Alaska Fisheries Science Center
of the
National Marine Fisheries Service

2003 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 2002

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 review of pertinent work by these tasks 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 . Lists or organization charts of groundfish staff of these three units are included as Appendices II, III, and IV.

RACE DIVISION

In 2002 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 (in odd years) and the Aleutian Islands and the upper continental slope of the eastern Bering Sea (in even years).

Three major bottom trawl surveys of groundfish resources were conducted in 2002 by RACE researchers on the eastern Bering Sea shelf, on the Aleutian Islands shelf, and along the

continental slope of the eastern Bering Sea. Groundfish habitat-related research (previously reported as Trawlex studies) was also continued by RACE scientists under the newly formed Habitat Research Team.

The Midwater Assessment and Conservation Engineering (MACE) Program conducted echo integration-trawl (EIT) surveys of midwater pollock abundance in the Bering Sea and Gulf of Alaska during the winter and summer, 2002. Regions included the Shumagin Islands and the southeastern Aleutian Basin near Bogoslof Island in February, and Shelikof Strait and areas south and east of Kodiak Island in March. MACE scientists conducted an EIT survey on the Bering Sea shelf and slope in June and July, and continued efforts with REFM scientists to study the interactions between commercial fishing, pollock, and Steller sea lions in an area east of Kodiak Island in August and September.

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. 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. Richard Marasco at (206)526-4172.

NMFS - AFSC - AUKE BAY LABORATORY

The Auke Bay Laboratory (ABL), located in Juneau, Alaska, is a division of the NMFS Alaska Fisheries Science Center (AFSC). In recent years, ABL's Groundfish Assessment Program has been primarily involved with research and assessment of sablefish and rockfish in Alaska and with the study of fishing effects on the benthic habitat. In 2001, the Groundfish Program began additional new projects to study the interaction between Steller sea lions and prey/predators in Alaska. Presently, the Groundfish Program is staffed by 16 scientists, including 14 permanent employees and 2 term employees. Four employees in other ABL programs have also been involved with research on groundfish in recent years.

In 2002 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) a study that used a manned submersible to

investigate distribution of deep-water corals in the Aleutian Islands; 2) a multibeam echosounder survey of two fishing grounds in the Yakutat area of the Gulf of Alaska to produce detailed bathymetric and habitat maps for these grounds; 3) a series of cruises in southeast Alaska to test the hypothesis that juvenile sea lion prey diversity and seasonality are related to Steller sea lion population trends; 4) the completion of a longline study in the central Gulf of Alaska to test the hypothesis that Pacific sleeper sharks prey on Steller sea lions; 5) ongoing scuba diving studies of growth rates of shallow water coral species to help determine effects of fishing on these taxa in Alaska; 6) continued juvenile sablefish studies, including tagging of juveniles and a laboratory young-of-the-year sablefish growth study; 7) a genetics study that determined species identification of young-of-the-year rockfish from offshore waters of the Gulf of Alaska; 8) electronic archival tagging of sablefish during the longline survey; and 9) a continuing habitat study of groundfish in nearshore areas of southeastern 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 three annual status of stocks documents for Alaska groundfish: sablefish, slope rockfish, and pelagic shelf rockfish. Other analytic activities during the past year were: 1) a continuing study of the use of echosounder signals to stratify trawl surveys for Pacific ocean perch and thereby improve survey precision; and 2) an analysis of the relative abundance of Pacific sleeper sharks in Alaska based on longline survey data. In addition, Groundfish Program staff spent considerable time working on analyses for two Supplemental Environmental Impact Statements (SEIS): a revised Programmatic SEIS for the Bering Sea/Aleutian Islands and Gulf of Alaska Groundfish Fishery Management Plans and a new SEIS for essential fish habitat in Alaska.

For more information on overall Auke Bay Laboratory programs, contact Laboratory Director Dr. Michael Dahlberg 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 completed from June 2- July 24, 2002. A total of 393 stations were 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 survey for the tenth consecutive year. This also marked the 21st survey of what is considered the 'standard' time series of consistent area, gear and sampling protocol.

Preliminary biomass estimates for major roundfish species indicated a slight increase from 2001 for walleye pollock and a decrease for Pacific cod. Most flatfish species showed little changes in abundance from the previous year. The relatively warm recent winters in the Bering Sea have apparently had an effect on the bottom temperatures. At 3.27 ^{o} C., 2002 had the 2nd warmest average bottom temperature in the 21 year time series.

Eighteen additional stations were sampled in the continuing experiment to evaluate inshore yellowfin sole distributions toward improving our population estimates. The first steps of an experiment to examine maturity of Chionocetes crabs were completed by the Kodiak

Laboratory and will continue with the Alaska Department of Fish and Game throughout the year. At the end of the survey, an experiment was completed to examine King Crab escapement under the footrope of the EBS standard 83-112 survey trawl.

For further information, contact Gary Walters, (206) 526-4143.

Bering Sea Upper Continental Slope Bottom Trawl Survey - RACE

After a hiatus of over 10 years, the bottom trawl survey of the continental slope of the eastern Bering Sea is back on line. An experimental survey was completed in 2000 to determine the best trawl gear to use, and the first production survey was completed from June 5- July 31, 2002. The survey completed 141 successful tows between 54° - 61° N and a depth range of 200-1200 m. The survey is scheduled to be repeated every two years and additional tows will be added until the survey reaches its target of about 200 hauls.

Two species of macrourids - giant and popeye grenadier, Pacific ocean perch, arrowtooth flounder, sleeper sharks, and the Alaska skate were the most abundant species, on a weight basis, during the survey.

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

Aleutian Islands Biennial Groundfish Bottom Trawl Survey - RACE

The eighth comprehensive bottom trawl survey of Aleutian region was conducted from May 13 through August 15. It was the second of the biennially scheduled surveys; previous Aleutian groundfish surveys occurred triennially between 1980 and 2000. The 140 vessel-day survey period was divided among the chartered commercial trawlers *Sea Storm*, *Vesteraalen*, and *Morning Star*. Sampling operations began on the north side of the Aleutian Islands between Unimak Pass (165° W longitude) and the Islands of Four Mountains (170° W longitude) and extended westward throughout the Aleutian Archipelago to Stalemate Bank (170° E longitude).

The primary focus of these ongoing surveys is to build a standardized time series of data to assess, describe, and monitor the distribution, abundance, and biological condition of various Aleutian groundfish and invertebrate stocks. Standard RACE Division methods and sampling gear have been used throughout the time series of the survey.

The Aleutian region is an extensive archipelago of volcanic origin typified by a relatively narrow continental shelf that is crossed by numerous deep passes. Very strong currents flow through the passes and across the shelf, sometimes making productive fishing operations difficult or impossible. Commercially valuable roundfish such as Atka mackerel, Pacific cod, walleye pollock, sablefish, flatfish (most notably Pacific halibut and Greenland turbot), rockfish species (including Pacific ocean perch, northern rockfish, rougheye and shortraker rockfishes), and invertebrates including golden king crab and scallops inhabit the area. Extensive areas of rough, rocky bottom provide abundant substrate for many species of bryozoans, hydroids, sponges and corals.

The Aleutian survey area was divided into 4 major sections based on geographic features and North Pacific Fishery Management Council (NPFMC) regulatory areas. Those sections were further divided into 45 area-depth strata to a depth of 500 m. A Neyman optimum allocation

strategy drawing on data from previous surveys was used to develop a stratified random sampling distribution among the strata.

Relatively little time was lost to bad weather, but during periods of extreme tidal flow, heavy currents sometimes caused work to be postponed or tows to be aborted. When satisfactory bottom conditions could not be found at a pre-assigned station, a pre-selected alternate location, or in some cases a new location within the proper area-depth stratum was sampled. Four hundred eighty-three tows were attempted during the survey. Successful tows were performed at 417 of 423 assigned stations ranging in depth from 20 to 470 m.

Biomass estimates indicate that Atka mackerel was, overall, the predominant species in survey trawl catches, but Pacific ocean perch (POP) was the predominant species in the Eastern area. POP ranked second in overall total biomass in the Aleutian region. Northern rockfish was third overall in total biomass, followed by walleye pollock. In the southern Bering Sea area walleye pollock ranked first in total biomass, followed by Atka mackerel and POP. Historically, biomass estimates for Atka mackerel and POP have varied considerably, but consistently have been the largest component of the groundfish biomass.

Among AFSC groundfish Aleutian triennial and biennial surveys, the coldest bottom temperatures were detected during 2000. The warmest years tend to lag about a year behind El Niño events. The three coldest years thus far detected (1994, 2000, and 2002) have occurred within the last eight years, with one of the warmest (1997) occurring in their midst. Generally, mean temperatures at depths shallower than 300 m vary more than those from waters deeper than 300 m.

For further information please contact Harold Zenger, (206) 526-4158 or refer to
http://www.afsc.noaa.gov/Quarterly/jas2002/RACE%20.pdf .

Recruitment Processes

The Recruitment Processes Program of AFSC's RACE Division is charged with meeting the Center's research needs on recruitment issues for Alaska's living marine resources. Most of the research is based on the paradigm that variability in recruitment to harvestable stocks is set early in the animals life (first year) and is the result of processes strongly influenced by the physical and biological environment in which the early life history stages occur. Within the program is Fisheries-Oceanography Coordinated Investigations (FOCI) -- a collaborative research project between two NOAA Line Offices: NMFS and Oceans and Atmospheric Research (OAR). OAR's representatives are physical oceanographers and atmospheric scientists from the Pacific Marine Environmental Laboratory. One objective of these coordinated investigations is to improve the timeliness information used by management for decisions on optimal harvest levels, by providing recruitment forecasts during the first year of each new year-class. The project's focus has principally been recruitment processes of walleye pollock. In recent years, however, the group has expanded its research to the early life histories of arrowtooth flounder, forage fish (age-0 pollock, capelin, eulachon, Pacific sand lance, and larval transport mechanisms of offshore spawning flatfish (arrowtooth flounder and halibut).

No update had been received from this program by the time this report was submitted.

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

Fisheries Behavioral Ecology Program - RACE

The Fisheries Behavioral Ecology Program conducts experimental research directed toward understanding 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 2002 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.

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 codend meshes. In studies related to discards, an attempt has been made to understand the key principles which control mortality, integrating analysis of behavioral and physiological assays along with observed mortality. Recent work with sablefish and Pacific halibut have shown that 1) environmental factors, including temperature and air exposure can interact with gear stressors to magnify morality; 2) susceptibility to stress and mortality is species specific and strongly influenced by fish size; and 3) mortality may be delayed, such that it is difficult to estimate through traditional approaches which capture and hold fish aboard vessels or in net pens in the field. Fish of various sizes were exposed for 10 to 60 min to air at 10, 14 and 18ºC. Mortality increased as a function of air time and air temperature, with smaller fish having greater mortality under any given treatment. The presence of higher levels of mortality in smaller fish indicates that the practice of highgrading in fisheries is counter productive for stocks and should be restricted. Behavior of fish was measured 1, 2, 3 and 24 h after stressor treatments as orientation and startle responses to mechanical and visual cues. Obvious deficits in behavior were observed even in fish that were exposed to minimal stressor intensity. Recovery of behavior to control levels did not occur within 24 h. The magnitude of behavioral deficits was correlated with stressor intensity and increased until mortality was observed. Clearly, discarded fish have behavioral deficits which make them more susceptible to predation after release and this is probably an additional source of indirect morality that is not presently being measured in field studies. Delayed mortality was not observed in fish exposed to air and increased temperature, but became apparent in fish that were towed in a net prior to exposure to air. The correlations between injury from fishing gear, environmental factors, behavioral deficits, immunosuppression and delayed mortality are presently being investigated in greater detail.

Further progress was made in studies related to the condition of fish escaping through codend meshes. Prior experiments had revealed that juvenile walleye pollock (age-2) were stressed by escape from a simulated trawl codend. This impaired their anti-predator behavior, rendering them more vulnerable to predation in the hours and days afterwards. Walleye pollock are relatively ‘fragile’ species, in terms of their ability to survive physical stress, so it was unclear whether this would be a generalized effect, influencing the behavior and survival of other fish species. In 2002, similar experimentation was completed on age-2 sablefish, a much more ‘durable’ species, compared to walleye pollock. These experiments yielded nearly identical results to those obtained for walleye pollock, with fish significantly impaired and more vulnerable

to predation after escape from a simulated trawl codend. This suggests that behavioral impairment of trawl escapes may be wide spread among commercial species and that behavioral competency should be considered in the design and evaluation of bycatch reduction devices (BRDs).

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 and other gear. In 2002, the Fisheries Behavioral Ecology Program conducted experiments to determine how changing environmental variables influence responsiveness of Pacific halibut and sablefish to baits. Halibut were tested under varying conditions of light and food deprivation in large laboratory tanks. Both had strong effects on fish locomotion and ability to locate and handle bait. The effects of light influence halibut catch rates related to season, time of day, and depth. Sablefish were tested under varying conditions of water temperature (2-8ºC) and food deprivation. Responsiveness to bait, both in terms of detection and attack times and rates, were strongly effected by both variables with temperature having the largest effect. Reduced sensitivity to olfactory cues, lower swim speed, lower attack frequency, and increased time to attack baits combine to reduce sablefish catchability and the effective area of baited fishing gear. Population sizes based upon baited gear surveys can be greatly underestimated in conditions where environmental variables such as light and temperature reduce feeding motivation or locomotion.

Habitat Studies

Features of the benthic environment such as bedform and the presence of structures provided by sessile organisms may influence habitat suitability for young fishes, and the abundance of these structures can be reduced by fishing gear. Juvenile flatfishes are generally thought to gain shelter from sediment, either through burial or cryptic coloration, and eventually escape from predation through growth. However, emergent structure in low relief benthic habitats may also play an important role in the ecology of juvenile flatfishes. During 2002, mesocosm experiments with juvenile rock sole and Pacific halibut were completed. These experiments demonstrated that both species have a preference for habitats with complex structure over bare sand habitat, although this preference was greater in halibut than rock sole. Structures tested included sponges, bryozoans, bivalve shells, and sand waves. Age-0 fishes were more selective than age-1 juveniles.

The effect of habitat structure upon predation vulnerability of juvenile (age-0) Pacific halibut and northern rock sole was examined in experiments completed in 2002. When allowed to forage in bare sand, or sand with 16% sponge coverage, predators (age-2 halibut) consistently consumed fewer age-0 flatfish in the sponge habitat, with halibut generally more vulnerable to predation than rock sole. This was largely due to lower encounter rates between predator and prey in the sponge habitat. Importantly, age-0 Pacific halibut and rock sole differed considerably in their anti-predator behavior. Rock sole utilized stereotypic flatfish defense mechanisms, relying upon motionlessness, burial and crypsis, and were less likely to flush at a predator' approach than halibut. Halibut, while less cryptic, have a deeper/narrower body that confers greater swimming speed, and were more likely to flush as a predator approached. This flushing/flight response was facilitated by the presence of structure (sponge), and coupled with their greater vulnerability to predation, may explain why halibut showed a greater preference for structured habitats.

As part of an effort to extend these laboratory finding to the field, during 2002 trials were initiated near Kodiak Island, to test the efficacy of a towed camera sled for quantification of density and habitat associations for juvenile flatfishes and other demersal species. These preliminary field trials demonstrated that the towed camera yielded much higher fish counts for age-0 flatfishes than fine-mesh beam trawls, and provided density estimates equal to or better than diver surveys. The camera sled can be used to cover great distances at relatively low cost and provides a permanent record for surveying both fishes and habitat features. Field studies will continue in 2003.

Other Ecological Studies

Vision and Fish Behavior: In coastal oceans and estuaries, fish are often faced with the challenge of foraging and avoiding predators under conditions where turbidity severely degrades their visual capabilities. In addition to increasing light attenuation, the light-scattering properties of suspended materials decreases apparent contrast, reducing the distance at which objects can be seen. This should have a greater impact upon fish which detect their prey at distance, for example piscivorous species, than it does upon fish which detect prey in the near-field, e.g. planktivores. During 2002, the Fisheries Behavioral Ecology Program conducted research in collaboration with researchers of the Northwest Fisheries Science Center, examining the relative impact of turbidity upon the foraging behavior of age-2 sablefish (a piscivore) and age-0 chum salmon and walleye pollock (both planktivores). As predicted, the ability of sablefish to detect prey was greatly impaired at even moderate turbidities, whereas chum salmon and walleye pollock foraging was unimpaired at even very high turbidities. These results suggest that turbid environments may be advantageous for planktivorous fish because they will be less vulnerable to predation by piscivores, but will not experience a substantial decrease in their ability to capture zooplankton prey.

Growth Studies: New research projects have been initiated examining environmental influences on growth rates and growth strategies of juvenile fishes. Energy reserves (lipids) generally enhance survival of fishes during periods of resource limitation, but their accumulation must occur at the expense of increases in muscle mass, likely resulting in increased predation risk. During 2002 a laboratory experiment addressed the impact of an interruption in growth on the subsequent growth and energy storage strategy of juvenile sablefish. Energetic analyses of these fish are pending. In another experiment, the growth, consumption and energy storage of juvenile northern rock sole were examined across the range of temperatures generally encountered by this species. Rock sole maintained minimal positive growth at temperatures as low as 2^{o}C, with growth rates increasing rapidly at higher temperatures. Preliminary data suggests that allocation between growth and energy storage was not strongly affected by temperature in this species. These processes are critical to the recruitment of juvenile fishes and determine the response of populations to variable environmental conditions.

Dr. Thomas Hurst joined the program in March 2002 to lead studies on the behavior and ecology of walleye pollock, sablefish, and flatfishes. Scott Haines and Paul Iseri joined the technical staff in 2002.

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, data manager/technician, and 10 age readers. Ages are usually determined from otoliths, but scales and/or finrays 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 whiting, Pacific cod, sablefish, Pacific Ocean perch, northern and dusky rockfishes, Atka mackerel, yellowfin sole, rock sole, rex sole, and misc. sole and rockfish species.

Craig Kastelle and Joan Forsberg (IPHC) recently published a paper (Kastelle and Forsberg, 2002) investigating the loss of Rn-222 from otoliths using young, 5-7yr old, halibut collected in 1960. Craig Kastelle, Kim Shelden (NMML), and Dan Kimura (Kastelle et al. 2003) have recently published a paper on radiometric age estimation for mysticete whales. The procedure appeared to work for gray whales but not bowhead whales. Craig is currently working on the radiometric age validation of walleye pollock.

Charles Hutchinson is working on his Masters Thesis which is focused on rockfish age determination. Areas of study include the first three years of Pacific ocean perch; developing shortraker age determination criteria by comparing ring counts with radiometric ages; and bomb carbon age validation of canary rockfish with Kevin Piner (NWFSC).

The Age and Growth Program recently hired Lisa Conkey who comes to us through the University of Idaho; and John Brogan who recently graduated from New Mexico State University.

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

Resource Ecology and Ecosystem Modeling - REFM

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 2002, we collected samples during bottom trawl surveys of the Aleutian Island and the eastern Bering Sea shelves. Observers collected stomach samples during fishery operations from the eastern Bering Sea. In total, 13,490 stomachs were collected from the eastern Bering Sea and 2,870 from the Aleutian Islands. Laboratory analysis was conducted on 16,433 fish stomachs from the Bering Sea, 2,868 from the Gulf of Alaska and Aleutian Islands, and 541 from the Washington-Oregon-California region.

Multispecies, foodweb, and ecosystem modeling and research is 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.

