Marine Ecology & Stock Assessment Program

2011 Sablefish Longline Survey

The AFSC has conducted an annual longline survey of sablefish and other groundfish in Alaska from 1987 to 2011. The survey is a joint effort involving the AFSC's Auke Bay Laboratories (ABL) and Resource Assessment and Conservation Engineering (RACE) Division. It replicates as closely as practical the Japan-U.S. cooperative longline survey conducted from 1978 to 1994 and also samples gullies not sampled during the cooperative longline survey. In 2011, the thirty-third annual longline survey of the upper continental slope of the Gulf of Alaska and eastern Bering Sea was conducted. One hundred-fifty-two longline hauls (sets) were completed during 25 May - 28 August 2011 by the chartered fishing vessel *Ocean Prowler*. Sixteen kilometers of groundline were set each day, containing 7,200 hooks baited with squid.

Sablefish (*Anoplopoma fimbria*) was the most frequently caught species, followed by giant grenadier (*Albatrossia pectoralis*), Pacific cod (*Gadus macrocephalus*), shortspine thornyhead (*Sebastolobus alascanus*), and arrowtooth flounder (*Atheresthes stomias*). A total of 98,592 sablefish were caught in 2011, representing a substantial increase over the 2010 survey sablefish catch. Sablefish, shortspine thornyhead, Greenland turbot (*Reinhardtius hippoglossoides*), spiny dogfish (*Squalus suckleyi*), and lingcod (*Ophiodon elongates*) were tagged and released during the survey. Length-weight data and otoliths were collected from 2,532 sablefish. Killer whales *(Orcinus orca)* took fish from the longline at seven stations in the Bering Sea region, five stations in the western Gulf of Alaska, and one station in the central Gulf of Alaska. This represents a slight increase in killer whale interactions in the Western Gulf compared to 2010 but a decrease in the Bering Sea. Sperm whales *(Physeter macrocephalus)* were often present during haul back and were observed depredating on the longline at nine stations in the East Yakutat/Southeast region, four stations in the West Yakutat region, and one station in the central Gulf of Alaska. These numbers represent an increase in sperm whale interactions over the previous year but are below the highest number of interactions seen in 2008.

Several special projects were conducted during the 2011 longline survey. Lingcod and spiny dogfish were tagged with archival temperature/depth tags in the West Yakutat and central Gulf of Alaska regions. Forty-five satellite pop-up tags were deployed on spiny dogfish throughout the Gulf of Alaska. Information from these tags will be used to investigate the movement patterns of spiny dogfish within and out of the Gulf of Alaska. Additionally, genetic tissue and otoliths of giant grenadier were sampled to see if geographic stock structure exists and to determine if three distinct otoliths shapes identified in previous work correspond to different subspecies or subpopulations. Finally, opportunistic photo identification of both sperm and killer whales were collected for use in whale identification projects.

By Chris Lunsford

Sablefish Maturity Cruise Completed

AFSC biologists Katy Echave (Fig. 1) and Jim Stark completed a 10-day cruise in December off Kodiak Island, Alaska, aboard the chartered fishing vessel *Gold Rush* as part of a special study to better define the reproductive patterns of sablefish in Alaska waters. The new study, a joint effort between ABL and the RACE Division, is designed to provide important, accurate estimates of sablefish age and length at maturity, a critical component of the stock management models used to set the overfishing limit and maximum sustainable yield

Managed by the North Pacific Fishery Management Council, the sablefish population in Alaska waters is healthy and above biomass limits. Continuing this sustainable fishery into the future will benefit consumers, fishermen, processors, shipyards, and the fishing community.

More information on the project is available in this issue in the RACE Division's Groundfish Assessment report.

By Julie Speegle

Figure 1. Auke Bay Lab scientist Katy Echave at the sampling station aboard the fishing vessel *Gold Rush* during the sablefish maturity cruise near Kodiak, Alaska, December 2011.

Survival of Deep-Water Rockfish After Barotrauma

Because rockfish (*Sebastes* spp.) are physoclystic (their gas bladders are closed off from the gut), they often suffer internal injuries from rapid, internal air expansion when caught and brought to the surface. Many discarded rockfish do not survive either because they cannot submerge due to excessive buoyancy or because of internal damage. There is some evidence that recompression may greatly increase the survival of barotrauma-injured rockfish. However, because survival can be species-specific, it is important to gauge the impacts on each species of interest.

Research completed in 2010 and 2011 demonstrated that rougheye rockfish (*S. aleutianus*) caught at depths from 500 to 800 ft and exhibiting barotrauma can survive if recompressed after capture in portable pressurized tanks. This result is noteworthy because it is the deepest known successful capture and recompression of any rockfish species, which suggests there is potential to conduct scientific tagging studies to track movements and behavior. In September 2011, we chartered the fishing vessel *Seaview*, a longline vessel out of Juneau, Alaska, to sample rougheye rockfish on reefs near the NOAA Little Port Walter Research Station on Baranof Island, Southeast Alaska. After rougheye were caught and brought to the surface, they exhibited signs of barotrauma such as stomach eversion, exophthalmia (bulging eyes), and corneal gas bubbles. Of 21 fish that were recompressed immediately after capture in portable pressure tanks, 13 survived and are currently held for long-term monitoring at the ABL Lena Point facility in Juneau. Some of these fish still have corneal gas bubbles, but other signs of barotrauma have since subsided. Other rougheye rockfish caught during the cruise were tagged and subsequently released at 200-250 ft using a weighted crab ring and a downrigger (n=47). In 2012 we hope to increase the number of tagged fish at-large, make the first attempt to recapture fish tagged in 2011, and increase the number of fish brought back to ABL and held for long-term observation.

By Cara Rodgveller

Recruitment and Response to Damage of an Alaskan Gorgonian Coral

Benthic habitats in deep-water environments experience low levels of natural disturbance and recover slower than shallow-water habitats. Deep-water corals are particularly sensitive to disturbance from fishing gear, in part because they are long-lived, grow slowly, and are believed to have low rates of reproduction. Limited data describes recruitment and recovery of deep-water corals. This information is critical to understanding long-term effects of anthropogenic disturbances, such as commercial fishing, on the population dynamics of living benthic habitat.

In 2009, ABL scientists initiated a multiyear study to examine recruitment and recovery of the gorgonian coral *Calcigorgia spiculifera*, a species broadly distributed in the Gulf of Alaska and along the Aleutian Islands. *Calcigorgia spiculifera*, as well as many other gorgonian corals, is found in areas and depths that coincide with trawl and longline fisheries and is often damaged by these fisheries. The body plan of *C. spiculifera* is similar to many other gorgonian corals commonly found throughout the North Pacific Ocean. Therefore, sensitivity to disturbance, rate of recovery, and recruitment of *C. spiculifera* are likely to be similar to other coral species, and thus results from this research may be applied broadly. Recovery rate and recruitment data are necessary for modeling habitat impacts and forecasting recovery and will ultimately guide fisheries managers in making decisions regarding benthic habitat conservation measures. In this study, recruitment is being investigated by observing settlement of coral planulae onto rings equipped with natural stone tiles, and coral recovery is being examined by observing the response of colonies to damage treatments.

The study site, Kelp Bay, Southeast Alaska, offers hundreds of *C. spiculifera* colonies concentrated at depths easily accessible to scuba divers. Field operations in Kelp Bay began in August 2009 when a team of four divers located and tagged 48 *C. spiculifera* colonies. Of that total, nine colonies were fitted with settlement rings equipped with removable tiles. The remaining 39 tagged colonies were ascribed to three damage treatment groups and a control group. The damage treatments were designed to mimic actual damage that can occur from a passing trawl. These treatments were performed *in situ* and included deflection, soft tissue excision, and branch severance. Video of each colony was recorded before and after the treatments were performed to establish baseline coral characteristics and to identify immediate treatment effects. Since the initial site visit, the dive team has returned to observe the tagged corals on three additional occasions (June 2010, September 2010, and August 2011). On each visit, a subsample of the stone tiles was collected and preserved in solution for subsequent inspection in the laboratory for adhesion of coral recruits. Damaged and control colonies were also videotaped so that comparisons can be made to pretreatment images. At least one subsequent site visit is planned for 2013 to allow additional tile collections and to capture long-term effects of disturbance.

By Patrick Malecha

Groundfish Stock Assessments

This quarter, scientists from ABL's Marine Ecology and Stock Assessment (MESA) program completed nine full stock assessments and two updated assessments for 11 species/species groups of Alaska groundfish. Full assessments included Alaska sablefish, Gulf of Alaska sharks, and the following assessments for Gulf of Alaska rockfish: Pacific ocean perch, thornyheads, northern rockfish, dusky rockfish, rougheye/blackspotted rockfish, shortraker rockfish, and "other rockfish." Short stock assessment updates included Alaska grenadiers and Being Sea/Aleutian Islands sharks.

Substantial changes and improvements were made to the assessments for northern rockfish and what was previously the pelagic shelf rockfish management complex. The pelagic shelf rockfish complex was dissolved, and dusky rockfish (the complex's dominant species) is now its own assessment chapter, while the other two pelagic shelf species (yellowtail and widow rockfish) were combined with the previous "other slope rockfish" complex and renamed simply "Gulf of Alaska other rockfish." A stock structure analysis was completed for dusky rockfish, and it was determined that the structure was reasonably consistent with current management units. In addition, Gulf of Alaska shortraker rockfish is now a separate assessment chapter, having been removed from the "Gulf of Alaska shortraker and other slope rockfish" chapter.

The northern and dusky rockfish models were both updated with new maturity data, using a novel approach that combined multiple maturity data sets and accounted for uncertainty within the model. For northern rockfish, an extensive analysis was conducted to examine the best way to choose the number of bins used in analyzing age composition data. As a result, the age-composition bin structure was increased by 10 years, resulting in an improved fit to the data. For dusky rockfish, different selectivity patterns yielded similar fits to the data with far fewer parameters. The Alaska sablefish stock assessment model was unchanged from 2010 and showed a modest increase in Total Allowable Catch (TAC) recommendations as a result of 2 years of relatively high longline survey abundance estimates.

Stock Assessment and Fishery Evaluation (SAFE) reports or executive summaries were prepared for each assessment, and results were presented to the North Pacific Fishery Management Council's Groundfish Plan Teams in November and also reviewed by the Council's Scientific and Statistical Committee in December. The Council used these assessments as the primary source for determining catch quotas (levels of TAC) for these species in 2012.

For more information about these assessments, see the Status of Stocks & Multispecies Assessment Program's article "Groundfish Stock Assessment for 2012: Fishery Quota Recommendations" in the Resource Ecology and Fishery Management (REFM) Division section of this issue or the full stock assessment reports on the AFSC website at *www.afsc.noaa.gov/refm/stocks/assessments.htm*.

By Dana Hanselman

Genetics Program

Auke Creek Salmon Research: 2011 Was a Big Year

The Genetics Program at ABL includes science operations at Little Port Walter Marine Station, Ted Stevens Marine Research Institute, and Auke Creek Weir and Research Station. Auke Creek is a 400-m stream that connects the Auke Lake watershed with Auke Bay, an estuarine embayment near Lynn Canal, Southeast Alaska. The stream is on the road system close to Juneau, Alaska.

Each year, thousands of salmon and trout pass through Auke Creek where for over 30 years the National Marine Fisheries Service has operated a counting weir to track both upstream and downstream migration. The year 2011 was a busy year at Auke Creek. In the spring, in addition to other trout and salmon species, 31,000 pink salmon fry, 10,500 coho salmon smolts, and over 32,000 sockeye salmon smolts were counted and sampled at the weir. The coho smolt migration count is the highest we have observed in 30 years of direct monitoring. The data we collected included size and age sampling that provides information both to long-term monitoring studies and local area management plans. In fall 2011, in addition to char, trout, coho, and sockeye adults, there was a return of 27,000 adult pink salmon to the weir, which were counted and sampled with each fish being handled at least once (on the upstream migration) and sometimes twice (when they completed spawning and died). The total 27,000 fish is the second highest total for adult pink salmon during the more than 30 year time series and is almost three times the long-term average return for Auke Creek pink salmon of 9,891. The Auke Creek Weir and Research Station is a critical resource and the only weir in the state of Alaska, and one of very few on the West Coast that tracks both juvenile fish outmigration and adult returns, thus providing a very valuable data set for correlating weather and population productivity information over extended time periods. In addition, it has formed the major experimental support for a myriad of graduate research work, enhancement technology development, and long-term genetic studies of the variety of anadromous fish that reside there.

The weir is operated by John Joyce with help from Jesse Echave, Scott Vulstek, and Andrew Eller (Fig. 2). In addition to his studies regarding the effects of climate change on coho salmon, John also has collaborations with researchers at the University of Alaska-Fairbanks to study supplementation effects in sockeye salmon, the University of Alaska-Southeast to study the effects of climate change on fish migration, and the Alaska Department of Fish and Game to monitor salmon productivity.

By Jeff Guyon and John Joyce

Figure 2. Auke Creek Weir near Juneau, Alaska. The weir is operated by John Joyce (upper holding pen) with help from Jesse Echave (in stream recording counts), Scott Vulstek (middle holding pen), and Andrew Eller (lower right).

FMA Observer Program Activities in 2011: A Record Breaking Year!

The year 2011 brought the biggest training and deployment workload in 3 years to FMA. For the 2011 fishing year, 800 observers were trained, briefed, and equipped for deployment to vessels and processing facilities operating in the Bering Sea and Gulf of Alaska groundfish fisheries. These observers collected data onboard 262 vessels and at 20 processing facilities for a total of 45,188 observer days. This is an increase in effort of approximately 10,000 observer days from 2010 and an increase of 6,000 observer days from our previous high of 39,463 in 2008. The high level of effort was due to new coverage regulations resulting from the Amendment 91 regulations affecting the Bering Sea pollock fishery. See our article in the April-May-June 2011 Quarterly Report (*www.afsc.noaa.gov/Quarterly/amj2011/tocFMA.htm*) for details regarding the Amendment 91 regulations.

New observer candidates are required to complete a 3-week training class with 120 hours of scheduled class time and additional tutelage by training staff as necessary. In 2011, the FMA Division provided training for 89 new observers in Seattle and 136 new observers in Anchorage at the Observer Training Center through a contract with the University of Alaska.

Returning observers are required to attend an annual 4-day briefing class prior to their first deployment each calendar year. These briefings provide observers with the necessary updates regarding their responsibilities. Prior to subsequent deployments, all observers must attend a 1-day, 2-day, or 4-day briefing; the length of the briefing each observer attends is dependent on that individual's needs. FMA staff briefed 330 observers in Seattle and 192 observers in Anchorage.

After each deployment, observers meet with a staff member for debriefing to finalize the data collected. There were 110 debriefings in Anchorage and, due to a larger debriefing staff, 584 debriefings in Seattle. Note that the values for the numbers of briefings and debriefings do not represent a count of individual observers as many observers deploy multiple times throughout the year.

In preparation for the 2011 fishing season, extensive work was performed modifying and updating the 2011 Observer Sampling Manual. Each new year brings some degree of change to observer data collections as part of our efforts to meet the various needs of the end data users. There may be a need to change how data are captured, the amount of data obtained for a specific collection, or the need for a new data collection may arise. For 2011 we modified Pacific cod and pollock specimen collections and added skate vertebrae specimen collections as a standard collection. Skate vertebrae specimens were previously collected as a research project by only specific observers.

Figure 1. Liz Chilton, FMA Field Operations Supervisor.

Another highlight of 2011 was the addition of a new supervisor position to our Division. Beginning December 5, Liz Chilton joined FMA as our Field Operations Supervisor (Fig. 1). Liz's extensive experience in Alaska fisheries began in the winter of 1990 when she worked for Alaskan Observers Inc. as a North Pacific groundfish observer, the first year domestic observers were required. After receiving an M.S. in Fisheries Oceanography from the University of Alaska Fairbanks, Liz worked for the Observer Program as a debriefer from September 1998 through October 1999. For the following 6 years, Liz worked as a research fisheries biologist at the AFSC's Kodiak Laboratory for the Groundfish Assessment program conducting rockfish maturity and natural mortality research as well as serving as Field Party Chief and deck boss on NMFS groundfish bottom trawl surveys conducted every summer in the Gulf of Alaska or the Aleutian Islands. From November 2005 until taking this position with FMA, Liz worked with the Shellfish Assessment Program at the Kodiak Laboratory designing and conducting fisheries oceanographic research of commercial crab species in the eastern Bering Sea. In addition to her extensive experience in fisheries, Liz spent 2011 participating in the Department of Commerce Aspiring Leadership Development Program. This highly competitive 1-year program for Department of Commerce employees provided several hands-on training opportunities including a 2-month assignment with the NMFS National Observer Program in Silver Spring. The FMA Division is very pleased that Liz brings her skills, experience, and enthusiasm to this important new position.

By Allison Barns and Ren Narita

Alaska Ecosystems Program

Changes in Northern Fur Seal Foraging Behavior with Increasing Population Density on Bogoslof Island, Alaska

The northern fur seal (*Callorhinus ursinus*) population in the United States has been declining at a rate of more than 3% per year since 1998. This is primarily the result of continued declines in pup production at the largest breeding colonies on the Pribilof Islands, Alaska (Fig. 1). In contrast, a recently established northern fur seal colony on Bogoslof Island, Alaska (Fig. 1), is showing a very different trend. The first report of breeding northern fur seals on Bogoslof Island came in 1980, after previous surveys reported only young males hauling out on the island. Since 1980, the population has grown rapidly with 17,574 ± 843 pups born on Bogoslof Island in 2007 (Fig. 2).

