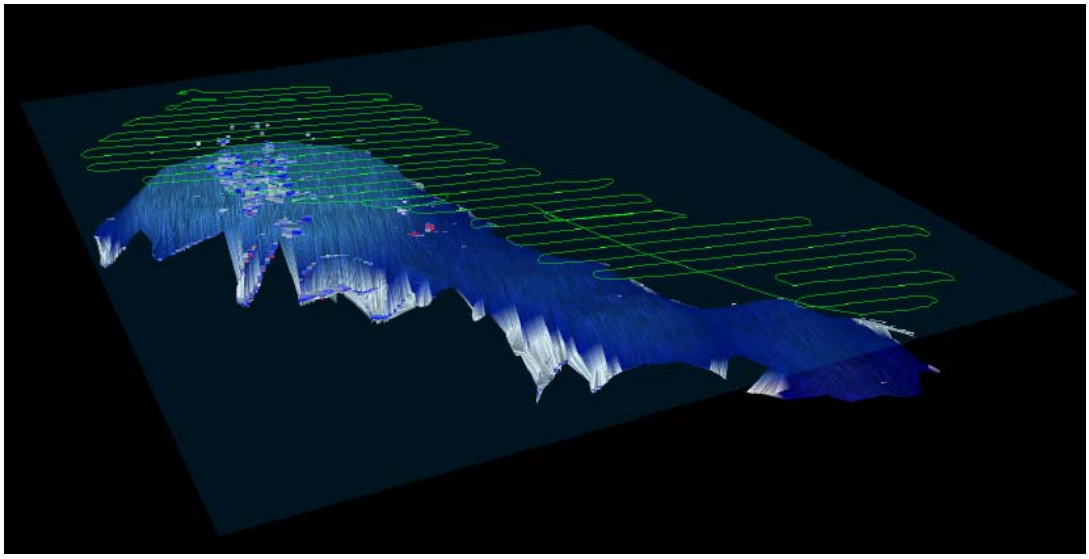


**Figure 4.** An acoustically-derived image of the bathymetry (surface) overlayed with rockfish aggregations (grey, blue, and red spots) at Forty-Three Fathom Bank, located approximately 45 n.mi. west of San Diego. The rockfish were identified using a multi-frequency delineation technique. The bathymetric surface was derived by interpolating the depth measurements recorded along the survey tracks (yellow lines) using the 38 kHz echosounder. Note that virtually all the rockfish are aggregated at the rocky high spot.

## 2. Groundfish Habitat Ecology

The SCL's Habitat Ecology team has developed a research program to respond to the Essential Fish Habitat (EFH) requirements of the MSFCMA. In addition to the *in situ* surveys of cowcod in the Cowcod Conservation Areas mentioned in the stock assessment section, the habitat team has evaluated the role of structure forming invertebrates in CCAs, by identifying over 500,000 organisms of 15 taxa seen in the CCA submersible survey. Efforts are ongoing to quantifying their density and size distributions relative to depth and substratum types, and quantifying associations between these organisms and their communities, particularly fishes. Among the products of this work have been the first descriptions of black corals (genus *Antipathes*) off southern California, including at least one new species to date. Interestingly, few organisms, and virtually no fishes, seem to be associated with these animals, suggesting that fishes are not intimately associated with structure-forming invertebrates in the areas surveyed. Other efforts have focused on using direct observation methods from an occupied submersible to survey fishes and habitats in tandem with bottom longline surveys, to compare direct observations with bottom longline methods for determining abundance, size and species composition, catchability coefficients and selectivity, and appropriate conversion factors for relative and absolute abundance. Finally, a post-doctoral fellowship funded jointly by the SCL and USGS Coastal and Marine Geology has generated research products and tools for evaluating the relationship between patterns in groundfish distribution and abundance and seafloor habitats at a range of spatial scales.

## 3. Trawl Location Mapping

The Pacific Grove Environmental Research Division has developed a GIS demonstration of trawl location mapping with improved resolution. Trawl lines based on the start and endpoints of 28,000 individual trawls from California logbook database were mapped for a test region in Central California. The density of trawling effort trawl lines was mapped on a 2-km grid for each year from 1997 to 2002. Associated information such as tow hours, date, port and pounds landed was retained with each line and used to create different maps. Landings by species from associated fish receipts matched to tows by California Department of Fish and Game were aggregated into 1-minute blocks (about 3sq km each, 100 per 10 minute fishing logbook block) to calculate catch per tow hour by species with much greater resolution than in the past. Maps detailing the distribution of trawling effort and landed species will provide detailed information to fisheries managers for the decision process for area closures. These maps also will provide information on how past regulatory actions, including rockfish conservation areas, have affected the spatial distribution of fishing effort and catch. The Environmental Research Division has been examining the relationship of environmental signals to time series of California commercial landings, including groundfish. Principal component analysis identified two signals closely related to sea surface temperature and southward wind stress that together describe over half the variability in commercial groundfish landings over the last 70 years.

## 4. Integration of Marine Protected Areas and Fisheries Science and Management

The Santa Cruz Laboratory and the National Marine Protected Areas Science Institute have convened a technical working group to develop the scientific information necessary to integrate MPAs and traditional fisheries management strategies. Prior to convening the working group, a NOAA planning committee was initiated, consisted of members representing the various line offices within NOAA, the Pacific Fishery Management Council (PFMC), and the MPA Federal Advisory Committee. The Science Integration working group held its inaugural meeting in October 2004 where it defined three main topics for review and analysis by individual teams. The topics were distilled from a longer list based upon their relevance, urgency, and tractability for MPA science integration. Three teams were formed to address separate topics and main objectives. These teams were (1) Fisheries – MPA/ecosystem team, charged with using models and other means to identify and evaluate the trade-offs of different fishery management measures (MPAs are one of them) in terms of common currencies for fisheries and ecosystems. This includes considerations of how an MPA would likely affect traditional fishery management science, such as stock assessment reference points. (2) Connectivity team, will develop tools to identify connectivity patterns at the ecosystem scale and to translate that information into the design of effective MPAs that meet the needs of fishermen and other stakeholders. (3) Natural heritage MPA team: develop guidance and measurable objectives for the design and evaluation of an MPA implemented for natural heritage purposes. Discussions are ongoing among some members of the working group about adding a fourth team to identify institutional and legislative barriers to integration of MPAs and traditional fishery management, and develop strategies to overcome these barriers. The working group will continue participate in a series of focused workshops over a span of two years to discuss and define the critical concepts and issues, and use in-depth analysis and synthesis develop a rational approach for integration of the dominant, yet divergent, management approaches based in single species population dynamics versus multi-

species ecosystem dynamics. This process is ultimately designed to address the need to derive ecosystem and fisheries level standards, reference points and control rules to evaluate the trade-offs (ecologically and economically) between MPA and other fisheries management strategies.

# GROUNDFISH PUBLICATIONS OF THE SWFSC, 2004 - present

## *1. Primary Publications*

**Anderson, T**., **M. Yoklavich**, and S. Eittreim. In Press. Linking fine-scale groundfish distributions with large-scale seafloor maps: issues and challenges of combining biological and geological data. In: P. Barnes and J. Thomas (eds). Benthic habitats and the effects of fishing. AFS Symposium 41, Bethesda, Maryland.

**Amend, M., M. Yoklavich**, Y. Rhzanov**, C. Grimes**, and W. Wakefield. In press. Mosaics of benthic habitats using laser line scan technology: it's in the details. In: B. Todd and H. G. Greene (eds.), Proceedings of GeoHab: Marine geological and biological habitat mapping (Moss Landing, California, 2002).

**Benet, D., D. E. Pearson**, and **E. J. Dick**. In prep. Life history of greenspotted rockfish (*Sebastes chlorostictus*) in Central California.

Berkeley, S. A., C. Chapman, and **S. M. Sogard**. 2004. Maternal age as a determinant of larval growth and survival in a marine fish, *Sebastes melanops*. Ecology 85(5):1258-1264.

Black, B. A., G. W. Boehlert, and **M. M. Yoklavich**. In review. Using tree-ring crossdating techniques to validate age in longlived fishes.

**Buonaccorsi, V. P**., **C. Kimbrell**, **E. Lynn** and **R. D. Vetter**. In press. Limited realized dispersal and introgressive hybridization influence genetic structure and conservation strategies for brown rockfish, *Sebastes auriculatus*. Conservation Genetics

**C. Hsieh**, M.J. Allen, **J.R. Hunter**, R.N. Lea, **C. Reiss**, R. Rosenblatt, **P.E. Smith**, G. Sugihara, **W. Watson**. (submitted) A comparison of long-term trends and variability in populations of larvae of exploited and unexploited fishes in the Southern California region: a community approach. Progress in Oceanography.

Copps, S., **M. Yoklavich**, G. Parkes, W. Wakefield, A. Bailey, H. G. Greene, and C. Goldfinger. In review. Applying habitat data to fishery management on the US west coast. In: B. Todd and H. G. Greene (eds.), Proceedings of GeoHab: Marine geological and biological habitat mapping (Moss Landing, California, 2002).

Dalton, M. G., and **S. Ralston**. 2004. The California Rockfish Conservation Area and groundfish trawlers at Moss Landing Harbor. Marine Resource Economics 19:67-83.

**Dick, E. J**. 2004. Beyond 'lognormal versus gamma': discrimination among error distributions for generalized linear models. Fisheries Research 70:351-366.

**Field, J. C**., and **S. Ralston**. In press. Spatial variability in California Current rockfish recruitment events. Canadian Journal of Fisheries and Aquatic Sciences.

**Field, J. C**., R. C. Francis, and K. Aydin. In review. Top down modeling and bottom up dynamics: linking a fisheries-based ecosystem model with climate hypotheses in the Northern California Current. Progress in Oceanography.

**Field, J. C**., and **R. C. Francis**. In prep. Considering ecosystem-based fisheries management in the California Current.

Gunderson, D. and **R. D. Vetter**. Mtapopulation Structure in Temperate Rocky Reef Fishes. In press. In Marine Metapopulations. Kritzer, J. P and P. F. Sale (eds.) Academic Press.

**He, X**., M. Mangel, and **A. MacCall**. In review. A one-tailed prior for steepness based on an evolutionary persistence principle.

**Kahn, R. G**., **D. E. Pearson**, and **E. J. Dick**. In press. Comparison of standard length, fork length, and total length for measuring fish. Marine Fisheries Review.

**Laidig, T. E**., **K. M. Sakuma**, and J. A. Stannard. 2004. Description and growth of larval and pelagic juvenile pygmy rockfish (*Sebastes wilsoni*) (family Sebastidae). Fishery Bulletin 102(3):452-463.

Love, M. and **M. Yoklavich**. In ppress. Fishes on deep rock habiats. IN: L. Allen, M. Horn, and D. Pondella (eds.), Ecology of California marine fishes. University of California Press.

**Mason, J.E**. 2004. Historical patterns from 74 years of commercial landings from California waters. CalCOFI Reports 45:1-11.

Mills, K. L., **S. Ralston**, **T. Laidig**, and W. J. Sydeman. In review. Functional response curves and the use of top predator diet as indicators of pelagic juvenile rockfish (Sebastes spp.) abundance in the California Current system.

**Narum, S. R**., **V. P. Buonaccorsi**, **C. A. Kimbrell**, and **R. D. Vetter**. 2004. Genetic divergence between Gopher Rockfish (*Sebastes carnatus*) and Black and Yellow Rockfish (*S. chrysomelas*) Copeia 2004: 926-931.

**Norton, J. G.**, and **J.E. Mason**. 2003. Environmental influences on species composition of the commercial harvest of finfish and invertebrates off California. CalCOFI Reports 44:123-133.

**Norton, J.G.** and **J.E. Mason**. 2004. Locally and remotely forced environmental influences on California commercial fish and invertebrate landings. CalCOFI Reports 45.

**Pearson, D. E.**, and F. R. Shaw. 2004. Sources of age determination errors for sablefish (*Anoplopoma fimbria*). Fishery Bulletin 102(1):127-141. (Doc ID - 119)

**Piner, K.R.**, J.R. Wallace, O.S., Hamel, and R. Mikus. (submitted). Evaluation of ageing accuracy of bocaccio (*Sebastes paucispinis*) rockfish using bomb radiocarbon. Fisheries Research.

**Piner K. R**., O. S., Hamel, J. L., Menkel, J. R., Wallace, and C. E. Hutchinson. In press. Age validation of canary rockfish (*Sebastes pinniger*) from off the Oregon coast (USA) using the bomb radiocarbon method. Canadian Journal of Fisheries and Aquatic Sciences.

**Piner, K. R**., and Wischniowski, S. G. 2004. Pacific halibut (*Hippoglossus stenolepis*) chronology of bomb radiocarbon in otoliths from 1944-1981 and a validation of ageing methods. J. Fish Bio. 64:1060-1071.

**Ralston, S**., **W. H. Lenarz**, and **D. P. Woodbury**. In prep. Long-term variability in year-class strength of northern California rockfishes (Sebastes spp.) in relation to the larval ocean environment and young-of-the-year growth. (Doc ID - 21)

**Ralston, S**., **J. R. Bence**, **M. B. Eldridge**, and **W. H. Lenarz**. 2003. An approach to estimating rockfish biomass based on larval production, with application to Sebastes jordani. Fishery Bulletin 101:129-146.

Reynolds, J. A., **S. Ralston**, and T. M. Powell. In prep. Temporal stability of the association between widow rockfish (Sebastes entomelas) and bottom depth.

**Sakuma, K. M**., **S. Ralston**, and **D. A. Roberts**. In prep. Temporal patterns of larval Pacific hake (*Merluccius productus*) and rockfish (*Sebastes* spp.) at a single fixed station off central California.

**Sakuma, K. M**., C. A. Taylor, and **W. Watson**. In review. Pigment variability in larval *shortbelly rockfish*, Sebastes jordani, off central California.

**Sogard, S. M**., **R. Fisher**, and S. A. Berkeley. In prep. Maternal investment strategies in rockfishes: larval condition vs. larval size.

Stephens, A., and **A. MacCall**. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fisheries Research 70: 299-310.

Taylor, C.A. and **W. Watson**. In press. Utility of larval pigmentation to identify nearshore rockfishes of the *Sebastes* subgenus Pteropodus from Southern California. CalCOFI Reports 45.

Tissot, B. N., **M. M. Yoklavich**, M. S. Love, K. York, and **M. Amend**. In review. Structure-forming invertebrates as components of benthic habitat on deep banks off Southern California.

**Westerman, M.E., V. P. Buonaccorsi, J. Stannard, C. Taylor, E. A. Lynn, C. A. Kimbrell and R. D. Vetter.** 2005. Cloning and characterization of novel microsatellite DNA markers for the grass rockfish, *Sebastes rastrelliger*, and cross-species amplification in 10 related *Sebastes* spp. Molecular Ecology Notes 5: 74-76.

**Yoklavich, M**., M. Love, and **K. Forney**. In review. A fishery independent assessment of cowcod (*Sebastes levis*) in Southern California's cowcod conservation areas using direct observations from an occupied submersible.

## *2. Other Publications*


Alonzo, S. H., M. Key, T. Ish, and **A. D. MacCall**. 2004. Status of the California sheephead (*Semicossyphus pulcher*) stock (2004). 171 p. [Report submitted to California Department of Fish and Game.]

**He, X., S. Ralston, A. MacCall, D. Pearson, and E. Dick**. In prep. Status of the widow rockfish resource in 2005. Pacific Fishery Management Council, Portland, Oregon.

Key, M., **A.D. MacCall**, T. Bishop and B. Leos. In prep. Stock assessment of the gopher rockfish (Sebastes carnatus). Pacific Fishery Management Council, Portland, Oregon.

King, J., G. McFarlane, A. Hollowed, **A. MacCall**, and J. Polovina. 2005. Implications for the management of marine resources. In: J. R. King (ed.), Report of the Study Group on Fisheries and Ecosystem Responses to Recent Regime Shifts. PICES Scientific Report 28:51-54.

King, J., H. Batchelder, J. Boldt, W. Crawford, A. Hollowed, S. Kim, V. Lapko, **A. MacCal**l, D. Mackas, N. Mantua, G. McFarlane, S. McKinnell, J. Overland, I. Perry, J. Polovina, J. Schweigert, **F. Schwing**, Q. Tang, A. Yatsu, and J. Zhao. 2005. Coherent Regional Responses. In: J. R. King (ed.), Report of the Study Group on Fisheries and Ecosystem Responses to Recent Regime Shifts. PICES Scientific Report 28:37-50.

**MacCall, A**., H. Batchelder, J. King, D. Mackas, N. Mantua, G. McFarlane, I. Perry, J. Schweigert, and **F. Schwing**. 2005. Appendix 2: Recent Ecosystem Changes in the California Current System. In: J. R. King (ed.), Report of the Study Group on Fisheries and Ecosystem Responses to Recent Regime Shifts. PICES Scientific Report 28:65-86.

**MacCall, A.D**. In prep. Status of Bocaccio off California in 2005. Pacific Fishery Management Council, Portland, Oregon.

**MacCall, A.D**. In prep. Assessment of Vermilion Rockfish in Southern and Northern California. Pacific Fishery Management Council, Portland, Oregon.

**Piner, K**. In prep. 2005 Stock Status of Cowcod in the Southern California Bight and Future Prospects. Pacific Fishery Management Council, Portland, Oregon.

**Ralston, S**. In prep. Stock Assessment of Starry Flounder. Pacific Fishery Management Council, Portland, OR.

**Watson, W**. and **L. L. Robertson**. In press. Development of kelp rockfish, *Sebastes atrovirens* (Jordan and Gilbert 1880) and brown rockfish, *S. auriculatus* (Girard 1854) from birth to pelagic juvenile stage, with notes on early larval development of black-and-yellow rockfish, *S. chrysomelas* (Jordan and Gilbert 1880) reared in the laboratory (Pisces: Sebastidae). NOAA Professional Paper NMFS 3. 30pp.

# STATE OF ALASKA
# GROUNDFISH FISHERIES

# ASSOCIATED INVESTIGATIONS IN 2004

**Prepared for the Forty Sixth Annual Meeting of the Technical Subcommittee of the Canada-United States Groundfish Committee**

**May 3-4, 2005**

**With contributions from:**
**Eric Coonradt, Dan Urban, Charlie Trowbridge, William Dunne, Victoria O'Connell, Tom Brookover, Cleo Brylinsky, Scott Meyer, Kristen Munk, Mike Jaenicke, Lee Hulbert, Nick Sagalkin, and Evelyn Russell**

**April 2005**

**ALASKA DEPARTMENT OF FISH AND GAME**
**DIVISION of COMMERCIAL FISHERIES & DIVISION of SPORT FISH**
**Capital Office Park**
**1255 W. 8th. Street**
**Juneau, AK 99802-5526**

# STATE OF ALASKA GROUNDFISH FISHERIES AND ASSOCIATED INVESTIGATIONS IN 2004

# REVIEW OF AGENCY GROUNDFISH RESEARCH, STOCK ASSESSMENT, AND MANAGEMENT

## A. Agency Overview

### *1. Description of the State of Alaska commercial groundfish fishery program:*

The Alaska Department of Fish and Game (ADF&G) has jurisdiction over all commercial groundfish fisheries within the internal waters of the State and to three miles offshore along the outer coast. A provision in the federal Gulf of Alaska (GOA) Groundfish Fishery Management Plan (FMP) gives the State of Alaska limited management authority for demersal shelf rockfish in federal waters east of 140$^{o}$ W. longitude. North Pacific Fisheries Management Council (NPFMC) action in 1997 removed black and blue rockfish from the Gulf of Alaska FMP, thus the state manages these species in both state and federal waters (of the GOA). The State also manages the lingcod resource in both state and federal waters of Alaska. Other groundfish fisheries in Alaskan waters are managed by the federal government, or in conjunction with federal management of the adjacent Exclusive Economic Zone (EEZ). The information related in this report is from the state-managed groundfish fisheries only.

The State of Alaska is divided into three maritime regions for marine commercial fisheries management. The Southeast Region extends from the Exclusive Economic Zone (Equi-distant line) boundary in Dixon Entrance north and westward to 144$^{o}$ W. longitude and includes all of Yakutat Bay (Appendix II). This is a change from recent years when the Central Region began at 140$^{o}$ W. longitude. The Central Region includes the internal waters of Prince William Sound (PWS), Cook Inlet, and Bristol Bay and the Outer District off the 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.

**Southeast Region**

The **Southeast Region** Commercial Fisheries Groundfish Project is based in Sitka with the groundfish project leader, assistant project leader and 2 port biologists located there. Seasonal port samplers and data entry staff was employed in Petersburg, Ketchikan, Sitka, Craig and Douglas. The project also received biometrics assistance from the regional office in Douglas.

The Southeast Region's groundfish project has responsibility for research and management of all commercial groundfish resources in the territorial waters of the Eastern Gulf of Alaska as well as black and blue rockfishes and lingcod in the EEZ. The project cooperates with the federal government for management of the waters of the adjacent EEZ. The project leader participates as

a member of the North Pacific Fisheries Management Council's Gulf of Alaska Groundfish Plan Team and produces the annual stock assessment for demersal shelf rockfish for consideration by the North Pacific Fishery Management Council.

Project activities center around fisheries monitoring, resource assessment, and in-season management of the groundfish resources. In-season management decisions are based on data collected from the fisheries and resource assessment surveys. Primary tasks include fish ticket collection, editing, and data entry for both state and federal-managed fisheries; dockside sampling of sablefish, lingcod, Pacific cod, and rockfish landings; and skipper interview and logbook collection and data entry. Four resource assessment surveys were conducted during 2004. Funding for the Southeast Groundfish project comes from NOAA Grants NA16FN1273 and NA06F10074 and NA97FN0121, CFDA 11-407.

## Central Region

**Central Region** groundfish staff is headquartered in Homer and is comprised of a regional groundfish management biologist, a regional shellfish/groundfish research project leader, a groundfish sampling coordinator, a groundfish fish ticket entry position, two marine research biologists, and one seasonal commercial catch sampler. An area management biologist and a seasonal commercial catch sampler are also located in Cordova and regional support comes from Anchorage. The research project leader also functions as a member of the North Pacific Fishery Management Council's Gulf of Alaska Groundfish Plan Team. The R/V *Pandalus*, home ported in Homer, and the R/V Solstice, home ported in Cordova, conduct a variety of groundfish-related activities in Central Region waters.

Groundfish responsibilities in Central Region include research and management of most groundfish species occurring in territorial waters of Central Region. Within Central Region, groundfish species of primary interest include sablefish, rockfish, pollock, Pacific cod, lingcod, sharks, and skates. Stock assessment data are collected through port sampling, and through ADF&G trawl, longline, jig, scuba, and ROV surveys. Commercial harvest data (fish tickets) are processed in Homer for state and federal fisheries landings at Central Region ports.

## Westward Region

The **Westward Region** groundfish management and research staff is located in Kodiak and Dutch Harbor. Kodiak staff is comprised of a regional groundfish management biologist, an area groundfish management biologist, an assistant area groundfish management biologist, a groundfish research project leader, a groundfish research project assistant biologist, a groundfish dockside sampling coordinator, a seasonal age-determination unit biologist, two seasonal fish ticket processing technicians, and a seasonal dockside sampler. A full-time assistant area groundfish management biologist, a seasonal fish ticket processing technician, and a seasonal dockside sampler are located in the Dutch Harbor office. Seasonal dockside sampling also occurs in Chignik, Sand Point, King Cove, and Adak. The R/V Resolution, R/V K-Hi-C, and R/V Instar are home ported in Kodiak and conduct a variety of groundfish related activities in the waters around Kodiak, the south side of the Alaska Peninsula, and in the eastern Aleutian Islands.

Major groundfish activities include: fish ticket editing and entry for approximately 11,000 tickets from both state and federal fisheries, analysis of data collected on an annual multi-species trawl survey encompassing the waters adjacent to the Kodiak archipelago, Alaska Peninsula and Eastern Aleutians, management of black rockfish, state-waters Pacific cod, lingcod, and Aleutian Island state-waters sablefish fisheries, conducting dockside interview and biological data collections from commercial groundfish landings, and a number of research projects. In addition, the Westward Region has a member on the North Pacific Fisheries Management Council's Bering Sea/Aleutian Island Groundfish Plan Team (Ivan Vining) and the Gulf of Alaska Groundfish Plan Team (Nick Sagalkin).

**Headquarters**

The Alaska Fisheries Information Network (AKFIN) project began in 1997 in response to the 1996 Magnuson-Stevens Act. The Alaska Department of Fish and Game (ADF&G) entered into a contract with the Pacific States Marine Fisheries Commission to expand data collection and management duties previously carried out under PACFIN. The purpose of the AKFIN program is to collect and make available the fishery catch information from Alaska's marine fisheries. This includes the major federal and state groundfish fisheries as well as the Bering Sea and Aleutian Island crab fisheries. The AKFIN project provides accurate and timely fishery data that has been essential for management, pursuant to the biological conservation, economic and social, and research and management objectives of the fishery management plans for groundfish and crab resources.

