Auke Bay Laboratories (ABL)

HABITAT ASSESSMENT & MARINE CHEMISTRY PROGRAM

Aleutian Survey Reveals New Species of Benthic Marine Algae

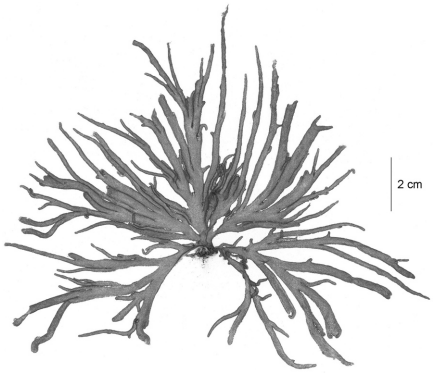

Figure 1. A new species of red seaweed, *Dudresnaya* sp., endemic to the Aleutian Islands.

Benthic marine algae have been poorly surveyed in the Aleutian Islands due to the remote and harsh nature of this island archipelago which spans over 1,800 km from the Alaska Peninsula to Attu Island. Surveys conducted during 2006 and 2007 by the Alaska Department of Environmental Conservation as part of the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program have resulted in a major collection of benthic marine algae. Mandy Lindeberg of Auke Bay Laboratories was an invited scientist who assisted in the collection and identification of all algae. Collections were made from 97 sites throughout 24 different islands of the Aleutian Archipelago resulting in a catalog of over 900 specimens. Preliminary results show 151 species have been identified including 16 new species, 9 of which appear endemic to the Aleutian Islands, and 52 new distribution records. Many of the new species belong to the phyla Rhodophyta or red seaweeds (Fig. 1).

A highlight of the collection is the discovery of a kelp representing a new genus and species we have formally named *Aureophycus aleuticus*. Many of the new species were discovered west of the biogeographic boundary Samalga Pass, a common finding among a variety of Aleutian marine species. A report describing the algal collections with distribution maps and photographs is forthcoming.

By Mandy Lindeberg

Fisheries Monitoring & Analysis (FMA) Division

FMA HOSTS ELECTRONIC FISHERIES MONITORING WORKSHOP

Participants representing Federal, state, and international agencies, nongovernmental organizations, observer providers, and members of the fishing industry met in July for a 2-day workshop on electronic fisheries monitoring technology (EM), which was held at the NOAA Sand Point facility in Seattle. The goal of the workshop was to assess the current state of EM in fisheries, its applicability to research and management of North Pacific fisheries, its potential, and to identify research and development needs. Interest in the use of EM for monitoring fisheries has increased in recent years due to growing needs and limitations of using onboard human observers for some applications. Several video-based EM applications have been developed, and many are currently in use in the North Pacific (Figs. 1 and 2). During the workshop, video applications within the context of broader electronic monitoring technologies and information systems and the potential for incorporation with other data and data acquisition systems were reviewed

The workshop's keynote address, presented by Howard McElderry, Archipelago Marine Research (AMR), focused on an assessment of the current state of video applications in fisheries in the United States and internationally. AMR has conducted numerous pilot studies on EM, and this technology is being used on approximately 500 fishing vessels. EM systems employ closed-circuit television cameras, a GPS receiver, a hydraulic pressure sensor, a winch sensor, and a system control box. These systems can be used on a variety of fishing vessels to monitor a range of information needs such as catch location, catch composition, catch handling, fishing methods, interactions with protected species, and mitigation measures. EM technology is a useful tool for fisheries monitoring and is viewed as an adjunct to, but not a replacement of, onboard (human) observers who can collect larger amounts of data on a more detailed level.

The keynote address and discussion were followed by five moderated panels consisting of panel member presentations and discussion. The first day of the workshop brought participants to a general understanding of the current knowledge related to use of EM in fisheries. The first panel was moderated by Martin Loefflad, FMA Director, and provided a summary of the lessons learned to date from video applications in fisheries. The second panel, moderated by Nicole Kimball, North Pacific Fishery Management Council (NPFMC), shared perspectives from the fishing industry. The challenges faced by the National Marine Fisheries Service (NMFS) in implementation of video systems were the focus of the third panel, moderated by Chris Oliver, NPFMC.

The second day of the workshop focused on the future of video monitoring in fisheries management. The fourth panel, moderated by Jennifer Watson, NMFS Alaska Regional Office, reviewed ongoing research projects and identified potential future applications of electronic monitoring in fisheries. Clarence Pautzke, North Pacific Research Board (NPRB), moderated the last panel, which focused on research and development advancements and future needs. The workshop concluded with a preliminary synthesis of the presentations and panel discussions as well as an opportunity for all participants to comment.

The FMA Division has been involved in several projects to assess the use of EM in the North Pacific groundfish fisheries. Research conducted during the Gulf of Alaska rockfish fishery in 2007 and continuing in 2008 is evaluating the use of EM to quantify the amount of Pacific halibut discarded at sea by trawl vessels. During 2008 FMA staff have been working with staff from the International Pacific Halibut Commission and AMR to collect data to

Figure 1. Electronic monitoring gear (foreground) being prepared for installation on a longline vessel. One of the video cameras that will be mounted to the vessel is in the lower left corner.

Figure 2. An observer (facing camera) collects data while two cameras, shown in the upper right quadrant of the image, videotape fish captured on longline gear.

evaluate the use of EM and standard observer sampling methods on commercial longline vessels that are not required to carry observers due to the small size of the vessels. The field component of this project will be completed this year. EM technology is currently in use, along with onboard observers, on specific catcher processor vessels in the Bering Sea/Aleutian Islands fisheries.

EM has potential for enhancing at-sea monitoring needs, yet it cannot meet all monitoring needs. The technology may be useful for monitoring catch handling on a variety of fishing vessels. On some vessels multiple cameras may be required to effectively monitor all areas of catch handling and for some vessels this may not be feasible. EM may also be used to monitor fishing duration and location issues. Biological sampling is a critical component of many at-sea monitoring programs, and EM alone is not effective in meeting this objective. Collections of biological data such as fish length and weight as well as otolith and tissue samples are best performed by onboard observers. Investigations into use of EM continue to improve its utility and assess the applicability of EM to a variety of at-sea monitoring needs.

The workshop proceedings are available online at http://www.fakr.noaa.gov/scales/elecmonworkshop_proceedings2008.pdf .

By Allison Barns and Patti Nelson

Habitat & Ecological Processes Research

AFSC OCEAN ACIDIFICATION RESEARCH PLAN PUBLISHED

The North Pacific Ocean is a sentinel region for signs of ocean acidification. Approximately 30%-50% of global anthropogenic carbon dioxide (CO_2) emissions are absorbed by the world's oceans. Dissolving CO_2 increases the hydrogen ion (H+) concentration in the ocean, and thus reduces ocean pH. Corrosive waters reach shallower depths more so in the North Pacific than in other ocean basins, especially in Alaska, and so biological impacts will likely occur earlier than in many other places. Ocean acidification reduces the calcium carbonate ($CaCO_3$) saturation point, which stresses calcifying organisms by making calcification more difficult.

The Alaska Fisheries Science Center Ocean Acidification Research Plan focuses on commercially important fish and shellfish species, their prey (calcareous plankton) and shelter (corals). Ocean acidification will likely impact the ability of marine calcifiers, such as corals and shellfish, to make shells and skeletons from $CaCO_3$. Ocean acidification may also affect fish, marine mammal, and seabird species through reduced abundance of calcareous plankton at the base of the food web. Species-specific studies of shellfish, calcareous plankton, corals and fish will be conducted to understand physiological effects (growth and survival). The $CaCO_3$ content of calcareous organisms is not well known and a survey of shellfish, calcareous plankton and corals will be conducted to assess species vulnerabilities to ocean acidification. The results of the species-specific studies will be incorporated into population and ecosystem models to forecast population and ecosystem impacts. Bioeconomic models of Alaskan crab fisheries will be used to forecast fishery performance for a range of climate and ocean acidification scenarios.

By Mike Sigler

National Marine Mammal Laboratory (NMML)

ALASKA ECOSYSTEMS PROGRAM

Steller Sea Lion Research, Summer 2008

The National Marine Mammal Laboratory's (NMML) Alaska Ecosystems Program (AEP) conducted fieldwork in July–September 2008 in support of the following Steller sea lion (*Eumetopias jubatus*) research projects (see Fig. 1 for geographic extent of field work in summer 2008): 1) Abundance Trend Monitoring of Steller Sea Lions in Alaska, 2) Steller Sea Lion Vital Rates, 3) Steller Sea Lion Stock Structure Investigations, 4) Steller Sea Lion Foraging Ecology and Health Studies, and 5) Food Habits of Steller Sea Lions and Northern Fur Seals.

The primary field activity associated with the Abundance Trend Monitoring of Steller Sea Lions in Alaska project was an aerial survey of more than 350 terrestrial rookery and haul-out sites in Alaska, conducted 7 June–6 July, from Dixon Entrance in Southeast Alaska to Attu Island at the western end of the Aleutian Islands. The main objective of the survey was to photograph and count adult and juvenile Steller sea lions for population status and trend determination. The survey was conducted using a deHavilland Twin Otter aircraft piloted by LCDR Mark Nelson and LCDR Nicole Cabana, with assistance from mechanic Michael Merek, from the NOAA Aircraft Operations Center, in Tampa, Florida. Scientific personnel on the survey were Kathryn Sweeney (AEP) and Morgan Lynn and Jim Gilpatrick (Southwest Fisheries Science Center).

Digital images were captured with a Canon EOS-1Ds Mark III digital camera (22 megapixels), with a 50-mm f1.2 lens, using a computer-controlled mount with forward-motion compensation. Location, time, altitude (from a radar altimeter), frame number, and mount settings were automatically logged for each image. The camera was oriented vertically and images were shot through the plane's belly port, which was open to the outside. This was the first use of this camera for the survey as well as the first survey in which only digital photography was used. The 2008 nonpup survey was the most complete adult and juvenile survey since 2004. During over 90 hr

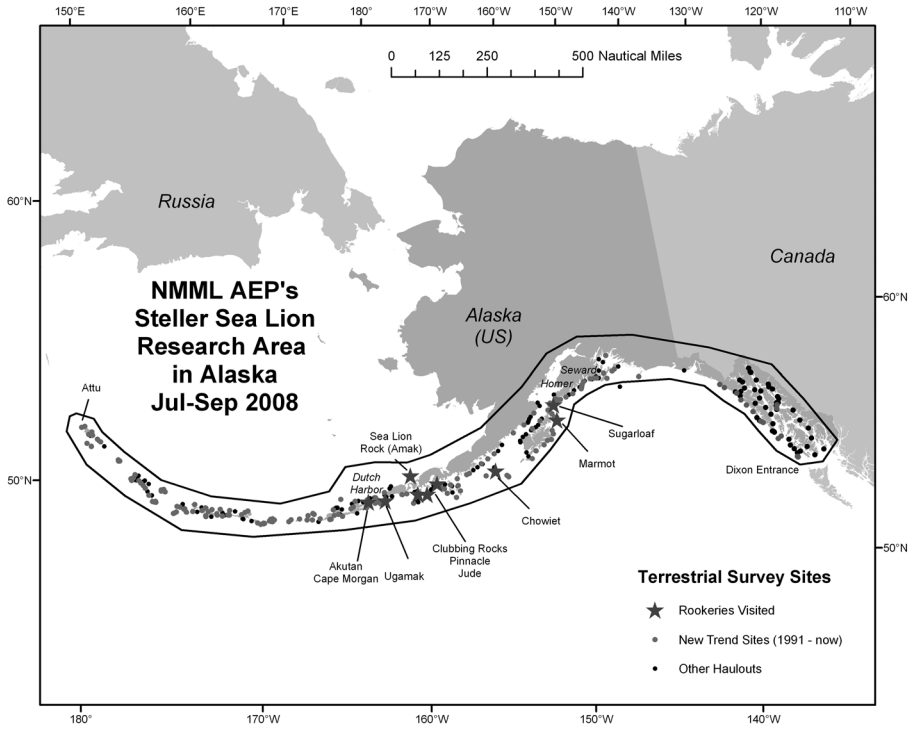

Figure 1. The Alaska Ecosystems Program's (AEP) Steller sea lion research area in Alaska, July–September 2008. Outlined area shows the extent of the aerial survey for adult and juvenile Steller sea lions. Rookeries visited during the pup capture, condition, and branding cruise are shown, along with the locations of the two field camps on Marmot and Ugamak Islands.

of flight time, covering approximately 8,000 miles of Alaska's southern coast, 341 of the 356 known rookery and haul-out sites were surveyed, along with 167 of the 173 sites used to monitor population trends. Results from the survey will be available in November 2008.

Estimation of survival and reproduction (vital rates) is fundamental to understanding any potential cause of the decline of the Steller sea lion population in Alaska and provides a mechanism to monitor their recovery. Mark-recapture (or resighting) studies are the best way to determine vital rates by sex, age, region, and cohort. The AEP reinitiated marking studies in 2000 by hot-branding pups born on two rookeries (Marmot and Sugarloaf) in the central Gulf of Alaska near Kodiak. In subsequent years, pups were branded on two rookeries near Prince William Sound (Fish and Seal Rocks) and another in the eastern Aleutian Islands (Ugamak). Through 2005, a total of 1,449 pups had been branded. No pups were branded in 2006 and 2007, pending the completion of an Environmental Impact Statement on Steller sea lion research activities written in response to a lawsuit filed by the Humane Society of the United States.

The AEP conducted three field projects in summer 2008 that contributed significantly to the Steller Sea Lion Vital Rates research project:

Pup capture, branding, and condition cruise aboard the U.S. Fish and Wildlife Service research vessel *Tiglax*, 24 June–7 July 2008, between Dutch Harbor and Homer, Alaska: AEP personnel on the cruise included Kate Call, Brian Fadely, Tom Gelatt, Carey Kuhn, Michelle Lander, Jeremy Sterling, Jim Thomason, and Rod Towell. Other participants included Eric Boerner and Bob Caruso (both of NMML), Kimberlee Beckman (DVM, Alaska Department of Fish and Game), and Heather Harris (DVM, The Marine Mammal Center). As part of the vital rates project, 178 pups were hot-branded with individual marks at Sugarloaf Island (5 July; N = 93) and at Marmot Island (6 July at Beach 4; N = 85). Each pup was also weighed, measured, and sexed, and skin and blood samples were taken from a subsample as part of the Steller Sea Lion Stock Structure Investigations and Steller Sea Lion Foraging Ecology and Health Studies projects, respectively. Approximately 50 pups were also weighed, measured, and sexed at each of six rookeries in the eastern Aleutian Islands, western Gulf of Alaska, and central Gulf of Alaska (Akutan/Cape Morgan, Sea Lion Rocks, Clubbing Rocks, Pinnacle Rock, Jude, and Chowiet); in addition, skin and blood samples were taken from approximately 25 of these pups. Scat samples were also collected at rookeries as part of the Food Habits of Steller Sea Lions and Northern Fur Seals research project.