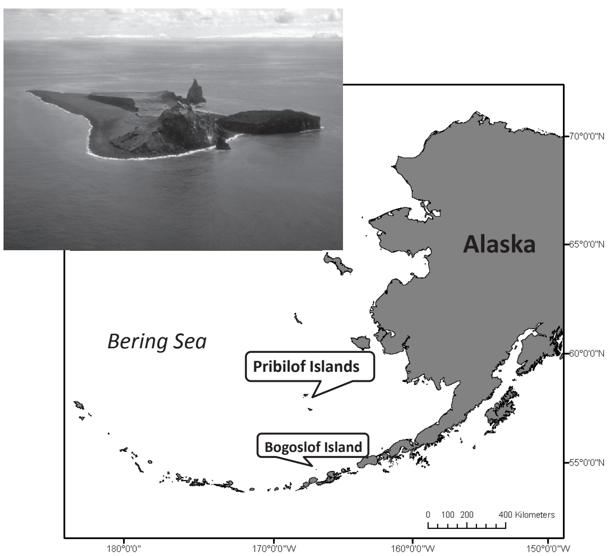


Figure 1. Northern fur seals were studied at Bogoslof Island, Alaska (53.92°N, 168.03°W), which is located just north of the Aleutian Island chain in the Bering Sea. The largest breeding population of northern fur seals occurs on the Pribilof Islands, Alaska. Map inset: Aerial image of Bogoslof Island.

This recent colonization event and the continued increase in abundance has provided a unique opportunity for researchers from the Alaska Ecosystems Program (AEP) at the National Marine Mammal Laboratory (NMML) to examine the impact of increasing population density on northern fur seal foraging behavior. During the breeding season, female fur seals are reliant upon local prey resources as they alternate time on land nursing a growing pup with time at sea acquiring resources. In seabird studies, researchers found that as colony size increased, prey resources near the colony became depleted due to the higher number of predators. As a result, the birds had to expend greater foraging effort and travel further from the colony to feed. To determine if there is evidence of resource depletion occurring around Bogoslof Island, we examined changes in northern fur seal foraging behavior intermittently over an 11-year period (1997, 2005, 2006, and 2007). Specifically, we examined differences in dive behavior, movement patterns, and space use among years focusing on adult female fur seals with a dependent pup. The foraging behavior of 57 fur seals was measured by equipping seals with a time-depth recorder (TDR) and satellite-tracking transmitter (PTT) (Fig. 3). The TDRs recorded detailed information about dive depths and durations, whereas the PTTs provided at-sea locations making it possible to reconstruct foraging trips.

For all years, average dives by fur seals on Bogoslof Island were short (37.7 ± 0.5 seconds) and shallow (9.2 ± 0.2 m), similar to the dive behavior reported for northern fur seals on other islands. For most dive characteristics (e.g., mean depth, duration, post-dive surface interval), we found no differences among years or obvious patterns of change. The one significant difference among years was an increase in the maximum dive depth recorded during a foraging trip. Maximum depths increased from 28.3 ± 1.9 m in 1997 to 70.2 ± 4.0 m in 2006, and some dives in 2006 reached depths well over 130 m. This suggests that fur seals may have been exploring deeper areas of the water column to find prey in the later years of the study.

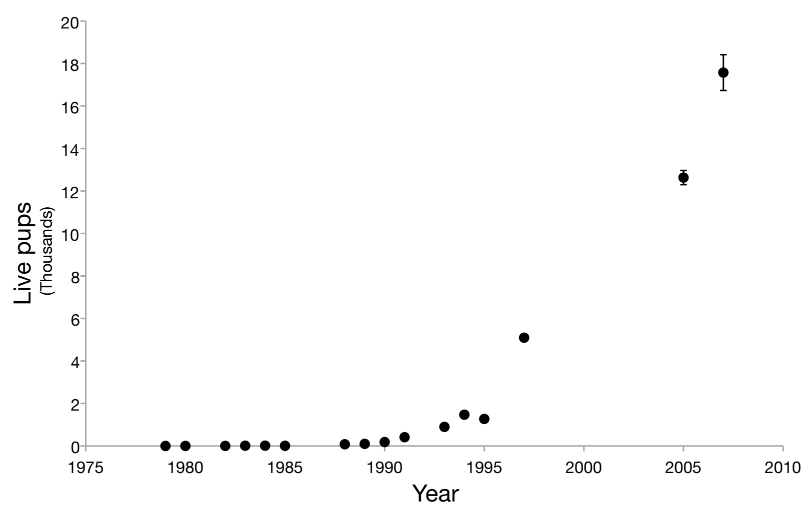


Figure 2. Northern fur seal pup production on Bogoslof Island, 1979-2007. Pups were directly counted from 1979 to 1997, and the shear-sampling method for estimating production was employed from 2005 to 2011. Error bars represent variance estimates based on shear-sampling count replicates.

Figure 3. An adult female northern fur seal instrumented with a satellite-tracking transmitter (PTT) and a time-depth recorder (TDR), posterior to the PTT.

In contrast to dive behavior, we found significant differences among years in all of the movement patterns examined. Trip durations increased from just under 1 day in 1997 to nearly 3.5 days in 2006 (Fig. 4). During these longer duration foraging trips, the maximum distance a female fur seal travelled from the rookery also increased (Fig. 4). This led to an expansion in the overall foraging range from 1997 to 2006 (Fig. 5). Interestingly, trip durations, distances traveled, and overall foraging habitat did not change between 2006 and 2007.

The changes we found in fur seal foraging behavior, specifically increased trip durations and greater foraging range, were similar to what has been reported for expanding seabird colonies. For these seabird studies, the authors concluded that this trend was a result of an increased number of predators depleting local resources. We believe that fur seals on Bogoslof Island may also be experiencing localized resource depletion associated with the rapidly growing population.

In August 2011, researchers from the AEP and staff from the Alaska Regional Office returned to Bogoslof Island. During this trip, pup production for 2011 was estimated and 10 adult female fur seals were equipped with GPS tracking instruments to examine at-sea behavior. Although the analysis is ongoing, preliminary results show that the population is continuing to grow, as approximately 23,000 fur seals were born on Bogoslof Island in 2011. This newly collected data will be combined with the analysis to date for a forthcoming publication entitled "Changes in northern fur seal (*Callorhinus ursinus*) foraging behavior with dramatically increasing population density."

By Carey Kuhn

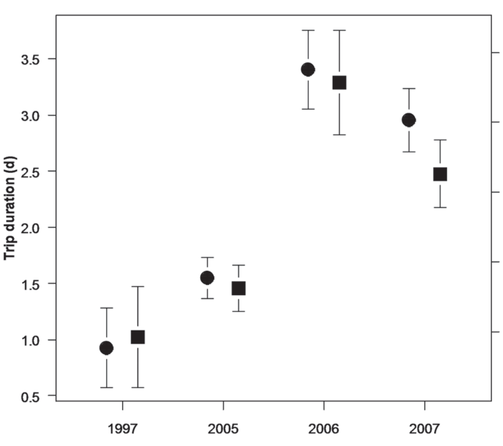


Figure 4. A comparison of trip durations (circles) and maximum travel distances (squares) by year. Foraging trip duration and maximum distance from the rookery increased from 1997 to 2006 but did not change between 2006 and 2007.

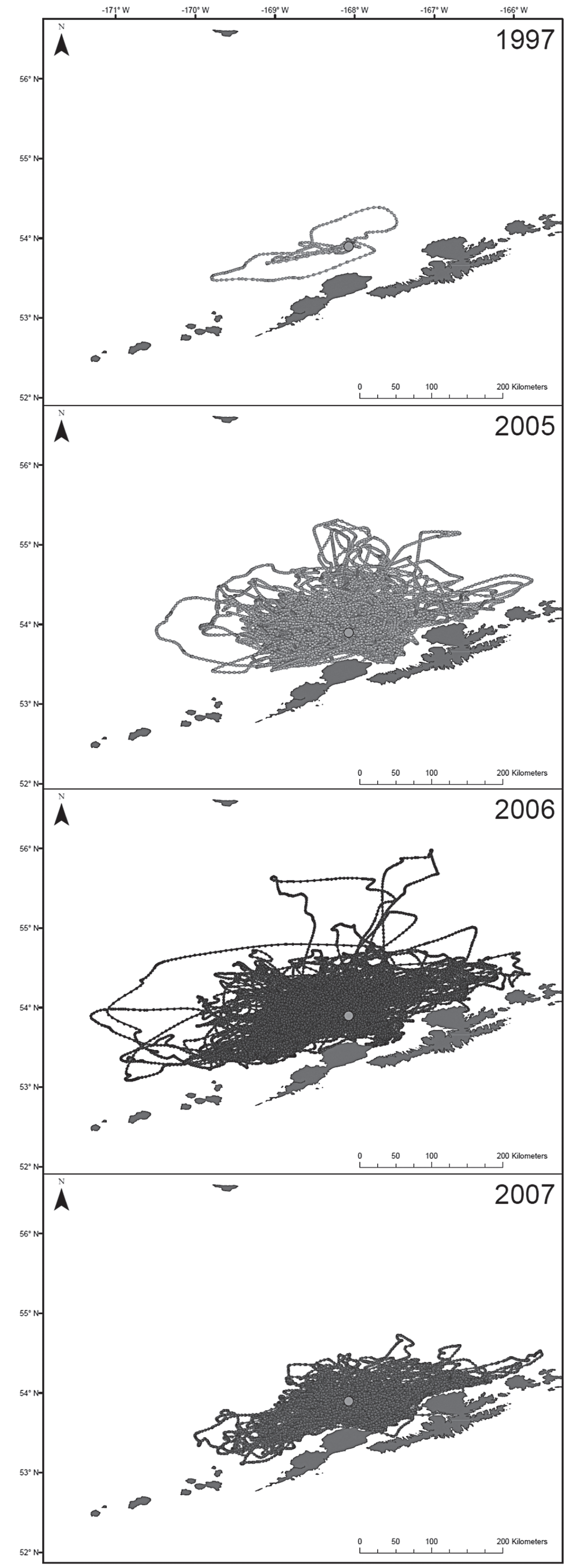


Figure 5. Tracks of northern fur seal foraging trips for each study year, showing the increase in foraging range from 1997 to 2006. Circle denotes Bogoslof Island.

Cetacean Assessment
& Ecology Program

Southeast Alaska Harbor Porpoise Research

Harbor porpoise (*Phocoena phocoena*) are known to range throughout Alaskan waters (Fig. 6). Given their wide range of occurrence and distribution in Alaska, we assume that regional populations exist. Currently, three biological stocks of harbor porpoise have been recognized in Alaska: 1) the Southeast Alaska stock, occurring from the northern border of British Columbia to Cape Suckling, Alaska; 2) the Gulf of Alaska stock, occurring from Cape Suckling to Unimak Pass; and 3) the Bering Sea stock, occurring throughout the Aleutian Islands and all waters north of Unimak Pass. It should be noted, however, that these boundaries were based on very limited scientific information and additional studies are needed to fully examine stock structure for this species.

Figure 6. Harbor porpoise. Photo by Ari Friedlaender.

Harbor porpoise primarily inhabit waters less than 100 m deep. Their preference for shallower waters makes this species vulnerable to being caught incidental to net-fishing operations. The nature and magnitude of incidental takes are unknown but could be significant in some Alaskan salmon (*Oncorhynchus* spp.) and herring (*Clupea pallasi*) gillnet and purse-seine fisheries.

In 1991, NMML initiated harbor porpoise studies aboard the NOAA ship *John N. Cobb*, with survey coverage throughout the inland waters of Southeast Alaska. Between 1991 and 1993, line-transect methodology was used to define overall distribution patterns and seasonality of harbor porpoise, obtain population estimates, and establish a baseline for detecting trends in abundance. Three surveys, in spring, summer, and fall, were carried out each year by a team of six observers. Annual surveys were continued by NMML between 1994 and 2005; however, only two trips (one in either spring or summer and the other in fall) were conducted per year. Although standard line-transect methodology was not used in these surveys, all observed cetaceans were recorded. During this 12-year period, observers reported fewer annual encounters with harbor porpoise. Although this raised concerns, our confidence in these data was low due to the lack of standardized effort, different numbers of surveys per year, differences in methodology, differences in survey coverage and duration, variable observer experience, differences in seasonal or yearly porpoise density, and the fact that focal studies were aimed at humpback whales and killer whales.

During this 12-year period, observers reported fewer annual encounters with harbor porpoise.

To update abundance estimates and assess population trends for Southeast Alaska harbor porpoise, NMML, with the assistance of the Alaska Regional Office, initiated line-transect surveys in 2006, 2007, and 2010 using methods comparable to those employed during the early 1990s. In 2006 and 2007, we successfully completed the spring, summer, and fall surveys on the *John N. Cobb*. Unfortunately, a catastrophic engine failure in 2008 resulted in the decommissioning of this ship; therefore, our summer and fall surveys in 2010 were conducted aboard charter vessels.

Harbor porpoise were seen throughout the inland waters of Southeast Alaska in clumped distributions. Within each year, greater densities of harbor porpoise were observed in the Glacier Bay/Icy Strait region (Fig. 7) and near Zarembo and Wrangell Islands and the adjacent waters of Sumner Strait. These areas of porpoise concentrations persisted throughout the three seasons sampled, although during summer, and to a lesser extent during fall, harbor porpoise occupying the waters near Wrangell Island appeared to expand their movements west into Sumner Strait.

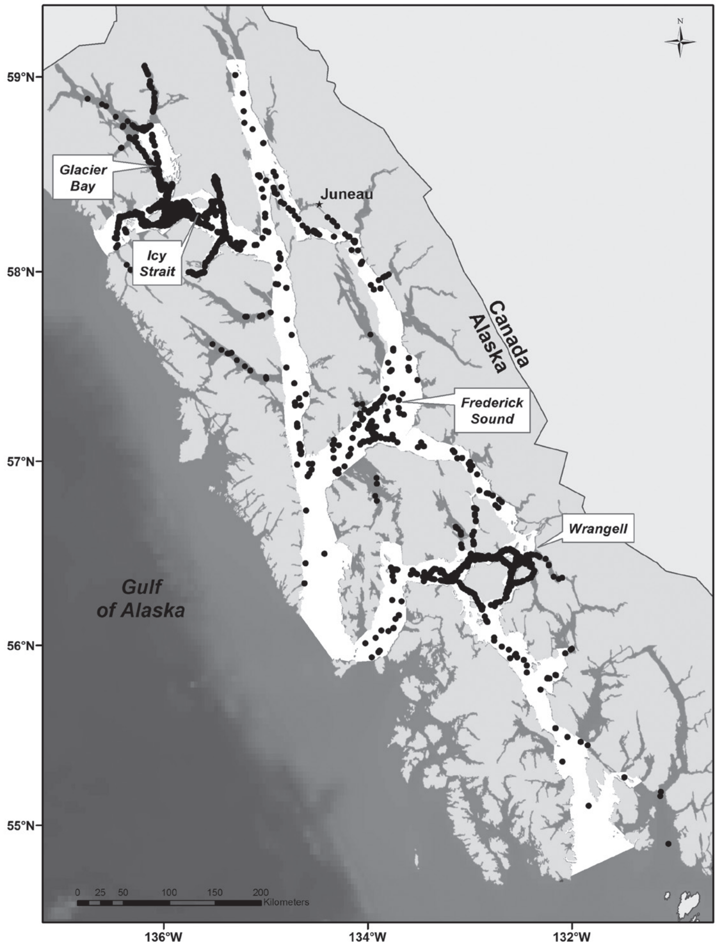


Figure 7. Distribution of harbor porpoise based on NMML line-transect surveys in the inland waters of Southeast Alaska (1991-93, 2006, 2007, and 2010).

Harbor porpoise mean group size varied by year and by season. Significantly larger groups were seen in fall (1.88 ± 1.12) than in spring (1.56 ± 0.86) or summer (1.61 ± 0.99). Despite the larger fall group size, there was no evidence of seasonality.

Total harbor porpoise abundance in the entire study area was highest in 1991 (1,293; CV=0.15), lowest in 2006 (485; CV=0.17), and equaled 809 animals (CV=0.19) in 2010. The overall abundance estimate does not include a correction factor for perception basis to correct for animals not counted because they were not observed.

Population trends for the whole study area, and for selected sub-areas where higher concentrations have been documented, were assessed from the time series of abundance estimates with a Bayesian exponential model. Results indicated high (65%-99%) probability that the population has decreased in these areas, with an estimated decline of 3.0% per year between 1991 and 2010 for Southeast Alaska inland waters. Regional trend estimates indicated that harbor porpoise abundance slightly decreased in the Icy Strait and Glacier Bay area, but more pronounced declines were observed in the southern range of the survey area, near Wrangell and Zarembo Islands and in Frederick Sound. The reasons for the negative trends are not well understood and could include fisheries bycatch; changes in prey distribution; a decrease in survival or shift in distribution due to habitat degradation, predation, or disease; or a combination of these factors. It is noteworthy that a greater decline was observed in areas where gillnet and purse-seine fisheries exist.

In 2011, summer and fall surveys were completed. These data are currently being analyzed and will provide NMML with updated abundance and trend estimates for Southeast Alaska harbor porpoise. NMML plans to continue annual surveys in Southeast Alaska to monitor harbor porpoise populations. Additional studies are needed to address harbor porpoise stock structure, dietary preferences, and the cause(s) of the current decline.

By Marilyn Dahlheim, Alex Zerbini, Janice Waite, and Amy Kennedy

Polar Ecosystems Program

Habitat Use and Seasonal Movements of Adult Bearded Seals in Kotzebue Sound, Alaska

Building on relationships and techniques developed during earlier tagging programs that focused on young-of-the-year bearded seals (*Erignathus barbatus*), NMML researchers contracted with the Kotzebue IRA to support a pilot study in late June and early July 2009 in Kotzebue Sound. This effort resulted in the successful capture and tagging of one adult male and two sub-adult male bearded seals (see AFSC Quarterly Report, October-November-December 2009). This was the first adult bearded seal ever tagged in Alaska. The seals were instrumented with satellite-linked data recorders (SDRs) and released.

