Alaska Fisheries Science Center
of the
National Marine Fisheries Service

2002 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 2001

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 2001 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, Aleutian Islands, and the upper continental slope of the eastern Bering Sea. The Division conducted its final West Coast (California, Oregon, and Washington) continental shelf and slope bottom trawl surveys in 2001,

as well as its final echo integration/trawl survey for Pacific whiting (hake). The AFSC has transferred responsibility for future West Coast surveys to the NWFSC.

Four major bottom trawl surveys of groundfish resources were conducted in 2001 by RACE researchers on the eastern Bering Sea shelf, in the Gulf of Alaska region, along the continental shelf of the West Coast, and on the West Coast upper continental slope. **Additional bottom trawl survey work was done in late winter 2001 investigating Pacific cod and walleye pollock resources in Steller sea lion critical habitat in the eastern Bering Sea, Shumagin Islands, and around Kodiak Island.**

The Midwater Assessment and Conservation Engineering (MACE) Program conducted comprehensive acoustic/trawl surveys of pollock abundance in the Shumagin Islands region in February 2001, in the Bogoslof Island/southeastern Bering Sea shelf region in February-March 2001, in Shelikof Strait in March 2001, and in the area east of Kodiak Island in March 2001. MACE also conducted the ninth triennial acoustic/trawl survey of Pacific whiting off the West Coast during June and July 2001. MACE and REFM scientists conducted a study on the interactions between commercial fishing, pollock, and Steller sea lions in an area east of Kodiak Island**. The Recruitment Processes task conducted several Fisheries-Oceanography Coordinated Investigations (FOCI) cruises during the spring and summer of 2001, investigating environmental conditions affect recruitment of Gulf of Alaska and eastern Bering Sea groundfish stocks.** Dr. Jeff Napp was selected to manage the FOCI program.

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, and Status of Stocks and Multispecies Assessment. Scientists at AFSC assist in preparation of stock assessment documents for groundfish in the three management regions (Bering Sea/Aleutian Islands, Gulf of Alaska, and Washington-Oregon-California), 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, 1 term employee, and 1 temporary. One personnel change that occurred in the Groundfish Program during 2001 was the hiring of Dave Csepp as a term employee to work on Steller sea lion prey studies.

In 2001 field research, ABL's Groundfish Program, in cooperation with the AFSC's RACE Division, conducted the annual NMFS sablefish longline survey in Alaska. Other field work by ABL included 1) a study near Kodiak Island on the effects of trawling on soft-bottom habitat colonized by sea whips; 2) a multibeam echosounder survey of a major fishing ground in the Gulf of Alaska to produce detailed bathymetric and habitat maps for this area; 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) a longline study in the central Gulf of Alaska to test the hypothesis that sleeper sharks prey on Steller sea lions; 5) ongoing scuba diving studies of growth rates of shallow water coral and sponge 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) an ongoing genetics and plankton study to identify rockfish larvae to species; 8) electronic archival tagging of sablefish during the longline survey; and 9) a continuing habitat study of rockfish in nearshore areas of southeastern Alaska.

Ongoing analytic activities involved management of ABL's sablefish tag database 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 study of the use of echosounder signals to stratify trawl surveys for Pacific ocean perch and thereby improve survey precision; 2) an analysis of the variability of trawl survey catches of Pacific ocean perch, shortraker rockfish, and rougheye rockfish for use in future survey designs; 3) establishment of a sablefish logbook database and computation of longline fishery catch rates; and 4) a study based on past trawl survey data of the distribution and abundance of various "living substrates" in Alaska and of associations of commercial fish and crab species with these substrates; and. In addition, groundfish program staff spent considerable time preparing a revised Programmatic Supplemental Environmental Impact Statement (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 May 29- July 19, 2001. A total of 419 stations were sampled covering over 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 ninth consecutive year. This also marked the 20^{th} 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 significant decrease from 2000 for walleye pollock and the first real increase for Pacific cod since 1994. Size composition results suggest potentially good news for the future for both these species. Most flatfish species showed increases in abundance from the previous year. Despite an extremely rare winter ice distribution in 2001 in which almost no ice extended south of St. Matthew Island, mean bottom temperature during the summer survey was very close to the long term mean at 2.57^{o}C.

Nineteen additional stations were sampled in the continuing experiment to evaluate inshore yellowfin sole distributions toward improving our population estimates. In addition, 25 stations were added to the northern boundary of the survey for a special evaluation of *Chionoecetes* crab distributions. Prior to the start of the survey an experiment was performed to evaluate footrope behavior with changes in speed for the EBS standard 83-112 survey trawl.

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

Gulf of Alaska Biennial Groundfish Assessment Survey - RACE

The second in the series of biennial bottom trawl surveys of Gulf of Alaska (GOA) groundfish resources was conducted from 17 May through 25 July. Unlike the 1999 survey, which sampled the continental shelf and slope (depths 20-950 m) from Islands of Four Mountains (long.170ºW) in the eastern Aleutian Islands to Dixon Entrance, the 2001 survey was restricted to the continental shelf (20-448 m) of the central and western GOA. Between 1984 and 1996, GOA bottom trawl surveys had been conducted on a triennial schedule. All of the triennial surveys covered the continental shelf but only the 1984 and 1987 surveys included the continental slope. Future biennial surveys will cover the entire GOA continental shelf and slope.

The primary objective of the biennial groundfish surveys is to build a standardized time series of data to monitor the distribution, abundance, and biological condition of GOA groundfish stocks. These data include information on relative catch rates, size and age composition, details on distribution, and a variety of other biological parameters.

Sampling was conducted aboard the chartered commercial trawlers *Vesteraalen* and *Morning Star* and proceeded from near the Islands of Four Mountains eastward to the central GOA off Prince William Sound (long.147ºW). Stations were preselected but sometimes replaced with nearby alternate stations if trawling proved impossible. Of the 528 attempted standard survey tows, 489 were successfully completed.

In the central and western GOA, walleye pollock continued a decade-long downward trend in abundance, declining from 783,000 t in 1990 to 593,000 t in 1999 and only 209,000 t in 2001. The 2001 pollock biomass estimate ranked sixth among all species and exhibited a 41-59% split between the western and central GOA, respectively. Compared to the 1999

population, when the size distribution included many 35- to 60-cm fish, the 2001 population was composed of about 70% fewer large fish and twice as many fish less than 20 cm. Pacific cod in abundance, ranked fifth among all species, declined 10% from 285,000 t in 1999 to 256,000 t in 2001 and was evenly divided between the western (51%) and central (49%) GOA.

Over the central and western GOA survey area, arrowtooth flounder was by far the most abundant species with a total biomass estimate of nearly 1.4 million t, a 41% increase over the 1999 estimate in the same area. Nearly 93% of this estimate was from the central GOA survey area. The second-most abundant species was Pacific ocean perch (712,000 t) up 10% from the 1999 survey. POP was relatively evenly distributed between the central (60%) and western (40%) GOA. Northern rockfish (344,000 t) showed a 47% increase since 1999, ranking third in abundance. Nearly 74% of northern rockfish biomass was located in the central GOA survey area. Pacific halibut (347,000 t), the fourth-most abundant species, had a similar biomass distribution with 73% occurring in the central GOA.

For further information, contact Eric Brown, (206) 526-4157.

West Coast Continental Shelf Bottom Trawl Survey - RACE

The RACE Division's West Coast Groundfish Team completed the 2001 triennial West Coast bottom trawl survey of groundfish resources between June 1 and August 27. Two vessels, the F/V *Sea Storm* and the F/V *Frosti*, were each chartered for 65 days to conduct the survey, which continued the triennial time series begun in 1977. This year's survey exactly replicated those done in 1995 and 1998, which sampled the same stations each year between 50 and 500 m depth from Point Conception, California (34°30' N lat) to mid-Vancouver Island, British Columbia (49°40' N lat). Despite fewer charter days than previous years, we were able to sample all but the northernmost 30-40 miles of the survey area. This was the final time that the AFSC will conduct this survey. Responsibility for surveying this region has been transferred to the Northwest Fisheries Science Center.

A total of 506 stations were successfully sampled during the survey. Catches were sorted by species, weighed, and counted. Biological information (length, sex, individual weight, maturity, age structures, etc) was collected from samples of commercially and ecologically important species. Effort (net width × distance fished) was measured for each tow and average catch rates (kg/ha) were expanded to abundance estimates (biomass and population numbers) using the area-swept method. Size and age compositions of important stocks have also been estimated from the length frequency data and age structures collected during the survey.

Pacific whiting, sablefish, and Dover sole were the most abundant species in survey catches. Whiting biomass estimates showed a continued decline in abundance since 1995, though the 2001 bottom trawl estimate was still the fourth highest estimate among all nine triennial surveys. Sablefish and Dover sole biomass estimates for 2001 were the highest on record for the survey series. The sablefish estimate was 75% larger than the next highest estimate (from the 1992 survey) and the Dover sole estimate was 77% larger than the next highest estimate (from the 1998 survey).

Pacific whiting were larger on average in 2001 than in 1998 and we did not see many fish smaller than 30 cm. Sablefish, on the other hand, were smaller on average in 2001 than in 1998

and most fish were smaller than 45 cm. Large catches of 35-45 cm fish occurred all along the coast during the survey.

The West Coast triennial shelf and upper continental slope bottom trawl surveys are the main source of fishery-independent information on the abundance, distribution, and length and age composition for most of the commercially important groundfish species along the West Coast. Results from the 2001 shelf survey have already been incorporated into assessments of West Coast stocks of Pacific whiting, canary rockfish, bocaccio, and sablefish.

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

West Coast Trawl Survey of Upper Continental Slope Groundfish Resources - RACE

The RACE Division completed a four-week bottom trawl survey of the upper continental slope groundfish resources off Washington, Oregon, and California on November 8, 2001. Sampling for the survey began near the U.S./Canada border and progressed southward to Point Conception (lat. 34°30'N), covering the upper continental slope habitat between depths of 183 and 1,280 m. Two-hundred-and-twenty-two (222) tows were attempted during the survey. Out of 208 possible stations, 207 were sampled successfully.

Results from annual slope groundfish trawl surveys are used by fishery scientists and managers to assess stock conditions and establish annual harvest guidelines for sablefish, Dover sole, shortspine and longspine thornyheads, and several of the deeper-dwelling rockfish species. This was the thirteenth RACE Division survey in a series dating back to 1984 monitoring the long-term trends in the distribution and abundance of West Coast upper continental slope groundfish resources. Results of the 2001 survey have not been summarized in a report yet, but are currently being incorporated into the stock assessment for West Coast sablefish.

For more information, contact Bob Lauth, (206)526-4121.

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).

In 2001 the Recruitment Processes Program conducted (1) winter cruise, (2) spring cruises, and a fall cruise aboard the NOAA ship *Miller Freeman* in support of recruitment processes research. In addition, we continued our collaboration with Japanese scientists from Hokkaido University on summer distribution of age-0 pollock in the southeastern Bering Sea with a July cruise on the T/S *Oshoro Maru*. Four cruises were conducted in support of the Gulf of Alaska GLOBEC (Global Ocean Ecosystem Dynamics) program aimed at understanding recruitment variability of pink salmon (3 on the Univ. of Alaska, Fairbanks UNOLS ship R/V *Alpha Helix* and 1 on the NOAA ship *Ron Brown)*. Last, a late summer cruise supported by the North Pacific Marine Research Initiative was undertaken to understand summer trophodynamics and production of prey for juvenile fish on the southeastern Bering Sea shelf (R/V *Alpha Helix)*.

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 2001 continued under two long-term research themes: bycatch stress and fish ecology. Studies on capture stress have been focused on the potential for recovery of juvenile and adult fishes that initially survive capture or are otherwise impacted by fishing gear. Ecological studies were conducted with juvenile stages of walleye pollock, sablefish and flatfishes to examine their responses to environmental conditions and how these influence growth, survival, habitat utilization, distribution.

<u>Experimental Bycatch Studies</u>

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 recent studies related to discards an attempt has been made to understand the key principles which control mortality, integrating analyses of behavioral and physiological assays along with stress-induced mortality. Recent work with walleye pollock, sablefish, lingcod and halibut have shown that 1) environmental factors, such as light, temperature and air can interact with gear stressors to magnify mortality; 2) susceptibility to stress and mortality is species

specific and influenced by fish size; and 3) mortality may be delayed, such that it is difficult to estimate through traditional "capture and hold" approaches conducted aboard vessels or with net pens in the field. For example, with regards to light, when towed in nets in the dark, fish had decreased ability to orient or swim, which resulted in greater injury, behavioral deficits and mortality. Similarly, temperature may play a critical role; exposure to increased temperature (12°C and above) in thermoclines and on deck magnified bycatch stress and mortality. The interaction of capture stressors and environmental factors is also important in controlling mortality and sublethal stress and may determine whether discarded fish are able to feed successfully and avoid predation, a potential source of secondary mortality. With regards to fish which escape trawl gear at depth, it is known that a substantial fraction (30-40%) of the fish which escape trawls via the codend die as result of their passage. Experiments conducted in the Behavior Program, which simulated entrainment and escape from a trawl, demonstrated that juvenile walleye pollock and sablefish suffered significant behavioral impairment. These fish were slower, schooled poorly and were unable to maintain safe distances from predators, which ultimately rendered them more vulnerable to predation. Even minimal stress in fish escaping from fishing gear leads to increased susceptibility to predation after escape. This suggests that there may be a large and unobserved source of fishing mortality associated with bycatch escape devices in towed gear that should be considered in design of bycatch experiments, whether in the laboratory or field.

Ecological Studies

Vision and Fish Behavior: The role of vision in fish foraging continues to be an important research topic under investigation by the Fisheries Behavioral Ecology Program. Specialized infrared monitoring systems developed for this research have allowed experimentation with fish under the full range of light levels which they encounter at various depths in the ocean, day or night. Recent research demonstrated that juvenile halibut, like juvenile walleye pollock and sablefish, while being highly visual foragers, are capable of locating and capturing planktonic prey in complete darkness. This may play a vital role in their feeding, growth and survival during periods of prolonged darkness, such as winter at high latitudes, or at depths where light in greatly reduced.

