AUKE BAY LABORATORIES (ABL)

HABITAT ASSESSMENT & MARINE CHEMISTRY PROGRAM

Forage Fish in Nearshore Waters of Prince William Sound, Alaska

Nearshore fishes were sampled at eight locations in western Prince William Sound (PWS) in July and August 2007; this was the second year of a 2-year study funded by the North Pacific Research Board and the Alaska Oil Spill Research Institute. At each sampling location in July, fish were collected during the day with a beach seine in three shallow water (<5 m deep) habitats (eelgrass, kelp, bedrock outcrops). In August, sampling was limited to eelgrass and kelp, and each location was sampled during the day and night. A total of 28,957 fish representing 26 species were captured in July 2007 compared to 5,274 fish representing 36 species in July 2006. Two large seine hauls of juvenile saffron cod (11,482 fish) and Pacific herring (13,078 fish) accounted for the much greater summer catch in 2007. Of the total catch in July 2007, 90% were captured in eelgrass; the dominant species were juvenile Pacific herring, saffron cod, and pink salmon. In August 2007, total catch was similar between day and night sampling–629 fish were captured during the day compared to 552 fish at night. Species richness, however, was greater at night (30 species) than during the day (20). Pacific herring was the most abundant forage species captured in 2007. Other forage species captured in small numbers were Pacific sand lance and capelin. Nearshore vegetated areas provide habitat for juvenile herring, particularly in summer in western PWS.

By Scott Johnson

MARINE SALMON INTERACTIONS PROGRAM

Live Capture of Young-of-the-Year Slope Rockfish

Slope rockfish (*Sebastes* spp.) are an important part of the ecosystem and a valuable fishery in the North Pacific Ocean. The most abundant and historically most harvested slope rockfish is the Pacific ocean perch (*S. alutus*). Other important slope rockfish species include shortraker (*S. borealis*), rougheye (*S. aleutianus*), and northern rockfish (*S. polyspinis*). As young-of-the-year, slope rockfish can be found in the upper water column over abyssal depths. Eventually, they adapt to a demersal life and are associated with the benthos. The relationship between juvenile slope rockfish and benthic habitat is poorly understood due to the depths at which the fish reside, which is usually greater than 150-200 m. Aside from broad-scale habitat associations determined from trawl data and limited observations from submersibles and ROVs (remotely operated vehicles), little data exist that detail habitat use of these deep-dwelling rockfish species.

Because it is difficult and expensive to bring scientists to the natural milieu of slope rockfish, new research is bringing slope rockfish to scientists, with the ultimate objective of identifying habitat utilization amongst various benthic habitat types such as sponge and coral. In September 2007, scientists from Auke Bay Laboratories (ABL) Marine Salmon Interactions (MSI) Program and the Marine Ecology and Stock Assessment Program took part in research activities aimed at capturing live young-of-the-year slope rockfish. Thirty-three surface trawls were performed onboard the Alaska Department of Fish and Game (ADF&G) vessel *Medeia*. Trawling took place up to 60 nautical miles offshore of Southeast Alaska between Icy Point and Cape Ommaney. The trawl was equipped with an aluminum aquarium codend (livebox) (Fig. 1) that directed fish and invertebrates into a calm water-filled holding chamber. Once on deck, live specimens were transferred from the aquarium codend to holding tanks with running seawater. At the

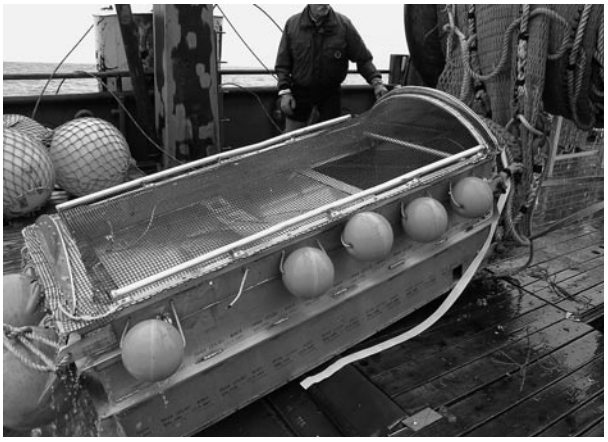

Figure 1. Aquarium codend (livebox) ascending the stern ramp of the vessel *Medeia*. A trap door in the stern of the aquarium codend allows fish and invertebrates to enter a water-filled chamber free of turbulence.

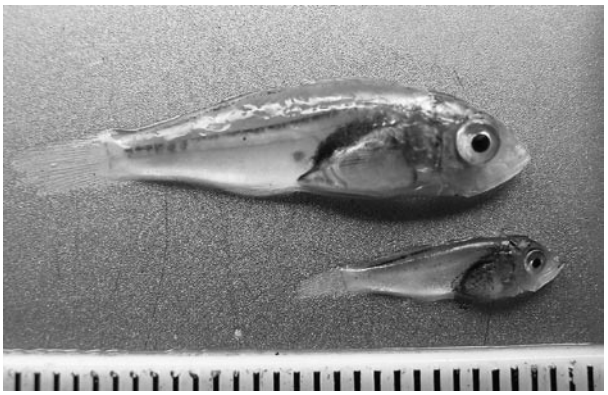

Figure 2. Unidentified rockfish (*Sebastes* spp.) caught with an aquarium codend in surface waters offshore of Southeast Alaska.

conclusion of the cruise, live rockfish were transferred to ABL's Little Port Walter Marine Station and placed in aquariums in the station's behavior laboratory. Of the 230 rockfish captured, about 95% survived the trawling process including fish as small as 14 mm (Fig. 2). An estimated eight or nine different species of rockfish were captured, although genetic analyses will confirm species identifications. The aquarium codend caught other live species as well, including juvenile and adult salmon (*Oncorhynchus* spp.), Pacific saury (*Cololabis saira*), larval rex (*Glyptocephalus zachirus*), Dover sole (*Microstomus pacificus*), and Pacific herring (*Clupea pallasii*). Many unidentified small squid were also captured live. The greatest biomass in the catch was attributed to jellyfish, primarily *Aequorea* sp.

Once the rockfish are acclimated to conditions in the behavior lab, they will be observed in four distinct habitat types (coral, sponge, cobble, and gravel) under both daytime and nighttime conditions and in the presence and absence of a predator. This study will build on previous work that focused on quillback rockfish (*S. maliger*), a demersal shelf rockfish. These assessments will be helpful in determining the relative productivity of various habitats and will aid in establishing priorities for their protection.

By Pat Malecha

SECM Pink Salmon Forecast on Target for 2007

Since 2004, ABL researchers have used information from the Southeast Alaska Coastal Monitoring (SECM) project to forecast adult pink salmon commercial harvest in Southeast Alaska. The SECM research, which focuses on juvenile salmon and their associated epipelagic species and oceanographic parameters, occurs from May to August as juvenile salmon migrate seaward to the Gulf of Alaska from southeastern Alaska. The parameters used in the forecast model are peak monthly average catch-per-haul of juvenile pink salmon and spring ocean temperatures. The SECM forecast for 2007 was 40.0 million pink salmon. The ADF&G preliminary harvest estimate for the 2007 season is 44.0 million pink salmon. An accurate forecast has major economic consequences to the industry because it enables processors and fisherman to devote the proper amount of resources to the anticipated harvest, which for pink salmon has an average exvessel value of about $20 million in the Southeast Alaska region.

In 2007, for the first time, ADF&G scientists used SECM juvenile pink salmon catch-per-haul data to improve their forecast, which previously relied exclusively on an exponential smoothing model of past harvest levels. By incorporating the SECM juvenile salmon index data into their model, ADF&G adjusted their original forecast for the 2007 harvest from 58.0 million to 47.0 million, much closer to the realized harvest of 44.0 million fish. The convergence of the two different forecast models towards similar predictions is indicative of the utility of the juvenile salmon index time series.

Catches of juvenile pink salmon during the 2007 SECM cruises were the lowest in the 11-year time series of the project, suggesting that pink salmon returns to Southeast Alaska in 2008 will be poor. The 2007 survey data are currently being finalized, and results and the 2008 SECM forecast will be presented at the Southeast Alaska Purse Seine Task Force meeting in Ketchikan, Alaska, on 28 November 2007. The task force meeting is an annual event sponsored by the ADF&G, the commercial purse seine fishing fleet, fishing industry processor representatives, and other resource stakeholders from Southeast Alaska communities.

By Alex Wertheimer, Joe Orsi, Molly Sturdevant, and Emily Fergusson

Surface Trawl Calibration Completed to Maintain SECM Data Time Series

From 1997 to present, the Southeast Alaska Coastal Monitoring project at ABL has used the NOAA ship *John N. Cobb* to accrue a time series of biophysical data in the Southeast Alaska region.

These data, which include surface trawl catches in the northern region of Southeast Alaska, are used to gain a better understanding of factors affecting year-class strength of salmonids and other fishes. Currently the data are being used to forecast pink salmon run strength to Southeast Alaska (see companion article above on forecasting). However, the *Cobb* is scheduled to be decommissioned after 2008, and there is no time line set for a replacement vessel. Because of this uncertainty, ABL contracted the ADF&G research vessel *Medeia* to develop intervessel calibration data for the Nordic 264 surface trawl used for the SECM fish collections in July 2007. The *Medeia* has previously been used by ABL to conduct research with the Nordic 264 surface trawl in the coastal waters of the Gulf of Alaska. (More information on that research effort is available on the North Pacific Anadromous Fish Commission website at http://www.npafc.org/new/publications/Documents/PDF%202006/956(USA).pdf).

Catch statistics were compared between the two vessels to determine if correction factors would have to be applied. A total of 28 trawl hauls were fished by each vessel alongside one another over a 6-day period in Icy and Chatham Straits from 26 to 31 July. Catches of juvenile salmon were significantly higher for the *Medeia*, averaging 1.7 times the catch of the *Cobb*. These higher catches were probably due to the faster towing speed of the *Medeia*, resulting in a significantly longer trawling distance by this vessel over the 20-minute haul durations. Although catch rates were higher for the *Medeia*, the species composition of the juvenile salmon catch did not differ significantly between the two vessels. Sizes of juvenile salmon captured also did not differ significantly between vessels.

The ratio of the catch of juvenile pink salmon between the two vessels (1.6 times higher by the *Medeia*) was similar to that of total juvenile salmon caught. However, the paired-differences for juvenile pink salmon were not statistically significant. The catches of juvenile pink salmon were the lowest ever recorded for July over the 11-year SECM time series, which resulted in lower statistical power. To increase statistical power and to develop a calibration factor applicable to higher catch-per-set observations, we plan to repeat the paired comparison in 2008, pending funding support from the Pacific Salmon Commission Northern Fund. The 2007 and 2008 data will enhance the feasibility of using the *Medeia* as a contractual option during the time period between *Cobb* decommissioning and replacement, and as a standard for future calibration of a *Cobb* replacement vessel or contracted trawler.

By Alex Wertheimer, Joe Orsi, Molly Sturdevant, and Emily Fergusson

Genetic Analysis Of Wild Coho Populations Before And After Local Coho Enhancement

The Marine Salmon Interactions Program staff have initiated a study on the effects of large-scale coho salmon enhancement on the population structure of nearby wild coho salmon populations. The field research will be based from ABL's Little Port Walter (LPW) research station, located on the southern tip of Baranof Island in Southeast Alaska. The project is supported with funding obtained from the Southeast Sustainable Salmon Fund.

Coho enhancement using Sashin Creek coho salmon as brood stock started at LPW in the early 1970s and ended in the late 1980s. Sashin Creek is the watershed draining into LPW. Subsequently, the Deer Lake coho enhancement project, located 9 miles north of LPW, and Port Armstrong hatchery, located 7 miles south of LPW, started culturing and releasing coho salmon and continue to release them to this day. Brood stock for both hatcheries originated from Sashin Creek and Deep Creek (located 15 miles north of Sashin Creek). Nakvassin Creek is located 5 miles north of LPW, midway between LPW and Deer Lake. Coho salmon from Nakvassin Creek have not been used as brood stock for any enhancement projects. The enhancement projects produce returns of adult coho salmon in the tens of thousands; Sashin Creek and Nakvassin Creek have wild adult escapements numbering in the hundreds.

This summer MSI staff collected samples from Port Armstrong hatchery, Sashin Creek, and Nakvassin Creek coho salmon for analysis with single nucleotide polymorphisms (SNPs) and microsatellite DNA assays to analyze the population structure. We will repeat the analysis on samples collected from the Deer Lake coho salmon enhancement project in the spring. The DNA results will be evaluated to determine the current degree of population differentiation among the enhanced and wild stocks. We will then extract DNA from archived Sashin Creek and Nakvassin Creek coho salmon scales collected by researchers at LPW in the 1960s, before any coho salmon enhancement was initiated

on Baranof Island. The results from the scale assays will be compared to the current population structure to evaluate whether the genetic structure of the wild populations has been affected by the local enhancement efforts.

The combined data will help assess the effect of enhancement practices (i.e., selection, drift, or stock transfers) on the genetic structure of hatchery populations and the degree of gene flow to nearby wild populations. This will help to determine whether current culture practices and the Alaska genetic policy are providing adequate protection for sustaining the genetic integrity of wild coho stocks.

By Andrew Gray and Alex Wertheimer

A North Pacific groundifsh observer waits for his ship to come in.

FISHERIES MONITORING & ANALYSIS (FMA) DIVISION

The Role of Observer Provider Companies in the North Pacific Groundfish Observer Program

Observer Provider companies provide critical operational support to the North Pacific Groundfish Observer Program (NPGOP). Provider companies recruit observers, provide all their logistical support during training and deployments in the field, and return them after deployment for final debriefing with staff from the Fisheries Monitoring and Analysis (FMA) Division. Observer Providers are responsible for salary, insurance, lodging, transportation, and per diem throughout the observer's employment. Most observers work for Observer Providers under short-term contracts which last up to 180 days. To ensure safety, Observer Providers are on call 24 hours a day to handle emergencies when their observers are in the field. They provide the National Marine Fisheries Service (NMFS) with logistical information on each observer deployment. Observer Providers ensure that observers attend appropriate NMFS training classes and travel throughout Alaska to meet industry needs for observer coverage. Additionally, Observer Providers arrange for observers to meet NMFS requirements for submitting data and data quality.

To recruit observers, Observer Providers advertise in a range of venues and then screen applicants to ensure that they meet qualifications established by NMFS, as well as any requirements the Observer Providers may have themselves. (Details of NMFS minimum qualifications are available on the AFSC website at: http://www.afsc.noaa.gov/FMA/qualifications.htm). Once hired, individuals are enrolled in NMFS-provided training courses. Successful completion of the training course leads to certification as a North Pacific Groundfish observer, qualified to observe on fishing vessels and at shore-side processing plants in Alaska.

Certified observers are deployed by their respective Observer Providers to ports throughout Alaska. Fishing in Alaska is a dynamic activity and the Observer Provider companies face many logistical challenges in meeting the observer coverage needs of the fishing industry. The busiest ports for observers and Observer Providers are Alaska's busiest fishing ports, Dutch Harbor and Kodiak. Observer Providers must ensure that their observers arrive to vessel or plant assignments on time and that they meet regulatory requirements designed to keep data quality high. Observer Providers must contend with unpredictable events such as weather delays or scramble to deploy an observer at the last minute due to a late request for coverage. Additionally, Observer Providers must be certain that they can provide an alternate observer in the event that illness or injury prevents the assigned observer from fulfilling his or her duties. Each Observer Provider works with industry members with whom they have contracted to provide observer services, and the industry pays for the costs of providing the observer.

Observer Providers ensure that deployed observers submit data to NMFS according to established timelines, often daily, and complete quality control data reviews in NPGOP field offices in Dutch Harbor or Kodiak. At the end of each observer's deployment, Observer Providers ensure that observers complete debriefing interviews and submit their data as part of the data quality control process, and return sampling and safety gear.

