Auke Bay Laboratories (ABL)

MARINE SALMON INTERACTIONS PROGRAM

Multiple Paternity Detected in Quillback Rockfish

Mating strategies such as polyandry, where one female mates with multiple males, has the potential to influence the amount of genetic diversity of a population and increase the reproductive success of a given individual. This type of mating strategy may help species maintain genetic diversity during genetic bottleneck situations such as overharvesting, severe environmental fluctuations, disease, and founding events. Multiple paternity thought to be inherent only in broadcast spawners has recently been observed in rockfish (*Sebastes* spp.) which are live bearers and reproduce by internal fertilization.

While recent studies of mating strategies in rockfish have focused on samples collected from aquarium populations and species caught off the coast of California and Oregon, scientists with Auke Bay Laboratories (ABL) recently had the opportunity to genetically test for multiple paternity in wild Alaskan quillback rockfish which are an inshore, demersal, nonschooling species.

Embryos and tissue samples from pregnant quillback rockfish were collected by members of ABL's Marine Ecology and Stock Assessment Program near NOAA's Little Port Walter (LPW) Marine Station, located on the southern tip of Baranof Island in Southeast Alaska. Parentage analysis using 13 microsatellites was conducted on 25 embryos each from 25 females. Preliminary results indicate multiple paternity in wild quillback, with multiple males contributing to 8 of 25 broods tested. Further analysis will be conducted to test for correlations between female age/length/weight with multiple paternity practices.

We also observed a larva which carried mtDNA from the mother but was homozygous for the paternal alleles across 13 microsatellite loci. The sample was analyzed twice with the same conclusion. This indicates either a haploid individual carrying only one set of paternal chromosomes, which would not be a viable individual, or an incident of natural androgenesis, where the paternal chromosomes are doubled and produce a viable individual. Further study of this unusual individual will be ongoing.

By Andy Gray

Facility Upgrades and Repairs at Little Port Walter Marine Station

With support from the NOAA Headquarters Facilities Maintenance section (Carol Ciufolo and Bob Williams), and with the help of ABL facility manager Jack Christiansen, procurement specialists Suzanne Johnston and Heather Mahle and information technology specialist Troy Martin, NOAA's Little Port Walter Marine Station is scheduled for substantial upkeep and upgrades. In part because of the extreme weather conditions (averaging greater than 200 inches of snowfall in the last 3 years), many of the LPW buildings were in need of new roofing and truss support. The main warehouse will also get a complete face-lift plus insulation to reduce the severe condensation problems in winter. Other upgrades will include buried power, plus a voice, data, and video conduit which will improve communications both within and offsite through satellite uplinks. As part of NOAA's commitment to reducing its facilities' carbon footprint, contracts were also initiated to determine the feasibility of replacing the diesel generation of electricity at the station with hydropower. Facility upgrades such as this will ensure NOAA Fisheries will continue to have a dynamic and flexible 2,500 acre research base situated in pristine, old-growth rainforest adjacent to the Gulf of Alaska and close to the center of salmon productivity in North America.

By Frank Thrower

Little Port Walter Marine Station Seventy-fifth Anniversary Event

Little Port Walter Marine Station on Baranof Island celebrated its seventy-fifth anniversary on 31 July 2009 in recognition of the many important contributions to fisheries science resulting from the 75 years of research conducted at the facility. As the oldest year-round biological station in Alaska, LPW is managed and operated by the Alaska Fisheries Science Center's Auke Bay Laboratories.

The special anniversary event was sponsored by NOAA Fisheries, Northern Southeast Regional Aquaculture Association (NSRAA), the University of Alaska School of Fisheries and Ocean Sciences, (SFOS), Alaska Department of Fish and Game (ADF&G), and the Alaska State Museum. The anniversary was highlighted by more than 110 visiting scientists, former staff, guest, and friends who convened at LPW where they discussed current and past research activities along with reviewing the facility's infrastructure. Senior retirees who worked at LPW during the 1940s, 50s, and 60s attended the event including Bernie Skud, Betty Olson, Ted Merrell, Willard Brewington, and Ralph Wells. (Bernie's and Willard's sons were also along to watch after their dads.) An Allan Marine catamaran took 70 people from Auke Bay Harbor to LPW where they joined with another contingent of more than 40 people from Sitka, Petersburg, Port Alexander and other parts of Alaska. Although LPW is well noted for its wet weather with a long-term average annual precipitation of over 240 inches, a beautiful, clear, sunny day made both the catamaran transit down Chatham Strait and on-site visits at LPW a memorable day for all.

A series of large posters on the catamaran and at LPW provided overviews on much of the history and research at the station. Several scrapbooks assembled by LPW staff over the years also were available for review, including one by Sam Hutchinson that covered the first few years of "LPW Camp" from its beginning in 1934. Several hundred digitized photographs of LPW events and activities had been uploaded for viewing to a computer on the transport catamaran. A detailed listing of all peer-reviewed publications, reports, documents, and other accounts of research activities at LPW had been compiled with listings both by year of publication and by author.

Assigned staff leaders provided tours of the station's points of interest to groups of 10-15 individuals. Based on general comments from participants the Little Port Walter Marine Station seventy-fifth anniversary event was deemed a great success!

By Bill Heard

Southeast Coastal Monitoring Project Outreach Yields Mutual Benefit

In this era of increasing competition for funding sources, many research programs look for efficient and creative means of supporting their projects. The Southeast Coastal Monitoring (SECM) project, which was initiated by ABL's Marine Salmon Interactions program in 1997, has conducted seasonal trawling and oceanographic work related to juvenile salmon ecology in northern Southeast Alaska for the past 13 years. With just four staff scientists in the SECM project and at least four annual surveys needing four people each, SECM has relied on outside help to maintain the long-term data collection. Over the years, field work has been supported by a wide variety of participants, including university students, professors, researchers, high school marine science students, public school teacher volunteers, visiting foreign scientists, NOAA staff from other programs and facilities, contractors, Alaska Department of Fish & Game employees, private nonprofit hatchery staff, and NOAA and other program interns. These participants have been much appreciated for their contributions. These external staffing opportunities also have had impact as NOAA-supported outreach activities.

Outreach activities are designed to provide educational opportunities involving NOAA science, and participating in field work is only one example. In 2009, Libby Parker, a student attending Dartmouth College, returned to her hometown of Juneau to work as a summer laboratory intern for the ABL Habitat Program. She had not yet settled on a college major, but wanted science experience. An opportunity to participate on an SECM survey as part of her internship became a life-changing experience. Here is an excerpt from her enthusiastic report of the experience:

"…My next foray into the Southeast Alaskan wilderness came in the form of a juvenile salmon survey with three of the most engaging and inspiring biologists. With one week to collect samples for water chemistry, oceanography, and salmon studies the learning curve was steep, and we were kept busy. Coached by my three mentors and encouraged by their contagious enthusiasm and curiosity, I learned how to identify different jellyfish and juvenile salmon species, dissect fish and determine the contents of their stomachs, perform plankton tows, send down CTD casts, and prepare a wide variety of samples for analysis in the lab. From sunup to sundown I was engaged in stimulating conversation and put in situations that required constant vigilance and quick thinking. I learned to love the dusty sheen of fish scales and to find the delicate beauty in stinging jellyfish tentacles. Upon returning to bio lab 208 [at ABL], dismayed to be back on firm ground, [Robert] was quick to tell me that the key to an excellent field experience lies in the group dynamics and how the beauty of a polished, smooth-working crew is not something to be taken for granted."

And the impact of that outreach activity? Libby went on to declare her major in Marine Ecology.

By Molly Sturdevant and Libby Parker

Fisheries Monitoring & Analysis (FMA) Division

NORTH PACIFIC GROUNDFISH OBSERVER PROGRAM RESTRUCTURING

The North Pacific Groundfish Observer Program (Observer Program) was established to address the need for unbiased data on catch, bycatch, and interactions with certain marine species of interest from the Alaska groundfish fishery. Levels of observer coverage required by vessels and shoreside processing plants are based on vessel length and amount of groundfish processed, respectively. Vessels and processors contract directly with observer provider companies to procure observer services to meet federally regulated coverage levels. While the Observer Program is widely recognized as a successful and essential program for management of the Alaska groundfish fisheries, it continues to face a number of longstanding concerns that result primarily from its underlying structure. These concerns include the inability of the National Marine Fisheries Service (NMFS) to determine when and where observers should be deployed, inflexible coverage levels established in regulation, disproportionate cost issues among the various fishing fleets, and the difficulty to respond to evolving data and management needs in individual fisheries.

Since its inception in 1990, there have been numerous failed attempts to 'restructure' the Observer Program such that NMFS would contract directly with observer providers for observer coverage, and this coverage would be paid for by a broad-based user fee and/or direct Federal funding. This report summarizes past efforts and recent progress in Observer Program restructuring.

The North Pacific Fishery Management Council (Council) last reviewed an amendment package with alternatives intended to restructure the Observer Program in 2006. However, due to concerns related to the inability to estimate industry costs and the lack of statutory authority, the Council did not move forward with restructuring the Observer Program but instead approved an extension of the current program by removing the December 2007 sunset date in existing regulations.

At the request of the Council, staff from the Council, NMFS, Alaska Department of Fish and Game (ADF&G), and the International Pacific Halibut Commission (IPHC) participated in the development of a discussion paper that addressed the primary obstacles to restructuring the Observer Program identified in 2006 and recommended changes to the problem statement and suite of alternatives, should the Council initiate a new analysis. The full text of the discussion paper can be found on the Council Web site at http://www.fakr.noaa.gov/npfmc/current_issues/observer/ObserverRest1208.pdf .

In December 2008, upon review of the discussion paper, the Council chose to move forward with restructuring the Observer Program approving changes to the 2006 problem statement and suite of alternatives. In addition, the Council specifically requested that staff begin their analysis by developing an 'Implementation Plan' (Plan) describing how NMFS would deploy observers under a restructured Observer Program. It was intended that the Plan would ultimately become a section of the overall analysis to restructure the Observer Program and feedback on the Plan would help determine the direction of other portions of the analysis.

Staff from the AFSC Fisheries Monitoring and Analysis (FMA) Division, the NMFS Alaska Regional Office, and the Council developed a draft Plan and presented it to the Council's Observer Advisory Committee (OAC) in September 2009, during a 2-day meeting held at the AFSC. A large portion of the Plan outlines funding consid-

erations, including issues such as start-up funding, mechanisms to collect fees from the fishing industry, legal guidance on fee authority, and establishment of standardized ex-vessel value pricing for commercial fish species. Another significant portion of the Plan focuses on observer coverage sample design and observer deployment which falls directly within the Observer Program's purview. This section of the Plan summarizes the current Observer Program sampling coverage design, past reviews of observer deployment, and a proposed observer deployment model. While the proposed deployment model will be more difficult to implement than the current system and will most likely incur additional costs, it would reduce bias while facilitating the development of statistically credible estimates of catch and associated variance. Since the number of observers and associated costs are finite, implementation of new deployment strategies is envisioned to be incremental. Exact identification of strata and their coverage rates are to be examined in the full analysis.

Other issues covered in the Plan include issues related to partial versus comprehensive restructuring, relative agency costs associated with alternatives, Federal regulatory modifications that will become necessary, and a projected timeline for full implementation. The full Implementation Plan can be found on the Council Web site at http://www.fakr.noaa.gov/npfmc/current_issues/observer/ObserverRestr_implan909.pdf

During the 2-day OAC meeting the committee discussed the Implementation Plan, focusing on the most significant questions of the OAC members and important clarifications. At the conclusion of the meeting, the OAC provided recommendations on each section of the Plan and recommended that staff revise the Plan according to the requests presented in Observer Advisory Committee – Meeting Report which can be found at: http://www.fakr.noaa.gov/npfmc/current_issues/observer/909_OACreport.pdf. A revised draft of the Plan will be presented to the OAC and Council in early 2010.

The implementation of a restructured Observer Program is a large and complex undertaking, and the projected timeline is dependent on several steps, many of which are associated with the normal Council and rulemaking process. Council initial review of the overall analysis, of which the Implementation Plan will become a part, is tentatively scheduled for June 2010. Council final action is tentatively scheduled for October 2010, with the associated rulemaking developed through 2011. Contract development for a contract of this projected scope is expected to take about 2 years to complete, with the potential implementation of a newly restructured Observer Program in 2013. The FMA Division will continue to provide periodic updates on this program funding and deployment restructuring effort through the *AFSC Quarterly Report*.

By Patti Nelson

National Marine Mammal Laboratory (NMML)

ALASKA ECOSYSTEMS PROGRAM

Steller Sea Lion Survival and Vital Rates Research, Summer 2009

The National Marine Mammal Laboratory's (NMML) Alaska Ecosystems Program (AEP) conducted Steller sea lion (*Eumetopias jubatus*) population and abundance research at remote Alaska field camps and from a chartered vessel during May–August 2009. This ongoing research is part of the AEP's Abundance Trend Monitoring and Vital Rates Investigations.