In 2010, the spring field effort was repeated and also expanded to incorporate the North Slope Borough (NSB). Unfortunately, poor sea-ice and capture conditions prevented us from capturing any bearded seals at either Kotzebue Sound or at our two NSB study sites: Peard Bay and Barrow. Based on reports of bearded seals using land for hauling out in the fall, a small field team returned to Barrow in October 2010; however, no seals were captured during this late-season field effort.

With the respective cooperation of the North Slope Borough Wildlife Department and the Kotzebue IRA, springtime field efforts were again mounted in Barrow and Kotzebue in spring 2011. Similar to 2010, no seals were captured in the NSB. However, two females and one male were successfully captured, instrumented with SDRs, and released in Kotzebue Sound (Table 1). Based on their size and dentition, we estimated that one of the females was a yearling (young sub-adult) and the other female and the male were 2-3 years old (sub-adults; see Table 1).

Individual bearded seals hauled out on pack ice were slowly approached in small boats, typically causing the seals to enter the water. One or two tangle nets were deployed in the water nearby. These large-mesh (12 in – 22 in stretch) twisted-monofilament nets were made of 1 to 3 net panels, each 90 ft long x 24 ft deep. The float line was made of a ¾-in diameter foam core wrapped in nylon, and the lead line was ¼-in diameter, light enough to allow a captured seal to reach the surface to breathe. The nets likely were visible to the seals, but some individuals, apparently out of curiosity, approached the nets and became entangled. Entangled seals were restrained alongside one of the small boats and moved to a nearby ice floe for handling, sampling, and tagging. Captured seals were lightly sedated, removed from the net, measured, and weighed. Samples of their blood and skin were collected to establish baseline blood parameters and for

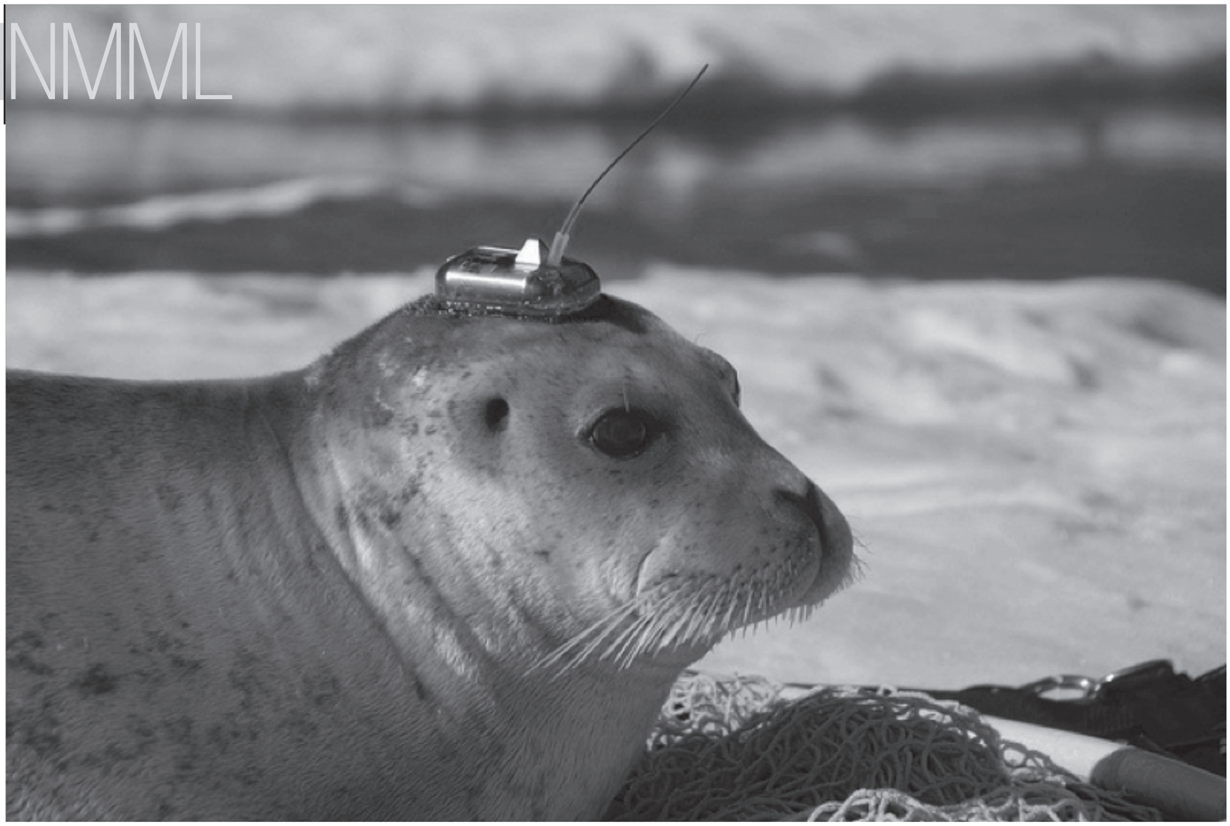


Figure 8. A sub-adult male bearded seal, instrumented with an Mk10 SDR. Photo by John Jansen.

DNA studies. Each seal was then instrumented with two SDRs: a SPOT tag, attached to a rear flipper, and an Mk10 tag glued to the hair on the seal's head (Fig. 8). The SPOT tag relays information on haul-out timing and long-term movements and will transmit for up to 3 years. The Mk10 tag provides the same information, as well as data on the timing and depth of the animal's dives, and will fall off when the seal molts during the following spring. Once the glue on the Mk10 tag had cured, each seal was released back into the water near where it was captured.

The initial movement pattern of the male sub-adult tagged in 2011 was very similar to the patterns displayed by the two sub-adult males tagged in 2009. Shortly after being released, it left Kotzebue Sound and followed the Alaska coastline north, remaining mostly within the relatively ice-free waters 50 nautical miles (nmi) from shore, preferring fairly localized regions between Point Hope and Barrow. In contrast, the two females traveled much farther from the coast, preferring less restricted foraging areas north of 70°N in the central Chukchi Sea. In the fall, all seals began moving south (Fig. 9) with the advancing ice and by December all had passed into the Bering Sea. Similar to the seals tagged in 2009, all seals tagged in 2011 routinely dove to the seafloor. Dive duration appeared to be related to dive and seafloor depth. In autumn, the females occupied areas of deeper water (50-150 m) than the males (approximately 50 m), and their dives were of longer duration (8-16 minutes vs. 6-10 minutes, respectively). In the winter however, when both sexes occupied water less than 50 m deep, dive duration was about 6-10 minutes for all seals. The patterns in the timing of hauling out were also very similar to seals tagged in 2009. When the females occupied areas with sea ice in July, they hauled out for up to 30 hours, but later in winter and early spring, despite the presence of sea ice, it was rare for either sex to haul out onto the ice. As of this writing, all SDRs continue to function properly, and a field effort is planned in both Kotzebue Sound and the NSB in spring 2012.

Table 1. Deployment information for bearded seals captured and instrumented in Kotzebue Sound, Alaska, in 2009 and 2011.

Season	Specimen Number	Capture Location	Capture Time (GMT)	Deployment (days to date)	Sex	Age	Weight (kg)
2009	EB2009_3000	66.3879°N 162.4174°W	6/23/09 00:30	719	M	Sub-adult	184
2009	EB2009_3001	66.5617°N 162.6854°W	6/25/09 01:38	729	M	Adult	253
2009	EB2009_3002	66.6110°N 162.8948°W	6/26/09 04:15	728	M	Sub-adult	197
2011	EB2011_3000	66.6872°N 163.0836°W	6/16/11 20:50	182	F	Sub-adult	161
2011	EB2011_3001	66.6431°N 162.9805°W	6/17/11 01:15	181	F	Sub-adult (Yearling)	115
2011	EB2011_3002	66.6438°N 162.9744°W	6/18/11 01:15	180	M	Sub-adult	158

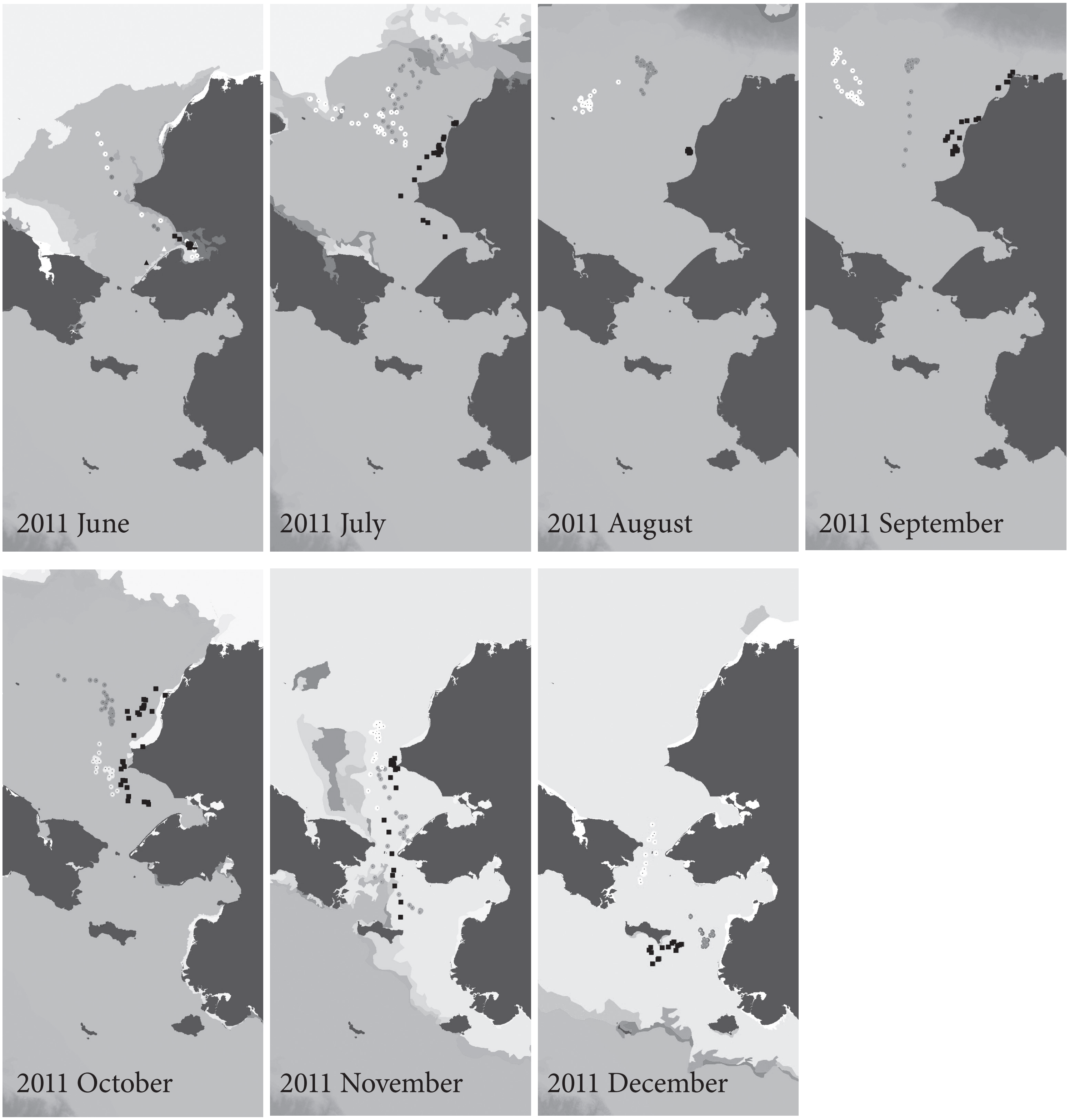


Figure 9. Maps of the sea-ice distribution and seasonal movements of bearded seals captured and tagged in Kotzebue Sound, Alaska, in June 2009 and 2011. white triangle=EB2009_3000 (sub-adult male); black triangle=EB2009_3001 (adult male); gray triangle=EB2009_3002 (sub-adult male); gray circle=EB2011_3000 (sub-adult female); white circle=EB2011_3001 (sub-adult female); and black square=EB2011_3002 (sub-adult male).

By Michael Cameron
and Peter Boveng

Groundfish Assessment Program

Sablefish Maturity Cruise Successfully Completed

AFSC biologists Jim Stark and Katy Echave completed a 12-day cruise in December off Kodiak Island, Alaska, aboard the chartered commercial fishing trawler *Gold Rush* as part of a special study to obtain biological specimens to improve knowledge about maturation of sablefish, *Anoplopoma fimbria,* in Alaska waters. The study, a joint effort between the AFSC's Auke Bay Laboratories and RACE Division, is designed to provide updated and more accurate estimates of sablefish age and length at maturity, which is critical to the stock management models used to set the overfishing limit and maximum sustainable yield. Sablefish (also known as black cod) is a deepwater groundfish common in the Gulf of Alaska which brings more than $100 million dollars per year to the commercial fleet.

In order to maintain sustainable fishery quotas, fishery managers need reliable estimates of the stock's female spawning biomass, an estimate that depends upon the age and length-at-50% maturity of females. For any species, maturity must be assessed from specimens just about to spawn. Available maturity estimates made nearly 25 years ago were based on crude maturity classifications collected from fish during the summer months when maturity is difficult to assess. The prespawning period for sablefish is December. Key information about the maturity of sablefish also has been difficult to obtain because adult sablefish inhabit the deep waters of the continental slope and shelf gullies at depths from 200 to 1,000 m.

With Stark as chief scientist of the cruise, the crew of the *Gold Rush* conducted 41 successful bottom trawls (Fig. 1). Working in the Pacific waters off of Kodiak is challenging, and the stormy seas in December made narrow windows for successful fishing. Trawling was conducted in outer Chiniak Bay, Chiniak Gully, Marmot Bay, Marmot Gully, Portlock Flats, and Amatuli Trough south of Kodiak. Trawling also occurred in the northern Kodiak areas of Shelikof Strait, Uyak Bay, Uganik Bay and Viekoda Bay. The crew took every advantage to safely fish during good weather day and night and to navigate the vessel between the fishing grounds and port.

Ovaries and otoliths were collected from 385 female sablefish ranging in size from 37 to 88 cm. Information on length, weight, the appearance of the ovary, and associated ocean conditions were collected as well. The ovaries will be examined to determine fecundity and egg size (Fig. 2). Satellite tags were successfully attached to five large sablefish as part of a tagging study to monitor sablefish movements during the spawning season. The tags are set to release from the fish in mid January and early February and upon surfacing will transmit data on location, depth, temperature and acceleration.

Figure 1. The fishing and scientific crew of the sablefish maturity cruise conducted aboard the F/V *Gold Rush*.

Figure 2. NOAA scientists will examine female sablefish ovaries like this one to gather data on maturity levels and number of eggs each female produces. Research was conducted for the first time in winter, when determining maturity is straight forward since females have developed eggs in time for the annual spawning cycle.

In order to accurately determine the maturity, egg sizes, and fecundities of each specimen the ovary samples will be processed for microscopic histological examination. The development and maturity of each specimen will be classified using the slides of ovary tissue and a compound microscope. Overall sablefish maturity will be estimated as a function of total body length and age with a statistical model to estimate the age (A_{50}) and length at 50% maturity (L_{50}). Environmental data collected during each haul also will be evaluated to determine if there are any significant correlations between sablefish maturity and depth, seawater temperature, and ambient light intensity. The number of eggs (fecundity) will be determined within each female categorized by size, assigned maturity classification, and age. Future work also will include developing a visual classification of maturity based upon photographs of ovaries correlated with the actual microscopic determination of maturity.

This project was designed to provide for improved sustainability in the fishery quotas which benefits consumers, fishermen, processors, U.S. balance of payments, shipyards and the fishing community. The sablefish population in Alaska is healthy and the fishing quota is managed conservatively. The new information on maturity and reproduction will fine-tune these estimates and help continue to protect the fishery and the renewable resource upon which it depends.

By Wayne Palsson and Jim Stark (RACE Division), and Katy Echave and Cara Rodgveller (ABL)

Columbia River Hydrographic Survey

Staff from the RACE Habitat Research Group (HRG) supported the Naval Undersea Warfare Center-Keyport Range Systems with a navigable area hydrographic survey in August 2011 on the free-flowing Hanford Reach of the Columbia River in Washington State. This 8-day survey conducted on the research vessel *Kvichak Surveyor* was designed and conducted to address specific concerns of the Puget Sound Naval Shipyard and additionally served to deliver accurate hydrographic quality survey data for updating the nautical charts in the assigned area. The work exemplified HRG expertise in mobilizing vessels of opportunity for conducting high quality ellipsoid-referenced hydrographic surveys and for delivering International Hydrographic Organization-compliant bathymetric data products. The project further illustrated the utility and benefit of an existing Memorandum of Understanding between NOAA and the U.S. Navy, thereby providing a seamless mechanism for interagency collaboration and the transfer of funds.