Five Observer Providers currently supply observers to NMFS: Alaskan Observers, Inc.; MRAG

Americas, Inc.; NWO, Inc.; Saltwater, Inc.; and TechSea International Inc. (Contact information is available on the AFSC website at: http://www.afsc.noaa.gov/FMA/observer_providers.htm.) Each company has extensive experience with observer programs in the North Pacific and elsewhere in the United States, and, for some, other regions of the world. These are competitive businesses, and this competition is important in keeping costs to the fishing industry for observer coverage relatively low. In 1991 ten companies were operating, while only three of the original companies operate as Providers in Alaska today.

Observer Program regulation and policy requirements are increasingly complex. To assist Observer Providers in understanding and meeting requirements, an FMA staff member serves as a liaison with the Provider companies. The liaison answers Provider's questions, listens to complaints and frustrations, and works to find effective solutions to problems. The liaison role has helped build a close relationship between NMFS and Observer Providers and is an integral and essential part of the successful operation of the Observer Program.

Persons or companies wishing to become Observer Providers in the NPGOP must obtain a permit from NMFS. Instructions for applying for a permit and the requirements and responsibilities of an Observer Provider are found in the Code of Federal Regulations at 50 CFR §679.50 Subpart E. Applications are evaluated by a NMFS review board appointed by the NMFS Alaska Regional Administrator. Once an application is approved and issued, it cannot be transferred and will not expire as long as the Observer Provider remains active in supplying observers in Alaska. Once issued a permit, the Observer Provider is authorized to provide observer services to the fishing industry, and the Observer Provider becomes accountable to NMFS via regulations.

North Pacific groundfish observers rest in the Dutch Harbor airport before their flight to the mainland.

FUTURE CHALLENGES

In 2008, new regulations implementing a change to the Bering Sea and Aleutian Islands Fishery Management Plan will increase demands on the workload of Observer Providers. This change, Amendment 80, allocates several groundfish species among trawl fishery sectors and facilitates the formation of harvesting cooperatives. Amendment 80 will require bottom trawl catcher-processors to carry two observers instead of one, increasing the number of observers deployed at any given time. The full impact of this change will only be understood as the year progresses. Due to the increased number of observer days at sea, the work of Observer Providers and FMA staff will increase. Our past cooperative efforts provide a solid basis for the Observer Providers and the FMA to work together to ensure the continued collection of high quality data for the management of the North Pacific groundfish fisheries.

By Allison Barns, Martin Loefflad, and Bob Maier

HABITAT & ECOLOGICAL PROCESSES RESEARCH (HEPR)

Bering Sea Integrated Ecosystem Research Program

The North Pacific Research Board (NPRB) decided the outcome of the Bering Sea Integrated Ecosystem Research Program (BSIERP) in July. NPRB awarded major support to a proposal written by university and federal scientists. The study focuses on understanding trophic interactions among: 1) colony-based foragers, 2) hot spot foragers, 3) pelagic forage species, and 4) pelagic predators. NPRB awarded support for several study components including oceanographic moorings, fish, whales, seabirds, trophic interactions and local and traditional knowledge. In addition, the National Science Foundation is funding complementary Bering Sea research through the Bering Ecosystem Study (BEST). The principal investigators from BSIERP and BEST will collaborate in this research; their first meeting occurred 17-19 September 2007 in Seattle. The BSIERP and BEST research programs will join several disciplines of marine science in an integrated study ranging from oceanography, fish, birds, and mammals to effects on human society. The integrated ecosystem research program will be immensely challenging both intellectually and organizationally. Program results will add understand-

ing of the Bering Sea and provide information that underpins an ecosystem approach to management.

By Mike Sigler

Habitat Data Workshop

Essential fish habitat research has been conducted since passage of the Sustainable Fisheries Act in 1996, but no formal effort has been made to inventory habitat data collected by the Alaska Fisheries Science Center. In 2005, the HEPR Team identified a habitat data inventory as high priority, and subsequently, funds were provided to support a workshop. Bob McConnaughey, John Olson, and Jon Heifetz organized a Habitat Data Workshop, which was held on 20 September 2007 in Seattle. Twenty-six people from the AFSC, NMFS Alaska Regional Office, North Pacific Fishery Management Council, Oceana, and the ADF&G participated. Twenty-two habitat data collections were inventoried with a standard format. The habitat data inventory will be published as an AFSC Processed Report. An additional workshop outcome is a georeferenced "Alaska Bathymetry/Seafloor Habitat and Biota" pilot database. The pilot database will be built from Alaska bathymetry developed by Steve Lewis (Alaska Regional Office) and small multibeam and submersible dive data sets from Jon Heifetz and Kalei Shotwell (Auke Bay Laboratories). The pilot database will follow the ShoreZone/Nearshore Fish Atlas approach.

By Mike Sigler

NATIONAL MARINE MAMMAL LABORATORY (NMML)

ALASKA ECOSYSTEMS PROGRAM

Bogoslof Island Northern Fur Seal Research

The population of northern fur seal (*Callorhinus ursinus*) pups on Bogoslof Island was estimated using shear-sampling, a mark-recapture method, in August 2007. A preliminary analysis indicates a continued increase in pup production on Bogoslof Island since the last estimate in 2005. Some of the increase in pup production may be a result of emigration of adults from rookeries on St. Paul and St. George Islands, where pup numbers have been declining. While on Bogoslof Island, staff of the Alaska Ecosystems Program instrumented 10 adult female northern fur seals with satellite tracking devices to continue investigations on summer foraging behavior and winter migration.

By Tonya Zeppelin

Steller Sea Lion Pup Survey

In June and July 2007, using the chartered research vessel *Norseman II* and the Alaska Maritime National Wildlife Refuge research vessel *Tiglax*, the Alaska Ecosystems Program conducted its annual cruise to survey Steller sea lion (*Eumetopias jubatus*) pups from the western Aleutian Islands through the central Gulf of Alaska. In order to assess pup condition and health status, morphometrics (weight, girth, length) and tissue samples (blood, tissue, fecal) were collected from 50 randomly selected pups at specific rookeries according to our biennial sampling schedule. Necropsies were conducted on freshly-dead pups at seven sites, and tissue samples of the dead pups were saved for histology, contaminants, and parasite studies. Additionally, we collected 59 scats from the eastern and central Gulf of Alaska regions and 121 scats from the central and western Aleutian Islands for dietary analysis.

By Tonya Zeppelin

Resight Surveys for Branded Steller Sea Lions

In order to estimate movement patterns, survival, and other vital rates of Steller sea lions, staff of the Alaska Ecosystems Program and the ADF&G have been marking pups with brands or flipper tags at rookeries in the eastern Aleutian Islands; the western, central, and eastern Gulf of Alaska; and in Southeast Alaska. Between July and August 2007, ship-based surveys were conducted on the chartered research vessels *Norseman* and *Norseman II* from the eastern Aleutians through Prince William Sound to resight branded and tagged Steller sea lions (Fig. 1).

Fifty-four sea lion haul-out and rookery sites were visited in the eastern and central Gulf of Alaska in June and July, and 90 branded sea lions were positively identified at 22 sites. Observed animals were born at four different western stock rookeries (Marmot, Sugarloaf, Wooded, Seal Rocks) and three eastern stock rookeries (Hazy, White Sisters, Forrester). In addition, 15 sea lions captured as juveniles by dive or land techniques were identified.

Thirty-seven sea lion haul-out and rookery sites were visited in the eastern Aleutian Islands in August, and 67 branded sea lions were positively

Figure 1. A branded Steller sea lion observed on a resight survey. Photo by Lowell Fritz.

identified at 10 sites. Most of the animals resighted in the eastern Aleutians were branded as pups on western stock rookeries. However, four of the sea lions were branded at eastern stock rookeries, and one was branded by Russian colleagues on Medney Island in 2006. Four sea lions captured as juveniles by dive or land techniques were also identified.

By Tonya Zeppelin

CETACEAN ASSESSMENT & ECOLOGY PROGRAM

Beluga Whales in Northern Cook Inlet, Alaska, August 2007

An aerial survey of the beluga population in Cook Inlet, Alaska, was conducted 1-2 August 2007. The 13.1-hour survey covered all coastal areas north of Moose Point and the Native village of Tyonek in the northern part of the inlet (Fig. 2). Consistent with NMFS surveys conducted since 1993, the August 2007 survey was flown in a high-wing, twin-engine aircraft (NOAA Twin Otter N56RF) at an altitude of 244 m (800 ft) and a speed of 185 km/hr (100 knots). The survey track paralleled the coast (1.4 km offshore) and crossed the inlet from just north of Moose Point to Tyonek on the first day and from Point Possession to the Beluga River on the second day. Two flights were flown each day to coincide with the morning high tide and the afternoon low tide. The intent of the survey was to obtain high-resolution video of each beluga group to determine age structure (white relative to gray individuals and dark gray calves) and an index of calf numbers.

Despite extensive surveys of the northern inlet, belugas were found only in the Susitna delta. During the morning high tide on 1 August, belugas were dispersed and swimming in random directions across the delta from the Ivan River to the eastern tributary of the Susitna River, precluding us from acquiring any useable video or counts. A smaller group in tight formation traveling upriver near the oxbow in the Little Susitna River was videotaped and counted (median count = 27 whales). By the afternoon low tide, whales were found in three compact groups traveling along the edge of the mudflats near the mouth of the Ivan River (median count = 53 whales), the eastern tributary of the Susitna River (median count = 96 whales), and the mouth of the Little Susitna River (median count = 32 whales) for a total median count of 181 whales. Similar results occurred on 2 August, with belugas found dispersed during the morning high tide across the Susitna delta and from the mouth to approximately 5 miles up the Little Susitna River. The afternoon low tide yielded two compact groups, one near the mouth of the Ivan River (median count = 88 whales) and the other near the Little Susitna River (median count = 53 whales), for a total median count of 141 whales. It was unusual that whales were not found in Chickaloon Bay or Knik Arm. The daily median estimates (a quick index of relative abundance not corrected for missed whales) were on par with August 2006 counts (126 belugas on 16 August, 143 on 17 August) but were below counts made in August 2005 (236 belugas on 11 August, 277 on 12 August).

By Kim Shelden, Kimberly Goetz, and Julie Mocklin

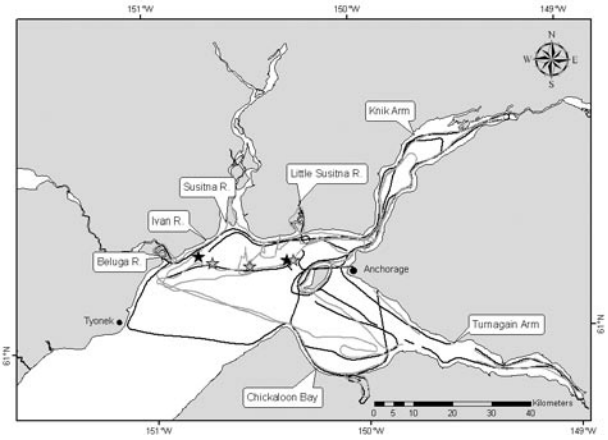

Figure 2. On-effort tracklines and beluga sightings (stars) in northern Cook Inlet, 1-2 August 2007: black = 1 August, gray = 2 August. Effort shown includes morning high-tide and afternoon low-tide surveys. Only the afternoon low-tide sightings used in the total median counts are shown.

POLAR ECOSYSTEMS PROGRAM

Harbor Seal Census in Southeast Alaska

NMML's Polar Ecosystems Program (PEP) is responsible for monitoring and estimating the abundance of harbor seals in Alaska. The PEP conducts aerial surveys of harbor seals every August during the seals' annual molt, when they spend much of their time out of the water while shedding and growing new hair. For logistical purposes, Alaska is divided into five regions and one region is surveyed each year. The five regions are the Gulf of Alaska, northern Southeast Alaska (surveyed this year), southern Southeast Alaska, the Aleutian Islands, and the north side of the Alaska Peninsula and Bristol Bay. The 2007 surveys were conducted 7-17 August 2007 using nine aircraft: three NOAA twin-engine planes (two AC-Shrikes and a DHC-Twin Otter) and six chartered single-engine floatplanes (Cessnas). Six planes and crew were based in Juneau, two in Sitka, and one in Yakutat. Each plane carried a single observer; eight observers were from NMML and one was from the National Park Service.

Starting in 2006, surveys were conducted under a new protocol designed to improve the spatial and temporal resolution of our surveys, data management, and workflow. The entire range of harbor seals in Alaska was divided into fixed areas (polygons) to better document seal counts and survey effort; each polygon covers several miles of coastline and can be surveyed in about 15 minutes, a period during which survey conditions (e.g., tide height, weather conditions) are relatively constant. In the past, seal haul outs and counts were associated with specific geographic coordinates. Such sites, however, were difficult to define as they were often scattered across many rocky islets or sand bars. This created problems in standardizing how different observers (using a portable GPS) were mapping site locations across years. Observers now only have to record a track of their day's flight and take photographs, ensuring that the area represented by each polygon is surveyed completely. The photographs are georeferenced, and the seals counted in them are assigned to the corresponding polygon instead of a specific site. This approach allows observers to focus on sighting seals and enhances continuity in the technique across years.

In contrast to last year, surveys in 2007 were flown with few weather delays or limitations. As usual, surveys were conducted daily within 2 hours of low tide. The first few survey days entailed reconnaissance flights to search for haul-out sites within all polygons along the entire coastline. Observers then targeted specific polygons where seals were observed, during reconnaissance flights or previous years' surveys, in order to get more replicate counts in polygons with seals. Flight tracks were automatically recorded on a portable GPS while observers kept track of when they were on effort (i.e., when searching wasn't hampered by visibility, turbulence, etc.). Photographs of seal haul outs were taken through side windows at elevations of 500-1,000 ft. Sites where seals were hauled out on ice were photographed using a down-looking camera linked to a GPS (see article below). At least four replicate surveys were conducted at most, if not all, of the larger seal haul outs. Larger haul outs (>20 seals) account for the vast majority of variability in counts across days. Image processing and counting will occur at NMML over the next several months.

By Dave Withrow, John Jansen, and Josh London

Tests of New Sampling Technique to Track Harbor Seal Populations in Alaska Fjords

Researchers from the Polar Ecosystems Program (PEP) are testing a new aerial survey technique for tracking populations of harbor seals that haul out in glacial fjords. Tidewater glacial fjords in Alaska attract the largest numbers of harbor seals in the state, if not the world, and because these seals (up to 5,500) are scattered across enormous fields of floating ice that shift with ocean and wind currents, they are particularly difficult to count. Traditional methods for estimating abundance by visual techniques or by taking oblique photographs have yielded highly variable counts or counts where the error was unknown. More recent techniques have used high-altitude (3,000-4,000 ft) photogrammetry of the entire seal haul out. However, these surveys require exceptional visibility and weather (not typical of survey areas), so this method has sometimes resulted in photographs of varying quality and less-than-certain seal identification. These surveys also require a considerable time investment in post-processing and analysis (e.g., digitizing negatives and distinguishing seals), which, when combined with the expense of outsourcing the photogrammetry, makes this method time-consuming and costly.