Experimentation has also progressed on the role of light in mediating the interaction between fish and commercial fishing gears. Recently completed experiments demonstrated that ambient light is a critical factor influencing how fish behave in trawls. When there is ample light, walleye pollock orient themselves in the direction of the tow, avoid the meshes of the net and attempt to hold position relative to the net, i.e. herding. In contrast, in the dark they are unable orient, fall rapidly back into the codend and strike the meshes more frequently. This suggests that fish which ultimately escape through the codend, by virtue of their small size, may incur greater physical injury when trawled at night and/or depth. This concurs with field research demonstrating greater mortality among undersized fish escaping codend at night.

Growth Studies: Laboratory studies were conducted with sablefish and walleye pollock to examine their capacity for compensatory growth. Juvenile sablefish have an extraordinarily high capacity for growth compared with

walleye pollock. However, walleye pollock exhibited clear evidence for growth compensation while juvenile sablefish displayed minimal acceleration in growth after a period of food deprivation. The mechanisms involved in growth acceleration appear to differ in the two species. After a period of food deprivation, walleye pollock encountering high food abundance compensate for earlier low growth by low activity rates and higher food consumption rates than fish supplied with continually high levels of food. Thus pollock that have not been food-deprived appear to sacrifice growth rate, perhaps to reduce predation risk. In contrast, previously deprived sablefish were not able to consume more food than control fish, and they appear to maximize growth under most circumstances, at the expense of other physiological and ecological factors.

Habitat Studies with Flatfishes: Habitats of flatfishes are ordinarily characterized on the basis of depth, sediment type, and temperature; however, the identification of essential habitat probably depends upon certain other environmental variables and fish size. Over the last year, laboratory experiments with juvenile rock sole and Pacific halibut were conducted to examine sediment preferences and burial capabilities. Both species demonstrated significant size-dependent changes in sediment choices during the first year of life, although choices made by rock sole were less specific than those of comparably sized halibut. Highest sediment selectivity occurred in the smallest individuals of both species, probably as a result of strong selective pressure exerted by predation. Association with sediment is the first line of defense for juvenile flatfishes, and the relationships shift rapidly with fish size during the first year of benthic life. Therefore, habitat descriptions and models for young post-settlement flatfishes need to be made for narrow size classes.

Features of the benthic environment such as bedform and the presence of structures provided by sessile organisms may also influence habitat suitability for young fishes. Mesocosm experiments with juvenile rock sole and Pacific halibut showed that both species have a strong preference for habitats with complex structure over bare sand habitat. Structures tested included sponges, bryozoans, bivalve shells, and sand waves. Age-0 fishes were more selective than age-1 juveniles. Juvenile flatfishes are generally thought to gain shelter from sediment, either through burial or cryptic coloration, and eventual escape from predation through growth. Strong preference for structured habitat in halibut and rock sole indicates high selective pressure for such behavior and the importance of benthic structures that are frequently removed by fishing gear. New experiments are underway to determine how habitat structure mediates the survivorship of age-0 flatfishes in the presence of their natural predators.

Dr. Susan Sogard transferred to the Santa Cruz Laboratory of NMFS in October 2001, after nearly 10 years with the Program, during which time she authored many papers on pollock and sablefish feeding, growth, mortality, and habitat utilization. Dr. Thomas Hurst joined the program in March 2002 to lead studies on the behavior and ecology of pollock, sablefish, and flatfishes. Talia Sanfilippo left the technical staff in 2001 and **Scott Haines joined the technical staff in March 2002.**

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

Fisheries Resource Pathology Program - RACE

During the 2001 survey season, the Fisheries Resource Pathobiology sub-task continued its monitoring effort of potentially important diseases of a number of species found in the Bering Sea shelf region. As part of an ongoing study, tissue samples of three species of king crab, red (*Paralithodes camtschaticus*), blue (*P. platypus*) and golden (*Lithodes aequispina*) were collected, fixed and will be microscopically examined to determine disease effects on population abundance and distribution. Hemolymph smears were collected from Tanner crabs, *Chionoecetes bairdi* and *C. opilio,* to determine the prevalence and distribution of bitter crab syndrome caused by *Hematodinium sp*, a parasitic dinoflagellate. Juvenile walleye pollock (*Theragra chalcogramma)* were collected and will be microscopically examined to determine the prevalence and distribution of diseases that may lead to mortality prior to recruitment age.

In addition to collections made in Alaskan waters, parasitic copepods were found in Pacific flatnose (*Antimora microlepis*) and parasitic barnacles (superorder Rhizocephala) were found in *Neolithodes sp.* crab along the West Coast slope region. These parasites were collected and will be identified. Tissue was also collected from the Oregon hair crab, *Paralomis multispina,* for disease identification and distribution.

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

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 has nearly completed a draft of his study with NMML to apply radiometric ageing to gray and bowhead whales. The results suggest that the method may possibly be applicable to gray whales, but probably not bowhead whales. The problem appears to be excess lead found in the bullae of bowhead whales.

In December 2001, Nancy Roberson completed her Masters Thesis on the Age Determination of Alaska Pacific Cod. Thin sections were used along with imaging equipment and Optimas software to measure otolith rings. Otoliths from tagged Pacific cod enabled the selection of a back calculation method and a partial validation of ageing criteria. Results from these measurements were used

to help determine ageing criteria, and whether miss-ageing had occurred. Results from this thesis indicate that both miss-ageing and environmentally caused changes in growth may have occurred.

The Age and Growth Program recently hired Irina Benson, (Far Eastern State University, Vladivostok, Russia, B.S. 1994); and Charles Piston, (Western Washington University, B.S. 1999).

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 2000...

Update for 2001 not available at "press time".

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

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.

Update for 2001 not available at "press time".

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 2001, 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 789 observers to 335 vessels and 23 shore plants in Alaska. These observers spent 36,572 days collecting data in 2001. 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.

Observer Program Cadre Is "Open for Business"

The Observer Program began full implementation of its' Cadre during the first quarter of 2001. The first five employees to join the Cadre were hired in December 2000. They are stationed out of new office space in Anchorage which was designed, constructed and leased in the Federal building annex during 2000. These new employees along with the existing two staff members in Anchorage, make up the Observer Program Cadre. The cadre is an inherently flexible unit of employees that can be deployed as needed to ports throughout Alaska. They help to increase the Observer Program's presence in the field and allow for more "front line" communication between NMFS, observers and the fishing industry. Todd Loomis, the Anchorage field office manager, is responsible for leading the Cadre.

AFSC Observer Program Hosts National Safety Training

Observer trainers from each NMFS region gathered at the AFSC in March, 2001 for a course titled "safety training for trainers. The National Observer Program sponsored three attendees per NMFS region to attend the course, which was designed specifically for teachers of sea safety. The purpose of the course was to ensure that NMFS staff, who are responsible for training fishery observers, have the expertise and resources necessary to provide the best possible safety training for the gear and vessel types they monitor. The class was taught by the Alaska Marine Safety Education Association. The 5-day course was intense, running well into the evenings, and packed with information on safety equipment, safety techniques, and ways to teach safety to observers. On the sixth day, the NMFS observer trainers met for discussion about their own program's training needs and ways to share resources.

Council Observer Advisory Committee Agrees That Federal Funding of AFSC Observer Program Would Solve Host of Problems

The Observer Advisory Committee (OAC) of the North Pacific Fishery Management Council (Council) met at the AFSC in late March to review options that would alleviate areas of concern with the present service delivery model (SMD) for the North Pacific Groundfish Observer Program (NPGOP). In the report from the March 22-23 OAC meeting, the primary concerns of each representative group were listed as follows:

Industry - effective sampling design, quality of observers, observer availability/operational efficiency, the need for an Observer Program that is more compatible with a vessel-by-vessel accounting system, appropriate coverage levels, and cost containment.

Observers - conditions of employment (vessel safety, adequate work station, etc.), lack of oversight by NMFS spurs the question of who is the actual employer of the observer.

Observer Contractors - observer retainment, "vesting/ownership" in the Program, need for improved communication with NMFS, vessel safety, operational advantage (competition among contractors), creating a less adversarial environment.

NMFS - effecting an arms-length relationship between the contractors and industry (conflict of interest problem), exclusivity, lack of agency management controls, retention of high quality observers, data quality and integrity, creating a less adversarial working environment.

At the meeting, Dr. Daniel Ito, Observer Program Leader, presented the idea of a pilot, "no-cost" contract approach in which NMFS would maintain a contract with one or more observer companies to provide observer services to the American Fisheries Act (AFA) offshore fleet of vessels. Under this approach, industry would still directly pay for observers, but observer companies that were awarded contracts with NMFS would have exclusive rights to provide observers to the offshore AFA fleet. This would create an "arms length" relationship between industry and the observer companies and would also give NMFS more management control through their contractual agreement with the observer companies.

Members of the OAC expressed doubts and concerns about the no-cost contract approach and therefore did not fully support this idea. The committee agreed that the ideal, long-term approach would be to secure Federal funding for the entire Observer Program. Thus resolving the majority of the problems outlined by the group, as well as NMFS concerns regarding conflict of interest. Therefore, while the committee supported the overall goal of a Federally-funded Observer Program, they recognized the short-term need to phase-in changes to the Observer Program through other mechanisms, such as regulatory changes. Observer Program staff began to work with NMFS Alaska Regional staff to move forward with various regulatory changes that would further the goals established by NMFS, industry, observer companies and observers.

AFSC Observer Program Staff Participate in National Discussion on Insurance, Liability and Labor Issues Impacting Observers

During June 12-14, 2001 staff from the AFSC Observer Program participated in a conference in Silver Spring, Maryland to discuss issues dealing with insurance coverage for observers. The conference participants included representatives from all NMFS regional observer programs, Department of Labor, Department of Commerce, NOAA General Counsel, insurance industry representatives, labor relation specialists, observers, observer providers, observer representatives as well as other interested parties. Topics of discussion at the conference included

- defining insurance and labor terms as they relate to observer programs,
- defining the roles of the insurance agent, underwriter and claims handler,
- explaining the various types of liability and compensation coverage,
- differentiating between coverage needs for land-based protection and seagoing protection,
- the definitions of seamen and non-seamen as they apply to observers under various insurance and labor laws,
- implications of the Service Contract Act to contracted observers,
- understanding the roles of base salary, overtime, and other supplemental pay (i.e. hazard pay) calculated under various labor laws for the purpose of insurance compensation,
- providing sufficient compensation to injured observers so that their quality of life is not drastically diminished,
- determining the feasibility of extending professional liability coverage to uninsured vessels that carry observers.

The conference was successful in providing all Observer Programs nation-wide with guidance on how to better protect their observers with comprehensive insurance coverage plans. It also provided insight into further study and analysis that will be needed in developing a risk management plan for Observer Programs and statutory amendments that will define observers and help to clarify their maritime ("seaman") status. The conference also underscored the need to inform observers of the various types of insurance currently available to them, specifically, Federal Employee Compensation Insurance.

AFSC Observer Program Hosts National Observer Contracting Workshop

The North Pacific Groundfish Observer Program hosted a contracting workshop from July 30, 2001 through August 3, 2001. The workshop was conducted by staff from the NMFS National Observer Program in Silver Spring, Maryland. The objective of the workshop was to bring together contracting specialists and representatives from all NMFS observer programs in order to develop contracting standards and improve contract management.

Workshop participants included contracting specialists from NOAA's western and eastern administrative support centers, contracting officer's technical representatives from three NMFS regional offices, a contracting specialist from the Alaska Department of Fish and Game, and other NMFS observer program staff who are involved in writing statements of work or evaluating bids for contracts.

The emphasis of the workshop was on the development of performance-based contracts that address the primary goals of an observer program. These goals were identified as: observer coverage, data quality, observer well-being, and observer program integrity. A template for a statement of work, with measurable performance standards, was drafted by the workshop participants.

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

Socioeconomic Assessment Program - REFM

Update for 2001 not available at "press time".

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

C. By species, by agency

1. Pacific cod

7. Research

Vertical Movement Patterns of Pacific Cod as Shown by Data Storage Tags

The RACE Division, in collaboration with the REFM Division and the ADF&G, has been conducting research on the vertical movement patterns of Atka mackerel and Pacific cod using externally attached data storage tags (archival tags) to collect depth and temperature information at 2-60 minute intervals.

In November, 2001, 224 Pacific cod were released with data storage tags off Kodiak Island, AK Thus far 143 tags have been recovered (64% return rate). The high return rate has resulted from the combination of very limited horizontal movements of cod and concentrated fishing by commercial long-line and pot fisherman on the location where tags were released. Based on the gradual return to the initial capture depths, Pacific cod likely had swimbladder damage from the initial capture, but most fish recovered after a period of one 1 to 2 weeks (Figure 4). Vertical movement patterns have not shown near the regularity in diel pattern that Atka mackerel displayed, however, intermittent periods of diel movement did occur. We plan a comprehensive analysis comparing vertical movement patterns between males and females, mature and immature fish, and among fish of different length and ages.

Planned data storage tag research for 2002 includes tagging of Pacific cod off Unimak Island in the eastern Bering Sea during April, tagging of walleye pollock off Kodiak Island during May, and tagging of additional Atka mackerel in Seguam and Tanaga Passes during June.