By Steven Intelmann

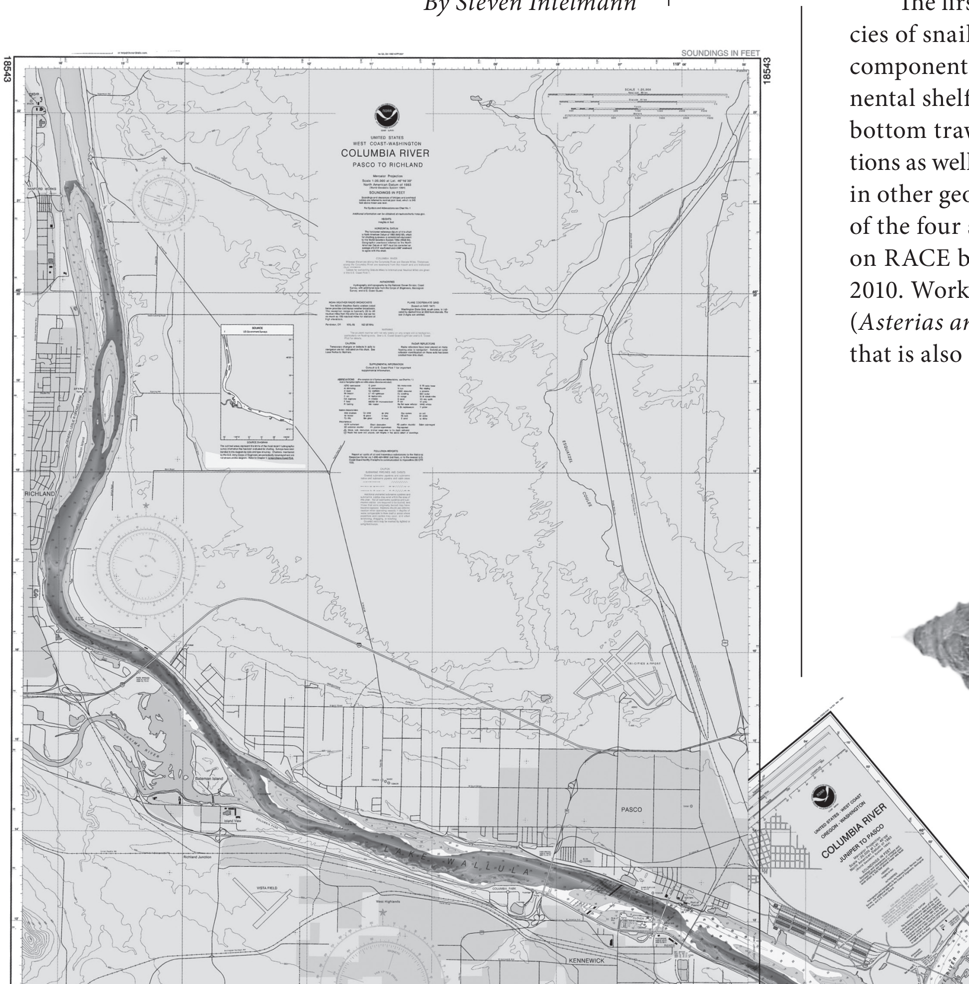


Figure 3. Columbia River hydrographic survey extent near the Tri-Cities region of Washington State. Data are shown with nautical charts 18542 and 18543.

Understanding the Life History and Ecology of Bering Sea Invertebrates – Focus on *Neptunea*

Habitat scientists are studying the life history and ecology of benthic invertebrates in the eastern Bering Sea (EBS) in order to better understand their role as habitat for commercially important species and to improve interpretation of population- and community-level changes due to fishing gear disturbances.

The community of clams, crabs, sponges, corals, snails, marine worms, and similar organisms are a living component of habitat. As a group, benthic invertebrates function as predators, prey, and competitors and provide shelter for other species. They also are useful indicators of the health and integrity of the ecosystem and are known to be an important factor affecting the distribution of managed species. Unfortunately, relatively little is known about their life histories and ecologies, let alone the complex linkages and dependencies that exist at the community and ecosystem levels. The available information for EBS species is generally sparse and frequently exists in unpublished reports. To address this need, we are assembling the existing information for individual species and summarizing it in a standard format that includes topics such as growth and development, sexual maturity, reproductive cycles, feeding and diet, mortality rates and causes, distribution and abundance, and anthropogenic interactions.

The first in a series of publications focuses on the four major species of snails in the genus *Neptunea* (Fig. 4). These snails are a major component of the benthic invertebrate community on the EBS continental shelf, and our research has demonstrated they are sensitive to bottom trawling. This synopsis summarizes studies of local populations as well as somewhat more extensive findings for *Neptunea* species in other geographic regions. Geographic distribution and abundance of the four species on the EBS shelf are represented with maps based on RACE bottom-trawl survey data for selected years from 1983 to 2010. Work is underway on a synopsis for the purple orange sea star (*Asterias amurensis*), an extremely abundant species in inshore areas that is also affected by bottom trawling.

By Keith Smith, Bob McConnaughey, and Claire Armistead

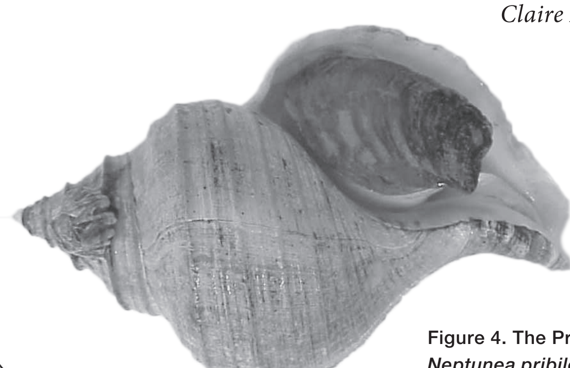


Figure 4. The Pribilof whelk, *Neptunea pribiloffensis*.

Groundfish Assessment Program—Kodiak Laboratory

The Influence of Polychaete Worm-Tube Habitat on the Food Habits, Prey Availability, and Condition of Juvenile Northern Rock Sole in a Coastal Nursery off Kodiak Island, Alaska

From an essential fish habitat perspective, the role of small-scale biogenic habitat structures has not garnered the same level of interest that the role of more conspicuous macro-invertebrates, such as deep sea corals and sponges, has. Nonetheless, juveniles of many commercially important fishes show a strong association with small-scale structures, such as polychaete worm tubes which can form extensive mats on the seafloor. In embayments around Kodiak Island, Alaska, age-0 northern rock sole, *Lepidopsetta polyxystra*, are the most common member of the juvenile flatfish assemblage during the summer. Field studies reveal that peak northern rock sole densities occur at depths less than 30 m and are closely associated with seafloor characterized by small-scale biogenic structures, most notably tube-building, ampharetid polychaetes (*Sabellides sibirica*).

We hypothesized that juvenile northern rock sole were attracted to areas of worm-tube habitat to feed directly on the worms or associated fauna. We further hypothesized that worm-tube habitat would contain higher densities of benthic infauna (potential prey) compared to adjacent areas devoid of worms, thereby creating enhanced feeding conditions for the juvenile northern rock sole. Lastly, we hypothesized that northern rock sole condition would be higher in worm-tube habitat, compared to areas devoid of worms, as a result of more abundant food resources.

In the summer of 2008 and 2009, age-0 northern rock sole were collected for stomach content and condition analyses at the Pillar Creek Cove (PCC) study site in Monashka Bay along the northeastern coast of Kodiak Island, Alaska. Beam trawl collections were conducted along five fixed-position parallel transects oriented parallel to shore, at depths of 3-20 m. Prior video surveys at this site indicated the shallowest transect lines (3, 6, and 10 m) were positioned over mostly sand substrate, while the two deepest transects (16 and 20 m) were located over areas of sparse to moderate worm-tube density. Diet composition was described using percentage frequency of occurrence and percentage numerical importance. Condition was assessed by using log-transformed length-weight regression residuals as an indicator of somatic growth. Positive length-weight residuals indicate fish are in better condition, whereas negative residuals indicate fish are in poorer condition. Lastly, benthic grabs were made along the same transect lines in July and August 2008 to characterize the benthic fauna to determine the influence of depth and habitat (worm tubes) upon benthic faunal density and species composition.

A total of 505 age-0 northern rock sole were collected for stomach content analyses in 2008 and 2009. In each sampling period, depth and the presence of worm-tube habitat had a major influence on northern rock sole diet composition, and there were several noticeable trends (Fig. 5). In July, the northern rock sole's diet was relatively restricted and was made up primarily of harpacticoid copepods, though the importance of copepods decreased with depth. Cumaceans, mysids,

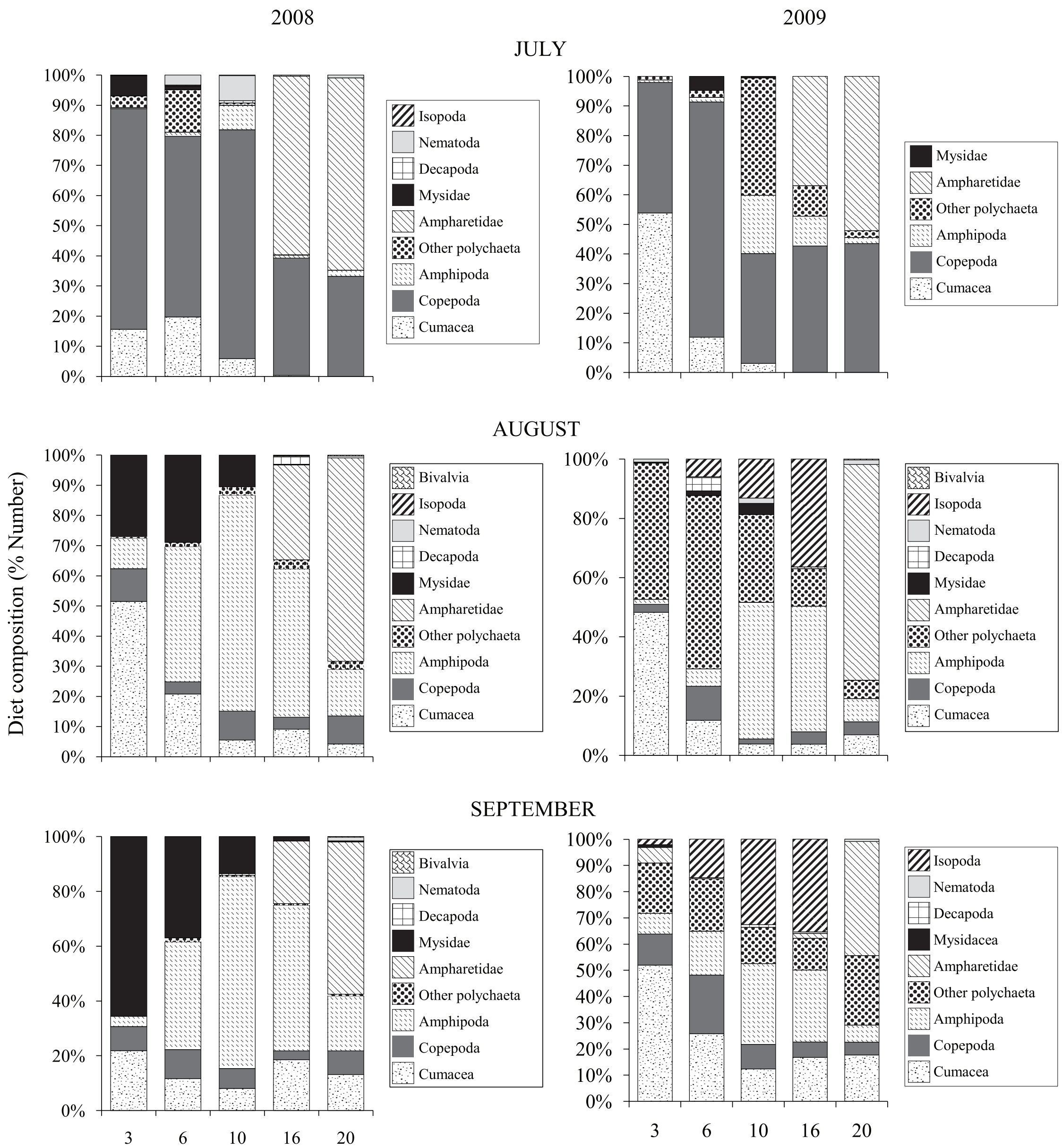


Figure 5. Diet composition (percentage by number) of age-0 northern rock sole collected at Pillar Creek Cove during the summer months of 2008 and 2009.

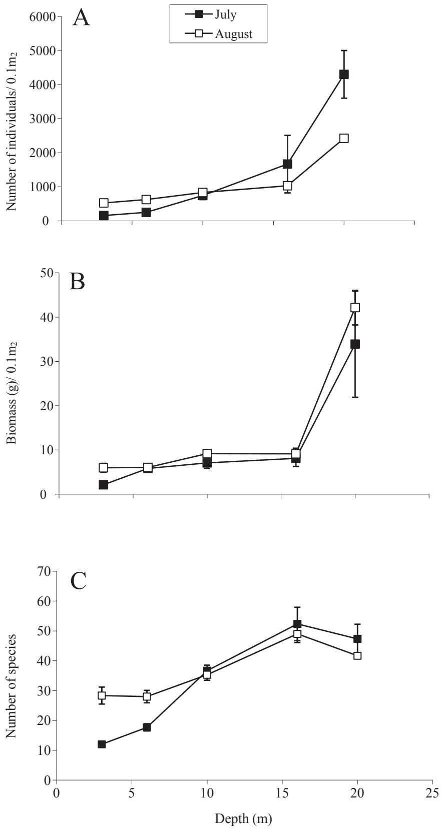


Figure 6. A- Mean number of individuals (± SE), B- Mean biomass (± SE), and C- Mean number of species of benthic infauna from Pillar Creek Cove over a range of depths during July and August 2008.

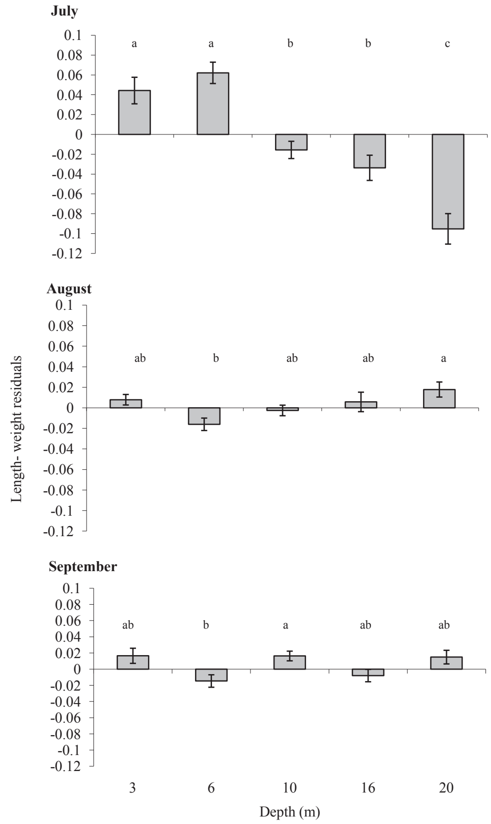


Figure 7. Mean length-weight residuals (± SE) for age-0 northern rock sole over a range of depths during July-August 2009 in Pillar Creek Cove. Letters indicate significant differences (Tukey test, P < 0.05).

and errant polychaetes were also important prey items in the shallow depths during August and September. Gammarid amphipods were generally the most important prey in the intermediate depths. Ampharetid worms were typically not consumed at depths less than 16 m, inshore of the worm-tube habitat. However, they were consistently the most important prey for northern rock sole at the deepest depth transect located in the worm-tube habitat. These results provide support for our first hypothesis by demonstrating that juvenile northern rock sole in the worm- tube habitat were feeding on the worms.

As expected, depth had a pronounced influence upon both the number and biomass of benthic invertebrates. The total number of individual organisms increased with depth, and in each month the number of individuals increased most dramatically at the greatest depth sampled (Fig. 6). Correspondingly, the total invertebrate biomass also increased significantly beyond 16-m depth. Additionally, the number of species increased with depth and peaked at 16 m in each month. Each of these measures increased most dramatically with the presence of the ampharetid worm tube. This suggests that the worms may act as a bioengineering species, creating habitat that is favorable to other species, thereby increasing overall benthic infauna biomass and density.

In general, northern rock sole body condition varied with depth, but a clear trend was only evident during July (Fig. 7). In July, the length-weight residuals decreased with depth, with the highest residuals at the two shallowest depths. In August and September, northern rock sole condition varied with depth, but no discernable pattern was evident. These findings show that depth-related effects on rock sole body condition were most significant shortly after northern rock sole settled into the coastal nurseries during July. The influence of depth and habitat (worm tubes) on northern rock sole condition diminished over the course of the summer as the juvenile northern rock sole grew and consumed a more diverse diet.

Overall, it was clear that northern rock sole associated with the worm-tube habitat fed predominantly on the ampharetid worms. Additionally, the results indicate the worm-tube habitat had a positive influence on the density and diversity of benthic infauna. These results provide support for the hypotheses that juvenile northern rock sole are attracted to worm-tube habitat to feed on the worms and that worm-tube habitat offers enhanced feeding opportunities for juvenile northern rock sole compared with areas devoid of worms.

However, higher densities of benthic infauna did not result in higher condition values for northern rock sole residing in the worm-tube habitat. In fact, an opposite pattern was observed, but only in July. It is possible that the residual index we used, which is a reflection of somatic growth, was not sensitive enough to detect fine-scale spatial differences in condition during the latter months. A more sensitive biochemical condition index, such as RNA:DNA ratios, or more direct measurements of condition (e.g., bomb calorimetry) may be more suitable in detecting short-term changes in northern rock sole condition. The observed spatial variations in condition may reflect differences in total energy intake of rock sole among the depths. Differences in energy intake would result from not only differences in prey energy content but also differences in the costs associated with finding, capturing, and handling prey among the depths. It is possible that the energetic costs of finding and capturing prey were less in the sand habitat as compared to the more complex worm-tube habitat. Furthermore, the worm-tube habitat also supports high abundances of other juvenile flatfish species and crustaceans that feed on similar prey. As a result, interspecific competition might limit food resources for juvenile northern rock sole, especially when their diet was restricted in July.