The Alaska Fisheries Information Network also:

1. Provides a forum for agencies to develop coordinated relational data/information systems encompassing State of Alaska and Federal fisheries data for use by fishery managers, associated agencies and the public.
2. Provides data management consultation and technical advice to participating agencies upon request.
3. Promotes the efficiency, effectiveness and timeliness of data acquisition and delivery with a minimum of duplication.
4. Maintains the AKFIN Support Center which conducts such projects set forth in the AKFIN work plan to insure that all available data are accessible to fishery managers, the North Pacific Fishery Management Council and its Plan Development Teams and Scientific and Statistical Committee, and each participating agency to meet respective fisheries management responsibilities.
5. Facilitates and support a comprehensive and coordinated program to collect, record, store, and make available social and economic data relating to fisheries and fishing communities.
6. Provides support for the acquisition, maintenance, and analysis of fishery dependent data (including but not limited to GIS-based fishing locations, otolith-based age determination, and port sampling) for inclusion in agency databases as appropriate.

The foundation of the state's AKFIN project is an extensive port sampling system for collection and editing fish ticket data from virtually all of the major ports of landing from Ketchikan to Adak and the Pribilof Islands, with major emphasis on Sitka, Homer, Kodiak, and Dutch Harbor. The port sampling program includes collection of harvest data, such as catch and effort, and also the

collection of biological data on the fish and crab species landed, and age determination based on samples of age structures collected from landed catches. ADF&G personnel continued to collect, review, edit and amend, data capture, and archive all ADF&G fish tickets submitted to local offices. These fish tickets include those required as well as tickets voluntarily submitted by EEZ operators.

The state's AKFIN program is supported by a strong commitment to development and maintenance of a computer database system designed for efficient storage and retrieval of the catch and production data on a wide area network. It supports the enhancement of the fish ticket information collection effort including; regional fishery monitoring and data management, GIS database development and fishery data analysis, catch and production database development and access, the age determination unit laboratory, database management and administration, Bering sea crab data collection and reporting, various fishery economic projects, and fisheries information services.

AKFIN-funded ADF&G personnel are cooperating with an Interagency Steering Committee to develop and implement an online electronic catch and production reporting program for the rationalized crab fishery by August 2005. The features that will be implemented include electronic landing and production reports, real time quota monitoring, immediate data validation, and printable (pdf) fish ticket reports. The goal is to move to statewide implementation of electronic reporting in all groundfish fisheries by January of 2006.

Local ADF&G personnel in nine locations throughout the state of Alaska (Craig, Ketchikan, Petersburg, Sitka, Juneau, Seward, Homer, Cordova, Kodiak, and Dutch Harbor) maintain close contact with fishers, processors and enforcement to maintain a high quality of accuracy in the submitted fish ticket records. Following processing, the data is electronically transferred to Headquarters. The research analyst working with this project works as part of a team to maintain a master statewide groundfish fish ticket database. Data feeds to Headquarters are merged to this master database. Data is routinely reviewed for accuracy with corrections applied as required. Within the confines of confidentiality agreements, raw data is distributed to the National Marine Fishery Service (both NMFS-ARO and NMFS-AFSC), the North Pacific Fishery Management Council (NPFMC), the Commercial Fisheries Entry Commission (CFEC), the Pacific States Fisheries Information Network (PACFIN) and the AKFIN Support Center on a regularly scheduled basis. Summary groundfish catch information is also provided back to regional ADF&G offices as well as to the State of Alaska Board of Fisheries, NMFS, NPFMC and the AKFIN Support Center (Contact Lee Hulbert).

## Gene Conservation Laboratory

The ADF&G Gene Conservation Laboratory continued studies on genetic diversity and gene flow for a variety of groundfish species in 2002. Efforts focused on black rockfish, light and dark dusky rockfish, and pollock (a list of *Sebastes* tissue samples stored at ADF&G's Gene Conservation Laboratory can be found in Appendix III).

**Age Determination Unit**

The ADFG's centralized statewide age-reading program at the Age Determination Unit (ADU) in Juneau continued to provide age data to ADFG regional managers in 2004. Age structures from approximately 12,150 groundfish, 12 species, were received through statewide commercial and survey harvest sampling efforts and 16,329 age data (also reflecting aging of backlogged structures) were released back to managers. Additional age data were produced through routine precision testing. The majority of funding for this project is through the Alaska Fisheries Information Network (federal), with a small degree (<5%) of general funding (state) and outside contract. Eleven people were employed for approximately 46 work months to age groundfish age structures or conduct associated work (sample preparation, data entry, archiving, otolith measurements). Only one employee was full-time and funded year round. Other individuals are seasonal (employed for 1-8 months duration).

Quality of age data is routinely assessed through second-reading 20% of the sample, either by the initial-reader or by a reader with equal or greater experience. Species-specific control limits are imposed and further guide release of age data; transgression of control limits direct reviewing of some or the entire sample.

In 2004, the ADU was in production status for all species received. Effort continues in increasing objective information to strengthen the foundation of pattern interpretation for all difficult species including, for example, pollock and Pacific cod.

The ADU Oracle database, AegIS (Age Information System), was used for simple importing and exporting of data throughout 2004. Developed as a shell application, the need for additional utility was recognized by late 2004. The AegIS makeover will occur in three phases in the first half of 2005.

Limited refinements to the ADU website (http://tagotoweb.adfg.state.ak.us/ADU/) were made.

## 2. Description of the State of Alaska recreational groundfish fishery program (Sport Fish Division)

ADF&G has jurisdiction over all recreational groundfish fisheries within the internal waters of the state, in coastal waters out to three miles offshore, and throughout the EEZ. The Alaska Board of Fisheries extended existing state regulations governing the sport fishery for all marine species into the waters of the EEZ off Alaska in 1998. This was done under provisions of the Magnuson-Stevens Fishery Conservation and Management Act, which stipulates that states may regulate fisheries that are not regulated under a federal fishery management plan or other applicable federal regulations.

Most management and research efforts are directed at halibut, rockfish, and lingcod, the primary species targeted by the recreational fishery. Statewide data collection programs include an annual mail survey to estimate overall harvest (in number) of halibut, rockfish, lingcod, and sharks, and a mandatory logbook to assess harvest of the same species in the charterboat fishery. The Deputy

Director of the Division of Sport Fish (Rob Bentz), located in Juneau, takes the statewide lead in federal-state jurisdictional management issues.

Regional programs with varying objectives address the estimation of recreational fishery statistics, including harvest and release magnitude and biological characteristics such as species, age, size, and sex composition. Research is funded through the Federal Aid in Sport Fish Restoration program and through a NOAA grant administered by NMFS. There are essentially two maritime regions for marine sport fishery management in Alaska. The Southeast Region extends from the Exclusive Economic Zone (Equi-distant line) boundary in Dixon Entrance north and westward to Cape Suckling, at approximately 144$^{o}$ W. longitude. The Southcentral Region includes state and federal waters from Cape Suckling to Cape Newenham, including Prince William Sound (PWS), Cook Inlet, Kodiak, the Alaska Peninsula, the Aleutian Islands, and Bristol Bay.

## Southeast Region Sport Fish

Regional staff in Douglas coordinate a data collection program for halibut and groundfish in conjunction with a regionwide Chinook salmon harvest studies project. The project leader is Mike Jaenicke while assistant project biologists were also located in Ketchikan (Kathleen Wendt) and in Juneau (Bruce White through 2004, Diana Tersteeg beginning February 2005). The project biometrician (Steve Fleischman) is located in Anchorage. A total of 21 technicians work at the major ports in the Southeast region, where they interview both anglers and charter operators and then collect data from sport harvests of halibut and groundfish while also collecting data on sport harvests of salmon. Data collected on groundfish are limited to species composition, length of halibut and lingcod, and sex of lingcod; no otoliths or other age structures are collected. Data are provided to the Alaska Board of Fisheries, other ADF&G staff, the public, and a variety of other agencies such as the NPFMC and the IPHC.

Area management biologists in Yakutat, Haines, Sitka, Juneau, Petersburg, Klawock, and Ketchikan are responsible for groundfish management in those local areas. In general, sport fisheries for groundfish are not actively managed inseason.

## Southcentral Region Sport Fish

The Southcentral Region groundfish staff consisted of the area management biologists and assistants for the following areas: (1) PWS and the North Gulf areas, (2) Lower Cook Inlet, and (3) Kodiak, Alaska Peninsula, and the Aleutian Islands. In addition, a regionwide harvest assessment project was based in the Homer office, consisting of a project leader, field supervisor, and six port samplers. The research project biometrician was located in Anchorage. Ongoing assessment of sport harvest and fishery characteristics at major ports throughout the region is the primary activity. Data are collected from harvested halibut, rockfishes, lingcod, and sharks, and anglers and charter boat operators are interviewed for fishery performance information. All age reading is done in Homer, and the staff are active participants in the Committee of Age Reading Experts (CARE). Seasonal technicians collected data from the sport harvest at seven major ports in the region, and two of them read all rockfish and lingcod age structures. Halibut otoliths collected in 2004 will be forwarded to the International Pacific Halibut Commission for age reading.

Southcentral region staff is responsible for management of groundfish fisheries in state and federal waters. For all species, the lack of stock assessment information has precluded development of abundance-based fishery objectives. As a result, management is based on building a regulatory framework specifying bag and possession limits, seasons, and methods and means that provides for sustained yield over the long term. Inseason management action has generally been unnecessary, but increasing harvests of some species will eventually necessitate development of a well-defined harvest strategy.

Typical duties also include providing sport halibut harvest statistics to the International Pacific Halibut Commission (IPHC) and NPFMC, assisting in development and analysis of the statewide charter logbook program and statewide harvest survey, working with Alaska Board of Fisheries, advisory committees, and local fishing groups to develop local area management plans (LAMPs), drafting, and reviewing proposals for recreational groundfish regulations, and dissemination of information to the public.

## B. By Species

### *1. Pacific Cod*

Catch rate and biological information is gathered from fish ticket records, port sampling programs, a tagging program, and during stock assessment surveys for other species. A mandatory logbook program was initiated in 1997 for the state waters of Southeast Alaska. Commercial landings in Southeast, Central Region and the Westward Region are sampled for length, weight, age, sex, and stage of maturity.

#### Research

The **Westward Region** has continued the cod-tagging program that was initiated in 1997 in the Central and Western Gulf of Alaska. Approximately 1,500 fish were tagged in 2004, bringing the total number of tags released to12,700. By year's end, 715 tags had been recovered, 481 of them with useable recovery location information. Results to date show that while the vast majority of Pacific cod are recovered within 15 km of their tagging location, much longer recapture distances are possible. Several fish were recaptured more than 500 km from their tagging location. The relatively small number of long distance recaptures show movement of cod are occurring from the Shumagin Islands into the Bering Sea, the Alaska Peninsula to Kodiak waters, and several fish tagged in Kodiak waters were recovered in Southeast Alaska.

#### Stock Assessment

No stock assessment programs were active for Pacific cod during 2004.

#### Management

Regulations adopted by the Alaska Board of Fisheries during November 1993 established a guideline harvest range (GHR) of 340 to 567 mt for Pacific cod in the internal waters of Southeast Alaska. The GHR was based on average historic harvest levels rather than on a biomass-based ABC estimate.

Pacific cod along the outer coast are managed in conjunction with the Total Allowable Catch (TAC) levels set by the federal government for the adjacent EEZ.

In 1996, the Alaska Board of Fisheries adopted state water Pacific cod Management Plans for fisheries in five groundfish areas – Prince William Sound, Cook Inlet, Kodiak, Chignik and South Alaska Peninsula. Under these plans, participation is not restricted to vessels qualified under the federal moratorium program. Included within the plans were season, gear and harvest specifications. Fishing seasons begin seven days after the close of the initial federal season in all areas except Chignik, which has a regulatory opening date of March 1. The BOF restricted state fisheries to pot or jig gear in an effort to reduce crab bycatch. The guideline harvest levels (GHL) are allocated by gear type. The annual GHLs are based on the estimate of allowable biological catch (ABC) of Pacific cod as established by the NPFMC. The initial GHLs were set at 15 percent of the Western Gulf ABC to be reserved for the South Alaska Peninsula Area, 15 percent of the Central Gulf ABC to be apportioned between the Kodiak, Chignik and Cook Inlet Areas, and 25 percent of the Eastern Gulf ABC for the Prince William Sound Area.

Additional regulations include a 58' vessel size limit in the Chignik and South Alaska Peninsula Areas and allocations between gear types in Kodiak, Cook Inlet and Prince William Sound. The fishery management plans also provided for removal of restrictions on exclusive area registrations, vessel size and gear limits after October 31 to increase late season production.

Efforts have increased to collect biological data through port sampling. In addition, observers are used on day-trips to document catches and at-sea discards in the nearshore pot fisheries.

There is no bag, possession, or size limit for Pacific cod in the recreational fisheries in Alaska. Pacific cod harvest and release information is not collected in the creel surveys and port sampling of the recreational fisheries in Southcentral or Southeast Alaska.

## Fisheries

Most of the Pacific cod harvested in Southeast Alaska are taken by longline gear during the parallel season. Pots have been the dominant gear in both the Cook Inlet and Prince William Sound areas. Overall, Pacific cod harvest from the Cook Inlet and PWS areas during the parallel season has declined in recent years. In the Westward Region, trawl gear takes over 60 percent of the harvest, with the remainder split between longline, jig, and pot gear. Prior to 1993, much of the cod taken in Southeast was utilized as bait in fisheries for other species. Pacific cod harvested since that time is roughly evenly divided between bait use and human consumption. In other areas of the state, Pacific cod are harvested in both state and federal waters and utilized primarily as food fish. Harvests of Pacific cod totaled 204 mt in the Southeast state-managed fishery during 2004, up 14 percent from the 2003 catch. The 2004 GHLs for the Cook Inlet and Prince William Sound state-managed Pacific cod harvest were set at 1,075 mt and 440 mt, respectively. Due to the low number of vessels making landings in the PWS Area in 2004, harvest figures remain confidential. Harvest from the Cook Inlet Area state-managed Pacific cod fishery totaled 958 mt. Harvest from the 2004 state managed fishery in the Kodiak Area totaled 4,552 mt, while 2,601 mt of cod were harvested in the Chignik Area, and the South Alaska Peninsula Area harvest totaled 5651 mt. The Kodiak and South Alaska Peninsula Areas obtained their maximum GHL 'step up'

provisions for 2000 and all subsequent years. The Kodiak Area will receive 12.5 percent of the Central Gulf ABC and the South Alaska Peninsula will receive 25 percent of the Western Gulf ABC in all future years. The Chignik Area achieved its maximum GHL 'step' up in 2003. The Chignik Area will receive 8.75 oercebt of the Central Gulf ABC in 2004 and all future years. Action by the Alaska Board of Fisheries during 2004 increased the Pacific cod allocation in the Cook Inlet Area from 3 percent to 3.75 percent of the Central Gulf ABC, the maximum allowed under regulation.

## *2. Rockfishes*

Rockfishes are managed under three assemblages: demersal shelf (DSR), pelagic shelf (PSR), and slope rockfish. Demersal Shelf Rockfish include the following species: yelloweye, quillback, china, copper, rosethorn, canary, and tiger. Pelagic shelf rockfish (PSR) include black, blue, dusky, yellowtail, and widow. Black and blue rockfish were removed from the PSR assemblage in the federal fisheries management plan and placed totally under state management in 1998. Slope rockfish contain all other *Sebastes* and *Sebastolobus* species.

**Research**

Detecting spatial structure in the genetic variation of some marine fishes is challenging as populations are often closely related through high gene flow and the relationships between populations may change over years. However, recent advances in molecular markers provide a large array of potentially valuable approaches to address these questions. The Alaska Department of Fish and Game Gene Conservation Laboratory is currently conducting studies of spatial and temporal variation in black rockfishes using analyses of microsatellite DNA.

Studies of black rockfish are investigating the spatial structure throughout the range of the species from the Pacific Northwest through the Bering Sea. Sample collection efforts were largely completed in 2001. Sites range from Oregon through the Alaska Peninsula. Ten individual collections were analyzed for eight microsatellite loci derived from black and quillback rockfishes. Loci were highly variable with an average heterozygosity of 0.748. Preliminary statistical analyses indicate small but significant differences among collections. $F_{st}$ values by locus varied from 0.001 to 0.020. A manuscript and final report are in preparation (Contact Lisa Seeb).

In the **Southeast Region,** port sampling and the mandatory logbook program for rockfish fisheries continued in 2004. The logbook and interview programs are designed to furnish detailed catch and effort information, estimate at-sea discards, and obtain more detailed information regarding specific harvest location. The port-sampling program provides species composition from the landed catch and an opportunity to collect biological samples. Otoliths were obtained from principal demersal shelf rockfish species and black rockfish and sent to the age-reading laboratory in Juneau for age determination. Data from these programs is entered into a regional database. In 2004, 1,769 yelloweye, 568 quillback, and 295 black rockfish were sampled for age, weight, length, sex, and maturity (Contact Mike Vaughn).

Rockfish habitat mapping projects continue in the Southeast Region. The objective of this project is to continue a bottom-mapping project of the Eastern Gulf of Alaska to provide detail on habitat characterization in this important fishing ground. To date, ADF&G has mapped approximately

2100 $km^2$ of seafloor. This represents over 7 percent of the total habitat inside the 100-fm contour along the outer coast of Southeast. More importantly, over 980 $km^2$ of rocky habitat has been mapped, approximately 32 percent of what is estimated to occur. The goals of this project are to produce a GIS compatible sun-illuminated multibeam mosaic of these areas complete with bathymetric contour mosaics and a geological habitat interpretation of the mosaics. Quantification of rockfish habitat based on the geological interpretation of multibeam data is subcontracted to Moss Landing Marine Laboratories.

In 2004, ADF&G began work on two projects to further the habitat portion of our DSR stock assessment project. The first project was a continuation of our high-resolution multibeam survey at the Fairweather Grounds, which was started in 2002. This required one 24-hour day of survey time and post processing of the data. We contracted Fugro Pelagos, Inc. for this project and had them combine the newly collected data with data that was collected from our 2002 survey. The result is a high-resolution backscatter and bathymetric image of the seafloor, which is being classified into habitat types by the Center for Habitat Studies at Moss Landing Marine Laboratory in California.

The second project is the post processing of multibeam data that was collected by NOAA for the purpose of updating the nautical charts for the areas close to Sitka Sound. We contracted with Fugro Pelagos for post processing. Our hope is that data collected by NOAA will be useful to us and save us the cost of mobilizing surveys of our own. The NOAA survey Fugro Pelagos is post processing is from the south end of Kruzof Island and approximately half of it was collected in a manner that will result in maps that will be useful for the delineation of rocky habitat in that area.

Skipper interviews and port sampling of commercial rockfish deliveries in the **Central Region** during 2004 occurred in Homer, Seward, Whittier, Anchorage and Cordova. Efforts during the first half of the year primarily sampled rockfish delivered as bycatch in other groundfish fisheries, primarily slope and demersal shelf species. During the last half of the year, sampling focused primarily on the directed jig fishery that targets pelagic rockfish. Additional sampling occurred during the Cook Inlet and PWS trawl and sablefish longline surveys. Sample data collected included date and location of harvest, species, length, weight, sex, and gonad condition. Otoliths were collected from most sampled fish. Homer office staff determined ages of pelagic and demersal rockfish otoliths. Otoliths from all other rockfish species were sent to the Age Determination Unit (Contact Willy Dunne).

In 2000, **Central Region** staff initiated a three-year project to evaluate sampling approaches for estimating black rockfish (*Sebastes melanops*) abundance in specific nearshore habitats of Southcentral Alaska along the Northern Gulf of Alaska. Harvest guidelines are currently based on long-term harvest levels of all rockfish species in aggregate and have not been established to reflect changes either in the abundance of individual species or in fishing patterns. Black rockfish comprise the largest component of state waters rockfish harvest along the northern Gulf of Alaska. This project attempts to use in-situ scuba diver observations and mark-recapture to obtain black rockfish abundance and density estimates and to assess the use of these and other methods as indices of relative abundance. In addition, protocols are being developed for diver observations of habitat type to aid in elucidating black rockfish habitat associations. A second project initiated in 2001 involves the use of a remotely operated vehicle (ROV) for the purpose of habitat and stock

assessment of a variety of marine species, including rockfish. This three-year project will focus on equipment purchase and the development of proficiency with the ROV (Contact Ted Otis).

The **Westward Region** continued its port sampling of the commercial rockfish and Pacific cod harvests in 2004. Rockfish sampling consisted mainly of black rockfish with opportunistic sampling of light duskies, dark duskies, and other miscellaneous *Sebastes* species. Skippers were interviewed for information on effort, location, and bycatch. Length, weight, gonadal maturity, and otolith samples were collected (contact Kally Spalinger or Carrie Worton). Staff from the Kodiak office has completed aging otoliths through the 2004 season

The Westward Region also continued several studies on Western Gulf of Alaska black rockfish. More monthly collections were made of female fish in an effort to determine reproductive seasonality and size of maturity. Hydroacoustic equipment was deployed in an effort at stock assessment. Repeated surveys of a small concentration of black rockfish were conducted through the tide cycle in an effort to determine how the tide currents affected the vertical movement of the fish. In addition, a small closed area in the Eastern Aleutians was surveyed. The results of that assessment were then compared with the results of a similar, nearby open area and an area in the Chignik area to determine if the reopening of the closed area was warranted. Development of protocols for the hydroacoustic surveying of black rockfish will continue in 2005 (Contact Dan Urban).

The **Division of Sport Fish—Southeast Region** continued to collect catch and harvest data from rockfish as part of a marine harvest onsite survey program with rockfish harvests tabulated back to 1978 in some selected ports. Data collected in the program include statistics on effort, catch, and harvest of the primary rockfish species commonly taken by Southeast Alaska anglers. Ports sampled in 2004 included Juneau, Sitka, Craig/Klawock, Wrangell, Petersburg, Gustavus, Elfin Cove, Ketchikan, and Yakutat. Primary species harvested in Southeast Alaska included yelloweye, black, and quillback rockfish (Contact Mike Jaenicke).

The **Division of Sport Fish—Southcentral Region** continued collection of harvest and fishery information on rockfish as part of the harvest assessment program. Rockfish objectives included estimation of 1) species composition, 2) age, sex, and length composition, and 3) the geographic distribution of harvest by the fleets by port. Approximately 3,250 rockfish were sampled at Seward, Valdez, Whittier, Kodiak, and Homer in 2004 (Contact Scott Meyer).

## Stock Assessment

The **Southeast Region** uses line-transect methods, conducted from the submersible "Delta", to collect density estimates of yelloweye rockfish. Biomass is the product of density, average weight, and area of rock habitat.

No new density estimates were collected for yelloweye rockfish during the 2004 field season. During 2003 density estimates for yelloweye rockfish were collected in CSEO and EYKT. The NSEO management area was last surveyed in 2001 and SSEO was last surveyed in 1999. We anticipate submersible surveys in the SSEO in 2005. Density estimates by area range from 1,420 to 3,557 adult yelloweye per $km^2$ of rocky habitat.

In the **Southeast Region,** no black rockfish surveys were conducted in 2004.

Beginning in 2000, **Central Region** groundfish staff initiated a three-year project designed to develop and implement a sampling approach for estimating black rockfish abundance in specific nearshore habitats of Southcentral Alaska along the Northern Gulf of Alaska. Harvest guidelines are currently based on long-term harvest patterns of all rockfish species in aggregate and have not been established to reflect changes either in the abundance of individual species or in fishing patterns. Black rockfish comprises the largest component of rockfish harvests along the northern Gulf of Alaska. This project used tagging and SCUBA to explore habitat-based assessment of black rockfish. In 2004, an additional project with funding for two seasons began, this project compares scuba and acoustic-based rockfish indices to catch indices from a commercial jig vessel. Rockfish are also tagged during these cruises (Contact Ted Otis).

## Management

Management of DSR is based upon a combination of guideline harvest ranges, seasons, gear restrictions, and trip limits. The state has management authority for demersal shelf rockfish in both state and federal waters of **Southeast Alaska**. Directed harvest of demersal shelf rockfish is restricted to hook-and-line gear. Directed fishing quotas are set for the four outside water management areas individually and are based on the poundage remaining after assigning a 2 percent harvest rate to the adult yelloweye biomass estimate and estimating bycatch (reported and nonreported) mortality. Directed fishery quotas for the two internal water management areas are set at 25 mt annually. Regulations adopted in 1994 include trip limits (within any 5 day period) of 6,000 pounds per vessel (12,000 pounds in EYKT), and added a requirement that logbook pages must be submitted with fish tickets for each fishing trip. The 2004 TAC for DSR was 450 mt in Southeast Outside. The directed DSR fishery quota is now allocated with 2/3 of the quota apportioned to the January 1- March 15 season and 1/3 of the quota apportioned to the November 16- December 31 season. A significant portion of the total harvest is taken as bycatch mortality during the halibut fishery and 288 mt of the TAC was reserved for bycatch in other fisheries. In 2004 the directed DSR fishery was reopened in the EYKT area for the first time in two years (Contact Tory O'Connell).