Development and extension of food web modeling techniques

REFM scientists, in collaboration with NMML scientists and the National Center for Ecological Analysis and Synthesis (NCEAS) are continuing to develop and improve ecosystem modeling techniques. The development and critical review of food web models culminated in a REFM-sponsored workshop held at the Alaska Fisheries Science Center on March 29 entitled 'Towards understanding Ecopath with Ecosim's potential role in fisheries management.' The meeting was attended by over 20 participants with presentations from researchers from REFM, NMML, the Pacific Fisheries Environmental Laboratory (PFEL),the University of Washington, the University of British Columbia, and the University of Cape Town, South Africa. The aim of this meeting was to discuss the appropriate uses of the popular food web modeling tools, with a focus on developing versions of these tools that may aid in future ecosystem management efforts. The discussion covered model methodology and data requirements, preliminary results and possible uses in investigating trophic interactions with respect to fisheries management. The creation of an extended version of these models with improved statistical capabilities is underway by REFM.

Uncertainty in Trophic Cascade Models

In conjunction with NMML researchers, Kerim Aydin prepared an analysis of the uncertainty inherent in attempts to manage and control trophic cascades in large marine ecosystems. Specifically, a 'general' and extremely simplified trophic model was built in which marine mammals (pinnipeds) competed with a fishery for a groundfish (gadid) species. Other species in the model included phytoplankton, zooplankton, a generic forage fish, and a fish predator, which was assumed to have no developable commercial value (Figure 1).

The model was calibrated so that, at the start of the modeled time period, the system was in equilibrium, and the fishing yield on the groundfish species was at maximum sustainable yield (MSY). The model was manipulated by reducing the pinniped population by 50% and allowing the model to reach a new equilibrium over 50 years. The resulting year-50 biomass levels and fisheries catch (assuming constant fishing effort) are shown in Figure 2. As can be seen, the reduction in pinnipeds did indeed increase groundfish biomass and fisheries yield by approximately 10% (columns in Figure 2). However, a Monte Carlo simulation of the error ranges for these estimates (assuming very low ±30% error for input diets, ±10% error for initial biomass and production levels) resulted in broad 95% confidence intervals. As can be seen, groundfish biomass and catch were likely to go down or up, and estimates of juvenile groundfish biomass range from explosively upward to crashing.

This result is explained by the fact that the removal of a slow component of the ecosystem (marine mammals) helps its competitors (faster-growing predatory fish of low commercial value) as often as it helps its prey (groundfish). This is true with the smallest realistic levels of input error (equilibrium assumptions, unrealistically small range of error in diets). In other words, trophic cascades are not possible to control across a large marine ecosystem (stock-level) management scale even with extremely precise data; rather, trophic manipulations must be directed and localized in time and place, to avoid causing 'undesirable' and unexpected changes in the system. New models are being prepared to include manipulations involving lower trophic level marine mammals (baleen whales) and are being extended to more detailed models (for example, the eastern Bering Sea model as modeled with 40+ functional groups).

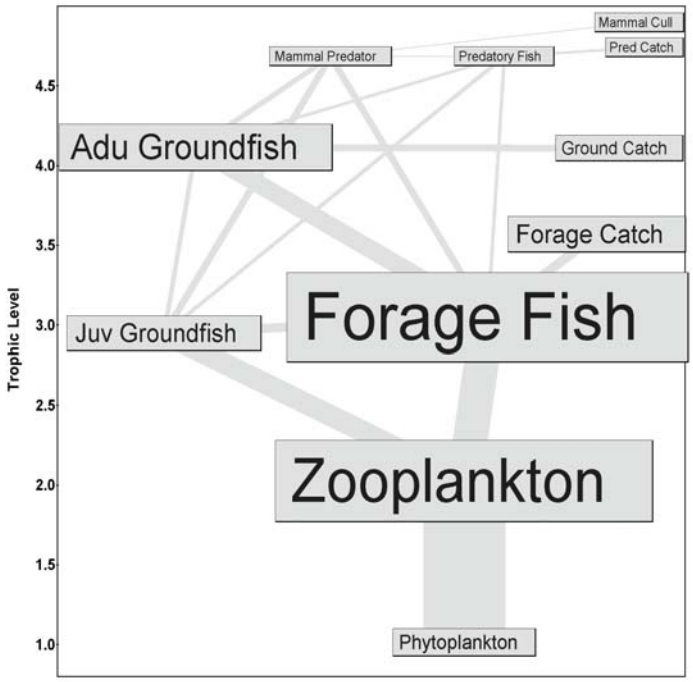

Figure 1. The simplified food web (including fisheries catch) used to examine the effects of mammal (pinniped) removal from the ecosystem. Box area is proportional to initial (equilibrium) biomass or yield.

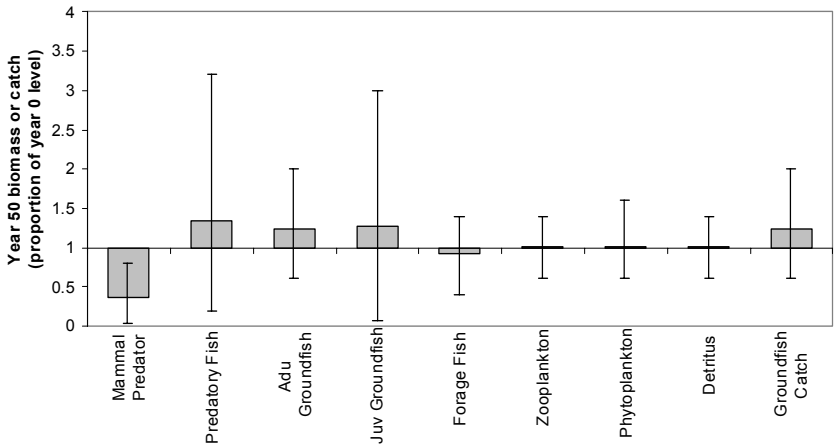

Figure 2. Year-50 biomass and groundfish catch for the system illustrated in Figure 1 (columns) and 95% confidence intervals obtained through Monte Carlo simulations assuming minimal uncertainty in initial (equilibrium) state.

Sensitivity analysis of the multispecies virtual population analysis model parameterized for a system of trophically-linked species from the Eastern Bering Sea.

A sensitivity analysis of a multispecies virtual population analysis (MSVPA) model parameterized for the Bering Sea was carried out by Jesus Jurado-Molina. Input parameters varied were residual natural mortality (M1), predator ration, and terminal fishing mortality of fish species in the MSVPA. Four variables related to the predation mortality (M2) and population size of age-1 walleye pollock and Pacific cod were chosen as response variables. The 10% perturbation of Pacific cod residual natural mortality was the only input parameter that resulted in a greater change in a response variable, the number of age-1 cod (15%). Results suggested that the response variables of walleye pollock were only slightly sensitive to changes in some input parameters. Pacific cod response variables were sensitive only to variables related to Pacific cod. Results from the individual perturbation parameter analysis also showed that the changes produced by large positive perturbations in the other food parameter were small. The results obtained in this work reinforce the overall conclusion of the robustness of the MSVPA found in previous works. They are also an important step in the validation of the MSVPA and MSFOR models and help in the identification of the parameters requiring further refinement, including the improvement of estimates of annual ration of predators and residual mortality. This model validation is necessary to incorporate multispecies models in ecosystem-based fishery management advice. However, it is also necessary to develop statistical multispecies models able to assess the uncertainty of parameters producing the largest effects in the MSVPA model.

Groundfish Food Habits and Predation on Commercially Important Prey Species in the Eastern Bering Sea from 1993 through 1996.

A processed report summarizing the diet composition and size, distribution and amounts of important prey consumed by eastern Bering Sea groundfish from 1993 through 1996 has been completed. Estimates of predation by major groundfish species (walleye pollock ,Pacific cod, yellowfin sole, flathead sole, rock sole, Alaska plaice, Greenland turbot, arrowtooth flounder, Pacific halibut, and skates on commercially important prey during the main feeding period of May through September are provided in this report. Diet information on butterfly sculpin and marbled, wattled, and shortfin eelpouts is also presented.

Estimated number-at-age of snow crab, Tanner crab, and walleye pollock consumed by groundfish predators are presented. Total numbers of age-0 snow crab consumed were small from 1993 through 1996 compared to 1990-1992. However, age-1 consumption was large relative to previous years and may indicate increased recruitment from the 1993-1996 year-classes. Consumption of Tanner crab of all age groups in 1993 to 1996 was low relative to previous years, a potential indication of low recruitment. Age-0 pollock consumption by groundfish was relatively high in 1994 and 1996. However, we know from survey and fishery data that the 1996 year class of walleye pollock was above-average while the 1994 year class was below average. Investigations are continuing to better understand the time and space distribution of cannibalism and the eventual effects of cannibalism on recruitment into the fishery.

Butterfly sculpins exhibited a diverse, primarily benthic diet by weight composed of amphipods (10%), polychaete worms (15%), shrimp (12%), echiurid worms (7%), walleye pollock (7%), and larvaceans (24%). Little dietary variation was seen with predator size for butterfly sculpins. Wattled, marbled and shortfin eelpouts also primary consumed benthic organisms such as polychaete worms (20-30%), amphipods (10-40%), brittle stars (25%) and miscellaneous fish(3-15%) including sculpins, pricklebacks, Pacific herring, snailfish, capelin,

and walleye pollock. Polychaete worms were more important by weight to smaller eelpouts while fish prey became more important with increasing eelpout size.

Ecosystem Considerations in Fishery Management

The Ecosystem Considerations section for 2003 that accompanies the Stock Assessment and Fishery Evaluation Reports that are provided to the North Pacific Fishery Management Council (NPFMC) was presented to the NPFMC groundfish plan teams in September, to the NPFMC SSC in October, and at the Ecosystem Forum of the NPFMC in December. The chapter content and format is very similar to last year, being primarily a status of the environment document. The full document is available on the Alaska Fisheries Science Center web site at http://www.afsc.noaa.gov/refm/docs/2002/ecochap.pdf. More survey data on non-target species (HAPC biota, forage, miscellaneous species) was included though trends in these have not been thoroughly analyzed yet to determine if those are meaningful. The chapter was also enhanced to contain more complete information on bottom trawl, longline, and scallop fishery distribution for understanding effects of gear on habitat. Data gaps still include information on lower trophic levels such as phytoplankton and zooplankton. There were some indicators of a shift in community composition particularly in Central GOA with increases noted in forage fish such as eulachon, shrimp, and Steller sea lions. More work is needed on trend indicators for HAPC biota and non-target species. Status and trend information for other managed resources such as salmon, herring, and shellfish should also be included in future versions.

Interpretation of observed changes needs to be done in the context of how the indicator relates to a particular ecosystem component. For example, particular oceanographic conditions such as bottom temperature increases might be favorable to some species but not for others. Future evaluations will need to follow an analysis framework that links indicators to particular effects on ecosystem components, such as that provided in the draft programmatic groundfish fishery environmental impact statement. This year, stock assessment scientists began using indicators in this chapter 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. We are still in early stages in 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. Next year, it is hoped that information in this chapter will be used in habitat and ecosystem-level assessments to accompany the single-species assessment chapters that traditionally comprise the Groundfish Stock Assessment and Fishery Evaluation (SAFE) advice to the North Pacific Fishery Management Council. These new chapters could assess 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.

Shannon Fitzgerald has been reassigned from the North Pacific Groundfish Observer Program to the Resource Ecology and Ecosystem Modeling Program to help with the increased emphasis on seabird fishery interactions and the incorporation of seabirds into ecosystem models being developed for the Bering Sea and Gulf of Alaska.

For more information please contact Pat Livingston at (206)526-4242.

Distribution and Habitat of Groundfish in Nearshore Waters of Southeast Alaska - ABL

Scientists in the Auke Bay Laboratory (ABL) Habitat Program continued to assess the distribution, habitat, and behavior of groundfish in nearshore waters of southeastern (SE) Alaska. Two sampling cruises were conducted in summer 2002 using the NOAA R/V *John N. Cobb* and one sampling cruise in winter 2003 using a charter vessel. Sampling methods included use of a beach seine to capture fish in shallow (<10 m deep), vegetated habitats (e.g., eelgrass meadows, understory kelps) and use of a remotely operated vehicle (ROV) to record *in situ* observations of fish in deeper water (10-90 m) habitats such as vertical bedrock walls and complex bottoms of boulders or broken rock. To date, we have identified over 50 species of fish that inhabit nearshore habitats including 23 species that are listed in Fishery Management Plans of the North Pacific Fishery Management Council. Commercially important species captured or observed included flatfish, Pacific cod, rockfish, salmon, and walleye pollock. Studies in 2003 will focus on linking fish assemblages to specific habitat types in nearshore waters of SE Alaska. Different habitats (e.g., pinnacles, gullies) will be identified from detailed bathymetric maps, and ROV surveys will be conducted in these areas. The ROV will be equipped with a GPS tracking system that will allow us to map the distribution of fish by habitat type.

For more information, contact Scott Johnson at 907-789-6063 or John Thedinga 907-789-6025.

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 regional management councils 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 2002, 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 678 observers to 312 vessels and 20 shore plants in Alaska. These observers spent 34,738 days collecting data in 2002. The Program was 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 were provided to the Alaska Regional Office to assist in management decisions regarding the catches of groundfish and prohibited species. Data were also collected regarding the operations of the groundfish fishery.

Proposed and Final Rule to Change Observer Program Regulations Is Published in the Federal Register

NMFS issued a proposed rule on September 16, 2002 and a final rule on December 6, 2002 that extends the Observer Program through 2007 and amends the current regulations implementing the Observer Program. The existing regulations for the Observer Program, would otherwise have expired at the end of 2002.

The regulatory changes:

1) Modify the observer and observer provider certification and decertification processes to ensure they are compliant with the Administrative Procedure Act.

2) Increase NMFS' management controls over observer providers and observers through changes in their duties and responsibilities and through clarification and strengthening of existing regulations.

3) Grant NMFS the authority to place NMFS staff and other qualified persons[1] aboard vessels and at shoreside or floating stationary plants to increase NMFS' ability to interact effectively with observers, fishermen, and processing plant employees.

The proposed and final rules were written through the combined efforts of Observer Program, AFSC and Alaska Regional office staff.

Observer Advisory Committee Meets to Discuss the Future of the Observer Program

The Observer Advisory Committee (OAC) of the North Pacific Fishery Management Council (Council) met on July 18-19, 2002 at the AFSC to discuss ways of restructuring the Observer Program to better meet the needs of NMFS, the fishing industry, observer provider companies and observers themselves. Conclusions drawn from the OAC discussion are as follows:

1) The funding mechanism for the Observer Program dictates to a large degree, the overall structure of the Observer Program and its service delivery model (SDM). Therefore, creating real change in the Observer Program must first involve changing the funding arrangements.

2) Full Federal funding of the Observer Program should be sought by NMFS and the Council as their preferred plan with a blend of Federal funding and fee collections as a secondary option.

3) The goal for restructuring the Observer Program should be collection of better scientific data to support fishery management rather than eliminating the conflict of interest inherent in the current Observer Program SDM. To achieve this goal, changes need to be made to the observer coverage requirements with particular attention to the vessels requiring 30% observer coverage and those vessels that carry no observers.

Observer Program and U.S. Coast Guard Join Together for Increased Safety of Observers at Sea

Observer Program managers met with representatives from the U.S. Coast Guards' (USCG) Marine Safety office to develop ways in which the Observer Program and the USCG could work together to increase observer safety at sea. Discussions centered around observer safety training, the USCG vessel safety decal system and improving communications between observers, Observer Program staff and the USCG. The meeting helped lay the groundwork for developing a Memorandum of Understanding (MOU) between the USCG and the Observer Program. When written, the MOU will outline an interagency working relationship fostering increased safety awareness and protection for observers at sea.

Observer Program Database Modernization and Improvements

The Observer Program developed an Internet, Web-based application for staff to use when interacting with the Programs' main database. This sped up connections to the database from remote field office sites in Alaska and simplified database management and maintenance. In addition, the Observer Program is developing a gear inventory application that utilizes barcode scanning and interfaces with the NORPAC database. This new gear inventory system will create

[1] "Other qualified persons" would most commonly be staff from the University of Alaska, Observer Training Center.

a more accurate and efficient system for the purchasing, dispersal and tracking of observer gear.

For further information or if you have questions about the North Pacific Groundfish Observer Program please contact Dr. Richard Marasco (206)-526-4172.

Socioeconomic Assessment Program - REFM

Economic and Socio-cultural Data Collection Programs

BSAI Crab Fishery Data:

In June, the NPFMC identified its preferred alternative for the BSAI crab fisheries.. The NPFMC described that alternative as a "Voluntary Three Pie Cooperative, designed to recognize the prior economic interests and importance of the partnership between harvesters, processors and communities". The elements of the rationalization program include individual fishing quotas that will be given to vessel owners and captains, processor quotas, increased CDQ quotas, binding arbitration, community protection measures, and mandatory reporting requirements for economic data. The NPFMC's motion for the data collection program states that:

> The North Pacific Fishery Management Council and the National Marine Fisheries Service shall have the authority to implement a mandatory data collection program of cost, revenue, ownership and employment data upon members of the BSAI crab fishing industry harvesting or processing fish under the Council's authority. Data collected under this authority will be maintained in a confidential manner and may not be released to any party other than staffs of federal and state agencies directly involved in the management of the fisheries under the Council's authority and their contractors.
>
> A mandatory data collection program shall be developed and implemented as part of the crab rationalization program and continued through the life of the program. Cost, revenue, ownership and employment data will be collected on a periodic basis (based on scientific requirements) to provide the information necessary to study the impacts of the crab rationalization program as well as collecting data that could be used to analyze the economic and social impacts of future FMP amendments on industry, regions, and localities. This data collection effort is also required to fulfill the Council problem statement requiring a crab rationalization program that would achieve "equity between the harvesting and processing sectors" and to monitor the "…economic stability for harvesters, processors and coastal communities". Both statutory and regulatory language shall be developed to ensure the confidentiality of these data.
>
> Any mandatory data collection program shall include: A comprehensive discussion of the enforcement of such a program, including enforcement actions that would be taken if inaccuracies in the data are found. The intent of this action would be to ensure that accurate data are collected without being overly burdensome on industry for unintended errors.

In February 2003, the NPFMC adopted elements of a program for the collection of economic data from the harvesting and processing sectors of the BSAI crab fisheries. PSMFC

will collect the data and provide it to analysts in a blind format to ensure confidentiality. NMFS and the Council will promote development of additional legislative and regulatory protection for these data as needed. The program is the result of cooperative efforts by the industry, the Council's Scientific and Statistical Committee, Pacific States Marine Fisheries Commission, Alaska Department of Fish and Game, other state agencies, and NMFS.

Electronic Logbook Pilot Project for the BSAI and GOA Groundfish Fisheries:

There are logbook record keeping and reporting requirements for fishing vessels greater than 60' LOA that participate in the BSAI and GOA groundfish fisheries. Software has been developed to allow fishermen to record and submit data electronically. The Alaska Regional Office has developed software to accept the electronic logbook data and it has approved the use of the electronic logbook system as an alternative to the hard copy logbooks. Electronic logbooks are expected to be an efficient method to provide improved access to more accurate and complete information for fisheries research and management In addition, electronic logbooks store data in a format that allows a vessel operator to use the data more easily and more productively to monitor and improve fishing operations. Therefore, through a cooperative agreement with the Pacific States Marine Fisheries Commission, the Center has initiated a pilot project to facilitate the use of electronic logbooks by trawl catcher vessels in the BSAI and GOA groundfish fisheries.

The plan is to provide the electronic logbook software, developed by OceanLogic, free of charge to 50 trawlers. During the first quarter of 2003, OceanLogic installed the software on 31 trawlers that participate in the pollock and Pacific cod fisheries. The electronic logbook system is being used on 11 of the 31 trawlers to record and report to NMFS the required logbook data. For many of the other 20 trawlers on which the software has been installed, it is being used experimentally to record data but not to submit the data to NMFS. The plan is to have the software installed on an additional 19 trawlers in the near future, to encourage its use on the 50 trawlers which will have received the software under this pilot project, and to ask vessel operators to submit voluntarily the frequent time and location data that are automatically recorded by the electronic logbook system on the vessels. In a cooperative effort among fishermen, OceanLogic and the Center, the software will be enhanced to allow fishermen to record additional data that will be of use to fishermen and NMFS in monitoring economic performance. There has been a lively discussions among fishermen about the pros and cons of using the electronic logbook system to both record and report logbook data.

