Alaska Fisheries Science Center
of the
National Marine Fisheries Service

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

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

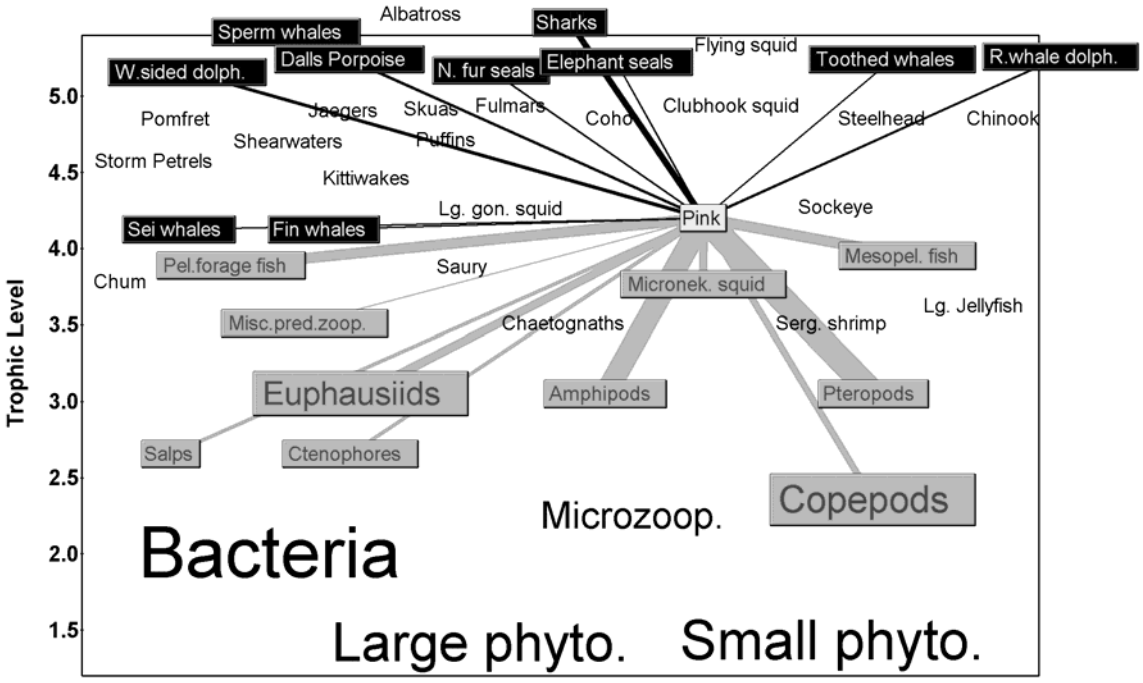


Figure 1. Food web of the oceanic Alaska gyre, emphasizing pink salmon. Prey of pink salmon are shown in grey; predators of pink salmon are shown in black. Line widths are proportional to the volume of flow (tons/year).

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.

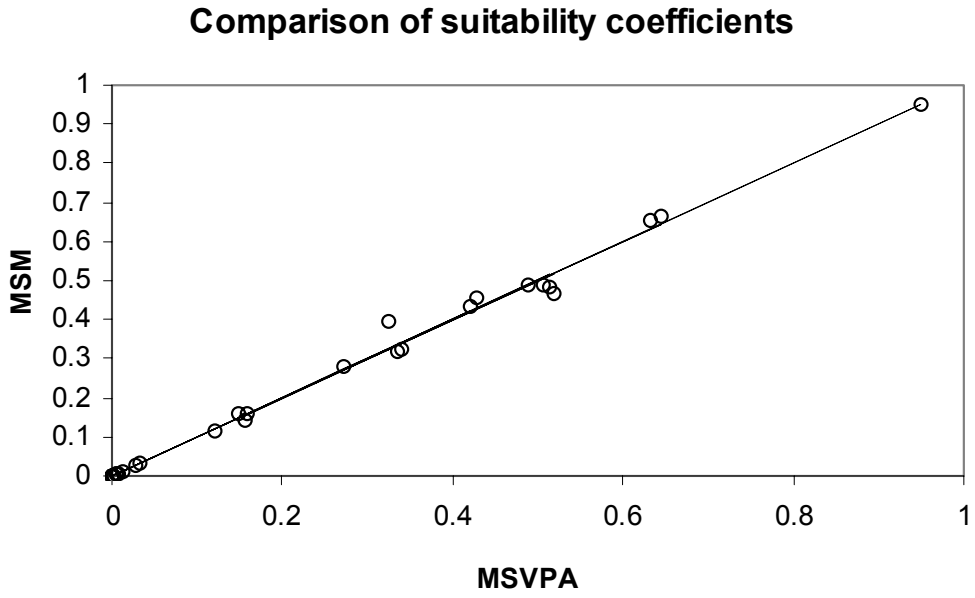


Figure 2. Comparison of estimates of average suitability coefficients for walleye pollock as predator from the multispecies virtual population analysis and the multispecies statistical model.