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

b. Stock Assessment

BERING SEA/ALEUTIANS

The present assessment is a straightforward update of last year's assessment, incorporating new catch and survey information. This year's EBS bottom trawl survey resulted in a biomass estimate of 830,000 t, an increase of 57% from last year's estimate, the lowest observed value for the survey. The Aleutian Islands trawl survey biomass estimate in 2000 increased 63% from the 1997 estimate. Estimates of abundance are higher for the 2001 assessment compared to the 2000 assessment. For example, estimated 2002 spawning biomass for the BSAI stock is 425,000 t, up about 25% from last year's F_{ABC} projection for 2002. The SSC has determined that reliable estimates of $B_{40\%}$, $F_{40\%}$,

and $F_{35\%}$ exist for this stock, and that this stock therefore qualify for management under tier 3 of the BSAI Groundfish FMP. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 431,000 t, 0.30, and 0.36, respectively. Pacific cod qualify for management under sub-tier "b" of tier 3 because projected biomass for 2002 is about 1% less than $B_{40\%}$. Fishing at an instantaneous rate of 0.30 is projected to result in a 2002 catch of 253,000 t, which is the maximum permissible ABC under Amendment 56. The chapter authors recommend setting the 2002 ABC at 223,000 t, 12% below the maximum permissible level. This recommendation is 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 $F_{40\%}$ harvest level. The Bayesian meta-analysis which has formed the basis for a risk-averse ABC recommendation in the last four assessments was not performed for the present assessment. Instead the ratio between last year's recommended F_{ABC} and $F_{40\%}$ (0.87) was assumed to apply this year as well.

A 12% reduction from the maximum permissible ABC is justified because: 1) decision-theoretic concerns stated above , 2)the estimated spawning biomass from the model has declined continuously since 1988, and 3) four of the last five year classes (assessed at age 3) appear to be below average. A 2002 catch of 223,000 t would represent an increase of 19% over the 2001 ABC of 188,000 t, the same upward trend as the 57% increase in the trawl survey biomass estimate. Spawning biomass projected for 2002 is 39% of it's unfished level. Spawning biomass is projected to decline through 2003, reaching a minimum of 407,000 t. This projection is much more optimistic than last year's assessment, which projected spawning biomass to reach a minimum of 314,000 t in 2003. A 2002 catch of 223,000 t corresponds to a fishing mortality rate of 0.26, below the value of 0.30 which constitutes the upper limit on F_{ABC} under tier 3b.

The recommended OFL was determined from the tier 3b formula, where fishing at a rate of 0.32 gives a 2002 catch of 248,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

GULF OF ALASKA

Size composition data from the 2000 and January-August 2001 commercial fisheries were incorporated into the stock assessment model for this assessment as well as size composition data and biomass data from the 2001 GOA bottom trawl survey. The Eastern area was not surveyed in 2001, therefore it was necessary to use the 1999 Eastern area survey value to provide a Gulf-wide value (the 2001 estimate of 256,025 mt, for the Western and Central areas only, was down about 10% from the 1999 estimate for the same two areas). 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 between the recommended F_{ABC} and $F_{40\%}$ estimate given in the 1999 assessment (0.87) was assumed to be an appropriate factor by which to multiply the 2002 maximum permissible F_{ABC} to obtain a recommended 2002 F_{ABC} .

The estimated 2002 spawning biomass for the GOA stock is 82,000 mt, down about 13% from last year's estimate and down about 2% from last year's F_{ABC} projection for 2002. The $B_{40\%}$ reference level is 85,000 mt, thus Pacific cod are in Tier 3b. The estimated 2002 total age 3+ biomass for the GOA stock is 428,000 mt, down about 9% from last year's estimate for 2001 and down about 3% from last year's $F_{40\%}$ projection for

2002. The Plan Team concurs with the author's recommended 2002 ABC for the GOA stock of 57,600 mt, which is down about 15% from last year's recommendation for 2001 and up about 3% from last year's F_{ABC} projection for 2002. The estimated 2002 OFL for the GOA stock is 77,100 mt, down about 15% from last year's estimate for 2001.

Apportionment of Pacific cod by area has been based on the most recent survey results which have been relatively consistent from survey to survey, with 36% , 57%, and 7% in the Western, Central, and Eastern areas, respectively in the 1999 survey. In the 2001 survey the apportionment changed somewhat with 47%, 45%, and 8% in the Western, Central, and Eastern areas respectively. Pacific cod are believed to move sufficiently from area to area, such that any harvest apportionment within the range of the 1999 or 2001 survey results as needed to address other concerns would be biologically acceptable to Pacific cod.

For further information, contact Dr. Grant Thompson at (206) 526-4232.

2. Nearshore Rockfish

a. Research

Distribution and Habitat of Rockfish in Nearshore Waters of Southeast Alaska

Scientists in the ABL Habitat Program continued to assess the distribution, habitat, and behavior of rockfish in nearshore waters of southeastern (SE) Alaska. Two sampling cruises were conducting in 2001 using the NOAA RV *John N. Cobb*. 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 rockfish in deeper water (10-90 m) habitats such as vertical bedrock walls and complex bottoms of boulders or broken rock. To date, 127 seine hauls and 244 ROV dives have been completed at 44 sites throughout SE Alaska. Of the over 30 species of rockfish known to occur in Alaska, 16 species were captured or observed in nearshore waters of SE Alaska. Studies in 2002 will focus on **linking rockfish 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.

Estimating Natural Mortality of Dark Dusky Rockfish - RACE

The natural mortality of an unexploited population of dark dusky rockfish (*Sebastes sp. cf. ciliatus)* is being investigated at the Kodiak Fisheries Research Center. Morphometric studies conducted by Jay Orr (AFSC) and Jim Blackburn (ADF+G) have determined that two distinct species of dusky rockfish occur in the Gulf of Alaska. Dark dusky rockfish are commonly caught in nearshore waters during the commercial

black rockfish jig fishery. In July 2001, 350 dark dusky rockfish were caught as bycatch on an ADF+G black rockfish survey in the Sanak Island and Sandman reef area. Due to the shallow depths and untrawlable bottom topography encompassing Sanak Island and Sandman reefs, it is unlikely that dark dusky rockfish populations were exploited during deep-water trawl fisheries targeting Pacific ocean perch or longline fisheries targeting Pacific cod and Pacific halibut in this area. There are several methods available to estimate natural mortality of a fish species, such as horizontal catch curve analysis and mortality as a function of maximum age or growth rate.

Each fish was weighed, sexed, measured, and the otoliths were removed. The AFSC Age and Growth Lab will determine the ages of the dark dusky rockfish. Stomach samples were collected from both black and dark dusky rockfish when the two species were caught in abundance at the same station and will be used to investigate niche overlap. A Quester Tangent QTC View bottom classification system recorded bottom topography of the area fished. This information will be used to describe and map the habitat types utilized by these rockfish species. With funding provided by the AFSC Rockfish Working Group, we plan to return to Sanak in July 2002 to target dark dusky rockfish at deeper depths, utilize improved methods for catching smaller sized fish and groundtruth the QTC bottom classification system using a remotely operated underwater camera.

For additional information, please contact Elizabeth Chilton, (907)481-1725.

3. Shelf Rockfish

a. Research

Size and Age at First Maturity for Light Dusky and Northern Rockfish - RACE

Light dusky rockfish (*Sebastes ciliatus*) and northern rockfish (*Sebastes polyspinus*) in the central Gulf of Alaska are being investigated to determine their size and age at first maturity. Maturity stage has been estimated at the gross visual level from a small number of rockfish ovaries taken from both species and this information is currently used as the age at first maturity parameter in annual stock assessment reports for both species. This project will provide microscopic evaluation of ovaries taken from light dusky rockfish and northern rockfish using standard histological techniques for comparison with the visual field observations. One objective of this project is to determine if it is possible to accurately evaluate the maturity stage of rockfish ovaries visually. Field observations of maturity stage of each ovary will be compared to its histological maturity evaluation. Digital photographs at each maturity stage were taken in conjunction with the histological samples. Once the appropriate maturity stage has been determined at the microscopic level, these photographs can provide field scientists with examples of known maturity stages for that species caught at a particular time of year. Histological maturity stages are currently being determined for both rockfish species. All histological preparations for this project, including slide mounting and staining, were conducted at the Kodiak Fisheries Research Center.

For additional information, please contact Elizabeth Chilton, (907) 481-1725.

b. Stock Assessment

GULF OF ALASKA

Pelagic Shelf Rockfish

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 2002 is calculated using biomass estimates based on trawl survey data. Gulfwide exploitable biomass, 62,489 mt, is based on the average of the biomasses estimated 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 2002 is the addition of these two ABC values: 5,485 mt.

For the first time, data were collected in 2001 for development of an age-structured model for dusky rockfish using the AD Model Builder template. Exploratory runs for the model will be presented to the Gulf of Alaska Groundfish Plan Team in 2002.

For more information, contact David Clausen at (907) 789-6049 or Jon Heifetz at (907) 789-6054.

4. Slope Rockfish

a. Research

GULF OF ALASKA

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

ABL 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. Echosounder signals were recorded with a Simrad ES60 echosounder during the 2001 Gulf of Alaska trawl survey. Dana Hanselman, a PhD graduate 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 2002 during the Aleutian Islands trawl survey and the Bering Sea slope trawl survey. Also, ABL scientists are planning an experimental application this summer of double sampling with echosounder signal at a study site off Cape Ommaney, southeast Alaska for surveying Pacific ocean perch.

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

Variability in Trawl Survey Catches of Pacific Ocean Perch, Shortraker Rockfish, and Rougheye Rockfish in the Gulf of Alaska

All the abundant species of slope rockfish in Alaska are usually assumed to be extremely variable or clustered in their distribution. Little analysis, however, has been done on this subject, especially regarding comparisons of variability among the different species. In this study, ABL scientists first examined data for Pacific ocean perch, shortraker rockfish, and rougheye rockfish from three experimental bottom trawl surveys in the Gulf of Alaska in 1993, 1998 and 1999 to compare the variability of catches for each species. Although these surveys were relatively small in scope, they all used the same survey vessel and the same experienced rockfish commercial captain, together with a net specifically designed for catching rockfish. Thus, they likely provide some of the best survey data available for these three species in Alaska. When catches of each species were analyzed within their optimum habitat, the coefficient of variation for Pacific ocean perch was approximately 2.5 to 3 times greater than that of shortraker and rougheye rockfish, indicating that Pacific ocean perch are much more clustered in their distribution. Shortraker and rougheye rockfish were similar to each other in their variability.

To provide additional comparisons of variability over a broader geographic area, catches of the three species were also examined from 7 large-scale trawl surveys conducted in the Gulf of Alaska from 1984 to 2001. Again, the analysis only included hauls that were made within the optimum habitat for each species. Results were very similar to the previous results from the experimental surveys: variability of Pacific ocean perch catches was about 2-3 greater than that for either shortraker or rougheye rockfish. Overall results of this study indicate that a stratified random trawl survey directed at shortraker and rougheye rockfish would be logistically feasible, because the low variability of these two species would require relatively few hauls to be made. However, a similar random survey aimed at a highly variable species such as Pacific ocean perch is probably not feasible because it would require too many stations to be cost effective. New and innovative methodologies for surveying Pacific ocean perch, such as the use of echosounders in

combination with trawling (described in the section immediately above), will be necessary to improve assessment of this species.

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

Species Identification of Rockfish Larvae and Other Larval Rockfish Studies

Rockfish (*Sebastes* spp.) 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. ABL scientists in cooperation with Dr. Anthony Gharrett of the University of Alaska Fairbanks, Juneau Center for Fisheries and Ocean Sciences, have attempted to resolve some of the difficulty using genetic techniques. Recombinant mitochondrial DNA (mtDNA) analysis has been used to identify individual *Sebastes* larvae that were photographed before preservation. Fourteen of 33 species known to occur in southeast Alaska have been identified from plankton samples in the area.

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

The POP complex consists of true POP (*Sebastes alutus*) and four other red rockfish species (northern rockfish, rougheye rockfish, sharpchin rockfish, and shortraker rockfish). Prior to 1991, the complex was managed as a unit in each of the two management areas. Since 1991 the North Pacific Fisheries Management Council has managed *S. alutus* separately from the other species in both areas, and has also split out rougheye and shortraker in the Aleutians. This was done to avoid excessive catches of the less abundant members of the complex, particularly shortraker and rougheye. Beginning in 1996, the ABC and TAC for true POP have been subdivided within the AI area, based on an average of the biomass estimates from the two most recent trawl surveys: Eastern subarea 25%, Central subarea 25%, and Western subarea 50%.

True POP (Sebastes alutus), Eastern Bering Sea and Aleutian Islands

The most recent assessment is based on a new assessment model that combines the AI and BS areas, and incorporates new information. Model results indicate that the

POP population (age 3+) in both areas has been stable over the last 15 years increasing annually to 373,800 t in 2001. Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, which qualifies for management under Tier 3 of the BSAI Groundfish FMP. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 141,000 t, 0.048, and 0.057, respectively. Projected spawning biomass for 2002 is 135,000 t, placing POP in the EBS in sub-tier "b" of Tier 3. The maximum F_{ABC} value allowed under Tier 3b is computed as follows:

$F_{ABC} \leq F_{40\%} \times (B_{2002} / B_{40\%} - 0.05)/(1-0.05) = 0.048 \times (134{,}694/140{,}660 - 0.05)/0.95 = 0.046$

Projected harvesting at a fishing mortality rate of 0.046 gives a 2002 catch of 14,800 t, the recommended ABC. The ABC was set regionally based on the 2001 apportionment as follows: BS = 2,620 t, area 541=3,460 t, area 542=3,060 t, area 543=5,660 t. The OFL fishing mortality rate is computed under Tier 3b as follows:

$F_{OFL} = F_{35\%} \times (B_{2002} / B_{40\%} - 0.05)/(1-0.05) = 0.057 \times (134{,}694/140{,}660 - 0.05)/0.95 = 0.055$

Projected harvesting at a fishing mortality rate of 0.055 gives a 2002 catch of 17,500 t, 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. The assessment authors provided an assessment for these species groups, by incorporating recent catch data and the 2000 AI survey results. For 2001 and again in 2002, the Groundfish Plan Team of the NPFMC recommended that the complex be broken out to separate species and managed accordingly. The Plan Team feels this is a conservation issue, because when managed as a species complex, there is a risk that one stock would be fished disproportional to its abundance, resulting in overfishing of that stock. This is especially true when one species has a higher value to the fishery that the other species. This has happened in the other red rockfish complex, and the assessment appendix showed that on a species basis, catches have sometimes exceeded what OFL would have been. This occurred for rougheye rockfish in the AI in 1997 and 2001, and northern rockfish in the Bering Sea in 2000. Establishing ABCs on a species by species basis would help prevent overfishing.