Vital rates (reproduction) and survival estimates are essential to understanding any potential cause of the decline of the Steller sea lion population in Alaska and provide a mechanism to monitor sea lion recovery. Mark-recapture (or resighting) studies are the best way to determine vital rates by sex, age, region, and cohort. The AEP conducted two field projects in summer 2009 that contributed significantly to these important research goals.

NMML has been branding pups in the central Gulf of Alaska near Kodiak Island (on Marmot and Sugarloaf Islands) since 2000 and in the eastern Aleutian Islands near Dutch Harbor (Ugamak Island) since summer 2001. In subsequent years, pups were also branded on two rookeries near Prince William Sound (Fish and Seal Rocks). Through 2009, 1,815 pups have been branded. No pups were branded in 2006 and 2007 due to a lawsuit filed by the Humane Society of the United States.

Remote field camps, staffed by a field team of two to three biologists, are located on Marmot Island (Beach 4 and Beach 7) and Ugamak Island (Fig. 1) from late May to early August. Weather permitting, counts by age group and sex, brand resights, and observations of reproductive

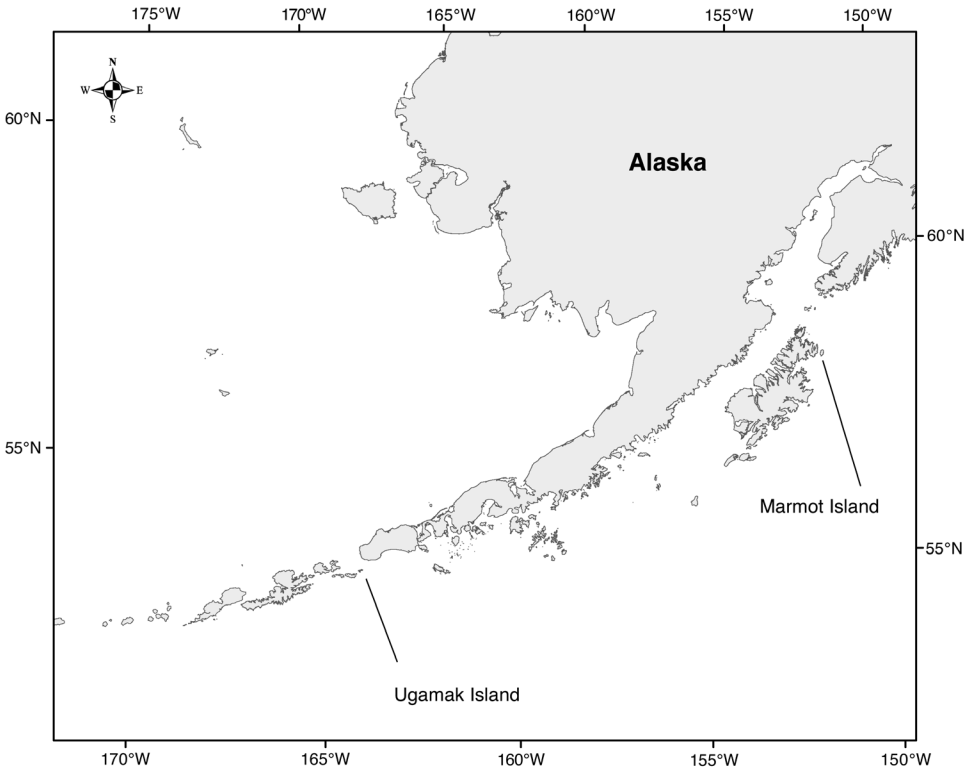

Figure 1. Locations of NMML Steller sea lion field camps in Alaska.

Figure 2. Marmot Island Beach 4 rookery from the cliff-top observation site. Photo by Cameron Hinman.

status and behavior are conducted daily throughout the 2-month field season from the edge of high cliffs (400-1,000 ft), using high-powered spotting scopes and binoculars (Figs. 2, 3). During the 2009 field season, Marmot Island field camp participants Jennifer Schmitt and Susannah Spock were stationed at the south end of Marmot Island (Beach 7), where they identified 59 individual, branded animals for survival analyses; 22 of these animals were adult females, which were also monitored for reproductive activity. Kathryn Chumbley, Cameron Hinman, and Katie Luxa were stationed at the north end of Marmot Island (Beach 4), and they identified 55 individual, branded animals for survival analyses, 24 of which were adult females. Kenady Reuland, Rebecca Scott, and Jessica Farrer were stationed on Ugamak Island, where they identified 322 individual, branded animals for survival analyses, 25 of which were adult females. Biologists on Ugamak Island also monitored the recovery of the rookeries at the South and North beaches, following the research disturbance associated with pup branding on 24–25 June 2009.

In addition to research conducted at the field camps, resightings of branded Steller sea lions were conducted from the chartered research vessel *Norseman*, 28 May–11 June 2009, in the eastern Aleutian Islands and western Gulf of Alaska: AEP personnel on this cruise included Sara Finneseth, Lowell Fritz, and Kathryn Sweeney. Steller sea lions were observed at 40 rookery and haul-out sites in the eastern Aleutian Islands and the western Gulf of Alaska. In total, 57 individual, branded Steller sea lions were observed and positively identified; 52 of these were branded as pups within the range of the endangered western population (west of long.

Figure 3. Branded, female Steller sea lion, T13, with her pup on Marmot Island. Photo by Naomi Worcester.

144°W throughout Alaska and Russia), and 5 were branded as juveniles captured on land or at sea away from their natal rookeries. In addition, 111 food-habits samples (scats) were collected at five locations.

By Kathryn Chumbley

CETACEAN ASSESSMENT & ECOLOGY PROGRAM

Killer Whale Genetics: Insight into Population Structure

The Cetacean Assessment and Ecology Program (CAEP) has been conducting annual vessel surveys for killer whales (*Orcinus orca*) throughout the Aleutian Islands and western Gulf of Alaska since 2001. These surveys comprise part of CAEP's ongoing research to determine the distribution, abundance, stock structure, and diet of killer whales off western Alaska. Two of the primary objectives of the vessel surveys are to collect identification photographs and tissue biopsy samples of individual killer whales throughout the surveyed region.

To maximize the geographic extent of our survey coverage and include killer whales from neighboring regions, samples collected by CAEP surveys are supplemented by biopsies collected by several other research groups within both Russian and Alaska waters. The scope of this large, collaborative project provides us with the opportunity to explore patterns of genetic subdivision among killer whales sampled across the northern North Pacific Ocean.

Untethered, lightweight darts are used to collect tissue biopsies from photographically identified killer whales (Fig. 4). These small biopsy darts collect samples of both skin and blubber for the purposes of ecotoxicology, dietary, and genetic analyses. Biopsies are subsampled according to tis-

Figure 4. Identification photograph of transient killer whales in the Aleutian Islands and a biopsy dart rebounding from the animal's dorsal surface. Photo by S. Ingram.

sue type, preserved according to protocols established for each of the target analyses, and later shared among the participating research groups for a battery of analyses including stable isotope, persistent organic pollutants, and genetic assays. The whole genomic DNA extracted from a skin subsample yields ample template DNA for both mitochondrial control region (CR) sequencing and nuclear microsatellite genotyping. This suite of genetic markers will allow us to confirm field identifications of the three ecologically distinct killer whale types ("residents," "transients," and "offshores"), often referred to as "ecotypes"; test for significant subdivisions among the sampled individuals within each type; and potentially identify significant geographic or ecological boundaries that define killer whale stocks.

To date, our samples represent killer whales from the Gulf of Alaska across to the Sea of Okhotsk (Fig. 5). We have amassed a collection of 449 samples, of which 249 were collected by NMML scientists. The dataset comprises 6 offshores, 248 fish-eating residents, 134 mammal-eating transients, and 61 samples of unknown ecotype. Mitochondrial CR sequencing has been performed for 97% of all samples (provided by the NMFS Southwest Fisheries Science Center and L. Barrett-Lennard at the Vancouver Aquarium/University of British Columbia), and alignment of the 980 base-pair (bp) fragment revealed 16 unique haplotypes, several of which are "rare" within our sampled dataset and previously unreported. All CR haplotypes are exclusive to one of the three ecotypes, supporting the genetic discreteness of the three killer whale types.

Currently, analyses are under way to test hypotheses based on CR phylogeny and photographic resighting data and to assess the existence of significant genetic subdivisions within the northern North Pacific using nuclear genetic markers. CAEP scientists are genotyping all killer whale samples using a suite of 27 polymorphic microsatellite markers. Individual samples are assigned to putative populations based on type and geographic sampling location. So far, multilocus genotypes have been generated for 385 samples, of which 369 represent unique individual whales. Preliminary analyses support the subdivisions according to type, with significant genetic differences among the three North Pacific types, and suggest that there may be significant differences between Gulf of Alaska and Aleutian Islands killer whales.

The final round of microsatellite genotyping, commencing in fall 2009, will include biopsies collected during the 2009 CAEP killer whale survey and additional samples collected in Russian waters. The resulting dataset will represent one of the largest genotyping studies of killer whales in North Pacific waters and will provide valuable insight into the structuring of killer whales throughout the region.

By Kim Parsons

POLAR ECOSYSTEMS PROGRAM

Harbor Seal Census Along Coastal Alaska

NMML's Polar Ecosystems Program (PEP) is responsible for monitoring and es-

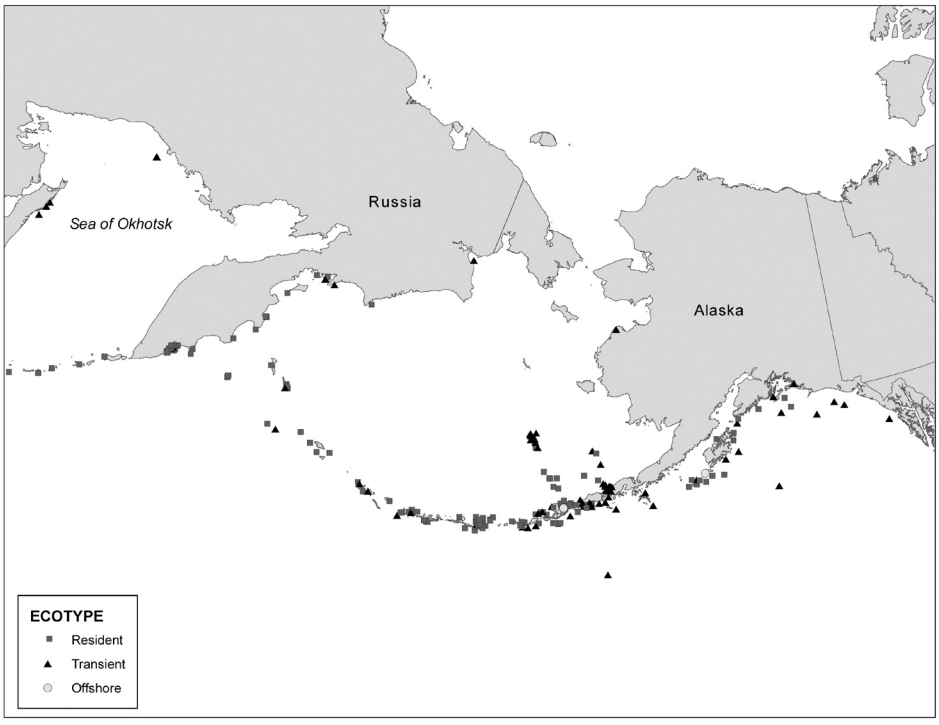

Figure 5. Map of killer whale biopsy sample locations in the northern North Pacific Ocean. Symbols indicate ≥ 1 individual sample.

timating 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. The 2009 surveys were conducted during the last week in July through the end of August. We utilized seven aircraft, including four NOAA twin-engine planes (two AC-Shrikes and two DHC-Twin Otters) and two chartered single-engine floatplanes. The scientific crew was made up entirely of NMML employees and contractors with a significant amount of aviation safety and survival training.

Prior to 2008, for logistical purposes, Alaska was divided into five regions and one region was surveyed each year. The five regions were the Gulf of Alaska, northern Southeast Alaska, southern Southeast Alaska, the Aleutian Islands, and the north side of the Alaska Peninsula and Bristol Bay. Beginning in 2008, the PEP developed and implemented a new system that allows annual surveys across the entire range of harbor seals in Alaska. Harbor seals range from Southeast Alaska through the extent of the Aleutians and north into Bristol Bay. We focus on surveying sites with historically large numbers of seals every year, and those sites with fewer seals are flown every 3-5 years. This should provide us with the data necessary to estimate harbor seal population and trends on an annual basis.