Thus, the PEP is testing a new aerial sampling method, which captures higher quality imagery of seals at lower altitudes (1,000 ft), along line tran-

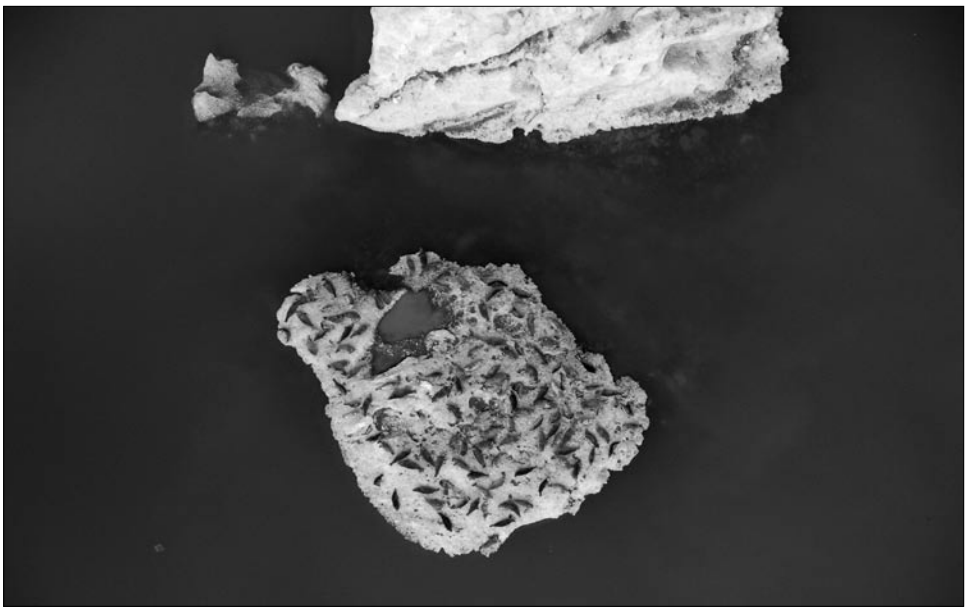

Figure 3. Unusually dense aggregation of harbor seals on grounded glacial ice in Bering Lake, southcentral Alaska. Photo by John Jansen.

sects, using a down-looking, high-resolution digital single-lens reflex (SLR) camera. The images are georeferenced and analyzed using conventional GIS software to map seal locations in non-overlapping images that represent about 40% of the ice field. This technique was developed to test hypotheses regarding seal disturbance in Disenchantment Bay, but it holds promise as a more timely and cost-effective method for estimating total abundance using spatial statistical models currently being developed. The high quality imagery also allows for detailed analyses of individual seals (e.g., discriminating mother-pup pairs and population structure) and ice characteristics.

As part of the PEP's annual harbor seal surveys, which rotate through five regions of the species' range in Alaska (see article above), biologists photo-sampled ice-hauling seals in five tidewater glacial fjords: Icy and Disenchantment Bays in the Gulf of Alaska, and Tracy Arm, Endicott Arm, and LeConte Bay in Southeast Alaska. The line transects were flown by NOAA Corp pilots Steve Kroening and Jason Seifert aboard the NOAA Marine and Aviation Operations' AC-500 Shrike (N47RF). A mounting platform constructed specifically for the surveys allowed the camera to be quickly installed and pointed vertically through the plane's belly port. Flights were timed daily to overlap with the peak abundance of seals, which radio-telemetry studies suggest occurs between 1300 and 1600 hours. Surveys were conducted from 5 to 21 August 2007 to coincide with the seals' annual molt. The single NMML observer was based first in Yakutat (for 10 days) and then in Juneau. Visibility was generally favorable in Yakutat and just manageable in Juneau, allowing the team to complete three replicate surveys of each glacial site. Surveys based in Yakutat included two unique sites (Malaspina and Bering Lakes) where seals haul out in fresh water at high densities on pieces of grounded (not tide or wind-forced) glacial ice (Fig. 3), a situation that doesn't present the same logistical problems as moving ice fields with scattered seals. This year, as in past surveys, tidewater glacial sites attracted several hundreds to thousands of seals, except for Endicott Arm, which averaged less than 10 seals. The unusually low number of seals in Endicott Arm was likely due to the relatively small amount of ice that had been calved from the glacier at the head of the arm.

By John Jansen and Luciana Santos

RESOURCE ASSESSMENT & CONSERVATION ENGINEERING (RACE) DIVISION

GROUNDFISH ASSESSMENT PROGRAM

Annual Eastern Bering Sea Bottom Trawl Survey: Groundfish

The twenty-sixth in the series of annual bottom trawl surveys of the eastern Bering Sea (EBS) continental shelf was completed on 2 August 2007

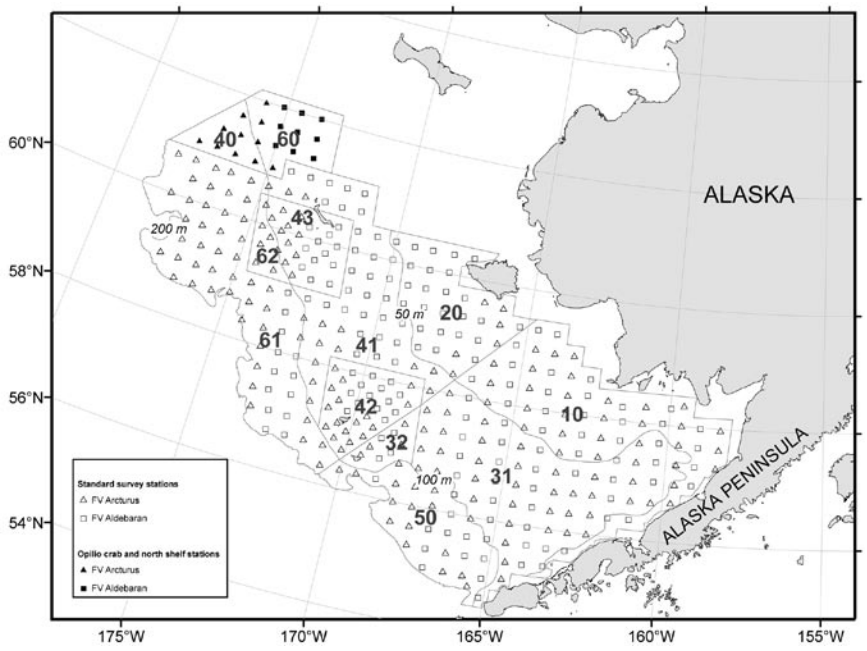

Figure 1. Standard and special study stations sampled during the 2007 eastern Bering Sea bottom trawl survey. Geographic regions shown indicate strata used for analysis of groundfish catch data.

aboard the AFSC chartered fishing vessels *Arcturus* and *Aldebaran*. Scientific staff from the AFSC, Alaska Department of Fish and Game, and the International Pacific Halibut Commission participated in the survey and completed standardized biological sampling of crab and groundfish resources at 376 stations (Fig. 1). Three-hundred fifty-six of these stations have been sampled annually since 1982, and the additional 20 stations in the northwest have been sampled every year since 1987 to investigate the northern distribution and abundance of opilio crabs and commercial fish species in response to the changing climate (Fig. 1).

Bottom temperatures on the EBS shelf were on average cooler in 2007 as compared to 2006, and the cold pool (≤2°C) extended farther south and east toward the Alaska Peninsula and into Bristol Bay (Fig. 2).

The largest catches of walleye pollock (Theragra chalcogramma) were concentrated along the northwest outer shelf and near the Pribiloff Islands where bottom temperatures were above 0°C (Fig. 3); large catches of walleye pollock were also observed north of the Alaska Peninsula near Unimak Island (Fig. 3).

Ninety-five percent of the trawl catches contained walleye pollock and the estimated total biomass increased to 4.16 million metric tons (t) in 2007 from 2.85 million t in 2006 (Fig. 4). Catches of walleye pollock from the inner and middle shelves were composed mainly of 1-year olds that ranged in size from 10 to 20 cm. Similar to walleye pollock, Pacific cod (*Gadus macrocephalus*) were broadly distributed across the EBS shelf and caught at nearly all stations. Total biomass declined for the second straight year (0.42 million t; Fig. 4); however, numbers of Pacific cod ranging in size from 10 to 20 cm were almost four times greater compared to 2006, which suggests there may be a large incoming year class. For all flatfishes except for yellowfin sole (*Limanda aspera*), the annual trend of total biomass declined from 2006 to 2007, but trends were less clear because of the variance associated with these estimates (Fig. 4).

In addition to abundance and biomass estimates, analyses of size and age composition will be completed for selected commercial groundfish species

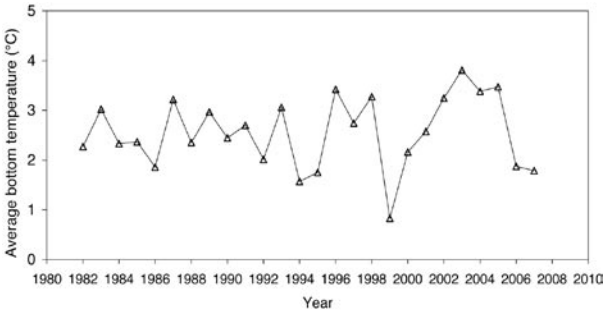

Figure 2. Average annual bottom temperatures recorded during the eastern Bering Sea groundfish bottom trawl surveys, 1981-2007.

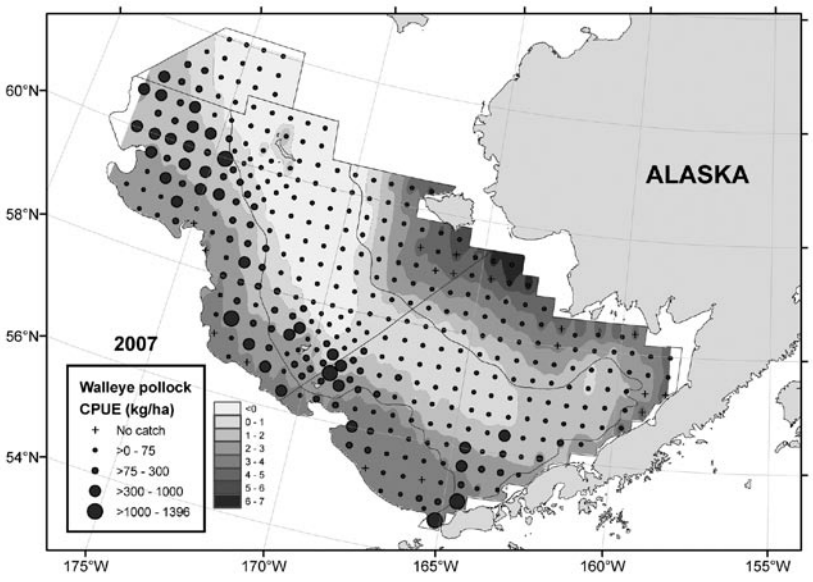

Figure 3. Map of the distribution of average bottom temperatures (°C) in relation to the abundance (kg/ha) of walleye pollock (*Theragra chalcogramma*) observed during the 2007 eastern Bering Sea groundfish bottom trawl survey.

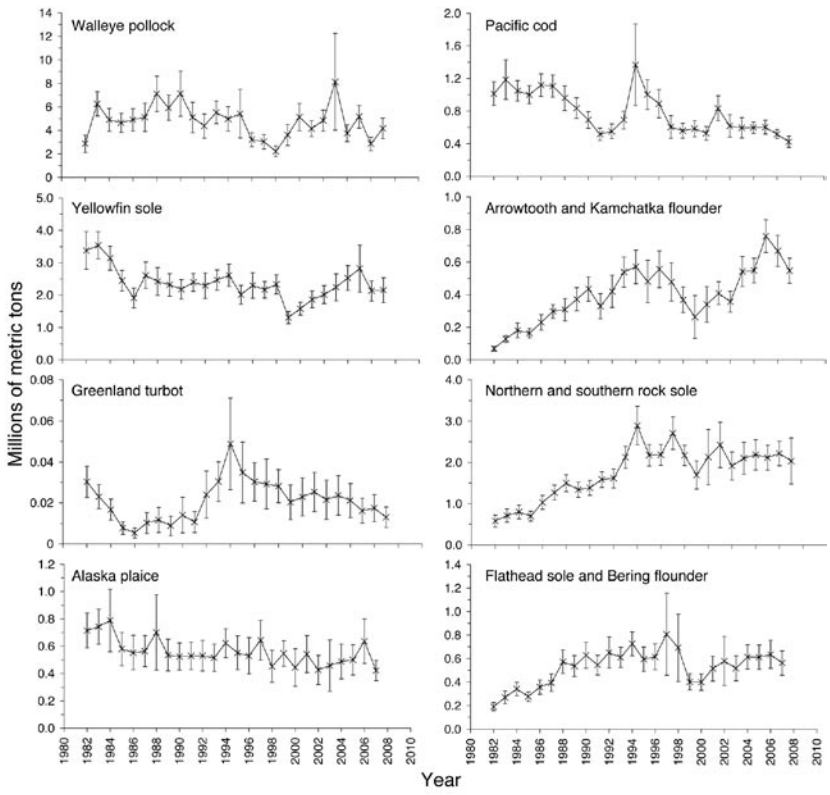

Figure 4. Plot of biomass (x10^6 t) for eight commercial fishes (or group of fishes) on the eastern Bering Sea shelf estimated from standardized trawl survey data collected by the AFSC from 1982 to 2007. Error bars are 95% confidence limits.

using collections of 64,903 length measurements and over 8,000 age structures. There were 22 special research projects conducted during the 2007 trawl survey (see April-May-June 2007 *Quarterly Report* for a list of the projects). For one of these projects, the *Arcturus* collected midwater acoustic data from transects across sampling grid cells where there were high densities of walleye pollock. The AFSC Midwater Assessment and Conservation Engineering (MACE) Program is evaluating the feasibility of using acoustic data from annual EBS trawl survey trawl charter vessels for estimating the midwater component of walleye pollock biomass during years without acoustic surveys. The Groundfish Assessment and Recruitment Processes Programs are also collaborating on the routine collection of bongo plankton samples from the EBS survey charter vessels. Plankton tows were conducted once daily from the *Arcturus* during the first and second legs. The goal is to expand coverage of plankton tows to include both vessels for the entire survey area.

By Robert Lauth

Gulf of Alaska Groundfish Trawl Assessment Survey Completed

The fifth in the series of biennial bottom trawl surveys of Gulf of Alaska (GOA) groundfish resources, which began 25 May, was completed on 7 August 2007, covering the continental shelf and slope between the Islands of the Four Mountains (170°W long.) and Dixon Entrance (U.S.-Canada border in Southeast Alaska) out to the 1,000-m depth contour. The survey was conducted aboard three chartered commercial trawlers, the FV *Gladiator*, the FV *Sea Storm,* and the FV *Vesteraalen*. A total of 820 tows were successfully completed, ranging in depth from 16 to 903 m (Fig. 5)

The primary focus of the biennial groundfish surveys is to build a standardized time series of data designed to assess, describe, and

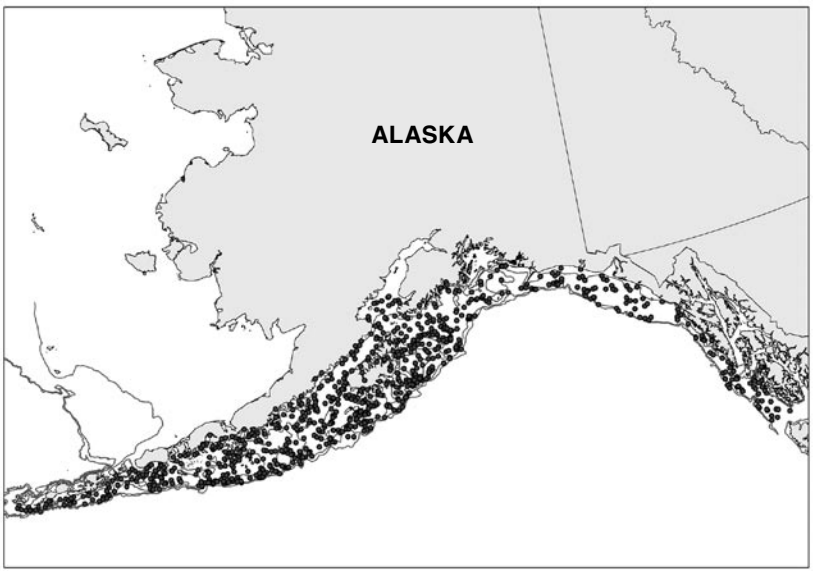

Figure 5. Map showing bottom trawl tows (filled circles) completed during the 2007 Gulf of Alaska groundfish survey.

monitor the distribution, abundance, and biological condition of various GOA groundfish stocks. Specific objectives of the 2007 survey, as in others preceding it, were to:

1. Define the distribution and relative abundance of the principal groundfish and invertebrate species inhabiting the continental shelf and slope of the GOA.
2. Collect data to define various biological characteristics of major groundfish species, such as age, sex, size, growth rates, length-weight relationships, and feeding habits.
3. Collect integrated fishing performance, net configuration, and position data for all trawl hauls with which to derive precise effort estimates.
4. Collect environmental data such as surface-to-bottom water column temperatures.
5. Collect biological specimens and data requested by scientists from the AFSC or other cooperating research groups.