Resightings of branded sea lions from the chartered research vessel *Norseman*, 17 June–11 July 2008, between Dutch Harbor and Seward, Alaska: AEP personnel on this cruise included Sara Finneseth, Lowell Fritz, and Carolyn Gudmundson. Steller sea lions were observed at more than 100 rookery and haul-out sites between the eastern Aleutian Islands and Prince William Sound. A total of 207 individual branded sea lions were observed and positively identified; 160 were branded as pups within the range of the endangered western population (west of 144°W through Alaska and Russia), 14 were branded as pups within the range of the threatened eastern population (east of 144°W through Southeast Alaska, British Columbia, Washington, Oregon, and California), and 33 were branded as juveniles captured on land or at sea away from their natal rookery. In addition, particular attention was paid to the observation of 72 marked adult females to determine whether they had given birth in 2008 or in a previous year (if they were observed nursing a juvenile). Cruise participants assisted with branding operations at Sugarloaf and returned to the site the following day to monitor post-disturbance recovery at the rookery.

Resightings of branded sea lions by observers based at field camps on Marmot and Ugamak Islands, late May–early August 2008: Jason Jones and Paula von Weller were stationed at the south end of Marmot Island from 28 May to 28 July 2008, where they identified 138 individual, branded animals for survival analyses; 28 of these animals were adult females, which were also monitored for reproductive activity. Kathryn Chumbley (AEP), Naomi Worcester, and Alyse Forrest were stationed at the north end of Marmot Island from 28 May to 28 July 2008. They identified 110 individual, branded animals for survival analyses, 16 of which were adult females. Perry Comolli, Mary Malley, and

Rebecca Scott were stationed on Ugamak Island from 2 June to 31 July 2008, where they identified 141 individual, branded animals (including 42 adult females) for survival analyses. In addition to looking for branded animals, field camp scientists also counted animals on each haulout and rookery beach as frequently as weather permitted and conducted behavior scans. Personnel on Marmot Island also monitored the recovery of the rookery at Beach 4 following the research disturbance associated with pup branding on 6 July.

By Lowell Fritz

Northern Fur Seal Research, Summer 2008

The Alaska Ecosystems Program (AEP) conducted fieldwork in July–September 2008 in support of the following northern fur seal (*Callorhinus ursinus*) research projects: 1) Annual Population Assessments, 2) Mortality Studies on St. Paul Island, 3) Summer Foraging Behavior, 4) Vital Rates, and 5) Food Habits of Steller Sea Lions and Northern Fur Seals.

Population assessments of northern fur seals consist of annual counts of adult males and biennial estimates of pup production on the Pribilof Islands (St. Paul and St. George), the primary breeding rookeries for the species in the North Pacific Ocean. Current adult male counts and estimates of pup production on the Pribilof Islands are approximately one-third the numbers estimated during the 1950s, when the population was assumed to be at its peak. Adult male northern fur seals have been counted annually since the early 1900s on the Pribilof Islands and provide an index of population trend; counts on both St. Paul and St. George declined by 37% between 1997 and 2007. In July 2008, John Bengtson and Robert Caruso (NMML) counted adult males on St. Paul, while Michael Williams (NMFS Alaska Regional Office) counted males on St. George. Pup production is estimated every other year using a mark-resampling technique involving the application of a temporary mark (shearing fur off the top of their heads) to thousands of pups and estimating the ratio of marked to unmarked pups (Fig. 2). This work requires a large field crew, which on St. Paul consisted of Kate Call, Brian Fadely, Sara Finneseth, Tom Gelatt, Carey Kuhn, Rolf Ream, Jeremy Sterling, Kathryn Sweeney, Jim Thomason, and Rod Towell (all of AEP), Robert Caruso (NMML), and others; on St. George, AEP staff included Lowell Fritz, Devin Johnson, Jeremy Sterling, and Jim Thomason. In August 2008, pup production field crews were on both St. Paul and St. George, and production estimates by rookery will be available in November 2008. Scat samples were also collected at rookeries as part of the Food Habits of Steller Sea Lions and Northern Fur Seals research project.

AEP scientists assess on-land mortality of northern fur seals on St. Paul Island during the summer months. Dead northern fur seal pups, juveniles, and adults were collected at selected sites, and necropsies were conducted by a veterinarian (Dr. Terry Spraker, Colorado State University) to determine the causes of mortality. This research is used to assess factors influencing mortality during the summer months and to identify changes or trends in these factors.

Survival and health of northern fur seals is likely related to the quality of the habitat they occupy and use for foraging. The location and duration of foraging trips by lactating adult females during the summer months in the Bering Sea have been examined using satellite telemetry. After many years of satellite-tag deployments, AEP scientists have generally described the travel routes and summer foraging habitats of adult female fur seals from different rookeries on the Pribilof Islands and have identified the oceanographic features and fish resources associated with these habitats. To obtain more detailed and higher-resolution data on adult female foraging, AEP scientists, led by Carey Kuhn, deployed stomach-pill telemeters in combination with GPS tags on adult female fur seals (with pups) on St. Paul Island in August 2008 to identify the occurrence and precise location of feeding events. Data are stored on these tags and the tagged animals will be recaptured in October 2008.

In fall 2007, AEP scientists, led by Ward Testa and Devin Johnson, initiated a tagging program on St. Paul to allow the estimation of survival and reproductive rates of adult female fur seals. The study was designed to evaluate the use of flipper tags and included the development of new statistical methods to estimate tag loss as well as new resighting methods that were implemented in summer 2008 by Oregon State University graduate student and former AEP scientist Erin Kunisch.

By Lowell Fritz

Figure 2. Photograph of northern fur seal pups on St. Paul Island, showing those with and without the temporary shear marks used for pup production estimation. Photo by Kathryn Sweeney.

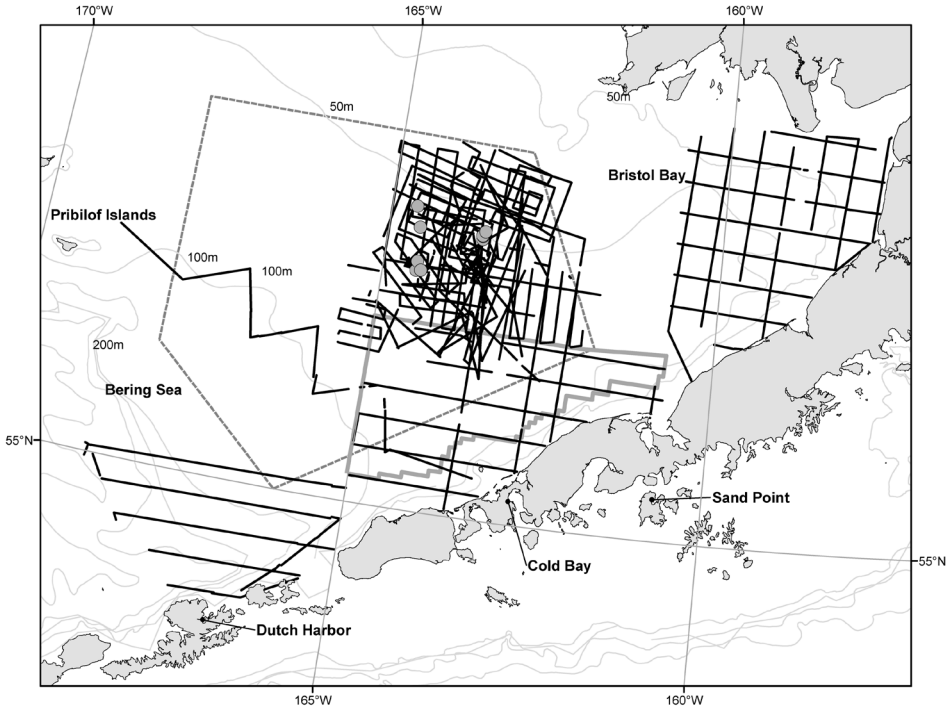

Figure 1. PRIEST 2008 aerial sighting and effort map. Dotted line indicates right whale critical habitat, thick gray line indicates vessel survey area, thick black lines indicated aerial survey effort, and large gray dots indicate right whale sightings.

CETACEAN ASSESSMENT & ECOLOGY PROGRAM

Pacific Right Whale Evaluation Study (PRIEST) July–August 2008

After an aerial survey plane crash in New Jersey in May 2008 took the life of observer Stephen Claussen, the PRIEST (Pacific RIght whale Evaluation STudy) aerial survey project was faced with a difficult task. Not only were we grieving for a beloved friend, but we were also faced with pulling together a survey on short notice, since Stephen was the lead observer for this project. With heavy hearts, we persevered through the difficult times and completed a successful aerial survey.

Through an interagency agreement between NMFS and the Minerals Management Service (MMS), NMML's Cetacean Assessment and Ecology Program (CAEP) is conducting a multiyear study on the distribution, abundance, and habitat use of North Pacific right whales in the North Aleutian Basin and southeastern Bering Sea using aerial and vessel surveys. The aerial surveys for this project included two components: 1) detection of right whales for the vessel survey and 2) aerial support during satellite-tagging operations. Survey design consisted of north-south and east-west transects covering Bristol Bay west to the Pribilof Islands. Initial aerial surveys, prior to arrival of the chartered research vessel, *Ocean Olympic*, focused on transect lines to identify concentrations of whales to optimize vessel time for the tagging and oceanographic components of this study. Upon arrival of the ship, aerial surveys were modified to help locate acoustically detected right whales, obtain photographs, and provide support during tagging operations.

Based out of Sand Point, Alaska, the aerial team conducted surveys in the Bering Sea, from 18 July to 31 August 2008, led by Chief Scientist/Right Whale Survey Coordinator Brenda Rone (CAEP) along with observers Jeff Foster and Greg Fulling. The aerial survey (146.8 flight hr) was flown in an Aerocommander 690A operated by Northern Commanders at an altitude of 229 m (750 ft) and a speed of 204 km/hr (110 knots). The team surveyed a total of 12,331 km (6,655 nautical miles) of trackline and documented several species, including three separate sightings of North Pacific right whales on 5, 21, and 28 August for a total of 13 animals (8 individuals) (Fig. 1). Operations were conducted using two observers in bubble windows and a third observer seated in the back acting as data recorder, observer, and photographer. When a right whale was sighted, flat passes over the animal were attempted until quality images for photo identification were obtained through the plane's belly port (Fig. 2).

During tagging operations, two 25-ft inflatable boats were launched from the *Ocean Olympic*. Both the plane and the ship served as support platforms for the inflatables by providing detailed sighting and behavioral information to the tagging crew. Countless hours of survey time paid off when a satellite tag was successfully placed on a right whale on 21 August 2008. As the three platforms worked together in a collaborative effort, the tag was implanted and all breathed a sigh of relief when the PRIEST project achieved its goal (Fig. 3).

By Brenda Rone

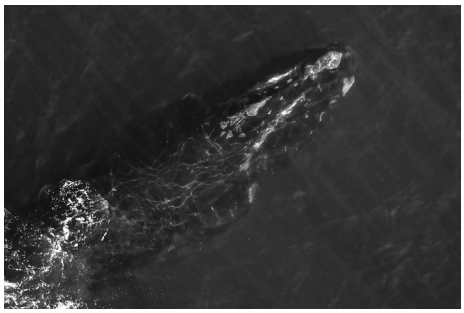

Figure 2. Subsurface North Pacific right whale displaying the callosity pattern used in identification of individuals. Photo by Brenda Rone.

Figure 3. PRIEST 2008 satellite-tagged North Pacific right whale. Photo by Brenda Rone.

Resource Assessment & Conservation Engineering (RACE) Division

GROUNDFISH ASSESSMENT PROGRAM

Annual Eastern Bering Sea Continental Shelf Bottom Trawl Survey: Groundfish

The twenty-seventh in the series of annual bottom trawl surveys of the eastern Bering Sea (EBS) continental shelf was completed on 28 July 2008 aboard the AFSC chartered fishing vessels *Arcturus* and *Aldebaran*. Scientists from the AFSC, Alaska Department of Fish and Game, and the International Pacific Halibut Commission participated in the survey and completed standardized biological sampling of crab and groundfish resources at 376 stations (Fig. 1). Three hundred fifty-six of these stations have been sampled annually since 1982, and the additional 20 stations in the northwest have been sampled every year since 1987 to investigate the northern distribution and abundance of opilio (snow) crabs and commercial fish species in response to the changing climate (Fig. 1). Abundance and biomass estimates and analyses of size and age composition will be generated for selected commercial groundfish species and used in the annual stock assessments of EBS groundfish.

Data collections from the EBS shelf trawl survey included: 163,523 individual length measurements representing 22 fish taxa; 8,427 age structures representing 12 fish taxa; 6,730 stomach samples representing 12 fish taxa, and 3,442 pathobiology samples from 6 different fish and invertebrate taxa. In addition to standard survey operations, there were 25 special research projects conducted during the 2008 trawl survey including the third year in a series for two projects: collecting acoustic data on midwater walleye pollock (*Theragra chalcogramma*) to augment the biennial Midwater Assessment and Conservation (MACE) Program echo integration-trawl time series, and collecting summer bongo samples to monitor distribution and abundance of zooplankton on the EBS shelf. It was also the first year for collecting a synoptic environmental dataset for the North Pacific Research Board (NPRB) Bering Sea Integrated Ecosystem Research Program (BSIERP). Data collections included profiles of light intensity, water temperature, and salinity for each trawl station. Using a newly installed sea chest, the *Aldebaran* made underway surface temperature, salinity, nitrate, chlorophyll and dissolved oxygen measurements during the survey. In addition, temperature and salinity profiles were collected from most of the bottom trawl operations by attaching a conductivity-temperature-depth (CTD) profiler to the bottom trawl headrope.