For each species, the Plan Team recommends setting F_{ABC} at the maximum value allowable under Tier 5, which is 75% of M. Accepted values for M are: rougheye rockfish--0.025, shortraker rockfish--0.030, and northern rockfish--0.060. Multiplying these rates by the best estimates of species-specific biomass gives the following 2002 ABC's:

Northern Rockfish (BSAI)	6,760 mt
Rougheye Rockfish (BSAI)	262 mt
Shortraker Rockfish (BSAI)	766 mt

Sharpchin rockfish are at the extent of their range in the BSAI, and are not common. Therefore, no specifications for this species are recommended.
There is some risk associated with establishing area-wide ABCs if there are truly separate stocks of shortraker and rougheye rockfish in the AI and EBS. For rougheye rockfish, there has been some genetic samples collected in the EBS, but most of the research to date has been done in the Gulf of Alaska. To address this concern, the TAC's for these species be apportioned among BS and AI areas. Apportionments of the full ABC based on average (1991-2000) survey biomass are as follows:

	BS	AI
Northern	19 mt (0.3%)	6,741 mt (99.7%)
Rougheye	32 mt (10.9%)	230 mt (89.1%)
Shortraker	84 mt (11.0%)	682 mt (89.0%)

To prevent topping off of northern rockfish, rougheye, and shortraker rockfish, these species may be prohibited to retention in the EBS at the beginning of the year. Another possibility would be to reduce the maximum retainable bycatch levels from the current 15%.

The Overfishing level was determined from the Tier 5 formula, where setting F_{OFL}=M for each species gives 2002 OFLs:

Northern Rockfish (BSAI)	9,020 mt
Rougheye Rockfish (BSAI)	349 mt
Shortraker Rockfish (BSAI)	1,020 mt

As Tier 5 stocks, it is not possible to determine whether any species in the EBS "other red rockfish" complex is overfished or whether it is approaching an overfished condition.

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 293,240 mt, and the exploitable biomass for northern rockfish is 94,350 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 this year using the AD Model Builder template, but 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 2002 ABC's are as follows: Pacific ocean perch, 13,190 mt; shortraker/rougheye rockfish, 1,610 mt; northern rockfish, 4,980 mt, and other slope rockfish, 5,040 mt.

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

Rockfish Age-Structured Modeling Workshop

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

West Coast

Pacific Ocean Perch
For further information, contact Dr. James Ianelli at (206) 526-6510.

5. Thornyheads

b. Stock Assessment

GULF OF ALASKA

YEAR	ABC	BIOMASS	CATCH[1]
2000	2,360	52,950	1,307
2001	2,310	52,100	1,323
2002	1,990	77,840	

[1] Catch through November 15, 2001.

The updated assessment model for the most recent assessment incorporated new catch data, biomass estimates from the 2001 trawl survey and relative population numbers from the 2001 sablefish longline survey. The assessment evaluated several models that examined different estimates of natural mortality and growth. Based on an evaluation on how alternative models fit the data, the authors initially selected the baseline model configuration. However, this model resulted in natural mortality that appears unrealistically high. An alternative model that assumed a natural mortality = 0.038 was

chosen as the preferred model for the assessment. This rate is considered reasonable compared to species of similar life history characteristics.

Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock and stock status relative to $B_{40\%}$ qualified the stock for management under Tier 3a of the GOA Groundfish FMP. Updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 77,840 t, 0.035, and 0.042, respectively. The area specific apportionments are 360, 835 and 795 mt to the Western, Central and Eastern areas respectively. The overfishing level was determined to be 2,330 mt.

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 1987-2001. 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 2001, the twenty-third annual longline survey of the upper continental slope of the Gulf of Alaska was conducted, along with a similar survey of the eastern Bering Sea slope. One hundred-fifty-three longline hauls (sets) were completed between 2 June 2001 and 3 September 2001 by the chartered fishing vessel *Ocean Prowler*. Sixteen kilometers of groundline were set each day, containing 7200 hooks baited with squid.

Sablefish (*Anoplopoma fimbria*) was the most frequently caught species, followed by giant grenadiers (*Albatrossia pectoralis*), Pacific cod (*Gadus macrocephalus*), and arrowtooth flounder (*Atheresthes stomias*). A total of 94,033 sablefish were caught during the survey. A total of 4,323 sablefish, 626 shortspine thornyhead (*Sebastolobus alascanus*), and 128 Greenland turbot (*Reinhardtius hippoglossoides*) were tagged and released during the survey. Length-weight data and otoliths were collected from approximately 2,500 sablefish. Sperm (*Physeter macrocephalus*) and killer (*Orcinus orca*) whales took fish from the longline at several stations, as in previous years, and may have affected catch rates at these stations.

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

Sablefish Logbook Database and Fishery Catch Rates

A sablefish logbook program was initiated by 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. Voluntary logbooks are also submitted by vessels less than 60 feet and are included in the data set when available. 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 and 2000. The 2001 data should be available by June 2002.

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 (970) 789-6008 or Michael Sigler at (907) 789-6037.

ABL Sablefish Tag Recovery Program

Processing tag recoveries and administration of the reward program continued during 2001. About 600 tags have been received so far this year, down slightly from the last three years. Over 17% of the fish recovered in 2001 had been at liberty longer than 15 years. The three fish at liberty the longest (28+ years) were all released in upper Chatham Strait in 1973. Two were recovered in Chatham Strait and one off Queen Charlotte Sound in Canada.

Tagging continued on the 2001 sablefish longline survey, with 4,323 sablefish tagged and released. Tag releases in the database, including adults and juveniles, now total 308,970. There are 24,004 recoveries to date.

An additional 1,002 sablefish were tagged and released on three seamounts in July when the longline survey vessel transited from the Western to Eastern Gulf of Alaska, bringing the total released on seamounts since 1999 to 2,800. Seamount tagging began in 1999 in an effort to determine whether fish which travel to the seamounts ever return to the continental slope. Seven fish released on seamounts in 1999 and two fish released in 2000 were recovered on the slope in 2000 and 2001, proving that emigration does occur. Seven tagged fish were recovered in 2000 and 21 in 2001, all from the same seamounts where they were released in 1999 or 2000. So far, no sablefish has been recovered on a seamount other than the one where it was released. Seamount tagging will continue in 2002.

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

Archival Sablefish Tags

During the 1998, 2000, and 2001 sablefish longline surveys, a combined total of about 463 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, 33 tags have been recovered. A $500 reward per tag is being offered to fishermen for the recovery of these tags. Plans are to release an additional number of sablefish with implants of archival tags during the 2002 longline survey. However, the reward for return of the archival tags released in 2002 will be lowered to $200.

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 have been conducted by ABL in Alaska since 1984 and were continued in 2001. A total of 110 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 2001. This cruise has been conducted annually since 1985, and the number of juvenile sablefish found and tagged here in 2001 was much less than in any other year except 1999. This relatively small bay is the only known location in Alaska where juvenile sablefish have been consistently found. A young-of-the-year (YOY) sablefish study, which started in 1995, was conducted again in 2001 using the survey vessel *Ocean Prowler* opportunistically during the sablefish longline survey. A small-mesh surface gillnet was fished at night at offshore locations in the Gulf of Alaska to capture YOY sablefish. Mean lengths of YOY sablefish caught in the gillnets during these surveys have ranged from 10 to 19 cm. In the 2001 survey, 42 surface gillnet sets were completed which yielded a low number of YOY sablefish (only 128 total) relative to most previous years. The number of YOY sablefish caught in 2000 was also low. Both the juvenile tagging and YOY sablefish studies will be continued in 2002.

A new juvenile sablefish study is also planned for summer 2002 that will involve sonic tagging of juvenile sablefish in St. John Baptist Bay. Objectives of this study are to provide information on juvenile sablefish behavior and habitat use in nearshore areas and on the timing and duration of the fish's emigration from the bay.
For more information, contact Thomas Rutecki at (907) 789-6051.

Young-of-the-Year Sablefish Age and Growth in the Gulf of Alaska

Experiments were completed in 2001 which examined the periodicity of otolith increment formation in the sagittal otoliths of juvenile sablefish (age 0, size range 73 mm to 186 mm). Otolith increments are alternating light and dark bands visible under a transmitted light compound microscope at magnifications of 250x to 1000x. A daily periodicity of otolith increment formation in juvenile sablefish (age 0) has been postulated, but never validated. The periodicity of otolith increment formation was tested in this study by chemically marking the otoliths of captive juvenile sablefish with strontium chloride

($SrCl_2$). Approximately 30 post-larval neustonic sablefish were captured along the continental shelf and transported alive to ABL on June 1, 2000. The fish were maintained in sea water tanks for up to 104 days. The water temperature was elevated and held at a constant 13 degrees C, and the photo period was lengthened and held at a constant 16 hrs of light per day. The otoliths were chemically marked by immersing the live fish in seawater containing 1000 ppm $SrCl_2$. For chemical marking, the fish were split into three groups of roughly equal size. The first group was marked in June, the second group was marked in July, and the third group was marked in August. Each group was marked twice over a period of between 15 - 17 days, and each group was sacrificed between 14 -17 days after the second marking event. The otoliths of marked fish were processed into thin sections and the resulting strontium bands were detected with electron scanning microscopy by staff at the University of Alaska Fairbanks. For each otolith, the number of increments between strontium bands was counted and compared to the number of days between $SrCl_2$ immersions. The number of otolith increments detected between strontium bands ranged from 10 to 25, and in general did not agree with the number of days between marking events (15 - 17 days, average percent error in agreement 19.5%). These results suggest that either the otolith increments detected in this study did not form with a daily periodicity or that the methods used in this study to detect otolith increments were not accurate. In either case, the use of a less complicated structure, such as the lapilli otolith, or a more accurate otolith increment detection method, such as scanning electron microscopy, may be required to validate the periodicity of otolith increment formation for the size range of juvenile sablefish examined in this study.

To investigate the use of lapilli otoliths in age determinations of juvenile sablefish, aging of lapilli otoliths was also completed in 2001 for fish collected in the Gulf of Alaska from 1999-2001. Up to 30 lapilli were read for daily age by staff under contract at the Hatfield Marine Science Center, Oregon State University. These age determinations will be used to estimate birth date and calculate growth rates for comparisons with year class strength, estimated from age-structured modeling of adult sablefish.

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

b. Stock Assessment

BERING SEA, ALEUTIAN ISLANDS, AND GULF OF ALASKA

The sablefish assessment shows 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 1970's due to heavy fishing; catches peaked at 56,988 mt in 1972. The population recovered due to exceptional year classes from the late 1970's; spawning abundance peaked again in 1987. The population then decreased as these exceptional year classes began dying off.

The longline survey abundance index increased 16% in numbers and 13% in weight from 2000 to 2001. These increases follow decreases from 1999 to 2000 in the survey abundance index of 10% in numbers and 8% in weight and in the fishery abundance index of 5% in weight**, so that relative abundance in 2001 is slightly higher than in 1999.** Fishery abundance data for 2001 were not analyzed because the fishery was still open at the time the assessment was completed. Exploitable and spawning biomass are projected to increase 4% and 2%,

respectively, from 2001 to 2002. **Alaska sablefish abundance now appears to be low and slowly increasing. The slow increase confirms the conclusion from last year's assessment that the abundance trend will increase slowly due to the above-average 1995 and 1997 year classes; the size of the increase depends on the actual strength of the above-average 1997 year class and the 1998 year-class, which is also likely above average. Spawning biomass is projected to increase to 35% of unfished spawning biomass in 2002, having been as low as 33% during 1998 to 2000.**

A simple Bayesian analysis was completed by examining the effect of uncertainty in natural mortality and survey catchability on parameter estimation. A decision analysis was completed using the posterior probability from the Bayesian analysis to determine what catch levels likely will decrease abundance. The decision analysis indicates that a yield of 17,300 mt will maintain spawning biomass. The maximum permissible yield from an adjusted $F_{40\%}$ strategy is much higher, 21,300 mt. The $F_{40\%}$ yield was not recommended because it had a high probability of decreasing abundance. An ABC value of 17,300 mt was recommended for the combined stock in 2002. This yield is likely to maintain spawning biomass and is slightly higher than the 2001 ABC of 16,900 mt.

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 2001 stock assessment updates the 2000 assessment, including incorporation of new catch and survey information. The 2001 EBS bottom trawl survey resulted in a biomass estimate of 1,855,000 t, an increase of 17% from the 2000 survey but 20% less than estimated in 1998. Colder water temperatures in part may have reduced biomass estimates during 1999 and 2000 by decreasing catchability and delaying spawning so that some fish remain at the spawning grounds in shallow water outside the standard survey area.

Previous assessments assumed that survey catchability equaled 1.0. In this year's assessment, the authors explored models to determine if survey catchability differed from 1.0 and also the relationship between water temperature and survey catchability. Both models significantly improved the fit to the suite of observed fishery and survey age composition data and survey abundance data. The temperature affect model provided the best fit and was adopted as the best representation of the yellowfin sole population. Estimated catchability for this model averages 1.36 for the period 1982-2001, lowering abundance estimates compared to last year's assessment, which assumed catchability was 1.0. The estimate of the 2001 biomass is 68% of the value estimated when catchability

equals 1.0. The population has been in a slow decline for the past 15 years and the present female spawning biomass is estimated to be at 70% of the peak value from 1985.

Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock which qualifies for management under Tier 3 of the BSAI Groundfish FMP. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 392,000 t, 0.11, and 0.13, respectively. Given that the projected 2002 spawning biomass of 454,000 t exceeds $B_{40\%}$, the Plan Team's ABC and OFL recommendations for 2002 were calculated under subtier "a" of Tier 3. F_{ABC} at the $F_{40\%}$ (=0.11) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2002 ABC of 115,000 t. The Overfishing level was determined from the Tier 3a formula, where an $F_{35\%}$ value of 0.13 gives a 2002 OFL of 136,000 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.

Rock sole

The present assessment includes use of year-specific weight-at-age schedules, and incorporation of new catch and survey information. The 2001 EBS bottom trawl survey resulted in a biomass estimate of 2,420,000 t, an increase of 13% over the 2000 survey estimate. The stock assessment model estimate of 2+ total biomass is 1,991,000 t, a 30% decline from the peak biomass estimate in 1995. The decline is a result of reduced levels of recruitment observed during the first half of the 1990s.

Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, requiring that rock sole are managed under Tier 3 of the BSAI Groundfish FMP. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 268,000 t, 0.16, and 0.20, respectively. Given that the projected 2002 spawning biomass of 658,000 t is well above the $B_{40\%}$ level, the ABC and overfishing reference points for 2001 were calculated under sub-tier "a" of Tier 3. F_{ABC} was set at the $F_{40\%}$ (=0.16) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2002 ABC of 225,000 t.

The overfishing level was determined from the Tier 3a formula, where an $F_{35\%}$ value of 0.20 gives a 2002 OFL of 268,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

Flathead sole

The recent assessment is a straightforward update of last year's assessment with incorporation of new catch and survey information. The 2001 EBS bottom trawl survey resulted in a biomass estimate of 514,000 t, about a 25% increase relative to the 2000 survey estimate. The stock assessment model results indicate that the flathead sole population (age 3+) peaked at 897,900 t in 1991 and has declined over 30% since to the 2001 estimate of 612,300 t. The decline is due to below-average recruitment during the 1990s. The harvest has remained at low levels during this time.

Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, and flathead sole is managed under Tier 3 of the BSAI Groundfish FMP. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 142,000 t, 0.30, and 0.38, respectively. Given that the projected 2002 spawning biomass of 262,000 t exceeds $B_{40\%}$

(141,930 t), the ABC and overfishing level recommendations for 2002 were calculated under subtier "a" of Tier 3. F_{ABC} was set at the $F_{40\%}$ (=0.30) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2002 ABC of 82,600 t. The overfishing level was determined from the Tier 3a formula, where an $F_{35\%}$ value of 0.38 gives a 2002 OFL of 101,000 t. Model projections indicate that this stock is neither overfished nor approaching an overfished condition.

Other flatfish

This management complex consists of sixteen flatfish species of which Alaska plaice is the dominant species. The complex has remained at a stable, and presumably high, level of abundance throughout the modern history of the EBS survey time series (i.e., since 1982, when the present survey net configuration was adopted). The present assessment includes an update of catch and trawl survey information to the age-structured model used to estimate Alaska plaice abundance. The stock assessment model indicates that the Alaska plaice population biomass peaked in 1984 at 1.4 million t and is presently estimated to be at 75% of that peak level (1.1 million t) 17 years later.

This year's EBS bottom trawl survey resulted in biomass estimates of 538,000 t for Alaska plaice and 78,300 t for the remaining species in the "other flatfish" complex. The other "other flatfish" are Dover sole (<1%), rex sole (28%), longhead dab (16%), Sakhalin sole (<1%), starry flounder (55%), butter sole (1%) and English sole (<1%). This represents a increase of 18% in Alaska plaice and an increase of 10% of "other flatfish" relative to last year's estimates. Last year, plaice increased and "others" decreased.

Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock complex, and therefore it qualifies for management under Tier 3 of the BSAI Groundfish FMP. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 133,000 t (Alaska plaice only), 0.28, and 0.34, respectively. Given that the projected 2001 spawning biomass (Alaska plaice only) of 265,000 t exceeds $B_{40\%}$, the ABC and OFL recommendations for 2001 were calculated under sub-tier "a" of Tier 3. Because 85% of the "other flatfish" category is Alaska plaice and the assessment author calculates plaice separately, the ABC and OFL for Alaska plaice were determined separately from the other species. For Alaska plaice, F_{ABC} was set at the $F_{40\%}$ level (=0.28), which is the maximum allowable under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2001 ABC of 143,000 t for Alaska plaice. For the remaining species in the flatfish complex, F_{ABC} was also set at the $F_{40\%}$ level (=0.30), which is the maximum allowable under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2001 ABC of 18,100 t for "other" non-plaice flatfish.

As with the ABC, Alaska plaice is separated from the "other" flatfish species for overfishing determinations. The OFL was calculated using the Tier 3a formula, where, for Alaska plaice an $F_{35\%}$ value (=0.34) gives a 2002 OFL of 172,000 t. For the "other flatfish" species, an $F_{35\%}$ value (=0.38) was used giving a 2002 OFL of 21,800 t. Model projections indicate that this stock complex is neither overfished nor approaching an overfished condition.

Greenland turbot

The current assessment model uses the same data as past assessments, but now aggregates across both sexes. The updated model incorporated the most recent catch data, an aggregated longline survey index and trawl survey information on biomass and length frequency data for this species which has been in decline for the past 20 years due to a lack of recruitment. Reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock and stock status relative to $B_{40\%}$ qualified the stock for management under Tier 3a of the BSAI Groundfish FMP. Updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 83,000 t, 0.26, and 0.32, respectively. Projected spawning biomass for 2002 is 132,000 t. The maximum permissible value of F_{ABC} under Amendment 56 Tier 3a translates into a 2002 catch of 32,400 t.

Since the stock condition has not changed substantially over the past several years, the authors recommend setting the 2002 ABC at a value substantially less than the maximum permissible. Using $F_{ABC} = 0.25 \times \max F_{ABC}$, results in a 2002 ABC of 8,100 t corresponding to a full selection fishing mortality rate of 0.065. The overfishing fishing mortality rate is computed under Tier 3a, $F_{OFL} = F_{35\%} = 0.32$, and translates into a 2002 OFL of 36,500 t. This reduction is warranted for the following reasons: 1) stochastic trajectory of female spawning biomass and projected catches at maximum F_{ABC} indicate that the population would decline below $F_{35\%}$ within three years; 2) estimated age 1+ biomass has trended downward continually since 1972; 3) annual catches have average less than 8,000 tons over the last 15 years and if the maximum permissible ABC of 32,400 t were actually caught, this would constitute the highest catch since 1983, even though spawning biomass in 2002 is projected to be less than half of what it was in 1983. The senior assessment author acknowledged large uncertainties in the assessment and concluded that biomass estimates may not be reliable. Arbitrary adjustments to ABC made in the assessment are due to this uncertainty. Additional information will need to be incorporated into future stock assessments or a suitable tier adjustment will be necessary. Tier 5 or 6 status may be more appropriate if uncertainty in survey biomass estimates can not be reduced. Analysis of the 2000 pilot survey of the EBS slope region has been completed and a new survey will commence in summer of 2002. These data will substantially enhance current knowledge of Greenland turbot and other species susceptible to trawl gear in this region.

Arrowtooth flounder

The present assessment updates last year's assessment, with incorporation of new catch and survey information. This year's EBS bottom trawl survey resulted in a biomass estimate of 409,000 t, a 20% increase relative to last year's estimate. The assessment model results indicate that the population has steadily declined since a peak in 1995 due to reduced recruitment observed in the 1990s, although the stock is well above the $B_{40\%}$ level.

Since reliable estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ exist for this stock, arrowtooth flounder are managed under Tier 3. The updated point estimates of $B_{40\%}$, $F_{40\%}$, and $F_{35\%}$ from the present assessment are 180,000 t, 0.22 and 0.28, respectively. Given that the projected 2002 spawning biomass of 423,000 t exceeds $B_{40\%}$, the Plan Team's ABC and OFL recommendations for 2001 were calculated under sub-tier "a" of Tier 3. F_{ABC} was set at the $F_{40\%}$ (=0.22) level, which is the maximum permissible level under Tier 3a. Projected harvesting at the $F_{40\%}$ level gives a 2002 ABC of 113,000 t.

The overfishing fishing mortality rate under Tier 3a is $F_{35\%}$ (=0.28), translating into a 2002 OFL of 137,000 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

Species/group	2001 ABC (t)	BIOMASS (t)	CATCH (t)[1]
Deep water	5,300	74,460	805
Rex sole	9,440	74,600	2,939
Shallow water	37,860	299,100	6,173
Flathead sole	26,270	207,520	1,910
TOTAL	78,870	655,680	11,827

[1] Catch through November 15, 2001.

The flatfish group is subdivided into deep water flatfish, rex sole, shallow water flatfish, and flathead sole. The 2002 exploitable biomass for each group is based on results from the 2001 NMFS triennial 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 2002 increased almost 10 percent from 2001, driven primarily by an increase in the ABCs for rock sole and starry flounder in the shallow water group. Individually, the deep water flatfish group ABC declined from 5,300 mt in 2001 to 4,880 mt in 2002 and the flathead sole ABC declined from 26,270 mt to 22,690 mt. The rex sole ABC increased from 9,440 mt to 9,470 mt and the shallow water flatfish ABC increased from 37,860 mt to 49,550 mt. 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 2000, the ABC from the Eastern GOA was split between the WYAK and EYAK/SEO subareas. The resulting 2002 ABCs are:

Species/group	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	23,550	23,080	1,180	1,740	49,550
Flathead sole	9,000	11,410	1,590	690	22,690

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

OVERFISHING				
Species/group	F_{ABC}	F_{OFL}	LEVEL	TIER
Deep water	0.075	0.10	6,430 t	5,6
Rex sole	0.15	0.20	12,320 t	5
Shallow water	0.15-0.17	0.2-.21	61,810 t	4,5
Flathead sole	0.15	0.20	29,530 t	5

Arrowtooth flounder

YEAR	ABC	BIOMASS	CATCH[1]
2000	145,360	1,571,670	24,056
2001	148,150	1,586,530	19,909
2002	146,260	1,760,000	

[1] Catch through November 15, 2001.

The 2002 exploitable biomass of 1,760,000 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. One change from last year's assessment was the removal of the weighting factors used on the survey inputs to the model. Because the NMFS trawl survey did not cover the eastern GOA, the 1993-1999 average biomass was used to estimate the EGOA biomass. Female spawning biomass in 2002 is estimated to be greater than $B_{40\%}$ and ABC was determined to be 146,264 mt, based on Tier 3a calculations ($F_{40\%}$ = 0.134). The overfishing level was determined to be 171,060 mt ($F_{35\%}$ = 0.16). The Team recommended that ABC be apportioned among regulatory areas in proportion to biomass distributions in the 2001 trawl survey. The resulting ABCs (t) are:

WESTERN	CENTRAL	WYAK	EYAK/SEO	TOTAL
16,960	106,580	17,150	5,570	146,260

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

9. Pacific Whiting (Hake)

a. Research

Acoustic/Trawl Survey - West Coast (California - British Columbia)

The MACE Program conducted the ninth triennial echo integration-trawl (EIT) survey of Pacific hake off the U.S. and Canadian west coasts from Monterey, California (36°N), to

northern Vancouver Island, British Columbia (50°N), between June 15 and July 29, 2001, to collect echo integration data and midwater and bottom trawl data necessary to determine the distribution, biomass, and biological composition of Pacific hake. Parallel transects were spaced 18.5 km apart. About 3,000 nmi of tracklines were covered and 76 midwater and 14 bottom trawls were conducted. The survey was part of a collaborative effort with Canadian scientists from the Pacific Biological Station, Nanaimo. An intership calibration was performed with the Canadian research vessel *W.E. Ricker*, which surveyed the area from 50°N to Dixon Entrance, Alaska.

Pacific hake echo sign was broadly distributed along the coasts of California and southern Oregon from Monterey Canyon (37°N) to Heceta Bank (44°N). Few hake were detected north of Heceta Bank, with the only substantial aggregations observed off Barkley Sound, Vancouver Island. Juvenile hake (<40 cm) comprised 84% of the hake south of Heceta Bank, whereas adult hake (40 cm and longer) comprised 92% of the hake north of Heceta Bank.

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

10. Walleye pollock

a. Research

BERING SEA

Acoustic/Trawl Surveys - Southeastern Bering Sea Shelf and Bogoslof Island Area

The Mace Program conducted an echo integration-trawl (EIT) survey of walleye pollock on the southeastern Bering Sea shelf and in the Bogoslof Island area during winter 2001. The primary cruise objective for the Bering Sea shelf section was to assess abundance and distribution of 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 pollock in the southeastern Aleutian Basin near Bogoslof Island. The biomass estimate for 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 first leg of the survey took place between February 19 and March 3, and covered an area of the southeastern Bering Sea shelf north of Cold Bay, AK, to northeast of Umnak Island. Twenty-three north-south parallel transects spaced 8 nmi apart covered a 14,200 nmi^2 area. Pollock were most concentrated northeast of Unimak Island. They were also concentrated near the 200 m isobath. Fork lengths ranged from 9 to 65 cm among pollock sampled in shelf area trawl hauls. Estimates of shelf pollock abundance by size indicated two dominant modes, one at about 46 cm and one at about 12 cm. The mode of small pollock was from aggregations centered on the shelf north of the 200 m isobath, between about 166°30W and 167°40W longitude. Maturity composition for pollock greater than 29 cm long (approximately ages 3 and older) showed that 50% of the females and 57% of the males were pre-spawning. Thirty-five percent of females and 22% of males were developing. One percent of females and about 5% of males were actively spawning. Among pollock sampled that were smaller than 29 cm long, 96% were

immature. Females were estimated to be 50% mature at 43 cm. The mean gonadosomatic index (GSI) for pre-spawning females on the shelf was 0.10. Abundance estimates for pollock in the Bering Sea shelf survey area between 14 m below the surface and 0.5 m off-bottom were 1.424 billion fish and 0.825 million metric tons (t).