At this time, the value of the worm-tube habitat in terms of northern rock sole condition and growth remains unclear. Further studies are needed to investigate the factors influencing juvenile northern rock sole condition and growth in relation to habitat features within the nursery. Regardless, it is clear that the ampharetid worm-tube habitat altered the foraging behavior of juvenile rock sole. The worms were an important food source, though they were spatially restricted to the deeper depths. In addition, the worm-tube habitat supported higher densities of benthic infauna compared to adjacent areas devoid of worms. The worm-tube habitat could have implications for both individual northern rock sole growth and overall nursery productivity by altering both the quantity and quality of available prey resources. This research highlights the importance of understanding the mechanisms influencing fish-habitat relationships which is a fundamental principle of ecosystem-based management.

By Brian Knoth

Recruitment Processes Program—
Fisheries-Oceanography Coordinated Investigations

Feeding Ecology and Niche Separation of Age-0 Northern Rock Sole and Age-1 Yellowfin Sole in the Eastern Bering Sea

Benthic productivity is an important component in the understanding of fish population dynamics in the eastern Bering Sea. The study of fish-trophic interactions is relevant to understanding benthic production. Feeding success during the early juvenile phase is a significant factor influencing overall survival, which has implications for the number of successful survivors to the fishery.

In order to better understand the factors influencing flatfish feeding success, the feeding habits of two commonly-occurring and commercially important flatfishes are being studied. Specifically, age-0 northern rock sole (*Lepidopsetta polyxystra*) and age-1 yellowfin sole (*Limanda aspera*) from the eastern Bering Sea are being examined for diet overlap, prey resource partitioning, and habitat preference. Juvenile northern rock sole and yellowfin sole spatially co-occur in shallow, nearshore waters in the eastern Bering Sea in fall. Collections were made along the nearshore waters during September 2008 and 2010 using a 3-m modified plumb-staff beam trawl. In both years the principal prey were gammarid amphipods and annelids for northern rock sole. In 2010 northern rock sole diets were more diverse and included bivalves and harpacticoid copepods. Northern rock sole diets were spatially structured in both 2008 and 2010. Northern rock sole and yellowfin sole diets also appear to be age-structured, but structuring was not related to geography in yellowfin sole. In 2008 yellowfin sole diets were diverse and showed no spatial structuring; however, 2010 diets indicate limited spatial structuring within the inner shelf. We will be investigating further with additional statistical analysis on age structure, length of flatfish, and prey field. This study will improve our understanding of habitat usage and factors that influence recruitment of flatfishes in the eastern Bering Sea.

By Christina Jump, Janet Duffy-Anderson, Kathy Mier, and Dan Cooper

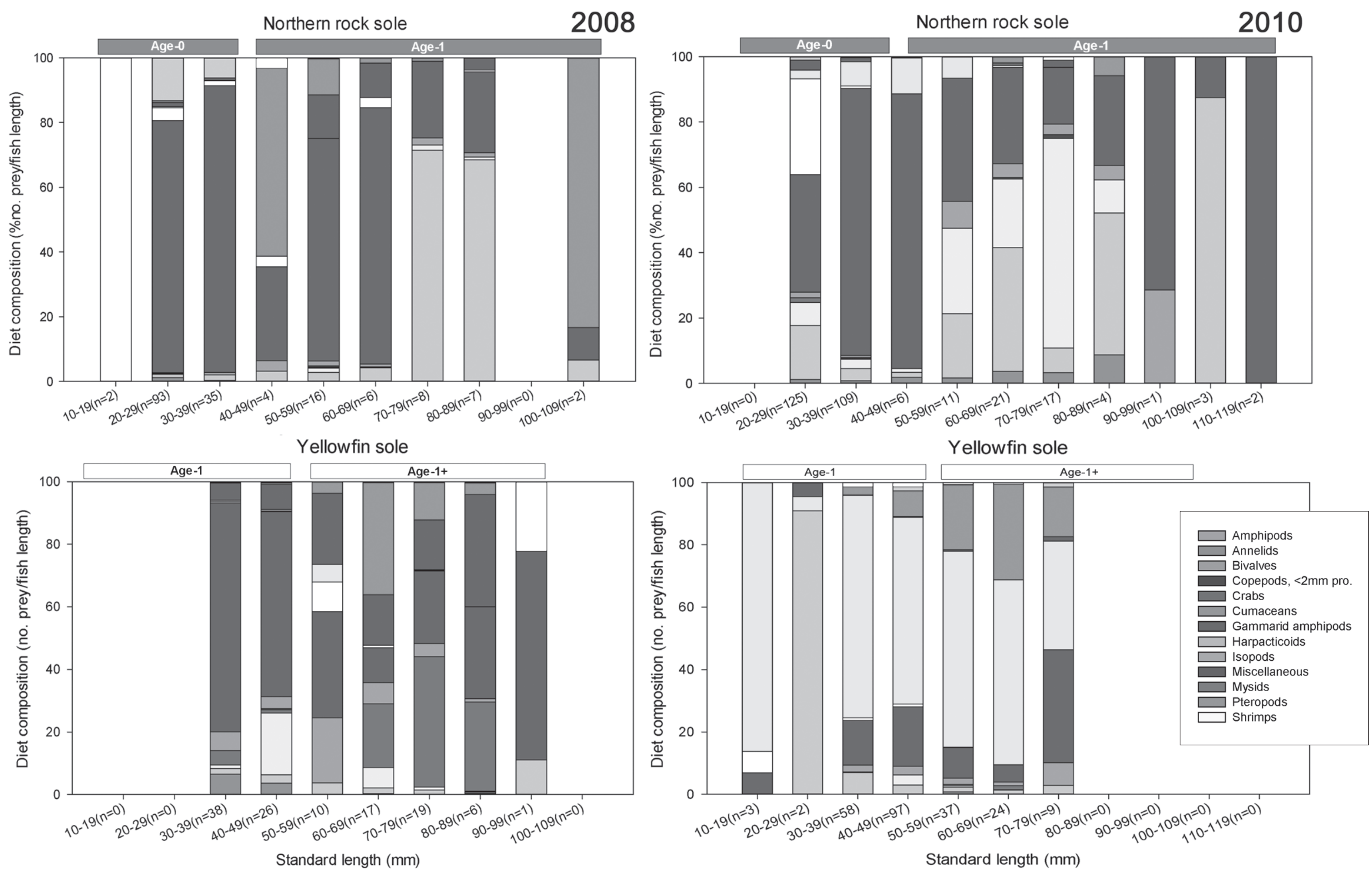


Figure 8. Taxonomic composition by standard length for 2008 and 2010. In 2008, gammarid amphipods comprised the majority of the diet of age-0 northern rock sole (NRS); annelids and mysids comprised the majority of the diet of age-1 NRS. Gammarid amphipods were the majority of the diet of age-1 yellowfin sole (YFS); gammarid amphipods, copepods miscellaneous (echinoderms and gastropods), and mysids comprised the diets of age-1+YFS. Diet compositions of both species displayed ontogenetic shifts; however, patterns have not been statistically verified. In 2010, gammarid amphipods again comprised the majority of the diets of age-0 NRS; bivalves, annelids, and gammarid amphipods comprised the majority of the diets age-1. Isopods were the majority of the diet of age-1 YFS and age-1+. The diets of the age-1+ YFS also had higher proportions of gammarid amphipods and mysids.

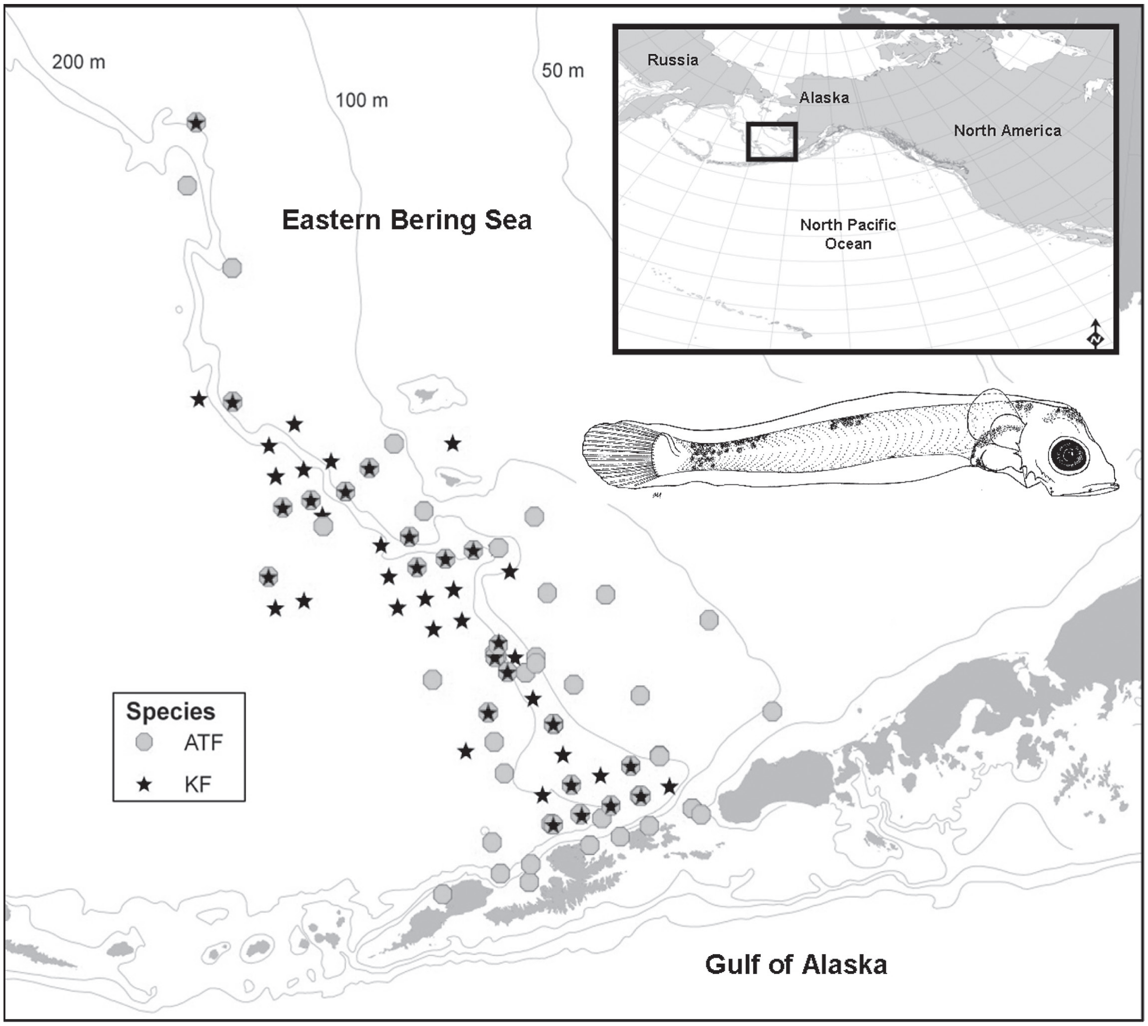


Figure 9. Distribution of genetically identified specimens collected in the eastern Bering Sea.

These early life stages of arrowtooth flounder have been difficult to study in the eastern Bering Sea because the early life stages of its congener, Kamchatka flounder, are morphologically similar.

Current Knowledge of the Early Life History of Arrowtooth Flounder (*Atheresthes stomias*) in the Eastern Bering Sea: With Comments on Kamchatka Flounder (*A. evermanni*)

Arrowtooth flounder are large, predatory flatfish that occur along the west coast of North America from central California to the Bering Sea. They are major predators of the commercially important fish walleye pollock, and in recent years abundance of arrowtooth flounder in the eastern Bering Sea has been increasing. The cause of this increase is unknown; however, factors influencing growth and survival of the early life stages have been hypothesized. These early life stages of arrowtooth flounder have been difficult to study in the eastern Bering Sea because the early life stages of its congener, Kamchatka flounder, are morphologically similar. Initial genetic work with collected larvae has shown that both arrowtooth flounder and Kamchatka flounder larvae are caught in the eastern Bering Sea and are quite often caught in the same hauls. As a result, all specimens collected in the eastern Bering Sea have been identified as *Atheresthes* spp. until a method of visual identification can be presented. In this study we collected larval and early juveniles of both species from the eastern Bering Sea (2006-10), used genetic techniques to conclusively identify them, visually assessed specimens to identify species-specific morphological traits, and then used these identified specimens to study the ecology, distribution, and relative condition of arrowtooth flounder early life stages in the eastern Bering Sea. Results provided in this study are of the first comprehensive ecological data on arrowtooth flounder in the eastern Bering Sea.

by Lisa De Forest, Tracy Smart, Janet Duffy-Anderson, Ann Matarese, Ron Heintz, Elizabeth Siddon, and Ingrid Spies

Resource Ecology & Ecosystem Modeling Program

Fish Stomach Collection and Lab Analysis

During the fourth quarter of 2011, Resource Ecology and Ecosystem Modeling (REEM) program staff focused their stomach contents analysis effort on samples from the Aleutian Islands and Bering Sea. The contents of 1,206 stomach samples (38 species of fish and squid) were analyzed from the Aleutian Islands, and 4,345 stomach samples (28 fish species) were analyzed from the Bering Sea. REEM staff also analyzed 61 stomach samples from the Gulf of Alaska. In total, 24,244 records were added to the REEM food habits database. In preparation for stable isotope analysis, tissue samples of muscle and liver from arrowtooth flounder, Pacific cod, and walleye pollock have been dried, ground, and tinned (400, 284, and 423, respectively).

By Troy Buckley, Geoff Lang, Mei-Sun Yang, Richard Hibpshman, Kimberly Sawyer, Caroline Robinson, and Sean Rohan

Octopus Catch Limits and Beak-Size to Body-Mass Relationship

This year, food habits data were used as the basis for calculating predation-based estimates of octopus natural mortality to define the allowable biological catch (ABC) and overfishing limit (OFL) for the Bering Sea/Aleutian Island octopus stock (2,590 t and 3,450 t, respectively). The method combined groundfish ration, diet, and biomass estimates from 25 years of surveys to calculate both these estimates, their confidence limits, and range of interannual variation.

In discussion of this new methodology, questions were raised about the size distribution of the consumed octopus. To answer these questions, AFSC staff will be estimating the size of octopus prey from the size of octopus beaks found in the stomach contents of groundfish. A reference set of beaks, stylets, and statoliths from octopus of known size was collected as part of North Pacific Research Board (NPRB) Project 906, Field Studies in Support of Stock Assessment for the Giant Pacific Octopus *Enteroctopus dofleini* (PIs – E. Conners, R. Brewer, and C. Conrath). We took several standard measurements from both the upper and lower halves of these beaks to assess the relationship of beak size to the known body mass of *E. dofleini* specimens and to assess the ease and consistency of taking the measurements. We found hood length (for both upper and lower beak) has advantages over several other beak measurements: endpoints are clearly defined so consistent measurements among analysts is possible, and these endpoints are relatively easy to access when the beak remains encased in the buccal muscle mass, so handling-time is minimized during stomach content analysis. Based on preliminary data (Fig. 1), a power function of hood length to predict body mass produces an R^2 of 0.86 for the lower beak and 0.85 for the upper beak. The reference collection of *E. dofleini* hard parts is being used to examine possible methods for ageing octopus by Lisa Kautzi from the Age and Growth program.

By Troy Buckley, Kerim Aydin, Sean Rohan, Christina Conrath, Elizabeth Conners and Lisa Kautzi

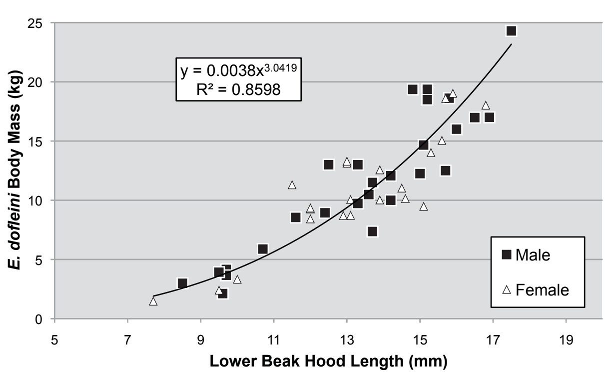


Figure 1. The relationship between beak-size and body-mass for *Enteroctopus dofleini*. Although each sex is distinguished in the plot, the regression is independent of sex because this can rarely be determined from the remains in the predator stomachs.

Incidental Take of an Endangered Short-Tailed Albatross

A groundfish fishery observer reported to their inseason advisor that they had recovered a short-tailed albatross (*Phoebastria albatrus*) while monitoring gear retrieval on a Bering Sea freezer longline vessel fishing for Pacific cod. The AFSC immediately reported this take to the U.S. Fish and Wildlife Service and also informed interested parties in NOAA, the fishing industry, and environmental non-government organizations. Based on information supplied by AFSC staff, the Alaska Regional Office issued a Fisheries Information Bulletin on 31 October 2011, describing this most recent take. The take occurred on 25 October 2011 at lat. 56°35'N, long. 172°52'W. This is an area over the Bering Sea shelf break, directly west of the Pribilof Islands. The bird had a leg band placed on it by Japanese scientists during their standard research activities at the colony on Torishima Island. The bird was less than 2 years old. The current Biological Opinion for short-tailed albatross provides for the incidental take of four birds in a 2-year period. A new 2-year period began on 16 September 2011, making this the first take in the current period. The vessel was using paired streamer lines and had not observed any short-tailed albatross in the area prior to the take event.

See the full information bulletin for additional details and a map of where short-tailed albatross takes have occurred: *www.fakr.noaa.gov/index/infobulletins/bulletin.asp?BulletinID=7771*

By Shannon Fitzgerald

Ecosystem Considerations for 2012

The Ecosystem Considerations report is produced annually for the North Pacific Fishery Management Council (NPFMC) as part of the Stock Assessment and Fishery Evaluation (SAFE) report. The goal of the Ecosystem Considerations report is to provide an overview of marine ecosystems in Alaska through ecosystem assessments and tracking time series of ecosystem indicators. The ecosystems currently under consideration are the eastern Bering Sea, the Aleutian Islands, and the Gulf of Alaska.