The 2009 surveys were the first surveys flown under this new method to cover the entire harbor seal range. In 2008, we were unable to fly much of the central and western Aleutian Islands. This region was added in 2009 and surveyed with a second NOAA Twin Otter. The Aleutian Islands survey also served as a test site for using an infrared (IR) camera to assist in the detection of harbor seals in the highly complex habitat. A FLIR A325 camera was mounted in one of the belly ports on the NOAA Twin Otter, and a live image was displayed on a laptop during the survey flights. In the end, we determined that the angle of the camera and the resolution of the image were too limited for our needs. However, we do feel this was an excellent first step and hope to work with the NOAA Aircraft Operations Center to find a better solution for future surveys.

The 2009 surveys also included our continued effort to monitor the population and trends of harbor seals that rely on tidewater glacier habitats for pupping and molting. During the month of August, biologists photo-sampled ice-hauling seals in tidewater glacial fjords. Icy and Disenchantment Bays in the Gulf of Alaska; Tracy Arm, Endicott Arm, and LeConte Bay in Southeast Alaska; and College Fjord and Columbia Glacier in Prince William Sound. Seals in these fjords (up to 5,500) are scattered across enormous fields of floating ice that shift with ocean and wind currents, which makes them particularly difficult to count.

To address these issues, an aerial sampling method was used for population estimates of ice-hauling seals in tidewater glacial fjords. The line transects were flown by NOAA Corps pilots aboard the NOAA AC-500 Shrike (N47RF). Flights were timed daily to overlap with the peak abundance of seals, which occurs between 1300 and 1600 hours. This method allowed scientists to capture higher-quality imagery of seals at lower altitudes (1,000 ft), using a down-looking and high-resolution digital single-lens reflex (SLR) camera. The images were georeferenced and analyzed using conventional GIS software to map seal locations in non-overlapping images that represent about 40% of the ice field. The estimated total abundance is calculated using spatial statistical models. Besides abundance estimation, the high-quality imagery also allows for detailed analyses of individual seals (e.g., discriminating mother-pup pairs and population structure) and ice characteristics.

By Josh London, Luciana Santos, and Dave Withrow

Resource Assessment & Conservation Engineering (RACE) Division

SHELLFISH ASSESSMENT AND GROUNDFISH ASSESSMENT PROGRAMS

Annual Eastern Bering Sea Continental Shelf Bottom Trawl Survey

The twenty-eighth annual bottom trawl survey of the eastern Bering Sea (EBS) continental shelf was conducted between 28 May and 2 August 2009 aboard the chartered fishing vessels *Arcturus* and *Aldebaran*. Scientists from the AFSC, Office of Sustainable Fisheries, 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 covering an area of 144,493 square nautical miles and bottom depths ranging from 20 to 200 m. In addition, both vessels returned to Bristol Bay to resample 32 stations between 27 and 30 July due to the delaying effects of colder than average water temperatures on the red king crab reproductive cycle (see shaded area in Fig. 1).

Trawl surveys of the EBS shelf started in the early '70s when the Bureau of Commercial Fisheries and the commercial fishing industry worked together to develop a red king crab (*Paralithodes camtschaticus*) fishery by surveying different parts of the shelf. An environmental assessment related to oil exploration was the motivation for the first large-scale survey of the EBS shelf in 1975. Trawl surveys continued through 1981 with a nonstandard station distribution and using a slightly different survey trawl than is presently used.

Since 1982, 356 stations have been systematically sampled during the May-August time period using the same standardized set of survey trawl gear (Fig. 1). An additional 20 stations in the northwest were added to the standard area in 1987 to investigate the northern distribution and abundance of snow crab (*Chionoecetes opilio*) and commercial groundfish in response to the changing climate (Fig. 1). Abundance estimates and analyses of size or age composition generated from this survey time series are used in stock assessments for management of commercial crab and groundfish species by the North Pacific Fishery Management Council.

EASTERN BERING SEA SHELF WATER TEMPERATURES

Bottom temperatures measured during the survey ranged from -1.7° to 6.3°C (Fig. 2). The weighted average bottom temperature of the EBS shelf survey area was slightly higher in 2009 (1.23°C) compared to 2008 (1.13°C) with the cold pool (<2°C) extended southward down the middle shelf and into Bristol Bay.

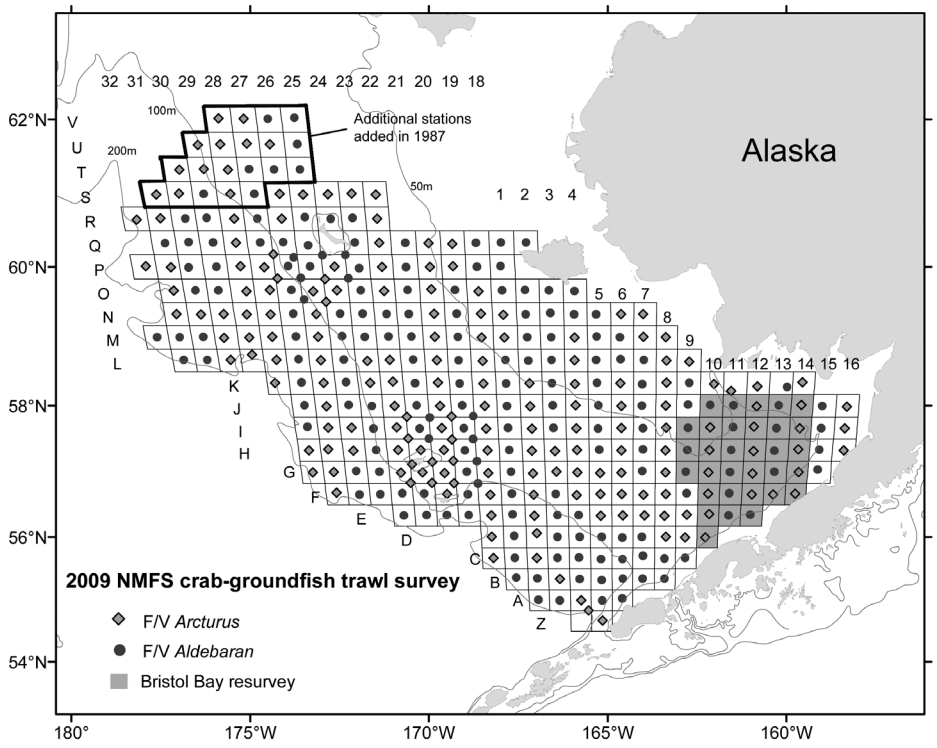

Figure 1. National Marine Fisheries Service eastern Bering Sea bottom trawl area surveyed by the chartered fishing vessels *Arcturus* and *Aldebaran* from 2 June to 19 July 2009. Shaded area depicts Bristol Bay resampled stations, 27 to 30 July 2009

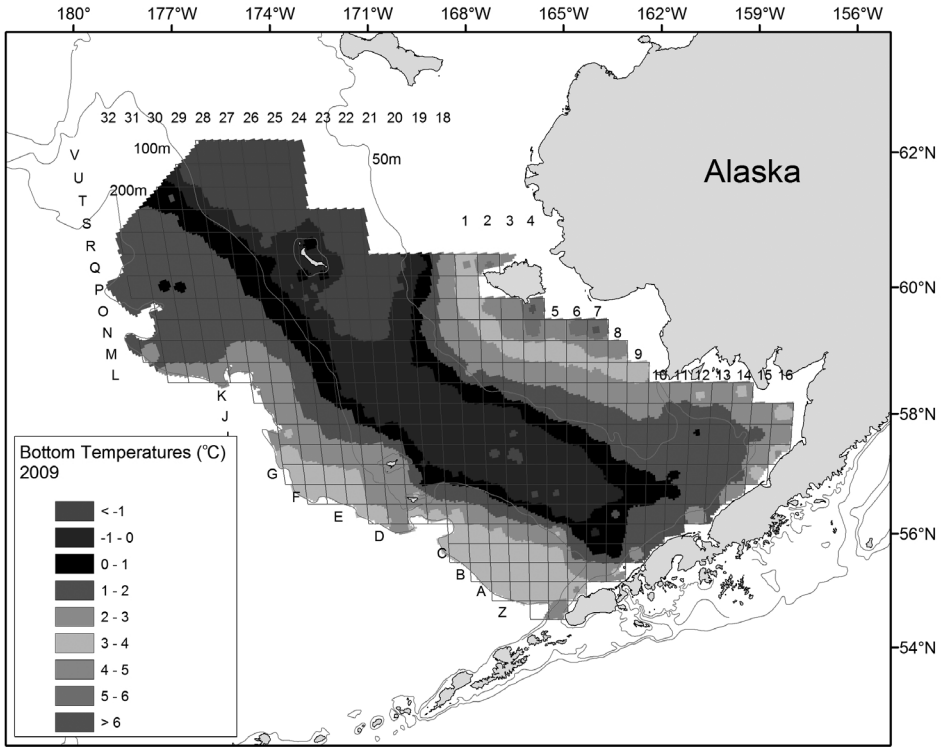

Figure 2. Mean bottom temperatures (°C) measured at stations from the eastern Bering Sea bottom trawl survey, beginning 2 June 2009 in Bristol Bay and ending on 19 July 2009 at station N28. This figure does not reflect the 32 resampled stations in Bristol Bay, surveyed from 27 to 30 July 2009.

COMMERCIAL CRAB

Over 46,800 individual crab, including red king crab, blue king crab (*P. platypus*), snow crab, Tanner crab (*C. bairdi*), Tanner/snow hybrid (*C. bairdi* × *opilio*), and hair crab (*Erimacrus isenbeckii)* were sampled (Fig. 3); other biometric data such as shell and egg condition, weight, chela height, and presence of parasitism were also recorded.

From 2008 to 2009, estimates of legal red king crab abundance in the Bristol Bay and Pribilof Districts decreased, with a substantial decrease in the number of small males in the Bristol Bay District. Female red king crab in both districts also showed an overall decrease in abundance. Legal blue king crab in the Pribilof District showed a slight increase; legal blue king crab in the St. Matthew District decreased while prerecruit males increased in abundance. It is noted that estimates for blue king crab have low precision due to the few numbers of crabs caught during the survey. Legal prerecruit and large female Tanner crabs in all districts decreased since 2008, and there was a slight increase in the number of small females. Legal male snow crab abundance increased slightly while small female snow crab abundance increased significantly in all districts. The 2009 point estimates for all legal-sized males of commercial crab stocks in the eastern Bering Sea are shown in Table 1.

For the fourth year in a row, a return to Bristol Bay to resample predetermined stations for red king crab was required. Many of the mature female red king crab caught at the beginning of the survey had not extruded new clutches of eggs due to cold water temperatures. Because spawning stock assessment models rely upon future recruitment and mating success, the delay of the new clutches necessitated the return to Bristol Bay. At the time of the resampling, virtually all mature females had completed the mating and molting cycle and extruded new clutches (Fig. 4).

These data with expanded description of the survey and additional station information are available in the NOAA Technical Memorandum "The 2009 Eastern Bering Sea Continental Shelf Bottom Trawl Survey: Results for Commercial Crab Species" posted on the AFSC Web site at http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-201.pdf.

Table 1. The 2009 point estimates (± 1.96 SE) for legal-sized males (millions of crab) of commercial crab stocks in the eastern Bering Sea.

	2009 legal-sized males (millions of crab)
Bristol Bay District red king crab	8.5 ± 6.6
Pribilof District red king crab	0.7 ± 0.9
Pribilof District blue king crab	0.07 ± 0.08
St. Matthew Island Section blue king crab	1.4 ± 0.7
Tanner crab, all districts	6.9 ± 2.8
Snow crab, all districts	371.8 ± 86.4
Snow crab, all districts > 4.0 inches	130.1 ± 42.4

GROUNDFISH

Data collections from the EBS shelf trawl survey included 149,098 individual length measurements representing 22 fish taxa; 9,264 age structures representing 13 fish taxa; 5,622 stomach samples representing 19 fish taxa; and 1,212 pathobiology samples from 40 different fish and invertebrate taxa. A majority of trawl catches contained walleye pollock (*Theragra chalcogramma*), although the estimated total biomass decreased from 3.03 million metric tons (t) in 2008 to 2.28 million t in 2009. The largest catches of walleye pollock were concentrated along the northwest outer shelf and near the Pribilof Islands where bottom temperatures were above 0°C; large catches of walleye pollock were also observed north of the Alaska Peninsula near Unimak Island. Similar to walleye pollock, Pacific cod (*Gadus macrocephalus*) were broadly distributed across the EBS shelf and caught at nearly all stations. There was a marginal increase in Pacific cod total biomass from 0.40 to 0.42 million t and a much higher proportional increase in population due to higher numbers of 15-20 cm and 40-50 cm Pacific cod. For yellowfin sole (*Limanda aspera*), rock sole (*Lepidopsetta* spp.), flathead sole (*Hippoglossoides* spp.), arrowtooth flounder (*Atheresthes stomias*), and Greenland turbot (*Reinhardtius hippoglossoides*), the estimates of total biomass declined 13%-25% from levels estimated for 2008. A 4% increase in biomass was observed for Alaska plaice (*Pleuronectes quadritubeculatus*) and a 21% increase in Pacific halibut (*Hippoglossus stenolepis*).