The second leg took place March 5 to 11 and covered the southeastern Aleutian Basin adjacent to the Aleutian Islands north of Unalaska Island to west of the Islands of Four Mountains. Twenty-two north-south transects spaced 5 nmi apart covered a 3,000 nmi^2 area. This year's survey area for Bogoslof was reduced compared to previous years' survey areas, based on observation of extremely low to zero pollock densities in some of the offshore deep water area during the past 5 years. In the Bogoslof area pollock were limited to a few regions and were most concentrated in the Samalga Pass area. Among pollock sampled in trawl hauls, fork lengths ranged from 38 to 70 cm. Size-based population estimates for Bogoslof pollock indicated that their average length was 55 cm. Maturity composition analyses indicated that 96% of female and 68% of male pollock were in pre-spawning condition. One percent of females and about 26% of males were actively spawning. The mean GSI for pre-spawning females was 0.17, the same as in Bogoslof in winter 2000, indicating that survey timing was similar in relation to peak spawning. The abundance estimate for 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 171 million fish and 0.232 million t. The abundance of pollock estimated for the subset of Bogoslof pollock inside U.S. management area 518/CBS specific area was 150 million fish and 0.208 million t, about 90% of the estimated population for the whole area.

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

GULF OF ALASKA

Acoustic/Trawl Surveys - Shumagin Islands, Shelikof Strait, and East Kodiak Areas

The MACE Program conducted an EIT survey of walleye pollock in the Shumagin Islands area between February 12 and February 19, 2001. Parallel transects were spaced 5.9 km apart, except in Shumagin Trough, where transect spacing was 9.3 km. The densest aggregations were located in Unga Strait and across the mouth of Stepovak Bay between Renshaw and Kupreanof Points. Quantities of pollock were also detected near the head of the Shumagin Trough near Korovin Island. Fish were most abundant within 50 m of the bottom. The numbers of age-1 and age-2 pollock greatly exceeded the catch of older pollock in tows conducted in West Nagai Strait and Shumagin Trough. Tows made north of Unga Island and up into Stepovak Bay caught mostly adult pollock (modal FL 49). The maturity composition for females longer than 40 cm FL was 0% immature, 3% developing, 52% pre-spawning, 15% spawning, and 30% spent. Comparison of these results with earlier Shumagin surveys conducted in mid-February suggest that the timing of peak spawning has varied among years. For example, the percent of the female pollock that were classified as either “spawning” or “spent” in 1995 was only 6%, whereas in 1996 it was about 37% which was similar to the value reported in 2001 (45%). The mean GSI for mature pre-spawning females was 0.16, which was higher than the mean GSI of 0.12 obtained during the 1995 survey but lower than the mean GSI of 0.19 obtained during the 1996 survey. The pollock biomass estimate of 0.108 million metric tons was about one-third of 1995 estimate, which was the only other complete survey of the Shumagin Islands area.

The MACE Program conducted 2 EIT survey passes of pollock within the Shelikof Strait area from Chirikof Island to Cape Chiniak between March 14-19 and March 23-26, 2001. For the first pass, parallel transects were spaced 13.9 km apart. Transect spacing was 27.8 km for the second pass. Inclement weather, however, prevented completion of the second pass, thus the results were not used to calculate an abundance estimate. The densest aggregations of pollock occurred from about 40 km northwest of Chirikof Island to about Cape Kekurnoi. Virtually no echosign was detected along the western portion of the Strait between Katmai Bay and Cape Nukshak, where mature pre-spawning pollock are typically observed. A small amount of pollock was detected on the east side of Strait between Uyak Bay and Kupreanof Strait, similar to that observed during the 1988 survey. Pollock from the 1999 year class formed a strong, well-defined midwater layer (150-200 m depth) from about Chirikof Island to Sitkinak Strait and off Cape Kekurnoi. Fish were most abundant within 50-150 m of the bottom. The female maturity composition of fish longer than 40 cm FL was 1% immature, 24% developing, 71% mature pre-spawning, 0% spawning, and 3% spent. The mean GSI of 0.12 obtained from pre-spawning females was slightly lower than the mean GSIs (0.14-0.19) reported for recent (1992-2000) Shelikof surveys, which suggested that the fish may have spawned relatively later in 2001. The pollock biomass estimate of 0.370 million metric tons was the lowest for the Shelikof Strait survey since 1989. About half of the 2001 biomass consisted of the 1999 year class.

The MACE Program conducted an EIT survey of pollock in Chiniak and Barnabas Troughs in the east Kodiak Island area between March 20 and March 23, 2001, to evaluate seasonal trends in pollock abundance and distribution patterns within this region of the Gulf of Alaska. Transect spacing in Chiniak Trough was 11.1 km and in Barnabas Trough was 5.6 km, except for the southernmost 3 transects, which were 11.1 km. Well-defined layers of juvenile pollock occurred in Barnabas Trough at 25-75 m depth near Sitkalidak Strait and Ugak Bay and in Chiniak Trough near Cape Chiniak. Few adult pollock were detected in either trough. During the summer 2000 and 2001 surveys, however, adult pollock were located in significant quantities in the northern portion of Barnabas Trough and throughout Chiniak Trough (see below).

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

b. Stock assessments

GULF OF ALASKA

The age-structured assessment model developed using ADModel Builder (a C++ software language extension and automatic differentiation library) used for assessments in 1999 and 2000 is basically unchanged. Model exploration focused on approaches to incorporating trawl survey data prior to 1984 and modeling information from a comparative trawling experiment between an ADFG 400-mesh Eastern trawl and a NMFS Poly Nor'eastern trawl.

Three surveys conducted in 2001all had lower estimates of pollock biomass relative to previous surveys:

1) the 2001 NMFS summer bottom trawl survey showed a 65% decline in biomass from the 1999 survey;
2) the 2001 Shelikof Strait EIT survey showed a 49% decline in spawning adults from the 2000 survey; and
3) the 2001 ADF+G crab/groundfish pollock biomass estimate declined by only about 15% from the 2000 survey.

In contrast to the low estimates of adult biomass, both the Shelikof Strait EIT survey and the NMFS summer bottom trawl survey found record numbers of juvenile pollock. The Shelikof Strait EIT survey estimate of age-2 fish was the highest on record, and the NMFS bottom trawl estimate of age-1 fish was the highest on record. If these year classes (1999 and 2000) prove to be as abundant as initial estimates indicate, increases in pollock biomass can be anticipated. At this time the assessment authors warn it is still too early to determine the strength of these year classes. A GLM analysis of historical trawl survey data (1961-82) produced indices of pollock abundance prior to the start of the NMFS triennial survey in 1984. Incorporation of these indices and information from a comparative trawling experiment made it possible to extend the time series of pollock biomass and recruitment back to 1961. Model results suggest that population biomass in 1961, prior to large-scale commercial exploitation of the stock, may have been the lowest observed. Major increases in pollock abundance occurred just prior to the 1977 regime shift.

The stock assessment model estimate of spawning biomass in 2002 is 158,300 mt, a decrease of 22% from last year's estimate for 2001, and a decrease of 8% from last year's projection for 2002. Spawning biomass in 2002 is estimated to be 26% of the unfished equilibrium spawning biomass. Lower model estimates of biomass in 2002 are primarily due to lower than expected biomass from the 2001 NMFS trawl survey and low abundance of spawning adults in the 2001 Shelikof Strait EIT survey. The $B_{40\%}$ estimate of 245,000 mt is similar to the estimate of 250,000 mt in the 2000 assessment. Gulf pollock are in Tier 3b. The projected 2002 age biomass estimate is 726,600 mt. A large part of this increase in 3+ biomass is due to the current estimate of the 1999 year class.

As a consequence of lower survey biomass estimates, the estimated fishing mortality in 2001 will be higher than anticipated. Had the entire 2001 ABC been taken, the overfishing limit as estimated in 2001 for pollock would have been exceeded. However, the projected catch for 2001 is substantially below the 2001 ABC. The assessment authors expressed concern that the maximum permissible ABC might not provide a sufficient buffer between ABC and OFL when the stock is below $B_{40\%}$. This led to a more conservative ABC recommendation (based on reductions to the maximum permissible ABC) to maintain the same buffer between ABC and OFL at low biomass as at high biomass. The assessment authors recommended this downward adjustment to the maximum permissible ABC primarily because of assessment uncertainty.

The 2002 ABC recommendation for pollock in the Gulf of Alaska west of 140° W long. is 53,490 mt (F_{ABC} = 0.17), a decrease of 34% from the last year's projected maximum permissible ABC for 2002. The recommendation is lower in part because of lower than projected biomass (21%), and in part because of a more conservative ABC recommendation (13%). The 2002 overfishing level is 75,480 mt (F_{OFL} =0.24). The 2002 recommended ABC for the Western, Central and West

Yakutat area is reduced to accommodate the 2002 Prince William Sound Groundfish Harvest Level (1,700 mt) resulting in an ABC of 51,790 mt.

Due to the lack of new survey data in the EGOA, the 2002 ABC recommendation for pollock in southeast Alaska (East Yakutat and Southeastern areas) is unchanged at 6,460 mt. The 2002 southeast OFL is also unchanged at 8,610 mt.

The 2001 RPAs 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. The Plan Team concurs with this approach, but recommends further survey work to better determine the winter biomass distributions. The recommended apportionment of the 2002 ABC of 51,790 mt assuming an initial allocation of 25% to each season, is:

	Area				
Season	Shumagin	Chirikof	Kodiak	West Yakutat	Total
A	2,916	8,618	1,122	292	12,948
B	2,916	8,618	1,122	291	12,948
C	5,949	2,905	3,803	291	12,948
D	5,949	2,904	3,803	291	12,947
Total	17,730	23,045	9,850	1,165	51,790

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

EASTERN BERING SEA

This year's pollock assessment features new data from the 2001 fishery and bottom trawl and echo-integration trawl surveys. The 2001 bottom trawl survey estimated a biomass of 4,140,000 t, a decrease of 19% relative to the 2000 estimate. Other new inputs include a revised age-length key for the 2000 echo-integration trawl (EIT) survey, age composition data from the 2000 fishery, and a revised fishery weight-at-age schedule. The reference model includes one methodological change from last year, consisting of a different (logistic) selectivity function for the bottom trawl survey schedule.

Seven alternative models (including the reference model) are presented in the assessment, all of which follow the statistical age-structured approach that has been used for the last few years. All of these models give point estimates of 2001 age 3+ biomass in the range 9,680,000 t to 15,900,000 t. The assessment authors based their recommendation for 2002 on the reference model (Model 1), which is similar to the model used in past years. The current assessment indicates that biomass is higher than estimated in last year's assessment. For example, this year's estimate of 2000 age 3+ biomass (11,700,000 t) is 11% higher than last year's estimate of 2000 age 3+ biomass (10,500,000 t), a difference which is well within the confidence intervals of the estimates. The coefficient of variation (CV) for the 2000 biomass estimate produced last year was 34%, and the CV for the same estimate produced this year was 33%.

Relative to last year's assessment, the current assessment gives higher estimates for the 1992 year class (as reflected in estimates of age composition from recent bottom trawl

surveys and the fishery, the 1995 year class and the 1996 year class). Since reliable estimates of B_{MSY} and the probability density function for F_{MSY} exist for this stock, EBS walleye pollock are qualified for management under Tier 1. Given the structure of the model, the senior assessment author feels that the Tier 1 reference points are reliably estimated.

The updated estimates of B_{MSY} and the harmonic and arithmetic means for F_{MSY} from the present assessment are 2,140,000 t, 0.52, and 1.2, respectively, compared to 1,780,000 t, 0.71, and 1.2, respectively, from last year's assessment. Projected spawning biomass for 2002 is 2,960,000 t, placing EBS walleye pollock in sub-tier "a" of Tier 1. The maximum permissible value of F_{ABC} under Tier 1a is 0.52, the harmonic mean of the probability density function for F_{MSY}. A fishing mortality rate of 0.52 translates into a 2002 catch of 2,110,000 t, the maximum permissible ABC under Tier 1a (compared to 2,130,000 t in last year's assessment). A catch of this magnitude has only a 6% chance of pushing the stock below $B_{20\%}$ by 2003 and a 55% chance of pushing the stock below B35% by 2003 ($B_{35\%}$ is substantially higher than B_{MSY} for this stock). 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 1.2, the harmonic mean of the probability density function for F_{MSY}. A fishing mortality rate of 1.2 translates into a 2002 OFL of 3,530,000 t. The EBS walleye pollock stock is neither overfished nor approaching an overfished condition.

ALEUTIANS

The 2000 bottom trawl survey of the Aleutians Islands region resulted in a biomass estimate of 106,000 t, an increase of 13% relative to the 1997 estimate (last year, discovery of discrepancies in stratum definitions caused the estimate from the 1997 survey to be revised downward from the value of 106,000 t used previously; if the 1997 estimate had not been revised, the 2000 and 1997 estimates would have been equal). 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 23,800 t (same as last year's recommendation). The overfishing level under Tier 5 is the product of the natural mortality rate and biomass, giving an OFL of 31,700 t for 2002. This is identical to the 2001 OFL. As a Tier 5 stock, it is not possible to determine whether Aleutian pollock is overfished or whether it is approaching a overfished condition.

BOGOSLOF

The 2001 hydroacoustic survey of the Bogoslof region resulted in a biomass estimate of 232,000 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, or 34,800 t. The overfishing level under Tier 5 is the product of the natural mortality rate and biomass, giving an OFL of 46,400 t for 2002. As a Tier 5 stock, it is not possible to determine whether Aleutian pollock is overfished or whether it is approaching an overfished condition.