Compared to the hard copy logbooks currently in use, electronic logbooks are expected to have several critical advantages with respect to providing data for fishermen, fishery research and management. The advantages are discussed below.

1) A vessel's data will be easier for the vessels operator to access and use because it will be in an electronic format that can be used by a variety of existing and planned software packages.
2) Much more timely data will be available to NMFS managers and scientists because the data will be submitted more frequently and quickly and entered into a database automatically shortly after being received. With hard copy logbooks, vessel operators are required to submit copies of their logbook data to the Region within one month of the end of each quarter; therefore, timely data are not available even in a hard copy format.
3) Data entry errors that occur after the Region receives the data will be reduced

because the data entered by the vessel operator and the vessel's electronic logbook system will feed directly into the agency's logbook database.

4) The quality of the data that is submitted to the Region will improve for the following reasons. First, the time and location of for each haul set and retrieval is entered automatically using data from the vessel's GPS system. The vessel operator simply pushes a button at the beginning and end of each haul. Second, the software that has been developed by the Region to receive the electron logbook data checks for errors and, if errors are found, the errors are flagged and sent to the vessel operator who submitted the data.
5) The electronic logbook system can provide more information than is available from the hard copy logbooks. The data recording software that has been developed by OceanLogic automatically and frequently collects vessel location information during each tow. The logbook data currently includes just the set and retrieval locations, not frequent vessel location data.

Cooperative Agreement with PSMFC

A cooperative agreement with the Pacific States Marine Fisheries Commission (PSMFC) was developed. Economic and social analyses of Federal management actions and policies are required to meet the stewardship responsibilities of the National Marine Fisheries Service (NMFS). They are also required by the Magnuson-Stevens Fishery Conservation and Management Act, the National Environmental Policy Act, the Endangered Species Act, the Regulatory Flexibility Act, Executive Order 12866, and other Federal laws. The primary objective of this cooperative agreement is to provide economic and sociocultural information that will assist NMFS and the NPFMC in conducting the required analyses. This objective will be met by the successful completions of projects that will do the following: (1) collect economic and sociocultural data relevant for the conservation and management of living marine resources; and (2) develop models to use that data both to monitor changes in economic and sociocultural indicators and to estimate the economic and sociocultural impacts of alternative management measures. This cooperative agreement will allow NMFS and PSMFC to continue to work collaboratively to improve substantially the economic and sociocultural information that is available to support the conservation and management of living marine resources off Alaska. The following 11 projects will be completed under this cooperative agreement.

1) Input price data collection
2) Cost, earnings and employment data collection program
3) Data verification
4) Electronic economic data logbook pilot study
5) Develop supply and demand models for groundfish
6) Improve regional economic models
7) Logbook enhancement and data entry
8) Economic value of sport halibut fishing in Alaska
9) Alaska halibut charter boat economics survey 2003
10) The non-consumptive value of Steller sea lion protection measures
11) Sociocultural data collection and research.

Data Collection and Research Project Funding for 2003

Five data collection and research proposals that were submitted to the NMFS Office of

Science and Technology will be funded and will supplement ongoing efforts to improve the data and models that are available to support regulatory analyses for the federally managed fisheries off Alaska. The five projects will support AFSC efforts to do the following: (1) implement mandatory reporting program for economic data from the harvesting and processing sectors of the BSAI crab fishery; (2) develop an EFH economic research program for Alaska FMP fisheries; (3) assess the economic effects of the American Fisheries Act; (4) collect commercial fishing vessel crew demographics data for Alaska fisheries; and (5) improve economic models and profiles for select Alaska fishing communities.

Measures of Economic Performance and Fleet Behavior

Annual Report on the Economic Status of the Groundfish Fisheries off Alaska:
The domestic groundfish fishery off Alaska is an important segment of the U.S. fishing industry. With a total catch of 2.0 million metric tons (t), a retained catch of 1.9 million t, and an ex-vessel value of $543 million in 2001, it accounted for 47% of the weight and 17% of the ex-vessel value of total U.S. domestic landings as reported in Fisheries of the United States, 2001. The groundfish fisheries accounted for the largest share of the ex-vessel value of all commercial fisheries off Alaska in 2001 (56%), while the Pacific salmon fishery was second with $189 million or 19% of the total Alaska ex-vessel value. The value of the shellfish catch amounted to $124 million or 13% of the total for Alaska. The gross value of the 2001 groundfish catch after primary processing was approximately $1.4 billion (F.O.B. Alaska). The annual report was prepared as the economic appendix to the SAFE documents for the BSAI and GOA groundfish fisheries. The report provides estimates of total groundfish catch, groundfish discards and discard rates, prohibited species bycatch and bycatch rates, the ex-vessel value of the groundfish catch, the ex-vessel value of the catch in other Alaska fisheries, the gross product value (F.O.B. Alaska) of the resulting groundfish seafood products, the number and sizes of vessels that participated in the Alaska groundfish fisheries, vessel activity, and employment on at-sea processors. In addition to data from the groundfish fisheries, this report contains data on some of the external factors which, in part, determine the economic status of the fisheries. Such factors include foreign exchange rates, the prices and price indexes of products that compete with products from these fisheries, cold storage holdings, domestic per capita consumption of seafood products, and fishery imports. This report also includes a summary of recent estimates of capacity, capacity utilization, and fishery utilization for the vessels that participated in federally managed commercial fisheries off Alaska in 2001. The report is available at: http://www.fakr.noaa.gov/npfmc/safes/safe.htm

Fishing Capacity:
A report,"Quantitative estimates of fishing capacity, capacity utilization, and fishery utilization for Alaskan commercial fisheries, 2001" was completed as part of an agency wide effort to estimate excess fishing capacity for all federally managed commercial fisheries. A significant difference between capacity and actual catch may signal the need for implementing measures to diminish or eliminate the incentives for, and presence of, excess capacity.

The capacity measures computed in this report were constructed using data on catch (in metric tons), participation (in weeks), and vessel characteristics of catcher vessels and catcher-processors that operated in federally managed Alaskan commercial fisheries for 1990 to 2001. That data was used to estimate fishing capacity, excess capacity, and capacity utilization in 2001 by fleet and species or species group. Fishery utilization was estimated for each fleet and

estimates of the number of vessels and mean number of fishing weeks by fleet were reported for 1990-2001.

There are wide ranges of fishing activities, vessel sizes, targeting strategies, and gear configurations in the various federally managed Alaskan fisheries. Generally speaking, however, groups can be established that are likely to share similar technological, economic, and regulatory (TACs, closures, seasonal delineation) constraints. In an attempt to establish such groups, vessel characteristics, fishery participation, and processing data (for catcher-processors) were examined. As a result, 12 catcher vessel fleets and 10 catcher-processor fleets were formed. Each of these fleets is comprised of similarly equipped, similarly sized vessels that engage in a common set of fisheries (and, in the case of catcher-processors, produce a similar set of finished products). Such a grouping allows us to present the capacity estimates on a fleet-by-fleet basis, which more clearly elucidates the sources of fishing capacity.

The estimates indicate that current capacity, in terms of total catch of all species, exceeds actual catch by nearly 40%. However, species-specific excess-capacity estimates range widely -- from 8% to over 300%.

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 a paper titled "Directions for Productivity Measurement in Fisheries", Dr. Ron Felthoven and Dr. Cathy Morrison Paul (UC Davis) 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. Specifically, they 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. They will use this framework in empirical research that is underway.

Recreational Fisheries and Non-market Valuation:

Three recreational fisheries and non-market valuation research and data collection projects are underway. The initial study design, work plan and contracting for the Steller Sea lion Valuation Survey have been completed. The Alaska halibut charter boat operator economic survey was conducted in cooperation with PSMFC and the final report is nearing completion. The Alaska Sport Fishing Economic Survey is underway.

Spatial Fishing Models:

The Center is funding an ongoing research project at University of Washington (Drs Dave Layton and Daniel Huppert, PIs) to develop spatial fishing models for the Bering Sea pollock and cod trawl fisheries. The object of the research is to develop behavioral models of fishing operations to assess alternative management approaches for reducing the impacts of the pollock and Pacific cod fisheries on Steller sea lions. Specific analytical problems for this fishery include: (1) movement of fish stocks seasonally and annually in response to ocean conditions and prey species abundance; (2) influence of bycatch restrictions on fishing site choice; (3) influence of market-related price changes both annually and seasonally; and (4) changing regulations regarding closed areas for a variety of reasons (e.g. avoidance of Steller sea lion rookeries, avoidance of crab bycatch, allocation of harvests among fishing fleets)

Bycatch Management

Center economists have participated in a renewed NMFS effort to address the issues of

bycatch. That effort includes: (1) preparing a summary of NMFS and Regional Fishery Management Council actions to reduce bycatch since the Magnuson-Stevens Act was amended in 1996 in part to improve bycatch management; (2) improving the NMFS strategy for managing bycatch; and (3) preparing a Federal Register Notice in response to Oceana petition for improved bycatch management. The improved NMFS strategy includes the development of a bycatch website that contains information about bycatch regulations and policy, bycatch-reduction research, bycatch experts, bycatch data sets, conferences/workshops, and technology-transfer efforts. The website is intended to assist the public in understanding the bycatch problem, the efforts that have been taken and are being taken to address the bycatch problem, and the commitment of NMFS to meeting its bycatch goal. The website is at: http://www.nmfs.noaa.gov/bycatch.htm

NMFS Social Science Workshop

The workshop was sponsored by the NMFS Office of Science and Technology and held in Silver Spring, Maryland. Workshop topics included: (1) spatial modeling in fisheries economics; (2) regional and headquarters social science program overviews; (3) draft guidelines for National Standard 8 (fishing communities); (4) cognitive models of fishery management; (5) nonmarket valuation methods and projects; (6) regional economic models; (7) recreational fisheries; and (8) commercial economics data collection. Dr. Todd Lee organized the session on nonmarket valuation and Dr. Joe Terry presented the overview of the Alaska Regional Office and AFSC economics and social science programs. The workshop provided an excellent opportunity for NMFS social scientists to exchange information and improve their ability to provide economic and socio-cultural analyses in support of the Agency's stewardship responsibilities.

Sociocultural Research

Subsistence Hunting and Fishing Practices:

Dr. Jennifer Sepez presented a paper at the Ninth International Conference on Hunting and Gathering Societies. The paper, "If Middens Could Talk: Comparing Ancient, Historic, and Modern Makah Subsistence Foraging Patterns" combined archaeological data with data from early ethnography and contemporary harvest surveys to examine consistency and change in Makah subsistence hunting and fishing practices between 1500 and today. The paper found that a high diversity of species that were used by tribal members prior to Euroamerican colonization are still in use today. A number of species that are no longer used can be explained by ecological factors such as post-colonial extirpation, as would be the case with wolves and fur seals. Others, such as small birds and small shellfish, may best be explained through foraging theory: easy access to commercial foods resulted in a consequent contraction of the subsistence diet breadth, especially for resources ranked lowest by rate of post-encounter caloric return. Political factors are also indicated as a possible explanatory mechanism for resource use changes where issues such as access rights and public perception are as important as population dynamics and effort/return ratios. Very few resources available in ancient times were not exploited in some way. Thus, newly exploited resources generally were limited to recent colonists to the area such as the California sea lion, imported and intentionally planted species such as the Pacific oyster, and resources in areas where new access capabilities affect encounter rates, such as grouse. Quantitative analysis indicates a significant shift in contribution of different resource groups to the animal protein diet between 1500 and today, with harvest of marine mammals dropping tremendously (from 92% to less than 1%), and the contemporary diet consisting primarily of fish

(50%), shellfish (11%), land mammals (15%), and store-bought meats (24%).

Jennifer Sepez presented a paper at the American Anthropological Association meeting. The paper, "Unalaska, Alaska: Memory and Denial in the Aleutian Landscape", explores history and globalization in Unalaska, an island in the Aleutian archipelago. World War II debris still litters the landscape, from concrete bunkers to sunken ships. Key occurrences such as the air attack by Japanese forces in June 1942, and the "evacuation" and internment of the native Aleut people were officially censored during the war. Since that time, Unalaska has become the nation's busiest commercial fishing port and the relevance of wartime history to the current sociopolitical landscape has become a locus of contestation between community subgroups reacting to the socioeconomic changes of globalization.

Dr. Sepez also prepared the chapter on tribal communities for the NMFS Sociocultural Practioner's Manual. The chapter states that social impact assessment (SIA) in tribal communities requires accounting for certain considerations beyond those suggested for non-tribal communities. The chapter addresses: (1) legal obligations stemming from the relationship between tribal entities and the federal government; (2) certain community characteristics and methodological approaches that are likely to affect SIA; and (3) elements to include in the analysis of tribal communities.

Driven by the requirements of the Magnuson-Stevens Act, the Executive Order on Environmental Justice, and the demand among stakeholders for social science to inform fisheries policy, the need for NMFS to conduct social science research is widely accepted. But how such research should be carried out is not at all well established. Challenges in the North Pacific include the wide-ranging geographical area and cultural diversity of communities involved in fishing, which makes it difficult to address the specifics of local sociocultural conditions through participant observation and ethnographic methods. Additionally, while agency emphases create a focus on community-level impacts, these must be situated analytically in terms of a series of nested scales, which include micro-level or sub-population experiences and important large-scale forces such as transnational labor migration and globalization. Amanda Poole and Jennifer Sepez discussed these issues in paper presented at the Society for Applied Anthropology meetings. The title of their paper is "NMFS Social Science in Challenges in Alaska: Reflections on Methodology and Scale".

The Alaska Fisheries Science Center was a co-sponsor for the Society of Ethnobiology 26th Annual Conference at the University of Washington, March 26-29th. Ethnobiology is the study of the relationships of plants and animals with human cultures worldwide. Also sometimes called folk biology, it can include things such as ethnobotany, ethnozoology, ethnoicthyology, ethnoentomology, ethnoecology, comparative taxonomy, indigenous intellectual property rights, subsistence practices, and traditional ecological knowledge. Jennifer Sepez, Christina Package and Amanda Poole helped organize the conference and Jennifer organized a session titled "Traditional Ecological Knowledge in Natural Resource Management Agencies". Session topics included the NMFS Local Fisheries Knowledge Project, EPA's Tribal Science Council, USFWS's Medicinal Plants Working Group, Skokomish and Swinomish wetlands projects, Traditional Knowledge in a North Slope EIS, and Using the Aleut language to name a new snailfish discovered by AFSC taxonomist Jay Orr. Other sessions will covered topics in ethnobotany, biocultural diversity, agroecology, and cognition/taxonomy.

The paper presented by Dr. Sepez was jointly authored with Dr. Jay Orr of the AFSC, and Moses Dirks, Aleut (Unangan) language teacher in the Unalaska School District. The paper describes their joint effort to name a newly recognized species of snailfish *(Careproctus* sp.) by referencing the local native language. This effort represents the first time such a collaborative

endeavor has been undertaken by NMFS, and is part of a larger trend in the agency towards integrating traditional native knowledge into fisheries science. Though the name and the knowledge of this fish are new, the naming process honors the ongoing relationship between the people of the Aleutian Islands and the local environment.

Field Research:

Social science field research was conducting during July and August in two Alaskan fishing communities by a small team of NMFS social scientists and research assistants. The group of three spent several weeks talking to community members in Dutch Harbor/Unalaska in the Aleutian Islands, and in Chignik Bay on the Alaska Peninsula. The team also visited nearby Chignik Lake and Chignik Lagoon, which together with Chignik Bay form a closely-knit interacting complex of villages. The research locations were chose as examples of a large fishing community and a small fishing community within the area. Additionally, both communities have small boat Pacific cod fishers that were differentially affected by Steller sea lion regulations.

More than 80 interviews were conducted with community members including such diverse representatives as cannery workers, vessel captains, community activists, and elected officials. About 65% of interviews were tape-recorded, which, once transcribed, will allow for textual analysis of data using ethnographic software. This data is in the process of being analyzed. Reports on the research will include a profile of each community, which will become part of a larger NMFS social science project to develop profiles and data sets on a wide variety of North Pacific fishing communities.

Regulatory Analyses

North Pacific Groundfish Observer Program Regulations:

The North Pacific Fishery Management Council (NPFMC) took final action on proposed regulatory changes to the Observer Program. The NPFMC recommended: (1) extending the Observer Program regulations through December 31, 2007; (2) changing the observer certification and decertification process to ensure that it is compliant with the APA; (3) changing the observer certification criteria and standards of behavior to clarify and strengthen these regulations; (4) replacing the observer provider (contractor) certification and decertification process with an APA compliant permitting process similar to that used for other NMFS Alaska Region permits; (5) changing the duties and responsibilities of observer providers in order to eliminate ambiguities and to strengthen the regulations governing the relationship between NMFS and the observer providers; and (6) increasing the ability of NMFS to interact effectively with observers, fishermen, and processing plant employees by granting to NMFS the authority to place NMFS staff and other qualified persons aboard groundfish and halibut vessels and at groundfish plants. Center economists assisted in preparing the analysis of the regulatory changes that were approved in 2002 and implemented in 2003.

Programmatic Environmental Impact Statement for the BSAI and GOA Groundfish Fisheries:

Program staff have assisted in the preparation of the PSEIS for the BSAI and GOA groundfish fisheries. This included preparing economic data that were used in the projections and directing efforts to obtain traditional ecological knowledge information to be used in the PSEIS.

For further information contact Dr. Joe Terry (206) 526-4253.

C. By species, by agency

1. Pacific cod

a. Research

Defining habitat of juvenile Pacific cod - RACE

Very little is known about the habitat requirements of Pacific cod, particularly during their early-life stages. Yet, the economic importance of the Pacific cod fishery in coastal Alaskan communities is considerable, and Pacific cod are a major prey item for Steller sea lions around Kodiak Island. Much of what we assume about the distribution of Pacific cod is based on either ancillary data from investigations focused on other species or investigations of Atlantic cod. Defining the nursery areas utilized by Pacific cod is a preliminary step toward identifying essential habitat and monitoring growth, survival, and subsequent recruitment.

The objective of this one-year study was to identify juvenile Pacific cod habitat in Chiniak Bay, Alaska. A variety of nearshore habitats were sampled between August 10 and 22, 2002. Stations were sampled along depth transects such that each transect had one station at depths of <5, 10, 15, 20, 25, and 30 m. At each of the 68 stations sampled, the relative abundance of juvenile cod and groundfishes was measured along with habitat characteristics. Habitat complexity (sediment type, vertical relief, % algae cover, associated invertebrates) was recorded at each station with an underwater video camera with real-time video. Vertical profiles of water temperature and salinity were measured at each station and a sediment sample was archived for grain size analysis, which will be used to verify the sediment type observed in the video.

A total of 6,077 fishes were captured, and juvenile Pacific cod ranked sixth in abundance among groundfish species. There were a total of 333 juvenile Pacific cod captured, with lengths ranging from 40 to 113 mm. This study verified the presence of juvenile Pacific cod in nearshore areas of Chiniak Bay. Once the distribution of juvenile Pacific cod is related to habitat complexity and physical properties (such as sediment grain size, depth, temperature, and salinity) then the habitat characteristics of their nursery areas can be defined.