Management of black rockfish is based upon a combination of guideline harvest limits and gear restrictions. The state has management authority for black rockfish in both state and federal waters of Southeast Alaska. Directed fishery guideline harvest limits are set by management area, and range from 11.3 mt in IBS to 57 mt in SSEOC, totaling 136 mt. A series of open and closed areas was also created so managers could better understand the effect a directed fishery has on black rockfish stocks. Halibut and groundfish fishermen are required to retain and report all black rockfish caught.

Shortspine thornyhead, shortraker rockfish, rougheye rockfish and redbanded rockfish may be taken as bycatch only (no directed fishing).

Rockfish in **Central Region's** Cook Inlet and PWS Areas are managed under their respective Rockfish Management Plans. Plan elements include a fishery GHL of 68 mt for each area and 5-day trip limits of 0.5 mt in the Cook Inlet District, 1.8 mt in the North Gulf District, and 1.4 mt in

PWS. Rockfish regulations underwent significant change beginning in 1996 when the Alaska Board of Fisheries formalized the 68 mt GHL into a 68 mt harvest cap for all rockfish species in Cook Inlet and PWS and a 5% rockfish bycatch limit for jig gear during the state waters Pacific cod season. In 1998, the board adopted a directed rockfish season opening date of July 1 for the Cook Inlet Area and restricted legal gear to jigs, primarily because this fishery typically targets pelagic rockfish species. At the spring 2000 meeting, the board closed directed rockfish fishing in the PWS area and established a bycatch-only fishery with mandatory full retention of all incidentally harvested rockfish. In November 2004, the board also adopted a full retention requirement for rockfish in the Cook Inlet Area and restricted the directed harvest to pelagic shelf rockfish. Rockfish bycatch levels were also set at 20 percent during sablefish and 10 percent during other directed fisheries. Proceeds from rockfish landed in excess of allowable bycatch levels are surrendered to the State of Alaska. (Contact Charlie Trowbridge)

The **Westward Region** has attempted to conservatively manage black rockfish since 1997, when management control was relinquished to the State of Alaska. Area guideline harvest levels were set at 75 percent 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 GHL's have been reduced in some areas that have received large amounts of effort.

In the Kodiak Area, vessels may not possess or land more than 5,000 pounds of black rockfish in a 5-day period. Additionally, vessel operators are required to register for a single groundfish fishery at a time. A registration requirement also exists for the Chingik Area; that area was also designated as super-exclusive for the black rockfish fishery beginning in 2003.

In 2004, 105 mt of black rockfish were harvested from six sections in the Kodiak Area. Effort and harvest increased in 2004 compared to 2003; however, harvest remained lower than the previous five years. Guideline harvest levels were attained in four sections. The 2004 black rockfish harvest in the Chignik Area totaled 45 mt and totaled 4 mt in the South Alaska Peninsula Area. Few processors within a reasonable distance from these fishing areas were willing to purchase black rockfish in 2003 and 2004. The staff of the Westward region is currently seeking an economically feasible and statistically valid means to conduct stock assessments on the rockfish resources of the region. A voluntary logbook program was initiated in 2000 in the hope of obtaining CPUE estimates as well as more detailed harvest locations; the logbook program was made mandatory in 2005. (Contact: Nick Sagalkin).

Statewide, the majority of sport-caught rockfish are taken incidental to recreational fisheries for halibut or while trolling for salmon. In **Southeast Alaska,** sport bag limits consist of five pelagic rockfish and five non-pelagic rockfish per day of which only two may be yelloweye rockfish. In addition, bag limits in areas near Ketchikan and Sitka are limited to three non-pelagic rockfish, only one of which may be a yelloweye rockfish (Contact Mike Jaenicke).

In most of the fisheries in **Southcentral Alaska**, bag limits in most areas have been designed to discourage targeting of rockfish yet allow for retention of incidental harvest. Bag limits in Prince William Sound, the North Gulf, and Cook Inlet are five rockfish daily, with no more than one or two being non-pelagic (DSR and slope) rockfish. The Alaska Board of Fisheries has allowed a 10-rockfish bag limit in the Kodiak and Alaska Peninsula areas because of lower levels of effort and predominance of pelagic species in the catch.

Given the lack of quantitative stock assessment information for much of Alaska, sport fish managers have established conservative harvest strategies for recreational rockfish fisheries. Recreational seasons and bag and possession limits for rockfish in Alaska are among the most restrictive on the West Coast.

## Fisheries

Reported harvest of rockfishes, from commercial fisheries in **Southeast,** totaled 809 mt in 2004, 198 mt of which was the directed DSR fishery and 17 mt the directed black rockfish fishery. The majority (23%) of the remaining rockfish taken in the Southeast district were DSR bycatch made in conjunction with the IFQ halibut fishery. All rockfish harvested in state-managed fisheries in Southeast is taken by hook-and-line gear either in directed fisheries or incidental to fisheries for other species.

The 2004 **Cook Inlet Area** directed rockfish fishery opened July 1 and closed December 31 with a total harvest of 54 mt, primarily pelagic rockfish. This was the fifth year that the jig-only gear restriction was in place. Total rockfish harvest for the PWS Area rockfish bycatch-only fishery was 24 mt. This included a 1.5 mt incidental catch of slope rockfish from the walleye pollock trawl fishery and a 22.5 mt incidental harvest of demersal and slope rockfish from the sablefish and halibut longline fisheries.

Estimates of sport harvest are obtained by three methods – the Statewide Harvest Survey (SWHS), charter vessel logbooks, and, in major ports, creel survey dockside sampling. Harvest reporting areas for these programs are different than commercial reporting areas making direct comparisons difficult. Additionally, species-specific data is available only from creel surveys.

The SWHS reports harvest for the general category of "rockfish", and the charter vessel logbook records rockfish harvest in two categories: "non-pelagic" and "pelagic". DSR are part of the "non-pelagic" category. Recreational rockfish harvest is typically estimated in numbers of fish. Estimates of the 2004 harvest are not yet available from the statewide harvest survey, but the average estimated annual harvest for the most recent five-year period (1999-2003) was 60,700 rockfish (all species) in Southeast Alaska and 60,800 fish in Southcentral Alaska.

Creel survey data for Sitka indicates that 12,350 individual yelloweye (approximately 35 mt) were retained by anglers in an area roughly equivalent to the CSEO in 2004. This is a 36% increase in the harvest of yelloweye since 2001. Creel and SWHS data for SWHS Area B (Prince of Wales Island) indicates that 4,000 yelloweye (approximately 13 mt) were retained in 2003. This area includes the SSEO and a portion of the SSEI. Given the restrictive bag limit for yelloweye (1 or 2 depending on area), it is likely that these numbers underestimate total sportfish induced mortality. These numbers do not include harvest of other species of DSR.

## *3. Sablefish*

**Research**

In 2004, sablefish longline surveys were conducted for the two Southeast Alaska state-managed sablefish fisheries, Southern Southeast Inside (SSEI) and Northern Southeast Inside (NSEI). These surveys are designed to measure trends in relative abundance and biological characteristics of the sablefish population. Biological data collected in these surveys include length, weight, sex and maturity stage. Otoliths are collected and sent to the ADF&G age determination unit in Juneau for age reading. The cost of these surveys is offset by the sale of the fish landed. The fish are dressed and iced according to industry standards and the state receives all the revenues from the sale of the fish.

In the SSEI survey, the overall CPUE (kg/hook) was 0.48 in 2004, 0.49 in 2003, 0.41 in 2002 and 0.38 in 2001. Spiny dogfish (*Squalus acanthias*) dominated the bycatch in all areas surveyed. In the NSEI survey, the 2004 overall CPUE (kg/hook) was 0.96, down slightly from 2003 (1.09) and 2002 (1.05). Thornyhead rockfish dominated the bycatch in all areas except the northern-most statistical area.

The on-going mandatory logbook program in the sablefish fisheries provides catch and effort data by date, location, and set. In the SSEI sablefish fishery, overall CPUE (adjusted for hook spacing) in round pounds/hook decreased 12 percent in 2004 (0.45 rd. lbs./hook) compared to 0.45 rd. lbs./hook in 2003 and a 4 percent decrease from 2002 (0.413 rd. lbs./hook). In the NSEI fishery, overall adjusted CPUE in round lbs./hook for vessels using conventional gear, was 0.71 in 2004, 5 percent lower than in 2003 (0.75).

In February of 2004, ADF&G completed a tag shedding study, using PIT tags, at the Seward Marine Center (University of Alaska Fairbanks). The department is investigating the use of PIT tags on sablefish to determine population size and exploitation rate.

During the fall and winter of 2003-2004, the Alaska Department of Fish and Game (ADF&G) captured, tagged and held 152 adult sablefish. Sablefish were tagged using passive integrated transponder (PIT) tags in order to: 1) test for differences in tag shedding rates between two candidate tagging sites 2) estimate a tag-shedding rate for each site and 3) estimate tagging-related mortality. Seventy-six of the 152 fish were implanted with a tag in the head (muscle mass just behind and below the left eye). The other half was implanted with a tag in the peritoneal cavity. The sablefish were then placed in 1 of 4 saltwater tanks (1/4 in each tank), with half of each treatment type per tank. Sablefish tagged in the cheek musculature showed a significantly higher tag retention rate than fish tagged in the peritoneal cavity, 96% and 75% respectively.

In 2004, ADF&G continued a mark/recapture study in NSEI, PIT tagging and releasing 6,357 sablefish using pot gear to capture the fish 1.5 months prior to the fishery (August 15, 2004). Fish were caught with pot gear to minimize the apparent "hook shyness" pattern of tag returns observed in 1997, 1998 and 1999 when longline gear was use to catch fish for tagging.

Within **Central Region,** ADF&G initiated a limited mark-recapture study in 1999 within PWS using the biennial bottom trawl survey as the capture vehicle. Tagging was continued in the 2003

PWS bottom trawl survey. Fewer than ten tagged fish have been recovered to date (Contact Ted Otis).

Skipper interviews and port sampling occurred in Whittier, Cordova and Seward for the PWS Area fishery and in Seward and Homer for the Cook Inlet Area fishery. Data obtained included date and location of harvest, length, weight, sex, and gonad condition. Otoliths were removed and sent to the Age Determination Unit (Contact Willy Dunne).

## Stock Assessment

In **Southeast**, the department is using mark-recapture methods with tags and fin clips to estimate abundance and exploitation rates for sablefish in the NSEI Subdistrict. Sablefish are captured with pot gear in mid-summer, marked with a tag and a fin clip then released. Tags are recovered from the fishery and fish are counted at the processing plants and observed for fin-clips. Based on Chapman's modification of the Petersen estimator, there were an estimated 2,675,118 sablefish in NSEI at the time of the 2004 fishery (Chapman 1948). The 90 percent confidence interval for the 2004 sablefish abundance estimate is 2,501,350 – 2,872,325 sablefish. Decrementing this estimate to account for natural mortality, and forecasting the exploitable numbers, the lower 90 percent confidence interval forecast for 2005 is 2,276,411 sablefish and 17,403,486 pounds of sablefish.

In addition to the mark-recapture work, annual longline surveys are conducted in both NSEI and SSEI to provide biological data as well as relative abundance information (Contact Sherri Dressel).

A longline survey, using ADF&G vessels, has been conducted in **Prince William Sound** annually since 1996. Mean CPUE has ranged from 0.07 fish/hook in 1997 to 0.13 fish/hook in 2000. Longline survey effort was recently extended into the North Gulf District in 1999, 2000 and 2002. The 2001 PWS survey focused on the northwest and southwest PWS, and was limited to the Northwest area in 2002 and 2003. Relative to recent surveys, sablefish catch rates (not weighted for available depth strata) increased from 2002 to 2003, but remained below rates in 2001. Survey costs are partially offset by the sale of the fish (Contact Ted Otis).

## Management

There are three separate internal water areas in Alaska which have state-managed sablefish fisheries. The Northern Southeast Inside Subdistrict (NSEI), the Southern Southeast Inside Subdistrict (SSEI), and the Prince William Sound District each have separate seasons and guideline harvest ranges.

In the **Southeast Region**, both the SSEI and NSEI sablefish fisheries have been managed under a license limitation program since 1984. In 1994, the BOF adopted regulations implementing an equal share quota system where the annual guideline harvest level was divided equally between permit holders and the season was extended to allow for a more orderly fishery. In 1997, the BOF adopted this equal share system as a permanent management measure for both the NSEI and SSEI sablefish fisheries.

Due to declines in fishery CPUE and preliminary results from our mark-recapture work, ADF&G reduced the NSEI quota 35 percent in 1999 to 1,415 mt where it remained through 2000. The quota was decreased in 2001 to 990 mt and to 909 mt for 2002 and 2003. In 2004, the quota was increased to 1,018 mt. In the NSEI area, the total allowable catch (TAC) is now set using an $F_{40\%}$ applied to the lower 90% confidence limit of the estimate of biomass. The TAC is then decremented by estimated mortality in other fisheries before the directed fishery quota is set. The SSEI quota was 316 mt in 2000, and has remained the same thru 2004.

During the January 2003 Alaska Board of Fisheries (BOF) meeting, the BOF made several major changes in regulations affecting the NSEI and SSEI sablefish fisheries: The opening date for the NSEI fishery was changed from September 1 to August 15; Permit holders are allowed to release healthy sablefish and are required to document the number of fish released in their logbook (All injured or dead sablefish must be retained); The retention of sablefish for use as bait is prohibited in state waters; Permit holders are allowed to carry-over up to 5 percent of their annual equal quota share as an overage or underage or transfer up to 5 percent of their legal harvest to another permit holder.

Sablefish fisheries in outer coastal state waters (0-3 miles) have been managed in conjunction with the federal-managed fishery in the EEZ. There is no open-access sablefish fishery in the Southeast Outside District as there are limited areas that are deep enough to support sablefish populations inside state waters. In some areas of the Gulf, the state opens the fishery concurrent with the EEZ opening. These fisheries, which occur in the North Gulf District of Cook Inlet and the Aleutian Island District, are open access in state waters, as the state cannot legally implement IFQ management at this time. The quotas are based on historic catch averages and closed once these have been reached.

The GHL for the North Gulf District is set using an historic baseline harvest level adjusted annually by the same relative reduction to the TAC in the Central Gulf Area. The 2004 fishery GHL was 40 mt. The sablefish fishery in PWS has occurred under limited entry since 1996. Permit holders are restricted to gear and vessel size classes. Additionally a commissioner's permit, which stipulates logbook and catch reporting requirements, must be obtained prior to participation in the fishery. The fishery GHL is set at 110 mt, which is the midpoint of the harvest range set by a habitat-based estimate. Fishery management continued to develop through access limitation and then into a quota share system wherein permit holders are allocated shares of the harvest guideline. Shares are equal within each of four vessel size classes, but differ between size classes. Central Region staff annually conducts dockside interviews and sample landings in the ports of Cordova, Whittier, and Seward.

There is no bag, possession, or size limit for sablefish in the recreational fisheries in Alaska. Sablefish harvest and release information is not collected in the creel surveys and port sampling of the recreational fisheries in Southcentral or Southeast Alaska.

## Fisheries

In the **Southeast Region,** the 2004 NSEI sablefish fishery opened August 15 and closed November 15. The 108 permit holders landed a total of 1,011 mt of sablefish. The fishery is managed by equal quota share; each permit holder was allowed 9.4 mt. The 2004 SSEI sablefish

fishery opened June 1 and closed November 15. Twenty-eight permit holders landed a total of 294 mt of sablefish, each with an equal quota share of 11.3 mt (Contact Tory O'Connell).

In the **Central Region,** the 2004 open access sablefish fishery in the North Gulf District was open for 24 hours beginning noon July 15; 17 vessels harvested 38 mt. In the Prince William Sound area, a "shared quota" system was adopted by the Board of Fish and instituted during the 2003 season. Season dates for 2004 were March 15 - May 15 and August 1 – 21. The system allocates half of the GHL equally among all registered participants with the balance of the GHL allocated using the number of registered permit holders within each vessel size class based on historic harvest within each class resulting in the following percentages: Classes A and B (90 and 60 feet maximum length = 18.53%; Class C (50 feet maximum length) vessels = 70.33% and Class D (35 feet maximum length) vessels = 11.14%. All sablefish landed in excess of an individual's quota are sold and the proceeds go to the State of Alaska. Skipper interviews and biological sampling were conducted in-season which gathered effort and location information as well as age, length, weight, sex and gonad condition data (Contact Charlie Trowbridge).

Within the **Westward region**, only the Aleutian Islands have sufficient habitat to support mature sablefish populations of sufficient magnitude to permit commercial fishing. All other sections within the region are closed by regulation to avoid the potential for localized depletion from the small amounts of habitat within the jurisdiction of the state. Bycatch from the areas closed to directed fishing is limited to 1 percent. The 2004 Aleutian Island fishery opened on May 15, 2004. Additional requirements for the fishery include registration and logbook requirements. The GHL was set at 299 mt for the state managed fishery. The preliminary harvest from the 2004 Aleutian Islands sablefish fishery was 147 mt. The season remained open until the November 15 closure date (Contact Barbi Failor-Rounds).

## *4. Flatfish*

### Research

There was no research on flatfish during 2004.

### Stock Assessment

There are no stock assessments for flatfish.

### Management

Trawl fisheries for flatfish are allowed in three small areas in the internal waters of **Southeast Alaska** under a special permit issued by the department. The permits are generally issued for no more than a month at a time and specify the area fished and other requirements. Trawl gear is limited to beam trawls, and mandatory logbooks are required, observers can be required, and there is a 20,0000 weekly trip limit.

**Fisheries**

There has been almost no effort in the **Southeast** fishery for the past five years, with no harvest reported for the 2003-2004 season. The Southeast flatfish trawl areas are also the sites of a shrimp beam trawl fishery. Most of the Southeast harvest is starry flounder. NMFS manages the flatfish fishery and harvest in the state waters of **Westward Region**.

## *5. Pollock*

State-managed pollock is limited to the **Central Region.**

**Research**

Pollock continue to be a dominant species in the **Central Region** ecosystem. Due to uncertainty about the appropriate harvest level for the PWS pollock fishery, assessment in 2004 included commercial fishery catch sampling and bottom trawl surveys of the summer (post-spawning) population. In 1996, interactions between pollock, herring, and juvenile salmon were also examined as part of Sound Ecosystem Assessment (SEA) funded by the *EXXON Valdez* Oil Spill Restoration.

With Pollock, we are testing for spatial patterns of genetic variation in six population samples from three regions: North America – Gulf of Alaska; North America – Bering Sea; Asia – East Kamchatka. We tested for annual stability of the genetic signal in replicate samples from three of the North American populations. These studies, begun in 1998 and 1999, continued into 2000. A manuscript documenting the findings is under internal review. Allozyme and mtDNA markers provide concordant estimates of spatial and temporal genetic variation. These data show significant genetic variation between North American and Asian pollock as well as evidence that spawning aggregations in the Gulf of Alaska, such as Prince William Sound, are genetically distinct and may merit management as distinct stocks. These data also provide evidence of inter-annual genetic variation in two of three North American populations. Gene diversity values show this inter-annual variation is of similar magnitude to the spatial variation among North American populations, suggesting the rate and direction of gene flow among some spawning aggregations is highly variable.

Skipper interviews and port sampling of Central Region commercial pollock deliveries during 2004 occurred in Seward and Kodiak. Additional sampling occurred during the Cook Inlet and PWS trawl and sablefish longline surveys. Sample data collected included date and location of harvest, species, length, weight, sex, and gonad condition. Otoliths were collected from most sampled fish. Homer office staff determined ages of pollock otoliths (Contact Willy Dunne).

**Stock Assessment**

Hydroacoustic surveys, with sample collection by mid-water trawl, were conducted in PWS in the winters of 1995, 1997, 1998, 2000, 2001, and 2002 by the Prince William Sound Science Center in cooperation with ADF&G. Biomass estimates of prespawning pollock aggregations have been relatively stable, except for 1998, with a slight decline indicated in more recent years. The department also conducts a biennial bottom trawl survey during the summer in PWS, and develops

a pollock biomass estimate used to establish the harvest guideline for the winter commercial fishery. This approach is justified, despite the belief that a significant portion of the spawning population targeted by the winter fishery immigrated from federal waters, because the summer population is not assessed by the NMFS summer survey. Survey biomass estimates from the biennial bottom trawl survey have declined in recent years, and the fishery harvest level has been reduced accordingly (Contact Ted Otis).

**Management**

Prince William Sound pollock fishery regulations include a commissioner's permit and a registration deadline of January 13. The permit stipulates logbooks, catch reporting, and accommodation of a department observer upon request. Vessels are required to check in and check out of the area and fishery as well as contact the department daily to report catch, effort, and fishing location. In 2001, new regulations were adopted dividing the PWS Inside District into three sections (Port Bainbridge, Knight Island, and Hinchinbrook) and limiting harvest to a maximum of 40 percent of the GHL from any section (Contact Bob Berceli).

**Fisheries**

The 2004 fishery opened on January 20 with a GHL of 923 mt. Catch and effort remained low until late February when aggregations of pollock in the Hinchinbrook section increased resulting in achievement of the 40% harvest level for that section. The section closed by emergency order on March 5. Subsequently, fishing improved in the Knight Island and Bainbridge sections, which closed on March 20 and 24 respectively due to concerns over increased bycatch. Total pollock harvest for all sections combined was 875 mt. As in past years, fishery bycatch was dominated by squid (5 mt), sharks (1.4 mt), and rockfish (1.5 mt).

## *6. Sharks*

**Research**

In the **Central Region,** Spiny dogfish and Pacific sleeper sharks have been tagged annually since 1997 as part of the PWS longline survey for sablefish, and since 2000 during bottom trawl surveys in Cook Inlet and PWS. Through 2003, over 400 each of spiny dogfish and Pacific sleeper sharks have been tagged. To date, ten tagged sleeper sharks have been recovered from PWS; maximum time-at-large was 1,259 days and most sharks moved less than 20 km between tagging and recapture locations. No spiny dogfish have been recovered. In 2003, 340 spiny dogfish were sacrificed and the posterior dorsal spine removed for age determination. In addition, 10-15 sleeper sharks have been sacrificed annually during 2000 to 2003 for parasite and contaminant analysis (Contact Ted Otis).

In recent years, a small **recreational** fishery targeting salmon sharks has developed in the Gulf of Alaska and Prince William Sound. Little information is available to assess the status or structures of targeted stocks. The Division of Sport Fish initiated a modest cooperative tagging program

with a few charterboat operators in 1998 and continues to collect biological data on all sharks harvested in the sport fishery through the port-sampling program.

## Stock Assessment

Among **Central Region** assessment projects, sharks are caught in the trawl surveys and the PWS longline survey. Catch per unit effort for Pacific sleeper shark ranged from 1.1 fish/set in 1996 to 4.3 fish/set in 1999. Spiny dogfish CPUE has ranged from 0.9 to 9.2 fish/set except for a dramatic increase to 51.3 fish per set in 1998. The high catch rates of spiny dogfish in 1998 appear to have been an anomaly (Contact Ted Otis).

The **Division of Sport Fish—Southcentral Region** collected harvest and fishery information on sharks through the groundfish harvest assessment program although no specific research objectives were identified. Shark harvest is still at a relatively low level, but it is hoped that size and age composition of the harvest can be estimated using multiple years of data. In 2004, 33 salmon sharks and 17 spiny dogfish were sampled for length, sex, and age structures from the sport harvest throughout the region (Contact Scott Meyer).

The statewide charter logbook program also requires reporting of the number of salmon sharks kept and released in the charter fishery. Charter anglers account for the vast majority of the recreational salmon shark harvest. In 2003, charter operators reported harvesting 30 salmon sharks in Southeast Alaska and 143 salmon sharks in Southcentral Alaska.

## Management

The Alaska Board of Fisheries prohibited all directed commercial fisheries for sharks in 1998. In 2000 the BOF increased the bycatch allowance in **Southeast Region** for dogfish taken while longlining for other species to 35 percent round weight of the target species and also allowed full retention of dogfish bycatch in the salmon setnet fishery in Yakutat. This action was an effort to minimize waste of dogfish in these two fisheries and to encourage sale of bycatch. In **Central Region**, bycatch is set by regulation at 20 percent of the round weight of the directed species on board.

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 overharvest, and sets a statewide daily bag limit of one shark and a season limit of two sharks of any species. Recreational demand for spiny dogfish remains low and they are widely considered a nuisance species. There is, however, a small directed charter boat fishery for salmon sharks in Southcentral Alaska, primarily at Seward and in Prince William Sound. Pacific sleeper sharks are occasionally caught but rarely retained.