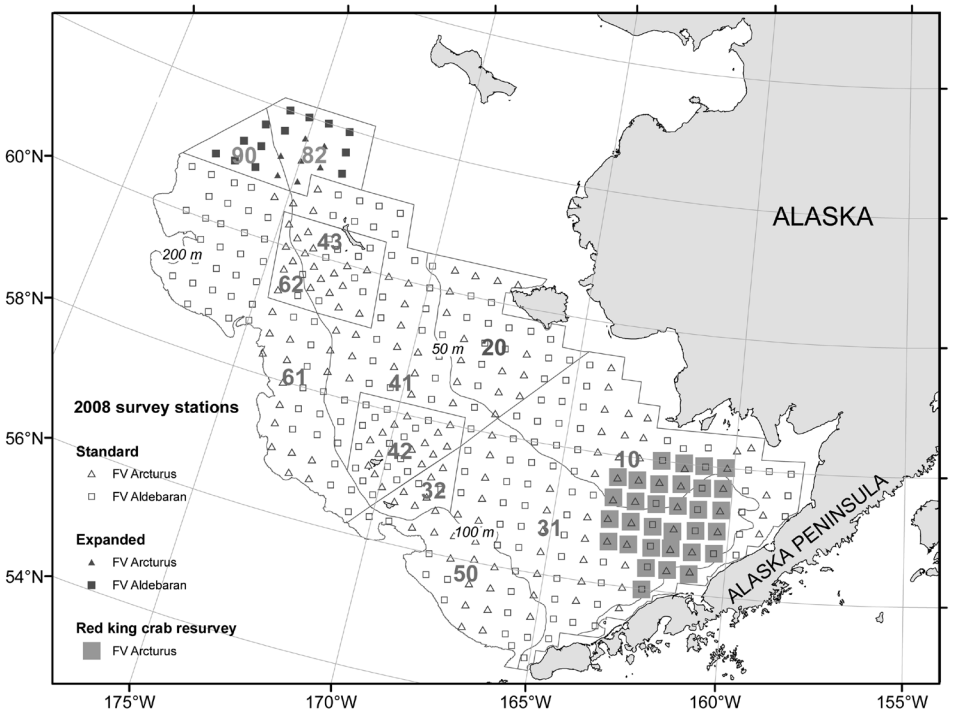

Figure 1. Standard and special study stations sampled during the 2008 eastern Bering Sea continental shelf bottom trawl survey. Geographic regions shown indicate strata used for analysis of groundfish catch data.

Bottom temperatures on the EBS shelf were on average cooler in 2008 as compared to 2007 (Fig. 2), and the cold pool (<2°C) extended farther south and east toward the Alaska Peninsula and into Bristol Bay. The cooler than average bottom temperatures also delayed molting and spawning of female red king crab in Bristol Bay, so 32 stations had to be resampled at the end of the survey after female red king crab had completed molting and spawning (Fig. 1)

Ninety-five percent of the trawl catches contained walleye pollock; the estimated total biomass decreased to 3.03 million metric tons (t) in 2008 from 4.34 million t in 2007 (Fig. 3). Catches of walleye pollock from the inner and middle shelves were composed mainly of 1-year olds that ranged in size from 10 to 20 cm. 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. Total biomass declined for the third straight year (0.40 million t; Fig. 3); however, the high abundance of 25 to 40 cm Pacific cod indicated a strong incoming 2006 year class. For all flatfishes except

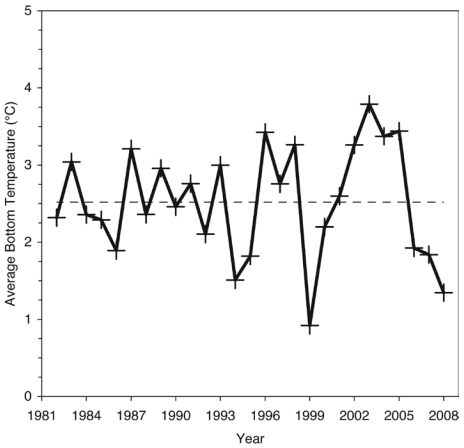

Figure 2. Average annual bottom temperatures standardized by day to 1 July from the eastern Bering Sea groundfish bottom trawl surveys, 1981-2008.

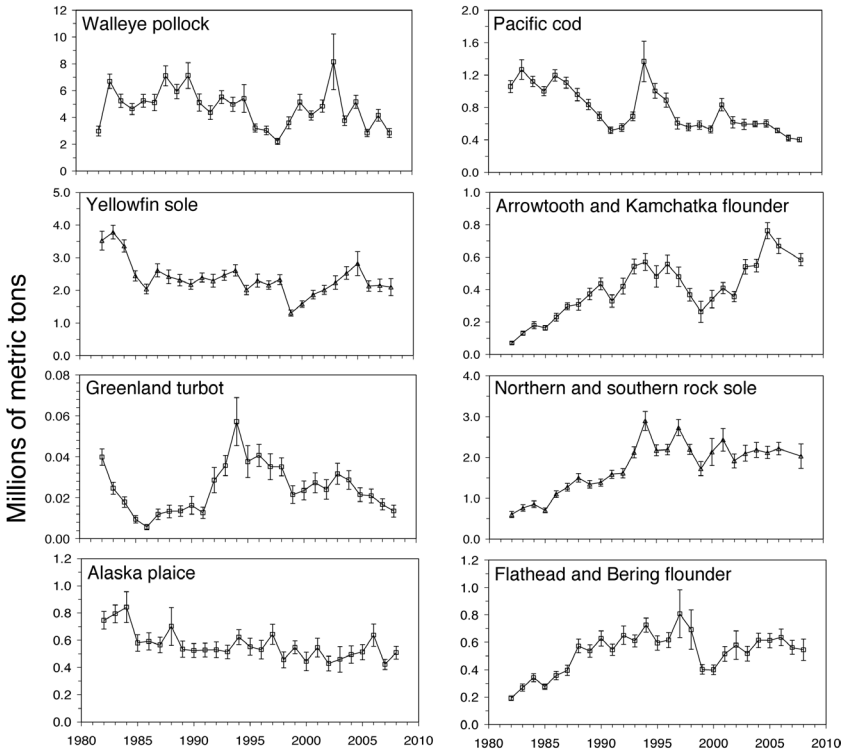

Figure 3. Plot of biomass (in million metric tons) for eight commercial fishes (or group of fishes) on the eastern Bering Sea shelf estimated from standardized trawl survey data collected by the AFSC from 1982 to 2008. Error bars represent the standard errors.

for Alaska plaice (*Pleuronectes quadrituberculatus*), the estimates of total biomass declined from 2007 to 2008, but trends were less clear because of the variance associated with these estimates (Fig. 3).

By Robert Lauth

2008 Biennial Eastern Bering Sea Upper Continental Slope Bottom Trawl Survey: Groundfish

During June and July 2008 the RACE Division conducted the biennial eastern Bering Sea upper continental slope groundfish survey. The 2008 survey marked the third effort that extended the time series comprising previous efforts in 2002 and 2004 (2006 not attempted). We completed 200 successful tows at depths of 200-1,200 m along the continental slope of the eastern Bering Sea from Akutan Island toward the northwest to the international boundary. The objectives of the survey are to describe the status and trends of groundfish and invertebrate resources by current composition, spatial and depth distribution, and relative abundance of groundfish and invertebrate resources, and to collect biological data from a variety of commercially and ecologically important species. In addition we collect environmental and ocean condition measurements such as bottom depth, surface and bottom water temperatures, light levels, and sea states to relate long-term changes in fish and invertebrate distribution with changes in oceanographic conditions.

By Gerald Hoff

Untrawlable Grounds Research in the Eastern Aleutian Islands

Biennial bottom trawl surveys conducted in the Gulf of Alaska (GOA) and Aleutian Islands (AI) by the RACE Division are a primary method of monitoring the status and trends of commercial groundfish abundance. These stock assessment surveys follow a stratified random sampling design. However, trawling is not possible in areas that are too rough, hard, or steep. Thus, a bias persists when using bottom trawl surveys to estimate groundfish biomass when the unknown (but presumed large) amount of the continental shelf is not accounted for with our standard survey bottom trawl gear.

In July 2008 we completed our second cruise using acoustics and video groundtruthing to develop methods for classifying trawlable and untrawlable grounds in the GOA and AI trawl survey areas. All operations were conducted aboard the NOAA ship *Miller Freeman*. Seabed acoustic backscattering was collected continuously along a series of transects with a Simrad ER60 scientific echosounding system incorporating four centerboard-mounted transducers (18, 38, 120, and 200 kHz). A towed camera and winch system with artificial lighting (Fig. 4) was used for video validation of acoustic data.

Only about half of the planned work was completed because the ship suffered mechanical problems and was forced to return to Dutch Harbor well before the completion of the cruise. Nevertheless, about 1,000 km of acoustic transect data (about 14 GB) were collected, along with over 10 hours of seafloor video and five CTD casts (Fig. 5). Vessel motion data, which is critical for correcting the acoustic returns, were successfully collected throughout the cruise. Seafloor substrate types ranged from soft mud to gravel to boulders, providing valuable contrast for distinguishing different acoustic signatures. We were able to locate limited areas of sponge and a skate nursery on a GOA Essential Fish Habitat closure area that is proposed as a potential Habitat Area of Particular Concern site. A new Atka mackerel (*Pleurogrammus monopterygius*) nursery area was also discovered.

Figure 4. A towed video camera system aboard the NOAA ship *Miller Freeman* is deployed during a study of untrawlable grounds in the eastern Aleutian Islands. Photo by Frank Shaw.

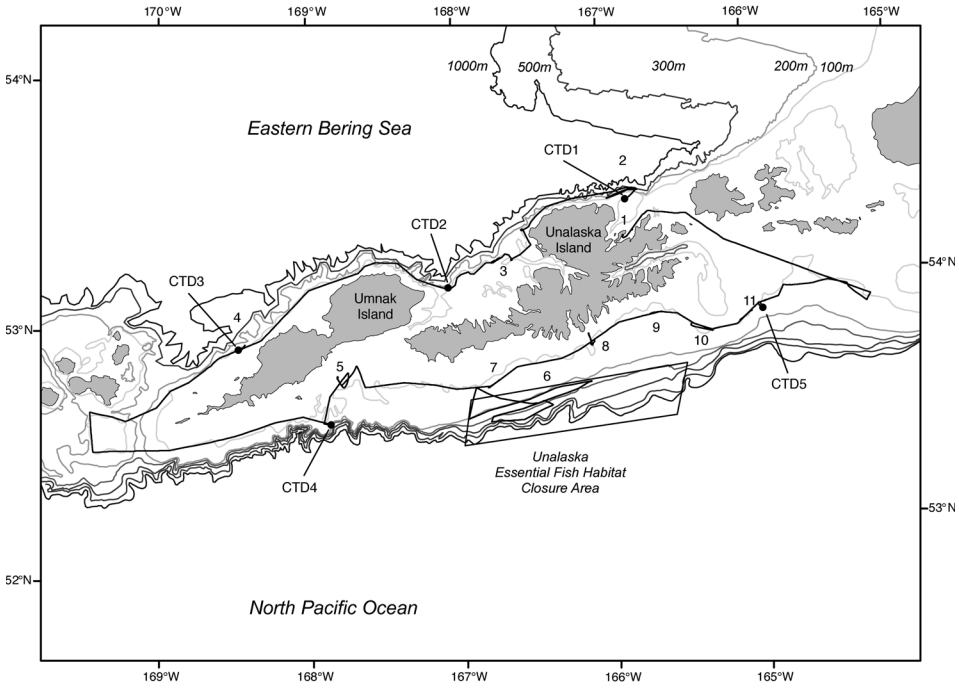

Figure 5. Transects completed during cruise MF0807. Black numbers indicate approximate locations of video camera drops. Black dots indicate conductivity-temeperature-depth (CTD) casts.

We thank John Harms of the Northwest Fisheries Science Center and Matt Barnhart and Jim Benante of the Pacific States Marine Fisheries Commission for the use of their camera system and for so graciously sharing their expertise with us. Scott McEntire (AFSC) provided technical expertise and equipment in preparation for this cruise.

By Mark Zimmermann

RACE Scientist Participates in North Atlantic Deepwater Trawl Survey

In September 2008 Jerry Hoff participated in a deepwater survey conducted in the North Atlantic by the Fisheries Research Services Marine Laboratory in Aberdeen, Scotland. Jerry served as an invited international scientist aboard the fishery research vessel *Scotia* joining scientists from Scotland, Russia, and Wales (Fig. 6). The 2008 survey was the 10th in an annual series conducted to assess the groundfish and invertebrate resources of the slope environment. The groundfish survey conducted trawls between 500 and 1,800 m along the western continental slope from northern Ireland to north of the Outer Hebrides Islands, Scotland.

During the cruise Jerry worked with lead scientist Francis Neat to understand his survey operations, approach, and long-term goals for the survey. Jerry gained insight into the challenges that appear common to deepwater surveys and exchanged ideas on survey standardization and deepwater habitat assessments. The trip was very informative and provided exposure to an entirely new fish and invertebrate fauna from that of the North Pacific and Alaska waters (Fig. 7).

By Gerald Hoff

SHELLFISH ASSESSMENT PROGRAM: KODIAK LABORATORY

Annual Eastern Bering Sea Continental Shelf Bottom Trawl Survey: Crab

The 2008 eastern Bering Sea bottom trawl survey conducted by the Groundfish and Shellfish Assessment Programs took place from 4 June to 24 July aboard the chartered fishing vessels *Aldebaran* and *Arcturus*

Figures 6. Participants in the deepwater survey conducted in the North Atlantic by the Fisheries Research Services Marine Laboratory display a catch of orange roughy (*Hoplostethus atlanticus)* aboard the fisheries research vessel *Scotia* off western Scotland in September 2008. Scientists from Scotland, Wales, Russia, and the United States participated.

Figure 7. Gerald Hoff holding a large ratfish (*Hydrolagus pallidus*) collected during September 2008 aboard the *Scotia* off the west coast of Scotland.

(Fig. 1). Three hundred seventy-five standard stations were sampled starting from Bristol Bay and moving west past St. Matthew Island on the Bering Sea shelf. In addition, three extra stations were sampled after encountering a *Paralithodes camtschaticus* (red king crab) and *Chionoecetes bairdi* (Tanner crab) "hot spot," defined as 100 or more legal-sized males. Over 50,000 individual crab of five commercially important species, including red king crab, *P. platypus* (blue king crab), *C. opilio* (snow crab), Tanner crab and *Erimacrus isenbeckii* (hair crab) were measured, and other biometric data such as shell and egg condition, weight, chela height, and presence of parasitism were recorded. Several special studies were conducted in addition to the assessment, including reproductive potential of snow and red king crab, hemolymph collections from *Chionoecetes* spp. to monitor bitter crab syndrome, and population genetics studies of *Paralithodes* spp.

Figure 1. Scientists (Joel Webb, Duane Stevenson, Nancy Roberson, Claire Armistead, Jay Clark, Jason Conner) measuring crab caught in a Tanner and red king crab hot spot tow. Photo courtesy of Nick Malahovsky.

Table 1. The 2007 and 2008 abundance estimates (± 95% confidence interval) for legal and preferred sized males (millions of crab) of commercial crab stocks in the eastern Bering Sea.

Stock	2008	2007
Bristol Bay District red king crab	10.5 ± 3.1	13.3 ± 5.3
Pribilof District red king crab	1.2 ± 1.1	1.6 ± 1.3
Pribilof District blue king crab	0.02 ± 0.04	0.11 ± 0.08
St. Matthew Island Section blue king crab	1.7 ± 0.9	1.4 ± 0.9
Tanner crab, all districts	13.2 ± 7.4	12.1 ± 6.8
Snow crab, all districts	368.6 ± 75.9	495.2 ± 134.8
Snow crab, all districts > 4.0 inches	119.7 ± 27.5	150.9 ± 61.6
Hair crab, all districts	2.3 ± 1.1	2.0 ± 0.8

For the third time in as many years, after the majority of the standard stations were completed, one of the vessels returned to Bristol Bay to resample predetermined stations for red king crab. (See EBS groundfish survey summary, page 13.) 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, 99% of mature females had completed the mating and molting cycle and extruded new clutches.