For further information, contact Alisa Abookire (907) 481-1735.

b. Stock Assessment

BERING SEA/ALEUTIANS

For the most part, the present assessment is a straightforward update of last year's assessment, incorporating new catch and survey information. However, one small change in the model was made at the request of the SSC, namely, the inclusion of a separate set of fishery selectivity parameters for the period 2000-2002. This year's EBS bottom trawl survey resulted in a biomass estimate of 617,000 t, down 26% from the 2001 estimate and near the minimum for the time series (534,000 t). The Aleutian Islands were surveyed in 2002. Biomass decreased 39% from 2000 and is the lowest value of the time series.

Model estimates of abundance are higher for the 2003 assessment compared to the 2002 assessment. For example, estimated 2003 spawning biomass for the BSAI stock is 423,000 t, up

about 4% from last year's *FABC* projection for 2003. The SSC has determined that reliable estimates of *B40%*, *F40%*, and *F35%* exist for this stock, and that this stock therefore qualifies for management under tier 3. The updated point estimates of *B40%*, *F40%*, and *F35%* from the present assessment are 431,000 t, 0.35 and 0.42, respectively. The point estimates for *F40%*, and *F35%* are substantially higher than last year's values of 0.30 and 0.36, respectively. Pacific cod qualify for management under subtier "b" of tier 3 because projected biomass for 2003 is about 1% less than *B40%*. Fishing at an instantaneous rate of 0.35 is projected to result in a 2003 catch of 278,000 t, which is the maximum permissible ABC under Amendment 56.

The ABC for 2003 recommended by the authors is 245,000 t, 12% below the maximum permissible and based on a risk-averse optimization procedure which considers uncertainty in the estimates of the survey catchability coefficient and the natural mortality rate in the computation of an *F40%* harvest level. The Plan Team, however, recommended setting the 2003 ABC at 223,000 t, equal to the 2002 ABC and 20% below the maximum permissible level. This ABC corresponds to a fishing mortality rate of 0.28, below the value of 0.35 which constitutes the upper limit on *FABC* under tier 3b.

There is concern regarding the continuous decline in spawning biomass since 1988 and the fact that three of the last five year classes (assessed at age 3) are "below average" and an "above average" year class hasn't occurred since 1992. Furthermore, there is concern that Pacific cod abundance may be overestimated due to the assumed values of survey catchability and natural mortality and their interaction with the estimated parameters for growth and dome-shaped selectivity. Trawl catchability is assumed to equal 1, yet estimated age-3+ biomass is much greater than survey biomass. The model estimate of trawl survey selectivity is sharply dome-shaped, implying that significant amounts of large cod are missed by the shelf trawl survey. However, the comparison of 2002 slope and shelf survey length data may not support this implication, indicating that the dome-shaped selectivity currently estimated for the shelf survey may not be due to large fish residing on the slope at the time of the survey. The recommended OFL was determined from the tier 3b formula, where fishing at a rate of 0.41 gives a 2003 catch of 324,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

GULF OF ALASKA

For the 2002 assessment, size composition data from the 2001 and January-August 2002 commercial fisheries were incorporated into the assessment model. This year's model was modified to estimate separate selectivity schedules for the intervals 1978- 1986, 1987-1999, and 2000-present. In previous assessments only two intervals were estimated: 1978-1986, and 1987-present. The Bayesian meta-analysis, which has formed the basis for a risk-averse ABC recommendation in the 1996-1999 assessments, was not performed for the present assessment. Similar to last year's approach, the ratio (0.87) between the recommended *FABC* and *F40%* estimate given in the 1999 assessment was assumed to be an appropriate factor by which to multiply the 2003 maximum permissible *FABC* to obtain a recommended 2003 *FABC* .

The estimated 2003 spawning biomass for the GOA stock is 88,300 mt, up about 8% from last year's estimate for 2002. Pacific cod are in Tier 3b, as the *B40%* reference level is estimated to be 90,300 mt. The estimated 2003 total age 3+ biomass for the GOA stock is 452,000 mt. The 2003 ABC is 52,800 mt, down about 8% from last year's recommendation for 2002. The 2003 OFL for the GOA stock is 70,100 mt. For the 2002 fishery, allocation of ABC among

regulatory areas followed the average biomass distribution estimated by the three most recent (1996, 1999, and 2001) trawl surveys, giving the following apportionment: Western-39%, Central-55%, and Eastern-6%. Assuming that this apportionment is retained for the 2003 fishery, the recommended ABC would be allocated as follows: Western-20,600 mt, Central-29,000 mt, and Eastern-3,200 mt.

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 three species (dusky, 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 a bottom trawl fishery since the late 1980's. Two varieties of dusky rockfish are seen: an inshore, dark-colored form, and a light-colored variety found offshore. The trawl fishery takes the light variety. Recent taxonomic work indicates these two forms are separate species, and a publication presenting this information is currently in preparation by Jay Orr of the AFSC RACE Division.

Similar to previous years, ABC for the assemblage in 2003 is calculated using biomass estimates based on trawl survey data. Gulfwide exploitable biomass, 62,489 mt, is based on the average of the biomass estimates for the assemblage in the three most recent trawl surveys of this region (those in 1996, 1999, and 2001). This biomass is comprised of 56,336 mt for dusky rockfish and 6,153 mt for yellowtail and widow rockfish. Applying an F=M strategy to the biomass for dusky rockfish, in which the annual exploitation rate is set equal to the estimated rate of natural mortality for dusky rockfish (0.09), yields a Gulfwide ABC of 5,070 mt. Applying a more conservative F=0.75 x M strategy to the biomass for yellowtail and widow rockfish (in which the M for dusky rockfish is also applied to the former two species), yields an ABC of 415 mt. Total recommended Gulfwide ABC for the assemblage in 2003 is the addition of these two ABC values: 5,485 mt.

In 2002, an age-structured model for dusky rockfish was developed for the first time, based on the AD Model Builder template. Two alternative model configurations were explored, each of which varied in terms of its likelihood components. Both model configurations yielded similar ABC values of around 6,500 mt, which was higher than the recommended ABC of 5,070 mt discussed above. Because of the exploratory nature of the model, we believed it prudent to base the 2003 ABC recommendation on the old method instead of using the model results. In 2003 we plan to further refine the model and hope to use it to determine our actual ABC recommendations for 2004.

For more information, contact David Clausen at (907) 789-6049 or Chris Lunsford at (907) 789-6008.

4. Slope Rockfish

a. Research

GULF OF ALASKA

Species Identification of Young-of-the-Year Rockfish Collected in Offshore Waters of the Gulf of Alaska

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, 2001, and 2002. The YOY rockfish were caught in rope trawls towed near the surface along several different transects in offshore waters of the GOA in the same year, sometimes in large concentrations, and there is some coincidence in sample locations between years. These collections are significant because very little is known about the species identification, distribution, or habitat of YOY rockfish in Alaska. In a pilot study of species identification, ABL scientists in cooperation with Dr. Anthony Gharrett of the University of Alaska Fairbanks, Juneau Center for Fisheries and Ocean Sciences used mitochondrial DNA markers, supplemented by morphological analysis by Dr. Arthur Kendall (recently retired from the AFSC's RACE Division) to identify a small subsample of these fish. Seven different species were identified, the most abundant (40 of 55 fish) of which was the Pacific ocean perch. The POP ranged in size from 27.0 to 49.5 mm standard length. To our knowledge, these are the first POP in this size category that have ever been positively identified in Alaska. The remaining 15 YOY fish were identified as two shortraker rockfish, one rougheye rockfish, two dusky rockfish, four darkblotched rockfish, three widow rockfish, and three yellowmouth rockfish.

Future examination of more specimens could incorporate: 1) exploring the possibility of developing morphological methods for species identification, 2) assessing spatial and interannual variation in species abundance, and 3) determining the extent of POP genetic divergence between year-classes and between geographic locations. The Ocean Carrying Capacity surveys are planned to continue in 2003 and 2004, so samples of YOY rockfish may also become available for these additional years.

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

Application of Echosounder Signal to Improve Trawl Survey Precision for Pacific Ocean Perch

Auke Bay Laboratory staff have been examining ways to improve trawl survey design for Pacific ocean perch, including methods for efficiently increasing sample size and precision. One way to increase sample size with minimal effort is to collect hydroacoustic signals, both during trawl hauls and between hauls. Further evaluation of this technique to improve rockfish survey precision continued during 2001 and 2002. Echosounder signals were recorded with a Simrad ES60 echosounder during AFSC RACE Division trawl surveys of the Gulf of Alaska in 2001 and of the Aleutian Islands and eastern Bering Sea slope in 2002. Dana Hanselman, a NMFS Population Dynamics intern and PhD student at the University of Alaska Fairbanks, Juneau Center for Fisheries and Ocean Sciences, is currently processing these data and has done some

preliminary evaluation. Plans are underway by AFSC rockfish scientists and RACE survey scientists to collect further data in 2003 during the next Gulf of Alaska trawl survey.

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

Species Identification of Rockfish Larvae and Other Larval Rockfish Studies

Rockfish larvae and early post larvae present vexing problems in marine ecology. As a group they are most abundant in the spring and early summer zooplankton where they may have important trophic roles. Although easily identified to genus, specific identification of Sebastes larvae using morphology and pigmentation patterns is very difficult. Auke Bay Laboratory scientists in cooperation with Dr. Anthony Gharrett of the University of Alaska Fairbanks, Juneau Center for Fisheries and Ocean Sciences, attempted to resolve some of the difficulty using genetic techniques. Recombinant mitochondrial DNA (mtDNA) analysis was been used to identify individual Sebastes larvae that were photographed before preservation. Fourteen of 33 species known to occur in southeast Alaska were identified genetically.

The genetic analysis and photographic comparisons indicate that several species have identical or similar pigmentation patterns during the preflexion stage. Additionally, several different pigmentation patterns have been attributed to the same species using mtDNA analysis. Although pigmentation patterns and morphology do not appear to be reliable characters to identify species of Sebastes larvae from field collections, we are analyzing our data to determine if pigment patterns can be used to distinguish subgenera or other species groupings.

For more information, contact Bruce Wing at (907) 789-6043.

b. Stock Assessment

BERING SEA AND ALEUTIAN ISLANDS

Pacific ocean perch (POP)

The present assessment is a straightforward update of last year's assessment, including incorporation of 2001 catch, 2001 fishery age composition, and biomass and size composition from the 2002 AI bottom trawl survey. The SSC has determined that reliable estimates of *B40%, F40%,* and *F35%* exist for this stock, thereby qualifying Pacific ocean perch for management under Tier 3. The current estimates of *B40%, F40%,* and *F35%* are 137,000t, 0.048, and 0.057, respectively. Projected spawning biomass for 2003 is 135,000 t, placing POP in sub-tier "b" of Tier 3. The maximum *FABC* value allowed under Tier 3b is computed as follows:
FABC = F40% ×(B2003 /B40%-0.05)/(1-0.05) = 0.048×(135,000/137,000-0.05)/0.95 = 0.047
Projected harvesting at a fishing mortality rate of 0.047 gives a 2003 catch of 15,100 t, which is the recommended ABC. The ABCs are set regionally based on the 2002 apportionment as follows: BS = 2,410 t, Eastern Aleutians (Area 541) = 3,495 t, Central Aleutians (Area 542) = 3,330 t, Western Aleutians (Area 543) = 5,835 t.

The OFL fishing mortality rate is computed under Tier 3b as follows: FOFL = F35%×(B2003 /B40%-0.05)/(1-0.05)= 0.057×(135,000/137,000-0.05)/0.95 = 0.056 Projected

harvesting at a fishing mortality rate of 0.056 gives a 2003 catch of 17,900 t, which is the recommended OFL for the BSAI. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

Other Red Rockfish

Through 2000, the other red rockfish complex was split out into northern/sharpchin and rougheye/shortraker groups in the AI, and a combined other red rockfish group for the eastern Bering Sea. In 2002, sharpchin rockfish was moved into the other rockfish complex.

In 2001 and 2002, the Authors recommended that the complex be managed as single species. The Plan Team noted a conservation issue related to managing rockfish in a complex, namely, the risk that one stock would be fished disproportional to its abundance. This is especially likely when one species has a higher value to the fishery than the other species. This has happened in the other red rockfish complex, and the assessment shows that on a species-by-species basis, catches have sometimes exceeded current estimates of what OFL might have been had OFL likewise been set on a species-by-species basis (e.g., rougheye rockfish in the AI in 1997 and 2001 and northern rockfish in the BS in 2000).

In 2001, the Authors, SSC, AP, and Council recommended separating shortraker and rougheye rockfish species and setting BSAI area-wide ABCs and TACs for 2002. However, NMFS was unable to implement those recommendations because of the difficulty in identifying shortraker and rougheye rockfishes to species in commercial catches. NMFS established separate BS and AI TACs for northern rockfishes and separate BS and AI TACS for the combined shortraker/rougheye rockfishes category. Staff with the NMFS Regional Office and Observer Program met in August 2002 to discuss data issues related to managing these groundfish at the species and area levels. The team concurred with NMFS staff recommendations to:

1. retain a single TAC for shortraker/rougheye for 2003;
2. implement changes in observer sampling procedures to improve species composition data on the proportion of shortraker and rougheye rockfish in longline sets;
3. monitor whether the changes in procedures result in significant improvements in the available data;
4. assess the feasibility of a system to utilize species composition data from observers to estimate the composition of the commercial catch.

The Groundfish Plan Team continues to support single species management for this complex, but defers to the proposed analysis for revising management of target and non-target species management. The team endorses the Council procedure for setting a combined BSAI OFLs and ABCs for northern rockfish and shortraker/rougheye rockfishes in the interim. The SSC has determined that a reliable estimate of the natural mortality rate exists for the stocks in this complex, thereby qualifying "other red rockfish" for management under Tier 5. *FABC* was 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, and northern rockfish--0.060. Harvesting at these rates gives a 2003 BSAI ABC for northern rockfish of 7,000 t and a 2003 BSAI ABC for shortraker/rougheye rockfishes of 967 t. The recommended OFLs for 2003 are based on Tier 5 formula, where *FOFL=M*. The recommended BSAI OFLs are 9,330 t for northern rockfish and 1,290 t for shortraker/rougheye rockfishes. It is not possible to determine whether the "other red rockfish" complex is overfished or whether it is approaching an overfished condition because it is managed under Tier 5.

Other rockfish complex

This year's assessment includes a new survey biomass estimate, catch distribution maps, updated catch data, and length frequency graphs for light dusky rockfish and shortspine thornyheads. It also includes a recommendation from the assessment authors to assign a separate ABC for light dusky rockfish. This recommendation was based in part on an estimated value of 0.34 for the average exploitation rate of light dusky rockfish during the period 1997-2002. The Authors feels this value is likely an overestimate. While there is no reason to suspect that catches have been overestimated during this period, survey biomass estimates have not decreased, implying that biomass may be underestimated by the survey (i.e., if the exploitation rate were truly 0.34, it seems likely that a long-lived species such as light dusky rockfish would have undergone a significant decrease in abundance). Therefore, the Authors does not concur with the author's recommendation to assign a separate ABC for light dusky rockfish at this time, instead deferring any recommendations on separating species from complexes to the proposed analysis for revising management of target and non-target groundfish species.

The SSC has determined that a reliable estimate of the natural mortality rate exists for this complex, thereby qualifying "other rockfish" for management under Tier 5. The Authors recommends setting *FABC* at the maximum value allowable under Tier 5, which is 75% of *M* (0.07), or 0.053. Multiplying this rate by the best estimate of complex-wide biomass gives a 2003 ABC of 960 t in the EBS and 634 t in the Aleutian Islands. The recommended OFLs are based on the Tier 5 formula, giving a 2003 OFL of 1,280 t in the EBS and 846 t in the AI. It is not possible to determine whether the "other rockfish" complex is overfished or whether it is approaching an overfished condition because it is managed under Tier 5.

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

GULF OF ALASKA

Slope rockfish are defined as those species of Sebastes that, as adults, inhabit waters of the continental slope and outer continental shelf, generally in depths greater than 150-200 m. Twenty-one species of rockfish are classified into the slope assemblage, the most abundant of which are Pacific ocean perch, and northern, rougheye, redstripe, sharpchin, shortraker, silvergray, and harlequin rockfish. Until 1993, the stock abundance of slope rockfish, especially Pacific ocean perch, was considered to be quite depressed compared to its former abundance in the early 1960's. The 1993 trawl survey of the Gulf of Alaska showed a substantial increase in biomass of Pacific ocean perch. This increase has continued in subsequent years based on trawl surveys in 1996, 1999, and 2001, and this suggests that current abundance of Pacific ocean perch is much improved in comparison with its formerly depressed condition. Age-structured models are applied to Pacific ocean perch and northern rockfish. Based on these models, the best estimate of exploitable biomass for Pacific ocean perch in the Gulf of Alaska is now 298,820 mt, and the exploitable biomass for northern rockfish is 108,830 mt. Exploitable biomass for all other species in the assemblage is presently estimated from the average values in the 1996, 1999 and 2001 trawl surveys, and totals 66,830 mt for shortraker/rougheye rockfish, and 107,960 mt for other species of slope rockfish. Development of an age-structured model for rougheye rockfish was initiated in 2001 using the AD Model Builder template, but relatively few samples of rougheye rockfish have been aged, and this model is still in a very preliminary stage.

To prevent possible over-exploitation of the more desirable species, the slope rockfish assemblage is divided into four subgroups: Pacific ocean perch, shortraker/rougheye rockfish, northern rockfish, and other slope rockfish. Separate ABC's are assigned to each subgroup. Pacific ocean perch and northern rockfish are presently managed using an $F_{40\%}$ strategy adjusted for relative spawning biomass. The other subgroups are managed under an F=M strategy, in which the annual exploitation rate is set equal to or less than the rate of natural mortality. The 2003 ABC's are as follows: Pacific ocean perch, 13,660 mt; northern rockfish, 5,530 mt; shortraker/rougheye rockfish, 1,620 mt; and other slope rockfish, 5,050 mt.

For more information, contact Jonathan Heifetz at (907) 789-6054, Dean Courtney at (907) 789-6006, David Clausen at (907) 789-6049 or James Ianelli at (206) 526-6510.

5. Thornyheads

b. Stock Assessment

GULF OF ALASKA

The updated model incorporated new catch data and relative population numbers from the 2002 sablefish longline survey. The current assessment extended last year's investigation of alternative values of natural mortality and length at age. Based on an evaluation on how alternatives fit the data the authors selected the baseline model configuration. However, this model resulted in estimates of natural mortality that were quite high.

The Groundfish Plan Team supported the base model's configuration and advised continued use of the model with additional investigation of selectivity assumptions and prior distributions for natural mortality. The base model was used to obtain reference levels and an adjustment to the maximum permissible ABC was made due to uncertainty in life history parameters, insufficient catch at length sampling from the longline fishery, and uncertainties associated with the incomplete depth and area coverage of the 2001 GOA trawl survey. The assessment recommended an ABC of 2,000 mt which is the yield in the current assessment from an alternative model. This alternative model was used to set the 2002 ABC and assumed a fixed value of M of 0.038. The recommended ABC of 2,000 mt is associated with an $F = 0.067$ and is lower than the maximum permissible ABC of 2,555 mt ($F = 0.085$) from the base model. The projected 2003 female spawning biomass is 22,800 mt which is above the *B40%* estimate of 15,800 mt, thus thornyhead rockfish are in tier 3a. The area apportionments of the recommended ABC are: Western - 360 mt, Central - 840 mt, and Eastern 800 mt. The *F35%* value is 0.102 and the OFL is 3,050 mt (base model).

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 1987-2002. 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 2002, the twenty-fourth 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 4 June 2002 and 3 September 2002 by the chartered fishing vessel Alaskan Leader. Sixteen kilometers of groundline were set each day, containing 7,200 hooks baited with squid.