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

13. Other Species - Atka mackerel

a. Research

Vertical Movement Patterns of Atka Mackerel as Shown by Data Storage Tags

The RACE Division, in collaboration with the REFM Division and the ADF&G, has been conducting research on the vertical movement patterns of Atka mackerel and Pacific cod using externally attached data storage tags (archival tags) to collect depth and temperature information at 2-60 minute intervals.

In July 2000, 117 Atka mackerel were released with data storage tags in Seguam Pass, AK. Thus far, 13 tags have been recovered for fish at liberty from 42 to 407 days. All movement away from the bottom occurred approximately between sunrise and sunset. At night, fish apparently remained on bottom. Due to the shorter day-length during winter, Atka mackerel spent longer periods on the bottom than at other times of the year. During summer months, fish often returned to the same depth each night, indicating that fish likely maintained a home-site. Daytime vertical movements were correlated with light intensity, time of day, and current velocity. Vertical movements increased with increasing light during the morning and early afternoon, but then decreased with increasing time. The currents in Seguam Pass, which reach velocities in excess of 4 knots, affected the magnitude or distance of vertical excursions away from the bottom. Surface-directed excursions were reduced in magnitude during periods of greater current velocities (spring-tide periods), whereas slope-directed excursions increased in magnitude. The diel behavior of Atka mackerel should be taken into account when conducting resource assessment surveys. Current bottom-trawl surveys are conducted only during daylight hours when Atka mackerel are often above the bottom (Results on Atka mackerel are in review at Marine Ecology Progress Series).

Planned data storage tag research for 2002 includes tagging of Pacific cod off Unimak Island in the eastern Bering Sea during April, tagging of walleye pollock off Kodiak Island during May, and tagging of additional Atka mackerel in Seguam and Tanaga Passes during June.

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

Identification and Characterization of Atka Mackerel Reproductive Habitat

This study (in 1999) was the first to identify and describe spawning and nesting areas in U.S. waters. We found large aggregations of males off Seguam and Amlia Islands guarding nests of adhesive embryos at depths ranging from 14 to 32 m in areas with rocky bottom and tidal current. Recent recoveries of archival tags from males in the vicinity of Seguam Pass (see preceding article) show behavior consistent with nest guarding at broader depth ranges. If Atka mackerel nesting extends beyond the 32 m contour, and if spawning areas extend further west in the Aleutian Islands, the essential habitat required for Atka mackerel nesting could cover a much vaster area than previously thought. The temporality of the annual nesting cycle and how it may vary by area is also unclear.

The primary objectives for this research are to 1) determine the spatial extent of nesting sites by surveying for nesting sites further west in the Aleutian Islands in nearshore areas and deeper regions close to where the commercial fishery operates; 2) describe the variability of nesting habitat over a larger spatial scale in terms of area, bottom depth, current, temperature, and biota; and 3) determine the temporal variation in the utilization of the nesting habitat during courtship, spawning and nest guarding as it relates to temperature, current, and time of day at the Seguam Island nesting site.

To expand our capabilities for searching, verifying, and quantifying Atka mackerel reproductive habitat, it was necessary to explore the use of a more innovative sampling tool. High vessel charter costs and time-consuming dive operations limit our ability to search over large areas where nesting may take place. During 2001, we developed the Quadrat Underwater Assessment Drop Camera (QUADCAM). The new camera will enable us to quickly search for new nesting areas in nearshore and deeper regions with rough bottom, kelp and high current using a portable winch and an inflatable skiff as the research platform. The camera system is capable of discerning embryo masses on a rocky substrate and measuring a fixed area for estimating embryo mass density and quantifying habitat types. The QUADCAM system consists of a bottom resistant tripod frame, high-resolution-progressive-scan digital video camcorder with high frequency strobes, 1000 m aluminum pressure case with water corrected optics, live feed ultra-low light camera with 250 m of cable, GPS overlay, and a data logger for measuring depth, temperature, and light. In the late summer/early fall of 2002, we plan to work in conjunction with the U.S. Fish and Wildlife Service aboard their R/V *Tiglax* to use the QUADCAM for documenting the spatial distribution of nesting areas and density of embryo masses in different parts of the central and western Aleutian Islands.

Two time lapse cameras will be deployed at the Seguam Pass nesting site in early June in conjunction with the AFSC's Aleutian Island groundfish bottom trawl survey and will be retrieved during the R/V *Tiglax* cruise in early September. These cameras will also be equipped with current meters and time/depth data loggers.

For more information, contact Bob Lauth, (206)526-4121.

4. Other Related Studies

Research on "Habitat Areas of Particular Concern"

A survey of a potential Habitat Area of Particular Concern (HAPC) was carried out by ABL in late May 2000. The manned submersible *Delta* was used to run transects at the site about 20 km W of Cape Ommaney, Baranof Is., southeastern Alaska during a series of 7 dives. The submersible was tracked at 30 sec intervals from the support vessel using DGPS and an ultra-short baseline acoustic tracking system. Continuous images of the sea floor were obtained using an externally-mounted video camera fitted with a laser scaling device. The audio tracks on the videotapes were used to note time when the transects began and ended, water depth, estimated current velocity, substrate, megahabitat and microhabitat characteristics, lateral water visibility, faunal assemblages, behavior and associations of individual species within those assemblages, presence of derelict fishing gear along transects, and any damage to epifaunal invertebrates.

The area of the potential HAPC site that was surveyed measures approximately 400 x 600 m with maximum vertical relief of 55 m, and water depths range between 201 and 256 m. The area studied is likely a ridge projecting southeastward from the 200 m isobath on the continental shelf, and may be part of a series of such features. The substrate is primarily bedrock and large boulders, most likely composed of mudstone, and provides abundant cover in the form of caves and interstices of various sizes. The epifaunal community is rich and diverse, much more so than the surrounding low-relief sand-gravel habitat. Largest epifauna were gorgonian red tree coral colonies and several species of sponge. These organisms were not randomly distributed at the study site. Numerous species of fish, particularly adult and sub-adult rockfish, were present in relatively large numbers and were often associated with gorgonian coral colonies and several species of sponge. Derelict longline gear was commonly observed, as were dead and damaged red tree coral colonies.

The submersible depth and location data were used to produce a precise bathymetric chart of the site by Nautical Solutions Inc., of Annapolis, MD. Data on physical and biological parameters recorded in real time on the submersible system's event log, as well as data recorded on the video and audio tapes, have been entered into computer files. These are being formatted for GIS, and a series of chart overlays depicting locations of particular habitat features and associated biota will be produced.

In June 2001 the submersible *Delta* was also used to make a series of dives in the northeastern Gulf of Alaska to observe sites where significant quantities of red tree coral had been brought up during past NMFS trawl surveys. A total of 20 dives were made at 16 locations. The video and audio data are currently being analyzed, and the information will be presented as a series of chart overlays similar to those being produced for the May 2000 dives.

For more information, contact Linc Freese at (907) 789-6045.

Effects of Fishing on Sea Floor Habitat

Effects of Bottom Trawling on Soft-bottom Sea Whip 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, 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.

Analyses completed indicate that 1): trawling intensity, although high for the Gulf of Alaska, is relatively low compared to other areas worldwide, and 2) effects on the sedimentary and biogeochemical features of the seafloor and infauna community structure from present levels of bottom trawling were minor, and clear patterns were not detectible. Although epifaunal community structure analyses are incomplete, a clear relationship between total epifaunal biomass and sea whip abundance is apparent. This relationship indicates that sea whip habitat may have increased productivity. Recent studies in the Bering Sea have shown a similar functional relationship for sea whip habitat.

In June 2001, ABL scientists initiated a second study to investigate the immediate effects of intensive bottom trawling on soft-bottom habitat and in particular on an area colonized by sea whips. Sea whip biological characteristics and their resistance to two levels of trawling were studied. A before-after-control-impact (BACI) type study design was used. Sea whips are highly visible, and changes in their abundance can be readily quantified. Within the study site, at least two species of sea whips (*Halipterus* sp. and *Protoptilum* sp.) are present with densities up to 16 individuals per m^2. Sea whip beds provide vertical relief to this otherwise homogeneous, low relief habitat. This habitat may be particularly vulnerable since sea whips can be removed, dislodged, or broken by bottom fishing gear. Furthermore, because sea whips are believed to be long-lived, recolonization rates may be very slow.

The study consisted of three phases. In Phase 1, baseline data were collected. The *Delta* submersible was used to collect *in situ* videographic documentation of the seafloor along 20 predetermined transects within the study area. Additionally, a bottom sampler was deployed from the submersible tender vessel to collect sediment samples from the seafloor. During Phase 2, a commercial trawler outfitted with a Bering Sea combination 107/138 net, mud gear, and two "NETS" High Lift trawl doors made a single trawl pass in one corridor of the study area and repetitively trawled (six trawl passes) a second corridor. Catches were sampled for species composition, and stomachs were collected from 10 groundfish species caught during trawling activities to identify important prey items. Phase 3 repeated the videographic and sediment sampling following the trawling phase. A scientist inside the *Delta* observed the seafloor in synchrony with the external cameras and vocally identified biota and evidence of trawling, including damaged or dislodged biota and marks on the seafloor from the various components of the bottom trawl (e.g., trawl door furrows, and ground gear striations).

The 2001 study will allow quantification of effects resulting from known levels of trawling, and the experimental trawling will allow testing of hypotheses related to the observed 1998-99 sediment and infauna changes. Additionally, the 2001 study will provide information for evaluating measures to minimize fishing effects such as area closures or gear modifications; and if on-bottom observations can be made in future years, an evaluation of sea whip recolonization and changes in productivity relative to sea whip abundance can be completed.

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 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 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 five colonies were tagged at 2 sites in southeastern Alaska in July 1999. Thirty two (91%) and thirty (86%) of those colonies were found again when the sites were revisited in 2000 and 2001, respectively. The five missing colonies had presumably detached from the seafloor. Growth measurements were possible for 16 colonies in 2000 and 21 colonies 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. Future research priorities are to focus on growth of smaller colonies and to establish a third study site where colonies are more numerous and more variable in size (i.e., age).

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

Study of Alaskan Sponges

A recent study of the effects of mobile fishing gear on the benthos of the continental shelf in the eastern Gulf of Alaska has shown that several species of large, erect sponge provide important components of structural habitat on the seafloor, and are particularly susceptible to removal or damage by commercial trawling activity. No sign of recovery from trawl damage was noted during a follow-up investigation conducted one year post-trawl. In contrast, experimental trawling carried out in warm, shallow water on the continental shelf of the southeastern U.S. has shown that sponge communities are quick to recover to pre-trawl abundances and that individual damaged sponges undergo rapid regeneration. Because the ability of benthic epifauna to recover from trawl damage may be a consideration in future Fishery Management Plans, ABL biologists initiated a study of several species of sponge in 2001. A small community of sponges was previously discovered at scuba diving depths in Seymour Canal, Admiralty Island, southeastern Alaska. Several of the species present were also found in deeper waters on the continental shelf in the Gulf of Alaska.

The purpose of this study is to determine some basic life history parameters of shallow, cold-water sponges. Growth and regeneration is of particular interest. Annual observations began at the Seymour Canal site in April 2001, and at an additional site located at south Benjamin Is., near Juneau, Alaska, in December 2001. We hope to collect further information regarding large-scale distribution, habitat associations, and recruitment. During 2001 we 1) roughly charted the distribution of the sponge communities; 2) tagged 76 individual sponges at both sites; 3) took manual measurements of individual sponges; 4) videotaped individual sponges so growth can be measured; and 5) removed pieces of a known size from individual sponges to examine regenerative ability and to determine species through spicule analysis. In 2002 we will revisit both sites to conduct follow-up studies.

For additional information contact Linc Freese at (907) 789-6045.

Living Substrates in Alaska: Distribution, Abundance and Species Associations

"Living substrates" have been identified as important marine habitat and are susceptible to impacts from fishing activities. In the Gulf of Alaska, Aleutian Islands, and Bering Sea, little is known about the distribution of deepwater living substrates such as sponges (Phylum Porifera), sea anemones (Order Actiniaria), sea whips and sea pens (Order Pennatulacea), sea squirts (Class Ascidiacea), and ectoprocta (Phylum Bryozoa). In order to facilitate management practices that minimize fishery impacts to these living substrates, distributional maps were created based on National Marine Fisheries Service trawl survey data from 1975 through 2000. In general, the five groups of living substrates were observed along the continental shelf and upper slope in varying densities. Catch-per-unit-effort (CPUE) of sponges was greatest along the Aleutian chain, while CPUE of sea squirts and ectoprocta was greatest in the Bering Sea. Large CPUE's of sea anemones, sea pens, and sea whips were observed in both the Bering Sea and Gulf of Alaska. Species associations between living substrates and commercial fish and crab were also investigated. Flatfish were most commonly associated with sea squirts and ectoprocta; gadids with sea anemones, sea pens, and sea whips; rockfish and Atka mackerel with sponges; and crab with sea anemones and sea squirts.

For more information, contact Patrick Malecha at (907) 789-6053.

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 Bering Sea/Aleutian Island Crab Observer Program, we are building reference and teaching collections at ABL and Dutch Harbor. A "Preliminary Field Key to the Alaskan Hydrocorals" has been developed and is being distributed for informal testing. Keys and field guides to the Octocorals ("gorgonians") are planned but require additional collections and resolution of taxonomic problems.

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 ABL 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 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 current 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.