SPECIAL PROJECTS

In addition to standard survey operations, numerous special research projects were conducted during the 2009 trawl survey. It was the fourth year in a series for collecting acoustic data on midwater walleye pollock to augment the biennial Midwater Assessment and Conservation (MACE) Program echo integration-trawl time series, and also the fourth consecutive year for collecting summer bongo samples to monitor distribution and abundance of zooplankton on the EBS shelf. It was also the second year for collecting a synoptic environmental dataset for the National Science Foundation (NSF)/North Pacific Research Board (NPRB) Bering Sea Integrated Ecosystem Research Program (BSIERP). Profiles of light intensity, water temperature and salinity were collected by attaching a light meter and conductivity-temperature-depth (CTD) profiler to the bottom trawl headrope. A sea chest onboard the *Aldebaran* also made continuous measurements of surface temperature, salinity, nitrate, chlorophyll and dissolved oxygen during the course of the survey. Several special crab studies were conducted including reproductive potential of snow and red king crab, hemolymph collections to monitor bitter crab syndrome, and population genetics studies of *Paralithodes* spp. From 19 to 25 July, the AFSC also participated in a cooperative study with the Bering Sea Fisheries Research Foundation to estimate the efficiency of the EBS survey trawl for snow crab (see below).

By Bob Foy and Bob Lauth

Estimating The Catching Efficiency of the Eastern Bering Sea Survey Trawl For Snow Crab

Following the 2009 eastern Bering Sea (EBS) bottom trawl survey, the AFSC Groundfish Assessment Program, in collaboration with the Bering Sea Fisheries Research Foundation (BSFRF), conducted a cooperative trawling experiment to estimate the catching efficiency (i.e., the proportion of crab within the trawl path actually captured) of the standard NMFS survey trawl for snow crab. The project

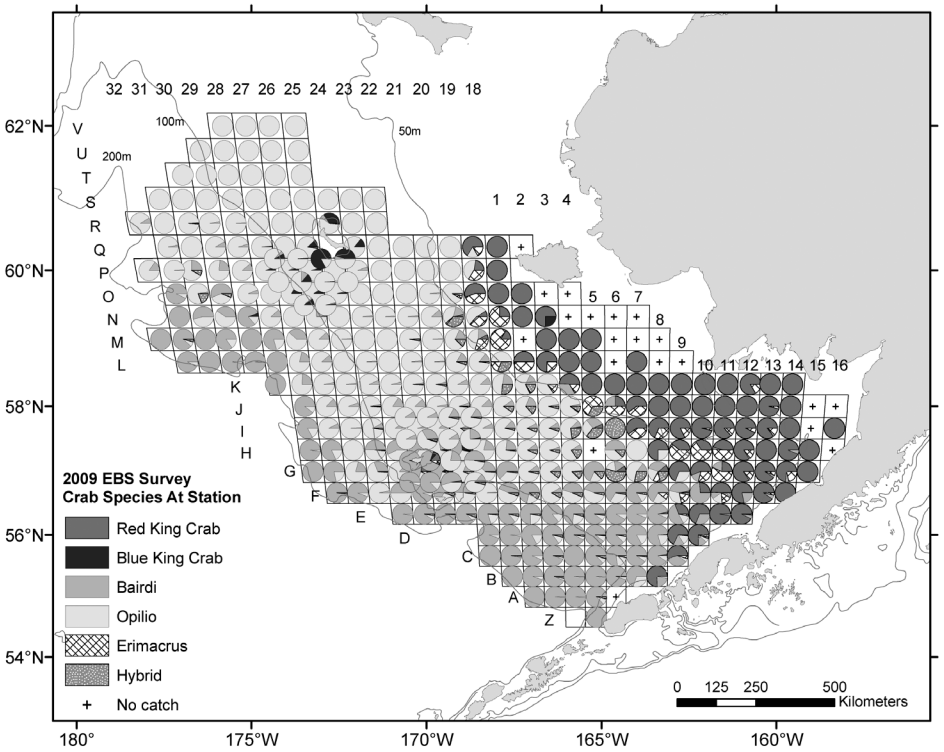

Figure 3. Distribution of crab by species based on trawl survey abundance from the eastern Bering Sea bottom trawl survey.

Figure 4. Biologists Jan Haaga, AFSC, Kodiak, and Molly Fox, University of Alaska Fairbanks, measure red king crab during the 2009 Bristol Bay retow after mature females had completed the mating and molting cycle and extruded new clutches. Photo by Ken Weinberg.

sought to improve upon the findings of a previous (1997) study by extending the sampling area to cover a wider region of the species range and sampling a broader size distribution, particularly smaller crab. The results of the 2009 study will provide the basis for developing sex-specific selectivity functions along with estimating other selectivity parameters for the purpose of improving the snow crab stock assessment model.

The experiment, conducted on the Bering Sea snow crab grounds from 20 to 24 July, consisted of side-by-side comparative towing involving three vessels each using a different gear type: the NMFS chartered F/V *Arcturus* towing the standard 83-112 Eastern survey trawl using standard survey protocols, the NMFS chartered F/V *Aldebaran* towing a modified version of the survey trawl, and the BSFRF chartered F/V *American Eagle* towing a trawl designed for the European Norway lobster (*Nephrops norvegicus*) fishery. The NMFS modified trawl and the BSFRF trawl were intended to provide absolute density estimates to be used as the basis to compute the catching efficiency of the survey trawl. NMFS trawl modifications designed to increase crab catch of all sizes included the addition of a small mesh liner throughout the entire lower panel of the net, additional weight strung across the center of the trawl footrope, and the addition of a tickler chain designed to stir up snow crab embedded in the bottom just forward of the trawl footrope. Following field tests of the new equipment in snow crab habitat, it was decided to remove the tickler chain and to shorten the experimental tow duration to 5 minutes because catch rates of epibenthos and retention of mud by the trawl gear jeopardized the completion of the experiment.

The NMFS-modified trawl, with the ad hoc changes in design and fishing protocols, was used in 11 comparative tows with the NMFS standard survey trawl alone and 24 triplicate side-by-side tows involving all three gear types in which all snow crabs were sexed and then measured to the nearest mm (carapace width) in order to determine length-specific snow crab catch efficiency.

Preliminary results from this study have been presented at the NPFMC Crab Plan Team Meeting, held at the AFSC on 14 September. T-test results showed crab catch densities from the BSFRF trawl were significantly higher than the NMFS modified survey trawl for the five common size categories reported in the NMFS Annual Crab Report to Industry (i.e., market males >102 mm, pre-recruit males 78-101 mm, small males <78 mm, large females ≥50 mm and small females <50 mm). It was therefore concluded that the BSFRF trawl catch rates would be used as the basis for calculating the efficiency of the standard survey trawl (CPUE of the standard survey trawl/CPUE of the BSFRF trawl) with the assumption that the BSFRF trawl caught 100% of the crab in its trawl path. Preliminary results show that more escapement of snow crab under the footrope of the EBS survey trawl occurs than previously estimated. Specifically, only 35% of the large males, 27% of the pre-recruit males, 13% of the small males, 25% of the large females, and just 3% of the small female snow crab in the path of the survey trawl are captured.

The analyses for this study are ongoing. Future steps involve the calculation of selectivity functions by sex and exploring the effects these functions may have on the current stock assessment model output.

By Ken Weinberg

Mapping Skate Nursery Sites in the Eastern Bering Sea

In August 2009 we mapped four nursery sites in the eastern Bering Sea (Fig. 5) used for egg case deposition by the Alaska skate (*Bathyraja parmifera*). We used the SeaBED autonomous underwater vehicle (AUV) (Fig. 6) developed by Dr. Hanumant Singh at Woods Hole Oceanographic Institution. The SeaBED AUV produced high quality digital images of the seafloor while running transects across the nursery sites located in or near Bering, Pribilof, Pervenets, and Zhemchug canyons. The project, funded by NPRB, is designed to estimate Alaska skate production at nursery sites in the eastern Bering Sea. The digital images will enable us to estimate

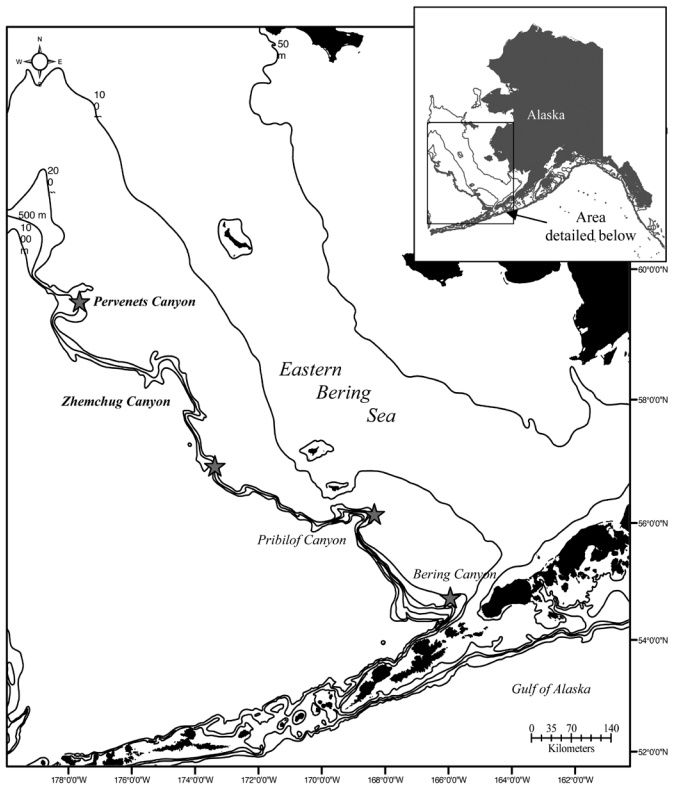

Figure 5. Location of four nursery sites (stars) for the Alaska skate (*Bathyraja parmifera*) that were mapped using the SeaBED AUV.

Figure 6. *Above,* the Autonomous Underwater Vehicle (AUV) SeaBED developed by Dr. Hanumant Singh of Wood's Hole Oceanographic Institution used to obtain images of the skate nursery sites. Photo by Gerald Hoff.

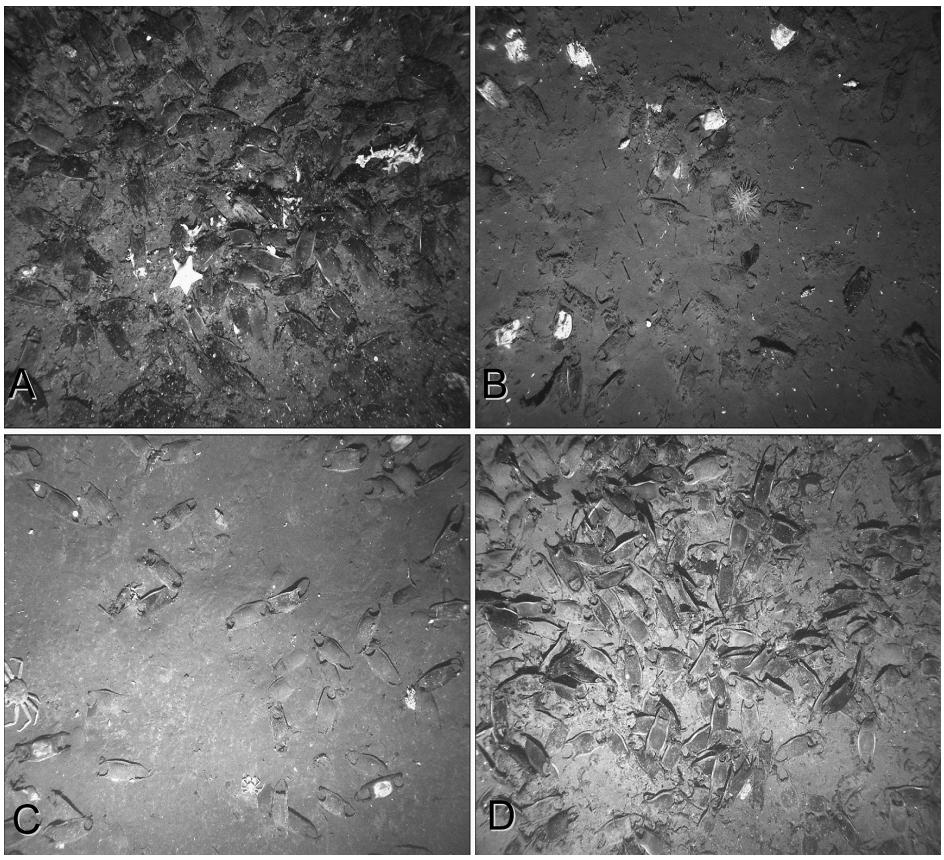

Figure 7. *Right*, images obtained by SeaBED (AUV) of egg cases of the Alaska skate (*Bathyraja parmifera*) at four nursery sites in the eastern Bering Sea. A) Pervenets Canyon; B) Zhemchug Canyon; C) Pribilof Canyon; D) Bering Canyon.

egg case densities at each site and couple it with a characterization of the habitat used for skate reproduction.