Over the entire survey area, the most abundant species in 2007 were, in descending order, arrowtooth flounder, Pacific ocean perch (POP), giant grenadier, Pacific halibut, walleye pollock, flathead sole, Pacific cod, and northern rockfish. Abundance has apparently decreased for most of these species since 2005; declines ranged from 10% for POP to 17% for pollock, giant grenadier, and halibut; to 24% for cod; and 37% for northern rockfish. The arrowtooth flounder abundance held steady since 2005. Of these major species, only flathead sole exhibited an apparent increase in estimated abundance of 31%. Other notable changes were dramatic increases in the apparent abundance of Pacific hake (69%) and spiny dogfish (238%).

Arrowtooth flounder and POP were the two most abundant species in both the eastern and central Gulf of Alaska. While arrowtooth were also the most abundant species in the western GOA, POP fell to third most abundant species in that area, surpassed by giant grenadier. Estimates of abundance, distribution, and size composition from the survey results have been provided to stock assessment analysts for updates to the annual Stock Assessment and Fishery Evaluation (SAFE) Report of the North Pacific Fishery Management Council's (NPFMC) GOA Plan Team.

Water temperatures observed during the 2007 survey exhibited a much different pattern than previous GOA surveys, as cooler water infiltrated shallower depths, often with warmer water below. Water temperatures from GOA surveys, adjusted to remove the effect of date of collection through the use of a general linear model, are shown in Figure 6.

The very warm near-surface temperatures that were observed in 2003 and 2005 were largely absent in 2007. In all years prior to 2007, water temperatures at depths greater than 400 m have generally been cooler than 4°C. In 2007, water warmer than 4°C extended to almost 600 m most of the time. The pattern of water temperatures in 2007 more closely resembles the pattern in 1993 than any other year, although the intrusion of colder water into shallower depths is much more pronounced in 2007.

By Mark Wilkins and Michael Martin

MIDWATER ASSESSMENT & CONSERVATION ENGINEERING (MACE) PROGRAM

Summer 2007 Pollock Acoustic-Trawl Survey

Midwater Assessment and Conservation Engineering (MACE) Program scientists conducted an acoustic-trawl survey from 2 June to 30 July 2007 on the Bering Sea shelf between 161°W and 175°E aboard the NOAA ship *Oscar Dyson*. The principal objective of the survey was to collect echo integra-

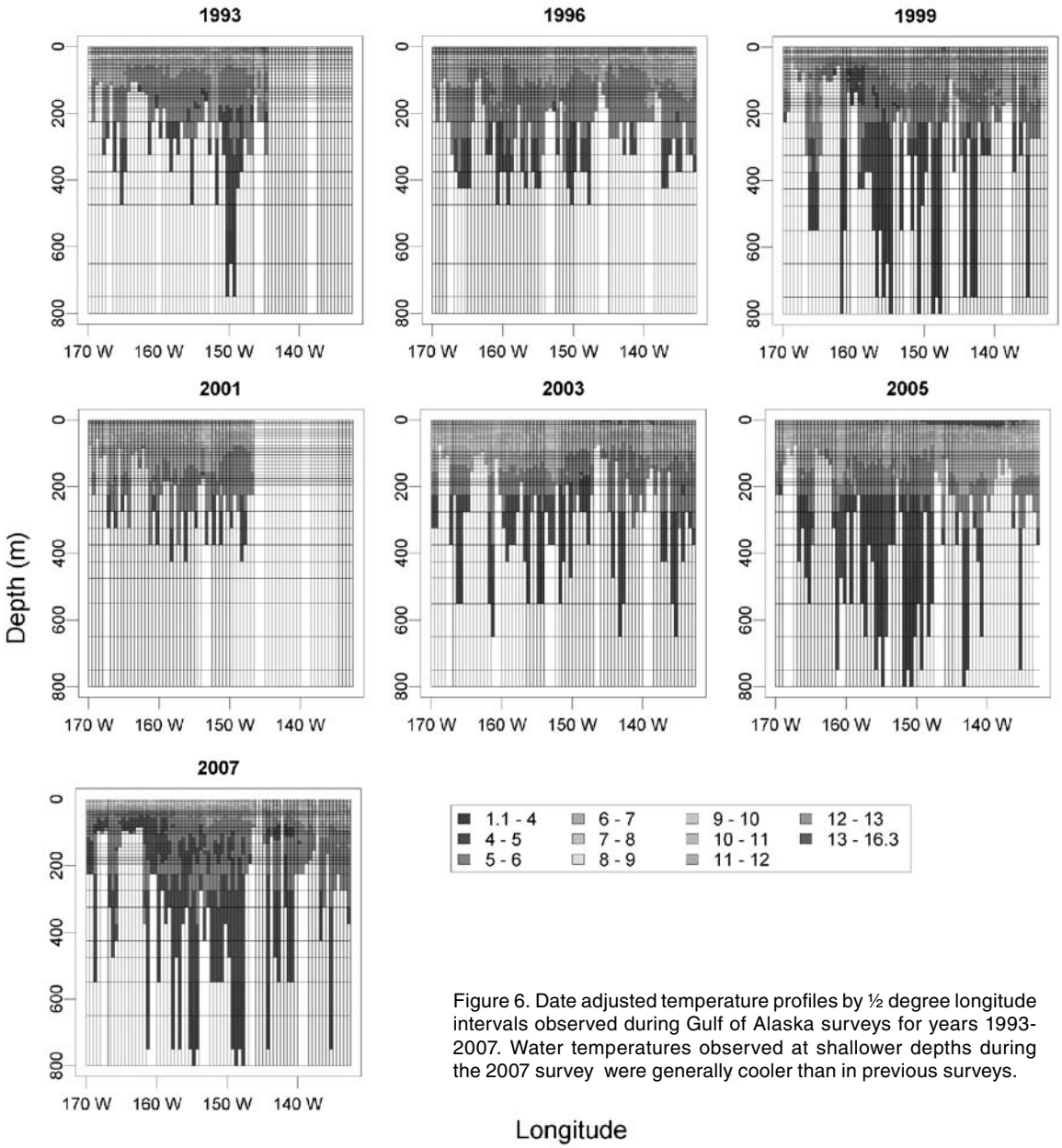

Figure 6. Date adjusted temperature profiles by ½ degree longitude intervals observed during Gulf of Alaska surveys for years 1993-2007. Water temperatures observed at shallower depths during the 2007 survey were generally cooler than in previous surveys.

tion and trawl data to estimate the abundance and distribution of walleye pollock. The survey design consisted of generally north-south oriented, parallel transects spaced 20 nautical miles (nmi) apart (Fig. 7). Acoustic and trawl data were collected during daylight hours. Nighttime operations included additional trawling, conductivity-temperature-depth-fluorometer (CTD) measurements and gear tests of a multiple opening/closing codend device for large trawls. Additional research projects included deployment of an underwater video recording system to examine trawl effects on the seafloor, trawl selectivity experiments, collection of acoustic-doppler-current-profiler (ADCP) data to investigate pollock movement, and measurement of underwater light level data to assess the effect of light intensity and light penetration on the distribution and behavior of walleye pollock. Seabird observers recorded underway line-transect data on seabird abundance throughout the cruise. Permission was received to survey Russian waters in the Cape Navarin region, and a guest Russian scientist from TINRO-Centre in Vladivostok participated aboard the *Oscar Dyson*.

Very few walleye pollock were observed on the eight easternmost transects between Bristol Bay and north of Unimak Island (Fig. 7). Walleye pollock numbers increased slightly north of Unimak Pass and along the 100-m isobath surrounding the Pribilof Islands.

West of the Pribilof Islands, pollock concentrations increased gradually towards the north and west. A large aggregation of age-1 juveniles was observed

along the southern section of transect 19. The highest concentrations of pollock were observed between 175° and 179°W. Adult walleye pollock (larger than 30-cm fork length (FL)) were most abundant offshore of the 100-m isobath along transects 24 and 25, and juveniles (smaller than 30-cm FL) were most numerous on transect 27. Walleye pollock size composition ranged from 10- to 74-cm FL across the shelf (Fig. 8). East of the Pribilof Islands (east of 170°W) the dominant length mode was 49-cm FL. West of 170°W the dominant length modes were 45-cm FL for adult walleye pollock and 14-cm for juveniles. In the Cape Navarin area of Russia, juveniles dominated the population numerically, with modes at 15 and 21 cm, followed by adults at 44 cm. Of the total estimated 2007 walleye pollock biomass in the Bering Sea, 13% was east of 170°W, 82% was west of 170°W in U.S. waters, and 5% was in Russian waters. More juvenile walleye pollock, especially age-1s, were observed in 2007 than in 2006.

In addition, several days were dedicated to trawl-oriented research projects. Trawl selectivity experiments were carried out to estimate pollock escapement from the Aleutian wing trawl (AWT), using 1-inch monofilament pocket nets attached to different parts of the trawl meshes, a DIDSON acoustic imaging device, and still stereo camera to observe fish size and position. Two trials were completed; one with eight and the second with six trawl hauls. The results of these trials will be used to estimate differential escapement of small pollock relative to that of large pollock. Additionally, field tests were conducted with a

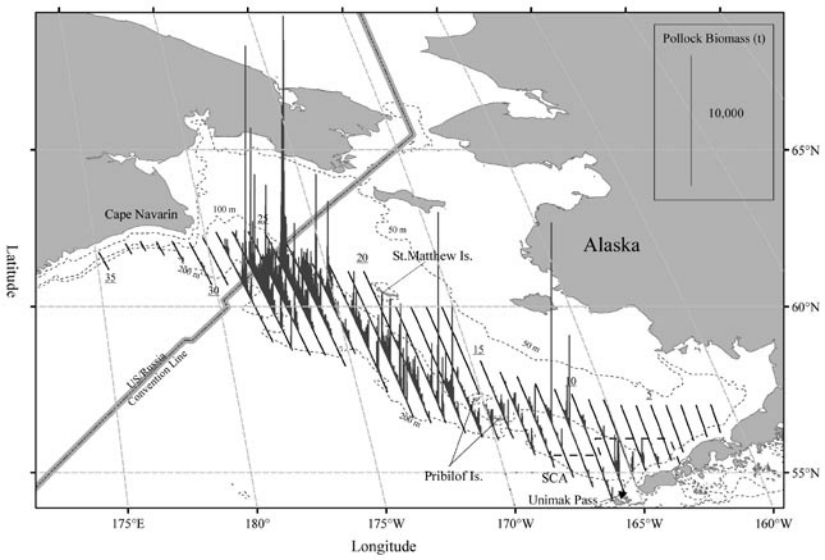

Figure 7. Estimated walleye pollock biomass between 14 m from the surface and 3 m off bottom along tracklines surveyed during the summer 2007 acoustic-trawl survey of the Bering Sea shelf. Transect numbers are underlined and the Steller sea lion conservation area (SCA) is outlined.

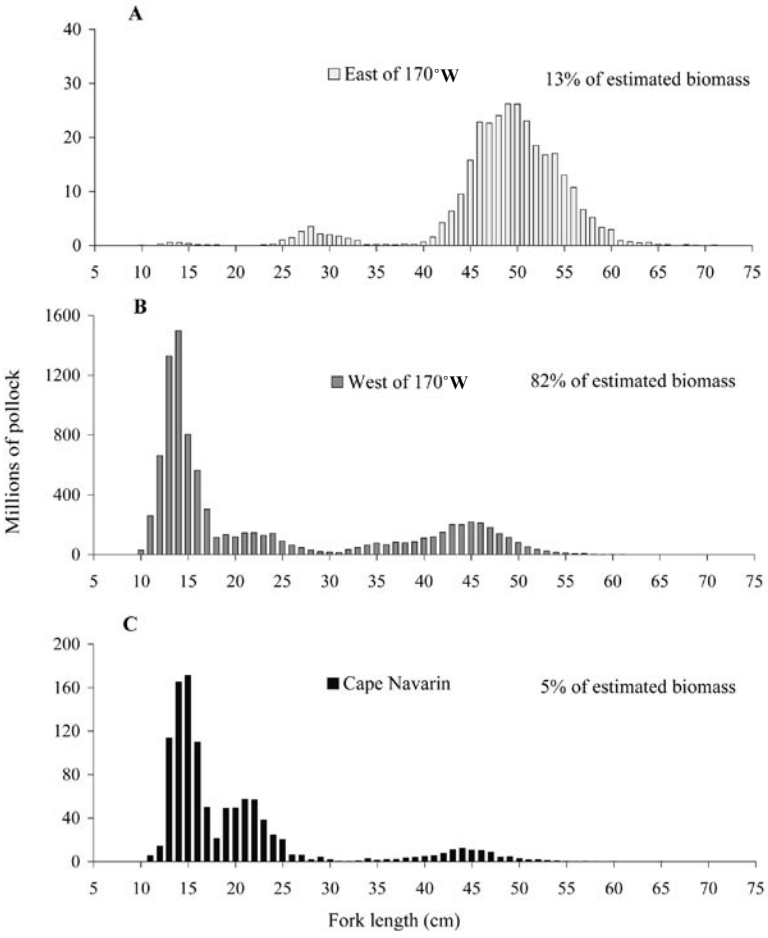

Figure 8. Population numbers at length estimated for walleye pollock from the summer Bering Sea shelf acoustic-trawl survey. Panel A shows walleye pollock east of 170°W, Panel B shows walleye pollock west of 170°W in U.S. waters, and Panel C shows walleye pollock in Russian waters near Cape Navarin. Note Y-axes differ.

multiple opening/closing codend device (MOCC) attached to the AWT. The MOCC is controlled by an acoustic link to the ship and contains three codends allowing up to three discrete samples to be collected during a single trawl haul. Four replicate trawl hauls of three codends each were made to estimate the transit time for fish to pass through the length of the AWT and into the MOCC in order to determine the appropriate time interval for tripping the MOCC codends. Initial results suggested that about 10 minutes were required for fish to transit the AWT.

By Taina Honkalehto

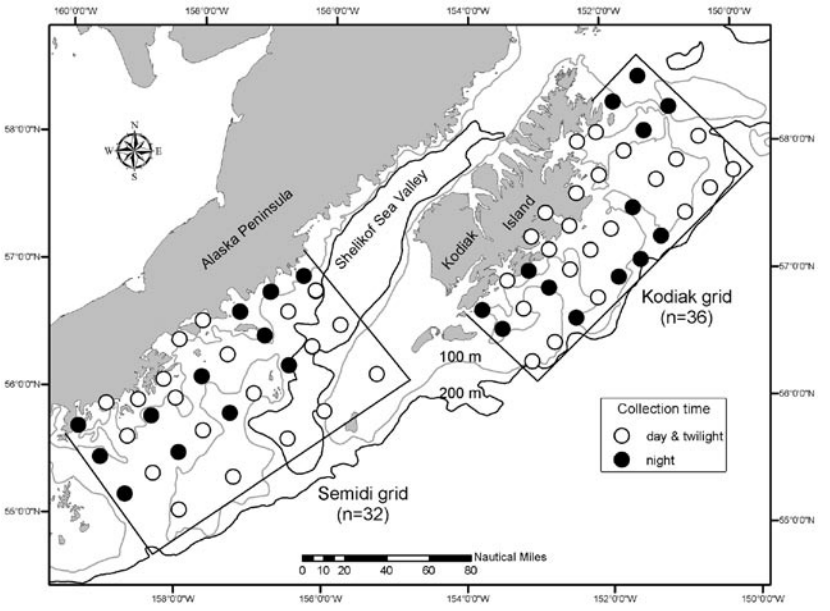

Figure 9. Location of stations occupied during the fall eco-FOCI cruise aboard the NOAA ship *Miller Freeman*, 4-16 September 2007.