Sablefish was the most frequently caught species, followed by giant grenadiers, Pacific cod, and arrowtooth flounder. A total of 87,141 sablefish were caught during the survey. A total of 3,802 sablefish, 588 shortspine thornyhead, and 26 Greenland turbot were tagged and released during the survey. Length-weight data and otoliths were collected from approximately 2,400 sablefish. Sperm and killer whales took fish from the longline at several stations, as in previous years, and may have affected catch rates at these stations. Overall sablefish catch was up over past years and there was an increase in smaller fish, indicating a strong year class and improved recruitment to the fishery.

Two special projects were conducted during the 2002 longline survey. Coral caught on the line was collected for identification and sample preservation. Many specimens including rare and uncommon species were collected in the Aleutian Islands region. In addition, the Alaska Department of Environmental Conservation (ADEC) is conducting a monitoring project for environmental contaminants in Alaskan fish. Several species of groundfish commonly caught on the longline survey were collected throughout the Gulf of Alaska and sent to ADEC for contaminants analysis.

Sablefish Logbook Database and Fishery Catch Rates

A sablefish logbook program was initiated by the Auke Bay Laboratory (ABL) in 1999 to collect detailed fishery information to better understand fishery characteristics and improve the sablefish assessment in Alaska. Vessel logbooks are required from sablefish longline vessels over 60 feet in length. The individual logbook sheets are designed to collect catch and effort information for all sablefish sets made by a vessel. With this information, catch rates for the fishery can be computed and compared to catch rates from the NMFS longline survey. A logbook database is now operational and currently contains data from 1999 through 2001.

A voluntary logbook program was created in 1997 for vessels less than 60 feet. This program targeted vessels in southeast Alaska that were not required to turn in logbooks and did not fall under Observer coverage. However, there was little effort to actively promote the program, and relatively few fishermen submitted the logbooks for analysis. In January, 2003,

ABL scientists along with the Petersburg Vessel Owner's Association and the Alaska Longline Fishermen's Association reintroduced the voluntary logbook program. The longline fishermen's associations print and distribute logbooks to owners and operators of these small vessels for completion and encourage voluntary submission to the International Pacific Halibut Commission port samplers or to ABL. The data from these voluntary logbooks will be used to compute fishery catch rates and compared to the required logbooks and the NMFS longline survey.

Preliminary work on fishery catch rates was conducted in 1999 using data collected by the domestic observer program. The analysis of catch rate trends is an important step in incorporating both survey and fishery data into the management process. More extensive analysis of fishery data is warranted because some fishermen are concerned that their catch rates have remained strong in some areas despite declines in longline survey catch rates. Using data that is now available from the sablefish logbook program and the domestic observer program, fishery catch rates are computed annually and included in the sablefish assessment model.

For more information, contact Chris Lunsford (907) 789-6008 or Michael Sigler at (907) 789-6037.

ABL Sablefish Tag Recovery Program

Processing tag recoveries and administration of the reward program by the Auke Bay Laboratory continued during 2002. Total tags recovered for the year are expected to be around 600, which is about the same as last year. Five fish which were at liberty over 29 years were recovered in 2002. All five were tagged and released in Chatham Strait in April 1973 and recovered in Chatham Strait in September 2002.

Tagging continued on the 2002 sablefish longline survey, with 3,802 sablefish tagged and released. Database sablefish releases, including adults and juveniles, now total 313,519. There are 24,645 recoveries to date.

An additional 610 sablefish were tagged and released on three seamounts in July during the longline survey vessel transit from the Western to Eastern Gulf of Alaska, bringing the total released on seamounts since 1999 to about 3,400. Seamount tagging began in 1999 in an effort to determine whether fish which travel to the seamounts ever return to the slope. To date, twelve fish from five different seamounts have been recovered on the continental slope, proving that emigration does occur. So far, no sablefish has been recovered on a seamount other than the one where it was released.

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

Archival Sablefish Tags

During the 1998, 2000, 2001, and 2002 sablefish longline surveys, a combined total of 596 sablefish were surgically implanted with an electronic archival tag. 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 a period of 1-1/2 to 2 years. Data from these tags will provide information about sablefish behavior in the sea as well as the marine environmental conditions

they experience. To date, 42 tags 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).

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

Juvenile Sablefish Studies

Juvenile sablefish studies in Alaska have been conducted by the Auke Bay Laboratory since 1984 and were continued in 2002. A total of 447 juvenile sablefish (age 1+) were tagged and released during a cruise of the NOAA vessel John N. Cobb at St. John Baptist Bay near Sitka in June 2002. This relatively small bay is the only known location in Alaska where juvenile sablefish have been consistently found.

During the June 2002 cruise a total of 10 electronic, acoustically-transmitting sonic tags were surgically implanted into juvenile, age 1+, sablefish captured in St. John Baptist Bay. The tags were programmed to acoustically transmit a record of temperature and depth experienced by the fish. Mobile acoustic receivers located onboard the John N. Cobb were used to monitor juvenile sablefish behavior and habitat utilization in rearing locations. Short term objectives are to use the sonic tags to provide information on juvenile sablefish behavior and habitat use in nearshore rearing areas and on the timing and duration of the emigration from nearshore rearing habitat. Fixed acoustic receivers located along corridors leading from the rearing locations to the open ocean will be used to monitor the timing of juvenile emigration from their nearshore rearing habitat to the more open waters of the Gulf of Alaska.

Longer term objectives are to utilize electronic archival tags in addition to the electronic sonic tags to provide information on juvenile sablefish behavior and habitat during their transition from nearshore rearing areas to the age at which they are intercepted by the fishery. The electronic archival tags would be programmed to record temperature and depth, be surgically implanted in age 1+ juveniles, and be designed for recovery in the commercial fishery at age 2+ or greater.

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

Young-of-the-Year Sablefish Studies

A young-of-the-year (YOY) sablefish study, which started in 1995, was conducted again by the Auke Bay Laboratory (ABL) in 2002 using the chartered survey vessel Alaskan Leader opportunistically during the sablefish longline survey. A small-mesh surface gillnet was fished at night at 25 offshore locations in the Gulf of Alaska to capture YOY sablefish. However, no YOY sablefish were caught in the gillnet during the 2002 survey. This is the first year of the gillnet study in which no YOY sablefish have been captured. The numbers of YOY sablefish caught in 2001 and 2000 have also been low relative to earlier years. YOY sablefish gillnet studies will be continued until 2004 after which the 10 year retrospective time series of gillnet catch will be

summarized.

On September 28, 2002, the Bering Aleutian Salmon International Survey (BASIS), captured 177 YOY sablefish (average fork length 128 mm) at one station west of the Pribilof Islands near the continental slope at approximately 57 degrees N by 172 degrees 30 minutes W. Jim Murphy with the ABL's Ocean Carrying Capacity Program provided specimens to ABL's Groundfish Program for further analysis. Up to 30 lapilli otoliths will be sampled from these specimens for daily age determinations by staff under contract at the University of California, Santa Cruz. Stomach contents from the same specimens will be analyzed by staff at the NMFS AFSC in Seattle for diet determination. Age and diet information will be compared with similar information obtained from YOY sablefish captured in the ongoing gillnet time series.

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

b. Stock Assessment

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

The 2002 sablefish assessment showed that sablefish abundance increased during the mid-1960's due to strong year classes from the late 1950's and 1960's. Abundance subsequently dropped during the 1970s due to heavy fishing; catches peaked at 56,988 t 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 increased 5% in number and 7% in weight from 2001 to 2002. These increases follow increases from 2000 to 2001 and decreases from 1999 to 2000, so that relative abundance in 2002 is about 10% higher than in 1999. Fishery abundance data for 2002 were not analyzed because the fishery was still open at the time the assessment was completed. Exploitable and spawning biomass are projected to increase 6 and 3%, respectively, from 2002 to 2003. Alaska sablefish abundance now appears moderate and increased from recent lows. Projected 2003 spawning biomass is 39% of unfished spawning biomass, having been as low as 35% during 1998 to 2000. The increase confirms the projection from last year's assessment that abundance would increase due to the above average 1997 year class. The 1997 year class is an important part of the total biomass and is projected to account for 24% of 2003 spawning biomass. Another year class likely is above average, the 1998 year class. Whether sablefish abundance falls after the 2003 peak depends on the actual strength of the 1998 year class.

Our previous approach for recommending ABC considered the abundance trend. We chose a catch level that avoided further abundance decreases because abundance was low. Abundance now has increased, so we changed our ABC recommendation method to adapt to the changed circumstance. In our new approach, we completed a decision analysis to determine what catch levels likely will avoid the historic low abundance observed in 1979. The decision analysis indicates that a yield of 18,400 mt has only 0.2 probability of reducing 2007 spawning biomass below the historic low. The maximum permissible yield from an adjusted $F_{40\%}$ strategy is much higher, 25,400 mt, but with a higher probability (0.6) of decreasing 2007 spawning biomass below the historic low. We recommended a 2003 ABC of 18,400 mt for the combined stock, a yield with low probability of reducing spawning biomass below the historic low and a yield six percent higher than the 2002 ABC of 17,300 mt, consistent with recently increased sablefish

abundance. A 2003 ABC of 18,400 mt was recommended by the NPFMC Groundfish Plan Teams. A higher 2003 ABC of 20,900 was recommended by the NPFMC Science and Statistical Committee (SSC) because the sablefish population is thought to be in moderate condition, near the $B_{40\%}$ level. The SSC believes that a smaller reduction from the maximum permissible ABC is warranted. A 2003 ABC of 20,900 was accepted by the NPFMC at its December 2002 meeting.

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

7. Flatfish

b. Stock assessments

BERING SEA

Yellowfin sole

The present assessment is a straightforward update of last year's assessment, including incorporation of new catch and survey information. This year's EBS bottom trawl survey resulted in a biomass estimate of 2,000,000 t, an increase of 8% from last year's survey. As in last year's assessment, the authors let catchability differ from 1.0 with a temperature effect. Reliable estimates of *B40%*, *F40%*, and *F35%* exist for this stock, thereby qualifying yellowfin sole for management under Tier 3 of the BSAI Groundfish FMP. The updated point estimates of *B40%*, *F40%*, and *F35%* from the present assessment are 385,000 t, 0.12, and 0.14, respectively. Given that the projected 2003 spawning biomass of 445,000 t exceeds *B40%*, the ABC and OFL recommendations for 2003 were calculated under sub-tier "a" of Tier 3. The Author recommends setting *FABC* at the *F40%* (=0.12) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the *F40%* level gives a 2003 ABC of 115,000 t.

The OFL was determined from the Tier 3a formula, where an *F35%* value of 0.14 gives a 2003 OFL of 135,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition. The yellowfin sole stock continues to decline, as do several other flatfish stocks, despite low exploitation rates. The decline is due to the low recruitment in the last decade. In response to SSC recommendations, the authors evaluated the static size-at-age assumption and considered reconfiguring the assessment in a manner that would permit management of yellowfin sole under Tier 1. The authors compared size-at-age data from 1987, 1994, 1999-2001, and found that static size at age is a reasonable assumption.

Rock sole

The recent assessment features significant changes in the model and new input data, including addition of the 2001 fishery age composition, 2001 survey age composition, and 2002 EBS bottom trawl survey biomass point estimate and standard error. This year's EBS bottom trawl survey resulted in a biomass estimate of 1,900,000 t, a 21% decrease from last year's survey estimate. The decline is a result of reduced levels of recruitment observed during the first half of the 1990s

Previous assessments of this stock assumed a catchability of 1.0, whereas the new model estimates catchability at a value of 1.8. The authors corroborated this finding with experimental

data indicating that the bridles used on the standard research trawl tend to herd rock sole into the net, thus increasing catchability. In addition to estimating catchability as a constant, this year's assessment also investigated the possibility of a linear relationship between catchability and temperature. However, the estimated value of the slope coefficient was close to zero, so the authors decided to retain the assumption of constant catchability. The new model provides a statistically significant improvement over the previous model. However, one of the results of adopting the new model is that the estimates of abundance are approximately half of the previously estimated values. Thus, while there was a 53% decrease between the 2002 age 2+ biomass projected last year and the 2003 age 2+ biomass projected this year, this is due largely to changes in the assessment model. For example, this year's estimate of age 2+ biomass is 970,000 t, meaning that the decrease from 2002 to 2003 estimated by this year's model is only 10%.

The SSC has determined that reliable estimates of *B40%, F40%,* and *F35%* exist for this stock, thereby qualifying this stock for management under Tier 3. The updated point estimates of *B40%, F40%,* and *F35%* from the present assessment are 158,000 t, 0.18 and 0.21, respectively. Given that the projected 2003 spawning biomass of 303,000 t exceeds *B40%*, the Authors's ABC and OFL recommendations for 2003 were calculated under sub-tier "a" of Tier 3. *FABC* was set at the *F40%* (=0.18) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the *F40%* level gives a 2003 ABC of 110,200t. The OFL was determined from the Tier 3a formula, where an *F35%* value of 0.21 gives a 2003 OFL of 132,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

Flathead sole

For the most part, the 2002 assessment is a straightforward update of last year's, incorporating new catch, discard, survey biomass, and length composition data. One small change in the model is that sex-specific age compositions from the survey are now used. Also, the sex-specific age-length conversion matrices and weight at age were re-estimated this year. This year's EBS bottom trawl survey resulted in a biomass estimate of 575,000 t, a 12% increase relative to last year's estimate, although the assessment model estimates total biomass and spawning biomass continue to decline. The SSC has determined that reliable estimates of *B40%, F40%,* and *F35%* exist for this stock, thereby qualifying it for management under Tier 3. The updated point estimates of *B40%, F40%*, and *F35%* from the present assessment are 124,000 t, 0.29, and 0.36, respectively. Given that the projected 2003 spawning biomass of 225,000 t exceeds *B40%*, the The ABC and OFL recommendations for 2003 were calculated under sub-tier "a" of Tier 3. Model projections indicate that this stock is neither overfished nor approaching an overfished condition, and that stock biomass is relatively high. *FABC* was set at the *F40%* (=0.29) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the *F40%* level gives a 2003 ABC of 66,000 t. The OFL was determined from the Tier 3a formula, where an *F35%* value of 0.37 gives a 2003 OFL of 81,000 t.

Alaska plaice

Alaska plaice was first managed as an individual species in 2002, having previously been managed as the principal species in the "other flatfish" complex. Apart from this reclassification, however, the present assessment is a straightforward update of last year's assessment, incorporating 2001 and 2002 total catch and discard data and 2002 trawl survey data. This year's EBS bottom trawl survey resulted in a biomass estimate of 425,000t, a 21% decrease relative to

last year's survey estimate, but only a 4% decrease relative to the 2000 survey estimate. The SSC has determined that reliable estimates of *B40%, F40%,* and *F35%* exist for this stock, thereby qualifying Alaska plaice for management under Tier 3. The updated point estimates of *B40%, F40%,* and *F35%* from the present assessment are 131,000 t, 0.28, and 0.34, respectively. The values are almost identical to those for 2002. Given that the projected 2003 spawning biomass of 255,000 t exceeds *B40%,* the Authors's recommendations for OFL and ABC for 2003 were calculated under sub-tier "a" of Tier 3. Projected harvesting at the *F40%* level results in a 2003 ABC of 137,000 t. The OFL recommendation was determined from the Tier 3a formula. The *F35%* value for Alaska plaice (0.34) results in a 2003 OFL of 165,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

Other flatfish

Following the removal of Alaska plaice from this category, the species currently harvested in the "other flatfish" category include Dover sole, rex sole, longhead dab, Sakhalin sole, starry flounder, butter sole, and English sole. Of those, starry flounder and rex sole comprise 89% of the catch. Because of insufficient information about these species, no model analyses are possible. The assessment incorporates 2001 and 2002 total catch and discard data and 2002 trawl survey information. This year's EBS bottom trawl survey resulted in biomass estimates of 97,900 t, a 25% increase relative to last year's estimate. Adding the AI bottom trawl survey estimate produces a BSAI biomass estimate of 107,000 t. The SSC has determined that reliable estimates of *F40%* and *F35%* exist for this stock complex, thereby qualifying "other flatfish" for management under Tier 4. However, the assessment authors have suggested that this determination may have been premature. Because there appears to be much more variability among *F40%* values between flatfish species than among natural mortality rates, the assessment authors have recommended that the SSC reclassify "other flatfish" for management under Tier 5, using a value of 0.2 for the natural mortality rate. Anticipating that the SSC will concur, the Authors's recommendations are based on Tier 5 formula. It should be noted that the Tier 5 formula are more conservative than the Tier 4 formula in this instance. The Authors recommends setting *FABC* 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 2003 ABC of 16,000 t, a decrease from the 2002 ABC of 18,100 t. This decrease is due to the recommended change in management tier for the complex. The Authors recommends a 2003 OFL of 21,400 t, based on the Tier 5 *F=M* formula. It is not possible to determine whether the "other flatfish" complex is overfished or whether it is approaching an overfished condition because it is not managed under Tiers 1-3.

Greenland turbot

This year's assessment incorporates new catch and length frequency data from the fishery, and new abundance and size composition data from the longline survey and the shelf and slope bottom trawl surveys. The new EBS slope survey information was helpful in resolving some of the previous assessment uncertainty. The SSC has determined that reliable estimates of *B40%, F40%,* and *F35%* exist for this stock, thereby Greenland turbot for management under Tier 3 of the BSAI Groundfish FMP. Updated point estimates of *B40%, F40%,* and *F35%* from the present assessment are 54,400 t, 0.26, and 0.32, respectively. Projected spawning biomass for 2003 is 64,900 t, placing Greenland turbot in sub-tier "a" of Tier 3. The maximum permissible value of *FABC* under Tier 3a translates into a 2003 catch of 14,700 t. The 2003 ABC was set at a

value less than the maximum permissible. Using *FABC* = 5-year average results in a 2003 ABC of 5,880 t corresponding to a full selection fishing mortality rate of 0.10.

The OFL fishing mortality rate is computed under Tier 3a, *FOFL =F35%* = 0.32, and translates into a 2003 OFL of 17,800 t. There is a continuing concern regarding further stock declines and the continued lack of apparent recruitment for this stock. The Authors acknowledge large uncertainties in the assessment. Additional slope trawl surveys are needed to improve measurement of abundance trend and estimates of biomass.

Arrowtooth flounder

The latest assessment introduces a new, split-sex model for arrowtooth flounder implemented in the ADMB programming environment. This year's EBS shelf bottom trawl survey resulted in a biomass estimate of 355,000 t, a 13% decrease relative to last year's estimate. The EBS slope survey estimated 61,000 t, for a total of 416,000 t in the EBS. The Aleutian bottom trawl survey estimated 88,700 t, a 5% decrease from the 2000 survey. For several years, there have been discussions regarding the high ratio of female to male arrowtooth flounder. A model was developed this year, enabling estimation of a separate natural mortality rate for males. The natural mortality for males was estimated to be 0.281 (0.2 had been used in the past). The new, split-sex model led to a change in estimated selectivity for both males and females, which, together with the change in M for males, accounts for the relatively large changes in the *F40%* and *F35%* estimates from previous years.

The SSC has determined that reliable estimates of *B40%*, *F40%*, and *F35%* exist for this stock, thereby qualifying arrowtooth flounder for management under Tier 3. The updated point estimates of *B40%*, *F40%*, and *F35%* from the present assessment are 206,000 t, 0.30, and 0.38, respectively. Given that the projected 2003 spawning biomass of 436,000 t exceeds *B40%*, the Authors's ABC and OFL recommendations for 2003 were calculated under sub-tier "a" of Tier 3. *FABC* was set at the *F40%* (=0.30) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the *F40%* level gives a 2003 ABC of 112,000t. The OFL fishing mortality rate under Tier 3a is *F35%* (=0.38), translating into a 2003 OFL of 139,000 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

The flatfish group is subdivided into deep water flatfish, rex sole, flathead sole, and shallow water flatfish. Flathead sole is presented in a separate assessment. The 2003 exploitable biomass for each group is based on results from the 2001 NMFS demersal trawl survey. However, the lack of survey effort in 2001 in the eastern GOA resulted in biomass in the eastern GOA being approximated by using the average of the 1993-1999 eastern GOA biomass estimates. In addition, biomass estimates for some species were also affected by the lack of sampling deeper than 500 m. The 500-1,000 m depth strata not sampled in 2001 is generally outside the depth range of most flatfish species, with the exception of Dover sole, Greenland turbot, deep-sea sole and, to a lesser extent, rex sole.