Preliminary analysis from images shows high densities of skate egg cases deposited directly on the seafloor over a relatively small area (Fig. 7). The nursery site at Bering Canyon showed eggs broadly scattered on a soft muddy bottom while the other three sites were much more concentrated over more scoured, hard packed bottom substrates. It is not clear why the heads of canyons are chosen for skate nursery sites however a relatively stable, warm bottom temperature, such as those found along the upper slope, may be an important factor in facilitating successful embryo development.

By Gerald Hoff

FISHPAC Cruise Investigates Fish Habitat and Updates Nautical Charts in the Eastern Bering Sea

Scientists from the RACE Habitat Research Group (HRG) assembled in Dutch Harbor for a multi-mission habitat cruise on the NOAA ship *Fairweather*. The FISHPAC project is an ongoing effort to evaluate the utility of acoustic backscatter for characterizing essential fish habitat (EFH) in the eastern Bering Sea (EBS) and to compare the performance of various acoustic systems for that purpose. This approach is based on prior HRG research indicating the distribution and abundance of many groundfish species is related to surficial sediment properties. Direct sampling of sediments with grabs and coring devices is, however, impractical over areas as large as the EBS shelf. Acoustic tools, on the other hand, are suitable for large-scale surveying and show great promise as a substitute for the more traditional samplers, but they have not been proven for EFH purposes. In keeping with NOAA's Integrated Ocean and Coastal Mapping Initiative, the HRG team is working closely with other branches of NOAA to acquire bathymetric data that meet hydrographic standards and can be used to update nautical charts in areas with outdated or non-existent information. In 2009, the project also had the good fortune to work with a very capable and energetic high school science teacher participating in the NOAA Teacher At Sea program.

The 2009 survey area consisted of six 110-140 nautical mile tracklines across the EBS shelf at depths ranging from 20 to 160 m. These survey lines were chosen to pass directly over 31 RACE bottom-trawl-survey stations at which a wide range of fish and invertebrate abundances has been observed. Nine additional stations were added at intermediate locations along lines 7 and 8, for a grand total of 40 stations. Over the period 26 July to 8 August, each line was navigated once with continuous shipboard operations. On every pass, backscatter and bathymetry data were collected using the ship's two multibeam sonars (Reson models 8111-ER operating at 100 kHz and 8160 at 50 kHz) with operator settings tuned for backscatter data. Two sediment grabs and multiple digital still photos were collected at each station using the Seabed Observation and Sampling System (SEABOSS)(Fig. 8). One of these grabs will be used for a laboratory analysis of sediment properties and the other will be processed to characterize invertebrate organisms living in the substrate. Actual sampling locations were determined with an ultra-short baseline (USBL) positioning system that was interfaced with the ship's navigational instruments. Geophysical properties of the seabed, as well as sound velocities in the water column, were measured at each station using a Brooke Ocean Technology free-fall cone penetrometer (FFCPT) (Fig.

Figure 8. *Left*, groundtruthing devices used during the FISHPAC 2009 cruise include the SEABOSS sediment grab/camera system (left) used to collect physical and biological samples from the seabed; *right*, the FFCPT sediment profiler which collects sound velocity data as it free falls in the water column and then takes geotechnical measurements as it imbeds itself into the bottom.

8). Conductivity-temperature-depth casts were also performed to provide additional sound-velocity data and ensure high-quality hydrographic products.

Three additional activities were undertaken using available ship time. During the cruise, a feature resembling a bowl or depression in the seafloor was detected between the standard survey lines. One of the *Fairweather* survey launches was deployed and investigated the area with a very high-resolution multibeam system (Reson model 8125 operating at 455 kHz). A preliminary review of the data revealed a depression of unknown origin, measuring approximately 29 m in diameter and 1.5 m deep (Fig. 9). A more comprehensive look at this feature will be undertaken in the future. In addition to the planned survey lines, the *Fairweather* and the FISHPAC team acquired bathymetry and backscatter data during two passes along a short transect near Dutch Harbor. These hydrographic-quality data will be compared with data collected a few weeks earlier by the NOAA ship *Oscar Dyson* using a multibeam sonar (Kongsberg ME70) configured to survey the water column rather than the seabed. At the end of the cruise, performance characteristics of the USBL system were investigated during the transit to Dutch Harbor. The USBL transceiver that communicates with transmitters on the various towed objects had previously been mounted on a pole that was temporarily attached to the *Fairweather*. In response to a structural failure of the mounting pole during the 2008 FISHPAC cruise, the USBL transceiver on the *Fairweather* was moved to the hull of the vessel during the winter repair period. Some significant deficiencies were noted during the investigation and additional testing of the hull-mounted transceiver is needed.

By Bob McConnaughey and Meghan McGovern

Gulf of Alaska Biennial Groundfish Assessment Survey Completed

The sixth in a series of biennial bottom trawl surveys of Gulf of Alaska (GOA)

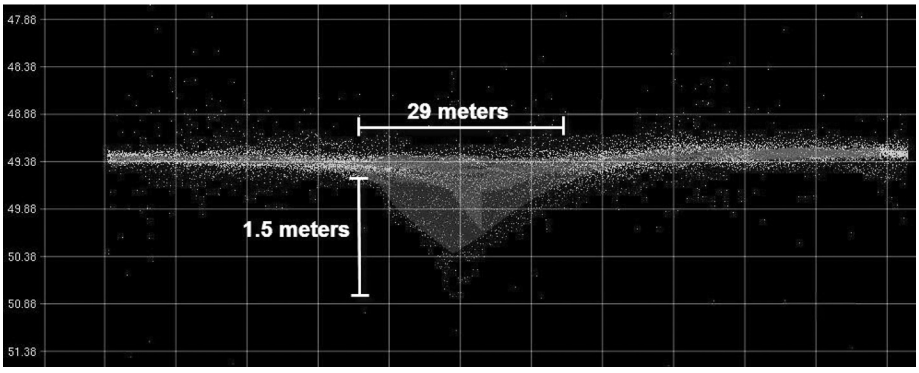

Figure 9. Two-dimensional representation of a previously unknown bowl-shaped feature detected in Bristol Bay during the 2009 FISHPAC cruise.

Figure 10. Alison Deary, Lisa DeForest, Todd TenBrink, and Jameson Gregg aboard the chartered fishing vessel *Sea Storm* during the 2009 Gulf of Alaska groundfish assessment survey.

groundfish resources was conducted between 18 May and 31 July 2009. Prior to establishing a biennial schedule in 1999, groundfish resources in the GOA had been surveyed by the RACE Division triennially between 1984 and 1999, making this summer's survey the eleventh in the overall time series of surveys used to assess stocks in the GOA. The GOA biennial surveys are designed to cover the continental shelf and slope between the Islands of the Four Mountains (long. 170°W) and Dixon Entrance (U.S.-Canada border in Southeast Alaska) out to the 1,000-m depth contour. While funding levels have affected the extent of the survey area covered in the past, we have enjoyed full geographic and depth coverage since 2005.

Sampling in 2009 was conducted aboard three chartered commercial trawlers, the *Pacific Explorer*, *Vesteraalen*, and *Sea Storm* (Fig. 10). The survey period was divided into four legs of 18-20 days each. Sampling began near the Islands of Four Mountains and progressed eastward on the continental shelf and slope to the U.S.-Canada border in Southeast Alaska. A total of 825 stations were allocated among 54 depth and geographic strata and were preselected randomly from a grid of potential sites overlaying the survey area. Nearby alternate stations were fished if rugged bottom or conflict with commercial fishing operations prevented sampling the pre-selected station. Of an attempted 883 tows, 823 were successfully completed, comprising depths that ranged from 21 to 984 m.

Overall, the most abundant species (in descending order of biomass) were arrowtooth flounder, Pacific ocean perch (POP), walleye pollock, Pacific cod, giant grenadier, and Pacific halibut. Biomass estimates increased dramatically for walleye pollock (+123%) and Pacific cod (+223%). Moderate increases in apparent biomass were seen for Pacific halibut and giant grenadier (18% and 47%, respectively), and small decreases were estimated for arrowtooth flounder and POP (–9% and –6%, respectively). Other notable changes included a continued increase in the apparent abundance of Pacific hake (+79%) and a 60% decrease in the estimated biomass of northern rockfish.

Regionally, POP and arrowtooth flounder were the two most abundant species in the eastern and central GOA, with POP predominating in the east and arrowtooth more abundant in the central GOA. Arrowtooth flounder and walleye pollock were the two most abundant species in the western GOA. Pacific cod ranked third most abundant in the western and central GOA. Pacific halibut was also abundant in all areas of the Gulf. All estimates of abundance, distribution, and size composition derived from the survey have been provided to stock assessment analysts for updates to the annual SAFE Report of the NPFMC GOA Groundfish Plan Team.

Ocean water temperatures observed during the 2009 survey resembled those seen during 2007. The patterns seen during both of these recent surveys were much different patterns than those from prior GOA surveys. For this comparison, water column temperatures from all GOA surveys were adjusted to remove the effect of date of collection on water temperature through the use of a general linear model. Temperatures were then binned and averaged by each half-degree of longitude and by depth increments (finer at shallower depths to broader at deeper depths). West of about long. 140°W, water temperatures in both recent surveys showed rapid cooling between the surface and about 50 m, below which warmer water was usually observed. Below 300 m, however, average temperatures from 2007 and 2009 have been warmer than those in previous years.

By Mark Wilkins and Michael Martin

Resource Ecology & Fisheries Management (REFM) Division

RESOURCE ECOLOGY & ECOSYSTEM MODELING PROGRAM

Fish Stomach Collection and Lab Analysis

During the third quarter of 2009, Resource Ecology and Ecosystem Modeling (REEM) staff participated in seven legs of the AFSC's summer groundfish trawl surveys in the eastern Bering Sea and the Gulf of Alaska to collect stomach and tissue samples. These samples provide trophic information for continued monitoring of predatory impacts on commercially important species and quantifying energy flow through Alaskan marine foodwebs. In addition, stomach and tissue samples were collected for targeted studies on flatfish prey selectivity in the eastern Bering Sea, genetic identification of difficult to distinguish larvae and prey, items, and functional foraging response of fish to predator, prey and environmental fields. Overall, 6,587 stomach samples and about 285 tissue samples were collected from the eastern Bering Sea. In the Gulf of Alaska, 4,636 stomach samples and 300 tissue samples were collected, and 2,014 stomach samples were analyzed at sea. Stomach samples were also returned by fisheries observers; 473 from the Gulf of

Alaska and 881 from the eastern Bering Sea. Survey participation reduces the amount of time spent analyzing stomach samples in the laboratory. During the third quarter, 931 samples from the eastern Bering Sea and 207 stomach samples from the Gulf of Alaska were analyzed in the laboratory. This resulted in 2,113 records added to the REEM food habits database.

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

Ecosystem Modeling and Assessment

The Ecosystems Considerations appendix to the Stock Assessment and Fisheries Evaluation (SAFE) report is updated annually by REEM staff to provide information on relevant ecosystem components to the North Pacific Fishery Management Council for consideration in management decisions. This appendix is composed of three parts: 1) an integrated ecosystem assessment, 2) time series of ecosystem indicators that measure components of the ecosystem, and 3) management indices that reflect the impact of humans on the marine ecosystem. The last two parts are composed of individual contributions from a broad range of scientists.

A draft has been completed for inclusion in the 2010 SAFE report. As of September, twenty-two contributions have been updated, and two new contributions have been added. One provides measurements of the potential area disturbed by trawl fishing gear in the eastern Bering Sea from 1990 to 2008. The second describes the spatial distribution of groundfish in the eastern Bering Sea from 1982 to 2008. Highlights from the draft were presented to the joint North Pacific Fishery Management Council plan teams in mid-September.