In 2000, the BOF prohibited the practice of "finning", requiring that all shark retained must be sold or utilized and have fins, head, and tail attached at the time of landing. "Utilize" means use

of the flesh of the shark for human consumption, for reduction to meal for production of food for animals or fish, for bait, or for scientific, display, or educational purposes.

**Fisheries**

Regulations adopted by Alaska Board of Fisheries in 1998 restricted all commercial shark fisheries to bycatch-only.

Estimates of **recreational** shark harvest in 2004 are not yet available, but charter logbooks and port sampling interviews in Southcentral Alaska provide some data. Preliminary logbook data indicate a charter harvest of about 20 salmon sharks in Southeast Region and 111 salmon sharks in Southcentral. Anglers interviewed in Southcentral Region that targeted salmon sharks caught 31 salmon sharks in 70 angler-days of effort and kept 17 of them. An additional 10 salmon sharks were caught (2 kept) by interviewed anglers in nearly 19,800 angler-days of effort targeting other species. Interviewed anglers caught 5,014 spiny dogfish in nearly 20,000 angler-days of effort, but only 58 dogfish were retained.

## *7. Lingcod*

**Research**

Over the past nine years, 8,500 lingcod have been tagged and 344 fish recovered. Opportunistic tagging of 160 young lingcod in Sitka Sound occurred during 2004. Length, sex and tagging location were recorded for all tagged fish (Contact Cleo Brylinsky).

In the **Central Region**, skipper interviews and port sampling were conducted in Cordova, Whittier, Seward and Homer. Data obtained included date and location of harvest, length, weight, sex and age. Gonad condition was generally not determined as nearly all fish delivered were already gutted (Contact Willy Dunne).

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 2004 included Juneau, Sitka, Craig/Klawock, Wrangell, Petersburg, Gustavus, Elfin Cove, Yakutat, and Ketchikan. Length and sex data were collected from 1,245 lingcod in 2004, 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 785 lingcod were sampled from sport harvest at Seward, Valdez, Whittier, Kodiak, and Homer in 2004. These ports accounted for the majority of recreational lingcod harvest in Southcentral Alaska (Contact Scott Meyer).

## Stock Assessment

The **Southeast Region** is not currently able to reliably estimate lingcod biomass or abundance. Lacking abundance estimates, and given the complex life history and behavior of lingcod, impacts to lingcod populations from fishing are difficult to assess. Analysis of catch per unit effort data (CPUE), in terms of fish per hook-hour for 1988–1998, showed that CPUE had declined between 21 to 62 percent in areas where a directed fishery and increased recreational catch had developed. Consequently the quota for lingcod was reduced in all areas in 1999. Commercial logbook data for the period 1999-2004 shows a recent increasing trend in CSEO and NSEO beginning in 2000. CPUE is level in the EYKT and NSEO areas.

The Sport Fish Division, Southcentral Region, has begun work on a lingcod stock assessment. Initial work focused on compiling data from sport and commercial fisheries, mining existing survey data from other agencies, estimating natural mortality from age data, and estimating length-weight and growth parameters. Some of the next steps include standardization and comparison of CPUE indices and compilation of spatial data.

## Management

Management of lingcod in **Southeast Alaska** is based upon a combination of guideline harvest ranges, season and gear restrictions. The state has management authority for lingcod in both state and federal waters. Regulations include a winter closure for all users except longliners between December 1 and May 15 to protect nest-guarding males. Guideline harvest limits were greatly reduced in 2000 in all areas and allocations made between directed commercial fishery, sport fishery, longline fisheries, and salmon troll fisheries. This was the first time sport catch was included in a quota allocation. The 27" minimum commercial size limit remains in effect and fishermen must keep their lingcod with the head on, and proof of gender to facilitate biological sampling of the commercial catch. Vessel registration and trip limits are allowed when needed to stay within allocations. In 2003, the Board of Fish established a super-exclusive directed fishery for lingcod in the IBS Subdistrict.

Regulations for the **Central Region** lingcod fishery include open season dates of July 1 to December 31 and a minimum size limit of 35 inches (89 cm) overall or 28 inches (71 cm) from the front of the dorsal fin to the tip of the tail. More recently, the Board of Fisheries adopted a jig only gear requirement for the directed lingcod fishery in the Cook Inlet Area. eginning in 1997, the department set commercial lingcod fishery GHLs for the Central Region at 50 percent of the average harvest for the period 1987 to 1996. However, GHLs were increased to 75 percent of this average in 2001 for PWS and in 2003 in Cook Inlet.

In **Southeast Alaska**, the sport fishery for lingcod is open from May 16 through November 30. The regionwide bag and possession limits are two per day, four in possession, with no size limit. However, the bag and possession limits in two areas near Sitka and Ketchikan are one per day, two in possession, and the Pinnacles area near Sitka is closed to sport fishing year-round for all groundfish.

In 2000, sport harvests of lingcod in Southeast Alaska were incorporated into a region wide lingcod management plan, which reduced GHLs for all fisheries (combined) in seven

management areas, and allocated a portion of the GHL for each area to the sport fishery. Since 2000, harvest limits reductions, size limits, and mid-season closures have been implemented by emergency order in various management areas to ensure sport harvests do not exceed allocations.

In 2004, lingcod bag limits were reduced from two to one fish per day region wide, slot limits were imposed for guided and nonresident anglers in all management areas except Southern Southeast Inside near Ketchikan, and the season was closed in northern Southeast management areas (NSI, CSO, and NSO) from June 16 through August 15 (Contact Tom Brookover).

Conservative harvest strategies have been established for recreational lingcod fisheries in **Southcentral Alaska** in light of the lack of quantitative stock assessment information. Resurrection Bay is closed to lingcod fishing year-round to rebuild the population, although no formal rebuilding plan is in place. The season is closed region-wide from January 1 through June 30 to protect spawning and nest guarding lingcod. Daily bag limits are 2 fish in all areas except the North Gulf, where the daily bag limit is one fish. All areas except Kodiak have a minimum size limit of 35 inches to protect spawning females (Contact Scott Meyer).

## Fisheries

Lingcod are the target of a "dinglebar" troll fishery in **Southeast Alaska**. Dinglebar troll gear is power troll gear modified to fish for groundfish. Additionally lingcod are landed as significant bycatch in the DSR longline fishery (35 percent limit), as bycatch in the halibut fishery (5 percent limit), and as bycatch in the salmon troll fishery. The directed fishery landed 57 mt of lingcod in 2004 and an additional 104 mt was landed as bycatch in other fisheries. The halibut longline fishery accounted for roughly 36 percent of lingcod bycatch in the Southeast Region and the salmon troll fishery accounted for 10 percent.

**Central Region** lingcod harvests have primarily occurred in the North Gulf District of Cook Inlet and the Outside District of PWS. The Cook Inlet GHL was 24 mt and the PWS GHL was 11 mt in 2004. Lingcod harvests in 2004 totaled 17 mt in Cook Inlet and 14 mt in PWS. The majority Cook Inlet Area lingcod harvest was by directed jig fishing, while the PWS harvest was mainly from longline bycatch to other (primarily halibut) fisheries.

Limited directed effort occurred for lingcod in the **Westward Region** during 2004. Incidental harvest in other fisheries totaled 23 mt for the year. The majority of the harvest occurred in the Kodiak Area with a minor amount occurring in the Chignik Area.

Recreational lingcod harvest is estimated in numbers of fish. Estimates of the 2004 harvest are not yet available from the statewide mail survey, but the average estimated annual harvest for the most recent five-year period (1999-2003) was 16,307 fish in Southeast Alaska and 10,476 fish in Southcentral Alaska.

## 8. Other Species

In 1997, the BOF based a new policy that would strictly limit the development of fisheries for other groundfish species in Southeast. Fishermen are required to apply for a "permit for miscellaneous groundfish" for all fisheries that do not already have specific regulations and permits do not have to be issued if there are management and conservation concerns. At this time, that includes all species except sablefish, rockfish, lingcod, flatfish, and Pacific cod. At this time, most other groundfish species taken in state waters are taken as bycatch in fisheries for other groundfish and halibut. The State also has a regulation that requires that the bycatch rate of groundfish be set annually for each fishery by emergency order unless otherwise specified in regulation.

A commissioner's permit is required before a directed fishery may be prosecuted for skates and rays. 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 2004, interest continued for a skate fishery in the Cook Inlet and Kodiak Areas. In the Cook Inlet Area, eight vessels obtained commissioner's permits and targeted skates in state waters. Total harvest was 8.5 metric tons. In the Kodiak Area, twenty-one vessels obtained commissioner's permits and prosecuted target fisheries for skates in state-waters; several additional vessels participated exclusively in federal waters. The majority of these vessels targeted the big skate *Raja binoculata* and Longnose skate *Raja rhina.* The 2004 harvest from state waters was 86 mt. In addition to the permit requirements listed above, vessel operators were required to notify ADF&G of deliveries. This was done to ensure that ample opportunity occurred to collect biological data from the landed catch. Dockside samplers performed species identification and obtained sexed lengths from the catch. In addition, vertebrae were collected for age analysis. A commissioner's permit is also required before any trawl fishery besides the existing beam trawl fishery for flatfish may be prosecuted in the Southeast District.

As part of a cooperative research study, tissue samples were collected from approximately 40 longnose skates in Prince William Sound for contaminant analysis.

Work on a "Developing Fisheries" policy, intended to reduce the potential for a fishery to escalate beyond management control, has halted at present.

The recreational halibut fishery is the focus of a statewide research and management effort. Data on the recreational fishery and harvest are collected through port sampling effort in Southcentral Alaska and creel surveys and port sampling in Southeast Alaska. These data are provided annually to the International Pacific Halibut Commission for use in an annual stock assessment, and to the North Pacific Fishery Management Council. The Council has used the information in the design and analysis of regulations governing the sport charter fishery.

As stated earlier in this report, the BOF took action in 2000 prohibiting the development of a live fish fishery for groundfish in the Southeast District.

## C. Other Related Studies

Staff in the **Central Region** has implemented a multi-year study to explore the utility of a remotely operated vehicle (ROV) as a stock assessment tool for a variety of groundfish resources. Initial efforts are focusing on identification of suitable rockfish and lingcod habitat along the northern Gulf of Alaska, and comparing ROV study results with habitat available in a GIS format form NOAA (Contact Mike Byerly).

The Department of Fish and Game manages state groundfish fisheries under regulations set triennially by the Board of Fisheries. The department announces the open and closed fishing periods consistent with the established regulations, and has authority to close fisheries at any time for justifiable conservation reasons. The department also cooperates with NMFS in regulating fisheries in the offshore waters.

By regulation, fish tickets are required for all shore-based landings in Alaskan ports and for all landings from state-managed fisheries. The catch data from the fish tickets is used as the primary means of tracking the in-season harvest levels. Groundfish fish tickets are collected from as many as thirty or more processors within the state. The fish tickets are edited for accuracy and the data is entered on microcomputers in Petersburg, Douglas, Sitka Homer, Kodiak, and Dutch Harbor. Because of the intensity of many of the groundfish fisheries, a "soft data" accounting system using processor contacts is also utilized, when necessary, to track landings during a fishery.

In 1997 at the Southeast Groundfish meeting, the Board of Fisheries adopted a regulation that requires all groundfish fishermen to complete mandatory logbook pages while fishing. These logbook pages must be submitted as part of their landing record and attached to their fish ticket at delivery. The Board also requires that fishermen obtain a conditional use permit when fishing for any species for which specific regulatory language is not in effect. This will allow ADF&G to deny permits for some species and allow exploratory or controlled fishing for others.

### *1. Dixon Entrance Area*

Total removals from the Dixon Entrance area (Alaska statistical areas 325431, 315431, 325401, and 315401) have declined in recent years, due mostly to reductions in sablefish quotas. The table below lists the catch by species group from 1988 through 2004 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 |

## *2. Marine Reserves*

In September of 1997, the ADF&G submitted proposals to both the BOF and the NPFMC requesting that they implement a small no-take marine reserve in **Southeast**. The purpose of these proposals was to permanently close a 3.2 sq. mile area off Cape Edgecumbe to all bottomfish and halibut fishing (including commercial, sport, charter, bycatch and subsistence) and anchoring to prevent over-fishing and to create a groundfish refuge. Two large volcanic pinnacles that have a diversity and density of fishes not seen in surrounding areas dominate the Edgecumbe Pinnacles Marine Reserve. The pinnacles rise abruptly from the seafloor and sit at the mouth of Sitka Sound where ocean currents and tidal rips create massive water flows over this habitat. These two pinnacles provide a very unique habitat of rock boulders, encrusted with *Metridium*, bryazoans and other fragile invertebrate communities, which attracts and shelters an extremely high density of juvenile rockfishes. The area is used seasonally by lingcod for spawning, nest-guarding, and post-nesting feeding. Yelloweye rockfish and pelagic rockfish species as well as large numbers of prowfish and Puget Sound rockfish also densely inhabit the pinnacles. This closure protects the fragile nature of this rare habitat, and prevents the harvest or bycatch of these species during critical portions of their life history. In February 1998, the BOF approved of the reserve and the NPFMC approved of the reserve at their June 1998 meeting. The NPFMC recommended to the BOF that they consider closure of the area to salmon trolling which would make the area a complete-no take zone. In February 2000, the BOF rejected closing the area to salmon trolling. The area is an important "turn-around" area for commercial trollers and the BOF did not believe there was sufficient conservation benefit to warrant closing the area to salmon fishing.

In 2004 a short movie of the Edgecumbe Pinnacles Marine Reserve was created because of increased public interest in our work, and to give others an opportunity to learn about, and view

the pinnacles from below the waters surface. This movie is available in either VHS or DVD format for schools or non-profit organizations through the Sitka office of the Alaska Department of Fish and Game.

## *3. User Pay/ Test Fish Programs*

The State of Alaska Department of Fish and Game receives receipt authority from the state legislature that allows us to conduct stock assessment surveys by recovering costs through sale of fish taken during the surveys. Receipt authority varies by region. In **Southeast Alaska,** we have several projects that are funded through test fish funds (total allocation approximately 300k), notably the sablefish longline assessments, the king crab survey, and the herring fishery and dive surveys. Also in 1995, the Southeast Region was given a separate receipt authority for $250,000 to conduct sea urchin research using test fish funds. In the case of sea urchins, the industry placed bids on the right to harvest and market sea urchins. The low bidder was responsible for paying for the department's expenses in research and management of this fishery and was limited to a 12 percent profit after state expenses were paid.

## *4. GIS*

The ADF&G Division of Commercial Fisheries Headquarters Office is using ArcGIS 9.0 for general map production, project planning and spatial analysis. Base maps are maintained in ArcGIS format. Statistical area charts are currently being updated using ArcGIS 9.0 and the NAD83 datum. All data and maps requests are made in NAD83 (the State of Alaska standard) or will be converted into NAD83, if possible. Final output and all metadata will be in NAD83. Some users in other divisional offices use ArcGIS 8 and ArcView 3.x for their GIS work. The Headquarters Office has reduced its GIS staff to one cartographer.

Hardcopy and digital groundfish and shellfish statistical area charts are available. Digital are available in Abode PDF and can be viewed or downloaded at http://www.cf.adfg.state.ak.us/geninfo/statmaps/charts.htm or in ArcGIS format at http://maps.cf.adfg.state.ak.us. The ADF&G Commercial Fisheries GIS Maps and Data Server will be home for all publicly available GIS maps developed by the division in the future. The server will also feature online maps using ArcIMS (Internet Map Server) software (contact Evelyn Russell).

## 5. Logbooks

In 1997, logbooks became mandatory for all state-managed commercial fisheries in Southeast Alaska. Logbooks for rockfish and lingcod had been mandatory for a number of years. All usable longline and jig logbook data through 2004 has been entered.

Number of commercial fishery logbooks collected by fishery, target species, and year.

| SE | Longline | | | | Jig/dinglebar | | | |
|---|---|---|---|---|---|---|---|---|
| Year | DSR | Pacific cod | Slope Rock | Sablefish | Lingcod | Black rockfish | DSR | PSR |
| 1986 | 21 | 1 | | | | | | |
| 1987 | 25 | | | | | | | |
| 1988 | 20 | | | | | | | |
| 1989 | 19 | | | | | | | |
| 1990 | 50 | 1 | 2 | | | | | |
| 1991 | 232 | 8 | 1 | | | | | |
| 1992 | 259 | 7 | | | | | | |
| 1993 | 190 | 8 | | | | | | |
| 1994 | 197 | 9 | 3 | | 108 | | | |
| 1995 | 140 | 13 | | | 215 | | | |
| 1996 | 261 | 8 | | | 252 | 31 | 6 | |
| 1997 | 204 | 98 | 4 | 466 | 177 | 64 | 8 | 1 |
| 1998 | 177 | 135 | 15 | 552 | 153 | 70 | 3 | 4 |
| 1999 | 165 | 223 | 9 | 405 | 89 | 21 | 1 | 1 |
| 2000 | 153 | 97 | 4 | 421 | 153 | 30 | | |
| 2001 | 128 | 48 | 2 | 332 | 44 | 2 | 2 | |
| 2002 | 143 | 27 | 5 | 276 | 53 | 31 | 4 | 0 |
| 2003 | 115 | 53 | closed | 298 | 54 | 37 | 2 | closed |
| 2004 | 96 | 55 | closed | 229 | 40 | 23 | 3 | closed |

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. The 2003 logbook was similar to the 2002 logbook format. Data collected for each vessel trip included port of landing, location(s) fished, angler residency, effort for salmon and bottomfish, and harvest and/or release (in numbers) of chinook, coho, sockeye, pink, and chum salmon, pelagic rockfish, other rockfish, lingcod, and salmon sharks. Information that has been dropped from collection in the saltwater charter vessel logbook program is angler residency (as of 2000) and halibut harvest and release data (as of 2002). In 2001, the **Sport Fish Division** conducted an initial evaluation of the 1998-2000 charter logbook data, including comparisons of data from the logbook, the statewide mail survey, and on-site interviews.

## References Cited

Chapman, D.G. 1948. A mathematical study of confidence limits of salmon populations calculated from sample tag ratios. Internat. Pac. Salmon Fisheries Comm. Bull. 2, 69-85.

## Web Pages

ADF&G Home Page: http://www.adfg.state.ak.us/
Commercial Fishery Division Home Page: http://www.cf.adfg.state.ak.us/
News Releases: http://www.adfg.state.ak.us/news/dept_news.php
Sport Fish Division Home Page: http://www.sf.adfg.state.ak.us/statewide/sf_home.cfm
Sport Fish Division Southcentral Region Halibut and Groundfish Program:
http://www.sf.adfg.state.ak.us/region2/groundfish/gfhome.cfm
Age Determination Unit Home Page: http://tagotoweb.adfg.state.ak.us/ADU/default.asp
**Region 1 Groundfish Home Page:**
http://www.cf.adfg.state.ak.us/region1/finfish/grndfish/grndhom1.php
Commercial Fisheries Entry Commission: http://www.cfec.state.ak.us/
State of Alaska home page: http://www.state.ak.us/
Gene Conservation Laboratory Home Page:
http://www.cf.adfg.state.ak.us/geninfo/research/genetics/genetics.php
Adobe PDF versions of groundfish charts can be viewed or downloaded at
http://www.cf.adfg.state.ak.us/geninfo/statmaps/charts.php
ArcView- and MapInfo-compatible charts can be downloaded from the ADF&G CF GIS Maps and Data Server at http://maps.cf.adfg.state.ak.us/. This server will be the home for all publicly available GIS maps developed by the division. In the future, this server will also feature online maps using ESRI's ArcIMS (Internet Map Server) software (contact Tim Haverland).

# REPORTS COMPLETED DURING 2004


Brylinsky, Cleo, V. O'Connell, H. G. Greene. Identification of yelloweye rockfish habitat: Geophysical survey data in comparison with fishery logbook data. Poster presentation at the Fifth International Symposium of GEOHAB in Galway, Ireland. May, 2004.

Byersdorfer, S.S. 2004. Common fish and marine invertebrates of the Pribilof Islands. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K04-18, Kodiak.

Coonradt, Eric E. co. Southeast Regional Groundfish Fisheries 06/04. http://www.cf.adfg.state.ak.us/region1/finfish/grndfish/grndhom1.php

Coonradt, Eric, D. Urban, C. Trowbridge, W. Dunne, V. O'Connell, T. Brookover, C. Brylinsky, S. Meyer, K. Munk, M. Jaenicke, B. Piorkowski, L. Seeb, T. Haverland, B. Bechtol, M. Ruccio. State of Alaska Groundfish Fisheries Associated Investigations in 2003, Prepared for the Forty Fifth Annual Meeting of the Technical Sub-committee of the Canada-United States Groundfish Committee. May 4-5, 2004, 38pp.

Failor-Rounds, B. 2004. Bering Sea-Aleutian Islands area state-waters groundfish fisheries and groundfish harvest from parallel seasons in 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No 4K04-45, Kodiak,

Holum, Deidra. Southern Southeast Inside (Clarence Strait and Dixon Entrance) Relative Abundance Sablefish Longline Survey Report for 2003. Alaska Department of Fish and Game Regional Information Report No. 1J04-09, 18pp.

O'Connell, Victoria, W. W. Wakefield, H. G. Greene, C. Brylinsky. Using In-Situ technology to identify and characterize essential fish habitat for classification as a marine reserve in the Eastern Gulf of Alaska. Poster presentation at The Fifth International Symposium of GEOHAB in Galway, Ireland. May 2004.

O'Connell, Victoria and C. Brylinsky. The Southeast Alaska Demersal Shelf Rockfish Fishery with 2004 Season Outlook. Alaska Department of Fish and Game Regional Information Report No. IJ03-43, 61pp.

O'Connell, Victoria and C. Brylinsky. 2004.Demersal Shelf Rockfish IN Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska. North Pacific Fisheries Management Council, P.O. Box103136,Anchorage,AK http://www.afsc.noaa.gov/refm/docs/2004/GOAdemersalrf.pdf

Richardson, Beverly and V. O'Connell. The Southeast Alaska Northern Southeast Inside Sablefish Fishery Information Report with Outlook to the 2004 Fishery. Alaska Department of Fish and Game Regional Information Report IJ04-03, 59pp.

Richardson, Beverly. 2003 NSEI (Chatham) Sablefish Longline Survey Report. Alaska Department of Fish and Game Regional Information Report No. IJ03-40, 73pp.

Ruccio, M.P., Spalinger, K.A., and Cavin, M.E. Jr. 2004. Annual management report for the groundfish fisheries in the Kodiak, Chignik, and South Alaska Peninsula management areas, 2003 Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No 4K04-44, Kodiak.

Spalinger, K. 2004. Bottom trawl survey of crab and groundfish: Kodiak, Chignik, South Peninsula, and Eastern Aleutians management districts, 2003 Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K04-32, Kodiak.

Spalinger, K. 2004. Special project plan 2004 bottom trawl survey of crab and groundfish: Kodiak, Chignik, South Peninsula, and Eastern Aleutian districts. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K04-33, Kodiak.

Spalinger, K. and Cavin, M.E. Jr. 2004. Standard project operational plan bottom trawl survey of crab and groundfish: Kodiak, Chignik, South Alaska Peninsula, and Eastern Aleutian areas Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No.4K04-47, Kodiak.