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)

The Trawlex-01 cruise was conducted to experimentally investigate possible adverse effects of bottom trawls on a soft-bottom community in the eastern Bering Sea and to evaluate a state-of-the-art side scan sonar and swath bathymetry system for exploration of benthic habitats. Whereas earlier work focused on chronic effects of trawling (Trawlex-96 and Trawlex-97), the present study is a more process-oriented look at short-term effects and recovery. The 155' trawler *F/V Ocean Explorer* was chartered and all scientific systems were successfully implemented, including an ultra-short baseline (USBL) tracking system, two complete side scan sonar systems with tow winches, a trawl mensuration system, and a survey-grade integrated navigation system with DGPS, two gyroscopic compasses and a vertical reference unit. All systems were tested and calibrated during gear trials in Puget Sound. During the 15 June-15 July Alaska cruise, biological, physical and chemical characteristics of the seabed were randomly sampled in six experimental-control corridor pairs. Individual corridors were 20.9 km long and 100 m wide, representing the long-term average tow for commercial bottom trawls in the study area. Biological sampling consisted of 15 min research trawls for epifauna (n=72 total) and 0.1 m^2 van Veen grab samples for infauna (n=144 total at 2 per epifauna site). At each infauna sampling site, a second grab sample (n=144 total) was collected for characterizing carbon and nitrogen levels in surficial sediments, as well as grain size properties. Sampling effort in experimental and control corridors was equally divided before and after fishing in the experimental units with a commercial bottom trawl (NETS 91/140 Aleutian cod combination trawl with Thyburon 120 doors). Each of the experimental and control corridors was also surveyed twice using a Klein 5410 side scan sonar system.

Preliminary observations indicate a very diverse epifaunal community (approximately 90 distinct taxa) on very-fine olive-gray sand at 60 m depth. The seafloor appears to be brushed smooth in the preliminary side scan imagery, probably due to sizable storm waves and strong tidal currents that regularly disturb the area. Occasional video deployments on the trawls indicated

somewhat greater complexity, with at least some areas of the seafloor having meandering ribbons of contrasting substrates. Significant numbers of derelict king crab pots were encountered and there is evidence of extensive feeding by walrus. Two conspicuous, as yet unidentified targets were also encountered. A more detailed characterization of the area will be possible once laboratory processing and analysis of the navigation, sonar, epifauna, infauna and sediment data are completed.

The trawl effects study continues in summer 2002 with recovery assessments in all six experimental-control corridor pairs. The full biological and geophysical sampling regime will be used to characterize changes that have occurred after a one year recovery period. Using a Before-After-Control-Impact ("BACI") experimental design, baseline information on natural variability in control corridors will be statistically factored out of the recovery responses observed in the experimentally-trawled areas. A 15 day cruise aboard the same charter vessel is scheduled for the June-July 2002 period. The experimental design will accommodate one additional series of (destructive) epifauna sampling and multiple years of grab sampling after 2002.

A possible second objective for 2002 field operations would be to use the Klein sonar system for high resolution reconnaissance mapping of the Bristol Bay shelf. This work would begin developing efficient mapping protocols in support of systematic studies of fishing gear effects. Currently, this research is hindered by an inability to extrapolate case study findings to meaningful geographic scales. **This mapping effort would also yield high quality information about a poorly described area.**

The Trawlex project had considerable technical support from its multidisciplinary partners. The U.S. Navy's Naval Undersea Warfare Center (Keyport, WA) provided side scan sonar and navigation services at sea. The University of New Hampshire-NOAA Center for Coastal Ocean Mapping/Joint Hydrographic Center (Durham, NH) assisted with electronic systems integration and calibration, as well as side scan sonar and swath bathymetry data processing. The University of Alaska Fairbanks, Institute for Marine Studies (Fairbanks, AK) has responsibility for infauna sample processing and surficial sediment analyses. Special arrangements with Klein Associates, Inc. (Salem, NH) made the Klein 5410 system available for use, with support from the NOAA Office of Ocean Exploration.

For further information, contact Dr. Bob McConnaughey, (206) 526-4150 and see http://www.afsc.noaa.gov/Quarterly/ond2001/divrptsRACE.htm#trawl_impact
http://oceanexplorer.noaa.gov/projects/alaskatools01/alaskatools01.html

Studies on Sea Lion/Groundfish Interactions:

2001 Winter Bottom Trawl Surveys of Steller Sea Lion Critical Habitat in the Southeastern Bering Sea and Gulf of Alaska

The AFSC conducted a series of bottom trawl surveys within selected areas of Steller sea lion critical habitat (SSLCH) in the southeastern Bering Sea and Gulf of Alaska during February

and March 2001. Three commercial trawlers were chartered and used to conduct surveys in the Slime Bank area north of Unimak Island, the Shumagin Islands region in the Gulf of Alaska, and the east side of Kodiak Island.

The primary objective of the winter surveys was to provide information on the relationship between Pacific cod, walleye pollock, and Steller sea lions within the SSLCH. The 2001 survey effort resulted in distribution and absolute abundance estimates for cod and pollock within the selected areas of SSLCH and provided an assessment of the feasibility of conducting future winter bottom trawl surveys.

The survey design incorporated a stratified random sampling scheme. The Bering Sea and Shumagin Islands survey areas were divided into high and low density sampling strata based on the expected distribution and abundance of Pacific cod, while the entire Kodiak survey area was sampled at a uniform sampling density. Primary stations were sampled in the nearshore or highest sampling density stratum and in the offshore or low sampling density stratum. Primary and secondary stations were assigned in the Kodiak Island area. Secondary stations were to be completed only if time remained after completing the primary stations.

All tows were conducted during daylight hours and consisted of 15-minute trawl hauls at preassigned stations with standard Poly-Nor'eastern bottom trawls rigged with roller gear. All fish and commercially important invertebrates were sorted, weighed, and enumerated by species. Biological information (lengths, individual weights, and maturity observations) was collected for cod and pollock.

Generally good weather allowed successful completion of all primary and many secondary stations in each of the three survey areas, including 58 good performance tows in the Slime Bank area of the southeastern Bering Sea, 24 stations in the Shumagin Islands region, and 72 stations off the east side of Kodiak Island.

Bering Sea Survey Area

Pollock and cod were the two most abundant species in the survey area, each appearing in 57 of 58 catches. Sixteen catches of pollock exceeded 1,000 kg and its estimated biomass in this area was 794,743 t. Sixteen catches of cod exceeded 100 kg and its estimated biomass within the survey area was 49,309 t. Other relatively abundant species or groups included arrowtooth flounder, northern rock sole, flathead sole, Pacific halibut, and rex sole.

Shumagin Survey Area

Pacific cod were the most abundant species in this region, accounting for 45% of the total catch. Cod were captured in 14 of 24 successful tows with two catches representing 63% of the total Shumagin cod catch. The estimated cod biomass was 142,863 t within this area. Cod in this area were consistently larger than those from the Bering Sea survey area. Pollock occurred in 18 of 24 trawl hauls, though only four catches exceeded 100 kg. The estimated pollock biomass for this area was 22,755 t. Other important components of the Shumagin catch included arrowtooth flounder, flathead sole, Pacific halibut, southern rock sole, rex sole, and eulachon.

Kodiak Survey Area

Pollock appeared in 66 of 72 hauls in this area but represented less than 10% of the total species catch. Most catches consisted primarily of age-1 fish. The estimated pollock biomass within the Kodiak survey area was 22,035 t. Similarly, cod were taken in 57 of the 72 hauls in this area but accounted for only 6% of the total species catch. The estimated cod biomass in this

area was 14,167 t. Mean size of cod was considerably smaller than that observed in the Bering Sea and Shumagin regions. Flatfish represented 78% of the total catch from this region. Arrowtooth flounder accounted for 48% of the total species catch. Other important components of the flatfish catch include flathead sole, Pacific halibut, and southern rock sole. Eulachon and pandalid shrimp were also relatively abundant in this region.

For further information, contact Eric Brown, (206) 526-4157.

Seasonality of Prey Availability in Regions of Contrasting Steller Sea Lion Abundance Trends

The Auke Bay Laboratory 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 (free fatty acid analysis), 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 North Pacific Universities Marine Mammal Research Consortium. 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 will be continued in 2002 and 2003.

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

Seasonal Composition, Distribution, and Habitat of Species Available as Forage for Steller Sea Lions in Nearshore Waters in the Vicinity of Sea Lion Haul-Outs in Southeastern Alaska

The nearshore waters in the vicinity of two sea lion haul-outs, Benjamin Island and the Brothers Islands in southeastern Alaska were sampled in summer 2001 and winter 2002. A total of 22 sites were beach-seined in shallow (<10 m deep) habitats, 23 sites 10 to 80 m deep were jigged, and 16 sites 10 to 90 m deep were surveyed with a remotely operated vehicle (ROV). Thirty-nine fish species were captured of which 10 are know to be prey of sea lions. In summer, catch of fish per seine haul was 67 at Benjamin Island and 6,119 at the Brothers Islands; the highest total catch of any species was about 65,000 walleye pollock, *Theragra chalcogramma*, at the Brothers Islands and about 600 at Benjamin Island. For jigging in summer, catch of fish per rod hour was 5.6 at Benjamin Island and 5.7 at the Brothers Islands. The same sites will be sampled in summer 2002 and winter 2003.

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

Investigation of Interactions Between the Pollock Fishery and Steller Sea Lions

The second year of a multi-year field experiment was completed off Kodiak Island in the Gulf of Alaska during 9-31 August 2001. 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 EIT 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 over the area where pollock had been encountered during earlier passes. The EIT survey operations included the collection of 38- and 120-kHz acoustic data, as well as net catch data from 42 midwater and 15 bottom trawls. The data were collected along a series of uniformly-spaced (i.e., 5.5 km) parallel transects during the 3-week survey effort.

Most of the acoustic backscattering was generally attributed to three principal species groups: juvenile pollock, adult pollock, and capelin. The distribution of adult pollock was located in the northern portion of Barnabas and throughout Chiniak Trough. Juvenile pollock were present throughout Chiniak but were restricted to the northern portion of Barnabas. Capelin were rarely encountered within the deeper waters of Chiniak trough, although large quantities of these smelt were consistently present near Cape Chiniak. They were abundant over deep water within the southern portion of Barnabas but rarely detected in the northern portion of the trough.

The biomass and distribution of pollock were reasonably stable over periods of days to weeks although an unusual, extremely dense, small-scale pollock aggregation was only detected in Barnabas during pass 1. It may be necessary to adjust survey methods to account for this high level of patchiness if this is common for adult pollock during this time of year. Preliminary results have yet to suggest a significant link between fishing activities and changes in adult and age-1 pollock geographical distribution, biomass, vertical distribution, or in various descriptors of pollock school size and shape.

The stability of spatial patterns for other potential sea lion forage species such as capelin, which generally occurred higher in the water column, were greater than for pollock. Subsequent analyses may find this increased variability particularly challenging in efforts to understand whether fishing effects impact this species.

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

Shark Predation of Steller Sea Lions

In August 2001 a study was conducted by ABL scientists to test the hypothesis that sleeper sharks prey on Steller sea lions. Longlines were used to capture sleeper sharks around 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 sleeper sharks. Twenty-one longline sets were completed near four Steller sea lion rookeries from 30 July 2001 through 10 August 2001 aboard the chartered fishing vessel *Norska*.

The diet of sleeper sharks was investigated by collecting stomach content data (including micro satellite DNA-based identification of questionable prey items) and by fatty acid analysis of tissue samples. Ninety-nine sleeper sharks were collected. Predominant prey items included walleye pollock, octopus, unidentified teleost fish, salmon, and cetacean tissue. Also, the vertical distribution of sharks was measured by tagging methods for comparison to the vertical distribution of Steller sea lions while at sea. Nine sleeper sharks were tagged and released with electronic pop-up archival transmitting tags which are programmed to release (pop-up) from the animal on a pre-determined date and time, and transmit the archived data and current location to a satellite.

A second and final cruise is scheduled for 10-21 May 2002. Shark stomach samples will be collected for diet analysis and an additional twenty-four archival tags are to be released to strengthen the biological information on depth, activity, and movements.

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

Survey Gear Performance Research

The Effect of Trawl Speed on Footrope Capture Efficiency of a Survey Trawl

In 1999, an investigation of the effect of trawling speed on the footrope contact of the RACE Division's standardized Poly Nor'Eastern bottom trawl revealed a tendency for footrope contact to degrade as speed through the water increased. Standard RACE trawl survey protocol includes a target towing speed of 3.0 knots (speed over ground). However, our means of determining towing speed with GPS doesn't consider the effects of current. During the 1999 study, investigators found that the footrope maintained good contact at trawl speeds under 3.0 knots (speed through water - STW), but at 3.0 knots the center of the footrope began to lift off bottom (1.8 cm, on average). At 4.0 knots (equivalent to towing at the survey-standard towing speed into a 1-knot current) the footrope lifted 6.7 cm, on average, and at speeds greater than 4.5 knots the footrope could lift off bottom by a

meter or more.

A follow-up study in 2000, conducted in the eastern Bering Sea, focused on determining whether increased trawl speed impacts capture probability at the footrope. The experiment consisted of repetitively towing at three vessel speeds (2.5, 3.0, 3.5 knots) with an auxiliary net attached underneath the trawl footrope to capture fish escaping beneath the trawl. Length-dependent capture efficiencies were then computed from the number of fish caught in both the trawl and the auxiliary net. Capture efficiencies for Pacific cod, walleye pollock, and Pacific halibut were not affected by fish length or trawl speed. Capture efficiency for skates decreased with increasing trawl speed but was not affected by fish length. Capture efficiencies for arrowtooth flounder and flathead sole increased with fish length and decreased with increasing trawl speed. Our results indicate that in areas of variable current, variation in survey CPUE could be reduced for some species by standardizing towing speed to speed through water or by reducing footrope lift by the addition of weight to the trawl footrope.

For more information, contact Ken Weinberg (206) 526-6109.

GIS Resources

No notable new developments, though some projects are in the works.

For more information, contact Jan Benson (206) 526-4183.

APPENDIX I - Alaska Fisheries Science Center Groundfish Publications in 2000
(AFSC authors are in bold text)

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APPENDIX III.--RESOURCE ECOLOGY AND FISHERIES MANAGEMENT DIVISION

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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