The second NMFS National Ecosystem Modeling Workshop (NEMoW II) was held 25-27 August 2009 at the Chesapeake Bay Foundation's Merrill Center in Annapolis, Maryland. NEMoW II continued work started at the first NEMoW in Santa Cruz, California, in 2007 to develop a regular ecosystem modeling (EM) workshop analogous to the National Stock Assessment Workshops and National Economist Meetings. In this context, EM includes a wide range of biophysical, multispecies, and ecosystem modeling methods. Where NEMoW classified major ecosystem model types and began a list of "best practices" for using the models, NEMoW II focused on sources of uncertainty in EM and how to provide management advice that appropriately expresses but is not hampered by uncertainty. Thirty-three NMFS participants and 6 outside observers attended the meeting.

Dr. Kerim Aydin (REEM Program) served on the steering committee and made a presentation outlining processes and audiences for EM review across NMFS science centers. Dr. Sarah Gaichas (REEM Program) contributed to meeting organization and made a presentation reviewing single-species and EM comparisons across science centers. Drs. Buck Stockhausen (AFSC/REFM Division) and Bern Megrey (AFSC/RACE Division) also represented the AFSC and contributed to presentations and the meeting report.

Data and information gaps for modeling were identified across science centers and prioritized to address major sources of EM uncertainty. Common types of uncertainty were identified, as well as approaches for addressing that uncertainty. Establishing and refining our list of best practices to address EM uncertainty should be continually re-evaluated. This workshop provided a strong basis for identifying those best-practices. A key conclusion from the workshop was that we need to better engage our stakeholders in terms of communicating, interacting and discussing ecosystem model rationales, uses, applications, and benefits.

A report to be issued in the future will include recommendations stemming from the workshop. The four preliminary major recommendations are suggestions to: 1) establish distinct EM review panels, 2) identify and note sources of EM uncertainty as a must for EM use, 3) bolster the value of strategic advice, and 4) bolster ecosystem modeling capacity.

By Sarah Gaichas, Stephani Zador, and Jason Link (Northeast Fisheries Science Center)

Ecosystem Ecology

Retrospective comparisons of zooplankton data and pollock diet data has begun. About 250 zooplankton sampling stations have been identified that are within reasonable temporal and spatial proximity (i.e., 7 days and 60 miles) to 85 stations where pollock diet information has been collected. Fewer stations will be available with zooplankton community composition data to match with pollock diet information. Frequency differencing is being used to provide estimates of euphausiid backscatter density from AFSC hydroacoustic surveys through a NSF/NPRB Bering Sea Integrated Ecosystem Research Program (BSIERP). During years prior to 2009, pollock stomachs were collected only from 14 trawl stations in the northern Bering Sea during the 2004 survey. Cursory examination of this data indicates no relationship between local euphausiid backscatter density and local pollock density. Average stomach fullness as a percentage of individual pollock body weight (%BW) appears to be related more to the variation in copepod consumption than euphausiid consumption as indicated by the average amount of each prey type eaten per fish (g-prey/fish). However, all evidence suggests the overall abundance of euphausiids in 2004 was extremely low.

By Troy Buckley and Kerim Aydin

Ecosystem Modeling

REEM modelers attended weekly meetings with the BSIERP vertical modelers to continue development of the Forage and Euphausiid Abundance in Space and Time (FEAST) model, a 3-D model of the Bering Sea on a 10-km resolution, which will model the coupling between physics, plankton, forage fish, and predatory fish. The coupling between fish and plankton is bidirectional and includes feedback between these components. Progress to date includes a fully coupled one-dimensional version (depth over time) producing expected growth rates and consumption for fish lengths 10 cm+ for 1999. The 3-D version of FEAST is fully coupled and ready for initial preliminary runs which will focus on refining movement parameters. Milestones during the next 6 months include the completion of 1-year runs for 1999 (a cold year) and 2004 (a warm year). Results of the 1-D model were presented and discussed during a workshop hosted by the BSIERP's Fish Group. This workshop, held in Seattle on 11-13 August 2009, focused on preliminary results of the fish projects, introduction to models and discussion of model outputs between modelers and field researchers. Updated results of the 1-D and 3-D models will be presented and discussed again at the annual BSIERP principal investigators meeting in mid-October.

By Ivonne Ortiz and Kerim Aydin

Figure 1. A seabird/paravane interaction session. The paravane cable runs down into the water from near the end of the boom (and back to the vessel under the boom). All other lines control the boom or are used to deploy and retrieve the block used to deploy the paravane. Very few interactions were recorded with these lines. Note the gull perched on the boom. Photo by Todd Loomis, Cascade Fishing, Inc.

Seabird Coordinated Studies

With funding from the National Cooperative Research Program and the NMFS Bycatch Reduction Engineering Program, a pilot study on seabird interactions with paravanes was conducted in August. A paravane is a device that trawl operators use to obtain signals from net monitoring equipment. The paravane receives acoustic signals as it is deployed at 5 or more fathoms deep via a boom alongside the vessel (Fig. 1). Because seabirds are often attracted to vessels to take advantage of fish discharge, they may come into contact with this gear. This study is the first work in the North Pacific on seabird paravane interactions.

Project goals were to 1) learn about the basic usage of paravane gear, 2) obtain baseline information on seabird interactions with the paravane gear, and 3) attempt to develop and deploy at least three different types of mitigation measures. Industry partners included the North Pacific Fisheries Foundation and Cascade Fishing, Inc., owners of the fishing trawler *Seafisher*. This study was needed due to a potential for interactions between paravanes and the endangered short-tailed albatross (*Phobastria albatrus*).

A biologist experienced with seabird mitigation was deployed to the trawler *Seafisher* for one trip 8-16 August 2009. During this period, all of the stated goals of the pilot project were achieved. There were 20 observation sessions of seabird/paravane interactions (without mitigation measures), which will provide baseline interaction rates for comparisons to rates while mitigation measures were deployed. The crew and biologist worked together to test six different types of mitigation measures. The biologist was able to conduct another 20 observation periods of these measures. There were no seabird mortalities or injuries associated with the paravane during this trip. Interaction rates varied from 0 to 138 per 15-minute observation session. Nearly all interactions were by Northern Fulmars (*Fulmaris glacialis*) and were of the paravane cable itself rather than the various lines supporting or controlling the paravane boom.

The AFSC also hosted the first strategic planning workshop for the NMFS National Seabird Program on 9-11 September 2009. The purpose of the workshop was to assess the current state of the program and to consider how the program can best address emerging issues related to seabird conservation, within U.S. waters and on the high seas. AFSC Science and Research Director Dr. Doug DeMaster gave opening remarks and thanked participants for their efforts to study and conserve these important living marine species. Topics of discussion included NMFS expertise in the study of seabirds at sea and in reducing seabird bycatch in fisheries, the importance of interagency collaboration, and the applicability of seabirds as indicators of changes in the marine environment, among others. NMFS shares responsibility for the conservation of seabirds with the U.S. Fish and Wildlife Service through its role managing fisheries — one of the greatest known threats of seabird populations worldwide. The workshop was organized by Kim Rivera (NMFS Alaska Regional Office and NMFS National Seabird Program Coordinator). Participants included NMFS staff from each of the regional offices, science centers, and from headquarters, as well as staff from the U.S. Fish and Wildlife Service, the U.S. Geological Survey, the academic community, and the North Pacific Fishery Management Council.

By Shannon Fitzgerald

ECONOMICS & SOCIAL SCIENCES RESEARCH PROGRAM

Understanding Net Economic Values and Impacts of Saltwater Sportfishing in Alaska

To understand the economic value residents of Southeast Alaska place on saltwater sportfishing, Drs. Dan Lew (Economics and Social Sciences Research (ESSR) Program) and Doug Larson (University of California, Davis) have developed a recreation demand model that describes saltwater anglers' choices of whether or not to fish and, if they decide to fish, where to fish. Using the model results, preliminary estimates of the net economic value of sportfishing trips (primarily for salmon) for resident anglers of Southeast Alaska were generated. These results indicate the expected value of a saltwater fishing trip occasion in Southeast Alaska for resident anglers is about $45.

Using data on saltwater fishing preferences for nonresidents of Alaska, the economic impacts of nonresident saltwater angling behavior were estimated under a variety of alternative sport fish harvest limits. To this end, Drs. Lew and Chang Seung (ESSR Program) developed and estimated a stated preference model of saltwater sport-

fishing participation to generate estimates of changes in participation resulting from changes in harvest limits for three primary recreational target species in Alaska saltwater fisheries: Pacific halibut, king (Chinook) salmon, and silver (coho) salmon. These estimates were then used in a state-level computable general equilibrium (CGE) model and a social accounting matrix (SAM) model to generate estimates of the economic impacts of harvest policies. The models indicate that much of the impacts from a change in the expenditures resulting from change in harvest limits leak out of the state due to the state's heavy dependence on imports of goods and services from the rest of the United States. Moreover, changes to harvest limits appear to have a small effect on the Alaskan economy, at least in comparison to the overall size of the state economy.

By Dan Lew

Fishing Revenue, Productivity and Product Choice in the Alaskan Pollock Fishery

A key element in evaluating fishery management strategies is examining their effects on the economic performance of fishery participants, yet nearly all empirical studies of fisheries focus exclusively on the amount of fish harvested. The economic benefits derived from fish stocks involve the amount of revenue generated from fish processing, which is linked to both the way fish are harvested and the products produced from the fish. In this study, Dr. Ron Felthoven (ESSR Program) and colleagues from the University of California, Davis (Catherine Morrison-Paul and Marcelo Torres), statistically estimate a revenue function for catcher-processor vessels operating in the Alaskan pollock fishery, using a flexible functional form that accomodates a wide range of production technologies. The statistical framework recognizes that some inputs and outputs in the production process are jointly determined and accomodations are made to avoid bias that can arise in estimating models in such a setting. Furthermore, the model expands previous research in this area by including a variety of fishing inputs and conditions that affect fishing and processing productivity. The authors find significant own-price supply responses and product substitutability, suggesting that product portfolios are responsive to changes in relative prices. The authors also find that revenues have increased due to the longer season and changes in fishing and towing duration after a regulatory change introduced property rights through a new fishing cooperative. They also find significant growth in economic productivity, or higher revenues over time after controlling for all the inputs used in production and changes in product prices. These patterns suggest that the move to a catch-shares management system has contributed significantly to economic performance in the pollock fishery. This article is in press at the *Environmental and Resource Economics* journal.

By Ron Felthoven

Estimating Heterogeneous Capacity and Capacity Utilization in a Multispecies Fishery

One of the main concerns in fishery management is the effect of excess fishing capacity on the biological and economic health of the fisheries. To assess overcapacity in fisheries, economists have developed and improved methodologies to provide estimates to fishery managers. In this research, we use a stochastic production frontier model to investigate the presence of heterogeneous production and its impact on fleet capacity and capacity utilization in a multispecies fishery. We propose a new fleet capacity estimate that incorporates complete information on the stochastic differences between vessel-specific technical efficiency distributions, where technical efficiency is a measure of the quantity of inputs used to create a unit of catch. Results indicate that ignoring heterogeneity in production technologies within a multispecies fishery as well as the complete distribution of a vessel's technical efficiency score, may lead to erroneous fleet-wide production profiles and estimates of capacity. Our new estimate of capacity enables out-of-sample production predictions which may be useful to policy makers. This article is in press at the *Journal of Productivity Analysis*.

By Ron Felthoven

Global Trade in Food and Energy Commodities Analyzed Under IPCC Scenarios

Scenarios from the Intergovernmental Panel on Climate Change (IPCC) are the basis for analyzing potential biophysical effects of climate change on Alaska's marine ecosystems, including economic impacts on commercial fisheries. Gauging the economic impacts requires analyzing both the biophysical effects that could accrue, and the socioeconomic conditions that would exist, under the IPCC scenarios. However, the emissions scenarios that are used to drive the climate models are based on energy-economic models that do not provide information on how household demand for food, energy, and other goods will be affected by projected changes in demographic variables such as population age-structure, household size, and urbanization. Each could have important effects on both the scale and composition of demand for food and energy commodities. Therefore, researchers from the AFSC, the National Center for Atmospheric Research (NCAR), and the International Institute for Applied Systems Analysis (IIASA) developed a global economic model, and supporting data, to analyze these effects.

In particular, the global model and data were used to analyze effects of demographic changes that are expected to occur over the next several decades on the demand for energy and food under assumptions about future technical change as embodied in the IPCC scenarios. The global model is a dynamic computable general equilibrium model, called the population-environment-technology (PET) model, with detail in energy and food sectors. The global data are comprised of economic trade and production data from the Global Trade Analysis Project (GTAP), sector-level energy data from the International Energy Agency, detailed data on consumption patterns across different demographic categories from several national household surveys, and household-level population projections. The household surveys include detailed information on consumption of food and other commodities, and these form the empirical basis for our results on future demands.