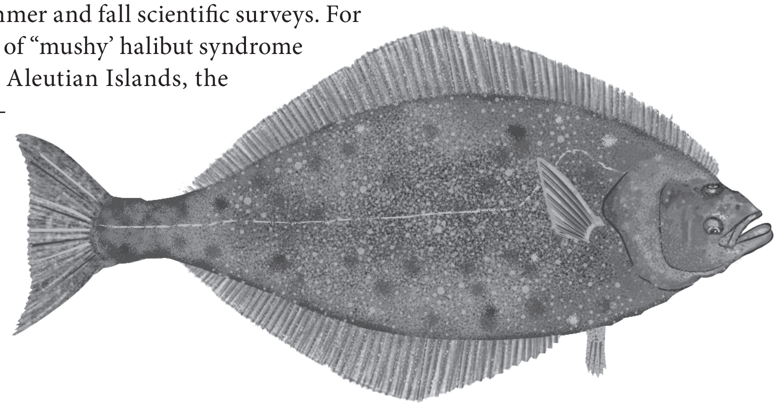
This year the report includes both new and updated sections. The section describing ecosystem and management indicators includes updates to 44 individual contributions and presents 7 new contributions. These include: 1) Phytoplankton biomass and size structure during late summer to early fall in the eastern Bering Sea; 2) Gulf of Alaska chlorophyll a concentration off the Alexander archipelago; 3) Long-term zooplankton trends in Icy Strait, Southeast Alaska; 4) Forecasting pink salmon harvest in Southeast Alaska; 5) Biodiversity (evenness) of the groundfish and invertebrate community for the eastern Bering sea slope; 6) A multivariate seabird index for the eastern Bering Sea; and 7) Indicators of Alaska-wide community regime shifts.

Last year, Hot Topics were presented for the first time as part of the new eastern Bering Sea assessment. This year, they extend to all three ecosystems.

The ecosystem assessment section includes a new Aleutian Islands Ecosystem Assessment developed by a multidisciplinary team of experts during a workshop in September 2011. The team was tasked with choosing a suite of indicators that together provide a comprehensive view of the Aleutian Islands ecosystem reflecting across trophic levels from the physical environment to top predators and humans, as well as both the nearshore and offshore. Numerous gaps in available time series were noted and discussed. Following presentations and review of existing physical and biological data, the team concluded that the significant variability in the island chain ecosystem warranted structuring the assessment by three ecoregions: Western, Central, and Eastern. Although a single suite of indicators was chosen for the entire ecosystem, not all of the indicators are available or applicable in each of the three ecoregions. The assessment will be updated annually, and the suite of indicators will be re-evaluated every few years.

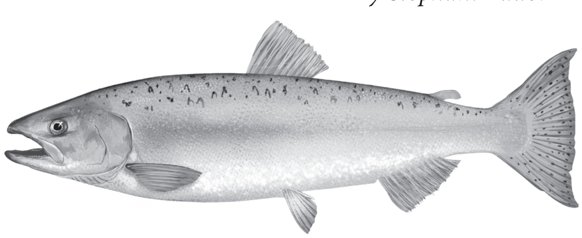
The updated eastern Bering Sea ecosystem assessment is included in this report, as well as a new section evaluating the predictions made in last year's ecosystem assessment. An assessment of the Gulf of Alaska ecosystem is not included, but the development of a new assessment following the methods of the eastern Bering Sea and Aleutian Islands assessments is planned for 2012.

The ecosystem assessment section also includes a Hot Topics subsection, which was designed to present a succinct overview of potential concerns for fishery management, including endangered species issues and early warnings of potential future fishery management interest. Last year, Hot Topics were presented for the first time as part of the new eastern Bering Sea assessment. This year, they extend to all three ecosystems. The topics for the eastern Bering Sea include endangered short-tailed albatross bycatch that occurred during fall in the Pacific cod longline fishery and recent increases in jellyfish seen in both summer and fall scientific surveys. For the Gulf of Alaska, the topics include the recent increased prevalence of "mushy' halibut syndrome and the controversial finding of infectious salmon anemia. For the Aleutian Islands, the topics include a discussion of fishery changes in the western and central ecoregions in 2011 and the release of the new Aleutian Islands risk assessment, which evaluates shipping traffic and oil spill trends.



Findings from the Ecosystem Considerations report were presented to the NPFMC joint plan teams in September and November and to the Science and Statistical Committee in December. To see the chapter in its entirety, see the AFSC website at *access.afsc.noaa.gov/reem/ecoweb*.

By Stephani Zador



Chukchi Food Web Modeling

REEM researcher Andy Whitehouse completed development of a preliminary mass-balance food web model for the continental shelf of the eastern Chukchi Sea (Fig. 2). The model provides a snapshot of community structure averaged over an annual time scale and describes key structural and functional components of the eastern Chukchi Sea food web.

The majority of biomass in this ecosystem was concentrated in benthic invertebrates (Fig. 3) and accordingly most of the mass flow above trophic level 2.0 was through this group. Mass flows to higher trophic levels through pelagic groups like zooplankton were an order of magnitude less. Arctic cod, *Boreogadus saida*, were the principal fish prey connecting production between lower and upper trophic levels. Seabirds and marine mammals collectively consumed about 75% of total arctic cod production.

To gain a broader perspective on the structure and function of the eastern Chukchi Sea, comparisons were drawn with the nearby subarctic eastern Bering Sea, using a set of system metrics derived from a common modeling framework. The total biomass density (t km^2) of the eastern Chukchi Sea was nearly equal the eastern Bering Sea but had less than half the total production (t km^2/yr). In practical terms, this fundamental difference between the eastern Chukchi Sea and eastern Bering Sea implies that the Chukchi may not be as resilient to fishing or other mortality agents such as a wide-spread oil spill.

This food web model provides a novel description of the trophic structure and functioning of the eastern Chukchi Sea. In the future it can be used to evaluate trophic changes that might accompany climate change and provides a means of assessing the ecosystem-wide impacts of the removal of fish species by a fishery.

By Andy Whitehouse

Figure 2. Map of the model area in the eastern Chukchi Sea. The area is bounded by the U.S.-Russian convention line to the west, Bering Strait to the South, Pt. Barrow to the east, and both the EEZ and 70-m isobath to the north. Near shore the model is bounded by the 20-m isobath.

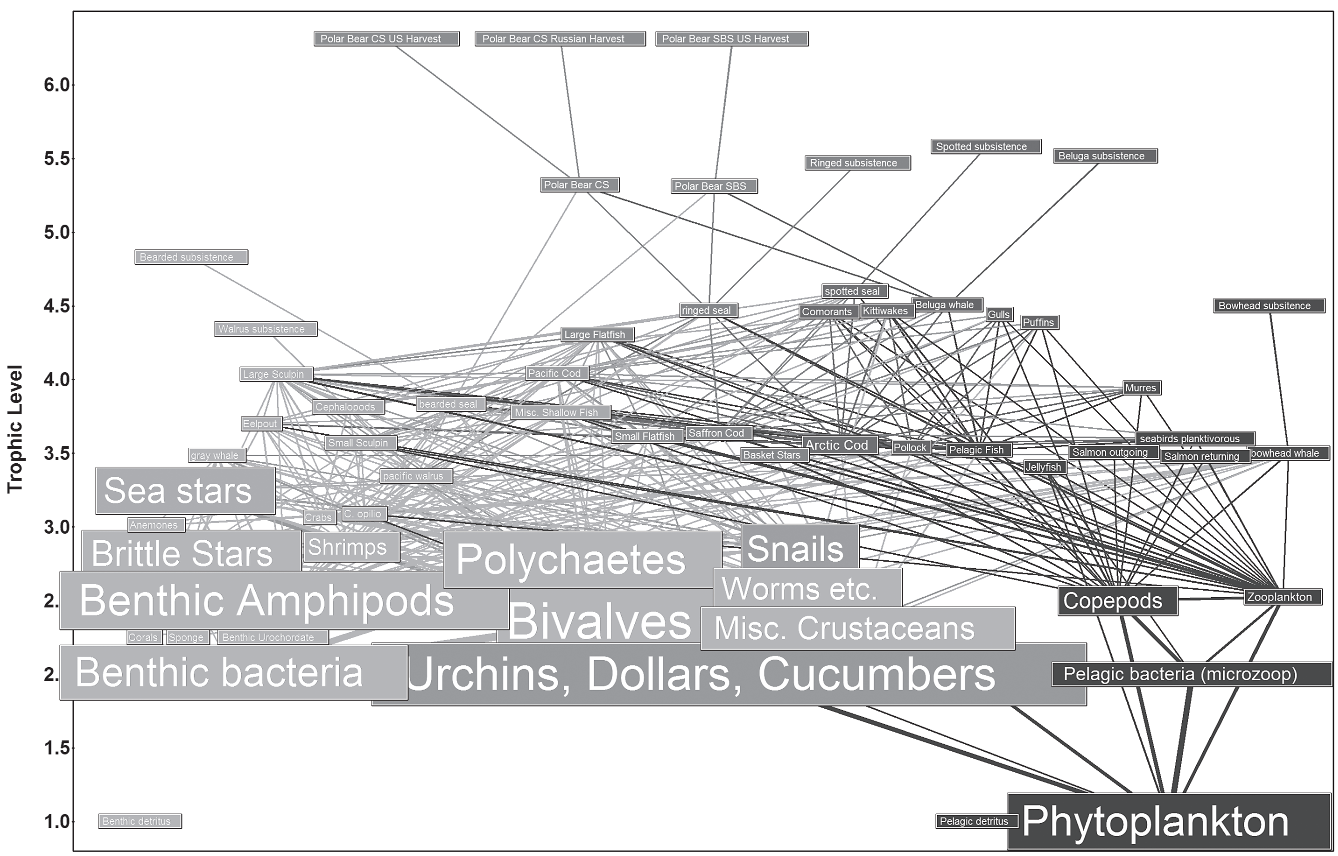


Figure 3. Food web diagram of the eastern Chukchi Sea. The boxes are arranged vertically by trophic level and box size is proportional to biomass density. Light gray boxes are associated with the benthic trophic pathway and dark gray denotes the pelagic pathway.

What are We Protecting? Fisher Behavior and the Unintended Consequences of Spatial Closures as a Fishery Management Tool

Economists Alan Haynie (Economics & Social Sciences Research (ESSR) program) and Joshua Abbott (Arizona State University) have a forthcoming publication in the journal *Ecological Applications* that examines the impacts of the red king crab savings area (RKCSA) on the Bering Sea flatfish fishery. Specifically, the paper examines the winter rock sole and Pacific cod fishery in the years immediatedly following the creation of the RKCSA in 1995. Spatial closures like marine protected areas (MPAs) are prominent tools for ecosystem-based management in fisheries. However, the adaptive behavior of fishermen (the apex predator in the ecosystem) to MPAs may upset the balance of fishing impacts across species. While ecosystem-based management (EBM) emphasizes the protection of all species in the environment, the weakest stock often dominates management attention. We use data before and after the implementation of the RKCSA to show how closures designed for red king crab protection spurred dramatic increases in Pacific halibut bycatch due to both *direct* displacement effects and *indirect* effects from adaptations in fishermen's targeting behavior. We identify aspects of the ecological and economic context of the fishery that contributed to these surprising behaviors, noting that many multispecies fisheries are likely to share these features. Our results highlight the need to either anticipate the behavioral adaptations of fishermen across multiple species in reserve design, a form of implementation error, or to design management systems that are robust to these adaptations. Failure to do so may yield patterns of fishing effort and mortality that undermine the broader objectives of multispecies management and potentially alter ecosystems in profound ways.

By Alan Haynie

Catch Share Metrics for Fisheries

The NMFS Offices of Science and Technology and Sustainable Fisheries are developing a national, standardized database of performance indicators for catch share programs and, in the out-years, non-rationalized fisheries. The initial set of indicators (Tier 1) includes the budget performance measures developed by F/SF to satisfy a request by the Office of Management and Budget (OMB) for basic information on recently implemented catch share programs. The OMB performance indicators were discussed at the Assistant Regional Administrators for Sustainable Fisheries meeting over the summer and include: Annual Catch Limit not exceeded, bycatch reduced, percent utilization increased, and revenue per vessel increased.

Tier 1 indicators are currently being calculated for all catch share programs managed by each region in the United States and include: quota allocated to the catch share program, aggregate landings, discards in the catch share program, whether the Annual Catch Limit was exceeded, the number of entities holding shares, active fishing vessels, season length, number of trips, days at sea, aggregate revenue from both catch-share and non-catch-share fisheries, whether a share cap was in place, and the amount of any cost recovery fee paid by industry.

In response to tasking from Assistant Administrator Schwab in advance of other catch share program analyses, Tier 1 indicators were derived and reported to the Office of Science and Technology for the BSAI Crab Rationalization management program by AFSC staff in cooperation with the Alaska Regional Office, Restricted Access Management Division, as well as with staff from the Alaska Fisheries Information Network. Collaboration will continue on reporting of performance indicators for the remaining catch share programs in the second quarter, and annually thereafter.

In addition to the Tier 1 set of indicators, Tier 2 and 3 indicators were developed by a national science and technology working group of economists and other social scientists, reflecting increasing data and analytical requirements as beyond the simpler Tier 1 indicators. Tier 2 and 3 indicators will be estimated and reported as feasible based upon developments in data collection and analysis.

By Ron Felthoven, Brian Garber-Yonts, and Jean Lee

Improving the Usefulness of Logbook Data in the North Pacific Groundfish Fisheries

ESSR researchers Stephen Kasperski, Alan Haynie, and Stephen Gmur, along with Craig Faunce (FMA Division) have nearly completed their research on how the paper logbook system could be improved to aid fisheries management in the North Pacific. Mandatory daily fishing logbooks provide a potentially valuable source of at-sea catch and effort information. However, their utility to fishery scientists and managers is limited since the logbooks are neither verified for accuracy nor digitized to make them readily available. While fishery observers from the North Pacific Groundfish Observer Program monitor activities of groundfish vessels > 60 ft in length, the majority of catcher vessels lack complete observer coverage. The National Marine Fisheries Service lacks information on the spatial distribution of hauls, haul-specific weight estimates, daily discard estimates, days steaming to and from the fishing grounds, days inactive, and crew size information (prior to the implementation of eLandings in 2007) for trips that are not observed. Also, because vessels 60-124 ft in length choose which of their trips are observed, it is possible that they fish differently when unobserved. The logbook data are a key source of data that can be used to examine whether observed and unobserved trips differ.

This study explores the current logbook system and its reporting requirements and uses digitized logbook data from catcher vessels participating in the 2005 Gulf of Alaska trawl fishery to analyze the utility of this data to fishery scientists and managers. We compare the digitized logbooks to observer and fish ticket data to analyze the relative attributes and deficiencies of each dataset. We find that reported discards are statistically significantly lower on unobserved trips than on observed trips in both the fish ticket and logbook data. Unobserved trips are also found to be statistically significantly shorter than observed trips, while the number of hauls per trip, average haul duration, and target species are not statistically significantly different on observed and unobserved trips for these vessels. We also find some evidence to suggest that the spatial pattern of harvests on observed and unobserved trips differ. As the spatial pattern of harvest and discards vary between observed and unobserved trips, the logbook data can provide some value for fishery managers if the data were available. Therefore, we suggest the replacement of the current paper logbook program with an expansion of the electronic logbook program (eLogbook). The eLogbook program currently is used only in the catcher-processor pollock fleet but could be effectively expanded to other fisheries in conjunction with their current eLandings reporting.

By Stephen Kasperski, Alan Haynie, Craig Faunce, and Stephan Gmur

Bio-economic Model to Forecast Effects of Ocean Acidification on Bristol Bay Red King Crab

A comprehensive bio-economic model for Bristol Bay red king crab is under development with support from NOAA's Ocean Acidification Program. Increases in atmospheric CO_2 concentrations, caused primarily by fossil fuel emissions and deforestation, has led to corresponding increases in oceanic CO_2 concentrations and, hence, changes in carbonate chemistry of the oceans and decreases in ocean pH. As CO_2 levels continue to rise over the coming decades, the pH in the ocean will fall even further. This trend could have substantial physiological effects on marine organisms, affecting growth, survival, reproduction, and behavior. Calcifying organisms may be particularly affected because the reduction in pH makes it more difficult to excrete and sustain a calcified shell or exoskeleton. Most of the management strategies developed for fish and invertebrate species in the United States and elsewhere are predicated on the assumption that the productivity of the resources remains constant over long time periods. This assumption is likely to be violated by the impact of ocean acidification. However, the impact of such violation is poorly understood generally and for North Pacific crab fisheries in particular.

The ideal tool to explore the biological and economic impacts of ocean acidification is a bio-economic modeling framework which a) integrates predictions regarding trends over time in ocean pH; b) separates life-history stages for growth and mortality of juveniles and adults; and c) includes fishery impacts by analyzing catch and effort in both biological and economic terms (Fig. 4). In this model, a size-structured population dynamics model component for larger animals is coupled to a stage-structured model component for smaller animals that have not been recruited into the fishery (i.e., "pre-recruits"). Including an explicit pre-recruit component is unusual in population dynamics models, and it is used in the new king crab bio-economic model to represent the impacts of ocean acidification on pre-recruit life-history stages. These impacts are the subject of ongoing laboratory experiments with juvenile crabs, and data from these experiments will be used to parameterize the pre-recruit component of the new bio-economic model.

By Michael Dalton, Dusanka Poljak (UW-SAFS), André Punt (UW-SAFS)

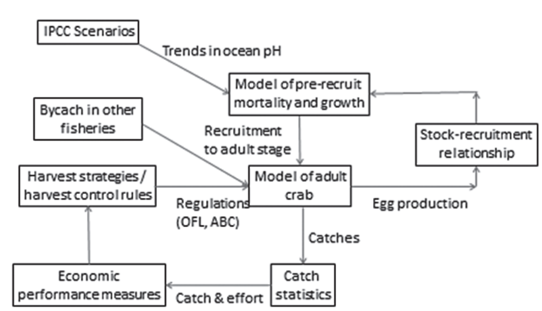


Figure 4. Outline of the linked bio-economic model.