Station locations and numbers of legal male red king crab, Tanner crab, and snow crab caught per square nautical mile are distributed in Bristol Bay and along the Bering Sea shelf. Due to low stock abundance, the fishery for blue king crab in the Pribilof District has been closed since 1999 and in the St. Matthew District since 1998. The red king crab fishery in the Pribilof District has also remained closed due to blue king crab bycatch concerns. Historically there was a fishery for hair crab, although there has not been one since 2000.

The 2008 abundance estimates for the five commercial crab species relative to the 2007 survey results showed a decrease in survey abundance in many stocks (Table 1). The 2008 abundance estimates for prerecruit male and females showed variable results compared to recent trends but are characterized by a large amount of uncertainty. These data and additional station information are available in the NOAA Technical Memorandum *The 2008 Eastern Bering Sea Continental Shelf Bottom Trawl Survey: Results for Commercial Crab Species*. The publication is posted on the AFSC website at http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-187.pdf.

By Jan Haaga, Liz Chilton, and Claire Armistead

MIDWATER ASSESSMENT & CONSERVATION ENGINEERING PROGRAM

Acoustic Measurements of Fish and Plankton in the Ice-Covered Areas of the Eastern Bering Sea

Scientists from the Midwater Assessment and Conservation Enginteering (MACE) Program conducted a study of the abundance and distribution of fish and plankton in the eastern Bering Sea in relation to seasonal sea ice cover. The goal of this work was to improve our understanding of the relationship between the abundance of fish and other animals and the position of the Bering Sea ice edge. Although major interannual changes in ice extent and ice persistence in the Bering Sea have been documented, little is known about the impacts of ice cover on the distribution of fish and plankton during winter months when much of the shelf is covered by ice. Previous work conducted during the ice-free summer months has shown that many species in the Bering Sea avoid the cold temperatures, and it is likely that areas of melting sea ice act as a barrier for fish due to the formation of very cold water at all depths. Because ice cover makes it difficult to sample fish with conventional sampling gear such as nets, acoustics was used to measure the distribution of fish in ice-covered waters.

MACE scientists worked with the vessel's crew to instrument the U.S. Coast Guard icebreaker *Healy* with scientific fishery echosounders. The equipment was used during the 13 March to 6 May cruise in the eastern Bering Sea as part of the interdisciplinary BEST (Bering Sea Ecosystem Study) program funded by the National Science Foundation. Although 2008 was a year of exceptionally heavy ice cover in the Bering Sea, *Healy's* icebreaking capabilities allowed extensive survey coverage of the ice-covered areas. In addition, the NOAA ship *Oscar Dyson* used the same instrumentation to survey in open water and in the marginal ice zone at the same time. A multifrequency echosounding technique was used to distinguish acoustic backscatter from plankton and fish.

Although analysis of the acoustic backscatter is only partially completed, preliminary results indicate that the abundance of

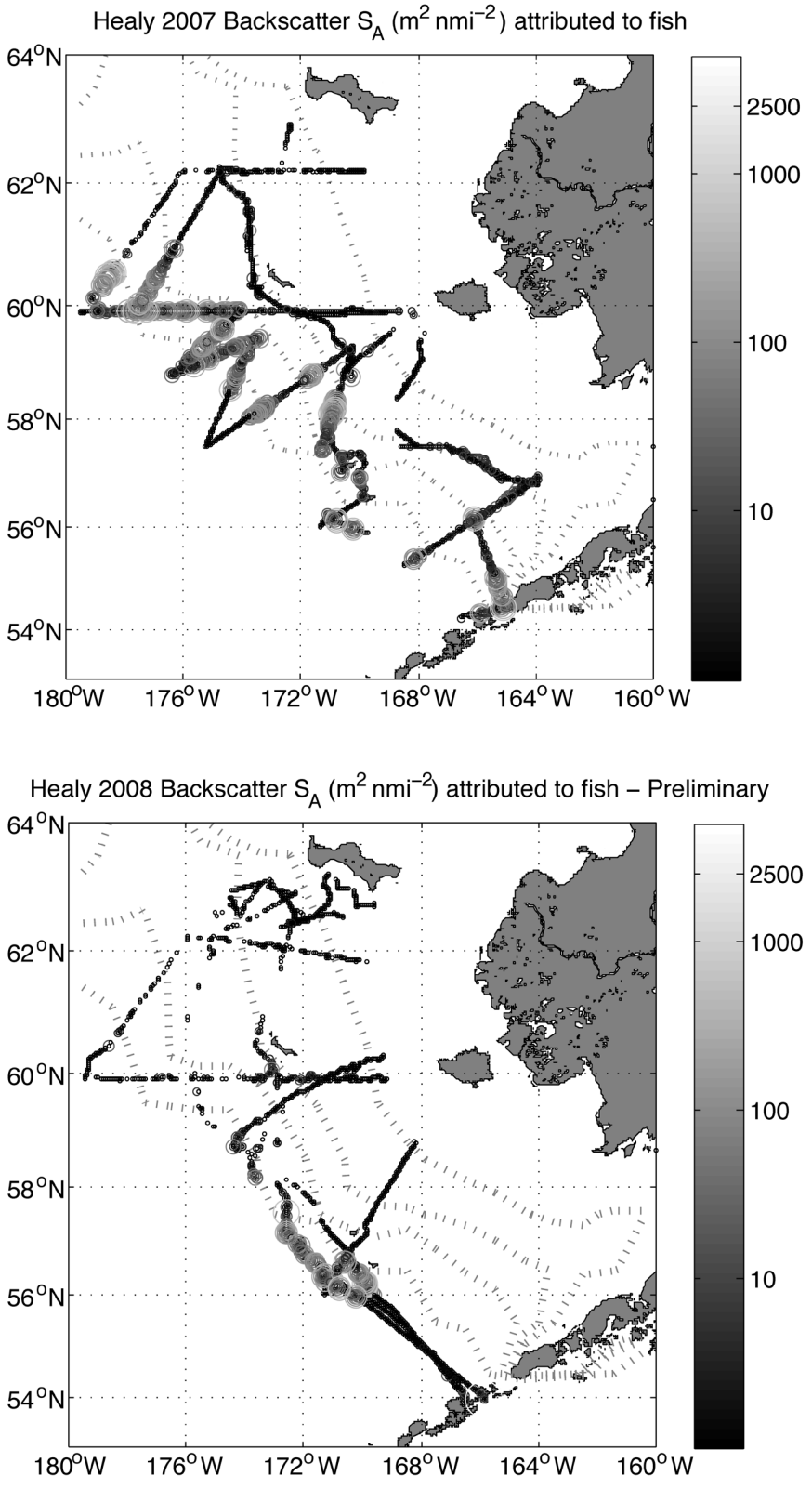

Figure 1. Acoustic backscatter (S_A m^2 nmi^{-2}) attributed to fish along *Healy's* trackline in 2007 (top) and 2008 (bottom). There was substantially higher ice cover in 2008 than in 2007. The approximate position of the 200-, 100-, 70- and 50-m isobaths are shown as gray dotted lines. Symbol size and gray tone is proportional to the intensity of acoustic backscatter.

fish in the water column in the cold and shallow ice-covered areas of the inner and middle shelf (depths <100 m) was much lower than in the ice-free regions of the outer shelf at depths greater than 100 m. From analysis of a subset of data collected during the 2007 and 2008 cruises, the distribution of fish appeared to be more restricted to areas near the shelf break where warmer water was observed during 2008 (Fig. 1). Very few fish were observed in the northern areas where near-bottom waters were cold (< ~1°C), even in areas where walleye pollock are abundant during the summer months. The observations suggest that walleye pollock, a dominant component of the ecosystem, may shift its distribution away from areas where very cold water is present, although complete analyses of the data are required to confirm these trends.

Acoustic backscatter attributed to plankton (primarily euphausiids) was more evenly distributed than backscatter attributed to fish during both years although some patches of abundant euphausiid backscatter were detected in the ice-covered areas. More comprehensive analyses of the acoustic backscatter from both vessels in relation to water column characteristics, sea ice cover, and the summer distribution of walleye pollock and euphausiids are currently under way.

By Alex DeRobertis

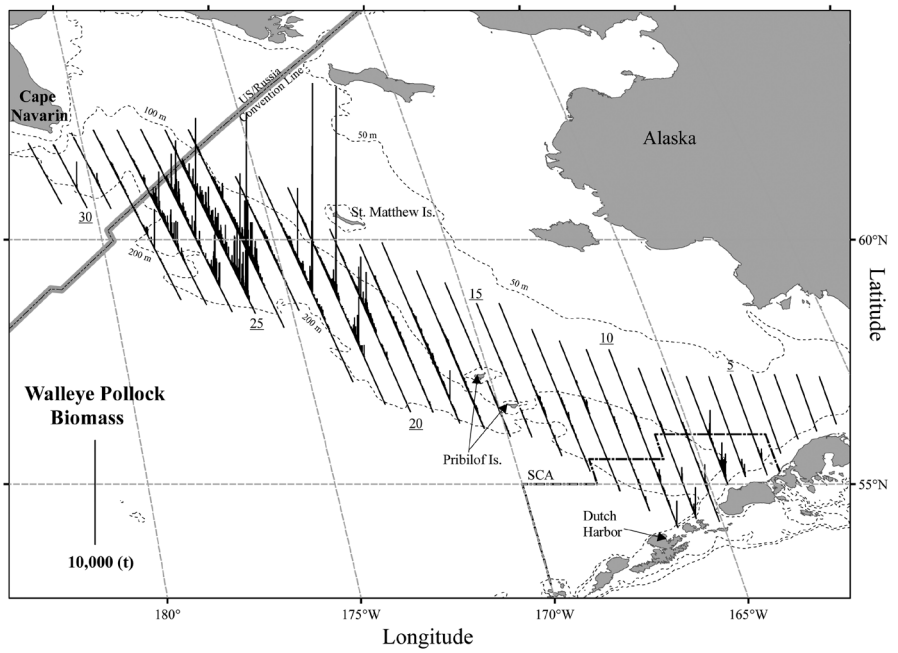

Figure 2. Estimated walleye pollock biomass (metric tons) along tracklines surveyed during the summer 2008 echo integration-trawl survey of the Bering Sea shelf. Transect numbers are underlined and the Steller sea lion Conservation Area (SCA) is outlined. All acoustic abundance estimates are for fish in the water column to within 3 m of the seafloor.

Echo Integration-Trawl Survey Of Walleye Pollock In The Eastern Bering Sea

MACE Program scientists completed an echo integration-trawl (EIT) survey of walleye pollock on the eastern Bering Sea shelf between 2 June and 31 July aboard the *Oscar Dyson*. The main purpose of the survey, which has been conducted since 1979, was to estimate the midwater abundance of walleye pollock.

The 2008 survey was conducted westward from Bristol Bay, Alaska, to the Cape Navarin region of Russia along north-south transects spaced at 20 nmi apart (Fig. 2). During daylight hours, acoustic backscatter data were collected along transects at five frequencies (18, 38, 70, 120, and 200 kHz), and opportunistic midwater and bottom trawls were conducted to classify the backscatter. Walleye pollock abundance estimates were based on the area scattering detected at 38 kHz. Nighttime activities included additional physical oceanographic data collections, trawl hauls for species classification, and work with other specialized sampling devices (e.g., a lowered transducer system for target-strength measurement, a free-drifting acoustic buoy to measure potential fish avoidance behavior to the vessel, and tests of a new generation multibeam sonar). Macrozooplankton and micronekton layers (principally euphausiids) were also sampled with a Methot trawl as part of the large, multidisciplinary BSIERP study.

Physical oceanographic data included trawl temperature-depth profiles, numerous CTD casts (e.g., temperature, salinity, and chlorophyll measurements) and XBT (expendable bathythermograph) profiles along selected transects. Temperature profile measurements indicated that 2008 was another cold summer, similar to 2007 and 2006.

Walleye pollock were largely concentrated west of 170°W in U.S. waters (Fig. 2). Estimated walleye pollock abundance (to within 3 m of bottom) was relatively low compared with recent surveys. Biomass in the U.S. EEZ (Exclusive Economic Zone) was 0.94 million t, which was a little over half that observed in 2007 (1.77 million t). The estimated pollock biomass in Russia was 0.03 million t, which represented only 3% of the total surveyed biomass. In 2007, about 6% of the total midwater biomass was in Russia.

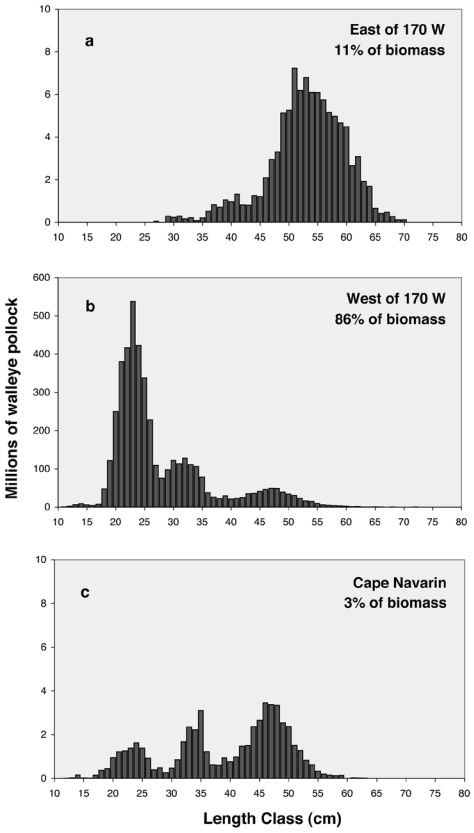

Figure 3. Estimated numbers of walleye pollock (millions) by size class for the areas (a) east of long. 170°W, (b) west of long. 170°W, and (c) in the vicinity of Cape Navarin, Russia, during the 2008 echo integration-trawl survey on the eastern Bering Sea shelf. All acoustic estimates are for fish in the water column to within 3 m of the seafloor.

Walleye pollock length composition differed by geographic area (Fig. 3). Large, older fish between 50 and 60 cm with a few juveniles comprised the biomass east of 170° (11% of total biomass was in this area). Age-2 fish (2006 year class) at 20 to 25 cm, some age-3 fish, and older fish between 40 and 55 cm numerically dominated the biomass west of 170°W (86% of total U.S. EEZ biomass was in this area).

Other notable fishes encountered during the survey included a few midwater schools of Arctic cod (*Boreogadus saida*) in the northwestern part of the survey area, along with the usual aggregations of Pacific ocean perch (*Sebastes alutus*) observed near Zhemchug Canyon.