To analyze future economic conditions, we developed a new model tuning procedure so that our global economic model matches gross domestic product (GDP), fossil-fuels based carbon dioxide (CO_2) emissions, and primary energy outcomes in two reference scenarios (A2 and B2) from the IPCC Special Report on Emissions Scenarios (SRES) as represented by numerical results from IIASA's MESSAGE model (http://www.iiasa.ac.at/web-apps/ggi/

GgiDb). The final set of simulations for A2 and B2 scenarios were completed recently using the PET model. A manuscript with these results is in preparation.

The PET model has been linked to a Global Biogeochemical Cycles model (i.e., Earth Systems Model of Intermediate Complexity), called the Integrated Science Assessment Model (ISAM). In collaboration with NCAR and the Department of Atmospheric Sciences at the University of Illinois Urbana-Champaign, the coupled PET-ISAM model (iPETS) will be used to develop a suite of ocean acidification scenarios for the Bering Sea. These are described in the AFSC Ocean Acidification Research Plan.

By Mike Dalton

Changes in Bargaining Power Under Sablefish Rationalization

In a study with coauthor Harrison Fell of the environmental economics research organization Resources for the Future, Dr. Alan Haynie (ESSR Program) has completed a paper that is soon to be published in the journal *Economic Inquiry,* entitled "Estimating Time-varying Bargaining Power: A Fishery Application." In this paper, they propose a novel approach to estimate bargaining power in bilateral bargaining frameworks. They apply the technique to the ex-vessel fish market in the sablefish fishery that changed management systems from a regulated open-access system to an individual fishing quota (IFQ) system during the period of the study. The authors find that post-IFQ implementation, fishers do improve their bargaining power and thus accrue more of the rents generated by the fishery. However, unlike previous studies, they find that fishers do not move to a point of complete rent extraction. Rather, fishers and processors appear to be in a near symmetric bargaining situation post-IFQ implementation. While it is difficult to know how this result may apply in other fisheries, this is an important result because concerns of complete rent-extraction by fishers have been one factor that has made processors very reluctant to move to a catch share system.

By Alan Haynie

STATUS OF STOCKS & MULTISPECIES ASSESSMENT PROGRAM

The 8th Republic of Korea – United States Fisheries Panel Conference

On 21-23 July 2009 the AFSC hosted the 8th fisheries panel conference between the United States and the Republic of Korea (ROK). The former South Korean government agency, MOMAF (Ministry of Maritime Affairs and Fisheries), is now the Ministry of Land Transportation and Marine Affairs (MLTM) and Ministry of Food, Agriculture, Fisheries and Forestry (MIFAFF), under a reorganization that occurred in early 2008. The National Fisheries Research and Development Institute (NFRDI) is the primary scientific organization of MIFAFF that participates in the fisheries panel exchanges. The U.S. cooperating partner is the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service. The fisheries panel is one of seven panels of the Joint Project Agreement (JPA). The JPA is on its third year of implementation under the second 5-year plan that ends in 2011.

Six scientists from the ROK and 14 scientists from the United States participated in the meeting. Discussions covered six primary research themes. 1) ecosystem approaches to management, 2) bycatch and discard reduction research, 3) fish stock rebuilding, 4) climate change effects on fisheries resources, 5) salmon enhancement research and 6) oil spill restoration. The meeting provided a forum for discussion and exchange of research findings between the two countries. The leads of the U.S. delegation (Patricia Livingston, REFM Division Director) and the R.O.K. delegation (Dae Soo Chang) reaffirmed that substantial benefits are obtained from the cooperative activities of the fisheries panel through the Korea-U.S. JPA. The panel activities have raised the level of scientific abilities and enhanced cooperation and exchange of data and techniques between fisheries scientists of both parties. The cooperative activities have contributed substantially to the fisheries assessment and management for sustainable fisheries resources of both countries.

The panel agreed to continue cooperation under the broad project themes discussed at the 7-10 July 2009 meeting of the MLTM/MIFAFF-NOAA JPA in Hawaii. The seven major projects for 2010 are 1) fisheries panel conference, 2) climate change impacts on fisheries, 3) ecosystem-based assessments and management, 4) policy training and stock rebuilding, 5) bycatch reduction research in tuna longline fisheries, 6) survey gear engineering research, and 7) a new project to develop an observer program to support fisheries management under an April 2008 Korean fisheries management law.

By Anne Hollowed and Loh-Lee Low

Nearshore Research In Bristol Bay

This summer, Dr. Olav Ormseth of the Status of Stocks and Multispecies Assessment (SSMA) Program conducted a nearshore fish and invertebrate survey in northern Bristol Bay, Alaska. The purpose of the project was to investigate the distribution and habitat of forage fishes and juvenile flatfishes and gadids in an area that has received little research attention. Most of the AFSC's survey efforts are focused on offshore areas in water greater than 20 m depth. Ormseth's survey was an attempt to "fill the gap" by sampling from the 20-m depth contour in to the shoreline. Two areas of the bay were sampled: one week was spent in Nushagak Bay, and a second week was spent to the west of the Nushagak Peninsula sampling in Kulukak and Togiak Bays and points in between. Bad weather was constant on this trip, and wind direction and tidal state determined sampling locations in Nushagak Bay. (In other words, most of the sampling could only be conducted at low tide and on a lee shore).

A chartered Bristol Bay salmon gillnetter, F/V *Willow*, was the ideal vessel for this work. Limited to 32 ft in length by law (an attempt to limit effort) and designed to operate in shallow water, the vessel was able to accommodate several different gear types. A beach seine was used to sample the shoreline and was deployed using a large skiff that was towed behind the boat when not in use. A small-mesh bottom trawl employing a heavyweight aluminum beam to provide horizontal spread was deployed off the net reel. These were the two main sampling types. Ormseth also experimented with a Kodiak trawl, a large surface net that is towed by two vessels (the skiff served as the second vessel). While this gear proved effective (especially at catching young-of-

the-year herring), it was cumbersome to deploy with all the other gear on board. One of the disadvantages of a small boat is the limited deck and storage space, as well as the number of scientific personnel (two) that can be accommodated.

Salinity and temperature are important habitat variables and were sampled using conductivity-temperature-depth recorders (CTDs). The CTDs used in this project were originally designed for groundwater monitoring and were small, lightweight, and relatively inexpensive units. Since they contained a memory chip, they could be deployed on moorings to look at changes in temperature and salinity over time. This was especially useful in Nushagak Bay, which has a huge tidal range. Four CTDs deployed on simple moorings at different points in the bay revealed dramatic fluctuations in salinity over the course of a tidal cycle. Because fish species differ in their ability to handle varying salinity, such daily changes might be significant for fish distribution.

Catches in both areas were dominated by shrimp and smelts (Fig. 2). The vast majority of the shrimps were members of the family Crangonidae and were small (less than 6 cm). The smelts were mainly juvenile rainbow smelt, *Osmerus mordax*, as well as some adults of this species. These two groups were found in almost every haul in both areas. In the Togiak area, small yellowfin sole (*Limanda aspera*) were abundant. Other fishes in the catches included a variety of sculpins, poachers, and Stichaeids. In general, catches were small and almost all of the captured fishes were small as well.

Perhaps the most unexpected result of the survey was the consistent species composition. Ormseth had hypothesized that the Togiak/Kulukak area would have a much different species composition due to the differences in topography and oceanography. However, the species composition appeared to change only gradually as the vessel headed west. Shrimp became less common and juvenile flatfishes and helmet crabs (*Telmessus cheiragonus*) (Fig. 2) more common. These results are preliminary and data will be analyzed further in the coming year.

The survey was a success, and Ormseth hopes to do more sampling in this area. One important addition will be to sample in several different seasons. Researchers at the University of Alaska Fairbanks' Bristol Bay campus are conducting similar work in the upper parts of Nushagak Bay, and Ormseth hopes to coordinate his activities with them in the future.

By Olav Ormseth

Figure 2. (Note: not to scale.) *Top*, a Crangonid shrimp captured in Nushagak Bay, Alaska; *middle*, juvenile rainbow smelt (*Osmerus mordax)*; *bottom*, captured helmet crabs (*Telmessus cheiragonus*) awaiting their return to the water after being measured. Photos by Olav Ormseth.

Testing Electronic Tags for Light-Based Geolocation of Alaska Groundfish

SSMA researchers are currently conducting a study to determine the utility of electronic archival tags (Fig. 3) for studying movement of Alaska groundfish. The initial work is being done on Pacific cod and, if successful, will be applied to other species such as skates. These tags have light, depth, and temperature sensors and store data from these sensors at user-determined time intervals. When the tag is recovered, the light record can be used to obtain daily estimates of latitude and longitude for the tagged fish. Lotek Wireless Inc. (Newfoundland, Canada) has developed a new type of tag that is smaller than previous models and uses an improved algorithm for estimating geographic position. Since these tags have not been tested in high latitudes, funds were obtained through a cooperative research grant to conduct a pilot study. This study is in two parts: 1) testing the position estimates provided by tags moored at a known, fixed location; 2) testing capture methods and tag implantation procedures on captive Pacific cod off Juneau, Alaska.

For Part 1, moorings were deployed during May 2009 in approximately 100-m water depth in Resurrection Bay, Alaska, (in the vicinity of Seward) and Captain's Bay outside of Unalaska in the eastern Aleutian Islands. Two sets of tags, each with three depths intervals, were on each mooring location. After 4 days the first set of tags was recovered to ensure proper installation and equipment performance. A second set remained in place and will be recovered in October. These deployments were

achieved with help from personnel of the Alaska SeaLife Center (Seward) and the University of Alaska Fairbanks (Unalaska). Preliminary results from the Unalaska tags suggest that the tags might have difficulty detecting enough light at depths greater than 50 m. Therefore, additional tags were placed at shallow depths in Resurrection Bay (Seward) to provide a greater range of light intensity values. The tags in Seward were recovered in September 2009, but the data have not yet been analyzed. The Unalaska tags will be retrieved in October 2009.

For Part 2 of the study, the F/V *Williwaw* was chartered to capture live Pacific cod using pot gear in the vicinity of Juneau, Alaska. During 24-28 August 2009, five Pacific cod were captured and transferred to a laboratory tank at Auke Bay Laboratories. These fish are currently in a recovery period, and archival tags will be implanted in three of the five individuals in September 2009. To reduce impacts on swimming ability and streamlining, the tags will be placed inside the body cavity. The tags have a sensor stalk approximately 10 cm long that extends out through the body wall and allows the recording of external light and temperature data. The fish will be kept in the live tanks for up to a year. In addition to the tag testing, these fish will be part of a controlled study linking otolith microchemistry to water temperature and fish growth. This is being done in conjunction with Tom Helser of the AFSC Age and Growth Program.

By Olav Ormseth and Susanne McDermott

Researchers to Use Pots, Tags, and Divers in Study of Alaskan Octopus

Research at the AFSC includes not only targeted fish species but also other species that form important parts of the food web and are taken incidentally in U.S. fisheries. Researchers from the AFSC's Seattle and Kodiak laboratories are preparing to study octopus in the nearshore waters off Kodiak Island in the central Gulf of Alaska and Dutch Harbor in the Bering Sea starting in winter 2010. Funding for the study has been provided by the North Pacific Research Board (NPRB).

The main focus of the study is giant Pacific octopus *(Enteroctopus dofleini),* which is the largest octopus in the world (Fig. 4) . While seven or eight species of octopus occur in Alaska waters, giant Pacific octopus are the largest and are most likely to be encountered by fishers and divers. Giant octopus captured in crab or groundfish pots often weigh 50 lbs, and individuals over 100 lbs have been documented. Like all octopus, they have eight arms lined with sucker disks, swim by forcing water 'jets' through a muscular funnel, and can change skin color and patterns to blend in with their surroundings. Their only hard part is a parrot-like beak that allows them to eat mollusks, crabs, and fish.

One important goal of the research is to document the reproductive biology and seasons of octopus in Alaska waters. Researchers need to gather more information about octopus in order to be prepared to provide advice for an ecosystem approach to management of these species, in case a target fishery is developed. Although there have been some investigations into commercial octopus fishing in the past, there is at present no commercial octopus fishery in U.S. waters off Alaska. Octopus caught incidentally in groundfish fisheries may be sold, but directed fishing for octopus is not permitted. In state waters (within 3 miles of the coastline), directed octopus fishing is allowed only with a special commissioner's permit from the Alaska Department of Fish and Game (ADF&G). Increasing global markets for octopus have led to increasing interest in retention and sale of octopus over the past few years.