RECRUITMENT PROCESSES PROGRAM- FISHERIES OCEANOGRAPHY COORDINATED INVESTIGATIONS (FOCI)

Summer Field Season

The Recruitment Processes Program had a busy summer field season. During 4-16 September, the program participated in NOAA's Ecosystems & Fishery Oceanography Coordinated Investigations program (Eco-FOCI) cruise in the Gulf of Alaska (GOA) aboard the NOAA ship *Miller Freeman*. The cruise was conducted to collect the necessary data to rigorously evaluate the relative quality of food available to juvenile walleye pollock in two important nursery areas (Fig. 9), and to begin to address the potential for prey switching by arrowtooth flounder that may act as a density-dependent community stabilizing mechanism, if it occurs. The data collected will also extend a time series established by the program that may be useful as a pollock recruitment predictor. Walleye pollock is a major component of the GOA groundfish fishery and marine ecosystem.

Data and samples were successfully collected at each of 68 predetermined survey grid locations. Environmental and zooplankton data were also collected at each station. The Stauffer (a.k.a., anchovy) net was used to collect small midwater fishes, which were sorted on deck (Fig. 10). A total of 2,600 walleye pollock were measured (Fig. 11), and many were preserved for subsequent determination of age and diet. The vast majority of the juvenile walleye pollock were collected from the Semidi grid, which indicates that it is a more heavily used nursery than is the area encompassed by the Kodiak grid. The number of juveniles collected was low relative to other years in the time series. Additional sampling at seven grid locations was conducted using a bottom trawl to collect arrowtooth flounder, which were dissected at sea to facilitate visual scan of stomach contents. Acoustic data were collected continuously at 18, 38, and 120 kHz using the Simrad ER60 (APC 10) echo sounder. Personnel in the AFSC Food Habits and MACE Programs provided gear and consultation necessary for the successful collection of the stomach scan and acoustic data.

The Recruitment Processes Program had several other cruises in the Bering and Chukchi Seas. Kevin Bailey, Morgan Busby, and Colleen Harpold joined our colleagues from Hokkaido University to sample the eastern Bering Sea shelf for zooplankton, ichthyoplankton, and juvenile fishes aboard the Japanese research vessel *Oshoro maru*. This is our tenth year of cooperation with Japanese scientists on this annual cruise. We also collected plankton samples aboard the F/V *Arcturus* in collaboration with the RACE Groundfish Assessment Program (GAP) during the sum-

Figure 10. Gary Cooper helps dump a catch of walleye pollock onto the sorting table. Photo by Ingrid Spies.

Figure 11. Ingrid Spies holds a juvenile walleye pollock while coworkers collect biological information. Photo by Ingrid Spies.

mer eastern Bering Sea bottom trawl survey. One sample was collected each day after the final trawl of the day. AFSC scientists Jay Clark collected samples during Leg 1 (June) and Elizabeth Logerwell collected samples during Leg 2 (July). Both worked along side GAP personnel to process trawl catches the majority of the time. Morgan Busby also participated in the Auke Bay Laboratories' Bering and Aleutian Island Salmon International Survey (BASIS) survey of the Chukchi Sea aboard the *Oscar Dyson* (August –September). This was a new opportunity for the Recruitment Processes Program to obtain and study larval fishes from areas much farther north than our usual collections areas.

Recruitment Processes, as part of the North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) project, a collaboration with NOAA's Pacific Marine Environmental Laboratory, staged an 18-day cruise aboard the University of Washington's research vessel *Thomas G. Thompson* to survey fall conditions in the eastern Bering Sea. Samples were taken on four cross shelf transects from the southeastern shelf to just south of St. Lawrence Island, and approximately 50 stations along the 70-m isobath were occupied and sampled from St. Lawrence Island south to mooring site M2. This is the third year that NOAA has sampled these stations in spring and late summer. We now have data from a warm year when sea ice coverage in spring was minimal (2005), a year of cool conditions and increasing ice (2006), and a cold year with moderate winter and spring ice coverage (2007). The data resulting from these cruises is being used to understand the role of sea ice in this ecosystem and to help predict how the eastern Bering Sea ecosystem may respond if the area experiences further warming and reductions in seasonal sea ice.

By Matthew Wilson

NEWPORT LABORATORY: FISHERIES BEHAVIORAL ECOLOGY PROGRAM

Reducing Elasmobranch Bycatch on Longline Gear: Laboratory and Field Studies With Rare-Earth Metal Deterrents

Unwanted bycatch of elasmobranchs is a worldwide problem in both commercial and recreational fisheries. Sharks, skates, and rays compete with target species for baits and can occupy a large proportion of hooks set on longlines, reducing capture efficiency and increasing costs of operation. Also, it is now recognized that declining populations of elasmobranchs might result in unintentional changes in ecosystem structure in both coastal and offshore waters. Thus, new methods are needed to reduce elasmobranch bycatch.

Spiny dogfish are found in temperate and subarctic shelf waters worldwide. This small shark (<120 cm) has some economic and cultural significance in certain areas, but its abundance, toxic spines, and low market value make it a frequent nuisance species in both recreational and commercial fishing in both the Atlantic and Pacific Oceans (Fig. 12). Spiny dogfish often occur in large schools and cause great damage to fishing gear. They can make up more than 90% of the catch in surveys for Pacific halibut conducted by the International Pacific Halibut

Commission (IPHC) at some locations off Alaska and British Columbia, where dogfish populations appear to be increasing. During 2006, spiny dogfish was the single most common species caught off British Columbia and the northwest United States, occupying 15% and 5% of the hooks fished in those areas, respectively. The area off Kodiak Island in Alaska also had high dogfish catch (16% of hooks), barely exceeding halibut catch. Over 20 years ago, the IPHC recognized the negative effects of dogfish on setline catchability of halibut, observing more than a four-fold effect on catchability ratios between areas with low and high dogfish abundances.

In 2006, the World Wildlife Fund grand prize for "Smart Gear" was awarded for the discovery that rare-earth magnets can be used to repulse certain sharks. It has long been known that elasmobranchs respond to magnetic and electrical fields using the ampullae of Lorenzini (special sensing organs), but this was the first fishing-related application aimed at reducing shark bycatch. We also know that nonmagnetic rare-earth alloys can produce a shark repulsing effect. For example, alloys in the lanthanoid series are electropositive, giving up electrons in seawater to the more electronegative skin of a shark. While the exact mechanisms of deterrence are not understood, the potential for reducing dogfish bycatch is promising. However, to date, there has been no peer-reviewed experimentation to assess the efficacy of rare-earth materials in deterring sharks.

During summer 2007, experiments were conducted at the AFSC's Newport Laboratory facility to test the hypothesis that rare-earth magnets and metals placed in close proximity to baits would reduce attacks on and consumption of baits by spiny dogfish. Trials were also conducted with Pacific halibut. Attacks on baits were tested in the presence of two different rare-earth materials (neodymium-iron-boride magnets and cerium mischmetal) both believed to affect the behavior of elasmobranchs. Pairwise tests of the rare-earth materials with inert metal decoys showed that dogfish detected both rare-earth materials, but magnets provided no protection for baits in feeding trials. However, baits tested with mischmetal were attacked and consumed at a lower frequency than mimic treatments (to 70% reduction), and times to attack baits were significantly higher, as were numbers of approaches before first attack. The time differential between mischmetal and mimic treatments and the number of baits consumed converged with increasing food deprivation (to 4 days), but differences were significant for all deprivation levels. Cerium mischmetal appeared to be irritating to dogfish and may disrupt their bait detection and orientation abilities. In contrast, Pacific halibut showed no reaction whatsoever to the rare-earth magnets or cerium mischmetal, and we concluded that the latter may be useful in reducing spiny dogfish bycatch in the halibut fishery.

Figure 12. Spiny dogfish snarled in a demersal longline. Adult dogfish may be up to 1.2 m long and weigh up to 10 pounds.

Following the encouraging results of laboratory trials, a fishing trial was conducted during September 2007, to test the efficacy of cerium mischmetal in deterring spiny dogfish in the field. The fishing trial was carried out off Homer, Alaska, in a joint effort between AFSC's Fishery Behavioral Ecology Program and the IPHC (Steve Kaimmer), with support from NOAA's Bycatch Reduction Program. Thirty-six longline sets were made in locations known for both the presence of halibut and abundant dogfish. Each set contained three skates of gear, one with standard hook gear, one with hooks protected with cerium mischmetal (Fig. 13), and one with inert metal mimics.

Preliminary results indicate modest reduction in dogfish catch on the mischmetal-protected hooks, only about 17%. Catch of longnose skates

Figure 13. Cerium mischmetal triangles are attached near the eye of circle hooks set for Pacific halibut.

was reduced 48%. Catch of legal-sized halibut was increased by 5%. While these differences are not large, it is clear that cerium mischmetal can affect catch rates of elasmobranchs. In our field trial, dogfish were caught on 35% of the hooks in short, 2-hour sets. Effectiveness in individual sets appears to be density-dependent, and we speculate that the deterrents will be more effective where dogfish are less abundant. Some other limitations may affect the use of cerium mischmetal in commercial operations. The material is relatively expensive, it has some hazardous properties (e.g., it is a flammable solid!), and hydrolyzes in seawater. While experiments are currently being conducted in Hawaii, New England, and Florida, our study represents the first rigorous experimentation with rare-earth materials in a fishery application.

By Allan Stoner

KODIAK LABORATORY: SHELLFISH ASSESSMENT PROGRAM

Eastern Bering Sea Annual Bottom Trawl Survey: Crab Resources

The 2007 eastern Bering Sea trawl survey took place from 4 June to 2 August conducted jointly by the Shellfish and Groundfish Assessment Programs aboard the chartered fishing vessels *Aldebaran* and *Arcturus*. Three hundred seventy-six standard stations were sampled from Bristol Bay to west of St. Matthew Island on the Bering Sea shelf (Fig. 14). In addition, four extra stations were sampled after encountering a Tanner crab (*Chionoecetes bairdi*) "hot spot", defined as 100 or more legal-sized males. When a hot spot is encountered, four additional tows are made 5 nmi miles in each direction (north, south, east, and west). Over 50,000 commercially important crab species including red king crab (*Paralithodes camtschaticus*), blue king crab (*P. platypus*), snow crab (*C. opilio*), Tanner crab, and hair crab (*Erimacrus isenbeckii*) were measured, and other biometric information, including shell and egg condition, weight, chela height and presence of parasitism were recorded.

Due to colder than normal bottom water temperatures at the beginning of the survey for the second year in a row, only 51% of the female red king crab caught in Bristol Bay had extruded new clutches of eggs. Spawning stock assessment models rely upon future recruitment and mating success so an accurate assessment of female reproductive condition is necessary. After most of the standard stations were completed at the end of July, the *Aldebaran* returned to Bristol Bay and resampled 32 stations (Fig. 14); over 98% of the females had completed the mating and molting cycle and extruded new clutches by this time.

Station locations and numbers of legal (i.e., 6.5-in width and greater) male red king crab, Tanner crab and snow crab caught per square nautical mile are shown in Figures 15, 16, and 17 respectively. Due to low stock abundance, the fishery for blue king crab in the Pribilof area has been closed since 1999 and in St. Matthew since 1998. The red king crab fishery in the Pribilofs has also remained closed due to blue king crab bycatch concerns. Historically there has been a fishery for hair crab, although there has not been one since 2000.

The following are the 2007 abundance estimates for the five species of crab with the percentage of change from 2006. These estimates are derived for the annual Report to Industry.

RED KING CRAB, BRISTOL BAY

Legal males: 13.3 million crabs; 6% increase.
Pre-recruits: 10.2 million crabs; 37% increase.
Large females: 35.4 million crabs; 19% increase.

Status: The abundance of legal males increased slightly in 2007. The 2007 index of pre-recruit males showed a notable increase, while that for small males decreased by 23%. The abundance of mature females increased relative to 2006, although that

for pre-recruit females declined by 72%. While the stock is not considered to be overfished, it remains well below the peak population levels of abundance of the 1970s.

RED KING CRAB, PRIBILOF DISTRICT

Legal males: 1.6 million crabs; 25% increase.
Pre-recruits: 0.2 million crabs; 8% decrease.
Large females: 1.7 million crabs; 85% increase.

Status: Crabs are highly concentrated, and indices of abundance of all categories are characterized by very poor precision. Male abundance estimates in this district are highly influenced by the results of a limited number of tows with positive crab catches. The overall male plus female population abundance in 2007 increased by 50%; total males increased by 28% and total females increased by 86%.

BLUE KING CRAB, PRIBILOF DISTRICT

Legal males: 0.1 million crabs; 46% increase.
Pre-recruits: 0.1 million crabs; 160% increase.
Large females: 0.2 million crabs; 49% decrease.

Status: The population is extremely low overall and trends in abundance are not easily detectable. Indices of male and female abundance are characterized by very poor precision. All male size categories increased in abundance relative to 2006, although the abundance in all female size categories declined. The overall male plus female population abundance in 2007 declined by 6%. Irrespective of the percent change in abundance relative to 2006, the 2007 assessment reveals indices among the lowest on record.

BLUE KING CRAB, NORTHERN DISTRICT (ST. MATTHEW)

Legal males: 1.4 million crabs; 1% decrease.
Pre-recruits: 2.3 million crabs; 212% increase.
Large females: 0.2 million crabs; 27% decrease

Status: Indices of abundance in this district are affected by the portion of the stock occupying inshore rocky untrawlable grounds. They are also characterized by low precision. The overall male plus female population abundance in 2007 increased by 113%. The 2007 assessment showed encouraging signs of a wider distribution of crabs around St. Matthew Island than encountered in recent past. Assessment of this stock is clouded by large uncertainty in estimated female abundance. The current assessment for small and pre-recruit males and small females are among the highest population estimates on record which may indicate future recruitment to the stock.

TANNER CRAB, EASTERN DISTRICT

Legal males: 12.1 million crabs; 17% decrease.
Pre-recruits: 92.5 million crabs; 26% increase.
Large females: 40.8 million crabs; 6% decrease.

Status: Since 2004, this stock demonstrated encouraging signs of recovery and increasing abundance in both 2005 and 2006. In 2007, with the exception of the pre-recruit male category, all sex-specific size categories decreased relative to 2006. The overall male plus female population abundance in 2007 decreased by 12%. The legal male abundance index is characterized by low precision, and legal-sized males continue to represent only a small portion of mature male stock abundance. The current estimates of small and pre-recruit male abundance are among the highest population estimates on record, which suggest future recruitment to the stock.

SNOW CRAB, ALL DISTRICTS COMBINED

Large males: 150.9 million crabs; 5% increase.
Pre-recruits: 344.3 million crabs; 19% increase.
Large females: 1244.4 million crabs; 19% increase.

Status: The abundance indices of all sex-specific size categories increased slightly in 2007 relative to 2006 with the exception of the small female category. The overall male plus female population abundance increased by 2%. The female reproductive stock is evidenced by high frequencies of old and very old shell crab which is of concern in terms of expected reproductive output. The mode of apparent male recruitment in 2006 was not replaced by new recruitment in 2007. With the exception of the pre-recruit and large male size categories which are average, the current assessment of small male abundance, and small and large female abundances are among the lowest estimates on record. There is apparent continued recruitment failure in the small male and female size categories; the recruitment trend since 1994 is dramatically low and future outlook for the stock is uncertain.

HAIR CRAB, ALL DISTRICTS COMBINED.