**APPENDIX I. ALASKA DEPARTMENT OF FISH AND GAME PERMANENT FULL-TIME GROUNDFISH STAFF DURING 2004.**

**COMMERCIAL FISHERIES DIVISION**
**HEADQUARTERS**, P.O. Box 25526, Juneau, Alaska 99802-5526

| | | |
|---|---|---|
| Fish Ticket Programmer/Analyst<br>Phil Witt<br>(907) 465-4753 | GIS Programmer/Analyst<br>Evelyn Russell<br>(907) 465-6147 | Fish Ticket Research/Analyst<br>Gail Smith<br>(907) 465-6157 |
| AKFIN Program Coordinator<br>Lee Holbert<br>(907) 465-6109 | Age Determination Unit<br>Kristen Munk<br>Box 25526<br>Juneau, AK 99802<br>(907) 465-3054 | |

**SOUTHEASTERN REGION**

| | | |
|---|---|---|
| Groundfish Project Leader<br>Tory O'Connell<br>304 Lake St. Rm. 103<br>Sitka, AK 99835<br>(907) 747-6688<br>tory_oconnell@fishgame.state.ak.us | Assistant Groundfish Project Leader<br>Eric E. Coonradt<br>304 Lake St. Rm. 103<br>Sitka, AK 99835<br>(907) 747-6688<br>eric_coonradt@fishgame.state.ak.us | Fishery Biologist<br>Cleo Brylinsky<br>304 Lake St. Rm. 103<br>Sitka, AK 99835<br>(907) 747-6688<br>cleo_brylinsky@fishgame.state.ak.us |
| Project Biometrician<br>Sherri Dressel<br>Box 240020<br>Douglas, AK 99824-0020<br>(907) 465-4216 | Fishery Biologist<br>Mike Vaughn<br>304 Lake St. Rm. 103<br>Sitka, AK 99835<br>(907) 747-6688 | |

**CENTRAL REGION**

| | | |
|---|---|---|
| Groundfish Research Biologist<br>Vacant<br>3298 Douglas Street<br>Homer, AK 99603-7942<br>(907) 235-8191 | CI/PWS Management Biologist<br>Charlie Trowbridge<br>3298 Douglas Street<br>Homer, AK 99603-7942<br>(907) 235-8191 | Groundfish Sampling Coordinator<br>William Dunne<br>3298 Douglas Place,<br>Homer AK 99603-7942<br>(907) 235-8191 |

| | | |
|---|---|---|
| Fish Ticket Entry Technician<br>Morris Lambdin<br>3298 Douglas Place,<br>Homer, AK 99603-7942<br>(907) 235-8191 | Fishery Biologist<br>Mike Byerly<br>3298 Douglas Street<br>Homer, AK 99603-7942<br>(907) 235-8191 | PWS Management Biologist<br>Robert Berceli<br>PO Box 669<br>Cordova, AK 99574-0669<br>(907) 424-3212 |

**WESTWARD REGION**

| | | |
|---|---|---|
| Shellfish/Groundfish Biologist<br>Wayne Donaldson<br>211 Mission Rd.<br>Kodiak, AK 99615-6399<br>(907) 486-1840 | Area Management Biologist<br>Nick Sagalkin<br>211 Mission Rd.<br>Kodiak, AK 99615-6399<br>(907) 486-1840 | Groundfish Research Biologist<br>Dan Urban<br>211 Mission Rd.<br>Kodiak, AK 99615-6399<br>(907) 486-1849 |
| Groundfish Sampling Coordinator Kally Spalinger<br>211 Mission Road<br>Kodiak, AK 99615<br>(907) 486-1840 | Assistant Area Management Biologist<br>Lynn Mattess<br>211 Mission Road<br>Kodiak, AK 99615<br>(907) 486-1840 | Assistant Area Management Biologist<br>Barbi Failor-Rounds<br>P.O. Box 920587<br>Dutch Harbor, AK 99692<br>(907) 581-1239 |
| Assistant Groundfish Research Biologist<br>Carrie Worton<br>211 Mission Rd.<br>Kodiak, AK 99615-6399<br>(907) 486-1871 | | |

**SPORT FISH DIVISION**

**HEADQUARTERS**, P.O. Box 25526, Juneau, Alaska 99802-5526

| | | |
|---|---|---|
| Rob Bentz<br>Deputy Director<br>Division of Sport Fish<br>PO Box 25526,<br>Juneau, AK 99802-5526<br>(907) 465-6187 | | |

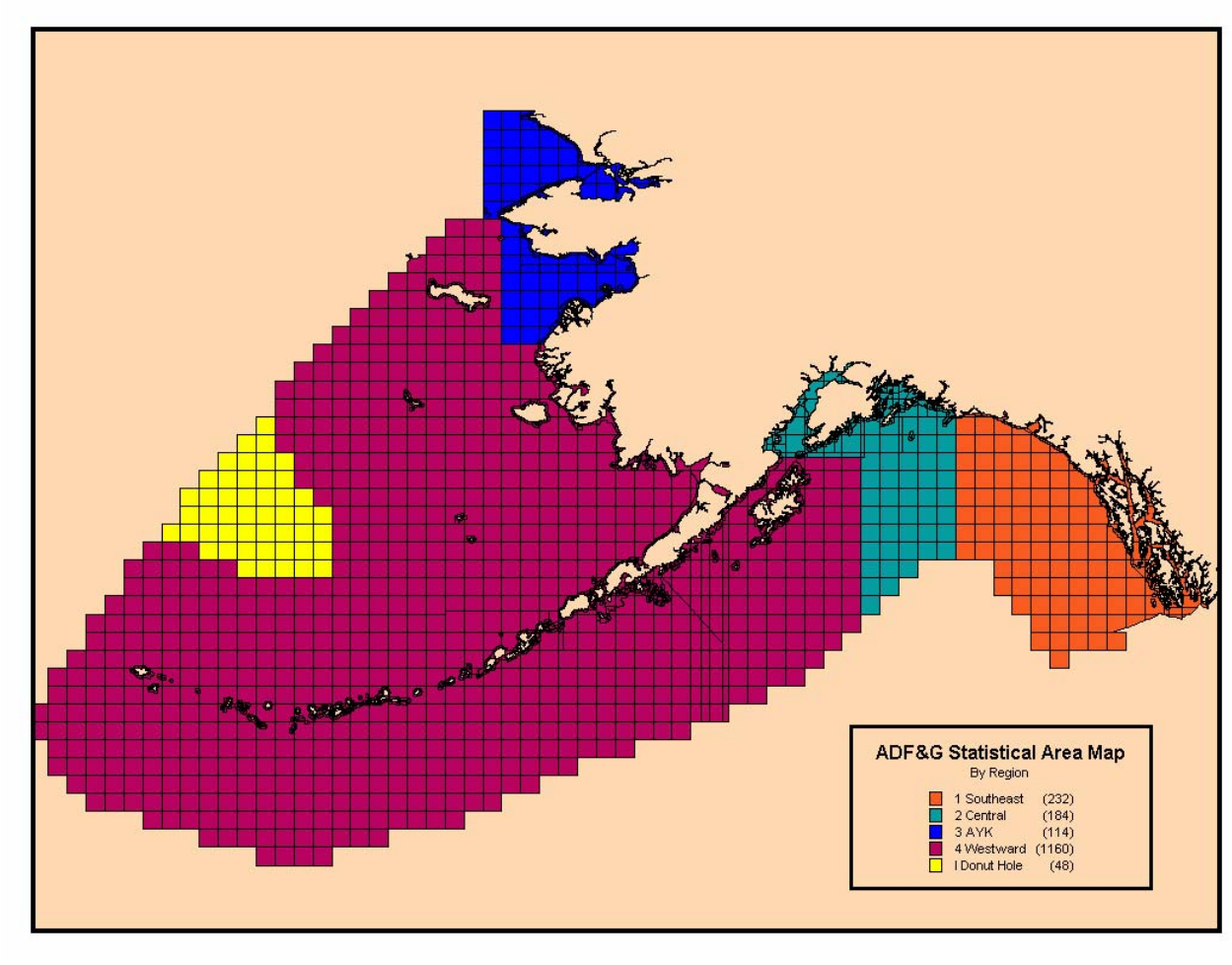
**SOUTHEAST REGION**

| | | |
|---|---|---|
| Mike Jaenicke, Project Leader<br>Marine Harvest Studies | Tom Brookover<br>Regional Management | |

| | | |
|---|---|---|
| Division of Sport Fish<br>802 3rd Street<br>PO Box 240020<br>Douglas, AK 99824-0020<br>(907) 465-4301 | Coordinator<br>Division of Sport Fish<br>304 Lake Street, Room 103<br>Sitka, AK 99835<br>(907) 747-3881 | |

**SOUTHCENTRAL REGION**

| | | |
|---|---|---|
| Scott Meyer<br>Groundfish Research and Lower Cook Inlet Management Biologist<br>Division of Sport Fish<br>3298 Douglas Place<br>Homer, Alaska 99603-8027<br>(907) 235-8191<br>scott_meyer@fishgame.state.ak.us | Matthew Miller<br>PWS and North Gulf Management Biologist<br>Division of Sport Fish<br>333 Raspberry Road<br>Anchorage, AK 99518-1599 | Len Schwarz<br>Kodiak, Alaska Peninsula, and Aleutian Islands Management Biologist<br>Division of Sport Fish<br>211 Mission Road<br>Kodiak, AK 99615-6399 |
| Steve Fleischman<br>Biometrician<br>Division of Sport Fish-RTS<br>333 Raspberry Road<br>Anchorage, AK 99518-1599 | | |




**Appendix II. Map Depicting State of Alaska Management Regions.**

**Appendix III. Tissue samples of *Sebastes* species collected for genetic analyses and stored at Alaska Department Fish and Game, Gene Conservation Laboratory, Anchorage. Species, sampling location and collection ID, year collected, sample size, and tissue type are given.**

| Species | Silly Name - Location | Year | Size | Tissue Type |
|---|---|---|---|---|
| | | | | |
| Yelloweye Rockfish | YERFLAM98 - Flamingo, British Columbia. | 1998 | 46 | fin clips; larvae |
| *S. ruberrimus* | YERTASU98 - Tasu, British Columbia. | 1998 | 50 | fin clips |
| | YERTOPK98 - Topknot, British Columbia. | 1998 | 49 | fin clips |
| | YERTRI98 - Triangle, British Columbia. | 1998 | 63 | fin clips; larvae |
| | | | | |

| | | | | |
|---|---|---|---|---|
| | YERSE298 - Sitka | 1998 | 49 | fin clips |
| | YRSE99 - Stat areas 355601, 365701 | 1999 | 100 | fin clips |
| | YERYAK99 - Fairweather grounds | 1999 | 100 | fin clips |
| | | | | |
| | YEPW91 – Prince William Sound; Gravina, Danger, Herring | 1991 | 27 | muscle, liver, eye |
| | YERGA98 – Prince William Sound, Knight Is./Naked Islands area | 1998 | 100 | fin clips |
| | | | | |
| | YERPWS100 - Whittier | 2000 | 97 | fin clips |
| | YERPWS200 - Whittier | 2000 | 50 | fin clips |
| | | | | |
| | YERRES99 – Resurrection Bay | 1999 | 100 | fin clips |
| | YERKACH99 - Kachemak Bay | 1999 | 58 | fin clips |
| | | | | |
| | YERKOD99 – Kodiak Island | 1999 | 115 | fin clips |
| | | | | |
| Black Rockfish | BRORE99 – Pacific Northwest; Oregon | 1999 | 50 | muscle, liver, heart |
| *S. melanops* | BRWASH98 - 47°08' / 124°37'; Washington | 1998 | 20 | fin clips |
| | | | | |
| | BRSIT98 - Sitka | 1998 | 50 | fin clips |
| | BRSIT99T - Sitka Sound | 1999 | 200 | fin clips |
| | BRSIT99 – Sitka | 1999 | 83 | fin clips |
| | | | | |
| | BRPWS100 - Valdez | 2000 | 13 | fin clips |
| | BRPWS200 - Whittier | 2000 | 16 | fin clips |
| | | | | |
| | BRRESB97 - Resurrection Bay | 1997 | 82 | muscle,liver,heart,eye,fin |
| | BRRESB98 – Resurrection, North Fox Island | 1998 | 24 | fin clips |
| | | | | |
| | BRKOD96 - Kodiak Island | 1996 | 2 | muscle, liver, heart, eye |
| | BRKOD197 - Ugak Bay | 1997 | 100 | muscle,liver,heart,eye,fin |
| | BRKOD398 - Westside Kodiak Island | 1998 | 114 | fin clips |
| | BRKOD198 - Eastside Kodiak Island | 1998 | 100 | fin clips |
| | BRKOD298 - Southwest side Kodiak Island | 1998 | 86 | fin clips |
| | | | | |
| | BRSAND98 - Carpa Island near Sand Point | 1998 | 40 | fin clips |
| | BRSAND99 - Castle Rock near | 1999 | 60 | fin clips |

| | | | | |
|---|---|---|---|---|
| | Sand Point | | | |
| | BRKOD00 - Chignik | 2000 | 100 | fin clips |
| | | | | |
| | BRBERS99- Akutan | 1999 | 100 | fin clips |
| | BRDUTS00 - Dutch Harbor<br>BRYAKU03- Yakutat | 2000<br>2003 | 6<br>130 | fin clips<br>fin clips |

# OREGON'S GROUNDFISH FISHERIES AND INVESTIGATIONS IN 2004

## OREGON DEPARTMENT OF FISH AND WILDLIFE

## 2004 AGENCY REPORT
## PREPARED FOR THE MAY 4 -5, 2005 MEETING
## OF THE TECHNICAL SUB-COMMITTEE
## OF THE CANADA-UNITED STATES GROUNDFISH COMMITTEE

**Edited by**

**Steven J. Parker**

**Contributions by**

**D. Bodenmiller**
**R. Hannah**
**J. McCrae**
**B. Mikus**
**C. Sowell**
**H. Weeks**

**Oregon Department of Fish and Wildlife**
**Marine Resources Program**
**2040 SE Marine Science Drive**
**Newport, OR 97365**

**April 2005**

# OREGON DEPARTMENT OF FISH AND WILDLIFE

## A. AGENCY OVERVIEW - MARINE RESOURCES PROGRAM

| | |
|---|---|
| MRP Program Manager | Dr. Patricia M. Burke |
| Resource Assessment and Analysis | Dave Fox |
| Management and Monitoring | Maggie Sommer |

The Marine Resources Program (MRP) is located within the Oregon Department of Fish and Wildlife (ODFW) and has jurisdiction over fish, wildlife, and habitat issues coast-wide. MRP is headquartered at Newport in the Hatfield Marine Science Center, with field stations at the coastal ports of Astoria, Tillamook, Charleston, Gold Beach, Brookings, and Corvallis. It is tasked with the responsibility for assessment, management, and sustainability of Oregon's marine habitat, biological resources and fisheries. In addition to direct responsibilities in state waters (from shore to three miles seaward), MRP provides technical support and policy recommendations to state, federal, regional, and international decision-makers who develop management strategies that affect Oregon fish and shellfish stocks, fisheries, and coastal communities. Staffing consists of approximately 50 permanent and more than 70 seasonal or temporary positions. The program budget is approximately $5 million yearly, with about 50% of funding from federal sources and the remainder from various state sources.

## B. MULTISPECIES STUDIES

### *1. Sport Fisheries Project*

Sampling of the ocean boat sport fishery by MRP's Ocean Recreational Boat Survey (ORBS) continued in 2004. Based on the results of year round sampling in 1999-2000, less than five percent of the annual fishing effort and catch occurred during the winter period (Nov - Feb). Oregon plans to continue sampling the March through October period during 2005.

Black rockfish remains the dominant species caught in the ocean boat fishery. Lingcod, several other rockfish species (blue rockfish, China rockfish and other nearshore species), cabezon and greenling are also commonly landed. Oregon's fishery for Pacific halibut continues to be a very popular, high profile fishery requiring International Pacific Halibut Commission (IPHC), federal, and state technical and management consideration and management.

The ORBS continued its species composition and biological sampling of groundfish species at Oregon coastal ports during 2003. Black rockfish and blue rockfish otoliths were gathered, in addition to lingcod fin rays, for ageing studies. ORBS continued collecting of length and weight data from groundfish species.

From April through September, a portion of sport charter vessels were sampled at sea for species composition, discard rates and sizes, location, depth and catch per angler (CPUE) using ride-along samplers.

Other ODFW management activities included participation in the U.S. West Coast Recreational Fish International Network (RecFIN) process, data analysis and sponsoring public hearings to discuss changes to the management of Pacific halibut, lingcod and rockfish fisheries. See the specific section for more details.

Through June 2003, port samplers continued conducting the federal Marine Recreational Fisheries Statistical Survey (MRFSS) by collecting demographic and creel data from boat and shore anglers in the ocean and estuaries. Species composition, length and weight data were collected.

The Shore and Estuary Boat (SEB) sampling program is focused on non-salmonid and non-sturgeon fisheries. Black rockfish continued to dominate estuary boat groundfish landings and surfperch made up the majority of shore-based catch by weight. Salmon dominated estuary boat landings by weight. Pacific herring made up the majority of both shore-based and estuary boat landings by number of fish.

ODFW continued funding for a project to determine if phone angler surveys for effort and trip type from shore and estuaries can be estimated based on an angler license frame.

Weekly harvest in the sport and commercial halibut fisheries were monitored for quota tracking purposes. The majority of recreational caught halibut continue to be landed in the central coast sub-area (Newport and Garibaldi). In 2004, the directed sport fishery was open for 42 days, which was up compared to recent years but drastically down from a decade ago when it was open nearly year round. The commercial directed fishery was open for four 10-hour periods. In 2004 as in recent years, the sport and commercial halibut fisheries received equal allocations. In 2004, Oregon commercial fishers landed 345,465 pounds down slightly from 341,521 pounds in 2003. Contact: Don Bodenmiller (541) 867-0300 ext. 223, Don.G.Bodenmiller@state.or.us

## *2. Maturity Studies*

We continued research begun several years ago to gather female maturity data from a variety of species for which such data is unavailable, outdated or only available for areas far from Oregon. This work continued in 2004, with a focus on nearshore rockfish, other nearshore species and poorly known slope rockfish species (aurora, POP, redbanded). This study also utilizes histology to validate maturity status on uncertain ovaries. This work will continue in 2005.

We investigated the maturity of female Pacific ocean perch (Sebastes alutus) in waters off Oregon. A comparison of visual and histological methods produced similar results during the December to March spawning season; however, neither method provided reliable determinations of maturity in other seasons. Evidence of abortive maturation, characterized by mass atresia of the developing class of oocytes, was observed in 7.1% of the fish sampled during the winter months, with a strong age-related decline in prevalence. Fish older than 18 (N=73) showed no evidence of abortive maturation regardless of size, further supporting the higher reproductive value of older rockfishes. Abortive maturation was associated with adolescence (age 5-9 years), but was also observed in post-adolescent fish, especially in 2001 samples. Rates of abortive maturation varied interannually, suggesting an environmental influence on successful egg development in younger fish. Pacific ocean perch off Oregon were 50% mature at a length of

about 31 cm and an age of six, two years younger than assumed in recent stock assessments for the west coast population.
Contact: Bob Hannah at (541) 867-0300 ext. 231, bob.hannah@oregonstate.edu

## *3. Cooperative Nearshore Survey Project*

During 2004, ODFW developed a cooperative research project with the Oregon South Coast, Port Orford Ocean Resource Team (POORT). The extended sampling project started in January 2004 and continued through December of 2004. The project involved POORT contracting commercial fishing vessels to catch three nearshore species of fish, china rockfish, kelp greenling, and cabezon. POORT also hired a sampling crew to record the species, length, and weight of the fish. The crew collected biological samples, otoliths for aging, gonad samples for histology, and fin-clips for genetic sampling. The ODFW supplied most of the sampling equipment, trained the sampling crew and monitored the project. Biological samples are stock piled until funding is available to analyze the data collected.
Contact Carla Sowell at (541) 867-0300 x222 SowellC@state.or.us.

## *4. Development and Testing of a Selective Flatfish Trawl*

The Oregon Department of Fish and Wildlife and the Northwest Fisheries Science Center of NOAA conducted an Exempted Fishing Permit fishery test of a new selective flatfish trawl to estimate bycatch rates in the continental shelf flatfish fishery in 2003, with the report completed in 2004. Eight vessels participated, with observer coverage from May through October 2003 (Figure 1). The trawl performed well and reductions in bycatch observed were consistent with the effects previously demonstrated in the controlled experiments. We recommend that a flatfish target fishery using this trawl be developed for use on the continental shelf off the west coast as a mechanism to reduce bycatch of some critical rockfish species.

We then tested the potential of a selective flatfish trawl to reduce bycatch of slope rockfish in the upper continental slope bottom-trawl fishery (250-500 m). The trawl we tested differed from typical slope trawls in that it was a low-rise, two-seam trawl with a severely cut-back headrope. The study used an alternate haul, randomized block design to compare catches of the experimental trawl with those of a typical 4-seam, high-rise design and to examine diel changes in catch rates for both trawls. The experimental trawl produced similar catches to the control trawl for all commercially valuable flatfish except arrowtooth flounder (*Atheresthes stomias*), which was reduced 24%. Catches of most rockfish and roundfish were significantly reduced in the experimental trawl (50-94% depending on species). However, the catches of darkblotched rockfish (*Sebastes crameri*) and redbanded rockfish (*Sebastes babcocki*) were not reduced significantly in the experimental trawl. Nighttime catches were reduced 30-99% for most rockfish species, with the greatest reductions observed in the experimental trawl. The nighttime catch reduction for several rockfish species with the control trawl (-86%) along with no reduction in Dover sole catch, suggests that fishing only at night may be a viable bycatch reduction strategy. The variation in relative catch rates of the two trawls, both between day and night and with increasing depth, indicates that a better understanding of near-bottom vertical distribution of fish is critical to development of more selective trawls.

In 2004, the selective flatfish trawl was evaluated by the PFMC for effectiveness and was implemented as required gear for trawling, shoreward of the Rockfish Conservation Area (RCA), starting in 2005, north of 40° 10' N. latitude. The reduction in projected canary rockfish bycatch resulting from mandating this style of trawl allowed the shoreward boundary of the RCA to be moved seaward to 100 fathoms for most of the year and allowed increased catch limits for most flatfish species shoreward of the RCA, potentially reducing fishing pressure on the upper continental slope species. We collaborated with Oregon Sea Grant Extension to conduct three informational workshops for fishermen to inform them of the regulation changes, introduce them to the trawl design, and discuss issues surrounding conversion of existing trawl gears to the new design.

Work in 2005 with the selective flatfish trawl will focus on using an imaging sonar to study fish behavior inside and ahead of a selective trawl to try and understand the factors that result in either capture or escapement. This is a cooperative project with NMFS, Northwest Science Center.

Contact: Bob Hannah or Steve Parker at (541) 867-0300 ext.231 or 256, steve.parker@oregonstate.edu bob.w.hannah@state.or.us

## *5. Nearshore Reef Habitat Studies*

Nearshore reef habitat studies continued on subtidal rocky bottom habitats off the Oregon coast. ODFW staff returned to Cape Perpetua for a fifth year to conduct ROV surveys of fish populations and habitat associations. Twelve transects, all but one of them repeats of previously surveyed transects, were surveyed over two days in September 2004. Analysis of 2003 survey data showed little apparent recovery from the 2002 hypoxia event, which will make analysis of 2004 survey data of greater interest.

### a. GIS Description:

The Marine Resources Program GIS was summarized in the 1997 TSC report. Additions to the GIS in 2004 are listed below.

### b. Base Maps and Baseline Data

Base Maps

No additions for 2004.

Baseline Data

Fish densities by habitat type at Cape Perpetua reef.

### *c. Software*

No additions for 2004.

### *d. Bathymetric Data Sources*

No additions for 2004.

Contact: Hal Weeks at (541) 867-0300 ext. 279; Hal.Weeks@state.or.us.

## *6. Developmental Fisheries Project*

The ODFW Developmental Fisheries Program was created in 1993 to allow for controlled development of new species and fisheries. Each year, the Developmental Fishery Board recommends to the Oregon Fish and Wildlife Commission a list of food fish species that are considered to be developmental and a harvest program that includes a limited entry system. The Developmental Fishery Board is made up of members from a broad range of fishing interests (harvesters, processors, and state agencies).

In 2004, a total of 89 permits were issued for all species; 47 permits for finfish species. This is a reduction in permits from 2003, mainly because nearshore rockfish were removed from the developmental species list in 2004. The main finfish of interest were-sardines, for which there were 20 permits issued. Other finfish species for which we issued permits were hagfish (15), anchovy/herring 10), and swordfish (1).

Market samples of sardines were collected for length, weight, maturity, and age data. See section 11(b) under "By Species: Mackerel and Sardines" for details.
Contact Jean McCrae for more information (541-867-4741) Jean.E.McCrae@state.or.us

## *7. Marine Finfish Ageing Unit*

In February, 2005, ODFW ended their participation in PacFIN groundfish ageing projects due to a lack of funding. Finfish ageing effort has shifted from species with lots of federal assessment effort to species of interest to the state that do not have other concentrated effort. Work is continuing on recreational black rockfish, Dover sole collected in seal scat, aurora rockfish, and other miscellaneous species. In addition time is being spent training a seasonal employee to age pacific herring.
Contact Bob Mikus (541) 867-0300, ext. 247. bob.mikus@oregonstate.edu

# C. BY SPECIES

## *1. Black Rockfish PIT Tagging*

Oregon's primary recreational groundfish fishery targets the nearshore species, black rockfish (*Sebastes melanops*). Previous assessments relied on the relative CPUE trends derived from recreational fishery sampling programs. These data are not robust to problems of sampling bias or changes in fishing distribution, and can result in errors in the trend of relative population abundance. The need to independently estimate exploitation rates for black rockfish off Oregon prompted us to investigate the use of passive integrated transponder (PIT) tags for a mark-recapture program. Because PIT tags are invisible to anglers, there is no tag non-reporting problem, and tag detection rates can be estimated directly. We tagged 2,550 fish in 2002, 3,000 fish in 2003 and 3,001 in 2004 (29 – 54 cm) with PIT tags (12mm x 2mm) during 20 days of fishing each year near Newport, Oregon. Tags were injected in the hypaxial musculature below the gill arches, determined to be the best site by a previous PIT tag retention study. At tagging,

categorical barotrauma symptoms were noted and fish with significant barotrauma symptoms were recompressed by immediate submersion in a cage and release at depth. During the fishing seasons (May-October), carcasses of almost all black rockfish landed by charter vessels in Newport and Depoe Bay were counted by samplers and electronically scanned for tags. We have had good recoveries each year (52, 86 and 167) and exploitation rates are within expected assessment values of approximately 5%. This program design will integrate well with the current tagging program used by Washington state and may result in a valuable abundance index for a combined Oregon-Washington assessment. We have begun the fourth year of tagging and will likely continue the project for the next 5 years.
Contact Bob Hannah or Steve Parker (541) 867-0300 ext 256 or 223 bob.w.hannah@state.or.us, steve.parker@oregonstate.edu

## *2. Barotrauma in Rockfishes*

We have built three pressurized aquaria that can hold up to 6 rockfish each and simulate depths of up to 30 m. We have documented the acclimation rates for black rockfish to increases and decreases in ambient pressures along with the physical symptoms associated with this barotrauma. We have also conducted process-oriented experiments to simulate hook and line capture and ascent to document physiological symptoms and mortality associated with capture. This information is intended to address assumptions in our PIT tagging program related to tagging mortality. Experiments indicated 97% ± 4% survival for fish in a simulated capture from 30m, with 2 minutes at the surface (in seawater) and a 30 second recompression to depth. Also, acclimation times to increase and decreases in pressure were very slow, with rates of about 1 ATA per 24 h of acclimation for increasing pressure, and 1 ATA every 12 h for decreasing pressure.