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.

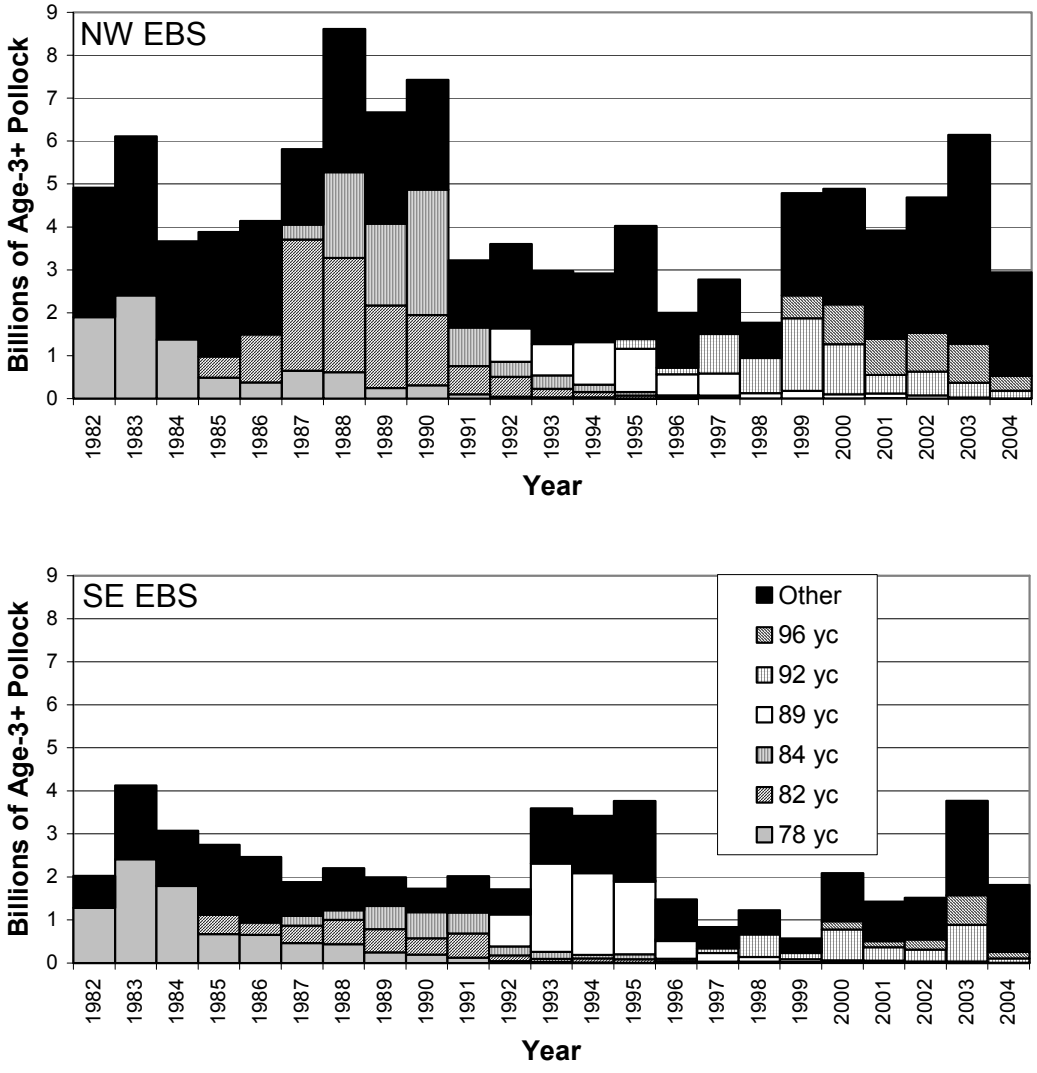


Figure 3. The number of walleye pollock, age-3 and older, in the NW and SE regions of the EBS shelf as found by the summer bottom trawl survey from 1982 through 2003. The contribution of large yearclasses (78, 82, 84, 89, 92, and 96) in each region are indicated in each year.