ABC and OFL were calculated by species, with individual species identified as tier 4, 5, or 6 depending upon the available data. The total flatfish ABC for 2003 decreased slightly from

2002 because maturity data for northern and southern rock sole allowed estimation of F40% and F35% and resultant ABCs for those species declined. Otherwise, ABCs remained the same as 2002.

Apportioning ABCs among the regulatory areas in proportion to biomass distributions in the 2001 trawl survey results in the area apportionments listed below. As in 2002, the Team recommends splitting the eastern GOA ABC between the WY and EYAK/SEO subareas. The resulting 2003 ABCs are:

	WESTERN	CENTRAL	WYAK	EYAK/SEO	TOTAL
Deep water	180	2,220	1,330	1,150	4,880
Rex sole	1,280	5,540	1,600	1,050	9,470
Shallow water	23,480	21,740	1,160	2,960	49,340

The overfishing levels for the flatfish groups are determined by the fishing mortality rates based on the tier structure of the exploitable biomass estimates. Those fishing mortality rates and associated catch levels are:

OVERFISHING

	FABC	FOFL	LEVEL	TIER
Deep water	0.075	0.10	6,430	5,6
Rex sole	0.15	0.20	12,320	5
Shallow water	0.15-0.2	0.192-.245	61,810	4,5

Arrowtooth flounder

The 2003 exploitable biomass of 1,302,000 mt is based on abundance estimates derived from an age-structured model developed with AD Model Builder software. Similar to the previous assessment, the model accommodated a higher proportion of females in the larger size intervals of both survey and fishery data by giving males a higher mortality rate than females. The only change from last year's model was that the survey selectivity was fit using a two parameter logistic model as opposed to a smoothed curve fit used in prior models. ABC was determined based on Tier 3a calculations ($F40\% = 0.14$). The overfishing level was determined to be 181,390 mt ($F35\% = 0.165$). The ABC is apportioned among regulatory areas in proportion to biomass distributions in the 2001 trawl survey. The resulting ABCs are:

WESTERN	CENTRAL	WYAK	EYAK/SEO	TOTAL
17,990	113,050	18,190	5,910	155,140

Flathead sole

This year an age structured model was run for the flathead sole assessment. Previously flathead sole had been included in the Flatfish Complex. The 2003 exploitable biomass of 132,264 mt is based on abundance estimates derived from an age-structured model developed with AD Model Builder software. Analysis of maturity by age and length was completed for Gulf of Alaska flathead sole and these data were included in the model. Age data from the trawl survey for 1984, 1993, and 1996 were used as well as length data from the trawl survey (1987, 1990, 1999, 2001) and the commercial fishery (1985-2002). The fishing mortality reference rates for

flathead sole were much higher than in the past, because of the updated information on length and age at maturity. Age at 50% maturity is estimated to be 8 years while age at 50% selectivity is estimated to be 10 years. Projected spawning biomass is estimated at 93,524 mt, above the B40% biomass of 38,163 mt; therefore flathead sole is in tier 3a. F40% was 0.417, resulting in an ABC of 41,402 mt. The overfishing level, F35% = 0.546, is 51,556 mt. Apportionment of the ABC was based on the fraction of the 2001 survey biomass in each area:

Western	Central	West Yakutat	East Yakutat/SE	Total
16,420	20,820	2,900	1,250	41,390

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

10. Walleye pollock

a. Research

BERING SEA

Echo Integration-Trawl Surveys - Southeastern Bering Sea Shelf, Southeastern Aleutian Basin near Bogoslof Island, and the Bering Sea Shelf and Slope

The Midwater Assessment and Conservation Engineering MACE Program conducted an echo integration-trawl (EIT) survey of walleye pollock on the southeastern Bering Sea shelf and in the southeastern Aleutian Basin near Bogoslof Island (Bogoslof Island area) during winter 2002. The primary cruise objective for the Bering Sea shelf section was to assess abundance and distribution of midwater pollock inhabiting the eastern portion of the Sea lion Conservation Area (SCA) east of 168°W. The primary objective of the Bogoslof portion was to assess the abundance of pre-spawning midwater pollock in the southeastern Aleutian Basin near Bogoslof Island. The biomass estimate for midwater pollock inside U.S. management area 518 (also known as the Central Bering Sea (CBS) specific area) obtained during this survey provides an index of Aleutian Basin pollock abundance which is discussed at each year's CBS Convention meeting. The Japan Fisheries Agency also conducted a winter EIT survey of pollock in the southeastern Aleutian Basin. This survey was conducted aboard the R/V Kaiyo Maru in cooperation with the United States in order to estimate distribution and abundance of pre-spawning pollock in the Bogoslof Island area, and in the basin and slope waters north of the Aleutian Islands west of 170°W to about 176°W. Prior to the start of the U.S. survey, the two vessels conducted an intership calibration to compare acoustic system performance, results will be reported elsewhere.

The Bering Sea shelf EIT survey began on 23 February, 2002 north of the Alaskan Peninsula at about 162° 30'W longitude and proceeded west across the shelf to about 168°W, ending on 4 March. The 25 north-south transects were spaced 8 nautical miles (nmi) apart and covered a 12,784 nmi^2 area. Pollock were most concentrated northeast of Unimak Island. Pollock fork lengths (FL) across the shelf ranged from 18 to 66 cm. Estimates of midwater shelf pollock abundance by size indicated two dominant modes, one at about 23 cm and one at about 46 cm. The mode of small pollock was from aggregations just north of the 200 m isobath, between about 166°57'W and 167°40'W longitude. Maturity composition for female pollock greater than 29 cm FL (approximately ages 3 and older) showed that 66% were pre-spawning, 27% were developing, and about 1% were actively spawning. For male pollock greater than 29 cm FL, 51%

were pre-spawning, 23% were developing, and about 20% were actively spawning. Among pollock sampled that were 29 cm FL and smaller, 87% were developing and 13% were immature. Females were estimated to be 50% mature at 41 cm FL. The mean GSI (gonad weight/total body weight) for mature pre-spawning females on the shelf was 0.12. The abundance estimate for midwater pollock in the Bering Sea shelf survey area between 14 m below the surface and 0.5 m off-bottom was 2.329 billion fish and 1.355 million metric tons t.

The southeastern Aleutian Basin EIT survey, near Bogoslof Island began 5 March, 2002 north of Unalaska Island at about 167°W longitude, and proceeded west towards the Islands of Four Mountains near 170°W, ending on 8 March. The 22 north-south transects were spaced 5 nmi apart and covered a 2,903 nmi^2 area within the U.S. management area 518/CBS specific area. Pollock were primarily concentrated in the Samalga Pass area, and some were distributed along the north slopes of the Aleutian Chain at the northeast end of Umnak Island. Among pollock sampled in trawl hauls, fork lengths ranged from 23 to 70 cm. Population estimates for Bogoslof pollock indicated a bimodal size distribution at about 47 cm and 58 cm FL. Maturity composition analyses indicated that 84% of female and 40% of male pollock were in pre-spawning condition. Three percent of females and about 46% of males were spawning actively. The mean GSI for mature pre-spawning females was 0.18. The abundance estimate for midwater pollock in the Bogoslof area between 14 m below the surface and 1,000 m (or to within 0.5 m off-bottom if bottom depth was shallower than 1000 m) was 181 million fish and 0.227 million t.

The MACE Program conducted an EIT survey of midwater walleye pollock on the Bering Sea continental shelf between 4 June and 30 July, 2002. This survey was conducted in cooperation with a research vessel from TINRO-Centre, Vladivostok, Russia. Intership calibration was conducted between both survey vessels and results will be reported elsewhere. The MACE survey design consisted of 28 north-south transects spaced 20 nmi apart over the Bering Sea shelf from Port Moller, Alaska, to the U.S./Russia Convention Line. Transects were chosen to coincide with lines of groundfish trawl stations sampled about 2 weeks earlier by bottom trawl survey vessels.

Pollock were observed on all transects across the shelf. They were most dense north of Unimak Island, and south and west of St. Matthew Island. Two types of echosign were attributed to pollock. The first formed low to high density layers rising from the bottom into midwater during daytime and was either composed of adult pollock or was a mixture of juvenile and adult pollock. The second formed discrete midwater schools near the 100 m isobath and was attributed to juvenile pollock (generally 10-35 cm FL). These schools were observed due north and northwest of Unimak Island (between 165°W and 167°W), due south of St. Matthew Island, and west of St. Matthew Island (between 175°W and 177°W). Estimated pollock abundance in the midwater region (14 m from the surface to 3 m off bottom) was 1.21 billion fish weighing 3.62 million t. East of 170°W, estimated pollock abundance was 1.44 million t (40% of the total biomass, representing 3.89 billion fish). West of 170°W, estimated abundance was 2.18 million t (60% of the total biomass, representing 8.23 billion fish). About 18% of the total biomass was inside the Steller sea lion Conservation Area (SCA). Proportions of estimated midwater pollock biomass east of 170°W and inside the SCA, were higher in summer 2002 compared with recent summer EIT surveys. Expressing pollock numbers at length as age groups (less than 20 cm FL, 21-29 cm FL, and greater than or equal to 30 cm FL; representing ages 1, 2, and 3 and older, respectively) shows that east of 170°W, 51% were 2-year-olds, 46% were3-years and older, and 3% were 1-year-olds. West of 170°W, 2-year-olds comprise about 38% by numbers, 3-years and older about 55%, and 1-year-olds about 7%. Overall midwater pollock abundance in 2002 was higher than in 2000 (3.62 vs. 3.05 million t).

GULF OF ALASKA

Echo Integration-Trawl Surveys - Shumagin Islands, Shelikof Strait, and East Kodiak Areas

The MACE Program conducted an EIT survey of midwater walleye pollock in the Shumagin Islands area between 10 February and 16 February, 2002. The survey extended from the southwest end of West Nagai Strait, AK to northeastern Stepovak Bay, and from Unga Strait out into the Shumagin Trough. Parallel transects were spaced 3 nmi apart, except in Shumagin Trough, where transect spacing was 5 nmi. An exploratory zig-zag pattern was used in Pavlof Bay and Sanak Trough. Densest aggregations were observed off Renshaw Point and in northwestern West Nagai Strait. The small amount of pollock echosign observed outside these two areas was distributed mostly off Swedania Point and in Shumagin Trough. The overall length composition varied between areas. Off Renshaw Point and West Nagai Strait, trawl hauls caught mostly adult pollock (modal FL 49 and 45 cm, respectively), and off Swedania Point, younger pollock were caught (modal FL 20 cm). Net reel malfunction prevented trawling operations in Shumagin Trough, Pavlof Bay, and Sanak Trough. The maturity composition for males longer than 40 cm FL was 2% developing, 72% pre-spawning, 15% spawning, and 11% spent. The maturity composition for females longer than 40 cm FL was 10% developing, 78 % pre-spawning, 5% spawning, and 8% spent. Female pollock were estimated to be 50 % mature at 44 cm FL and the mean GSI for mature pre-spawning females was 0.17. Among pollock sampled that were smaller than 40 cm FL, 96% were immature or developing. Comparison of the female maturity composition with previous Shumagin surveys conducted in mid-February suggests that the timing of peak spawning has varied. For example, the percentage of female pollock classified as either "spawning" or "spent" in 2002 (13%) was greater than in 1995 (6%) but substantially lower than in 1996 (37%) and 2001 (45%). Midwater pollock abundance estimates in the Shumagin Islands area are 202.1 million fish weighing 136.6 thousand t. This estimate does not include echosign observed in Shumagin Trough, Pavlof Bay, and Sanak Trough.

The MACE Program conducted an EIT survey of midwater walleye pollock at four locations around Kodiak Island, including the Shelikof Strait area, the continental shelf break east of Chirikof Island, Barnabas Trough, and Chiniak Trough between 14 and 26 March, 2002. The Shelikof Strait survey covered the area from near Chirikof Island to about Cape Chiniak on the Alaska Peninsula. The survey design consisted of parallel transects spaced 7.5 nmi apart. After completion of the Shelikof Strait area work, a survey was conducted along the shelf break from about 10 nmi east of Chirikof Island to the mouth of Barnabas Trough. The shelf-break trackline consisted of 19 transects spaced 6.0 nmi apart, except along a single transect midway through the survey where the lines were reoriented to maintain a perpendicular alignment to the bathymetry. Trackline for Barnabas Trough began near the final shelf-break transect and ended in Ugak Bay using transects spaced 3.0 nmi apart except for the first two transects, which were spaced 6.0 nmi apart. Chiniak Trough was surveyed using an exploratory zig-zag transect pattern.

In Shelikof Strait, densest echosign attributed to near-bottom pollock occurred from about 30 nmi northwest of Chirikof Island to about Cape Kekurnoi. Similar to the 2001 survey but unlike most other Shelikof Strait surveys, very little echosign was detected beyond Katmai Bay along the west side of the Strait, where the bulk of the mature pre-spawning pollock are usually found. Pollock from mostly the 1999 year class (modal FL 27 cm) formed well-defined midwater layers during the day at about 150 m depth and dispersed layers from about 50-175 m at night. Most of these layers extended from slightly north of the Semidi Islands to about Middle

Cape. The maturity composition of male pollock longer than 40 cm FL was <1% immature, 5% developing, 74% pre-spawning, 5% spawning, and 16% spent. The maturity composition for females longer than 40 cm FL was 0% immature, 16% developing, 84% pre-spawning, 0% spawning, and <1% spent. The percentage of females in the spawning and spent stage of maturity was similar in 2000 and 2001 (3% in both years) but substantially lower than in 1998 (17%), 1997 (15%), and 1996 (23%). Female pollock were estimated to be 50 % mature at 42 cm FL. The mean GSI for mature pre-spawning females of 0.12 was similar to the mean GSI from the 2001 survey but lower than the mean GSIs (0.14-0.19) reported for other recent (1992-2000) Shelikof surveys, which suggests that the fish may have spawned later in the Shelikof Strait area this year. The midwater pollock biomass estimate of 1.3 billion fish weighing 229,100 t was 38% lower than the 2001 estimate, and was the lowest in survey history.

Along the shelf break, most echosign attributed to midwater layers of pollock occurred between 300 and 500 m depth within the two shelf-break bights between Chirikof Island and Barnabas Trough over bottom depths of 300 to 800 m. However, the midwater layer occasionally was detected over bottom depths as shallow as 200 m and or in excess of 1,500 m. Adult fish dominated the size composition of pollock caught in the shelf-break area. Over 99% of the pollock exceeded 40 cm FL. The maturity composition for male pollock longer than 40 cm FL was <1% immature, 1% developing, 69% mature pre-spawning, 10% spawning, and 20% spent . The maturity composition for females longer than 40 cm FL was 2% developing, 97% pre-spawning, <1% spawning, and 1% spent. Female pollock were estimated to be 50% mature at 41 cm FL, and the mean GSI for mature pre-spawning females was 0.15. The abundance of midwater pollock in the shelf break area was estimated to be 76.5 million fish weighing 82,100 t.

Virtually no pollock were detected in Barnabas Trough except in Ugak Bay, where the single midwater trawl caught juvenile pollock (between 20 and 31 cm FL). The abundance of midwater pollock in Barnabas Trough was estimated at 12.1 million fish weighing 1,300 t.

For more information, please contact Dr. William Karp, (206) 526-4164.

b. Stock assessments

GULF OF ALASKA

The age-structured assessment model using ADModel Builder (a C++ software language extension and automatic differentiation library) for assessments since 1999 is unchanged. Model exploration focused on approaches to modeling survey time series, particularly the winter EIT surveys. Relative to the 2001 SAFE, new sources of information include: (1) total catch and age composition from the 2001 fishery; (2) biomass and age composition from the 2002 Shelikof Strait echo integration trawl (EIT) survey; (3) biomass and age composition from the 2002 ADF&G coastal trawl survey; (4) age composition for the 2001 NMFS bottom trawl survey; and (5) new maturity-at-age estimates using winter EIT survey data for 1983-2002.

Spawning stock estimates for 2003 strongly depend on the magnitude of the 1999 year class. The 2002 model estimate indicates the 1999 year class is 2.7 times larger than mean recruitment during 1979-2000. However, this year's assessment indicates that the 1999 year class was about 30% less than projected by the 2001 model (although precision has improved). The 2002 Shelikof Strait EIT survey estimate of spawning biomass is 38% lower than the 2001

survey, with a much greater decrease in biomass of pollock > 42 cm. In contrast, the Shelikof Strait EIT survey estimate of age-3 abundance was the third highest on record. Also, pollock biomass estimated by the 2002 ADF&G trawl survey increased 11% from the 2001 survey.

The stock assessment authors presented six models: model 1 estimated q instead of fixing q=1.0 as in other models; model 2 was similar to last year's assessment; model 3 excluded the 2002 Shelikof EIT data; model 4 excluded all Shelikof survey time series data; model 5 adjusted the 2002 EIT survey biomass distribution to historical averages; and model 6 excluded the ADF&G 2002 trawl survey data. Model 2 was the model of choice as it provided the best use of available data and maintained consistency with previous assessments. The estimated spawning biomass in 2003 is 177,070 mt and below the B40% value of 240,190 mt. This places Gulf of Alaska pollock in Tier 3b. The author presented analyses on the sensitivity of ABC recommendations to assumptions about the strength of the 1999 year class.

The projected 2003 age-3+ biomass estimate is 670,410, assuming average abundance for the 1999 year class, for the Western, Central, and West Yakutat areas and 28,170 mt for the East Yakutat and Southeast Outside areas. Although there is substantial uncertainty regarding the strength of the 1999 year class, a suite of new information will be available in 2003 from sources including: the NMFS biennial bottom trawl survey; the Shelikof EIT survey; a gulf wide summer acoustic survey; and additional fishery age and size data. Because of this uncertainty, a downward adjustment was made to the maximum permissible ABC for the 2003 fishing season.

The 2003 ABC recommendation for pollock in the Gulf of Alaska west of 140°W is 49,590 mt (*FABC* = 0.24), a decrease of 35% from the last year's projected maximum permissible ABC for 2002. Elements of risk-aversion in the recommendation include: (1) fixing trawl catchability at 1.0; (2) assuming an average 1999 year class; and (3) not adjusting the 2002 Shelikof Strait biomass estimates to account for a lower than anticipated portion of the spawning stock in 2002. The 2003 overfishing level is 69,410 mt (*FOFL* =0.35). The 2003 recommended ABC for the Western, Central and West Yakutat area is 47,890 mt after being reduced to accommodate the 2003 Prince William Sound guideline harvest level of 1,700 mt. The West Yakutat ABC was calculated as an annual allocation of 1,078 mt, resulting in an ABC of 46,812 for the Western and Central Areas. Due to the lack of new survey data in the EGOA, the 2003 ABC recommendation for pollock in southeast Alaska (East Yakutat and Southeastern areas) is unchanged at 6,460 mt. The 2003 southeast OFL is also unchanged at 8,610 mt. Steller Sea lion Protection Measures require apportionment of pollock among Gulf of Alaska management areas based on the seasonal distribution of biomass. The assessment used available data from a composite of winter surveys to apportion pollock in the A and B seasons and the summer bottom trawl surveys to apportion pollock in the C and D seasons.