We also constructed a "camera cage" in 2004 using a low-light underwater video camera to observe recompression and release at depth of 9 species of rockfish captured at depths up to 60m. Observations showed that many rockfish that appear dead at surface pressure are immobilized from gas expansion and show substantial recovery of normal behavior and appearance upon rapid recompression, generally appearing competent at release (properly oriented, swimming towards bottom). We attained depths of release up to 25m with the cage-camera system. Species differed in the percentage that appeared competent at release, with blue rockfish showing the poorest rate of recovery, at just 65%, despite appearing lively at the surface. Some species that have a reputation for surviving poorly at surface pressures (e.g., canary rockfish) appeared to fair better upon recompression. These results are encouraging in that they suggest survival of recompressed fish may be higher than anticipated based on apparent condition at the surface. Longer term survival of severe barotrauma though, remains unknown.

Contact: Bob Hannah or Steve Parker at 541-867-4741 Steve.parker@oregonstate.edu, bob.w.hannah@state.or.us

## *3. Black Rockfish Telemetry*

We studied the movement patterns of black rockfish (*Sebastes melanops*) along the open Oregon coast to estimate home range over short to annual time scales, describe the frequency and range of vertical movements, and evaluate the influence of environmental variation on behavior. We

moored 18 acoustic receivers in a 3x5 km grid south of Newport, Oregon, at depths from 9-36 m. We then surgically implanted black rockfish (34-40 cm) with coded, pressure transmitters with a lifespan of about six months. Fish were tagged in August (n = 6), September (14), October (7), and February (8, + 8 coded only). Within 6 months we recorded more than one million detections, and saw no evidence of mortality in tagged fish. Home ranges were small (< 25 ha) and did not vary from summer to winter. Most black rockfish showed significant vertical movement on a daily basis, especially in the summer. Our data indicate that black rockfish in open coastal waters live in a very restricted area for long periods, potentially making them susceptible to local depletion from targeted fishing, but also good candidates for protection using local area closures or small marine reserves.
Contact: Steve Parker at 541-867-4741 Steve.parker@oregonstate.edu

## *4. Petrale Sole*

ODFW, in collaboration with Steve Berkeley at UCSC, is conducting a feasibility experiment to capture flatfish (specifically Petrale sole) using a fish trap. If feasible, the use of a Petrale pot may allow more productive flatfish stocks to be accessed in areas closed to trawling due to rockfish conservation efforts. Initial experiments at UCSC determined that Petrale sole are attracted to dead bait and will pass through a tunnel to access squid and sardines. Commercial sized traps were designed by modifying Alaskan Opio crab pots to have a long wide entrance at the bottom on three sides, and varying the mesh materials. Initial field trials were conducted in the fall of 2004. Following the cruise, the pots were refitted with better mesh and tunnels were reconfigured to allow easier access for flatfish yet prevent lingcod and halibut from entering. Field trials with the new pots to compare catches in areas where Petrale presence is confirmed via trawler will occur in the summer of 2005.
Contact: Steve Parker at 541-867-4741 Steve.parker@oregonstate.edu

## *5. Pacific Hake*

The PFMC's optimum yield (OY) increased from 148,200 mt to 250,000 mt 2004 (Table 1). The tribal fishery was allocated 13.8% of the OY (32,500 mt) and began harvesting on May 20$^{th}$, 2004. Commercial fisheries received 86.2% of the U.S. OY. Allocations of this amount were 42% to vessels landing at shoreside processing plants (90,510 mt) (up from 50,904 mt in 2003), 34% to catcher/processors (73,270 mt), and 24% to catcher vessels delivering to motherships (51,720 mt). The directed season for mothership and catcher/processor at-sea processing (north of 42$^{o}$ N) began on the 15$^{th}$ of May 2004. The 2004 directed shoreside hake fishery began on 01 April 2004 off California (south of 42$^{o}$ N), and on 15 June 2004 off Oregon and Washington (north of 42$^{o}$ N). To avoid pre-empting more northerly segments of the fishery, the California component of the hake fishery is limited to 5% of the total shoreside allocation until the northern component of the shoreside fishery begins. The California fishery closed on May 22$^{nd}$ because 5% of the allocation was met. No landings were made in California for the rest of the primary season.

The primary issue in the 2004 fishery was canary bycatch. The entire fishery operated under a 7.3 mt cap and information was provided to the fleet to avoid canary rockfish areas of concentration. Total canary catch was 6.03 mt, with 4 mt taken in the non-tribal mothership fishery. In addition, the hake quota was reduced to 250,000 mt in an effort to reduce widow

rockfish bycatch. The shoreside sector took 28.59 mt of the 50 mt of widow rockfish taken by the whiting fishery in 2004.

Yellowtail rockfish otoliths and length-frequency information are provided to Sandra Rosenfeld at the Department of Fisheries Marine Fish & Shellfish Division in Olympia, Washington for future stock assessments on this species. Biological samples of Pacific mackerel are provided to the CDFG for their stock assessment work on this species. Biological samples of widow rockfish are sent to Don Pearson NMFS in Santa Cruz, California. Sablefish, jack and pacific mackerel, darkblotched, bocaccio and canary rockfish have been retained at ODFW and are available for future assessment efforts. Past shoreside hake observation reports are available on the internet at http://hmsc.oregonstate.edu/ odfw/reports/whiting.html
Contact: Steve Parker at 541-867-4741 Steve.parker@oregonstate.edu

### *6. Pacific Sardine*

In 2004, landings for sardine continued to increase. Nineteen vessels landed 79.6 million pounds (36,111 mt); a 43 % increase from 2003. Most of the sardine catch was by seine gear (99 %), and most fish were landed into Astoria and processed as bait for a Japanese longline fishery. Incidental landings of mackerel accounted for approximately 0.6 % of the catch.

We were, again, unable to hire a seasonal worker to conduct ride-along trips to observe bycatch, but staff made a few observed trips. From observed trips and logbook data, bycatch consisted of sharks and some salmon. Salmon averaged 0.9 per trip, with 68 % being released alive. Market samples were collected for length, weight, maturity, and age data. The average length and weight for all samples was 206 mm (standard length) and 154 gm. The length of sardines harvested in Oregon continues to be large and showed a slight increase over 2003. However, there was also an increase in the amount of small fish harvested, thus a smaller overall average size for 2004. In 2003, 15% of the fish were smaller than 200 mm in length; in 2004, 35% were smaller than 200 mm. The size composition of the harvested catch probably does not reflect the composition of the population off the Northwest as a whole. Harvesters reported actively avoiding schools of the very small fish, as they would plug the mesh of their nets.
Contact Jean McCrae for more information (541-867-4741) Jean.E.McCrae@state.or.us

## D. PUBLICATIONS

Davis, M. W. and S. J. Parker. 2004. Fish size and exposure to air: Potential effects on behavioral impairment and mortality rates in discarded sablefish. North American Journal of Fisheries Management 24 (2): 518–524.

Gallagher, C. M., R. W. Hannah and G. Sylvia. 2004. A comparison of yield per recruit models for the Oregon ocean shrimp, *Pandalus jordani*, fishery. Fisheries Research 66:71-84.

Hannah, R. W. and S. A. Jones. 2005. A Survey Evaluating Shrimp Abundance, Sex Composition, Bycatch and Trawl Gear Performance on the Northern Oregon Shrimp Grounds – Fall 2004. Oregon Department of Fish Wildlife, Information Report Series, No. 2005-01. 33p.

Hannah, R. W. and S. J. Parker. 2004. Use of an exempted fishing permit to test a discard reduction strategy for the deepwater complex trawl fishery. Oregon Department of Fish Wildlife, Information Report Series, No. 2004-03. 18p.

Hannah, R. W., S. J. Parker and T. V. Buell. (In Press). Evaluation of a Selective Flatfish Trawl and Diel Variation in Rockfish Catchability as Bycatch Reduction Tools in the Deepwater Complex Fishery off the U.S. West Coast. North American Journal of Fisheries Management.

King, S. E., R. W. Hannah, S. J. Parker, K. M. Matteson, and S. A. Berkeley. 2004. Protecting rockfish through gear design: Development of a selective flatfish trawl for the U.S. West Coast bottom trawl fishery. Canadian Journal of Fisheries and Aquatic Sciences. 61(3):487-496.

Parker, S. J., M. R. Saelens, S. A. Kupillas, and R. W. Hannah. 2004. Using an exempted fishing permit for a large-scale test of a selective flatfish trawl in the continental shelf flatfish fishery. Oregon Department of Fish and Wildlife Information Reports 2004-01. Fish Division, Salem, OR. 22p.

Wiedoff, B. L., and S. J. Parker. The shoreside whiting observation program: 2004. Oregon Department of Fish and Wildlife, Fish Research Project, 27 pp. Progress Report Series, Portland, Oregon.

## Projects planned for year 2005

1. **Barotrauma in rockfishes**: Work examining barotrauma and discard mortality is hampered by difficulties in capturing numbers of target rockfish species, and if captured, transporting them to lab facilities with low mortality. However, our work with recompression with black rockfish and with cage cam (see above) indicates that several species in deeper water at least orient and swim towards the bottom when released at > 20m depth. We plan to capture yelloweye rockfish in 30-40 m depth using hook and line, attach an external acoustic depth transmitter, recompress the fish in a video cage, and then return in 2-4 weeks with an ROV to find the fish and hopefully film it to show degree of recovery and potential mortality.
Contact: Steve Parker at 541-867-4741 Steve.parker@oregonstate.edu

2. **Nearshore Management Strategy**: In February 2005, Marine Resources Program will begin developing a comprehensive, nearshore marine resource management plan. The planning project involves three primary components: information-gathering, public process, and plan development. The public process includes a stakeholder advisory committee and public meetings to guide plan development. Participation will also be solicited from representatives of academia, government agencies, environmental organizations, and other interested groups. Individual experts will be consulted on specific issues as necessary. The product will be a plan document outlining conservation strategies, management regulations, and biological and ecological and ecological information on nearshore species. The nearshore plan is being developed in conjuncton with a larger statewide wildlife conservation planning effort.
Contact Brett Wiedoff at (541) 867-0300, ext 237, Brett.L.Wiedoff@state.or.us

# Washington Contribution to the 2005 Meeting of the Technical Sub-Committee (TSC) of the Canada-US Groundfish Committee

*Contributors:*

**Greg Bargmann**
**Michele Culver**
**Eric Eisenhardt**
**Larry LeClair**
**Sandie O'Neill**
**Wayne Palsson**
**Kurt Stick**

*Edited by:*

**Thomas Jagielo**
*Senior Research Scientist*

**Washington Department of Fish and Wildlife**

**May 3-4, 2005**

**Parksville, British Columbia, Canada**

# Review of Agency Groundfish Research, Assessment, and Management

## A. Puget Sound Area Activities

### *1. Puget Sound Management Activities.* *Contact: Greg Bargmann (360) 902-2825)*

**Dogfish Sharks**
An international conference on dogfish sharks is being held in Seattle in mid-June at the University of Washington. Sponsors are the Canadian Department of Fish and Oceans, the University of Washington, the Puget Sound Action Team and WDFW. Details can be found on the WDFW web site at:
http://wdfw.wa.gov/fish/dogfish_conference/index.htm

### 2. *Puget Sound Groundfish Monitoring, Research, and Assessment.*

*(Contributed by Wayne Palsson, Marine Fish Science Unit (425) 379-2313, palsswap@dfw.wa.gov)*

Staff of the Puget Sound Marine Fish Science Unit includes Wayne Palsson, Robert Pacunski, Tony Parra, Jim Beam, Karl Mueller, and Jamie Selleck. Their tasks are primarily supported by supplemental funds from the Washington State Legislature for the recovery of Puget Sound bottomfish populations. Most of the work of the staff is associated with the Puget Sound Ambient Monitoring Program (PSAMP) and is tasked by the Puget Sound Action Team. The main activities of the unit include the assessment of bottomfish populations in Puget Sound and the evaluation of bottomfish in marine reserves. This year, additional grants and contracts were received for special studies regarding marine fish habitat modifications and marine reserves in Puget Sound.

A major effort was undertaken this year to assess the status and biology of rockfishes in Puget Sound. A draft document was nearing completion at the end of 2004 that included the results of most sampling programs reviewed below.

### *Puget Sound Marine Habitat Studies*

Wayne Palsson and Robert Pacunski collaborated with Professors Don Gunderson of the University of Washington and Gary Green of Moss Landing Marine Labs in a Washington Sea Grant study to examine the distribution of marine fishes in relation to the distribution of different sea floor habitats in the San Juan Archipelago that were mapped Dr. Greene through the NOAA/CCS and other grants. San Juan Channel was mapped with a high-resolution multi-beam echosounder that collected detailed bathymetric and back-scatter information. These data were processed into geological formations based upon a hierarchical scheme of geomorphology that were condensed into four fish habitat types: Soft, Coarse, Complex Bedrock, and Smooth Bedrock. These subtidal habitats in San Juan Channel were stratified into North and South, Shallow and Deep, and Fished and Reserve treatments, and an ROV survey was developed to test

the null hypothesis that rockfish, lingcod, and other marine fish are distributed independently of habitat type, location, depth, and reserve status. The ROV was deployed at randomly selected starting points within each treatment and was piloted along the bottom in a direction to allow a consistent forward direction. An acoustic tracking system allowed us to navigate transects ranging from 0.1 nm to 0.2 nm in length. Transect widths were determined from a two parallel lasers mounted on a color video camera. All transects were video taped and analyzed in the laboratory for fish species, number, and sizes, invertebrates, and geomorphology.

Fifty-seven transects were conducted in San Juan Channel within 13 of the possible 16 treatment combinations. Rockfishes were almost exclusively distributed on the complex bedrock habitats in both northern and southern channel. Other complex habitat species included lingcod and kelp greenling. Smooth bedrock classification was not consistent with the observed habitat that ranged from cobble-pebble coarse sediments to fractured bedrock. Rockfishes were observed in fine-scale habitats that consisted of complex bedrock and boulder. Other marine fish species occupied the coarse and soft habitats including Pacific cod, walleye pollock, and red Irish lords.

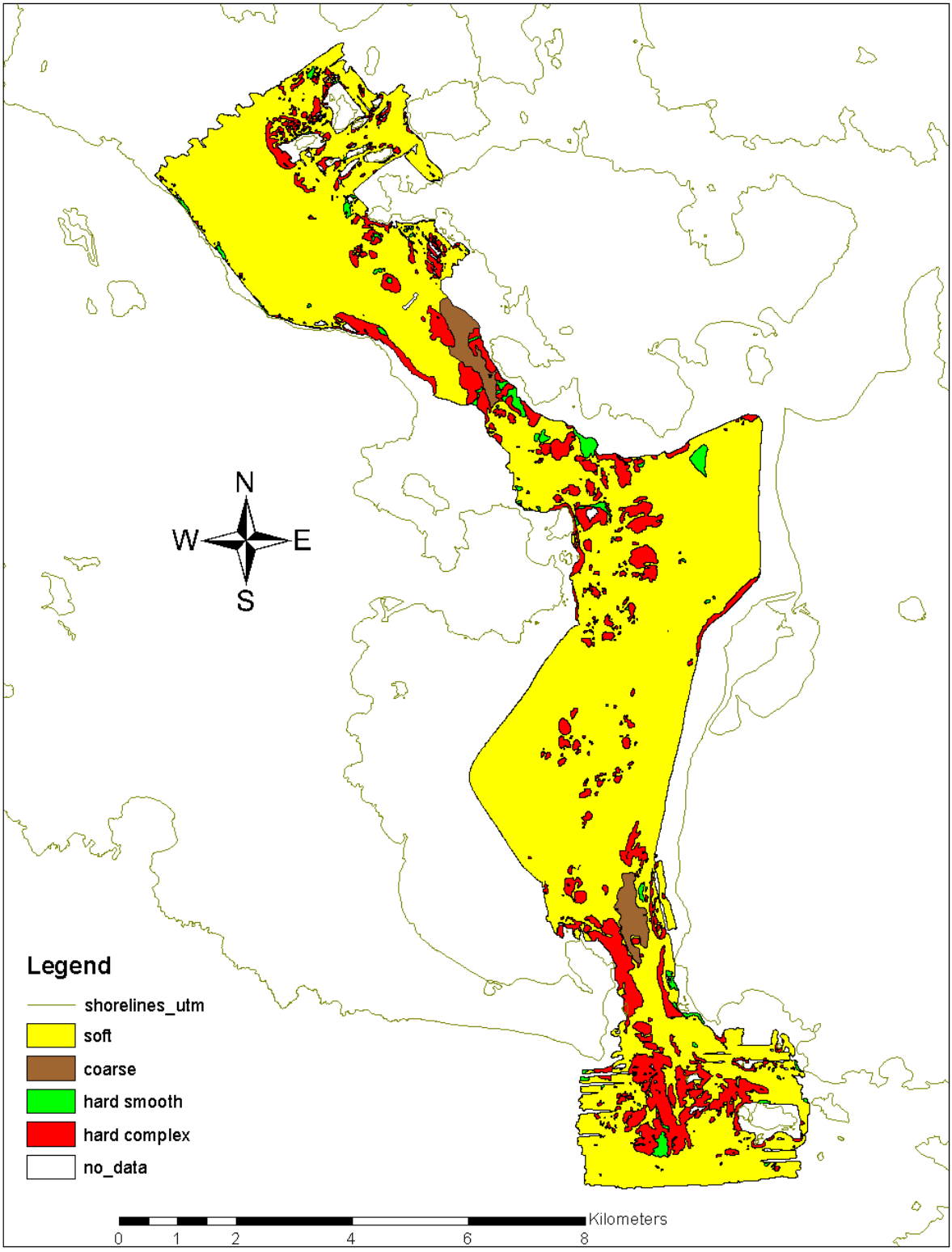



**Figure 1.** Initial stratification of geological habitats in San Juan Channel**.**

**Evaluation of No-Take Refuges for Rocky Habitat Fishes**

WDFW has developed a system of 18 fully and partially protected marine reserves in Puget Sound (Figure 2). As the system has expanded, MFSU staff has developed a plan to monitor a core series

of the marine reserves on a frequent basis and visit other subtidal reserves on a periodic basis. This plan builds upon field research at many of these sites that was begun as early as 1986. The field work primarily consists of scuba divers conducting visual censuses along strip transects. Along with estimating fish density, divers measure individual fish and in the case of lingcod, quantify nesting activity.

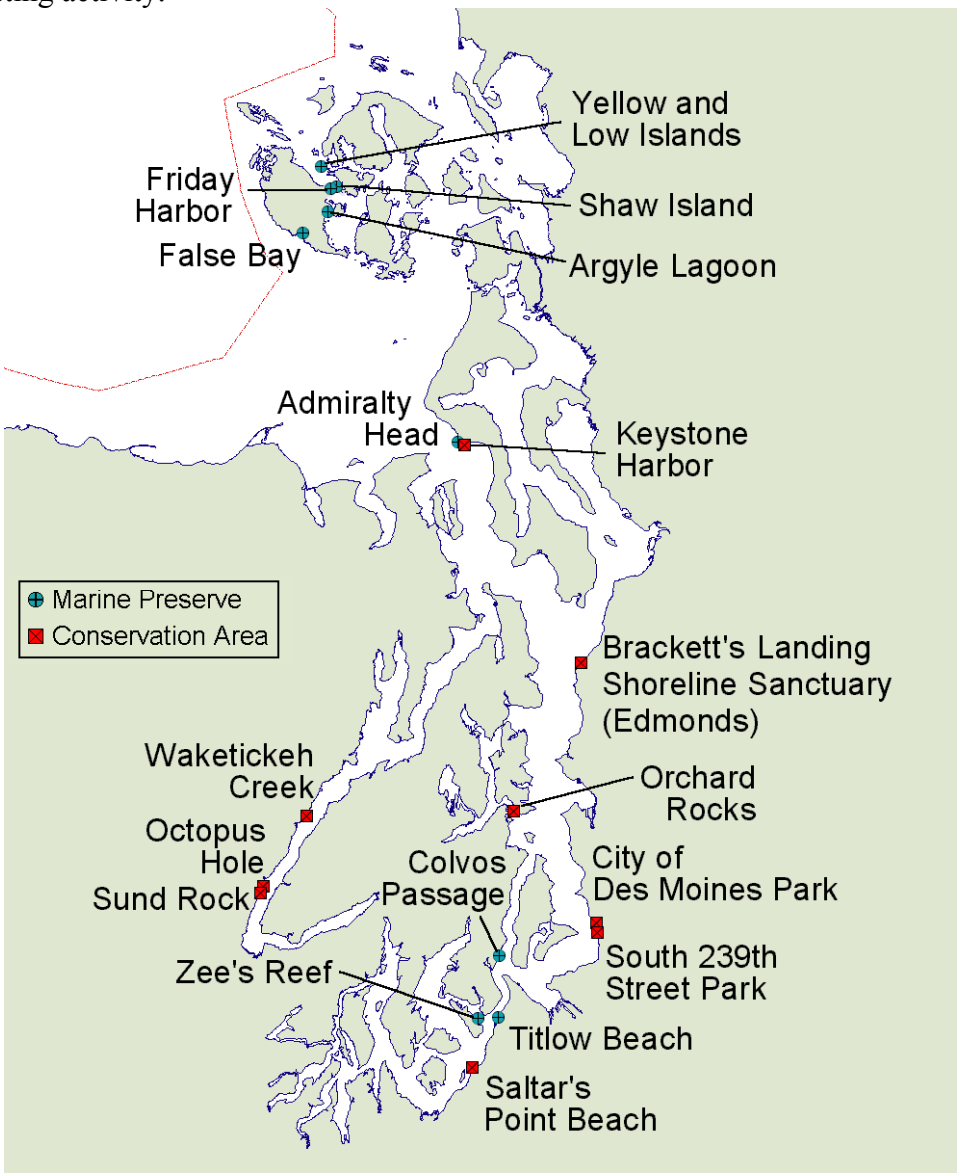



**Figure 2.** WDFW non-tribal marine reserves in Puget Sound. Conservation Areas are fully-protected, Marine Preserves are partially-protected.

Specific monitoring activities in 2004 included surveying many of the Puget Sound reserves and comparable fished sites. Several reserves in central Puget Sound were visited six times during 2004 as an extension of a study initiated in 1999 that takes advantage of the previous information collected at Orchard Rocks. This site was declared as a fully-protected reserve in 1998 but was a fished site monitored in 1986, 1987, and from 1995-1997. With the addition of a new fished site treatment at Point Glover, the newly created refuge in a formerly monitored fished area is an

excellent opportunity to evaluate the before and after impacts of refuge creation with a comparable fished site treatment. WDFW also created several new reserves in 2002. These included subtidal reserves at Admiralty Head and Keystone Jetty in Admiralty Inlet and Zee's Reef in Southern Puget Sound. Monitoring was initiated at Zee's Reef in 2002 with six surveys conducted again in 2004. The reserve at Colvos Passage was also monitored during the same survey series.