Current Efforts to Understand the Effects of Climate Change on Ocean Services in the United States

An effort is under way to draft the 2013 National Climate Assessment (NCA) Oceans and Marine Resources Technical Report. The purpose of the report is to collect, document, and synthesize the state of knowledge on the ecological, economical, and cultural effects of climate change on U.S. and neighboring oceans and marine ecosystems and their resources. The 2013 NCA will be used to a) produce a report designed to help the federal government provide climate change information and assessments that can be used by communities to create a more sustainable and environmentally sound plan for the future; and b) establish a framework for ongoing and future assessments of regional impacts and adaptive capacity. In particular, ESSR social scientists are leading efforts to draft a chapter of the report that synthesizes the effects of climate change on ocean services and human uses of marine resources.

This chapter will attempt to identify many of the important areas and directions of potential socio-economic effects of climate change on marine resources. The socio-economic effects of climate change on marine resources (both specific resources and environments and habitats – the "ecosystem") will be based on an assessment of climate change effects on specific biophysical marine resources and environments. For example, the effects of climate change on human fishing communities will be assessed given specific changes expected in fish populations and their characteristics stemming from climate change, followed by an assessment of the impacts of those changes on fishing behaviors, industries, infrastructure, communities, etc. This leads to one of the limitations in our current ability to assess these socio-economic impacts — uncertainty regarding the rate, direction, and extent of change in biophysical aspects of marine resources attributable to climate change. The direction of these changes may be the clearest — the rate and extent the least clear.

In order to address these and other issues associated with the effects of climate change on ocean services, the chapter will focus on case studies of currently documentable changes occurring in specific marine resources and associated socio-economic impacts throughout all U.S. marine regions, including the North Pacific. The corpus of such case studies is at the moment not large, but certain conclusions can be drawn from available data and information. Beyond the case studies, the authors also plan to construct generally expected scenarios of impact that may occur given certain changes in specific marine resources and environments. Finally, the chapter will explore the implications of all of these changes in the context of different marine resource governance systems; will these changes result in the need for new or different governance regimes or will they simply require adaptation of existing regimes and if so, what kinds of adaptation? Preliminary findings from the research in this chapter suggest that substantial socio-economic effects will result from changes in marine resources due to climate change.

By Amber Himes

Advancing the Stock Assessment and Fisheries Evaluation – Economic Status Report

Each year the ESSR program documents and reports the economic status of the North Pacific groundfish and crab fisheries. The results of this analysis are compiled into an economic chapter of the Stock Assessment and Fisheries Evaluation Report (eSAFE, *www.afsc.noaa.gov/REFM/Socioeconomics/SAFE/default.php*). The eSAFE gives managers and stakeholders recent estimates of economic variables in the fisheries, such as wholesale and ex-vessel value, production, and price; discards and prohibited species catch; and changes in the composition of the fleet. Additionally, the eSAFE also evaluates and reports on the economic status of the fisheries. These data are compiled and distributed not only to inform management decisions but also to provide stakeholders and the public access to data on North Pacific fisheries. As the needs of management and stakeholders evolve, so should the eSAFE evolve to meet these changing demands.

To this end, the ESSR program is advancing and improving the eSAFE in a number of ways. Three distinct areas for improvement have been identified: 1) extended content and analysis could be incorporated, 2) production and accessibility of the eSAFE content could be modernized through new technologies, and 3) feedback from the end users of the eSAFE should be obtained to improve quality and usability. Informal committees within the program have been formed to improve and expand the eSAFE to meet these goals. These committees are (unofficially) referred to as the content and analysis, document production technologies, and outreach committees.

- The role of the content and analysis committee is to identify and incorporate additional content and analysis into the eSAFE. Content in the eSAFE could include additional forms or (dis)aggregations of data that may be available because of improvements in data collection over time or to provide indices that are useful for analysis. Beyond delivering data, this committee will identify and carry out analysis that will strengthen the "evaluation" component of the eSAFE. This could include economic forecasts to complement the biological forecasts providing management with a more complete forecast of the state of the fishery.
- The document production technologies committee is tasked with leveraging current word processing and web interface technologies to streamline the production of the eSAFE as a document. Simplified production of the eSAFE will enable research to focus more attention on content and analysis. In addition, in conjunction with the Alaska Fisheries Information Network, this committee is seeking ways to improve accessibility to the data and analysis contained within the eSAFE through internet technologies.
- In an effort to reach out to the public and stakeholders, the outreach committee will be soliciting feedback to inform and improve the work of the other two committees. They have created a voluntary survey which is included within the eSAFE. The survey can be accessed at *www.afsc.noaa.gov/REFM/Socioeconomics/Contact/SAFE_survey.php*. In addition, they will be contacting known users of the eSAFE from industry, academia, the conservation community, and other members of the public. Additionally, we are attempting to schedule a feedback session during one evening of the North Pacific Fishery Management Council meeting in February 2012 (details not yet available). The experience of these users will be compiled and relayed to the other committees to improve the content and accessibility they are seeking to achieve.

The work and effort of these groups will produce advances in the eSAFE that will improve the usability and accessibility for management and the public. Readers of this quarterly report can contribute to our efforts to improve the eSAFE by completing the online survey accompanying the Groundfish SAFE Economic Status Report (link referenced above), by attending the feedback session at the NPFMC meeting in Seattle, February 2012, or by contacting us at *Ben.Fissel@noaa.gov*.

By Ben Fissel

Status of Stocks & Multispecies Assessment Program

Nearshore Surveys in the Gulf of Alaska

Scientists from the AFSC's REFM and RACE Divisions conducted a series of nearshore surveys in the Gulf of Alaska during 2011. These surveys were a component of the Gulf of Alaska Integrated Ecosystem Research Project (GOA IERP), funded by the North Pacific Research Board (NPRB). The GOA IERP is a multidisciplinary, comparative approach to understanding ecological variability at different trophic levels and over several temporal and spatial scales. Seasonal and regional variability are the key factors in the comparison. The main spatial comparison is between an eastern GOA region (basically the outer coast of southeast Alaska) and a western or central GOA region (the eastern side of Kodiak Island and the southern coast of the Kenai Peninsula). Within each of the main regions, nearshore survey operations were conducted at five sites and were coordinated with an offshore survey to provide a synoptic view of the GOA ecosystem (Fig. 5). Nearshore surveys were conducted in the spring (April/May), summer (July/August), and fall (September/October).

Young-of-the-year Pacific cod and juvenile Pacific sand lance captured in a purse seine during nearshore surveys conducted by AFSC scientists in 2011. Photo by Olav Ormseth

The nearshore surveys provided a comprehensive examination of the physical and biological characteristics of the sites, most of which were bays (e.g., Islas Bay in the east) or systems of bays (e.g., Port Dick in the west). At each site, 1-3 days were spent sampling fishes and habitat using a variety of gears. In the eastern region, sampling occurred aboard the 54-ft chartered fishing vessel *Seaview*; in the western region aboard 77-ft chartered research vessel *Island C*. In both areas, sampling took place on the main vessel and aboard a 16-ft inflatable skiff. Acoustic transects were conducted aboard both the main vessel and the skiff. Where possible, acoustic backscatter was sampled using a small midwater trawl (20 X 20-ft opening), hand jigging, and an underwater video camera. A small beam trawl (10-ft footrope) was used at several of the sites to sample bottom fishes. A 30-ft beach seine and 150-ft purse seine were used to sample very nearshore areas from the skiff. A number of captured fishes were saved for analyses of diet and energy content. Oceanographic instruments were deployed to measure temperature, salinity, zooplankton abundance, and chlorophyll and nutrient concentrations at stations within each site. Identical oceanographic stations and fish sampling sites were visited in each season.

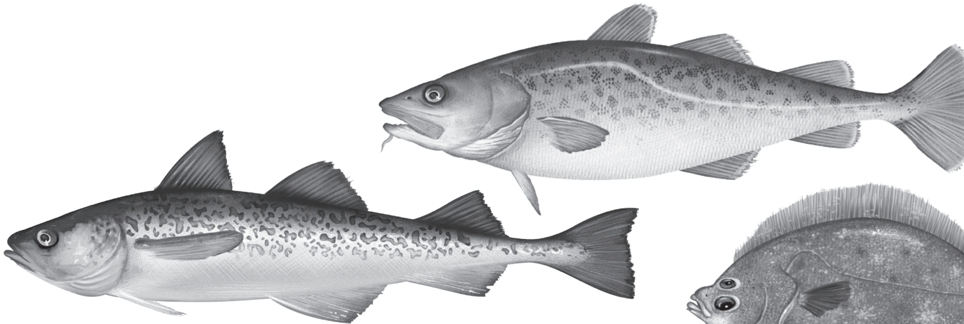
Figure 5. Map of research activities conducted as part of the Gulf of Alaska Integrated Ecosystem Research Project. Dots are the locations of research activities.

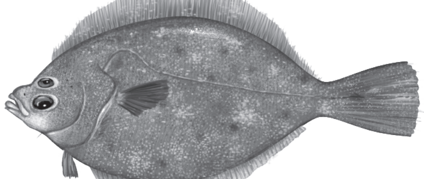
The last survey finished on 28 October, so results from the surveys are not yet available. However, below are a few general impressions from the survey efforts:

1) Pacific herring appear to be the most abundant and ubiquitous forage fish species in both regions of the GOA.
2) Chum and pink salmon fry were common throughout both regions during the spring, but absent in other seasons.
3) During the summer and fall cruises researchers encountered large numbers of young-of-the-year (YOY) saffron cod, Pacific cod, and walleye pollock in various habitats.
4) In summer and fall, nearshore water temperatures appeared to be consistently several degrees colder in the western region than in the eastern region.
5) The beach seining activities demonstrated that there is an abundance of brown bears in most of the bays that line the Gulf of Alaska coastline.

By Olav Ormseth

An AFSC biologist works up a beach seine catch in Kiliuda Bay on Kodiak Island. Photo by Olav Ormseth





Groundfish Stock Assessments for 2012: Fishery Quota Recommendations

The stock assessment and fishery evaluation (SAFE) reports compiled this year included 47 sections for individual species groups or stocks. These reports provided the scientific basis for groundfish acceptable biological catches (ABC) and total catch recommendations and present analysis of the extensive data collected by NMFS-trained fishery observers and AFSC scientists aboard dedicated research surveys. Observer data are used to estimate catch of target and prohibited species (e.g., salmon, crab, herring, and Pacific halibut) to ensure that fisheries do not exceed annually specified total allowable catches (TACs) or violate other fishery restrictions (such as time-area closures). Results from the AFSC surveys, combined with observer data, are critical in conditioning statistical stock assessment models. Results from these models (and their estimates of uncertainty) are used to determine the status of individual species and make recommendations for future catch levels. This TAC-setting process involves annual presentations of these reports at a series of public meetings.

These reports provided the scientific basis for groundfish acceptable biological catches (ABC) and total catch recommendations and present analysis of the extensive data collected by NMFS-trained fishery observers and AFSC scientists aboard dedicated research surveys.

The reports present analyses on individual stocks and species groups and provide targets and limits—ABC and overfishing levels (OFL), respectively. The North Pacific Fishery Management Council's (NPFMC) groundfish plan teams review drafts of these reports in September and November meetings and make recommendations for ABC and OFL levels (one each for the Bering Sea and Aleutian Islands and Gulf of Alaska regions) for review by the NPFMC Scientific and Statistical Committee (SSC). The SSC then makes the final ABC recommendation to the Council and the Council's advisory panel of industry representatives makes TAC recommendations during the December NPFMC meeting. Finally, the recommended TAC levels are adjusted (for some species) by the Council to ensure that other constraints (e.g., limiting the sum of all TACs in the Bering Sea and Aleutian Islands to be less than 2 million tons) are met.

Importantly, the following rule applies for each federally managed groundfish stock (or stock complex) in a given year:

$$\text{Catch} < \text{TAC} < \text{ABC} < \text{OFL}$$

In practice, catch is often less than TAC and TAC is often less than ABC. The multispecies management system is therefore based on the premise that individual components be fished at safe sustainable levels and that overfishing is avoided.

The Midwater Assessment Conservation Engineering (MACE) program of the Center's RACE Division conducted a survey in summer 2011 covering part of the Gulf of Alaska. This survey represents a new initiative to use acoustic equipment along with trawls to survey this area during the summer. It is hoped that this survey can be used in future assessments as an index of abundance for groundfish species, in particular pollock. The AFSC's Auke Bay Laboratories (ABL) Marine Ecology and Stock Assessment scientists again conducted the annual longline survey (see the ABL report in this issue), which is designed primarily for sablefish but also produces data used in Greenland turbot and some rockfish assessments. This survey covers the slope regions of the GOA along with segments of the Bering Sea and Aleutian Islands regions. The Groundfish Assessment Program (RACE Division) also conducted bottom-trawl surveys that covered two areas during summer 2011: the EBS shelf area and the Gulf of Alaska. Groundfish bottom-trawl surveys for the Aleutian Islands are presently on a biennial cycle with the next one planned for summer 2012.

The Ecosystem Considerations chapter was updated with 7 new contributions and 44 others that were updated for Council consideration in setting catch limits and other recommendations for management. In 2011 a diverse team of scientists was convened for the Aleutian Islands ecosystem assessment developments. The team reviewed the state of knowledge and available data sets and recommended structuring ecosystem assessments by three ecoregions. A similar process is planned for a similar synthesis and report card for the Gulf of Alaska (GOA) region for summer 2012.

Fisheries for groundfish species during 2010 landed 1.52 million metric tons (t) valued at approximately $1.9 billion after primary processing (Economic Chapter). This represents nearly half of the weight of all commercial fish species landed in the United States. The bulk of the landings are from eastern Bering Sea pollock which has declined since 2007 from previous years but totaled about 889,000 t and is up from 2009. Many of the flatfish stocks (e.g., rock sole, Alaska plaice, and arrowtooth flounder) remain at high levels but catches are relatively low. Yellowfin sole abundance is high, but a larger fraction of the ABC is caught compared to other flatfish stocks in the eastern Bering Sea. Atka mackerel biomass is variable, but recent recruitment puts the stock at above-average levels. Rockfish species comprise 5%-8% of the groundfish complex biomass and have been generally increasing based on recent surveys. Presently, projections of 2011 spawning biomass for the main groundfish stocks are estimated to be near or above their target stock size (B_{msy}) for both the BSAI and GOA regions. The following presents some assessment highlights by area and for selected species.

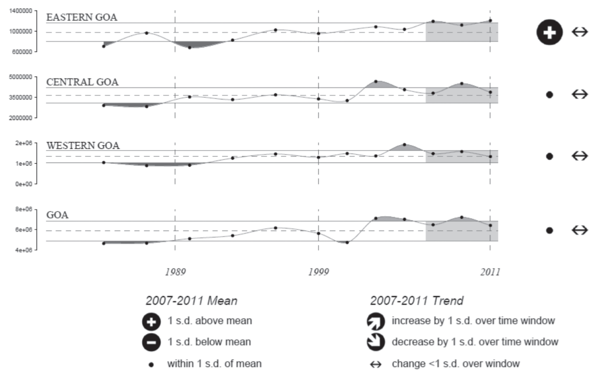


Figure 6. NMFS survey trends for all groundfish by Gulf of Alaska region (top three panels) and overall (bottom panel); 1984-2011.

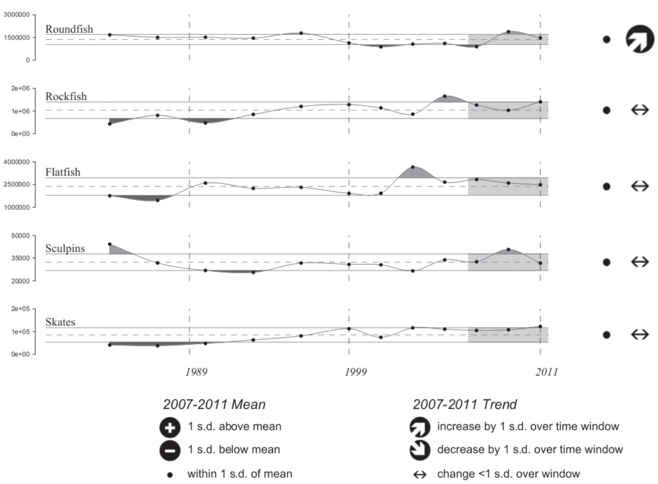


Figure 7. NMFS survey trends for groundfish species groups in the Gulf of Alaska. Roundfish include sablefish, pollock, and Pacific cod.

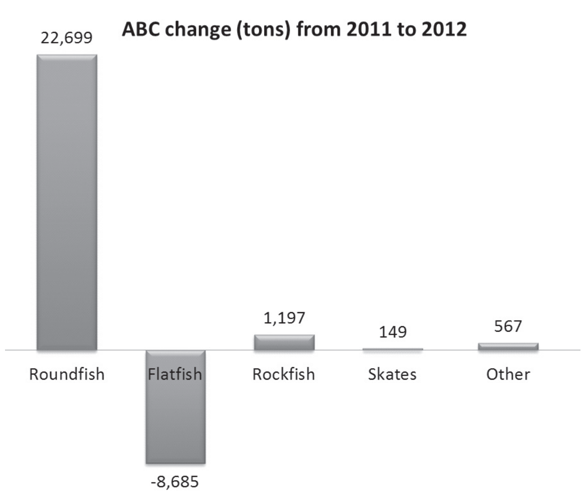


Figure 8. Relative change in GOA ABC estimates from 2011 to 2012 by broad species categories.