Legal males: 2.0 million crabs; 91% increase.
Total females: 1.3 million crabs; 65% decrease.

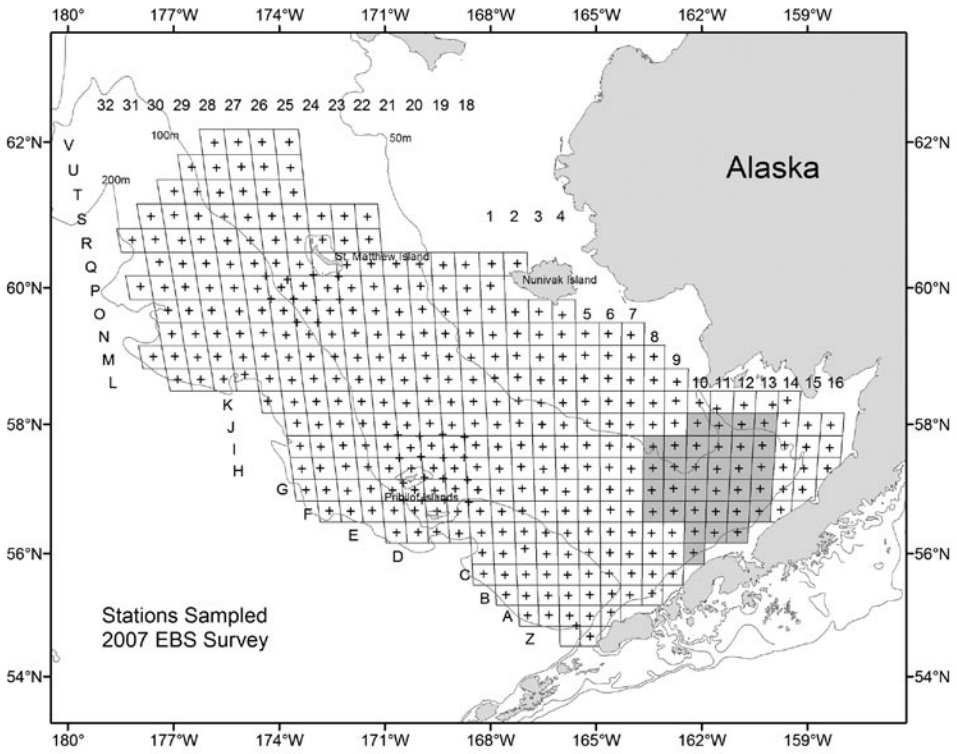

Figure 14. Stations sampled (+) by grid during the annual eastern Bering Sea bottom trawl survey during 2007. Shading in sampled areas indicates resampled stations.

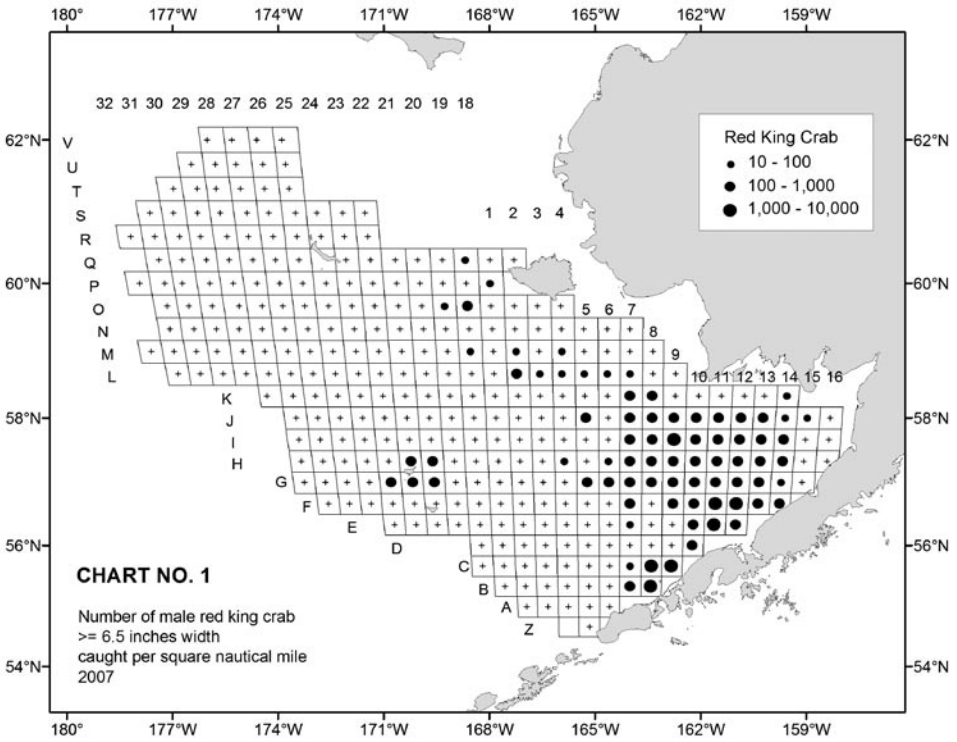

Figure 15. Catch rates by location of legal-sized male red king crab during the 2007 eastern Bering Sea bottom trawl survey.

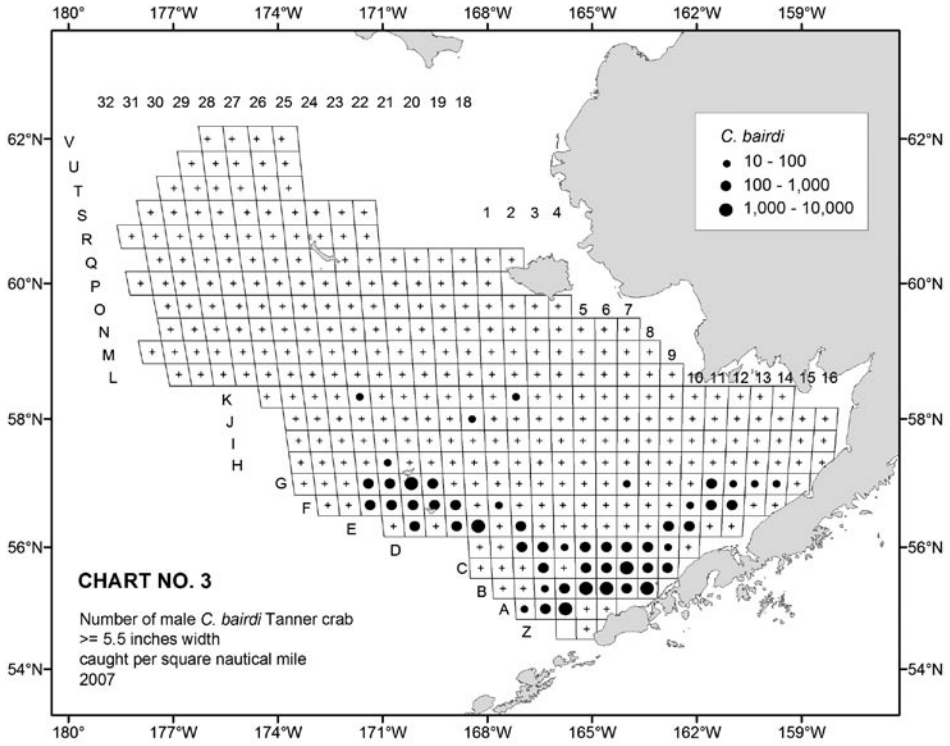

Figure 16. Catch rates by location of Tanner crab during the 2007 eastern Bering Sea bottom trawl survey.

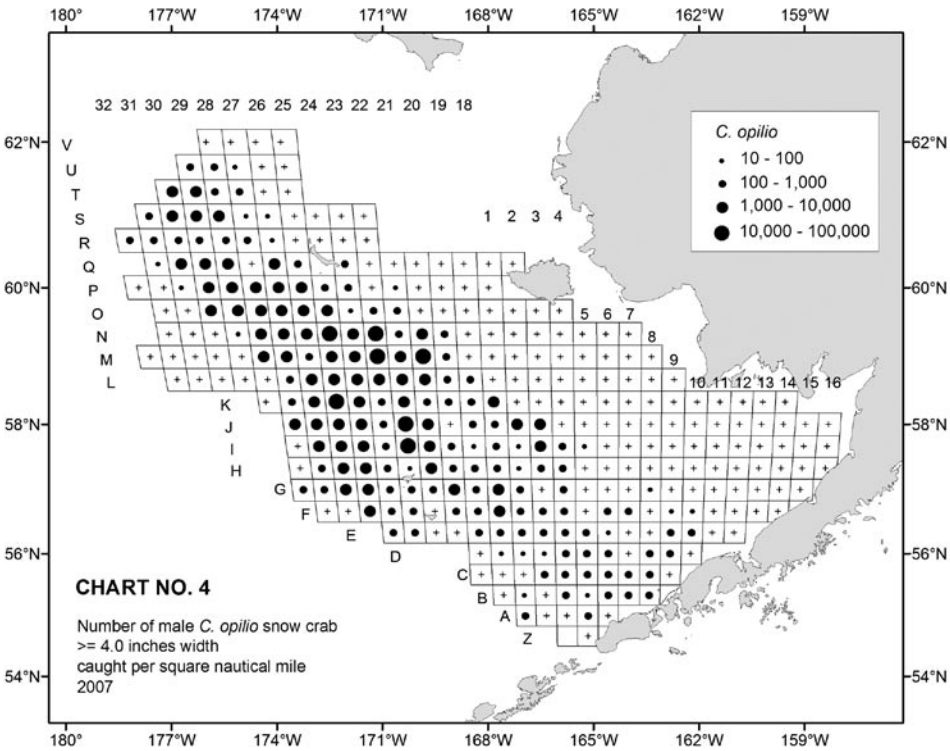

Figure 17. Catch rates by location of snow crab during the 2007 eastern Bering Sea bottom trawl survey.

Status: Since the early 1990s, this population has shown persistently declining trends in abundance. In 2007, the abundance indices of all male size categories increased relative to 2006, while female abundance declined substantially. Recruitment trends in this stock are unclear due to poor representation of small crabs in the survey and to the extremely poor precision of the abundance estimates. Current stock status is not well estimated.

Additional Research

Also, in 2007 the Bering Sea Fisheries Research Foundation (BSFRF), receiving funds from the fishing industry, NPRB, and NMFS, conducted a separate red king crab survey in Bristol Bay beginning in May. Comparative tows with the NMFS Bering Sea trawl survey vessels were carried out on 9 and 10 June. The BSFRF vessel, the F/V *American Eagle*, made 5-minute tows alongside the NMFS vessels, which made 19 standard 30-minute tows. Catch data from this effort is currently being analyzed.

By Jan Haaga, Lou Rugolo, and Claire Armistead

RESOURCE ECOLOGY & FISHERIES MANAGEMENT (REFM) DIVISION

RESOURCE ECOLOGY & ECOSYSTEM MODELING PROGRAM

Fish Stomach Collection and Lab Analysis

Laboratory analysis was performed on 786 groundfish stomachs from the eastern Bering Sea and on 185 groundfish stomachs from the Gulf of Alaska. During the eastern Bering Sea (EBS) trawl survey, 2,802 stomachs were collected, and 1,256 stomachs were analyzed at sea. A total of 3,416 stomachs were collected during the later legs of the Gulf of Alaska trawl survey, and 1,494 stomachs were analyzed at sea. Fisheries observers collected 809 stomach samples from the Bering Sea. A total of 2,773 records were added to the groundfish food habits database.

By Troy Buckley, Geoff Lang, and Mei-Sun Yang

Ecosystem Indicators Update

The Ecosystem Considerations report of the Stock Assessment and Fisheries Evaluation (SAFE) Report was presented at the North Pacific Fishery Management Council's September 2007 Plan Team meetings. Many of the physical environmental indices in the Ecosystem Considerations report were updated. For example, the Pacific Decadal Oscillation (PDO), the leading mode of North Pacific sea surface temperature (SST) variability, transitioned from moderately positive in early 2006 to moderately negative in summer/early fall 2006 and has slowly increased to weakly positive values during summer 2007. When the PDO is positive SST anomalies tend to be positive along the North American coast, extending to the southeastern Bering Sea. The Bering Sea experienced a relatively cold winter and spring in 2007. The presence of sea ice together with below normal ocean temperatures likely resulted in the first ice edge primary production bloom since 1999. Despite the presence of ice in the Bering Sea, there was a record low total area of sea ice in the Arctic in summer 2007. Unlike the northern Bering Sea and Arctic Ocean hot spots, the rate of warming in the southern Bering Sea is slowing down, suggesting a large natural variability component to recent extremes in addition to a background anthropogenic contribution toward warmer temperatures.

Some biological indices were also updated in this draft of the Ecosystem Considerations report. Demersal groundfish species in the Bering Sea-Aleutian Islands region (BSAI) and Gulf of Alaska (GOA), for example, had above-average recruitments from the mid- or late 1970s to the late 1980s, followed by below-average recruitments during most of the 1990s. There is an indication for above-average recruitment from 1994 to 2000 (with the exception of 1996). In the GOA, recruitment has been below average across stocks since 2001. Annual groundfish surplus production in the EBS and GOA decreased between 1978 and 2005. Declines in production may be a density-dependent response to observed increases in biomass and aging populations of groundfish. The eastern Bering Sea groundfish community appears to have fewer small individuals and more large individuals through time (Fig. 1a). The community size spectrum (CSS) slope became less negative and the CSS intercept decreased from 1982 to 1987, primarily due to significant changes in the slopes and intercepts of non-target fish over time (Figs. 1b and 2). This would imply that, overall (and particularly for nontarget fish), the groundfish community has fewer small individuals and more large individuals through time. Factors other than fish-

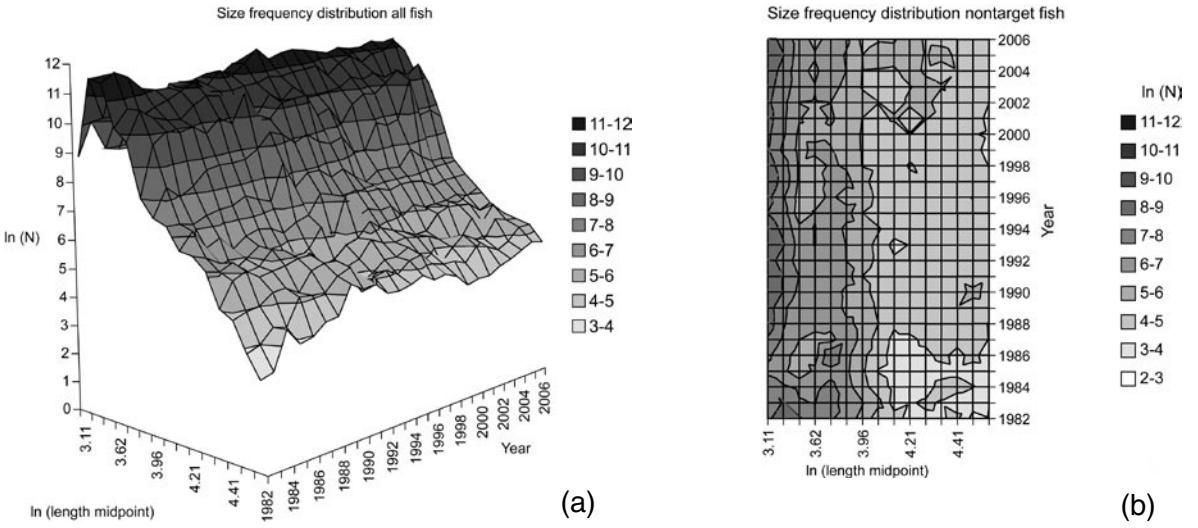

Figure 1. Eastern Bering Sea demersal fish (20-90 cm) community size spectrum (CSS), 1982-2006, for all fish in 3-D (a) and for nontarget fish only in 2-D (b).

ing, such as the regime shift in 1976/77, may have had an influence on the community size spectrum.

More updates will be provided in the final November 2007 report.