The marine reserve monitoring studies conducted in the San Juan Islands, Hood Canal, and Central Puget Sound were analyzed and the results presented at the 2004 Western Groundfish Conference held in Victoria, B.C. The results confirmed those previously reported that most marine reserves had higher densities of copper rockfish and lingcod than comparable and nearby fished areas. These fishes were also larger in the long-term reserve at Edmonds (Brackett's Landing) than at the fished areas. In Hood Canal, where the existing reserves amount to almost 20% of the available nearshore rocky habitat, increasing sizes of copper rockfish have been observed since 1996 at a site set aside as a reserve in 1994. However, recent comparisons among fished and reserves sites has found similar size compositions between reserve and fished area treatments. The densities of copper rockfish are significantly greater in the Hood Canal reserves than the fished area. In the San Juan Islands, rockfish and lingcod densities in the reserves are also greater than at nearby fished areas, but there have not been any discernable trends in size or density for copper rockfish over a span of ten years of monitoring and 12 years after reserve creation. For lingcod at these sites, the winter-time densities are substantially greater than in fished areas, but densities in both reserve and fished area treatments have been increasing. At Orchard Rocks, the central Sound reserve created in 1998, there has not been any increase in copper rockfish abundance, but lingcod abundance has increased.

The analysis also found a major change at the long-term reserve at Edmonds. The study site once harbored a large school of large copper rockfish that accounted for a high estimated reproductive advantage for the long-term reserve compared to fished areas. Since 1999, this school has disappeared with a resulting decrease in the density of copper rockfish at the site. During the same period, lingcod abundance has dramatically increased simultaneously with the decline in copper rockfish. While a number of competing hypotheses can not be ruled out to explain these patterns, the shift to a site dominated by large piscivores may reflect a shift in the trophic dynamics of the reserve. Co-incidentally, a new study on the ecological succession and trophic dynamics in Puget Sound reserves was initiated in 2002 (See below). An expanded abstract of this analysis was published as the following citation and can be found under publications at www.psat.wa.gov.

Palsson, W.A., R.E. Pacunski, and T.R. Parra. 2004. Time will tell: Long-term observations of the response of rocky habitat fishes to marine reserves in Puget Sound. In: 2003, Georgia Basin/Puget Sound Research Conference Proceedings, T.W. Droscher and D.A. Fraser, eds. Puget Sound Action Team, Olympia.

**Ecological Succession and Trophic Cascades in Puget Sound Marine Reserves**

With major funding from the Conservation and Re-investment Act Fund, administered by the U.S. Dept. of the Interior, the MFSU received a grant to examine the prey and predator relationships the array of long-term and newer reserves within Puget Sound as well as nearby fished areas. Karl Mueller was the lead biologist for this project. The grant was initially developed for a three-year study but was cut back to 1.25 years during the first year. The field work was completed during

the contract period and an initial analysis was conducted. The amended work plan included the following objectives: 1.) Develop protocols for monitoring prey species in an array of old and new marine reserves, 2.) Implement biodiversity monitoring in a range of old to new reserves, 3.) Interface biodiversity monitoring with existing surveys for managed species, and 4.) Review predator-prey literature for northwest rocky habitat species, identify data gaps, and recommend further studies.

Protocols for monitoring small fishes, invertebrates and other potential prey species in marine reserves were developed during a pilot study completed in September 2003. Several transect and quadrat sampling techniques were tested using scuba visual census methods. We selected a 0.5 $m^2$ quadrat placed randomly within rocky habitats to estimate the density of small supra-benthic fishes and invertebrates that are known prey items of rockfish, lingcod, and other predaceous bottomfish.

A two-season study was implemented during Fall 2003 and Spring 2004 at seven old and new marine reserves and four comparable fished areas in central and southern Puget Sound and Hood Canal. Thirty to 50 quadrat samples were collected from each study site during each season.

These sampling activities were conducted while other WDFW scuba teams surveyed the same sites for lingcod, rockfish and other, larger rocky habitat fishes. Finally during the study period, we conducted a literature survey to identify existing knowledge on diet, abundance, trends, and succession of marine species.

Final analysis and reporting of the results are pending.

**Low Dissolved Oxygen Conditions at Sund Rocks Marine Reserve**

Hood Canal is a fjord connected to Puget Sound in the north and extending 100 km to the south (Figure 1). The steep sides of the canal extend to depths of 180 m in the north and range to depths of over 125 m for most of the water body. Hood Canal is one of the water bodies identified in the Pew Ocean Commission report as a hypoxic dead zone. Dissolved oxygen (DO) concentrations of less than 2 mg/l have been observed for decades in deep and shallow waters in the southern portion of the canal (Warner et al. 2002; Collias 1974), and these low concentrations have been attributed to naturally poor circulation resulting from low estuarine flow and bottom water replacement. In recent years, low DO concentrations have become chronic, extending into nearshore waters and possibly becoming worse due to eutrophication (J. Newton, Washington Department of Ecology, pers. comm). Mass mortality events of fishes and invertebrates (Fish Kills) in 1926 and 1963 likely have resulted from poor water quality.

Beginning in 2001, WDFW began surveying marine fishes with respect to depth at the Sund Rocks Reserve. Two discrete and prominent rocky habitats located north and south of each other were surveyed independently. A team of three divers conducted the visual surveys. One diver swam the 9 m isobath and oriented the two recording divers along the longitudinal axis of each survey area. The two divers swam along predetermined depth zones and identified, counted, and measured key fish species along the rocky outcropping. The divers swam close together to coordinate their observations and not double count fishes. Total length measurements to the nearest 10 cm meter were made with the aid of a graduated plastic rod.

DO concentrations were obtained from the Washington Department of Ecology's Marine Water Monitoring group, the University of Washington's PRISM program, and citizen monitors with the Hood Canal Salmon Enhancement Group. The data were collected by calibrated continuous oxygen sensors or with water samples and subsequent laboratory titration.

Dive surveys at both the North and South Sund Rocks sites in November 2001 found that copper rockfish were distributed evenly from a depth of 5 m to a depth of 20 m and were generally not present in depths of less than 5 m. Monthly monitoring by WDOE revealed that DO concentrations were at least 3 mg/l in waters shallower than 20 m. In October 2002, we found rockfish were almost exclusively concentrated in depths of less than 7 m during a period when DO concentrations were greater than 4 mg/l in shallow water and less than 2 mg/l at greater depths. Rockfish were distributed evenly to 20 m in depth again by November 2002 when rains restored circulation and DO concentrations were once again greater than 4 mg/l in the nearshore zone. During the 2002 and 2004 low DO events, dead fish were not observed. On October 10, 2003, a fish kill was observed along the western edge of southern Hood Canal. WDFW divers observed dozens of dead copper rockfish, 24 other fish species, and many invertebrates along the shore and during census dives. Eighty dead copper rockfish were measured and they tended to be smaller than the live fish observed during the survey dives. The dive surveys also revealed that only half of the previous counts of copper rockfish were present . These numbers remained low during the subsequent November survey.

These field observations revealed that copper rockfish are hypoxia intolerant and cannot tolerate DO concentrations below 2 mg/l. The observed avoidance behavior is similar to the response of other marine fishes to low dissolved oxygen in Chesapeake Bay and other coastal waters where low dissolved oxygen limits the amount of available habitat (Breitburg 2002). The widespread occurrence of poor water quality in southern Hood Canal has many ramifications for sustainable fisheries pursued by tribal and recreational fishers and for the location and design of marine reserves in the area. Further work is planned for determining the causes of worsening water quality and the impact on marine resources.

**Second Tacoma Narrows Bridge Mitigation Study**

In March 2003, the Washington Department of Transportation (WSDOT) and the Washington Department of Fish and Wildlife (WDFW) established a contract to fulfill part of the terms of the mitigation agreement for the construction of a second bridge at Tacoma Narrows, connecting Tacoma with the Kitsap Peninsula across Puget Sound. The contract establishes that staff from WDFW will conduct sampling at the bridge site to determine the impacts of the disruptive activities associated with the construction of the bridge upon marine fish communities at the bridge site. Primary areas of interest include the two caisson and pier sites, the proposed anchor sites, and the rip-rap fields that will be placed at the footings of the existing and new tower piers. As part of the mitigation, a new artificial habitat will be created at Toliva Shoal. This habitat will be configured as a structure that will potentially attract juvenile rockfishes and improve the existing artificial rocky habitat that was intended to attract adult rockfishes and lingcod.

The first quarter of work was focused upon obtaining video and diving observations at the SNB site before construction activities began disrupting the existing habitats. A plan was submitted to WSDOT detailing the plan for the construction of a juvenile reef at Toliva Shoal as a mitigation measure for the bridge construction. Third quarter activities included indexing videotapes collected during the first quarter, developing protocols to analyze those tapes, and beginning to

quantify the habitat, fishes, and invertebrates in those tapes. The fourth quarter of work was focused upon obtaining video and diving observations in the vicinity of the SNB construction site, and establishing line transects to evaluate the proposed juvenile rockfish habitat at Toliva Shoal.

**Quantitative Video Surveys for Assessing Rocky Habitat Fishes**

Since 1994, Marine Fish Science staff has been conducting quantitative video surveys of nearshore rocky habitats in order to estimate population abundances of rockfishes, lingcod, greenlings, and other rocky habitat species. The survey was originally designed as the Video-Acoustic Technique (VAT) that consisted of a quantitative video camera to survey fishes within 2 m of the bottomfish and a scientific echosounder to survey fishes in the water column above rocky habitats. Beginning in 2002, the acoustic portion of the survey was dropped because of spending reductions. The remaining Video Assessment Techniques is based upon the area-swept method of quantitative surveys. The camera mounted on a platform is anchored at randomly-selected sites on identified rocky habitats. The camera is panned three times during the deployment and the video information is taped. The visual range of the camera is the radius of the area sampled by the camera and the fishes identified and enumerated during the last pan are used with the area to determine a density. The density observations are averaged and then multiplied by the amount of nearshore rocky habitat in the region.

Analysis of video data collected in the past and the estimation of population abundance has been limited by difficulties in estimating the visual range of video plots. Since 1998, two parallel lasers mounted on the camera aid in the determination of the visual range, but range estimates beyond three meters and during previous surveys is difficult and comparisons between observers and with previous determinations of the visual range have resulted in differences between 0.5 m and 1.5 m. Robert Pacunski led an effort in 2003 to develop criteria and tests of the observer's ability to determine visual range. A series of grids and plots were set up underwater around the video platform to measure the visual acuity of the camera. In separate tests without the grid field, wooden fish models were placed around the camera at random but known locations within and outside of the expected range of the camera without the knowledge of the observers. Their observations were then compared to the known locations. Generally, observer agreement was good within 3 m of the camera but became progressively poor to 6 m. which was near the functional limit of the camera. These tests provided the basis to objectively determine the visibility from past surveys and aid the determination of the visual range during current surveys.

In 2004, a quantitative video survey was conducted in the Strait of Juan de Fuca.

Robert Pacunski presented a poster and oral paper at the 2004 Western Groundfish Conference reviewing past survey activities and results and presenting the details of the visual range standardization study.

**2004 Bottom Trawl Survey of Northern Puget Sound**

In 2004, funding for the Bottom Trawl Survey was increased and allowed a synoptic survey of waters east of the Sediu River and north of Port Townsend (Figures 3 and 4). The goals and objectives of this survey were to estimate the abundance and describe the distribution of recreational and commercial groundfish and macroinvertebrate species, collect biological information from key species, and evaluate the relationship of abundance and distribution of key species to oceanographic features and the need for transboundary management. The subregions

included the eastern WA Strait (JE), the western WA Strait (JW), the San Juan Archipelago (SJ) and the US Strait of Georgia (GB).

The chartered *F.V. Chasina* was used as the sampling vessel which towed a 400 mesh Eastern net fitted with a 3 cm codend liner. Stations were selected with a stratified random approach based upon four depth zones for each of the subregions. The area sampled at each station was measured a with differential GPS and known net width openings. The catch from each trawl was identified, weighed, and enumerated, and the weights and numbers of each species were divided by the area sampled to estimate species densities. Abundance will be estimated by averaging station densities within each stratum and multiplying these by the stratum area. A total of 168 of 170 planned trawl stations were occupied and completed.


**Figure 3.** Trawl stations for the 2004 bottom trawl survey, Northern Part.

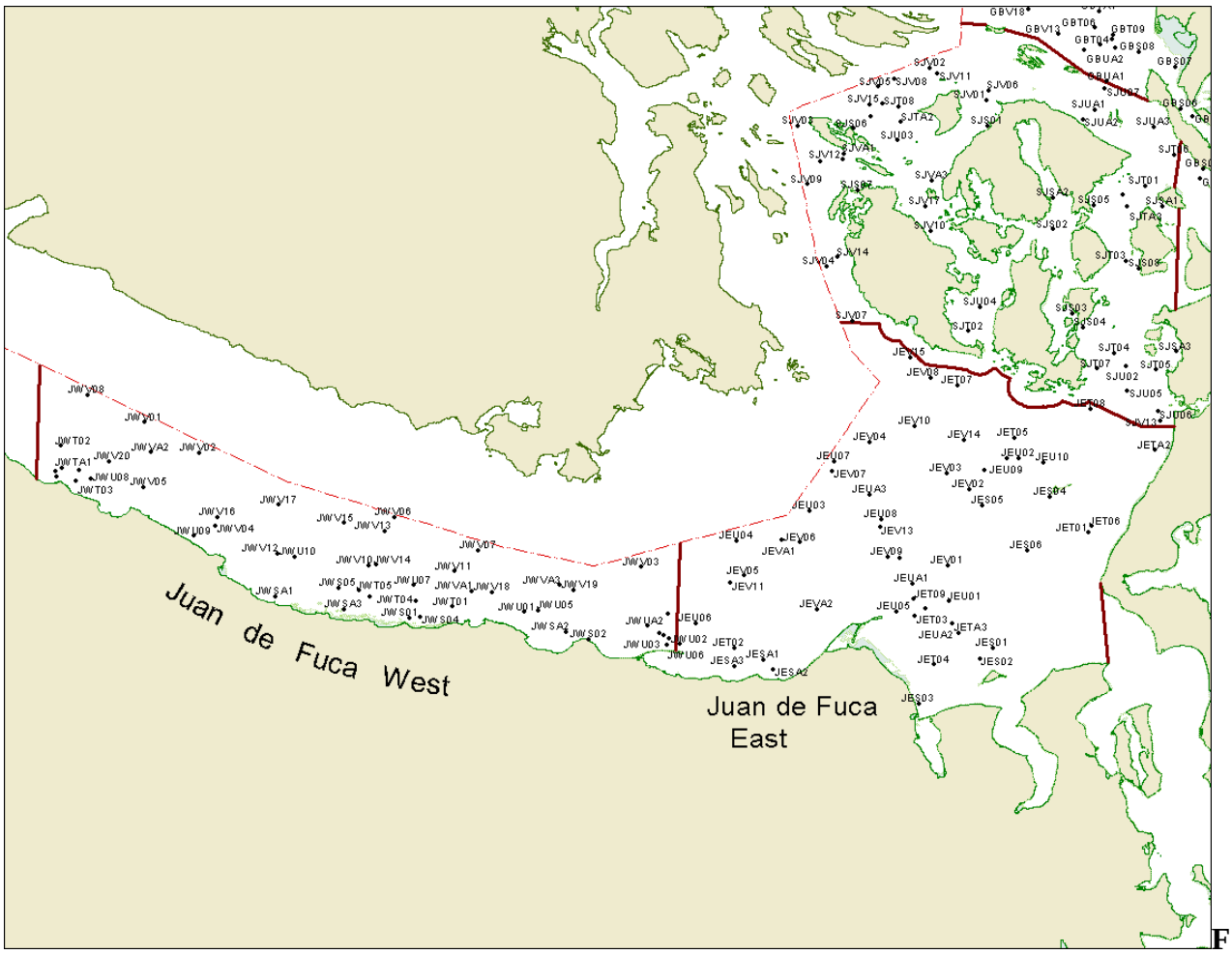



**Figure 4.** Trawl Survey Stations for 2004, Southern Part.

Two reports from past trawl survey reports were released and are available at www.wdfw.wa.gov:

Palsson, W.A., P. Clarke, S. Hoffmann, and J. Beam. 2002. Results from the 2000 transboundary trawl survey of the eastern Strait of Juan de Fuca and Discovery Bay. Wash. Dept. Fish Wildlife Report No. FPT 03-08, 76 p.

Palsson, W.A., S. Hoffmann, P. Clarke, and J. Beam. 2002. Results from the 2001 transboundary trawl survey of the southern Strait of Georgia San Juan Archipelago and adjacent waters. Wash. Dept. Fish Wildlife Report No. FPT 03-09, 109 p.

**Literature Cited:**

Breitburg, D. 2002. Effects of hypoxia, and the balance between hypoxia and enrichment, on coastal fishes and fisheries. Estuaries 25:767-781.

Collias, E.E., N. McGary, and C.A. Barnes. 1974. Atlas of Physical and Chemical Properties of Puget Sound and Its Approaches. Wash. Sea Grant..

Warner, M.J., M. Kawase, and J.A. Newton. 2002. Recent Studies of the overturning circulation in Hood Canal. 2001 Puget Sound Research Conference Proceedings. Puget Sound Action Team, Olympia.

## *3. Herring Stock Assessment.* *Contact: Kurt Stick (360) 466-4345 ext 243)*

Herring spawning biomass estimates were conducted on nineteen spawning grounds in Puget Sound and two coastal grounds in 2004. Stock assessment field work for the 2005 spawning season is in progress. Spawning biomass is estimated for each area by spawn deposition surveys and/or acoustic-trawl surveys.

The herring spawning biomass estimate for all Puget Sound stocks combined in 2004 is 12,007 tons, the lowest cumulative total since 1998. Central and south Puget Sound stocks are generally considered to be at average or above average levels compared to the previous 25 year mean.

The Cherry Point and Discovery Bay stocks are the primary significant Puget Sound stocks that continue to be at critically low levels of abundance. However, the Cherry Point stock spawning biomass estimate for 2004 (1,734 tons) was slightly higher than the 2003 estimate of 1,611 tons and is the highest observed estimate since 1996. The Cherry Point stock is currently under review for potential listing as endangered or threatened under the Endangered Species Act.

Estimated herring spawning biomass for 2004 for coastal stocks (Willapa Bay and Grays Harbor) was much lower than recent years. However, sampling there was limited primarily due to inclement weather conditions.

**HERRING SPAWNING BIOMASS ESTIMATES (SHORT TONS) BY STOCK AND REGION, 1995-2004.**
(blanks indicate no surveys done that year)

| | YEAR | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2004** | **2003** | **2002** | **2001** | **2000** | **1999** | **1998** | **1997** | **1996** | **1995** |
| Squaxin Pass | 828 | 2201 | 3150 | 1597 | 371 | 474 | 68 | 149 | 374 | 157 |
| Wollochet Bay | 52 | 152 | 106 | 133 | 142 | | | | | |
| Quartermaster Harbor | 727 | 930 | 416 | 1320 | 743 | 1257 | 947 | 1402 | 805 | 2001 |
| Port Orchard-Port Madison | 700 | 1085 | 878 | 2007 | 1756 | 2006 | 489 | 360 | 806 | 863 |
| South Hood Canal | 176 | 207 | 166 | 187 | 140 | 516 | 101 | 226 | 239 | |
| Quilcene Bay | 2342 | 916 | 2585 | 2091 | 2426 | 2464 | 1152 | 465 | 328 | 817 |
| Port Gamble | 1257 | 1064 | 1812 | 1779 | 2459 | 1664 | 971 | 1419 | 2058 | 3158 |
| Kilisut Harbor | 184 | 448 | 784 | 612 | 107 | 802 | 311 | 307 | 380 | |
| Port Susan | 429 | 450 | 1356 | 587 | 785 | 545 | 2084 | 828 | 110 | 363 |
| Holmes Harbor | 673 | 678 | 573 | 275 | 281 | 175 | 464 | 530 | 336 | |
| Skagit Bay | 1245 | 2983 | 2215 | 2170 | 646 | 905 | 209 | 893 | 736 | 891 |
| **South-Central Puget Sound Total** | 8613 | 11114 | 14041 | 12758 | 9856 | 10808 | 6796 | 6579 | 6172 | 8250 |
| Fidalgo Bay | 339 | 569 | 865 | 944 | 737 | 1005 | 844 | 929 | 590 | 1173 |
| Samish/Portage Bay | 351 | 299 | 496 | 470 | 196 | 555 | 643 | 509 | 636 | 194 |
| Int. San Juan Is. | 67 | 72 | 158 | 219 | 128 | 197 | | 30 | 277 | |
| N.W. San Juan Is. | 0 | 13 | 131 | 62 | 90 | | 107 | 79 | 53 | |
| Semiahmoo Bay | 629 | 1087 | 1012 | 1098 | 926 | 868 | 919 | 621 | 1219 | 1245 |
| Cherry Point | 1734 | 1611 | 1330 | 1241 | 808 | 1266 | 1322 | 1574 | 3095 | 4105 |
| **North Puget Sound Total** | 3120 | 3651 | 3992 | 4034 | 2885 | 3891 | 3835 | 3742 | 5870 | 6717 |
| Discovery Bay | 252 | 207 | 148 | 137 | 159 | 307 | 0 | 199 | 747 | 261 |
| Dungeness/Sequim Bay | 22 | 44 | 131 | 93 | 138 | 352 | 112 | 158 | 180 | 287 |
| **Strait of Juan de Fuca Total** | 274 | 251 | 279 | 230 | 297 | 659 | 112 | 357 | 927 | 548 |
| **Puget Sound Total** | 12007 | 15016 | 18312 | 17022 | 13038 | 15358 | 10743 | 10678 | 12969 | 15515 |
| Grays Harbor | 33 | 129 | 87 | 77 | 166 | 297 | 77 | | | |
| Willapa Bay | 0* | 398 | 389 | 150 | 345 | 397 | 57 | 144 | | |
| *partial survey coverage | | | | | | | | | | |
| **Coast Total** | 33 | 527 | 476 | 227 | 511 | 694 | 134 | 144 | | |

## *4. Puget Sound Ambient Monitoring Program (PSAMP).* *Contact: Sandie O'Neill (360) 902-2843*

The Washington Department of Fish and Wildlife continues to be a key component of the Puget Sound Ambient Monitoring Program Project (PSAMP), a multi-agency effort to assess the health of Puget Sound. To assess how the health of the Sound is affected by chemical contamination of it's fish, the PSAMP Fish Component monitors "legacy" pollutants like PCBs and DDTs that persist in the ecosystem despite restrictions in their use, PAHs, which are compounds associated with petroleum and with combustion, heavy metals, and emerging toxics like PBDEs that are used as flame retardants. The following are summaries of projects we have been working on this past year.

### Contaminant Levels in Pacific Herring

Since 1999, WDFW has annually monitored contaminant levels is whole bodies of Pacific herring at several sites in Puget Sound. The results of this ongoing monitoring were reported at the 2005 Research in Puget Sound Georgia Basin Conference and are summarized in the following abstract:

***Persistent organic contamination in whole bodies of Pacific herring (Clupea pallasi) in Puget Sound, Washington: evidence of environmental segregation of stocks based on contaminant levels and patterns of contamination.***

Presented by James E. West[1], Sandra M. O'Neill[1], and Gina Ylitalo[2]

[1]Washington State Department of Fish and Wildlife
[2]National Marine Fisheries Service

We assessed spatial variation in body burdens of toxics in spawning stocks of Pacific herring (Clupea pallasi) from Puget Sound, Washington to determine if stocks differ in the degree of contaminant exposure concentrations in this pelagic planktivore. We estimated exposure to persistent organic pollutants in adult fish by measuring whole body concentrations of PCBs, chlorinated pesticides (DDT and its metabolites) and hexachlorobenzene (HCB). Recent exposure to polycyclic aromatic hydrocarbons (PAHs), was estimating from biliary concentrations of PAH-metabolites, measured as fluorescing aromatic compounds (FACs). We observed higher exposures of PCB and biliary FACs (PAH metabolites expressed as equivalents of benzo-a-pyrene, and phenanthrene) in adult herring from the central Puget Sound basin where most of the urban bays are located. The higher toxics levels in herring from the central and southern Puget Sound basin suggest that zooplankton in the central and southern Puget Sound basins are contaminated. Unique contaminant exposure patterns indicate that winter-spawning stocks in northern Puget Sound and the Strait of Georgia feed in different area those in central and southern Puget Sound. The spring-spawning Cherry Point stock appears to have feed in a different location than any of the winter-spawning stocks.

**Contaminants in Prey of Killer whales**

The Washington Department of Fish and Wildlife (WDFW), in conjunction with NOAA Fisheries, is conducting a study to assess contaminant concentrations in prey of northern and southern resident killer whales. In 2003 AND 2004, we concentrated our efforts on known prey, especially Pacific salmon species, that are consumed by these whales during the summer and early fall as the salmon migrate back to their natal streams. In 2005, we plan to sample epi-benthic and demersal species that have been infrequently documented as prey items, mostly from gut contents of carcasses from stranded whales as well as potential prey items. Lingcod will be sampled for chemical analyses. The following is an abstract for a poster presented at the 2005 Research in Puget Sound Georgia Basin Conference held in Seattle, March 2005:

***Elevated levels of persistent organic pollutants in Puget Sound vs. other free-ranging populations of Pacific salmon: the importance of residency in Puget Sound.***

Presented by Sandra O'Neill[1], Gina Ylitalo[2] Margaret Krahn[2], Jim West[1], Jennie Bolton[2] and Donald Brown[2].