After completion of the stock assessment survey portion of the 2008 survey, a paired codend experiment was conducted to examine effects of codend liner mesh size on catch composition. A vessel comparison experiment was also continued to assess whether differences occurred between acoustic (and trawl) data collected by the *Oscar Dyson* versus the *Miller Freeman*. The EBS EIT survey has traditionally been conducted with the *Miller Freeman* but because the *Oscar Dyson* has become the primary vessel for this survey since 2007, results of the vessel comparison experiment will provide valuable information to evaluate the consequences of this vessel change.

By Taina Honkalehto

FISHERIES OCEANOGRAPHY COORDINATED INVESTIGATIONS (FOCI)

Recruitment Processes Program: Cruise Activities

The Recruitment Processes Program had an active summer field season this year. Activities started with the collection of marine zooplankton on the RACE Groundfish Assessment Program (GAP) cruises to the eastern Bering Sea shelf. Zooplankton biomass (food for walleye pollock, baleen whales, and seabirds) has paralleled (in recent years) changes in Bering Sea climate. J. Clark from the Recruitment Processes Program began collections during Leg 1 of the cruises, and P. von Szalay (RACE) and T. Buckley (REFM) were responsible for collections on the second and third cruise legs. A joint Russian–U.S. cruise scheduled for August to examine the marine ecosystem of the Chukchi Sea was unfortunately cancelled due to problems with ship availability and was rescheduled for 2009. The cruise was part of the RUSALCA (Russian American Long-Term Census of the Arctic) program to understand how climate variability is affecting the marine resources of the Arctic. During August, the Recruitment Processes Program collaborated with NOAA's Pacific Marine Environmental Laboratory (PMEL) on an examination of climate forcing and marine ecosystem productivity in the eastern Bering Sea (NPCREP–North Pacific Climate Regimes and Ecosystem Productivity study). PMEL chartered the research vessel *Melville* from the University of California San Diego to conduct physical and biological sampling over the eastern continental slope and shelf of the Bering Sea. The 20-day cruise repeated sampling along a line of stations stretching from Bristol Bay to St. Lawrence Island, and found very high concentrations of zooplankton along the southern portion of the transect line. These stations are in the vicinity where AFSC scientists from the National Marime Mammal Laboratory (NMML) found and tagged a North Pacific Right whale (see NMML's Cetacean Assessment and Ecology Program article in this issue on page 12). Right whales are thought to eat only one or two types of planktonic prey, and one of the known prey types was the dominant zooplankter in the patches samples by scientists on the *Melville*. To conclude our season, members of the Recruitment Processes Program returned to the eastern Bering Sea on the *Miller Freeman* to learn more about the nursery habitat of newly settled flatfish (Fig. 1). This cruise is part of our effort to understand the factors that are important in determining the transport and recruitment success of commercial (e.g., northern rock sole, Greenland halibut, Alaska plaice) and nontarget (arrowtooth and Kamchatka flounder) flatfish species in the eastern Bering Sea. The nontarget species are important predators of walleye pollock.

Early Life History of Greenland Halibut in the Eastern Bering Sea

Researchers from the Recruitment Processes Program and Oregon State University (OSU) are collaborating to examine transport of Greenland halibut (*Reinhardtius hippoglossoides*) eggs and larvae from spawning to potential nursery locations in the EBS. At one time, Greenland halibut supported a commercial fishery of up to 80,000 t, but catches have declined significantly since the 1970s. The reasons for the decline of Greenland halibut in the EBS are unknown, and we seek to determine whether recent atmospheric and hydrographic changes in the region have affected patterns of larval transport, dispersal, and survival of the early life history stage.

This ongoing project will assess five areas: 1) spawning locations, 2) egg and larval

Figure 1. Three examples of catches from the beam trawl used by the scientists to capture juvenile flatfish. Each example shows a different level of animal abundance and ratio of fish to invertebrates. Photos by Dan Cooper.

drift pathways, 3) egg buoyancy, 4) larval and juvenile feeding and growth patterns, and 5) vertical egg distribution. Results from the AFSC ichthyoplankton surveys (1982-2006) indicate that Greenland halibut larvae in the EBS have a long duration in the plankton and are subject to extended drift pathways. The early stage Greenland halibut larvae were found off the continental slope, mostly below 500 m, and drifted northward during spring. Highest larval abundances were observed in March. Larval lengths ranged from 9 to 25 mm standard length (SL) during spring. Larvae were found throughout the water column, but highest concentrations were at 45 m depth. This vertical distribution pattern suggests that adult Greenland halibut spawn in very deep water (below 500 m) and eggs and larvae slowly rise after hatching.

In February 2008, scientists from the AFSC and OSU conducted an ichthyoplankton survey in the EBS that targeted Greenland halibut eggs and larvae. Objectives were to describe the distribution of Greenland halibut eggs and larvae over the slope and in Bering Canyon in winter and to obtain eggs for buoyancy studies. A total of 45 bongo and 64 MOCNESS tows were completed. Greenland halibut eggs about 4 mm in diameter were found consistently in small numbers throughout Bering Canyon and were used to make shipboard measurements of instantaneous specific gravity. Greenland halibut eggs ranged in age from early to late stage. Using an Egg Density Gradient Apparatus (EDGAR), we measured egg density, which ranged from 1.02429 to 1.02889 at experimental temperatures. Preliminary results indicate that older eggs may have a greater density than younger eggs.

By Ann Matarese

BEHAVIORAL ECOLOGY PROGRAM: NEWPORT LABORATORY

Assessing Probability of Discard Mortality in Alaska Crab Species

Delayed mortality associated with discards of both crabs and fishes from fishing operations has ordinarily been observed through tag and recovery studies or prolonged holding in deck tanks, and there is need for a more efficient and rapid method for assessing probability of mortality. Over the last two summer seasons RACE biologists from Newport, Seattle, and Kodiak (i.e., Allan Stoner and Michael Davis, Craig Rose and Carwyn Hammond, and Eric Munk) have been partners in an effort to evaluate bycatch mortality in snow crab, Tanner crab, and red king crab. During the first year (2007) shipboard experiments conducted in the Bering Sea were aimed at determining whether reflex behaviors in Alaska crabs (primarily *Chionoecetes* spp.) can be used to predict mortality caused by encounters with trawl gear in the Bering Sea groundfish fishery.

Figure 1. Crabs collected in trawls were assessed for reflex impairment and injuries to the exoskeleton, then tagged and held in deck boxes to monitor delayed mortality.

Figure 2. Six reflex actions were identified in Tanner crabs during preliminary studies in Kodiak. These were reliable predictors of stress, and the suite of reflexes can be assessed in less than 30 seconds.

Tanner crab and snow crab collected with bottom trawls near the Pribilof Islands were evaluated for reflexes and injuries, then tagged and held in deck boxes for up to 11 days to track delayed mortality (Fig. 1). Six reflex actions involving movements of walking legs, chelae, eyes, and mouth parts (Fig. 2) were combined to calculate a reflex impairment index for each individual. Logistic regression revealed that reflex impairment indices provided excellent predictors of delayed mortality for both snow crabs (91% correct predictions) and Tanner crabs (79.5% correct predictions) (Fig. 3). The relationships were independent of crab gender, size, and shell condition and predicted mortality in crabs with no obvious external damage. An assessment can be made in less than 30 seconds. Relationships between reflex impairment and mortality provide substantial improvement over earlier mortality predictors that depend upon detecting injuries to the exoskeleton, and the new approach will help to increase the scope and replication of fishing and handling experiments. The results of this study and the general usefulness of Reflex Action Mortality Predictors (RAMP) for crabs are discussed in the October 2008 issue of *Fishery Bulletin*. RAMP approach should be equally valuable for a wide range of crustaceans.

Given that RAMP has proven to be a good tool for studying bycatch-related mortality in Alaska crabs, we conducted a field experiment in the Bering Sea during 2008 to explore how different trawl configurations, primarily sweeps and footropes,

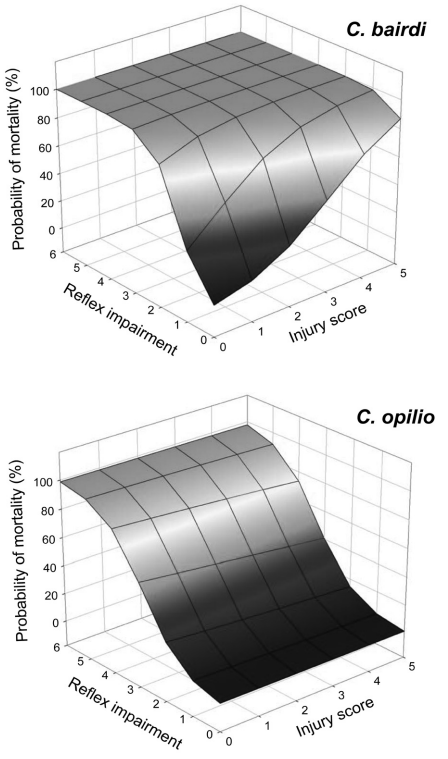

Figure 3. Surface plots showing the probabilities of mortality for Tanner crabs (*C. bairdi*) and snow crabs (*C. opilio*) with varied levels of reflex impairment and injury. Reflex impairment alone provided an excellent predictor of mortality in snow crabs, while injuries to the exoskeleton had a significant but smaller impact on the logistic regression model for Tanner crabs.

might be improved to decrease crab mortality associated with trawl contact. During the same cruise we conducted experiments to evaluate whether reflex actions can be used to predict freeze-related mortality in *Chionoecetes* species. The results of these two studies are currently under analysis and both look promising.

By Allan Stoner

Resource Ecology & Fisheries Management (REFM) Division

RESOURCE ECOLOGY & ECOSYSTEM MODELING PROGRAM

Fish Stomach Collection and Lab Analysis

During the third quarter of 2008, fisheries observers collected 590 stomach samples from the eastern Bering Sea and 64 stomach samples from the Gulf of Alaska and Aleutian Islands. AFSC scientists collected 9,468 stomach samples on groundfish surveys of the eastern Bering Sea and 366 stomach samples during the Beaufort Sea survey. Stomach samples were not analyzed at sea this summer, but 1,077 stomach samples from the eastern Bering Sea and 344 stomach samples from the Gulf of Alaska and Aleutian Islands region were analyzed in the laboratory. In total, 4,364 records were added to the REFM food habits database.

By Troy Buckley

Ecosystem Modeling

Resource Ecology & Ecosystem Modeling (REEM) Program staff worked actively on developing FEAST (Forage and Euphausiid Abundance in Space and Time), a spatial dynamic model of the Bering Sea forage community (Fig. 1) for the North Pacific Research Board's Bering Sea Integrated Research Program (BSIERP). This model will simulate the dynamics between plankton and fish communities on a 10-km scale grid of the Bering Sea, including dynamics for growth, migration, reproduction, and mortality. This work is closely integrated with a wide range of field studies that are part of the 5-year BSIERP study to predict the response of the Bering Sea to long-term climate variation.

By Kerim Aydin

Ecosystem Indicators

As part of the Ecosystem Considerations for 2009 report, appendix to the Stock Assessment and Fisheries Evaluation, updates were performed for 80 indicators including climate, oceanographic, production, species, community, and ecosystem-level indicators. This updated information can be accessed on the Ecosystem Considerations web site at http://access.afsc.noaa.gov/reem/ecoweb/index.cfm. A draft of this work was presented at the North Pacific Fishery Management Council's September 2008 Bering Sea/Aleutian Islands and Gulf of Alaska groundfish plan team meetings.

By Kerim Aydin and Jennifer Boldt

Seabird Research: Fourth International Conference on the Conservation of Albatrosses and Petrels

Shannon Fitzgerald and Dr. Ann Edwards participated in the Fourth International Conference on the Conservation of Albatrosses and Petrels, held in Cape Town, South Africa, 11-15 August. The conference is held once every 4-5 years. Fitzgerald and Edwards each provided presentations on aspects of albatross conservation in the North Pacific and met with individuals engaged in science, monitoring, and conservation from around the globe. The primary themes of this conference were pelagic movements of albatross and petrel as determined by satellite telemetry, elimination of threats on breeding colonies, and interactions with trawl fisheries. The U.S. contingent held a side meeting to begin planning efforts to improve monitoring of seabird bycatch in U.S. trawl fisheries in the Pacific.

By Shannon Fitzgerald

ECONOMICS & SOCIAL SCIENCES RESEARCH PROGRAM

Estimating Time-varying Bargaining Power: A Fishery Application

Analysts from the Economics & Social Sciences Research (ESSR) Program applied an "unobserved components" approach to estimate time-varying bargaining power in bilateral bargaining frameworks. They applied this technique to the exvessel fish market for Alaska sablefish, which has changed management systems from a regulated open-access system to an individual fishing quota (IFQ) system over the time span analyzed. The analysts found that post-IFQ implementation fishers improve their bargaining power and thus accrue more of the rents generated by the fishery. However, unlike in previous studies, the analysts found 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.

By Harrison Fell and Alan Haynie

BSAI Crab Economic Data Report (EDR) Documentation and Data Quality Review

As directed by the North Pacific Fishery Management Council (NPFMC), a rigorous set of procedures for assessing and documenting data quality of the Bering Sea Aleutian Islands (BSAI) Crab Economic Data Report (EDR) database have been developed and implemented by ESSR staff and contractors. Following presentation of EDR data quality documentation to the Council in February 2008 by ESSR Program economists, the Council issued a motion direct-

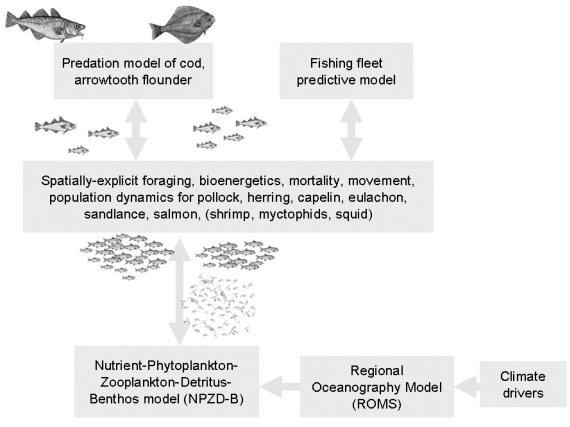

Figure 1. Diagram of the critical components of the FEAST (Forage and Euphausiid Abundance in Space and Time) model.

ing the Pacific Northwest Crab Industry Advisory Committee (PNCIAC) to participate in a formal review of EDR data quality and documentation.