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 "b" 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% less than last year's estimate and down about 8% 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% 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 Ientification 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 "b" of Tier 3. The maximum F_{ABC} value allowed under Tier 3b is computed as follows:

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

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 b iomass 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:

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

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 "a" 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 "Other 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 "Other 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. 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 "a" 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 "herding" 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 "a" 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 affects 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 "a" 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 "a" 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 – 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 "other 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 "a" 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 ($\leq$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 $F_{50\%}$ 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 "a" 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 5.5 ºC. 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.

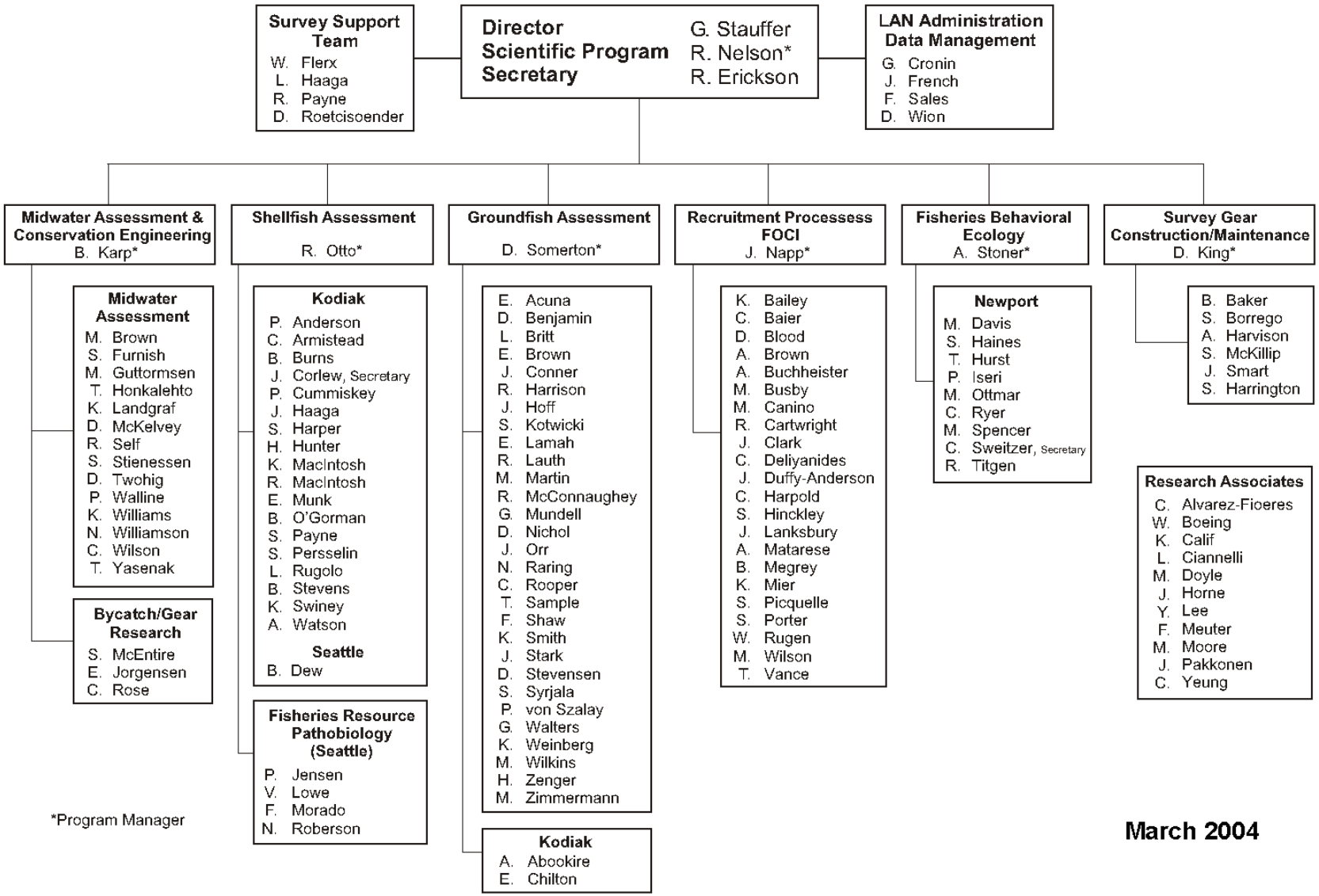
STEVENSON, D. E., and A. MATARESE.
(*In press*). The ronquils: a review of the North Pacific fish family Bathymasteridae (Actinopterygii: Perciformes: Zoarcoidei). Proc. Biol. Soc. Wash.

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 –Acting 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