Researchers have posted information with local dive shops and media asking SCUBA divers near Kodiak, Dutch Harbor, and Juneau to watch for octopus. If one is sighted, divers are asked to report the location, time, and date of the sighting, and whether there are egg clusters present in the octopus den. Once octopus dens are located, researchers will revisit the sites monthly from the late summer or fall of 2010 until the early spring of 2011 to determine when the eggs hatch and the octopus larvae leave the den.

AFSC scientist Christina Conrath will be examining reproductive organs of octopus captured in routine bottom trawl surveys, as well as octopus provided by cooperating commercial pot fishermen and fisheries observers, in order to determine when the octopus are ready to mate and lay eggs.

As part of the study, researchers will also be testing and developing 'habitat pot' gear specifically designed for catching octopus. A variety of sizes and materials will be used to build small unbaited pots that serve as artificial dens for octopus; a similar gear is currently used in Japanese octopus fisheries. The research also includes a pilot tagging study in Dutch Harbor by University of Alaska scientist Reid Brewer. This study will use tiny, bright, flexible tags that will

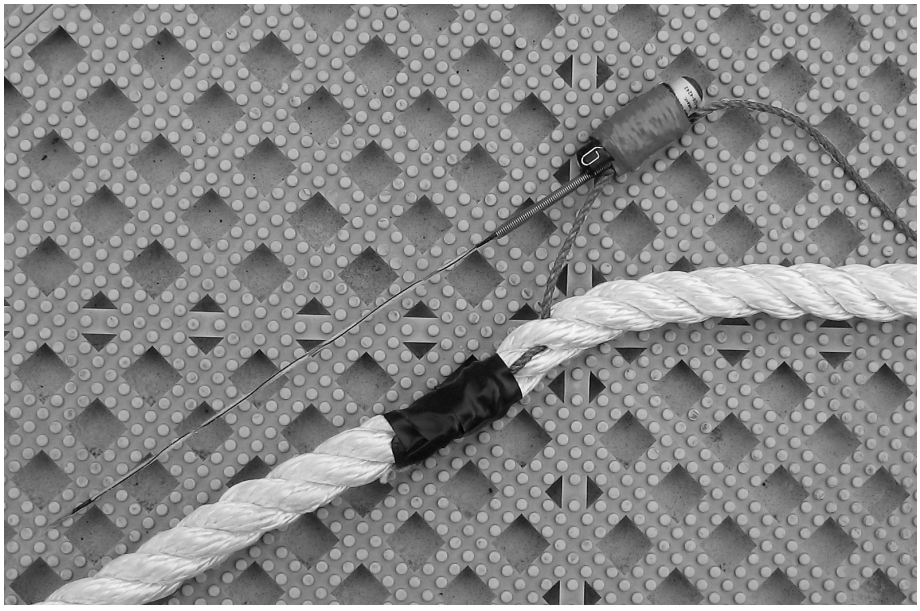

Figure 3. Closeup of archival tag attached to mooring line. The sensor stalk can be seen extending from the left end of the tag. The twine and tape were part of the mooring line attachment. For scale, the diameter of the tag is approximately 1 cm. Photo by Olav Ormseth.

show through the octopus' skin after they are implanted. Both tagging and habitat pot fishing are being developed as techniques to use in future studies to be used for octopus management.

The NPRB grant will provide funds for building habitat pot gear and for chartering commercial fishing vessels for tagging and pot studies. The ADF&G will also participate in the study by providing octopus specimens and helping to build and test habitat pot gear.

By Elizabeth Conners

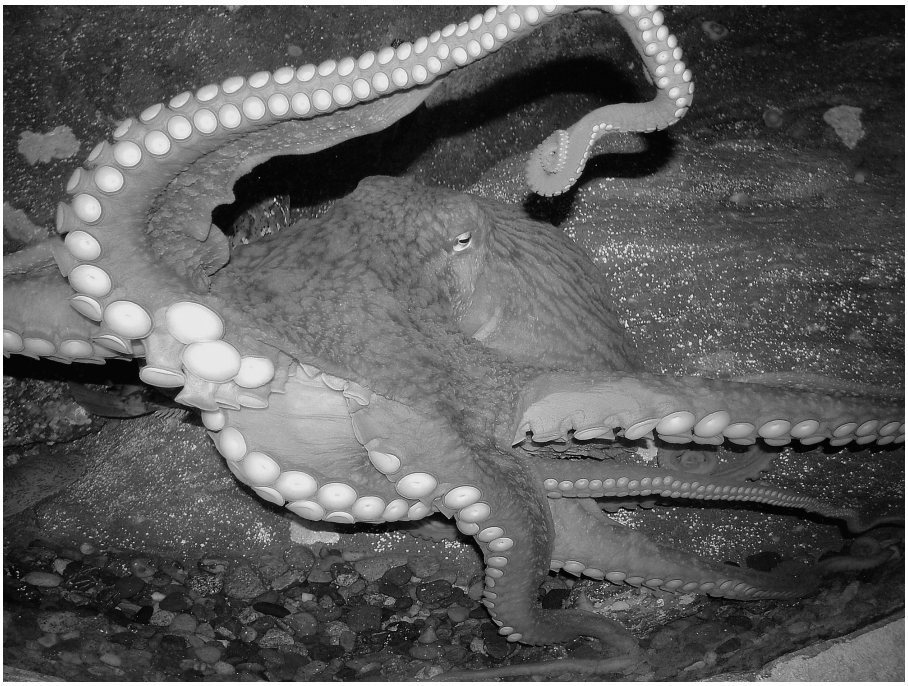

Figure 4. The giant Pacific octopus (*Enteroctopus dofleini).* Photograph © the Seattle Aquarium.

Summer Workshops

The busy field season coincided with a busy season for analysts to hone skills and obtain new ideas. Three major workshops (funded by outside sources) were coordinated by REFM Division staff: one on the spatial structure and dynamics of pollock in the Bering Sea, another on the practical considerations for natural mortality specifications in stock assessments, and the third on management strategy evaluations for southern bluefin tuna. The tuna workshop involved refining the technical aspects of developing an operating model (conditioned on available data) from which alternative management approaches can be tested. The other two workshops are summarized below.

Workshop on spatial structure and dynamics of walleye pollock in the Bering Sea

A 4-day workshop was hosted by the AFSC with outside funding from the Pollock Conservation Cooperative Research Center was convened 7-10 July 2009 to synthesize relevant information and modeling of the spatial structure and dynamics of the walleye pollock population in the Bering Sea. The synthesis was needed to address issues related to ecosystem effects of one of the world's largest fisheries on a finer temporal and spatial scale than is currently available. Workshop sessions reviewed empirical information from research surveys, the commercial fleet, and factors that influence the spatial distribution of pollock on seasonal and daily scales. Oceanographic and environmental conditions related pollock food and predators to possible regime shifts and forces affecting early life survival.

Discussions throughout the week centered on a number of questions including:

- What mechanisms best explain pollock spatial distribution? What are the tradeoffs of different movement model approaches (i.e., estimation features, scalability, data requirements)?
- Are technological issues for tagging studies prohibitive? What is the ideal field study to determine movement? What type of tag, what type of recovery effort and other design issues (e.g., sample sizes, locations, cost, logistics) should be considered? How have simulation studies shown the importance of tagging data? How would conventional tagging improve understanding of spatial processes? Can directed fishing where data are missing improve seasonal spawning distribution information?
- Has spatial modeling resolved retrospective patterns? Will spatial modeling reduce uncertainty (relevant for ABC/ACL specification)? How should current evidence of pollock movement be used to modify management approaches? How can spatially explicit modeling aid in operating model development to test management strategies?

Recommendations arising from these discussion points included:

- Continue model developments by disaggregating the present assessment model (e.g., developing seasonally and spatially disaggregated models where movement between areas may be included). This could form the basis of an operating model to test the simpler model that is presently used for management. One specification might be to have a single area-model but with fisheries spatially and seasonally defined.
- Conduct a synthesis of available information on population structure of pollock and develop a conceptual model of population structure (e.g., along the lines done by Kotenev and Glubokov 2007).
- Evaluate the implication of movement and fishery patterns on underlying stock-recruitment patterns.
- Examine the consistency of spawning aggregations year after year—are they the same group of fish? Can microconstituents or other method be used to identify a signature for these fish? For example, do Bogoslof spawning fish reside on the shelf during other

times of year? Examine spawning throughout the year, including the fall when roe is less of a target fishery.

- Promote further funding to determine whether tagging pollock is feasible. Such a pilot project should be designed to begin testing hypotheses on movement and spatial structure for EBS pollock. Also, consider the use of temperature recorders with the tag (technology has made them inexpensive and about the size of a dime).

- Extend the cooperative program for acoustic data loggers aboard commercial vessels to do additional directed transects to help fill in gaps on the seasonal distributions.

- Use caution when adding spatially explicit recommendations for catch levels for stocks that are relatively mobile since the uncertainty for spatially-disaggregated estimates is likely to increase. (For unit stocks, spatially explicit management recommendations generally occur for relatively stationary species).

Workshop on natural mortality in stock assessment applications

As part of the national program to improve interaction among fisheries stock assessment scientists, the Office of Science and Technology (through the Stock Assessment Methods working group) held a workshop at the AFSC on 11-13 August 2009. The meeting drew international experts and interested colleagues from each science center (25 NOAA participants) and representatives from universities and other agencies (18 participants). A large set of literature was compiled and made available for the workshop; the report of discussions and extended abstracts is in preparation.

The terms of reference for the workshop were: 1) identify and compare *alternative methods* of estimating natural mortality rates for conducting stock assessments, 2) make recommendations for *best practices* for estimating natural mortality rates, 3) *provide examples* of natural mortality rate estimation, and 4) prepare a *document* addressing these recommendations that will be used to guide future assessments by NMFS. Professor Kai Lorenzen (from Imperial College, London, UK) was guest speaker and provided talks on approaches he has used in a variety of settings and proposed a "Best Ad-hoc Mortality Model" (BAMM). This approach ties life-history specific characteristics (e.g., the onset of sexual maturity) to physiological changes that affect mortality rates with age. The workshop reviewed a variety of other dimensions related to natural mortality including how rates may change over time and the impact of factors such as changes in predator abundances and environmental conditions. Gender differences in natural mortality rates were also highlighted in a number of the presentations and in discussions.

In terms of information, a set of categories was proposed for approaches based on available information. For low information species, natural mortality estimates are often derived from life history correlates and are typically fixed. For stocks with moderate information, estimates may be available from numbers-at-age (e.g., via a catch curve analysis) or from tagging data and may consider gender differences. For data-rich stocks, mortality estimates may be derived from integrated analysis using size and/or age data providing that a fleet (or survey) can be adequately modeled with asymptotic selectivity, potentially with time-specific patterns. For the highest level of information available, natural mortality would have information that reliably links trophic interactions through ecosystem analyses.

By Jim Ianelli

Report of the BEST/BSIERP Fish Component, Patch Dynamics, and Modeler's Workshop, Seattle

On 11-13 August 2009, members of the Fish Modeling and Patch Dynamics Components of the BEST/BSIERP program met to discuss and exchange research findings among the three groups. Thirty-nine scientists attended the meeting. Participants presented key research findings on the following topics: forecasting future climate, oceanography of the Bering Sea (spring – summer), oceanography of the Bering Sea (winter), responses of phytoplankton and zooplankton to oceanography, oceanographic impacts on adult fish spatial distributions, adult fish vertical distributions, forage fish spatial distributions, patch dynamics, fish diets, foraging responses, climate impacts on the timing and distribution of spawning, dynamic climate downscaling for the regional ocean modeling system, nutrient phytoplankton zooplankton detritus and benthos model, Forage and Euphausiid Abundance in Space and Time (FEAST), and socioeconomic responses to climate. Overall, it was clear that the BEST/BSIERP program already is providing new information on the present and future status of the Bering Sea under a changing environment. A report summarizing the results of the workshop has been prepared and released to NPRB principal investigators.

By Anne Hollowed

AGE & GROWTH PROGRAM

Production Numbers

Age readers in the Age and Growth Program have been busy ageing hard structures for both production species and special research projects. Estimated production numbers for the period from 1 January through 30 September '09 include 19 speciesfor a total of 28,958, with 6,980 test ages and 399 that were determined to be unageable.

Species	Specimens Aged
Alaska plaice	353
Arctic cod	1,205
Atka mackerel	1,026
Bigmouth sculpin	40
Blackspotted rockfish	390
Dusky rockfish	515
Flathead sole	470
Greenland turbot	944
Northern rock sole	1,122
Northern rockfish	1,083
Pacific cod	3,801
Pacific ocean perch	1,305
Quillback rockfish	52
Rex sole	1,589
Rougheye rockfish	420
Sablefish	2,393
Shortraker rockfish	1,202
Walleye pollock	9,667
Yellowfin sole	1,381

By Tom Helser