[1]WA Dept Fish and Wildlife
[2]NOAA Fisheries, Northwest Fisheries Science Center

Free ranging populations of anadromous Pacific salmon generally have low levels of persistent

organic pollutants (POPs), as most of their growth occurs in open water of the Pacific ocean, distant from contaminant sources in populated coastal locations. However, the five species of Pacific salmon differ in their oceanic distribution with some species having a more coastal distribution. Furthermore, populations within species can also differ in their use of estuaries and in oceanic distribution. We analyzed whole body samples of 5 species of Pacific salmon from populated and unpopulated locations to assess species-specific body burdens in POPs and to determine whether Puget Sound salmon were more contaminated than other free-ranging populations. More Chinook populations were sampled than for the other salmon species, including a population resident in Puget Sound. Our results indicate that in remote, unpopulated areas, POP concentrations were highest in Chinook and sockeye salmon, likely because of their higher trophic position and higher fat content. For Chinook salmon, Puget Sound residents had the highest POPs concentrations, followed by Puget Sound populations believed to be ocean-reared and both were significantly higher than other free-ranging populations from other locations. A separate study on POPs in fillets of Puget Sound Chinook indicated that fish returning to spawn at a younger age (which were also less likely to have migrated far beyond Puget Sound) had higher POP concentrations than older fish that probably migrated further from Puget Sound. Collectively, these results suggest that residence in Puget Sound exposes Chinook salmon to higher POP concentrations and the longer a Chinook resides in Puget Sound, the greater its exposure to POPs will be.

**Evaluation of PBDE levels in Puget Sound Fishes**

WDFW completed a project to assess the degree to which chemicals associated with flame-retardants are accumulating in Puget Sound fishes. The results, summarized in an presentation at the 2005 Research in Puget Sound Georgia Basin Conference (see abstract below), clearly showed that polybrominated diphenyl ethers (PBDEs) are present in both benthic and pelagic fishes, often at concentrations higher than other west coast populations. This work was funded by angrant from US EPA, Region 10 and the Puget Sound Action Team. Abstract follows:

***A multi-species evaluation of the presence of polybrominated diphenyl ethers in the Puget Sound food web.***

Presented by Sandra M. O'Neill[1], James E. West[1], , and Gina Ylitalo[2]

[1]Washington State Department of Fish and Wildlife
[2]NOAA Fisheries, Northwest Fisheries Science Center

Concentrations of polybrominated diphenyl ethers (PBDEs) were measured in fish species representing a variety of life history traits to give a broad overview of contamination in Puget Sound. Our objectives were to determine to what extent PBDEs have infiltrated the benthic and pelagic food webs, and to assess potential exposure routes. A coarse assessment of PBDEs in the benthic food web indicated that PBDE concentrations in muscle tissue of English sole (Parophrys vetulus) were higher at urban sites compared to near-urban and non-urban sites. At one of these urban bays we also measured PBDEs in individual male quillback rockfish (Sebastes maliger) and individual female lingcod (Ophiodon elongatus) to assess biomagnification of PBDEs in species with different trophic status. PBDE concentrations were similar between English sole and rockfish from the same urban bay, despite rockfish's higher trophic status and greater age, but were considerably higher in lingcod, a high-level carnivore. Although PBDEs were not higher in

rockfish than English sole, they did accumulate with age in male rockfish. Overall, PBDE concentrations in benthic species were lower than concentrations measured in whole body samples of Pacific herring (Clupea pallasii) from Puget Sound, and in sub-adult resident Chinook salmon (Oncorhynchus tshawytscha), indicating broad PBDE contamination of the pelagic food web. A comparison of concentrations of PBDE and PCBs in benthic and pelagic fish suggests that PBDEs accumulate faster in lipid rich pelagic species. Finally, we determined that PBDEs in mature Chinook salmon from Puget Sound were considerably higher than other Pacific Northwest free-ranging populations, suggesting a Puget Sound source of PBDEs.

**English Sole Home Range Study**

WDFW and NMFS have a collaborative study designed to examine the home range and site fidelity of adult English sole in Eagle Harbor, an embayment with contaminated sediments. We tagged surgically implanted R256 (channel D) V8 transmitters in 20 English sole in 2003 and 19 in 2004. During both years, we maintained an array of six receivers in Eagle Harbor to detect entrance and exit of the English sole. The receivers were attached to aids to navigation, derelict piles, and moored to the bottom in some cases. We also conducted periodic mobile tracking with a VR60 to find fish in the bay. Our plan is to operate the receiver array through this summer, as many of our transmitters will still be ticking through December 2005. We are looking forward to possibly releasing yet another group of English sole in the Harbor in 2006 after a more extensive VR2 array is operational in Puget Sound. The following is an abstract for a poster presented at the 2005 Research in Puget Sound Georgia Basin Conference held in Seattle, March 2005:

***USE OF ACOUSTIC TAGGING TO STUDY HOME RANGE AND MIGRATION OF ENGLISH SOLE (PAROPHRYS VETULUS) IN PUGET SOUND: APPLICATION TO MANAGEMENT OF CONTAMINATED SEDIMENTS.***

O'Neill, Sandra M[1], Myers, Mark S[2], Moser, Mary L[2], Anulacion, Bernadita F[2], Quinnell, Stephen R[1*] and West, James E[1]

[1] Washington Department of Fish and Wildlife
[2] NOAA Fisheries, Northwest Fisheries Science Center

English sole are a suitable species for studies on effects of contaminants because they are broadly distributed in benthic habitats along the Pacific Coast where they can contact contaminated sediment. Historic tagging studies of Puget Sound stocks have shown that, with the exception of a winter spawning migration, adult English sole demonstrate site fidelity within sub-basins of Puget Sound, tending to remain on discrete feeding grounds most of the year. A significant correlation between liver disease in English sole and chemical contaminants in the sediments at their capture sites further support the hypothesis of high site fidelity. However, more complete information is needed on home range and habitat utilization to adequately characterize relationships between sediment contamination and fish health. A two-year study was initiated in 2003 to document movements by adult English sole tagged with acoustic transmitters. Twenty fish from Eagle Harbor, a small, contaminated bay, were implanted with transmitters and released at the site of capture. Stationary hydrophones were deployed to monitor fish moving in and out of the harbor. Individual fish movements within the harbor were actively tracked using portable hydrophones. Ten fish (50%) left the bay and did not return (9 of the 10 left within two weeks of release). Fish that stayed in the bay were generally found near the area of capture. Preliminary data analyses

from tagged fish released in 2004 indicated similar movements patterns for the fish. These data will help refine estimates of home range, habitat use, and migration timing of English sole so we can better understand their exposure to contaminated sediments.

## *5. Puget Sound Marine Fish Research.* *Contact: Ray Buckley (360) 902-2828*

**Trans-generational Marking of Viviparous Marine Fish in Puget Sound, Washington**
(Contact: Ray Buckley, Marine Fish Science, 360 902-2828, bucklrmb@dfw.wa.gov)

Investigators at the Washington Department of Fish and Wildlife have been experimenting with the use of elemental strontium as a means to mark the otoliths of viviparous marine fish larvae prior to birth. Laboratory trials with captive perch and rockfish have shown that a single intermuscular injection of strontium into gestating adults is sufficient to produce a lifelong strontium mark in the otoliths of larvae prior to birth, thus providing a potential method for directly estimating retention and dispersion rates from local populations.

Co-investigators at U.C. Santa Cruz developed FDA approved protocols for evaluating withdrawal rates of strontium chloride from injected fish. Depuration curves based on 30,000 ppm injections delivered at 5 ccs per kilogram of body weight (maximum anticipated dosage) produced strontium concentrations well below the FDA maximum allowable for human consumption. Based largely on these findings, the FDA granted regulatory discretion in June of 2004 for a period of four years to capture and release strontium injected rockfish and perch into two study sites: Point Heyer Artificial Reef, Washington and Point Lobos Ecological Reserve, California. The first field application is now underway.

Methods for capturing and injecting fish in situ using SCUBA and a self-filling syringe designed for use underwater were tested and refined in spring of 2004. Thirty-one late stage gravid brown rockfish were captured, injected, and released at Point Heyer during May through August, 2004. In conjunction with a companion project that is using genetics to search for evidence of self-recruitment (see below), sampling of juvenile rockfish commenced in May of 2004. Based on time of capture and length, a sub-sample of approximately 225 juveniles captured to date were judged to be potential recruits from progeny of injected females. Otoliths from these fish were dissected and 12 of them have been examined using wavelength dispersive elemental analysis to test for the presence of above ambient levels of strontium chloride. Strontium marks have not, thus far, been unequivocally detected. Juvenile fish collecting is ongoing and analytical techniques are being refined. More fish will be analyzed in coming months.

Transects will be established at Point Heyer in 2005 and surveyed periodically in order to produce estimates of rockfish and perch size distribution and abundance. This baseline data will be used to evaluate the extent of self-recruitment in the event that strontium marked offspring are recovered.

Use of Microsatellite DNA and Pedigree Analysis to Test For Self-recruitment in an Isolated Population of Brown Rockfish in Puget Sound, Washington
*(Contact: Larry LeClair, Marine Fish Science, 360 902-2767, leclalll@dfw.wa.gov)*

This collaborative study between the Washington Department of Fish and Wildlife and the University of Washington is aimed at using genetic markers to identify progeny of resident adult

brown rockfish among juveniles sampled at an isolated reef near Point Heyer, Washington. Non-lethal in situ sampling using tissue clipped from the dorsal lobe of the caudal fin are being used to genotype individuals at 12 microsatellite loci. To date, 137 adults, estimated to be about one third of the total adult population, have been sampled and genotyped. Genotypes from 118 juveniles have been obtained. Preliminary results using a maximum likelihood estimation approach indicate self-recruitment to be about 15%; however, low genetic variability and higher than expected genotyping error has lead to some ambiguity in assigning parent-offspring-sib relationships. Further work in coming months will focus on the development of additional marker loci with greater allelic richness and ways to reduce genotyping error. Genotypes will also be used to pedigree strontium marked juveniles if encountered (see above). Results are expected to be directly applicable to the design and placement of MPA's in Puget Sound and elsewhere.

## B. Coastal Area Activities

### *1. Coastal Groundfish Management.* *Contact: Michele Culver, (360) 249-1211 or Brian Culver, (360) 249-1205)*

**Council Activities**
The Department contributes technical support for coastal groundfish management issues via participation on the Groundfish Management Team (GMT), the Scientific and Statistical Committee (SSC), and the Habitat Steering Group (HSG) of the Pacific Fishery Management Council (PFMC). The Department is also represented on the Scientific and Statistical Committee and Groundfish Plan Teams of the North Pacific Fishery Management Council. Landings and fishery management descriptions for PFMC-managed groundfish are summarized annually by the GMT in the Stock Assessment and Fishery Evaluation (SAFE) document.

**Essential Fish Habitat Draft Environmental Impact Statement**
The Pacific Fishery Management Council is considering proposals to protect Essential Fish Habitat (EFH) for West Coast groundfish stocks. Under the Magnuson-Stevens Fishery Conservation and Management Act, regional fishery management councils are required to "describe and identify essential fish habitat…minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat…."

The Council will be considering alternatives that describe and identify EFH for groundfish and, as part of this process, will also consider establishing Habitat Areas of Particular Concern (HAPCs). Although the Magnuson-Stevens Act does not require regional councils to designate HAPCs, the National Marine Fisheries Service has encouraged them to do so, based on one or more of the following considerations: 1) the importance of the ecological function provided by the habitat; 2) the extent to which the habitat is sensitive to human-induced environmental degradation; 3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and 4) the rarity of the habitat type.

The National Marine Fisheries Service has produced a Draft Environmental Impact Statement (DEIS), which includes descriptions and analyses of the proposed EFH and HAPC alternatives.

The EFH DEIS is available online at:
http://www.pcouncil.org/groundfish/gfefheis/gfefheis_doc.html

Designation of areas as HAPCs does not automatically mean that management measures (e.g., prohibiting fishing activities) would apply to those areas. However, a conservation group, Oceana, has proposed a HAPC alternative whereby identified areas would be closed to bottom trawl fishing. The areas, which would be closed to bottom trawl fishing under this alternative, are described in a list of coordinates, which are included in the EFH DEIS.

The Washington Department of Fish and Wildlife is reviewing and analyzing the potential impacts to fishers by closing these areas to bottom trawling, based on trawl logbook data. The Department is not necessarily endorsing the Oceana alternative; rather, we are trying to gain a better understanding of the potential impacts to fishing activities that could result from these closures. We are also trying to facilitate communication between Oceana and the affected industry members in an effort to mitigate these potential impacts.

**Bycatch Plan Amendment**
In September 2004, the Pacific Fishery Management Council adopted a preferred alternative to address bycatch in the West Coast groundfish fishery. The Council is in the process of finalizing a Groundfish Fishery Management Plan (FMP) Amendment and a work plan to implement the preferred alternative.

The preferred alternative contains the following elements: 1) amend the FMP to require the use of current bycatch minimization measures; 2) amend the FMP to fully describe the current standardized bycatch reporting methodology; 3) amend the FMP to incorporate the Pacific Council's Groundfish Strategic Plan goal of reducing overcapacity in all commercial fisheries; 4) implement a sector-specific bycatch accounting methodology; 5) support the future use of individual fishing quota (IFQ) programs as bycatch reduction tools for appropriate fishery sectors (e.g., bottom trawl); 6) authorize the use of sector-specific total catch limit programs (total catch = landed catch + discard mortality) to reduce bycatch of overfished (depleted) species in appropriate sectors of the fishery. These programs could include monitoring standards, full retention programs, and individual vessel incentives for exemption from total catch limits.

**Spiny Dogfish Control Date**
The spiny dogfish fishery is currently prosecuted by a limited number of vessels specializing in the fishery during the winter and early spring months when dogfish occur in fishable concentrations off the northern Washington coast. The dogfish market is also relatively limited. A formal stock assessment for west coast dogfish has not yet been conducted, but one is planned for the next assessment cycle (2007). Even in the absence of a formal assessment, life history information indicates that characteristics of the spiny dogfish (slow growing, late maturing, low fecundity) make it susceptible to overfishing. Dogfish populations have been depressed as a result of fishing in areas of Puget Sound and have been declared overfished on the East Coast.

Dogfish are currently included in the optimum yield for "Other Fish" in the management specifications for the West Coast groundfish fishery. Given the life history characteristics of dogfish and their status in other areas, the Pacific Council may consider adopting a separate ABC and OY for dogfish along with harvest control regulations (trip limits, etc.) as part of the 2007-08

management cycle. Therefore, it might be prudent to consider a mechanism to maintain the viability of the historical fishery while remaining within the allowable catch. Requiring an endorsement or permit based upon catch history is one mechanism that could be used to preserve the stability and economic viability of the current fishery should overall reduction of total catch become necessary.

Implementation of a dogfish endorsement or other mechanism to control dogfish catch for would require an amendment to the FMP. The results of stock assessments conducted and reviewed in 2007 could affect management measures considered as part of the 2009-10 management cycle. Therefore, endorsements or other mechanisms to control dogfish catch, if approved, would be effective in 2009, at the earliest. While the potential effective date is a few years away, it will likely take over a year to draft the proposed and final rule and implement the resulting endorsement or permit application review, response, and appeal processes. As fishers are already aware that the Council may be considering limiting participation in the dogfish fishery in the future, the Pacific Council adopted a control date of April 8, 2005, to address the potential of speculation-based fishing activities.

## *2. Coastal Sardine Management.* *Contact: Michele Culver, (360) 249-1211 or Brian Culver, (360) 249-1205)*

**Experimental Purse Seine Fishery for Sardines**

In Washington, sardines are managed under the Emerging Commercial Fishery provisions, which provide for the harvest of a newly classified species, or harvest of a previously classified species in a new area or by new means. From 2000 through 2002, the Washington Department of Fish and Wildlife had trial purse seine fisheries for Pacific sardines, under which the number of participants cannot be limited. Following an extensive public process which included establishing and meeting with a formal Sardine Advisory Board, the Director decided to advance the sardine fishery to an experimental fishery in 2003, under the Emerging Commercial Fisheries legislation, which mandates that permits be limited.

Pacific sardines are managed under the Pacific Fishery Management Council's Coastal Pelagic Species (CPS) fishery management plan. The Pacific Council develops and adopts a coastwide annual harvest guideline, which is then allocated between the two areas which take into account the biological and ecological impacts of harvesting forage fish. Earlier this year, the Pacific Council adopted an interim allocation regime with plans to develop a long-term allocation strategy over the next year.

The Northwest sardine fishery has rapidly expanded over the past few years, which was the primary reason the Department decided to convert from a trial to an experimental fishery. Oregon began its limited developmental fishery in 1999, which yielded 771 mt in sardine landings. Since then, the Northwest landings have increased for a total of 37,923 mt in 2002, and 36,862 mt in 2003. In 2004, the overall coastwide harvest guideline increased from 110,908 mt in 2003 to 122,707 mt, producing an initial northern allocation of 40,493 mt.

The fishery opened on May 15, 2004, however, the first landing into Washington occurred on June 24. The Department issued a total of 21 permits and 14 permit holders participated in the fishery.

There were two primary vessels who accounted for 58% of the total landings–both vessels fished out of Ilwaco.

A total of 8,799.5 mt of sardines were landed into Washington. A total of 238 landings were made and 100 occurred within the month of August. A total of 375 sets were made with 89% (333) of them successful. Average catch per successful set was about 38 mt.

The Department provided observer coverage for the fishery and averaged about 27% coverage overall. Observers collected total catch data including species, amount, and condition, and noted whether the fish were released or landed. Bycatch included small amounts of salmon, spiny dogfish, blue shark, herring, mackerel, and other species of fish.

Department staff also collected and processed biological samples. Otoliths were extracted and sent to the Department's lab in Olympia for age-reading. Data collected on the samples include standard lengths, individual weights, sex, and maturity.

## *3. Coastal Groundfish Monitoring, Research, and Assessment*

**Black Rockfish Tagging Study.** *Contact: Eric Eisenhardt (360) 249-1208*
In 1998, WDFW began a multi-year mark-recapture survey near Westport Washington, the principal location of recreational landings of black rockfish along the Washington coast. The survey design involves annual releases of coded wire tagged (**CWT**) fish and recovery of tagged carcasses from the recreational fishery, both of which are currently on going. From 1998 to 2001, WDFW's R/V Corliss was used to capture, tag and release 2,622, 3,478, 2,779 and 3,200 black rockfish annually. Since 2002, commercial charter vessels have been used, including F/V Hula Girl, F/V Slammer and F/V Tequila Too. A total of 4,089 black rockfish were caught, tagged and released in 2002, 6,744 in 2003, 5,981 in 2004, and 3,716 in 2005. In 2004, passive integrated transponder (**PIT**) tags were used to reduce the labor need to read and match recovered tags. In 2005, all tagged fish released were tagged with both CWTs and PIT tags, which will allow estimation of PIT tag loss rates (since CWT loss rates are already known).

Fish are released on pinnacles distributed throughout the area fished by the Westport charter fishing fleet. Each CWT tagged fish had two tags placed in the opercular musculature: one on each side of each fish's head. The tags were marked to allow for identification of specific individuals upon subsequent recapture. No tag shedding or tag related mortality was observed during holding experiments during 1998, 1999 and 2003. PIT tags are injected into the throat patch musculature, and appear to have excellent retention and very low to non-existent shedding rates.

On an annual basis, roughly 40% of the total Westport recreational black rockfish catch is sampled for tags by passing fish carcasses through a metal detector tube (Northwest Marine Technologies R8000). A total of 14, 79, 365, 260, 423, 612 and 293 tags were recovered in 1998, 1999, 2000, 2001, 2002, 2003 and 2004 respectively. The cooperation of the charter boat fleet has been very good and enabled us to achieve the high sample proportion of the total number of fish landed (including those filleted at sea). Mark-recapture data is used to estimate fishing mortality (which is the primary driver for assessing trends in the fishery), as well as to measure growth and

movement of black rockfish in the Westport coastal area. Population parameter estimates will be incorporated into the 2005 black rockfish age structured model.

We are also in developing stages for two additional projects. First, we are deploying juvenile traps in a habitat stratified design this spring through late fall to monitor recruitment. This work is in collaboration with Susan McBride (UC Sea Grant) and Jennifer Bloeser (Pacific Marine Conservation Council) who have been conducting this research in California and Oregon since at least 2002. Second, we will place sonic tags in nine black rockfish this summer and monitor their movements using acoustic telemetry through the winter of 2005-2006.

# F. Groundfish Landed Catch Data

For Groundfish catch data please visit the Pacific Coast Fisheries Information Network on the web at: **www.psmfc.org/pacfin.**

# PRINTED BY

**Pacific States Marine Fisheries Commission**
**205 SE Spokane Street, Suite 100**
**Portland, Oregon 97202**

**Phone: (503) 595-3100**
**Fax: (503) 595-3232**

compiled and edited by:

Stephen Phillips,
Bess Wong and Susan Anderson

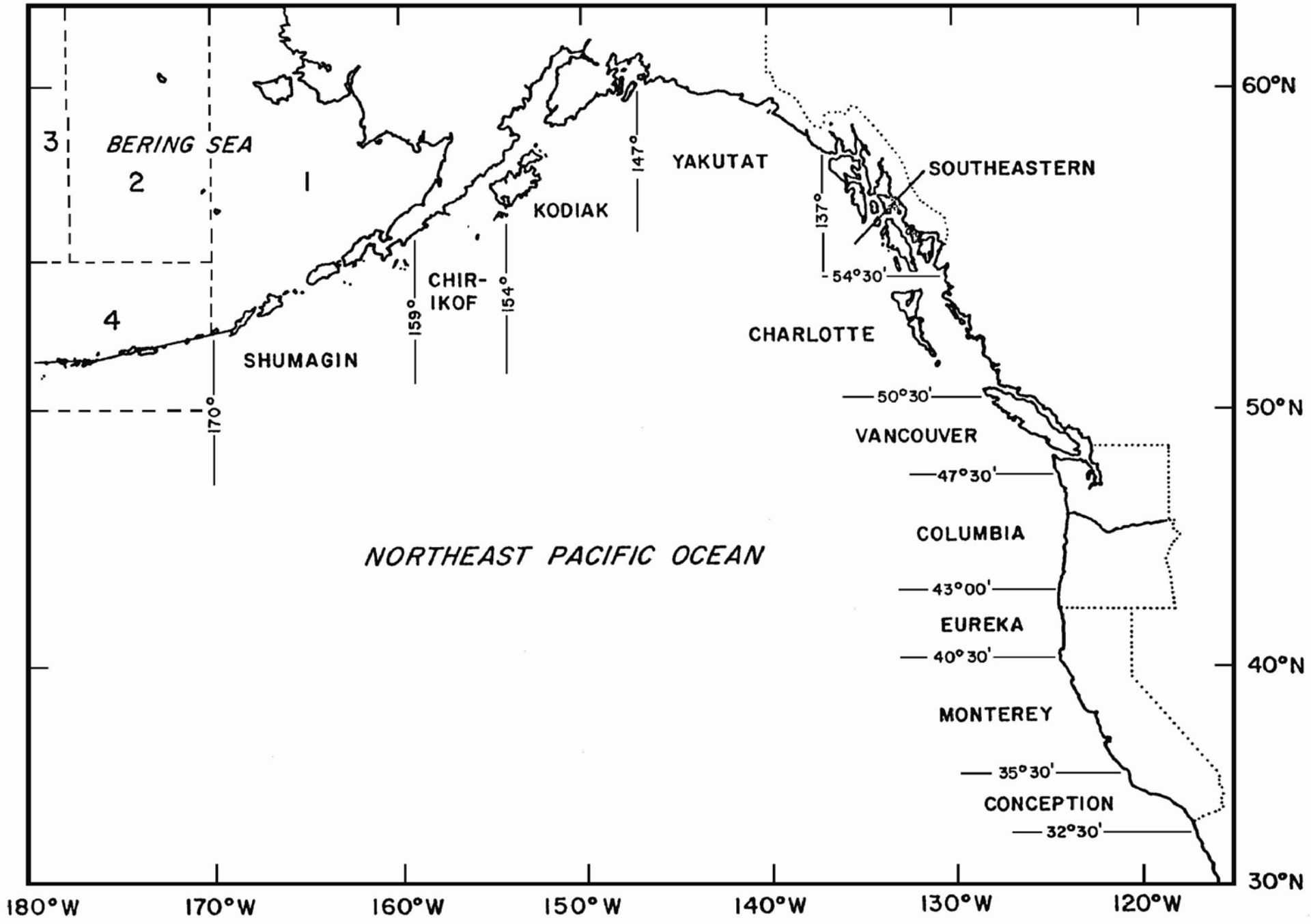



**Figure 1**.--International North Pacific Fisheries Commission (INPFC) statistical areas in the north Pacific Ocean.