Dataset documentation (metadata) includes extensive details, including table and field descriptions, source tracking to identify EDR form tables across versions and data collection years, data field use guidelines, and data quality results. Data quality information is derived from annual third party validation audits conducted by the accounting firm Aldrich, Kilbride and Tatone, LLC (AKT) and extensive submitter feedback. To facilitate improved database integrity and documentation, ESSR Program staff have collaborated with the Pacific States Marine Fisheries Commission (PSMFC) to complete migration of the database from MS Access into the Oracle relational database environment. The result has been improved database structure and usability and the ability to complete formal database logic checks. The database has also been integrated with secondary datasets, including eLandings catch and landings data and Commercial Operators Annual Report processor output and sales data.

The validation audit process includes both random audits, based on a statistical sample of the EDR population, and non-random audits of EDRs identified on the basis of missing variables or outliers in reported information. AKT annually selects vessels or processors for audit based upon a statistical sample; for each vessel or processor selected for audit, detailed support is requested and examined by AKT staff. Variables for audit are selected from those that can be validated by documented support. For each data variable requested, AKT critically evaluates the support provided against third party support, such as invoices or fish tickets; internally-generated information, such as crew settlement sheets, general ledger details, detailed internal reports, or financial statements; and estimates made, including the reasonableness of assumptions. Results of the audits conducted to date have indicated that documentation of support and accuracy of reported data have improved in 2006 and 2007 from the initial historical data conducted in 2005, in which data were reported for 1998, 2001, and 2004. However, despite improvements in definitions included in the EDRs, there is still variability in how information is reported based upon the ability to break down information in the manner requested in EDR forms and changing conditions and markets within the fishery. Variability in the quality of supporting documentation to information submitted in the EDRs has improved for the 2006 reporting year. In addition to providing quantitative information on data quality, the annual validation audit provides additional information for revising data collection forms and improving accuracy of reported data. Data collection for the 2007 calendar year was completed in 3rd Quarter 2008, and the validation audit by AKT for these data is ongoing.

In addition to validation audits, ongoing dialog between ESSR Program and Council economists and industry data providers has produced important documentation of data quality concerns and guidance for interpretation of individual EDR data fields. This dialog has continued more formally as part of the Council review process between ESSR Program staff and the PNCIAC membership. AFSC economists met with PNCIAC during 3rd Quarter 2008 and presented the draft metadata document for formal comments. The comment period ended 28 June, and replies to comments are being drafted and incorporated into the metadata document for presentation to the committee in September 2008. PNCIAC will report findings to the Council in October 2008 for Council deliberation regarding use of EDR data fields in analysis of effects of crab rationalization and potential management changes. In addition to providing the documentation required for formal industry review of the database, detailed metadata will ensure long-term integrity of the database and access the information in the EDR database by authorized data users.

By Brian Garber-Yonts and Ron Felthoven

Comprehensive Socioeconomic Data Collection for Alaska Fisheries

Many of the fishery management actions taken by the NPFMC require various types of socioeconomic analyses before they can be implemented. Typically these analyses must examine a range of alternatives, and the associated nature, magnitude, and distribution of the economic, welfare, and sociocultural impacts of the proposed action(s). Specifically, economic analyses, including benefit/cost analysis, as well as regional and community impact analysis of proposed fishery management policies are required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the Endangered Species Act, the Marine Mammal Protection Act, the National Environmental Policy Act (NEPA), Executive Order 12866, and other applicable Federal laws.

In addition, the 2006 reauthorization of the MSA includes heightened requirements for the analysis of socioeconomic impacts and the collection of economic and social data. These changes eliminate the previous restrictions on collecting economic data, clarify and expand the economic and social information that is required, and make it explicit that the Councils and the Secretary of Commerce have the authority and responsibility to collect the economic and social information necessary to meet requirements of the MSA (and that either the Councils or the Secretary can initiate the collection of said socioeconomic data).

This suggests that all fisheries under our jurisdiction should be examined for the adequacy of socioeconomic data. It is clear that, without access to the information needed to support many of the aforementioned analyses, the associated legal documents may fail to meet established standards. In order to better address these concerns, as well as others pertaining to community impacts, the NPFMC passed an October 2006 motion to draft a comprehensive program for collecting revenue, ownership, employment, cost, and expenditure data for all fisheries in and off Alaska (excluding those already covered, including BSAI crab and Amendment 80 fisheries).

Specifically, the NPFMC directed the AFSC staff to coordinate a workgroup of social and economic analysts and researchers from NMFS, Alaska Department of Fish and Game (ADF&G), and Council staff to "further develop the discussion paper on the structure of a comprehensive social and economic data collection program and survey formats for the collection of this data. The draft survey formats should be tailored to the sector specific data needs for revenue, ownership, employment, cost, and expenditure data. The discussion paper will include the collection of economic data from shoreside processors and motherships

in the event statute authority is established for collection of this information in the future. The workgroup will work with the draft problem statement as initial guidance and relevant experience garnered to date with existing and past collections and surveys of social and economic data to develop a practicable and reasonable approach for resolving issues identified for a comprehensive program. Additionally, the discussion paper will respond to the issues raised by the AP and SSC, particularly confidentiality issues."

In response, the ESSR Program coordinated a working group to propose a core set of data that is currently unavailable yet important for answering many of the questions raised when evaluating past and future management decisions, and conducting regulatory and legally mandated analyses. The working group was comprised of individuals representing NMFS, ADF&G, the Commercial Fisheries Entry Commission, NPFMC, NOAA General Council, and Alaska Department of Commerce. The result was a white paper that was presented to the Council and should eventually be published in a peer-reviewed fishery management journal.

Since the presentation of the paper, the NPFMC has developed a workgroup to define the specific elements to be included in the program. The workgroup is comprised of a broad set of stakeholders including industry, agency, and community members. This workgroup has conducted two formal meetings and at present is developing a formal template that defines the elements to be collected within the program and the mechanisms for collecting the data.

By Ron Felthoven and Brian Garber-Yonts

Crew Participation Data Collection System for Commercial Fisheries off Alaska

The need for crew member participation data in state and Federal commercial fisheries in Alaska is regularly voiced by crew members, communities in which crew members live and work, policy makers, and analysts. Crew member information is important to the NPFMC, Alaska Board of Fisheries, NMFS, Pacific States Marine Fisheries Commission (PSMFC), and coastal communities interested in understanding how proposed changes to current fishery management regimes will likely influence participation in commercial fisheries and social and economic impacts to fishery-dependent coastal communities. Information on crew member fishing activities is also important for local communities when applying to state and Federal programs. Crew members themselves are interested in developing a record of their participation in fisheries at a standard similar to data collection systems for permit and quota holders.

A person is required by ADF&G regulations to obtain a commercial crew member license in order to participate in commercial fishing in waters off Alaska if they do not already hold a valid Commercial Fisheries Entry Commission (CFEC) interim-use or limited entry permit card. Currently, basic identification and contact information is collected from the crew member license purchaser at the time of purchase, but no system exists for collecting information on commercial crew member fishing activities and the extent to which crew members are dependent on earnings from commercial fishing. Collection of crew member participation data is a necessary step in estimating the full economic contribution of commercial fisheries to Alaska and in estimating economic effects of any impact to the industry. It is important to have information on commercial crew members when planning how to respond to the changes in the economic conditions affecting commercial fishing in Alaska. For example, restructuring of fisheries, especially programs that restrict, limit, or reduce participation opportunities can have unanticipated and unintended effects on Alaska's fishing dependent communities and individual crew members.

The overall goal of this project is to implement a crew participation data collection program. This program will be defined by the ADF&G (Department) if they choose to adopt a formal system, or by an independent contractor should the Department conclude in their scoping that an independent survey is likely to be more successful or feasible than a larger program run through the Department. They will identify legal barriers and solutions; potential enforcement measures; data elements to be captured (with a priority ranking for each); expected uses of the data; appropriate reporting parties; potential audit measures; general system specifications; and expected costs, equipment requirements, and personnel needs for the Department or independent contractor. Specifically, PSMFC will utilize the results of this scoping process to provide personnel with the proper skills and experience to implement the data collection system that is deemed to be most effective by the Department's scoping study.

By Ron Felthoven

Predicting Fishing with Vessel Monitoring System (VMS) Data

The National Marine Fisheries Service has expanded requirements that vessels fishing in the Pacific cod, Atka mackerel, pollock, and other fisheries own and operate a vessel monitoring system (VMS). The system sends each vessel's location to NMFS every 20-30 minutes while the transmitter is operating. The VMS consists of two parts. A transmitter/receiver, installed on the vessel, queries GPS satellites and downloads vessel position, as well as estimates the heading and speed. The transmitter then sends these data to NMFS via the ARGOS (Advanced Research and Global Observation Satellite) system of polar orbiting satellites.

Though the VMS tells NMFS the location of each participating vessel, it does not directly determine whether the vessel is fishing or not. However, when a vessel is fishing, its course and speed are generally different from when the vessel is simply transiting an area. These differences produce a "signature" that indicates fishing is taking place. The nature of a given vessel's signature depends on many factors, including the gear type used (trawl, hook-and-line, or pot), the type of vessel deploying the gear, and the length of time the vessel spends fishing. In addition to VMS, many vessels carry a NMFS-certified observer during 30%-100% of their days at sea. Thus, NMFS can determine directly and independently whether or not fishing is taking place and can thus corroborate whether a given signature indeed demonstrates that fishing is taking place.

The primary purpose of this research is to determine the extent to which the signatures can be used to accurately predict whether fishing is occurring or not. In previous work by Dr. Pat Sullivan for the NMFS Alaska Region, a number of techniques were explored to predict fishing for a select number of vessels. This current project builds upon that exploratory work and develops

an operational algorithm. To the extent that a given signature can accurately predict whether fishing is taking place, NMFS will use the signatures to develop computer algorithms that will automatically predict whether a given vessel is or was engaged in fishing operations. The predictive power of the developed algorithms can be expressed as a percentage of predicted fishing events that correspond to actual fishing events. Functions of lagged speed and bearing have been developed which predict spatial effort with relatively low error. Preliminary results from this work were presented at the Fourth International GIS/Spatial Analysis Symposium this summer. Final results are being prepared for publication.

By Alan Haynie and Patrick J. Sullivan

Measuring the Value of a Statistical Life in the BSAI Crab Fisheries

The value of a statistical life (VSL) is revealed by one's choices regarding monetary returns and fatality risk. Estimates of the VSL have been extensively used to inform public policy and quantify preferences for environmental quality, health, and safety. To date little attention has been paid to investigate the tradeoffs associated with the returns from natural resource extraction activities and the risks incurred, and the effect that changes in safety regulations and the utilization of property rights management has had on the VSL. In this research we model fishing captains' discrete choices to fish on a given day or not, conditional on the observed risk present, in the Bering Sea and Aleutian Islands crab fisheries. We instrument for risk using fatality data from crab and noncrab fisheries, as well as information on wave height, wind speed, air temperature, and sea temperature (to capture ice risk propensity). We examine how the VSL and fatality risk have changed since the inception of both the U.S. Coast Guard (USCG) preseason boarding program and the BSAI crab rationalization program.

Notably, our estimation framework controls for the inherent sample selection bias present in many VSL estimates and when compared to those estimates which do not control for sample selection, illustrate the substantially upward biases which may arise. In addition, these estimates are robust to heterogeneous preferences which can bias homogeneous estimates of the VSL. By expanding our utility theoretic model to reflect captains' preferences for others' well-being, we may be able to recover the value of an altruistic life via the unique data generating process present within these fisheries. Preliminary empirical estimates provide a measure of the captain's value for crew lives and decomposing our estimated VSL (which includes the value of an altruistic life); we were also able to recover the captain's implicit value of his own life.

These estimates may be used to benefit contemporary fisheries policy. For instance, recently *The New York Times* reported that the fatality rates within the Pacific Northwest Dungeness crab fisheries possessed fatality risk rates that were 60 times greater than the average American worker. This article pointed out that the dockside safety program does not check every vessel participating in this fishery, whereas in Alaska the USCG preseason boarding program does. Presumably the cost of the program may be one of the reasons why this dockside boarding program is not perfectly executed. However, given our range of estimates for the VSL and our estimated reductions in the fatality risk resulting from the complete coverage of the USCG preseason boarding program, our model predicts that the annual benefits derived from this policy within the BSAI crab fishery are quite substantial.

By Kurt Schnier, William Horrace, and Ron Felthoven

Demand for Halibut Sport Fishing Trips in Alaska

The halibut sport fishery in Alaska is quite large. In 2004, for instance, over 480,000 halibut were harvested by sport anglers in the state. To assess the impacts of pending and potential regulatory changes on sport angler behavior, it is necessary to have estimates of the baseline demand for halibut fishing trips and an understanding of the factors that affect it. To this end, Dr. Dan Lew (ESSR Program) has been working with Dr. Doug Larson (University of California Davis) to develop and implement a survey that collects information about saltwater recreational fishing trips in Alaska and to analyze the data. Three primary survey instruments were developed, each customized to specific angler populations based on residency: non-Alaskan resident anglers (referred to as nonresident anglers), resident anglers of Southeast Alaska (referred to as SE resident anglers), and other Alaskan resident anglers (referred to as SC resident anglers).

The project has consisted of three major phases. The first phase involved developing and pretesting the survey instruments. This phase included testing the survey instrument using focus groups, cognitive interviews, and a formal pretest survey implementation. These activities were completed in 2006 following OMB approval. During the second phase, final versions of the survey were developed and implemented through a mail survey of Alaska sport anglers. Mail survey implementation followed a modified Dillman Tailored Design Method and consisted of an advance letter, a survey mailing (survey booklet, cover letter, map, and business reply envelope), a thank you/reminder postcard, and a second survey mailing. A follow-up telephone survey was also used to elicit participation. This phase of the project was completed in August 2007. The survey collected information about anglers' 2006 fishing activities.

The third and final phase of the project involves the description and analysis of the data. To date we have developed a summary of the general characteristics of the approximately 2,000 saltwater recreational anglers who completed the survey; this summary is too lengthy for the AFSC *Quarterly Report* but will be available in the Economic Status Report contained within the 2008 Stock Assessment and Fishery Evaluation (SAFE) report. Econometric models of recreation demand are currently being developed and estimated to assess the baseline demand for saltwater fishing trips in Alaska.

By Dan Lew

Post-Rationalization Restructuring of Alaska Crab Fishery Crew Opportunities

Rationalization of the Bering Sea crab fishery in 2005 resulted in swift consolidation of the fleet from more than 250 vessels to just 89. A large reduction in the exvessel prices paid for crab also occurred at this time. Among the most important impacts on communities has been the loss of crew jobs, estimated in a University of Alaska study to be approximately 1,350 positions.

As the initial effects of the rationalization program begin to stabilize, it is important to understand the actual impacts of this

program on crew members. Loss of crew jobs was a predicted effect, but the specifics of crew impacts are not understood in great detail. Beginning in fall 2007, this project used ethnographic interview techniques to study current and former crew members, how they have been affected, and how their jobs have been affected. Field sites have included Akutan, Kodiak, Old Harbor, Unalaska/Dutch Harbor, Alaska; Seattle, Washington; and Astoria, Oregon. Interviews have focused on issues of employment opportunities and job characteristics that may be useful in understanding how crew members might be affected in other rationalization initiatives. Decision theory and occupational communities theory provide the preliminary analytical framework for this research. A report detailing this research will be presented to the NPFMC at the October 2008 meeting in Anchorage.