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

EASTERN BERING SEA

The present assessment is a straightforward update of last year's assessment, incorporating new data from the 2002 fishery and bottom trawl and echo-integration trawl (EIT) surveys. The 2002 bottom trawl survey estimated a biomass of 4,820,000 t, an increase of 16% relative to the 2001 estimate. The 2002 EIT survey estimated a biomass of 3,600,000 t, an increase of 18% relative to the 2000 estimate (the last year an EIT survey was conducted). Other new inputs include age composition data from the 2001 fishery and the 2002 bottom trawl survey.

Seven alternative models are presented in the chapter, all of which follow the statistical age-structured approach that has been used for the last several years. All of these models give point estimates of 2003 age 3+ biomass in the range 10,200,000 t to 13,200,000 t. Concurring with the assessment authors, the Authors based their recommendations for 2003 on the reference model (Model 1), which is essentially identical to last year's model. The current assessment indicates that biomass is higher than estimated in last year's assessment. For example, this year's estimate of 2001 age 3+ biomass (11,800,000 t) is 6% higher than last year's estimate of 2001 age 3+ biomass (11,100,000 t). Such variability is well within the confidence intervals of the estimates. The coefficient of variation (CV) for the 2001 biomass estimate produced last year was 39% and the CV for the same estimate produced this year was 42%. Relative to last year's assessment, the current assessment gives higher estimates for the 1999 and 2000 year classes, but a lower estimate for the 1996 year class. The SSC has determined that reliable estimates of BMSY and the probability density function for FMSY 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, a conclusion with which the Authors concurs. The updated estimates of BMSY and the harmonic and arithmetic means for FMSY from the present assessment are 2,290,000 t, 0.52, and 1.1, respectively, compared to 2,140,000 t, 0.52, and 1.2, respectively, from last year's assessment. Projected spawning biomass for 2003 is 3,330,000 t (the confidence interval based on minus/plus one standard deviation extends from 2,700,000 t to 3,960,000 t), placing EBS walleye pollock in sub-tier "a" of Tier 1.

The maximum permissible value of FABC under Tier 1a is 0.52, the harmonic mean of the probability density function for FMSY. A fishing mortality rate of 0.52 translates into a 2003 catch of 2,330,000 t, which would be the maximum permissible ABC under Tier 1a (compared to 2,110,000 t in last year's assessment). This ABC is almost identical to the 2003 catch of 2,320,000 t that would be projected under an F40% harvest rate. Last year, the senior assessment author, the Plan team, and the SSC all recommended setting 2002 ABC at the maximum permissible value. This year, the senior author again recommends setting ABC at the maximum permissible value. Given that TAC will necessarily be set below the recommended ABC, the assessment also provides alternative harvest scenarios, including the seven standard scenarios analyzed in all age-structured assessments and two constant catch scenarios (1,300,000 t and 1,400,000 t). The OFL fishing mortality rate under Tier 1a is 1.1, the arithmetic mean of the probability density function for FMSY. A fishing mortality rate of 1.1 translates into a 2003 OFL of 3,530,000 t. The EBS walleye pollock stock is neither overfished nor approaching an overfished condition.

Aleutians:

The 2002 bottom trawl survey of the Aleutians Islands region resulted in a biomass estimate of 175,000 t (the confidence interval based on minus/plus one standard deviation extends from 133,000 t to 217,000 t), an increase of 65% relative to the 2000 estimate. Last year, the SSC determined that Aleutian pollock qualified for management under Tier 5. The maximum permissible ABC under Tier 5 is 75% of the product of the natural mortality rate (0.30) and biomass, giving a value of 39,400 t, which is the Authors's recommended ABC for 2003. This is an increase of 65% relative to last year's recommendation, an increase which is totally attributable to the change in the survey biomass estimate. The overfishing level under Tier 5 is the product of the natural mortality rate and biomass, giving an OFL of 52,600 t for 2003. As a Tier 5

stock, it is not possible to determine whether Aleutian pollock is overfished or whether it is approaching an overfished condition.

Bogoslof:

The 2002 hydroacoustic survey of the Bogoslof region resulted in a biomass estimate of 227,000 t (the confidence interval based on minus/plus one standard deviation extends from 200,000 t to 254,000 t). 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 34,000 t, which is the recommendation for 2003 ABC. This recommendation is 2% lower than last year's Authors recommendation, but much higher than last year's SSC recommendation of 4,310 t. If the formula used last year by the SSC is applied again, the resulting fishing mortality rate is 0.019, giving a 2003 ABC of 4,070 t. The overfishing level under Tier 5 is the product of the natural mortality rate and biomass, giving an OFL of 45,300 t for 2003. 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

13. Other Species

a. Research

Identification and Characterization of Atka Mackerel Reproductive Habitat

Atka mackerel is one of 10 species of hexagrammids that are endemic to the North Pacific Ocean. The Atka mackerel's schooling behavior is uncharacteristic among hexagrammids and their high abundance in the Aleutian Islands supports a multimillion-dollar a year commercial trawl fishery. Historical accounts and fish bones from Aleut Indian middens indicate Atka mackerel was also an important subsistence fish for indigenous populations. Furthermore, larval, juvenile, and adult Atka mackerel play a key role in the marine ecosystem as an essential forage species for planktivores, marine birds, picsivorous fishes and marine mammals, including the endangered Steller sea lion.

Major research efforts currently focus on offshore waters where a large percentage of the Atka mackerel population lives a semi-pelagic existence during much of the year. Of particular interest to behavioral and stock assessment biologists, however, is the Atka mackerel's annual spawning migration. Males move to nearshore areas of the Aleutian Islands during the early summer and establish nesting sites where females come to lay eggs after which males guard the nests. Since surveys of nesting sites in the Aleutian Islands have never been done, it is unknown to what extent Atka mackerel utilize the nearshore habitat surrounding the islands or deeper offshore where the commercial fishery operates. Understanding annual migration patterns should be an essential first step for developing a strategy for estimating the abundance of Atka mackerel. Also critical is knowledge of how spawning habitat overlaps with the commercial fishery. Nest or nesting habitat destruction by commercial trawls or direct removal of guardian males during the nesting period could adversely impact survival of embryos and ultimately the population.

This study was the first to locate and characterize an Atka mackerel nesting area in the U.S. Exclusive Economic Zone. In the nearshore areas of Finch Cove, Seguam Island, we were

able to estimate clutch density and document on video the behavior associated with courtship, spawning and nest guarding. In 2002, the F/V *Morning Star*, F/V *Sea Storm*, and the U.S. Fish and Wildlife's R/V *Tiglax* were used as support vessels for further investigation of Atka mackerel nesting habitat. On May 31, an *in situ* time-lapse camera was deployed at the Finch Cove nesting site before male Atka mackerel were present. Footage from the retrieved video camera revealed that an aggregation of males established the nesting site in mid June. Clutches of eggs were present and males were still exhibiting nest fidelity when a time-lapse camera was last reset on August 31. The camera will continue to sample daily footage for one minute per day through December 2002 so that we can observe when males finally depart the nesting site. Temperature, current and depth data loggers attached to time-lapse cameras will be used to see how utilization of the nesting habitat varies with changes in the physical environment. At the same site, two 30 m SCUBA transects were established to count clutches to see how the number varied over time. The number of egg clutches was 0 in May and peaked at 30 clutches in late August. One freshly laid clutch of eggs and several of unknown age were sampled at the beginning of August. These eggs were incubated at the AFSC in a controlled environment similar to what is found at the nesting site. The resulting developmental series will be a useful tool for estimating the age of egg samples obtained from clutches at various nesting sites.

To expand our capabilities for searching, verifying, and quantifying Atka mackerel reproductive habitat, we developed the Quadrat Underwater Assessment Drop Camera (QUADCAM) in 2001. The camera system was deployed successfully during summer 2002 using a 16-ft inflatable skiff outfitted with a portable winch and boom. Images from the digital video camera were clear and detailed. A real time navigation camera connected to a topside monitor was used to navigate the QUADCAM along bottom so it would not hang up. In over 200 drops in depths ranging from 15 m to 160 m, the QUADCAM photographed two Atka mackerel egg clutches. Still photographic images will be used to describe the physical and biological characteristics of the nesting habitat. Several deployments were made in Seguam Pass to depths below 150 m and one in Amukta Pass to 100 m. The bottom was prolific with colorful corals, sponges and other invertebrates and great numbers of Atka mackerel were seen scattered along the bottom. On the deeper deployments, no egg clutches were observed, nor were male Atka mackerel exhibiting nesting behavior. In shallower deployments, it was observed that nesting male Atka mackerel reacted to the QUADCAM's strobe lights. A low density of egg clutches, a small area of coverage of the QUADCAM, or both probably accounted for the low number of clutches observed. Egg clutches on vertical faces or under ledges would also be hard to detect.

After trying a variety of methods, we decided the best and quickest means for documenting nesting sites was to use the drop camera without lights. The drop camera did not affect behavior and we were able to use it to locate aggregations of brightly colored yellow males. These males exhibited the typical nesting behaviors we documented using time-lapse cameras, hence, we were able to use them for identifying nesting sites. Using this methodology, we located other nesting areas within the Aleutian Islands located including: 1) Austin Cove and Chigahof Island on Attu Island, 2) NW corner of Buldir Island, 3) western side of Amukta Island, and 4) Wharf and Lava Points on Seguam Island. Nesting sites were absent at many areas adjacent to these as well as other areas including Sweeper Cove on Adak Island, south end of Kagalaska Island, Umak Island and Kasatouchi Island. At all sites, temperature, depth and position data were collected with the camera drops for comparing the physical and biological environment.

For more information, contact Bob Lauth (206)526-4121 or Scott McEntire (206)526-4472.

Pacific Sleeper Shark Relative Abundance in the Northeast Pacific

Pacific sleeper sharks are a deepwater shark of the north Pacific. Some information suggests their abundance is increasing. However no quantitative statistical analysis of the trends in abundance has been completed to date. Our purpose was to analyze existing sleeper shark data to determine the trend in abundance and whether any change was statistically significant. We analyzed a long-term time series, 1979-2000, of Pacific sleeper shark bycatch from fishery-independent sablefish longline surveys in Alaskan waters of the northeast Pacific. Results indicated there appeared to be a significant increase in the relative abundance of Pacific sleeper sharks in the central Gulf of Alaska between the years 1989-2000.

Pacific sleeper sharks are not commonly captured in sablefish longline surveys, but shark catch has been recorded to species for the duration of the surveys. A total of 1,091 Pacific sleeper sharks were captured during sablefish longline surveys from 1979-2000. Pacific sleeper shark catches have increased during the survey from a low of 0 in 1979 and 1983 to a high of 175 in 1994. The most recent available catch is 111 Pacific sleeper sharks in 2000. Pacific sleeper shark CPUE (catch per 10,000 hooks) has increased steadily from a low of 0 in 1979 to a high of 2 in the year 2000.

Most Pacific sleeper sharks (59%) were captured in the 201-300 m depth stratum from stations located in gullies of the Bering Sea and Gulf of Alaska continental shelf. Many Pacific sleeper sharks (487 [45%] of 1,091) were captured in one gully, Shelikof Trough, and the Gulfwide increase in relative abundance of Pacific sleeper sharks was driven largely by increasing catches in this area.

95% bootstrap confidence intervals were calculated for estimates of Pacific sleeper shark relative abundance from the domestic longline survey between the years 1989-2000. The confidence intervals did not overlap for all years suggesting that there has been a significant increase in Pacific sleeper shark RPN's for some years between 1989 and 2000 (at the 95 % confidence level). The most substantial increase occurred between 1992 and 1993 and Pacific sleeper shark remained relatively abundant from 1994-2000.

These results were presented to the Gulf of Alaska Groundfish Plan Team and included in the Ecosystem Considerations Chapter of the Groundfish Plan Team's Stock Assessment and Fisheries Evaluation Report for 2003.

For more information, contact Dean Courtney at (907) 789-6006 or Mike Sigler at (907) 789-6037.

D. Other Related Studies

Effects of Fishing on Sea Floor Habitat

Distribution of Deep-water Corals and Associated Communities in the Aleutian Islands

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996, requires the regional Fishery Management Councils and NMFS to minimize, to the extent practicable, adverse effects from fishing on essential fish habitat including coral habitat. Major fisheries presently occur throughout the Aleutian Island Archipelago and down the continental slope to at least a depth of 1,500 m. Summaries of

archived data and recently acquired fisheries bycatch specimens indicate that the Aleutian Islands may harbor the highest abundance and diversity of temperate water corals in the world. These data reveal little about the distribution of corals in relation to the overall underwater landscape and the importance of corals to marine ecosystems.

In July 2002 Auke Bay Laboratory (ABL) scientists used the DSV Delta to study Aleutian Island coral habitat in waters down to 350 m depth near the Andreanof Islands and on Petrel Bank in the Bering Sea. Coral and sponges were found at 30 of 31 dive sites investigated and percent coverage ranged from approximately 5% on pebble substrate to 100% coverage on bedrock outcrops. Unique coral habitat consisting of high density "gardens" of corals, sponges, and other sessile invertebrates was found at 5 sites between 150 and 350 m depth. These "gardens" were similar in structural complexity to tropical coral reefs. This habitat had not been previously documented in the North Pacific Ocean or Bering Sea. Disturbance to epifauna, likely anthropogenically induced, was observed at most dive sites and may have been more evident in heavily fished areas.

Scientists from ABL, the Alaska Department of Fish and Game, and the University of Alaska plan to return to the central Aleutian Islands in 2003 and 2004. In 2003, multibeam bathymetry backscatter basemaps will be created for 17 locations systematically selected between Seguam Pass and Petrel Bank. The DSV Delta and ROV Jason II will be used in 2003 and 2004, respectively, to collect in situ observations and videographic data on strip transects at depths between 350 and 2750 m. Ultimately, the goal is to construct a model that predicts 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 also directly assist managers in developing methods to minimize fishing interactions with coral habitat in the Aleutian Islands.

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

Effects of Bottom Trawling on Soft-bottom Habitat in the Central Gulf of Alaska

In April 1987, the North Pacific Fishery Management Council closed two areas around Kodiak Island to bottom trawling and scallop dredging (Type 1 Areas). These areas were designated as important rearing-habitat and migratory corridors for juvenile and molting crabs. The closures are intended to assist rebuilding severely depressed Tanner and red king crab stocks. In addition to crab resources, the closed areas and areas immediately adjacent to them have rich stocks of groundfish including flathead sole, butter sole, Pacific halibut, arrowtooth flounder, Pacific cod, walleye pollock, and several species of rockfish.

These closures provide a rare opportunity to study the effects of an active bottom trawl fishery on soft-bottom, low-relief marine habitat because bottom trawling occurs immediately adjacent to the closed areas. In 1998 and 1999, the Auke Bay Laboratory (ABL) initiated studies to determine the effects of bottom trawling on these soft-bottom habitats. Direct comparisons were possible between areas that were consistently trawled each year and areas where bottom trawling had been prohibited for 11 to 12 years. The proximity of the closed and open sites allowed for comparison of fine-scale infauna and epifauna diversity and abundance, and

microhabitat and community structure. The goal of this study was to determine if bottom trawling, in some of the more heavily trawled areas in the central Gulf of Alaska, has chronically altered soft-bottom marine communities. Spatial distribution and abundance of epifauna were examined at two sites which overlapped areas open to trawling and closed areas where bottom trawling had been prohibited for 11-12 years. Continuous video footage of the seafloor was collected at each site from a manned submersible along strip transects that were bisected by the boundary demarcating open and closed areas.

The positions of 155,939 megafauna were determined along 89 km of seafloor. At both sites we detected general and site-specific differences in epifauna abundance and species diversity between open and closed areas that indicate the open areas are stressed or disturbed. Species richness was lower in open areas. Species dominance was greater in one open area, while the other site had significantly fewer epifauna in open areas. Both sites had decreased abundance of low-mobility taxa and prey taxa in the open areas. Site-specific responses were likely due to site differences in fishing intensity, sediment composition, and benthic currents. Prey taxa were highly associated with biogenic and biotic structures; biogenic structures were significantly less abundant in open areas. While current fishing levels may have produced detectable changes to these communities, we believe the differences are not of sufficient magnitude to cause broad-scale changes to these communities. Evidence exists, however, that bottom trawling has produced changes to the seafloor and associated fauna, affecting the availability of prey for commercially important groundfish. These changes should serve as a "red flag" to managers since prey taxa are a critical component of essential fish habitat.

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

Growth and Recruitment of an Alaskan Shallow-water Gorgonian

At least 20 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 is currently considering measures to establish several marine protected areas where gorgonian corals are abundant. A 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 was 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. In 2002, samples were collected to examine the reproductive characteristics of Calcigorgia spiculifera and in 2003 hydrocorals (suborder Stylasterina) will be tagged at one site to examine the growth rate of these widely distributed, fragile corals.

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

Effects of seafloor sediment composition, depth, and food availability on groundfish distribution

A fifteen-day cruise to investigate the effects of seafloor sediment composition, depth, and food availability on groundfish distribution was conducted aboard the F/V *Vesteraalen* from May 13 to May 27, 2002. The objectives of this cruise were to 1) collect simultaneous acoustic information with the hull-mounted echosounder system on a wide range of acoustically distinct sediments for the purpose of developing a "catalog" of bottom types for sediment classification research; 2) ground-truth the acoustic information with grab sampling and video; and 3) collect synoptic information on fish distribution and other physical and biological variables (seafloor sediment, food availability, depth) to allow examination of the relative influences of these environmental variables on fish distribution. The research area included five relatively small, discreet areas north and south of Unalaska Island and areas to the north of Akutan and Akun Islands. These areas were chosen based on previous survey trawl catches and the apparent diversity of sediment types.

Sampling in each area consisted of three distinct sampling phases: initial acoustic survey of the area, sediment and benthic infaunal sampling, and trawl sampling. Acoustic information from the ship's echosounder was collected continuously over the entire cruise. The goal of the initial phase of acoustic sampling in each area was to identify areas of trawlable bottom with acoustically distinct sediment types. The results of this initial survey determined areas for further investigation. Sediment grabs were attempted at least four times along each identified tow path to allow ground-truthing of the acoustic sediment data and characterization of the macrofaunal assemblage at each site. The grab samples will undergo grain size analysis by standard sieve fractionation. The remainder of each sample will be sieved through a 0.5-mm mesh and the macrofauna (preserved in formalin) will be identified to the lowest taxon possible. A video transect of the bottom along the path of each sampled site was conducted as time allowed.

Gear, as well as biological and effort data collection methods used during the trawl sampling phase were similar to those used on the Gulf of Alaska and Aleutian Island biennial bottom trawl surveys. An aluminum plankton net frame was attached to the headrope of the trawl. The frame opening was 40 x 50 cm and the net mesh size was 505 micron. The goal of the

zooplankton sampling was to characterize the distribution and abundance of zooplankton available to fish in the area sampled. Stomachs were also collected from a variety of commercially and ecologically important fish species to allow the description of the diets of the fish inhabiting the study area and allow comparison of their actual diets to the availability of potential prey items estimated from the grab and plankton sampling.

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

Alaskan Coral Identification

The "coral" fauna of Alaska is poorly known. Much of the taxonomic literature describing many of the Alaskan species is old and difficult to obtain. Although Alaskan cold-water corals are widely distributed and often abundant, materials for taxonomic studies have not been readily available. The recent interest in essential or critical fish habitat and the need to identify species contributing to "living substrates" has provided opportunity to improve our knowledge of critical species and to develop guides to their identification. In cooperation with Dr. Steven Cairns of the Smithsonian Institution and the Alaska Department of Fish and Game (ADF&G) Bering Sea/Aleutian Island Crab Observer Program, we are building reference and teaching collections at the Auke Bay Laboratory and Dutch Harbor. A "Field Guide to Alaskan Corals" written by Bruce Wing (ABL) and David Barnard (ADF&G) has been field tested and is being revised for publication.