By Jennifer Boldt

Multispecies and Ecosystem Modeling

Dr. Sarah Gaichas of the Resource Ecology & Ecosystem Modeling (REEM) Program organized the "Ecosystem Modeling Applications in Fishery Management Symposium" at the American Fisheries Society (AFS) annual meeting in San Francisco, California, 2-6 September 2007. The

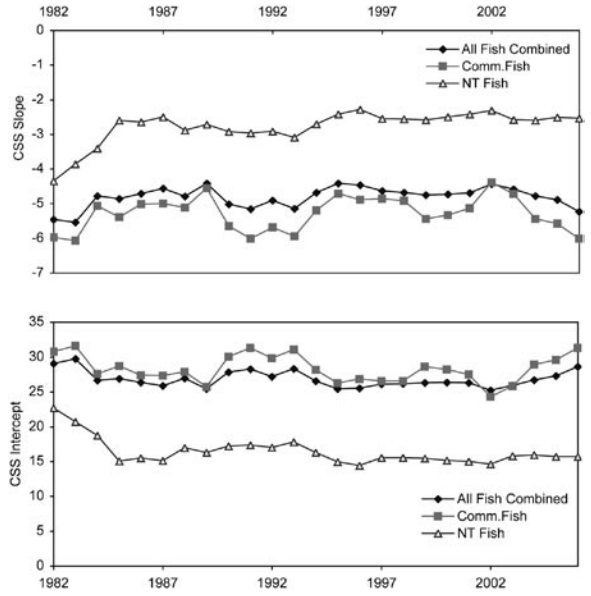

Figure 2. Eastern Bering Sea demersal fish (20-90 cm) community size spectrum (CSS), 1982-2006, changes in slope (a) and intercept (b) of the CSS, 1982 to 2006. NT= nontarget.

full-day symposium with poster session was co-organized with John Field (Southwest Fisheries Science Center), Jason Link (Northeast Fisheries Science Center (NEFSC)), Howard Townsend (NOAA Chesapeake Bay Program Office) and Megan Tyrell (NEFSC). AFSC participants included Dr. Grant Thompson who contributed a poster, Drs. Sarah Gaichas and Ivonne Ortiz who presented talks, and three University of Washington students, Jodie Little, Teresa A'Mar, and Doug Kinzey, who presented work done in collaboration with AFSC scientists.

The symposium was accepted and considered timely by AFS because the objectives of fishery management are extending beyond optimizing single species yields to consider the broader ecosystem effects of fishing. Ecosystem models can provide a structured framework for addressing uncertainty and unintended consequences in fisheries management decision-making. The objective of this symposium was to explore current and potential management applications of ecosystem modeling across marine, estuarine, and freshwater systems using a variety of modeling methods. The symposium was organized by practitioners for practitioners, with presentations including a broad range of work encompassing theoretical and technical modeling advances, as well as issue-oriented case studies, all within the context of real-world fishery management. It both showcased the current state-of-the-art in ecosystem modeling and facilitated the exchange of methods, ideas, and experience between participants working in diverse regions and ecosystems.

This symposium was intended to start an ongoing dialogue among scientists across disciplin-

ary boundaries to improve ecosystem modeling efforts for fisheries applications and was successful at gathering diverse presenters. Participants ranged from students to senior scientists working in both academic and agency environments. Marine ecosystems from Alaska and Hawaii through the Pacific Northwest, Gulf of Mexico, and New England were represented, in addition to the estuarine Chesapeake Bay, and a tidal marsh system in Louisiana. The symposium finished with an international fishery example from the Southern Ocean. The modeling applications presented encompassed single species models incorporating climate and predation effects, evolutionary models, individual based models, minimum realistic models of subsets of interacting species, spatially explicit models, and whole ecosystem food web models. These models were used in management applications including standard stock assessments, spatial allocation of quotas, optimal placement of marine protected areas, water and land use management, and full fishery management strategy evaluations for individual species and entire ecosystems. The poster session and talks were well attended for the duration of the symposium, and received many positive comments. For more information on the meeting, visit http://www.fisheries.org/sf/. Downloadable abstracts for all symposia can be found at http://www.fisheries.org/sf/images/documents/online_oral_abstracts.pdf.

By Sarah Gaichas

National Ecosystem Modeling Workshop (NEMoW)

REEM Program staff served on the steering committee and made presentations at the "National Ecosystem Modeling Workshop (NEMoW)" held by NMFS in Santa Cruz, California, 29-31 August 2007. NEMoW was held as a national workshop analogous to the national stock assessment workshops and national economists meetings for the purpose of exploring the establishment of ecosystem modeling (EM) standards of use and review for living marine resource management applications. In this context, EM includes a wide range of biophysical, multispecies and ecosystem modeling methods. There were 39 NMFS participants and 6 observers, including attendees from the AFSC's REEM and the Status of Stocks & Multispecies Assessment Programs. A report to be issued in the future will include recommendations stemming from the workshop. Given the expressed interest of our stakeholders relayed at the workshop, it was observed that EM efforts should continue or be expanded. A wide range of issues was identified as common and historically important. From these, workshop participants identified an extensive set of generic EM objectives and model classes that are widely applicable across NMFS. Addressing these objectives merit or in many cases require an EM approach. It was clear that these more holistic, broader EM issues will persist into the foreseeable future.

By Kerim Aydin

9th International Polychaete Conference

Mei-Sun Yang presented the results of a study of polychaete consumption by marine fishes in the Bering Sea and Gulf of Alaska at the *9th International Polychaete Conference* held in Portland, Maine, 12-17 August 2007. This study examined the percent in diet and geographic distribution of polychaetes (Fig. 3) consumed by marine fishes in the study region. The main fish predators of polychaetes included Alaska plaice (*Pleuronectes quadritubericulatus*), northern rock sole (*Lepidopsetta polyxystra*), yellowfin sole (*P. asper*), Dover sole (*Microstomus pacificus*), rex sole (*Errex zachirus*) and flathead sole (*Hippoglossoides elassodon*). Indices of polychaetes abundance (expressed as percentage of total stomach contents weight) by subregion were estimated to show the relative abundance of polychaetes consumed each year by groundfish in both the eastern Bering Sea (1981-2006) and Gulf of Alaska (1987-2006). Polychaetes abundance ranged from 71.11% of Alaska plaice stomach contents to 1% of flathead sole stomach contents in the eastern Bering Sea. In the Gulf of Alaska, polychaetes abundance ranged from 1% of flathead sole stomach contents to 56.91% of rex sole stomach contents. Estimates of the total amount of polychaetes consumed by the groundfish population during each summer feeding season of each year ranged from 93,111 metric tons (t) in 1999 to 27,705 t in 1990 for the Gulf of Alaska. In the eastern Bering Sea, the estimate ranged from 2,632,022 t in 1994 to 914,382 t in 1985.

By Mei-Sun Yang, Geoff Lang, Angie Greig, and Kerim Aydin

Seabird Interactions: Research Summary

The REEM Program participated in the ongoing development of the National Bycatch Report by providing information on fisheries, fishery monitoring, and related seabird bycatch for the Alaska groundfish fisheries. Staff also coordinated with the Washington Sea Grant Program (WSGP) as they

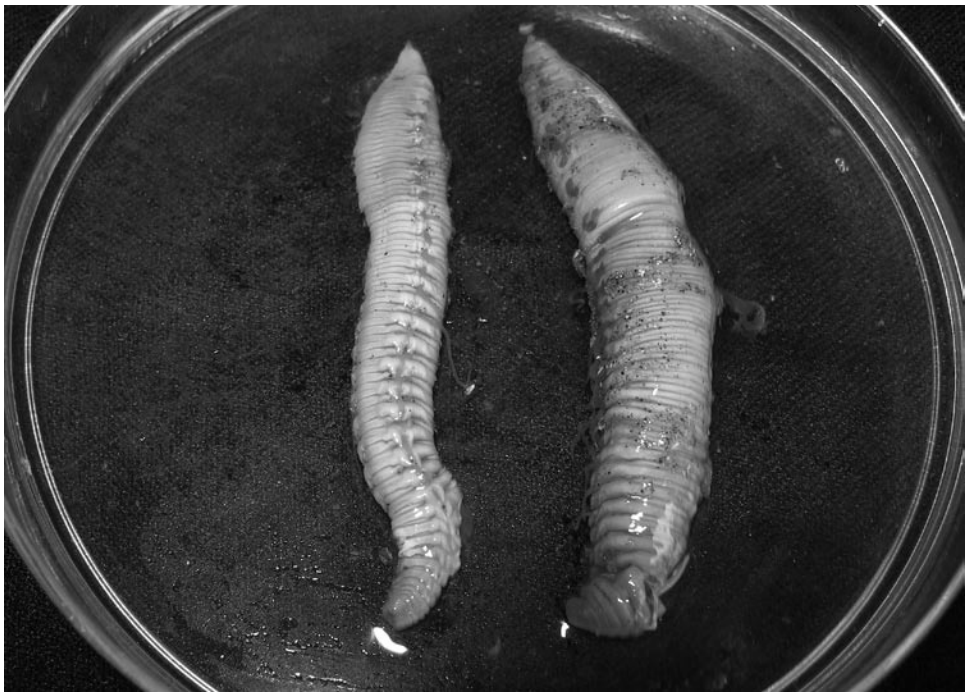

Figure 3. Polychaetes (Family Scalibregmidae) extracted from a southern rock sole stomach.

completed their study to characterize the aspects of the Alaskan groundfish trawl fleet that affect seabird interactions, including an effort assessment of trawl warp and third wires. That component was done under contract to the AFSC, and fulfills a requirement under the Short-tailed Albatross Biological Opinion. The WSGP will be publishing their report. Staff also participated in a review of the U.S. Fish and Wildlife Service (USFWS) draft Conservation Action Plan for Black-footed and Laysan Albatrosses. The report should help guide research and management efforts related to the conservation of seabirds for many years.

We previously reported that Dr. Ann Edwards, National Research Council postdoctoral fellow at the AFSC, had successfully initiated a pilot program with the USFWS to collect feather samples during albatross colony counts on Midway Island (AFSC 2007 January-March *Quarterly Report*). Results from the analyses of stable isotope values in feathers from Laysan albatrosses nesting on Midway Island in 2007 confirm that the delta-15N values of birds sampled on the colony differ, on average, from values of birds salvaged from longline fisheries off Alaska and Hawaiian waters. This paves the way for interpreting whether a fisheries-derived diet is correlated with reproductive success in Laysan albatrosses.

By Shannon Fitzgerald

ECONOMICS & SOCIAL SCIENCES RESEARCH PROGRAM

Steller Sea Lion Economic Survey Data Collection Completed

Little is known about the public's preferences for providing additional protection to the threatened and endangered stocks of Steller sea lions. These preferences are primarily the result of the non-consumptive value people attribute to such protection, which can take the form of active use values (such as the benefits of viewing Steller sea lions in the wild) or non-use values (such as the value associated with protecting Steller sea lions for future generations or the personal satisfaction of knowing they will continue to exist in the future). Since these types of values are not observed in markets, non-market valuation approaches must be used.

To understand these public preferences Dr. Dan Lew (Economics & Social Sciences Research (ESSR) Program), working with David Layton (University of Washington), and Stratus Consulting, has developed and implemented a non-market valuation survey that collects the information necessary to estimate the public's preferences and values for providing additional protection to Steller sea lions. In the survey, information about preferences for protecting Steller sea lions are primarily obtained through a series of stated preference choice experiment (SPCE) questions. This type of question is commonly used

in marketing and transportation research, health economics, and environmental economics to understand economic preferences and values. In this application, each SPCE question presents the respondent with a choice between maintaining the current set of protection actions and two options that involve doing more and spending more to protect Steller sea lions. Each option is described in terms of the expected population sizes and Endangered Species Act statuses for each stock in 60 years and the potential cost on the respondent's household each year. In this way, the SPCE questions are intended to emulate a market decision. Furthermore, different versions of the survey present different combinations of expected results and costs. This is necessary to ensure there is sufficient variation in the data for the econometric models to estimate the effect on choice behavior of the individual attributes describing each option (i.e., expected population sizes and statuses).

Following clearance under the Paperwork Reduction Act, the final survey implementation was begun in January and concluded in August. The mail survey was initially sent to a stratified random sample of 5,000 U.S. residents—800 Alaska residents and 4,200 other U.S. residents. A modified Dillman mail-telephone protocol was followed that involved multiple follow-up contacts (i.e., multiple mailings and telephone contacts). The implementation achieved response rates, excluding undeliverables, of 70% for Alaska residents and 60% for other U.S. residents, which are extremely good response rates for stated preference mail-based surveys. At present, the survey data are being summarized and the analysis of the SPCE question responses has begun.

By Dan Lew

A Quantitative Model for Ranking and Selecting Communities Most Involved in Commercial Fisheries

In an article for *NAPA Bulletin* (an applied anthropology journal), Drs. Jennifer Sepez and Ron Felthoven of the ESSR Program, along with colleague Dr. Karma Norman of the Northwest Fisheries Science Center, propose a quantitative model for ranking commercial fisheries involvement by communities. The model was developed for the purpose of evaluating the level of participation of communities involved in North Pacific and West Coast fisheries, using multiple indicators including vessel ownership, landings, and permit holdings.

Analysis of recent fishing community profiling projects from other locations in the United States shows there have been four basic approaches to selecting a manageable number of communities for analysis, including focusing only on major ports, aggregating communities by region, selecting representative examples, and focusing only on the top of a ranked list. Falling within the ranked list approach, the proposed model uses data envelopment analysis (DEA) as a nonparametric, multidimensional modeling method appropriate for evaluating and ranking fishing communities based on an array of quantitative indicators of fisheries involvement.

The results of applying this model to communities involved in West Coast and North Pacific fisheries are summarized in the article. Nineteen indicators of fisheries dependence and 92 indicators of fisheries engagement were modeled, yielding ranked lists of 1,564 and 1,760 U.S. communities, respectively. Communities assigned the highest possible score in one or more of the ranked lists by the data envelopment analysis (DEA) model for commercial fisheries dependence or engagement are listed in Table 1.

The strengths and weaknesses of the DEA modeling approach are discussed in the article, along with an evaluation of those situations in which it would be most beneficial to apply, and those in which it would not be appropriate. DEA modeling is not a substitute for ethnographic analysis of communities based on field work, but it does present an enticing way to consider which communities might be selected for fieldwork or profiling or as "fishing communities." Comparison of the DEA method's top-ranked communities in Alaska to those selected by an indicators-based, threshold-trigger model for Alaska showed 71% overlap of selected communities, indicating a reasonable level of robustness of the rankings. The threshold-trigger model communities in Alaska were profiled in NOAA Technical Memorandum NMFS-AFSC-160 as described in the AFSC *Quarterly Report* for Jan-Feb-Mar 2006 (see http://www.afsc.noaa.gov/Quarterly/jfm2006/divrptsREFM7.htm). Profiles of the DEA model communities for Washington, Oregon, and California and other states, described in the AFSC *Quarterly Report* for Apr-May-Jun 2006 (see http://www.afsc.noaa.gov/Quarterly/amj2006/divrptsREFM3.htm), will soon be released as NOAA Technical Memorandum NMFS-NWFSC-84. Drafts of these profiles are available at http://www.

Table 1. Top ranked fishing communities involved in North Pacific and/or West Coast fisheries based on multiple quantitative indicators.

Alaska	Washington	Oregon	California	Other States
Akutan, Anchorage, Chignik, Cordova, Dillingham, Dutch Harbor, Egegik, Elfin Cove, Excursion Inlet, Halibut Cove, Homer, Kasilof, King Cove, King Salmon, Kipnuk, Kodiak, Naknek, Pelican, Petersburg, Point Baker, Sand Point, Sitka, Togiak, Unalaska	Anacortes, Bellingham, Blaine, Cathlamet, Olympia, Seattle, Tokeland, Westport	Astoria, Bandon, Garibaldi, Hammond, Harbor, Newport, Port Orford, Roseburg	Bodega Bay, Crescent City, Fields Landing, Fort Bragg, Moss Landing, San Diego, San Pedro, Santa Barbara, Tarzana, Terminal Island	Seaford, VA

nwfsc.noaa.gov/research/divisions/sd/community-profiles/index.cfm.