By Jennifer Sepez, Heather Lazrus, and Ron Felthoven

Protected Marine Species Economic Valuation Survey

Estimates of the economic benefits of protecting threatened and endangered marine species are often needed by resource managers and policymakers to assess the impacts of alternative management measures and policies that may affect these species. However, few estimates of the benefits of protecting marine species exist, and none exist for many species protected by NMFS. To begin filling this information gap, Dr. Dan Lew (ESSR Program) is working with Kristy Wallmo (NMFS, Office of Science and Technology) on a nonmarket valuation survey research project to estimate the value of protecting several protected marine species.

Numerous cetacean, pinniped, sea turtle, and fish species have been selected for inclusion in the study, and survey materials continue to be developed. The survey employs stated preference questions to gather information on public preferences for protecting these species. Several sets of focus groups to test preliminary survey materials have been conducted over the last couple years. During 2007 and 2008, changes to the survey and related materials were made based on the results of these groups and input from biologists providing review of the scientific information being presented. Due to the complexity of the issues and the number of species covered in the survey, the project has been divided into two phases, each involving the implementation of an Internet-based survey intended to collect stated preference information about a subset of the total species being studied. In the initial phase, the set of eight species in the survey includes the endangered North Pacific right whale and two threatened Chinook salmon stocks. Focus group and other qualitative pretest activities for the first phase species continued through 2008. The first phase survey instrument has been programmed into the Internet-based format and is undergoing peer review at present. Following the review, a post-review version will be tested in a small online implementation, with full implementation expected to follow in 2009.

By Dan Lew

A Method for the Design of Fixed Time-Area Closures to Reduce Salmon Bycatch

Salmon bycatch in the U.S. Bering Sea pollock fishery has reached record levels in recent years, and the NPFMC has recently considered implementing time-area closures that would attempt to reduce salmon bycatch. To assist in this process, Dr. Alan Haynie has written a paper that offers a discussion of important issues for consideration in marine closure design and develops and implements a methodology to identify potential candidate closures.

The starting point for the design of closures in this analysis was to determine whether or not there are any time and area combinations that, if closed, would have reduced bycatch. A fundamental assumption of this methodology is that vessels reallocate effort from closed areas to open areas *proportional to other effort*. For example, if there were only three areas with one-third of the catch caught in each area, closing one area would lead to half of the catch being caught in each of the two areas that remain open. This is very different from assuming that the pollock effort vanishes with a closure and it means that in order for closures to be effective, there must be low-bycatch fishing areas available at the time of the closure. Of course, depending on which areas are closed, the proportional reallocation assumption may be limiting. We discuss this assumption in greater detail in the paper but believe that it is a good first approximation. Temporally, we consider closures lasting 2-8 weeks and spatially from 1 to 10 ADF&G statistical areas.

The results of this method may be considered "optimal" in the sense that it considers all of the potential area closures that could be created (using data from 2001-2006) and then presents the costs of salmon avoidance, in terms of both the size of the closure (in number of areas) and in the proportion of pollock catch reallocated by the closure. We use ArcGIS to identify neighboring areas and Matlab to systematically explore the bycatch reduction from different closures. "Inferior" closures, where fewer salmon are avoided for the same or greater relocation cost, can be eliminated from consideration, and policy makers are offered a range of closures that represent different policy trade-offs of salmon reduction and avoidance costs. The most effective of the closures here reduced bycatch by approximately 10% per year, on average. Given the significant size of the most effective closure, nine statistical areas, this is a small reduction, which demonstrates the limitations of static time-area closures in the context of dynamic target and bycatch populations. This work was presented at the Fourth International GIS/ Spatial Analysis Symposium this summer and final results are being prepared for publication.

By Alan Haynie

Climate Change and Changing Fisher Behavior in the Bering Sea Pollock fishery

One component of the recently initiated Bering Sea Integrated Ecosystem Research Project (BSIERP) is a spatial economic model that will predict changes in fishing activity in the Bering Sea pollock fishery that may result from climate change. Random utility models such as the model employed here have been used in the Bering Sea and elsewhere to model how fishers make decisions about where to fish. Commercial fishers choose different areas to fish based on myriad observable and unobservable characteristics of the area and the fisher. We commonly model location choice as a function of the expected catch (or revenue) in an area, fuel and fish prices, distance to an area, vessel characteristics, and to a more limited degree, institutional and environmental conditions. In the Bering Sea pollock fishery, climate variables affect many aspects of the fishing decision. Key among

these impacts is the role that climate has on fish location and abundance and the impact that weather plays in daily participation choices for smaller vessels. In this project, we are working to expand a robust spatial economic model to include climate data (e.g., ice cover, sea surface temperatures, wind). Including this information in the model will allow us to determine the relative impact of observable contemporaneous environmental conditions on location choices. We will also develop a framework to include predictions of changing pollock abundance in the model, which will allow us to estimate fisher response to scenarios developed by oceanographic and ecosystem modelers involved in the BSIERP project. An overview of the model and data to be utilized in this paper was presented in Gijon, Spain, in May 2008 at the PICES/ICES Conference on the Effects of Climate Change on the World's Oceans.

By Alan Haynie

Bering Sea and Aleutian Island Communities: Demography in a Changing Ecosystem

Fishery managers sometimes find social impact analysis difficult to incorporate into their decision-making processes in part because it does not come in the quantitative and predictive formats they are accustomed to receiving for stock assessments and economic impacts. This project seeks to improve the reception of social information by taking many of the usual concerns of social scientists—population, race and ethnicity, gender, community size and viability (resilience)—and presenting them in predictive models that assess the demographic impacts of fisheries on communities. Where possible, these predictions will indicate a quantitative range of the likely impacts of ecosystem changes such as fisheries harvest levels, climate change, and protected resources regulations. In other cases it will only be possible to characterize the direction and intensity of likely impacts. Regardless, this project will allow us to inform fishery managers of the way in which ecosystem changes may affect the overall human population levels in the large marine ecosystem and the distribution of those populations in terms of factors such as large and small communities, Alaska Native populations, immigrants, gender, and age.

This is a three phase project. Phase 1 (completed in 2006) compiled and analyzed existing population information for communities in the Bering Sea and Aleutian Island (BSAI) large marine ecosystem, resulting in two papers published in the 2006 SAFE report and a paper presented at Population Association of America Conference in March 2007. Conclusions from Phase 1 include:

- The region shows overall population growth since early 1900s.
- The region shows overall growth recently (1990- 2005).
- Military and fisheries are major drivers of population changes.
- Growth is not distributed evenly, nor do all 94 communities in the region show growth.
- Recent negative growth communities may possibly be characterized as salmon-dependent or military-dependent (subjected to falling prices and base closures).
- Recent positive growth communities may possibly be characterized as hub communities, subsistence communities, and nonsalmon-dependent fishing communities.

We are currently undertaking Phase 2, which will compile and analyze population structure information including age, gender, and ethnicity/race, and examine mechanisms of change tied to ecosystem factors such as fish landings and prices. Some recent ethnographic work in Bristol Bay indicates connections between fisheries and social factors, e.g., inmigration for labor, outmigration for educational opportunities, and Alaska Native birth rates in small villages (connected to educational opportunities for women, or lack thereof). Phase 2 will include a typology of BSAI communities that reflects recent demographic trends, comparative analysis of demographic trends and fisheries trends over the period 1990-2007, and a regression analysis of demographic, fishery, and ecosystem indicators in order to understand the factors that most effect population growth and decline at the community level. In a third phase that is as yet unfunded, we will construct models that can be coupled with bioeconomic model outputs to predict community-level demographic changes in response to fishery management decisions.

By Jennifer Sepez

STATUS OF STOCKS & MULTISPECIES ASSESSMENT PROGRAM

Figure 1. Ice near Pt. Barrow, Alaska, during the Fisheries Interaction Team Beaufort Sea fish survey. Photo by Erika Acuna.

Fish Survey of the Beaufort Sea

Staff from the Status of Stocks and Multispecies Assessment (SSMA) Program's Fisheries Interaction Team (FIT) led NMFS's first dedicated fish survey of the Beaufort Sea this summer (30 July to 30 August).

The survey was funded by the Minerals Management Service (Department of the Interior). Participating institutions included the University of Alaska and the University of Washington. The goals of the survey were to provide a baseline for analysis of the impacts of future oil and gas development in the Beaufort Sea and for the study of climate change. The results from the survey also will provide information for the Arctic Fisheries Management Plan currently under development by the NPFMC. The survey was conducted on the chartered vessel *Ocean Explorer* in shelf waters (20 to 500 m depth) between 155°W and 152°W. The species composition, distribution, and abundance of benthic fish and invertebrates were assessed with standard bottom trawl methods. Pelagic fish were surveyed with fisheries acoustics and midwater nets. In addition, oceanographic data and zooplankton samples were collected to assess water

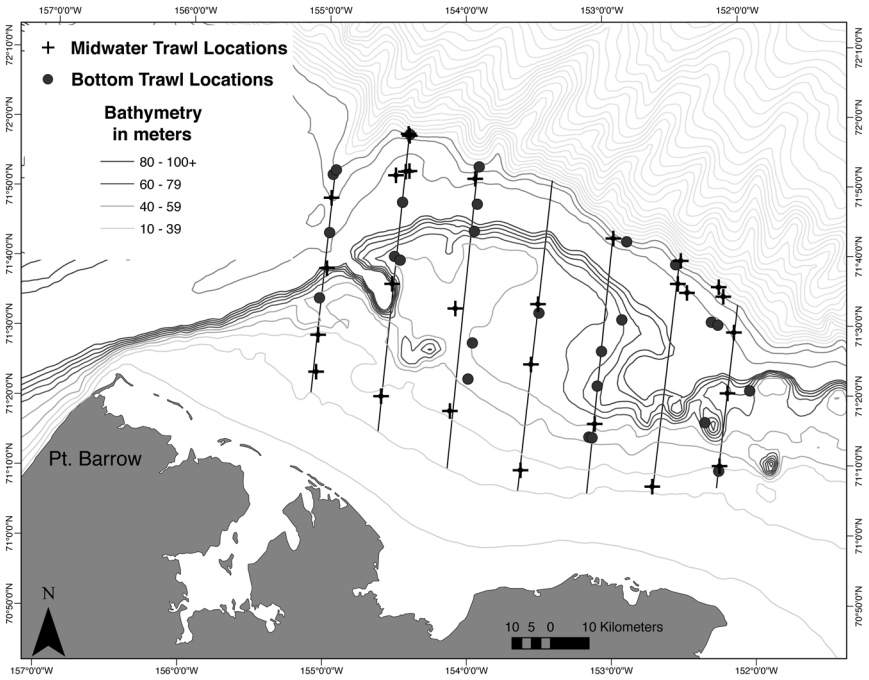

Figure 2. Location of midwater trawls, bottom trawls and acoustic transects during the Beaufort Sea survey, August 2008.

column properties and the prey available to fish. Scientists also recorded marine mammal observations and conducted transect surveys for seabird distribution and abundance.

The cruise was a success. One challenge was the presence of sea ice during the transit from Dutch Harbor and in the study area. The vessel encountered fairly heavy ice around Pt. Barrow, requiring approx. 24 hours of slow and careful steaming to work through it (Fig. 1). When the vessel arrived on the survey grounds on 6 August, dense sea ice covered the inner- and midshelf areas (20-100 m) and persisted for 6 days. Only the deepest stations could be sampled during that time (100-500 m depth). After 6 days it was possible to trawl at midshelf stations (less than 100 m water depth), although it required navigating through ice to reach open water, and fishing operations were conducted within 0.5 to 3 nmi of the ice. However, the next day (13 August), the midshelf region was mostly clear of ice, and ice was not encountered in densities requiring a change in survey plans for the remainder of the cruise.

A total of 26 bottom trawls and 27 midwater trawls were conducted. Seven approximately 30-nmi acoustic transects were surveyed (Fig. 2). Fish comprised 6% of the total weight captured in the bottom trawls of which 38 species of fish were identified. Of the total weight of fish captured in the bottom tows, 80% was Arctic cod (*Boreogadus saida*); several species of eelpouts (*Lycodes* spp.) made up 13% of the total weight.

Collections of other species resulted in extensions of known distributional ranges. For example, Bering flounder (*Hippoglossoides robustus*), walleye pollock (*Theragra chalcogramma*), Pacific cod (*Gadus macrocephalus*), marbled eelpout (*Lycodes raridens*), salmon snailfish (*Careproctus rastrinus*) and bigeye sculpin (*Triglops nybelini*) were not formerly known to inhabit Beaufort Sea waters (pending species confirmation with voucher specimens).

Invertebrates comprised 94% of the total weight captured in the bottom tows of which approximately 174 species were identified. Of the invertebrates, *Ophiura sarsi* (brittlestar) made up 41%, and *Chionoecetes opilio* made up 10% of the total weight. The pelagic fish community, as assessed with acoustics and midwater nets, was dominated by Arctic cod.

Data on the distribution and abundance of seabirds were collected during the transit to and from Dutch Harbor and during the acoustic transects when conditions allowed. Arctic terns, black-legged kittiwakes and phalaropes were the most abundant seabirds in the study area. Figure 3 shows the distribution of these three species. Terns appeared to be distributed primarily in offshore depths (approx. 100-500 m), whereas kittiwakes were most abundant in mid- and inner-shelf depths (20-100 m). Phalaropes were very patchy and observed in high abundances at just two locations in the midshelf area.

Opportunistic marine mammal sightings were recorded in collaboration with

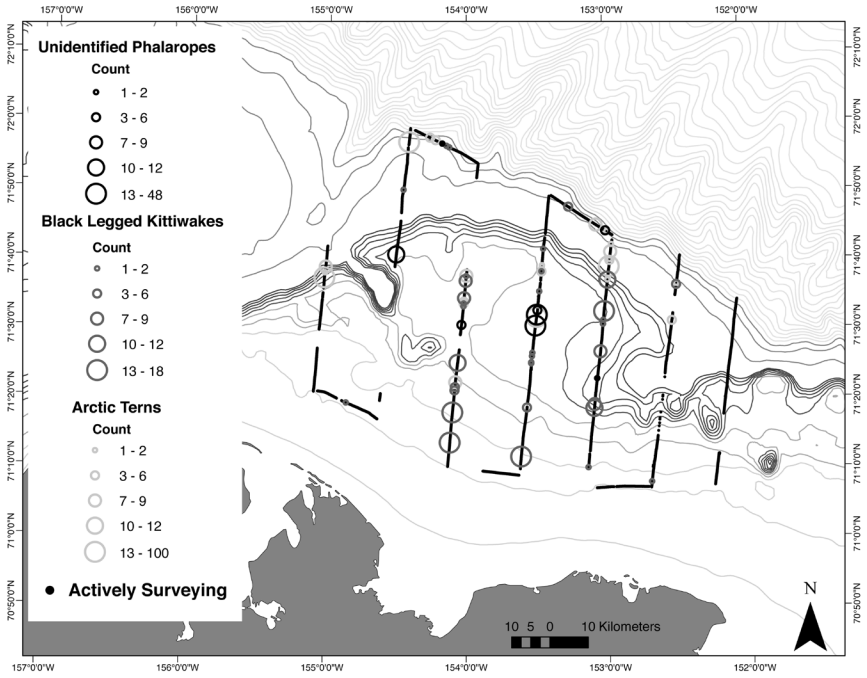

Figure 3. Distribution of three most abundant seabird species during Beaufort Sea survey, August 2008.