For more information, contact Bruce Wing at (907) 789-6043.

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, is an effort to attain such knowledge.

During summer 2001 high-resolution echosounder data (multibeam and backscatter) and video data were collected on the Portlock Bank area of the central Gulf of Alaska in the vicinity of extensive bottom trawl and longline fisheries for groundfish. The echosounder data were collected by chartered RV Davidson, and the video data were collected from the manned submersible Delta. The objective of the study was to characterize bottom habitat in or near heavily fished grounds to understand whether habitats in present fishing grounds are vulnerable to ongoing fishing activities. The area mapped by echosounder was about 1000 km^2 of the outer continental shelf and upper continental slope. Preliminary interpretations of multibeam and backscatter data indicate the presence of at least a dozen different benthic macro- or mesohabitats. The megahabitats of this area are distinctly the result of past glaciation with the glacial deposits

presently being reworked and shaped into moderate (cm-m) relief features. Many submarine canyons notch the upper slope and provide steep relief with alternating mud-covered and consolidated sediment exposures. The video data showed little evidence of trawling on the flatter grounds of the continental shelf, where perhaps the relatively level bottom does not induce door gouging and there is a lack of boulders to be turned over or dragged. The most common sessile epifauna were crinoids, small non-burrowing sea anemones, glass sponges, stylasterid corals, and two species of brittlestars. Occasional large boulders located in depressions were the only anomaly in the otherwise flat seafloor. These depressions may have afforded benthic fauna some protection from fishing gear, as the glass sponges and stylasterid corals attached to these boulders were larger than were typically observed. In the fished areas of the upper slope, there was evidence of boulders turned over or dragged by trawling. The uneven bottom of the slope may have induced gouging by the trawl doors. The substrate was mostly small boulders, cobble, and gravel. Presently there does not appear to be much habitat within the entire study area that can be damaged by trawl impacts. No large corals and very few large sponges were seen. Whether this is the result of past trawl activity is unclear.

During summer 2002 the study was expanded into the eastern Gulf of Alaska. 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 outer continental shelf and upper continental slope. The areas mapped by echosounder were 162 km^2 of Pamplona Spur from a depth of 120 m to 940 m, and 372 km^2 of the Yakutat Valley from a depth of 190 m to 1045 m. These mapped areas in the eastern Gulf were also in the vicinity of extensive bottom trawl and longline fisheries for groundfish. Video data of the bottom were previously collected in the mapped areas from the manned submersible Delta. The objective of the 2002 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 in the central Gulf. Analysis of the 2001 and 2002 data is ongoing.

For more information, contact Jon Heifetz at (907) 789-6054, Dean Courtney at (907) 789-6006, or Jeff Fujioka at (907) 789-6026.

Trawl Impact Studies in the Eastern Bering Sea (Trawlex)

Bottom trawling effects are being studied in a shallow, soft-bottom area of the eastern Bering Sea. In 2001, 12 10-mi long research corridors were surveyed before and after trawling with commercial gear. To investigate the recovery process, these same corridors were resampled in 2002 during a 21-day cruise aboard the F/V Ocean Explorer. Once again, surface-living organisms (epifauna), surficial sediments and organisms living in the sediments (infauna) were sampled using research trawls and van Veen grab samplers. A high-resolution side scan sonar system was also deployed to study possible changes in physical characteristics of the seafloor as a result of trawling. A multi-disciplinary team of scientists, technicians and fishers from government, university, military and industry sectors are working collaboratively on the study.

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

Large-scale seabed reconnaissance survey in Bristol Bay using side scan sonar.

Upon completion of the Trawlex bottom trawl study, a reconnaissance survey of Bristol Bay habitats was undertaken using the Klein 5410 side scan sonar. This system is new technology that not only produces extremely high-resolution images of the seafloor, but also simultaneously gathers swath bathymetry data using interferometry. Approximately 1 megabyte (MB) of data are collected from the towfish each second. Prior to deployments in Alaska, the research team developed an improved software interface during laboratory testing and sea trials in Portsmouth Harbor, NH and Puget Sound, WA. The reconnaissance effort was centered on an 800 mi^2 area of central Bristol Bay that has never been hydrographically surveyed by NOAA. Bathymetric data and imagery were collected along survey lines totaling nearly 600 linear miles. In support of coordinated EFH characterization studies in the area, the reconnaissance survey intentionally crossed 18 RACE Division trawl survey stations and followed 78 mi of seabed previously classified using a QTC View single beam acoustic system. The survey also intersected six of the Trawlex research corridors in order to provide a spatial context for these experimental results. Overall, a great diversity of complex sand-bedforms and other geological features were encountered in the survey area.

EFH characterization/mapping

Acoustic seabed classification of eastern Bering Sea shelf completed.

A QTC View seabed classification system (Quester Tangent Corporation, Sidney, B.C.; QTC) was used to collect nearly 8 million digitized echo returns from the seafloor during a 1999 hydroacoustic fishery survey in the eastern Bering Sea by the NOAA ship *Miller Freeman*. Acoustic data were simultaneously acquired at two frequencies (38 kHz and 120 kHz) along a 9,000 nmi trackline. The objective of this study is to develop an optimum seabed classification scheme for the eastern Bering Sea shelf using a fully objective automated process. The QTC View system uses principal components and cluster analyses to detect and map seabed types with distinct acoustic properties. However, current clustering methods require significant user input to decide which class to split next and when to stop splitting. To overcome this subjectivity, a new application of Bayesian Information Theory was applied to guide the clustering process. Because of the computational intensity of the Bayesian method, we have investigated use of simulated annealing for efficiently identifying global minima in the Bayesian Index which indicate the true number of seabed classes for each data set. We are now prepared to evaluate the QTC View system for benthic habitat studies using standardized measures of fish and invertebrate abundance from annual trawl surveys. Preliminary analyses indicate the QTC View system is able to detect and map seabed types with distinct acoustic properties. However, in order to have habitat mapping utility, this acoustic variability must correspond to environmental features that influence the distribution of demersal and benthic biota.

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 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 stable. 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, two study sites were selected where Steller sea lions are known to haul-out in relatively large numbers: 1) Benjamin Island, north of Juneau, and 2) the Brothers Islands in Frederick Sound. Field work began in March 2001, and each site has been visited on at least a quarterly basis since then. Prey abundance at each site is determined by echo-integration and midwater trawling, and sea lion scat is collected from the haul-outs to infer diet. Fish are also collected for proximate and free fatty acid analysis. These studies continued in 2002 and 2003.

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

Availability of Nearshore Prey to Steller Sea Lions at Two Haul-Outs in Southeastern Alaska

Nearshore waters in the vicinity of two Steller sea lion (SSL) haul-outs, Benjamin Island and the Brothers Islands in southeastern Alaska, were sampled by scientists from the Auke Bay Laboratory in summer 2002 and winter 2003. A total of 26 sites (<10 m deep) were beach-seined, 28 sites (10 to 80 m deep) were jigged, and 17 sites (10 to 90 m deep) were surveyed with a remotely operated vehicle (ROV). Overall, total catch and number of species was greater in summer than in winter at both haul-outs. Sixteen species that were captured are know to be prey of SSL. The nearshore provides important habitat for SSL prey, especially in summer. Less available prey in winter may force SSL to travel farther from haul-outs to forage. These same sites will be sampled in summer 2003 and winter 2004.

For more information, contact John Thedinga at (907) 789-6025 or Scott Johnson at (907) 789-6063.

Investigation of Interactions Between the Pollock Fishery and Steller Sea Lions

The third year of a multi-year field experiment was completed off Kodiak Island in the Gulf of Alaska between 13 August and 5 September, 2002 by scientists from the Midwater Assessment and Conservation Engineering Program and REFM. One major objective of this work is to determine whether commercial fishing activities influence the distribution and abundance of walleye pollock and other prey species important to endangered Steller sea lions (e.g., capelin). The study site consisted of two submarine troughs which served as treatment and control sites with commercial fishing allowed in one trough (Barnabas) and prohibited in another (Chiniak).

Two echo integration-trawl survey passes were conducted in each trough immediately before commercial pollock fishing operations began in Barnabas. During the fishery, a third pass was conducted in both troughs, and a 4th partial pass was also completed in Barnabas trough. The EIT survey operations included the collection of 38- and 120-kHz acoustic data, net catch data from 52 midwater and 21 bottom trawls used to sample fish echosign, and 2 Methot trawls used to sample macrozooplankton echosign. The data were collected along a series of uniformly-spaced (i.e., 3 nmi) parallel transects during the 3-week survey effort. Most of the acoustic backscattering was generally attributed to three principal species groups: adult pollock, juvenile pollock, and capelin. The distribution of adult pollock was located in the northern portion of Barnabas and throughout Chiniak Trough. Juvenile pollock were located throughout the two troughs, but usually were shallower in the water column at depths of about 75-150 m during the day. They dispersed broadly at night. Capelin were often broadly distributed over the shallower edges of Chiniak Trough, whereas in Barnabas, they were found over a wide range of bottom depths and mostly in the southern portion of the Trough. Analysis of the data are in progress.

For more information, please contact Dr. William Karp, (206) 526-4164.

Shark Predation of Steller Sea Lions

In August 2001 and May 2002, scientists at the Auke Bay Laboratory investigated the diet of Pacific sleeper sharks to test the hypothesis that sleeper sharks prey on Steller sea lions. Longline gear was used to capture sleeper sharks near four Steller sea lion rookeries in the central Gulf of Alaska during times of pup vulnerability to determine if live Steller sea lions are prey for the sharks. Twenty-one longline sets were completed in August 2001, and 15 longline sets were completed in May 2002 from aboard the chartered fishing vessel Norska. Ninety-nine sleeper sharks were collected during each research cruise for the diet study.

The diet of the sharks is being investigated by visual examination of their stomach contents, genetics identification of questionable prey items, and chemical analysis of fatty acids in their tissues. Predominant prey items identified from the visual examination include walleye pollock, octopus, unidentified teleost fish, salmon, and marine mammal tissue that appears to be from cetaceans. The stomach content analysis found no direct evidence of sea lion parts. Marine mammal tissue comprised 31% and 34% of sleeper shark diet by percent weight during the August and May sampling cruises, respectively. DNA analysis is being used to definitively identify the marine mammal tissue. Forensic pathology methods are also being used to infer whether the sharks had consumed living marine mammal prey or carrion. The fatty acid analysis of tissue samples from the sharks will help determine if fish versus marine mammal prey in the

diet can be discerned.

In addition to the diet study, data on the vertical and geographic movement of sleeper sharks was collected by tagging methods for comparison with the vertical distribution of Steller sea lions while at sea. Thirty-three sleeper sharks were tagged with archival satellite tags that are designed to transmit archived data and location to polar orbiting Argos satellites. Data from 12 archival tags have been recovered. Endpoint locations from the tags show the sharks had typically moved less than 100 kilometers from the release locations. Archived depth data shows that sleeper sharks regularly traverse over 100 meters per day and sometimes come to the surface at night.

For more information contact Leland Hulbert (907) 789-6056 or Michael Sigler at (907) 789-6037.

E. Other Items

Protocols for Groundfish Bottom Trawl Surveys - NMFS

The AFSC hosted the National Trawl Survey Standardization Workshop November 13-15 in Seattle. The objective of the workshop was "to ensure that all aspects of preparation for trawl surveys and trawl survey procedures are consistent and in keeping with the highest quality standards to provide for survey data accuracy and consistency from one survey to the next." For the purpose of this workshop, the definition of "trawl surveys" was restricted to activities using non-rigid bottom sampling trawls yielding catch per unit effort data as a product. The focus was further narrowed to address only issues relating to obtaining the sample and did not address catch sampling issues. Each of the five regional NMFS Fisheries Science Centers (FSC) were represented at the workshop.

Workshop participants identified five categories for which general protocols were established. These included length measurement of trawl warps, use of auto-trawl systems, survey operational procedures, trawl construction and repair, and changes to regional trawl survey protocols. The group also recommended that trawl wire rope specifications and measurement methods be standardized, that a working group be formed to carry forward with issues pertaining to trawl survey standardization, and that trawl construction and repair training be developed and required for field biologists involved with bottom trawl surveys.

Following the workshop, each of the regional FSCs developed regional protocols for each of the bottom trawl surveys they are responsible for conducting. These protocols become the "standard operating procedures" for the respective surveys and any alterations to the protocols must be reviewed and approved by the appropriate FSC Science Director.

A report entitled "NOAA Protocols for Groundfish Bottom Trawl Surveys of the Nation's Fishery Resources" was compiled under the direction of Drs. Gary Stauffer and David Somerton. The report includes the general protocols developed during the workship, as well as the regional protocols for each of the FSCs. The report underwent international review and has been revised and resubmitted to NOAA leadership.

For further information, please contact Dr. David Somerton, (206) 526-4116.

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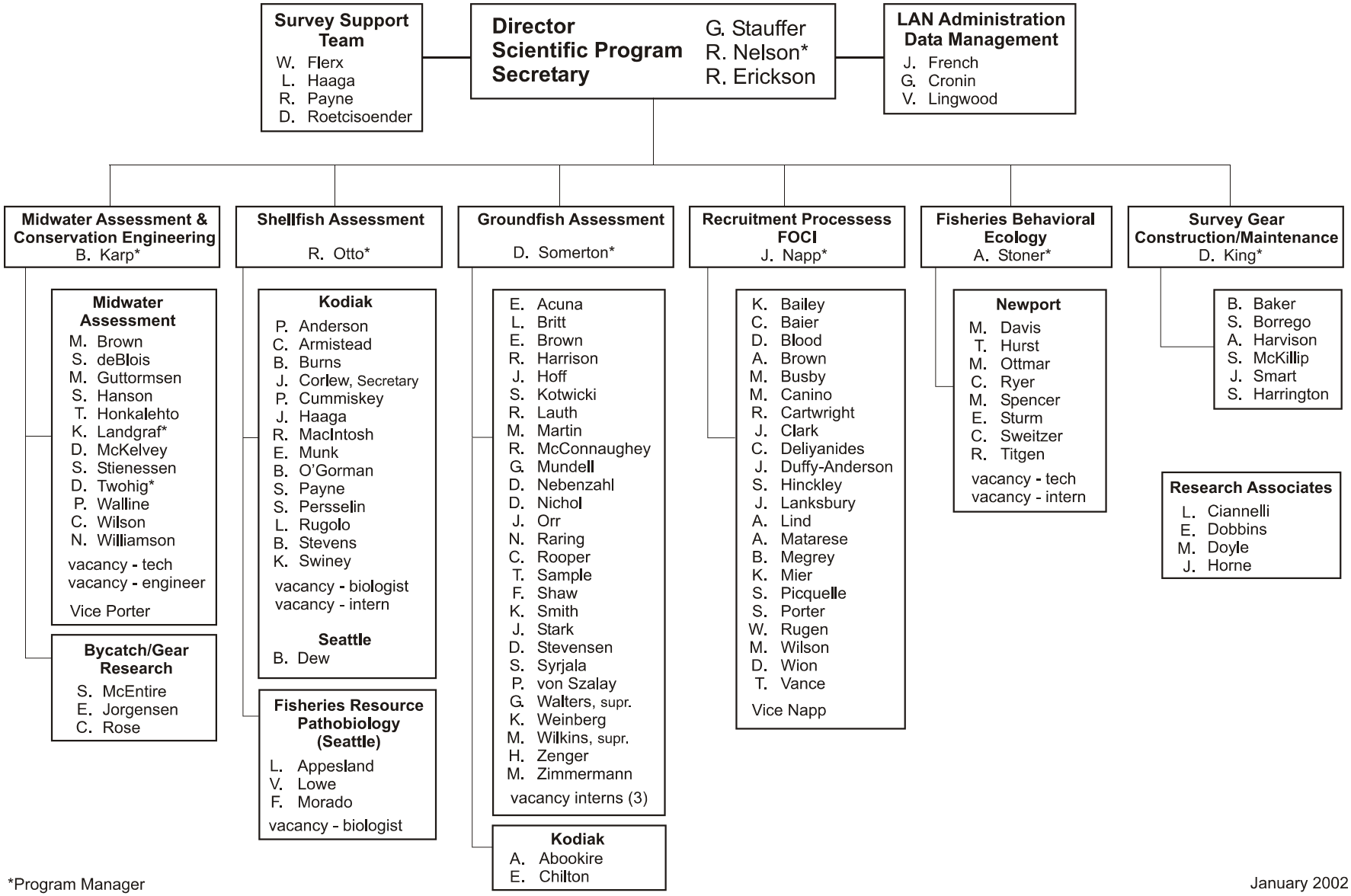
APPENDIX II.

RACE ORGANIZATION CHART 2002



*Program Manager

January 2002

APPENDIX III.--RESOURCE ECOLOGY AND FISHERIES MANAGEMENT DIVISION

Richard Marasco -- Director

Loh Lee Low -- Deputy Director

North Pacific Groundfish Observer Program

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Barbeaux, Steven
Barns, Alison
Berger, Jerry
Campbell, Glenn
Corcoran, Andrew
Corey, Sheryl
Dakan, John
Davis, Sharon
Decker, Daniel
DeMorett, Kim
Dixon, Brian
Dunn, Ed
Ferdinand, Jennifer
Fitzgerald, Shannon
Hewitt, Robert
Kenney, Heather
Kruse, Kenneth
Limpinsel, Douglas
Loefflad, Martin
Loomis, Todd
Maier, Robert
Mandina, Stephanie
Martin, Troy
McCauley, Kathleen
Middleton, Angela
Moser, John
Narita, Ren
Neidetcher, Sandra
Nordeen, Carrie
Reeves, Brenda
Ridley, Patricia

Age Determination Unit

Kimura, Daniel -- Supervisor
Anderl, Delsa
Blaisdell, Mark
Gburski, Christopher
Goetz, Betty
Hutchinson, Charles
Johnston, Chris
Kastelle, Craig
Price, Tim
Roberson, Nancy
Shockley, Wes
Short, Jonathan

Observer Program (continued)

Risse, Peter
Seither, Russ
Swanson, Rob
Teig, Karen
Thompson, Lisa
Vijgen, Alison
Watson, Jennifer
Weikart, Heather

Status of Stocks and Multispecies Modeling

Hollowed, Anne -- Supervisor
Bailey, Michael
Dorn, Martin
Fritz, Lowell
Gaichas, Sarah
Ianelli, James
Ingraham, James
Lowe, Sandra
Munro, Peter
Pearce, July
Spencer, Paul
Thompson, Grant
Turnock, Jack
Wennberg, Sherrie
Wilderbuer, Thomas

Resource Ecology and Ecosystems Modeling

Livingston, Patricia -- Supervisor
Buckley, Troy
Derrah, Christopher
Goiney, Bernard
Lang, Geoffrey
Yang, Mei-Sun

Socio-Economic Assessment

Terry, Joe -- Leader
Felthoven, Ron
Hiatt, Terry
Lee, Todd

Revised May 2001

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, Stock Assessment, Sablefish Daily Growth
Dave Csepp	Sea Lion Prey/Predation
Linc Freese	Effects of Fishing, Sponge Life History
Jeff Fujioka	Sablefish, Rockfish, Stock Assessment, Effects of Fishing
Jon Heifetz	Rockfish, Sablefish, Stock Assessment, Effects of Fishing
Leland Hulbert	Sea lion prey/predation
John Karinen	Gulf of Alaska Groundfish
Mitch Lorenz	Essential Fish Habitat
Chris Lunsford	Rockfish, Sablefish, Stock Assessment, Longline Survey
Patrick Malecha	Effects of Fishing
Nancy Maloney	Sablefish Tag Database, Longline Survey, and Seamounts
Tom Rutecki	Sablefish, Webmaster
Mike Sigler	Sablefish, Stock Assessment, Sea Lion Prey/Predation
Robert Stone	Effects of Fishing, Coral 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