By Jennifer Sepez

Anthropology and Fisheries Management

Fisheries management in the United States has seen a growing contribution from the field of anthropology. Understanding the cultures and communities of those involved in fisheries is an important aspect of ecosystem-based management and contributes to the successful and productive management of marine ecosystems. Cultural and environmental anthropologists in many locations around the United States, including Alaska, are studying the people who fish, the things they know about fish, the ways they fish, and the communities that fishing sustains.

Recognizing that the field of fisheries anthropology is growing, Dr. Palma Ingles of the NOAA Fisheries Southeast Regional Office and Dr. Jennifer Sepez of the AFSC compiled and edited a volume of the peer-reviewed anthropology journal *NAPA Bulletin* to showcase research and methods employed by anthropologists studying U.S. fisheries. NAPA is the National Association for the Practice of Anthropology, a section of the American Anthropological Association, and the bulletin is published by the University of California Press. Contributors include NOAA Fisheries anthropologists, representatives of state fisheries agencies, academics, and contract researchers.

By Jennifer Sepez

Developing an Alaska Fishery CGE Model

Fixed-price models such as input-output (IO) and social accounting matrix (SAM) models are often used for analysis of fisheries. However, these models have several important limitations. In these models, prices are assumed to be fixed, and no substitution is allowed between factors in production or commodities in consumption. As a result, in cases where the fixed-price assumption may not be realistic, these models tend to overestimate impacts. Computable general equilibrium (CGE) models overcome these limitations. In CGE models, prices are allowed to vary, triggering substitution effects in production and consumption. The CGE model therefore enables analysts to easily examine the economic welfare implications of a policy change. Furthermore, the CGE approach is generally more appropriate than other regional economic models for analyzing the impacts of a change in productive capacity of resource-based industries.

This project, for the first time in analysis of Alaska fisheries, will build a multi-sector CGE model of the Alaska fishery. The investigators will use IMPLAN and other available data. Once developed, the CGE model will be used to estimate the distribution and magnitude of economic impacts associated with harvesting, processing, and support activities related to Alaska fisheries. As of now, the fishery-related data needed to develop the CGE model have been compiled. The remaining steps include 1) developing a social accounting matrix (SAM) with the fisheries-related data, 2) obtaining or estimating key parameters and coefficients for CGE modeling, and 3) developing the fishery CGE.

By Chang Seung

Common Property, Information, Cooperation: Commercial Fishing in the Bering Sea

Substantial theoretical and experimental literature has focused on the conditions under which cooperative behavior among actors providing public goods or extracting common-property natural

resources is likely to occur. The literature identifies the importance of coercion, small groups of actors, or the existence of social norms as being conducive to cooperation. We are investigating a natural experiment in which information on extractive activities with respect to a common property resource is relayed to all players. These players operate under an overall harvest total allowable catch (TAC), and consequently, one player's actions can have a deleterious effect on all players. The case we investigate is incidental catch (termed bycatch) of halibut by the Alaskan flatfish fishery, where participants voluntarily report bycatch information to an agent who then distributes data to the fleet. Consequently, fishermen know the extent to which other fishermen are avoiding bycatch, and are thereby able to observe efforts by other fishermen to avoid bycatch and to extend the fishing season for marketable fish species. Using a mixed logit model of spatial fishing behavior our results show that cooperative behavior is prevalent early in the season, but significant heterogeneity with respect to bycatch avoidance arises as bycatch TACs tighten.

By Alan Haynie

Examining Dynamic Impacts of Alaska Fisheries within Time Series Modeling Framework

Professor Sung Ahn (Washington State University) and Dr. Chang Seung (ESSR Program) are developing a vector autoregressive (VAR) time-series model to measure the time and magnitudes of the economic impacts of industries including seafood industry for Alaska. To validate the model, they have conducted out-of-sample forecasts for each of 17 aggregated industries. They have also developed procedures to generate impulse response functions (IRF) which measure the dynamic, temporal impacts of each industry. The models employ various assumptions about the lag structure, and include exogenous variables such as landings by species. Because the Alaskan economy is dependent on the rest of the United States (RUS) economy, the models include total U.S. employment (as a proxy for Alaska's exports to the RUS). With this exogenous variable, it was found out that the mean absolute percentage error (MAPE), which is one way of measuring the forecasting performance of the model, decreases for some sectors while the MAPE for other sectors increases slightly. Once completed, the VAR model will be able to calculate the temporal economic impacts of the seafood industry.

By Chang Seung

STATUS OF STOCKS & MULTISPECIES ASSESSMENT PROGRAM

Workshop on Forecasting Climate Impacts on Future Production of Commercially Exploited Fish and Shellfish

The workshop "Forecasting Climate Impacts on Future Production of Commercially Exploited Fish" was held in Seattle on 19-20 July 2007. The workshop was sponsored by the North Pacific Marine Science Organization (PICES) and the North Pacific Research Board (NPRB). The workshop was a follow-up to a PICES Fishery Science Committee (FIS) sponsored workshop held in October 2006 at the *PICES XV Annual Meeting* in Yokohama, Japan on "Linking Climate to Trends in Productivity of Key Commercial Species in the Sub-arctic Pacific." Participants of the workshop represented a significant number of the most knowledgeable people who are researching the impacts of climate on fisheries. Participants included an interdisciplinary team of 38 scientists from six countries. Several scientists had strong links to the PICES organization including members from the Physical Oceanography & Climate (POC), Biological Oceanography (BIO), and FIS committees, as well as members of the PICES interim Climate Forcing and Marine Ecosystem (CFAME) task team. The goal of this workshop was to develop a coordinated international effort to provide quantitative estimates of the impacts of climate change on major fish populations. Members from each nation discussed this goal and agreed that they would be interested in participating in this effort. For the interim purposes of this report we refer to the project as the PICES Panel on Fisheries and Climate Change (PPFCC). Official establishment of this panel requires formal approval at some future PICES meeting.

Participants discussed how PPFCC differs from other national or international research programs focused on climate change impacts. PPFCC complements several ongoing research activities within the PICES region and the sub-arctic as a whole. Several features of the program make it unique.

First, PPFCC plans to provide quantitative estimates of the impacts of climate change on fisheries in the North Pacific. Second, the program is a coordinated interdisciplinary and multinational effort that will involve the application of similar methods and forecasting approaches to provide an opportunity to compare responses of fish across their range. Third, PPFCC focuses on the response of major commercial fish and shellfish species, and not the ecosystem response. Participants will develop forecasting tools that allow the inclusion of environmental impacts on fish and shellfish production, distribution and growth. PPFCC proposes to utilize selected scenarios from the Inter-governmental Panel on Climate Change (IPCC) effort to develop scenarios for regional oceanographic changes that will then be linked to changes in ocean forcing on upper trophic level species (see discussion below). PPFCC builds on the history of research regarding mechanisms underlying production that set the stage for the development of quantitative climate change impacts on fisheries scenarios.

Participants at the workshop not only recognized the importance of ocean and climate effects on recruitment, they also accepted the concept of decadal-scale variation. This is a very important advancement and a key result of the workshop.

LINKS TO OTHER PROGRAMS

PPFCC provides a critical link to other national and international research programs that are expected to be active in the PICES region in the next decade. PPFCC builds on the work of the IPCC that will provide the climate change scenarios needed for modeling impacts on fisheries. PPFCC may employ coupled bio-physical modeling approaches that are being developed through national programs such as the U.S. National Science Foundation's Bering Sea Ecosystem Study (BEST), the U.S. GLOBEC Northeast Pacific program (NEP), and the U.S. North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) program as well as international programs such as the GLOBEC international studies of marginal seas. PPFCC scientists will coordinate with on-going research on upper trophic level response to environmental forcing, which is occurring in most national research institutions. In particular, the PPFCC program will provide a first order forecast for use in developing more complex process-oriented programs that seek to forecast the response of the whole ecosystem such as the NPRB Bering Sea Integrated Ecosystem Program (BSIERP) and NOAA's Loss of Sea Ice (LOSI) program. PPFCC also provides a regional forecasting approach that can be used to guide comparative research across the northern hemisphere which is sponsored by the Ecosystem Study of Sub-arctic and Adjacent Seas (ESSAS), and the U.S. Comparative Analysis of Marine Ecosystem Organization (CAMEO) program. The goals of this program are consistent with the climate forecasting element of the proposed PICES FUTURE research program and the U.S. Fisheries and the Environment (FATE) program.

Participants expect that the results of the PPFCC-coordinated research effort will be utilized by a broad spectrum of individuals outside of the research community. We anticipate that stakeholders who rely on fish and shellfish resources will utilize our results to anticipate changes that would influence their businesses and communities. Fisheries managers will utilize the forecasts to evaluate whether actions are needed to sustain fisheries in their regions. Conservation groups will be interested to better understand the regional and species-specific risks and challenges that climate change poses for species of interest.

Several participants noted that the forecasts developed through this effort will help to identify research gaps that could be the focus of interdisciplinary research programs involving field work. Just as recognition of regime shifts was used to promote the development of large national and international interdisciplinary research programs, participants thought that the international research effort to investigate the impacts of climate change on marine fish populations may promote the expansion of national and international research programs on climate change and marine ecosystems.

The workshop provided a forum for discussion of four components needed to complete the forecasts in a timely and coordinated fashion including: IPCC scenarios, predictions of oceanographic impacts, modeling approaches, and scenarios for natural resource use and enhancement. The group discussed the structure for future activities. The group reviewed the list of target species for the PPFCC effort. After careful consideration, 23 species were selected for further consideration. Participants also reviewed the regional partitions proposed in

October 2006. Participants agreed to project implications of climate change at 10-year and 30-year time horizons.

By Anne Hollowed

Multispecies Modeling Workshop

In August REFM scientists hosted a 4-day multispecies modeling workshop at the AFSC. The goal of the workshop was to review and develop technical aspects of fitting statistical age-structured multispecies models. Three of these types of models are being developed for the eastern Bering Sea (EBS), Aleutian Islands, and Gulf of Alaska (GOA). The Aleutian Islands study is being developed by a University of Washington graduate student whereas the GOA work is being done by a student at the University of Alaska. The EBS study extends from earlier studies published by REFM scientists. Workshop participants from South Korea and from New England (Grand Banks) also presented approaches to multispecies modeling applications from their regions.

The common linkage over all regions and models was that conventional age-structured models were at the core of the approach. That is, configuration options allow normal stock assessment data (e.g., observer size and age composition estimates, survey abundance indices) to be tuned independently among species included in the model. This provides a realistic diagnostic check for assumptions about individual stocks since they can be compared with standard single-species stock assessments. Also, this allows for the gradual introduction of trophic interactions through the use of bioenergetics and stomach content data.

For the Aleutian Islands, the statistical model was the most highly developed since it implemented the ability to evaluate a variety of functional feeding responses. In particular, the parameterization for these functional responses was done in a manner that allowed for robust estimation methods. Also, consumption rates as predicted from the model were used to compute ration, and the ration was subsequently tuned to information on the available bioenergetics for each species. Data availability and the complexity of the boundary current Aleutian Islands system were seen as problems that may require additional assumptions for parameter estimation purposes.

For the EBS, the data are more extensive with a somewhat simpler environmental setting. The development of this model was closer to traditional multispecies virtual population analysis (VPA) methods where age-specific prey "suitabilities" were taken as values based on observed stomach content data. This model implements an algorithm that stabilizes the populations (which are generally conditioned on each other's abundances) and allows for Bayesian evaluation of model uncertainties. Model developments underway include a careful evaluation of the impact of arrowtooth flounder abundances in the EBS and the ability to use size-based stomach content data rather than approximated age. Also, there appears to be the potential to link growth data with temperatures and evaluate interannual variability in ration, particularly for EBS pollock.

By James Ianelli

Studies to Evaluate the Impact of Incidental Salmon Catch in Groundfish Fisheries

The regulations on incidental take of Pacific salmon by Alaska groundfish fisheries are an important part of the multispecies management system. These regulations are currently being revised due to new information collected over the past decade and due to changes in the magnitude and pattern of salmon catch. To evaluate these practices, methods that appropriately account for the impact incidental catches have on salmon populations are required. Recently, REFM Division scientists have developed a simulation model that is proposed for analyses that will be undertaken by the North Pacific Fishery Management Council. The model is designed to account for the observed interannual variability of salmon run-sizes and allows for sources of variability including the salmon age-composition, ocean

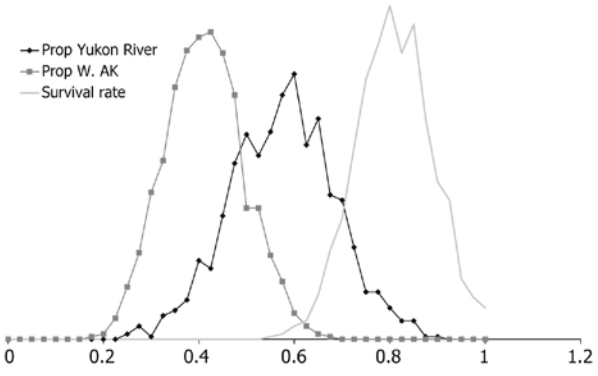

Figure 4. Example of relative probabilities of randomized input values used in the simulation model to evaluate bycatch impacts on salmon populations.

survival, and run-size estimation uncertainty (e.g., Fig. 4). The model and results from an example case study was presented to the Council's Salmon Bycatch Workgroup. Preliminary results show how variability propagates from these sources and that the identified sources of uncertainty make it possible to assess the impact of bycatch levels on salmon runs. This provides a tool that will allow managers to quantitatively assess alternatives and better understand the trade-offs in evaluating effective real-time management systems, in particular, caps that limit incidental salmon takes.

By James Ianelli

AGE & GROWTH PROGRAM

A Bit of AFSC Ageing History

Determining fish ages from reading otoliths underwent a revolution during the early 1980s when it was determined that older specimens of many species aged from otolith surfaces were being underaged. At the AFSC, the Age and Growth Program began applying a new technique of ageing otoliths, the break and burn method, in 1981. The break and burn method entails taking a transverse cross section by breaking (usually sawing) an otolith in half and then exposing the transverse surface to an alcohol flame. This process makes finer marks associated with later annual marks more visible than viewing from the otolith surface. Both the surface and break and burn methods are often used to best estimate a specimen's age, but the percentage varies by species and to a large extent the year the otoliths were aged. For example, the percentages of otoliths aged with the break and burn method were typically low in the early 1980s, then increased and plateaued in the 1990s. However, the percentage broken and burned for rockfish is typically high for all years.

The statistics for this aspect of ageing history at the Center are now available on the AFSC website at http://access.afsc.noaa.gov/al/collection_details/collection_search.php. The site provides summaries of ageing methods (surface, break and burn, or section) used to age fish otoliths. Result tables can be viewed showing the numbers read using each method, by year collected, by year read, or by individual collections. Results include specimens collected as far back as 1980 and are updated daily around midnight.

By Dan Kimura.

Estimated production figures for 1 January 2007 through 30 September 2007. Total production figures were 30,577 with 8,785 test ages and 329 examined and determined to be unageable.

Species	Specimens Aged
Giant grenadier	359
Greenland turbot	502
Flathead sole	516
Alaska plaice	449
Dover sole	447
Northern rock sole	1,241
Yellowfin sole	496
Bering flounder	258
Walleye pollock	11,131
Pacific cod	4,999
Sablefish	2,366
Atka mackerel	1,629
Pacific ocean perch	2,316
Northern rockfish	506
Rougheye rockfish	1,502
Shortraker rockfish	772
Blackspotted rockfish	390
Warty sculpin	185
Yellow Irish lord	513