Figure 4. An adult polar bear (presumably female) and two cubs on the ice near Pt. Barrow. Photo courtesy of Joao DoMar.

the Platforms of Opportunity program at the National Marine Mammal Laboratory. Highlights included an adult polar bear (presumably female) and two cubs on the ice near Pt. Barrow (Fig. 4). A swimming polar bear was also observed in the same area. Large numbers of gray whales were observed during the transit to and from the study area, in the Chukchi Sea/Bering Strait area. They appeared to be feeding. No confirmed bowhead whale sightings were made during the transit or in the study area.

Temperature-depth data were collected with a trawl-mounted microbathythermograph (MBT) on all trawls. Figure 5 shows bottom temperature at all bottom trawl locations. Bottom temperatures ranged from -1.4° to 1°C. The coldest bottom water appeared to be found at depths ranging from around 70 m to 300 m, with warmer water inshore and offshore of those depths.

By Libby Logerwell

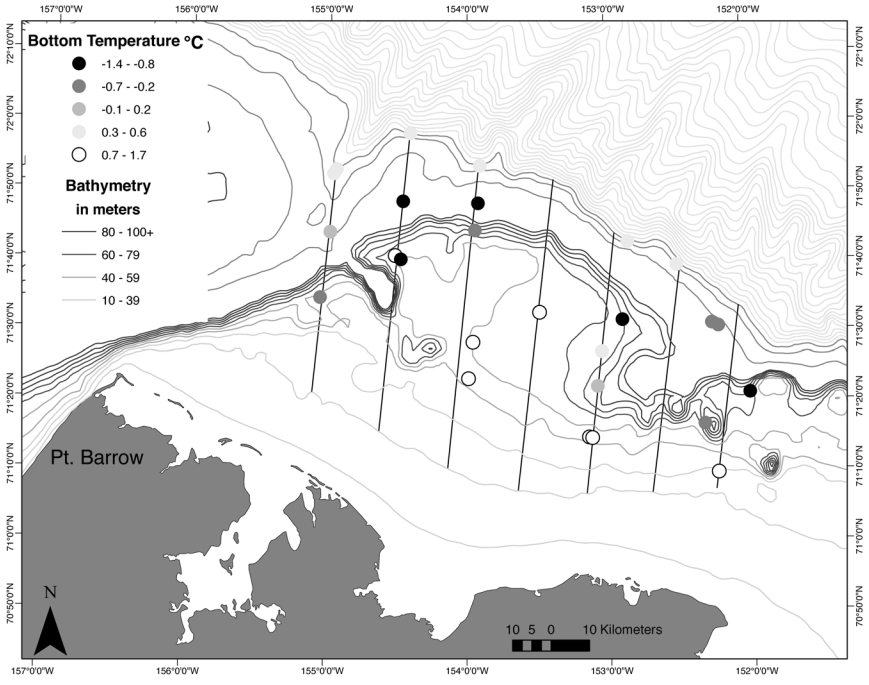

Figure 5. Bottom temperature at bottom trawl stations during the Beaufort Sea survey, August 2008.

138th Annual Meeting of the American Fisheries Society

Drs. Olav Ormseth and Paul Spencer, SSMA Program, attended the 138th annual meeting of the American Fisheries Society (AFS), held in Ottawa, Canada, 17-21 August. The meeting theme "Fisheries in Flux" reflected our growing awareness of the dynamic nature of fish populations and ecosystems as well as changes occurring in the discipline of fisheries science. The meeting started with several keynote addresses, including a slide show on an expedition that retraced the 1940 Steinbeck-Ricketts expedition to the Sea of Cortez. Many changes have occurred there over the last 68 years, including a shift in the size distributions of many species towards smaller individuals and the expansion of a mesopelagic hypoxic zone. At the awards ceremony, Dr. Ole Mathisen was recognized posthumously for his contributions to fisheries science in Alaska. Presentations at the AFS meeting occur within separate symposia, and there were a wide variety of topics ranging from sturgeon conservation to tagging. Of special interest was a symposium titled "Evolving Fish, Changing Fisheries," which focused on evolutionary changes induced by fishing. The speakers provided evidence for potential long-term effects of fishing through the use of modeling, laboratory, and field studies. This field is itself evolving, and the 3 days of the symposium were heavily attended. Elsewhere, the presentations by Ormseth and Spencer focused on the issue of how female attributes (e.g., age and size) affect offspring viability, and the implications of such effects for fisheries management. Abstracts of their presentations are provided below.

The influences of maternal age of spawning, recruitment variability, and life-history pattern upon harvest reference points and fishery management

Marine fish stocks exhibit a wide variety of responses to oceanographic variability and harvesting, reflecting largely differences in reproductive biology and stock-recruitment relationships. For some stock such as Pacific rockfish (genus *Sebastes*)

and Atlantic cod (*Gadus morhua*), there is evidence that larval viability may be affected by the age of the spawner, thus potentially complicating stock-recruitment relationships. These maternal effects can be viewed as redefining the units of reproductive output from spawning stock biomass (i.e., eggs) to "viable larvae" (i.e., larvae remaining after mortality dependent upon spawner age is applied). For Alaska Pacific ocean perch (*Sebastes alutus*), this redefinition results in estimates of F_{msy} that are similar but slightly reduced from those obtained using spawning stock biomass as reproductive output, and steeper reductions in sustainable yield with fishing rates higher than F_{msy}. Simulated "cod-like" and "rockfish-like" populations were used to further explore how estimates of management reference points such as F_{msy} and F_{crash} (the F level where equilibrium yield is reduced to zero) may be affected by life-history pattern, recruitment variability, and exploitation. In these simulations, larval survival was dependent upon spawner age, and estimates of F_{msy} and F_{crash} were made using either total larvae (proportional to eggs and spawning stock biomass) or viable larvae. Over a range of harvest rates and levels of recruitment autocorrelation for each life-history type, estimates of F_{msy} obtained when using total larvae were similar to those obtained when using viable larvae. However, estimates of F_{crash} obtained when using total larvae were larger than those obtained when using viable larvae because of the pronounced truncation of age structure and decreased larval survival rates associated with the high fishing mortalities of F_{crash}. This suggests that estimation of stock productivity at low stock sizes may be biased high if larval survival is dependent upon spawner age and this relationship is not reflected in the units of reproductive output utilized for stock-recruitment analyses and estimation of fishing rate reference points.

Reproductive potential of Pacific cod in Alaska

In some species of marine fish such as Atlantic cod, older and larger females produce eggs and larvae with greater viability. Because the reproductive potential of these females is higher, the age structure of the population may be an important determinant of reproductive and recruitment success. To determine whether similar phenomena occur in Pacific cod (*Gadus macrocephalus*), I analyzed fecundity and egg size over a 4-year period in three regions of Alaska. Contrary to expectations, no maternal effects on egg size were observed. Females defend length-specific fecundity levels at the expense of egg size, implying that the number of eggs produced is the primary determinant of reproductive potential in Pacific cod. It is possible that the maternal effects observed in species such as Atlantic cod result from fishery-induced early maturation of young fish. Therefore, the lack of such effects in Pacific cod may reflect the fact that similar changes in age structure and maturation have not occurred in Alaskan cod populations. Alternatively, there may be environmental factors that favor a reproductive strategy that relies on maximizing the number of eggs produced rather than the size of individual eggs.

By Olav Ormseth and Paul Spencer

U.S.-Norwegian Catch Estimation Workshop at the AFSC

On 16–19 September the AFSC hosted the second Norway-U.S. workshop on commercial catch sampling and estimation. This workshop was a follow-up on one hosted by Norway in February 2007. The theme of these workshops was to compare and contrast catch estimation and fishery sampling programs between Alaska, New England, and Norway. Participants from the United States included the NMFS Alaska Regional Office and AFSC staff to represent Alaska, and a number of scientists from the Northeast Fisheries Science Center and the University of Massachusetts Dartmouth to represent catch-sampling off of New England. The participants from Norway were from the Institute of Marine Research.

The workshop was organized into sessions discussing a) fishery data collection programs; b) the use of "study fleets" to estimate catch; and c) comparison of catch-at-age estimation methods and the implications of these sources of variability in stock assessments. Workshop participants drafted a set of documents based on these session topics, which when complete, will provide a valuable reference document and contribute to the literature on catch estimation methods. For example, a metric which provides an evaluation of catch-at-age precision was developed and will assist in providing specifications of estimation uncertainty in stock assessments.

By Jim Ianelli and Dana Hanselman

NMFS Fisheries and the Environment (FATE) Principle Investigator Meeting

Drs. Anne Hollowed and William Stockhausen participated in the annual NMFS Fisheries and the Environment Program (FATE) Principal Investigator Meeting on 13-14 August in La Jolla, California. The meeting provided a forum for fisheries oceanographers and modelers from across the United States to discuss FATE research. Dr. Art Miller (Scripps Institution of Oceanography) was a guest speaker, and his presentation focused on long-term changes in the climate of the California Current, with biological impacts. Principal investigators provided oral presentations on the progress of their research. A complete list of presentations can be found on the FATE website at http://fate.nmfs.noaa.gov. The FATE program recently released its annual announcement of opportunity. All interested investigators are encouraged to apply.

By Anne Hollowed

Bering Sea Crab Working Group Progress Report

King and Tanner crab stocks of the eastern Bering Sea (EBS) are managed under the Bering Sea/Aleutian Islands (BSAI) King and Tanner Crab Fishery Management Plan of the NPFMC. The plan provides the framework for cooperative management of stocks between the ADF&G and NMFS. Under the plan, certain management controls such as setting of annual catch quotas are deferred to the ADF&G, while NMFS is responsible for the annual status determinations of overfishing and overfished, and for ensuring plan compliance with the Magnuson-Stevens Fishery Conservation Management Act (MSFCMA) and National Standard Guidelines (NSGs). Since 1998, four of the ecologically important and economically valuable crab stocks of the EBS have been declared overfished, and fisheries for several more stocks were closed due to low levels of stock biomass. Overfishing definitions for managed BSAI crab stocks were established in 1998 with a provision for review after 5 years. A working group of

the NPFMC's Crab Plan Team consisting of NMFS and ADF&G scientists was formed in September 2003 to evaluate the existing overfishing definitions and to propose revisions to those definitions so as to ensure the conservation and effective utilization of the stocks.

The complex nature of crab reproductive dynamics, mating processes, male only fisheries, and the lack of age and other essential biological information contributed to the difficulties of this work. In February 2006, the NPFMC sponsored a workshop to assist in clarifying some of these complex biological issues. Through the efforts of the working group, simulation models were developed, resulting in improvements to length-based stock assessment methodologies and enabling the evaluation of overfishing control rules and rebuilding strategies of overfished stocks. A principal product of the working group was the definition of a tier system analogous to that employed for the management of NPFMC groundfish stocks.

In April 2006, NMFS funded a peer review of the working group's modeling products and preliminary results by the Center for Independent Experts (CIE). The CIE review resulted in many informative suggestions on the work to formulate new overfishing definitions. Results of preliminary analyses by the working group and the CIE review were presented to the NPFMC's Scientific and Statistical Committee (SSC) in June 2006. Based on these results, the SSC approved the Crab Plan Team and Working Group to proceed with developing a Draft Environmental Assessment (EA) to amend the existing BSAI King and Tanner Crab fishery management plan. A 191-page Environmental Assessment (Amendment 24 to the BSAI KTC FMP) was approved by the SSC in December 2007. The EA that defined the new process was produced cooperatively by scientists from the AFSC, ADF&G, NMFS Alaska Regional Office, and NPFMC.

The culmination of 5 years of working group meetings, simulation modeling, technical workshops and scientific reviews resulted in the implementation of new overfishing definitions for BSAI King and Tanner crab stocks for the 2008/09 fishing seasons. As prescribed by Amendment 24, annual stock assessments, reference point determinations and total catch overfishing limits are now subject to review and recommendation by the Crab Plan Team, the NPFMC SSC, the industry and stakeholders. The new assessment and evaluation processes will result in the best available science being applied to the setting of annual threshold limits on stock status and fishery performance in a transparent manner similar to the North Pacific groundfish process. The Amendment 24 revisions also establish a framework that will allow future research to be incorporated into stock assessments and OFL determinations without major and time consuming formal revisions to the fishery management plan.

By Jack Turnock and Lou Rugolo

AGE & GROWTH PROGRAM

Estimated production figures for 1 January through 30 September 2008 are presented in Table 1. Total production figures were 28,409 with 7,726 test ages and 268 examined and determined to be unageable.

Validation of Dover Sole Ages

Dover sole (*Microstomus pacificus*) is a deepwater flatfish caught commercially from Southern California through the Gulf of Alaska. Dover sole can be very difficult to age, and the ages using the break-and-burn method have never been validated. The Age and Growth Program has recently completed a bomb carbon (C-14) age validation of Dover sole, which validated ages from 8 to 47 years. This age validation study (Kastelle et al.) has been published in the October issue of *Fishery Bulletin*. Although this paper generally validates ages for Dover sole having clear growth patterns, there will always be many specimens having growth patterns that are difficult to age. (See the Age Reading Demonstration program (ARD) on the age and growth website at http://www.afsc.noaa.gov/REFM/Age/interactive.htm for examples of Dover sole otoliths that are both easy and difficult to age.). Nevertheless, this study is an important advancement in our knowledge of the life history of Dover sole.

By Dan Kimura

Table 1. Estimated production figures for 1 January through 30 September 2008,

Species	Specimens Aged
Alaska skate	111
Flathead sole	2,859
Rex sole	596
Alaska plaice	339
Dover sole	371
Northern rock sole	465
Yellowfin sole	1,272
Bering flounder	58
Kamchatka flounder	112
Walleye pollock	11,824
Sablefish	2,327
Atka mackerel	1,125
Pacific ocean perch	1,983
Northern rockfish	535
Rougheye rockfish	1,015
Shortraker rockfish	690
Dusky rockfish	861
Quillback rockfish	41
Warty sculpin	683
Plain sculpin	780
Bigmouth sculpin	90
Yellow Irish lord	272