Gulf of Alaska (GOA)

In the GOA, assessments for 24 stocks or stock groups were completed. Since new primary groundfish survey data were available, full assessments were presented for all stocks. A brief overview of the GOA survey trends by region (all groundfish species combined) indicates increases in all areas since the 1980s but relative stable conditions since the 2007 survey (past 5 years; Fig. 6). By broad species groups, the GOA survey trends (region-wide) reflect similar increases except for roundfish (pollock, sablefish, and Pacific cod) which shows a decline in the early 2000s and a recent increase since the 2007 survey (Fig. 7). These survey estimates, as moderated by models for many of the stocks, translate to similar changes in 2012-projected ABCs for the species categories relative to 2011 (Fig. 8). The sum of the recommended ABCs for 2012 is 606,048 t, which represents a 3% increase from the 2011 total. The largest contributor to this increase was due to improved stock conditions for Pacific cod and pollock:

		ABC (t)			
Species	2011 catch (t)	2011	2012	Change	
Pollock	79,805	96,215	116,444	up 20,229	(21%)
Pacific cod	58,836	86,800	87,600	up 800	(1%)
Sablefish	11,057	11,290	12,960	up 1,670	(15%)
Flatfish	9,929	121,245	112,828	down 8,417	(-7%)
Arrowtooth flounder	29,703	213,150	212,882	down 268	(0%)
Rockfish	22,650	34,653	35,850	up 1,197	(3%)
Atka mackerel	1,613	4,700	4,700	same	(0%)
Skates	4,016	8,273	8,422	up 149	(2%)
Other species	2,135	13,795	14,362	up 567	(4%)
Total	219,744	590,121	606,048	up 15,927	(3%)

Units are metric tons.

For most stocks, the Council established TACs equal to ABCs with some exceptions. These exceptions include Pacific cod, where the quota was reduced approximately 24% to account for removals in the state-managed fishery, and those fisheries where the bycatch of other target species is a concern, specifically for shallow water flatfish (Western and Central GOA); flathead sole (W and C GOA); arrowtooth flounder (GOA-wide); and other slope rockfish (East Yakutat/Southeast Outside). For those fisheries, the TAC was set below the ABC. Atka mackerel was also established at levels to meet incidental catch needs in other fisheries only (no directed fishing is allowed). Brief summaries of the full assessments for the GOA species or species group follow.

GOA Pollock: The 2011 summer bottom trawl survey indicated a similar biomass compared to the 2009 survey (about 670 thousand t) whereas the Alaska Department of Fish and Game (ADF&G) survey (nearer shore) suggested a decline from the previous 2 years but above the near-term mean. New in 2011 was the attempt to conduct an acoustic trawl survey of GOA resources (including pollock as the principal species). Due to some unfortunate conditions and equipment failures, the summer acoustic trawl survey only covered about 75% of the area that had been planned. Model estimated abundance of mature fish in 2012 is projected to be 11% higher than in 2011, and is projected to increase gradually over the next 5 years. The model estimate of spawning biomass in 2012 is 228 thousand t (about 34% of the unfished spawning biomass estimate). A Center for Independent Experts (CIE) review of the pollock assessment is scheduled for 2012.

GOA Pacific cod: The 2011 NMFS bottom trawl survey estimate was just over 0.5 million t, which is about 21% higher than the mean survey estimate from 1984 to 2011. A sequence of models was evaluated which considered alternatives for growth specifications, inclusion of age composition data, and survey variability treatments. The model selected for management purposes projected the spawning biomass estimate in 2012 is 121,000 t (about 46% of the estimated unfished stock size). Near-term estimates indicate the spawning stock will increase in 2013, stabilize, then decline after 2015, given projected catches.

GOA/BSAI Sablefish: The sablefish fishery abundance index was down 9% from 2009 to 2010 (the 2011 data are unavailable) but the survey abundance index increased 3% from 2010 to 2011 following a 10% increase from 2009 to 2010. There are signs of incoming recruitment based on longline survey data. Research on depredation issues with both killer whales and sperm whales continues. Sablefish spawning biomass has increased from a low of 30% of unfished biomass in 2002 to 37% projected for 2012.

GOA Flatfish: REFM scientists completed six flatfish assessments including a new multi-species, split-sex, length-based model of northern and southern rock sole. The Council used this new assessment to establish the stock as qualifying for Tier 3 (under the NPFMC Fishery Management Plan (FMP) rules. Importantly, this satisfied one of the MSC certification conditions set for this fishery (which was certified by their ecolabeling program in June 2010 and includes flathead sole, arrowtooth flounder, and rex sole). These stocks are all well above their target stock size and catches are typically on the order of 10% of the ABCs; nonetheless, a number of ABCs declined relative to the 2011 values:

	ABC (t)			
Species	2011	2012	Change	
Shallow water flatfish	56,242	50,683	down 5,559	(-10%)
Deep water flatfish	6,305	5,126	down 1,179	(-19%)
Rex sole	9,565	9,612	up 47	(0%)
Flathead sole	49,133	47,407	down 1,726	(-4%)
Arrowtooth flounder	213,150	212,882	down 268	(0%)
Subtotal	334,395	325,710	down 8,685	(-3%)

GOA Rockfish: Scientists with the Auke Bay Laboratories MESA program completed eight full stock assessment chapters for rockfish in 2011. The northern and pelagic shelf rockfish assessments models were modified with dusky rockfish replacing “pelagic shelf rockfish” as a chapter on its own (yellowtail and widow rockfish were combined with the other slope rockfish complex and renamed simply “Gulf of Alaska other rockfish”). The largest rockfish stock in the GOA is Pacific ocean perch, which was virtually unchanged in ABC recommendations relative to 2011. Trends in other stocks (in particular northern rockfish and shortraker rockfish) were up relative to 2011 giving rockfish as a group a 3% increase relative to 2011:

	ABC (t)			
Species	2011	2012	Change	
Pacific ocean perch	16,997	16,918	down 79	(0%)
Northern rockfish	4,854	5,507	up 653	(13%)
Shortraker	914	1,081	up 167	(18%)
Dusky (Pelagic shelf)	4,754	5,118	up 364	(8%)
Rougheye/blackspotted	1,312	1,223	down 89	(-7%)
Demersal shelf rockfish	300	293	down 7	(-2%)
Thornyhead rockfish	1,770	1,665	down 105	(-6%)
Other rockfish	3,752	4,045	up 293	(8%)
Total	34,653	35,850	up 1,197	(3%)

GOA Skates: This stock complex is managed as split into three groups for ABCs: big skate, longnose skate, and other skates (mostly *Bathyraja* spp). The biomass (and ABC) breakout is roughly 45:30:25; respectively, for these species and species groups. The trend is up slightly for big skates and stable for the others. The fishery and incidental catches in other fisheries have been about two-thirds of the TAC for big skates and less than half for longnose and “other” skates.

GOA Sculpins: The sculpin complex ABC determination is linked to the survey biomass and estimate of natural mortality. Recent catches of sculpins are well below the ABC established for the sculpin complex (beginning in 2011; prior to this they were managed as part of the “other species” group). Based on survey results, the stock status trend indicates a 4% increase over 2010 estimates.

For most stocks, the Council established TACs equal to ABCs with some exceptions. These exceptions include Pacific cod, where the quota was reduced approximately 24% to account for removals in the state-managed fishery, and those fisheries where the bycatch of other target species is a concern

Bering Sea/Aleutian Islands

The sum of the ABCs for 2012, as recommended by the Scientific and Statistical Committee, is about 2.51 million t, nearly the same as for 2011 totals (2.53 million t). The largest component is EBS pollock ABC (1.22 million t for 2012 compared to 1.267 million t in 2011). The largest ABC increase (97,000 t) came from Pacific cod, which in 2011 was 272,000 t.

In 2011 the AFSC's survey resources were devoted to the Gulf of Alaska which means that new survey data was generally unavailable for the Aleutian Islands and Bering Sea Slope region. In these years, assessments for long-lived rockfish species consisted of an executive summary. In 2012 the AFSC anticipates being able to conduct groundfish surveys in the Aleutian Islands and complete full assessments for these species.

EBS pollock: Data on the eastern Bering Sea pollock stock showed mixed signals relative to surveys from 2010. The anticipated increased biomass in the bottom trawl survey was absent (a 17% decline in the survey from the 2010 estimate) primarily due to the lower appearance of the 2006 and 2008 year classes. Since the acoustic trawl survey was diverted to the GOA, information on the younger pollock was lacking. However, new in this year's assessment was the opportunistically collected acoustic data from the bottom trawl survey boats as they transited between bottom trawl stations. This new index spanned 2006-11 and represents a new index to evaluate midwater pollock (Fig. 9). The AFSC's MACE program scientists are to be credited with their efforts to provide this new index. Other new presentations in the assessment include an evaluation of catch rates from shore-based catcher vessels (tons of pollock per hour towed) and an examination of the fact that younger fish are generally farther from port and what type of impact that might have on Optimal Yield estimates (where economics are taken into account due to added fuel costs for trips farther from port).

With respect to EBS pollock stock status, the spawning biomass in 2008 was at the lowest level since 1980, but has increased by 43% since then, and further increases are projected for the next few years. The 2008 low was the result of below-average recruitment from the 2002-05 year classes. Recent and projected increases are due to above-average 2006 and 2008 year classes. Spawning biomass is projected to be 17% and 26% above B_{MSY} in 2012 and 2013, respectively. For ABC, setting the recommendations for 2012 and 2013 were below their respective maximum permissible levels; specifically, at values corresponding to the average harvest rate over the most recent five complete years (0.30). Poor fishing conditions observed by the fleet (on average) after the beginning of August 2011 through to the end of the season became an important consideration during plan team, SSC, and Council deliberations. It was noted, however, that pollock schooling behavior appeared different than in other years and that the dispersion onto broader areas of the EBS shelf may in part explain the poorer fishery catch rates.

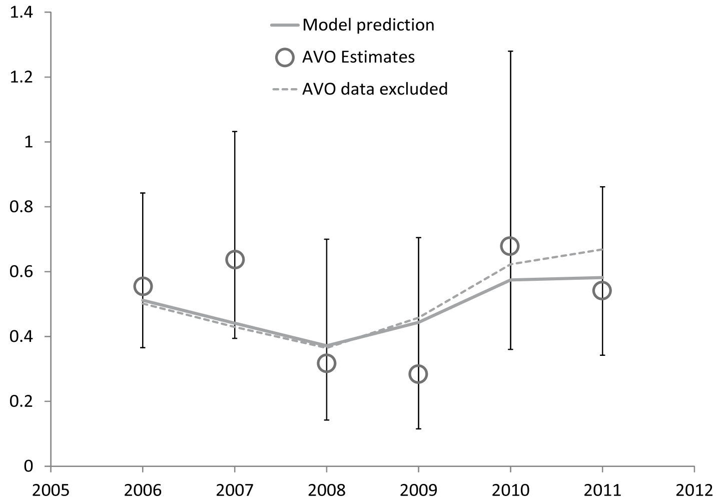


Figure 9. Model results of predicted EBS pollock biomass following the AVO index (AVO=Acoustic Vessel of Opportunity) with and without inclusion of the index. Error bars represent assumed 95% confidence bounds.

BSAI Pacific cod: Considerable effort to respond to the public and the Council comments on the Pacific cod assessment continued in 2011 with meetings in May, September-October, and November-December. The accuracy of age readings for this stock has been a continuing concern, mainly because the mean size at age from age readings did not match the first three clear modes of cod length frequencies in the Bering Sea trawl survey. Other issues have been the trawl survey catchability coefficient, the modeling of commercial selectivity (variable or not, asymptotic or not, fishery by fishery), and the modeling of growth (constant, cohort-specific, year-specific). In 2011 there was a CIE review which also contributed to suggestions for model and assessment refinements. The range of models explored produced similar fits to the survey abundance data and similar estimates of historical recruitment and present abundance. All models predicted mean length at age of younger fish in good agreement with the modes in the trawl survey length frequencies. The selected model fit the survey age data best in most years. Survey data indicate that after all-time lows from 2006 through 2008, the 2009 Bering Sea survey biomass for Pacific cod was slightly higher than the 2008 estimate, and the 2011 biomass estimate was 4% higher than the 2010 estimate (which was more than double the 2009 estimate). The 2006 and 2008 year classes appear to be strong, and stock abundance is expected to increase substantially in the near term. The Pacific cod ABC for 2012 increased by 34% relative to the 2011 value, to 314,000 t. The projected spawning biomass in 2012 is 410,000 t or about 46% of the estimated unfished stock size. The SSC has recommended that the stock be managed under a combined BSAI OFL and separate BS and AI ABCs sometime in the near future (presently both specifications are for BSAI combined).

BSAI yellowfin sole: The 2011 EBS bottom trawl survey biomass estimate was within 1% of the 2010 survey value, and updated model results indicate stock condition that is about the same as in 2010. This was despite a model change in the estimated average weight at age used. The stock assessment model indicates that yellowfin sole have slowly declined since the early 1990s, although they are still at a fairly high level (74% above B_{MSY}). The projected female spawning biomass estimate for 2012 is 593,000 t and suggests a reversal of the generally monotonic decline in spawning biomass that has prevailed since 1994. This upward trend in the population may be expected due to apparent high recruitment from the 2003 year class.

BSAI northern rock sole: The stock assessment model estimates a 2012 age-2+ biomass estimate of 1,860,000 t, which is equal to the

2011 value projected in last year's assessment. The stock is expected to increase because of recruitment from the 2000–05 year classes, all of which were stronger than any year class spawned between 1991 and 1999. Spawning biomass for 2012 is projected to be at more than two times B_{MSY} and the 2012 ABC is 208,000 t. The stock is stable and lightly exploited primarily because it is constrained by prohibited species catch limits (i.e., Pacific halibut).

BSAI flathead sole: Model estimated spawning biomass has declined from a high of 328,000 t in 1997 to a low of 243,000 t in 2009, increasing slightly to 247,000 t for 2011 with projections for 2012 of 250,000 t. These slight increases are consistent with increases in 2012 ABC (70.4 thousand t) relative to the 2011 estimate (69.3 thousand t). The 2001–03 year classes are estimated to be above the 1994–2008 average, but recruitments from 1994–2008 on average have been much lower than recruitments from 1974–89.

BSAI Alaska plaice: This resource continues to be estimated at a high and stable level with very light exploitation. The 2011 model biomass (age 3+) dropped from the 2010 estimate due to a modification in the assumption of survey catchability. Exploitation occurs primarily as bycatch in the yellowfin sole fishery and has averaged only 1% from 1975-2011.

BSAI Greenland turbot: The 2011 EBS shelf trawl survey biomass estimate was increased again in 2010 after more than doubling the 2009 estimate. It represents the highest biomass since 2003. More significantly, the population numbers were the highest ever recorded (since the standard survey began in 1982). The total 2010 and 2011 population estimate (in numbers, all ages) from the EBS survey was over five times the average for Greenland turbot. The high numbers were almost entirely due to indications of 1- and 2-year-old Greenland turbot in this survey. Nonetheless, spawning biomass has declined continuously since 1978; projections indicate that it should increase after 2015, as recent cohorts mature. The projected spawning biomass for 2012 is estimated to be at 88% of unfished levels.

BSAI Atka mackerel: The projected female spawning biomass for 2012 using the catch levels in the proposed Steller sea lion reasonable and prudent alternatives (Atka mackerel is a key forage species) is 129,000 t, which is 50% of unfished spawning biomass and above $B_{40\%}$ (102,000 t). The 2012 estimate of spawning biomass is down 12% from last year's estimate for 2011 (146,000 t). The projected age 3+ biomass at the beginning of 2012 is 405,000 t, down slightly (7%) from last year's estimate for 2011. Strong cohorts arising from 1998–2001 and 2006–07 year classes have caused increased and variable biomass patterns for this stock. Current estimates indicate spawning biomass reached an all-time high in 2005, then decreased until a slight upturn in 2010–11, with further decreases projected through 2014.

By Jim Ianelli

Age & Growth Program

Age and Growth Program Production Numbers

Estimated production figures for 1 January – 31 December 2011. Total production figures were 30,498 with 6,427 test ages and 296 examined and determined to be unageable.

Species	Specimens Aged
Alaska plaice	448
Alaska skate	525
Atka mackerel	993
Blackspotted rockfish	23
Dusky rockfish	1,004
Flathead sole	2,089
Great sculpin	149
Greenland turbot	1,468
Kamchatka flounder	24
Northern rock sole	1,068
Northern rockfish	1,760
Pacific cod	1,976
Pacific ocean perch	2,060
Plain sculpin	176
Rex sole	910
Rougheye rockfish	854
Sablefish (black cod)	2,361
Shortraker rockfish	19
Silvergray rockfish	84
Southern rock sole	415
Walleye pollock	10,100
Yellow Irish lord	618
Yellowfin sole	1,374

By Jon Short

International Workshop on Explanations for the High Abundance of Pink and Chum Salmon and Future Trends

On 30-31 October, several ABL scientists attended the International Workshop on Explanations for the High Abundance of Pink and Chum Salmon and Future Trends hosted by the North Pacific Anadromous Fish Commission (NPAFC) in Nanaimo, British Columbia. This workshop brought together scientists from around the Pacific Rim (Korea, Japan, Russia, Alaska, British Columbia, Washington, and Oregon) to review the status and discuss the future trends of pink and chum salmon abundance.

At the workshop, there were 38 oral and poster presentations. Oral presentations by ABL scientists included: “Why are pink and chum salmon so abundant in the Gulf of Alaska?” by William Heard and Alex Wertheimer; “Do Asian pink salmon affect survival of Bristol Bay sockeye salmon?” by Alex Wertheimer and Edward Farley; and “Recent harvest trends of pink and chum salmon in Southeast Alaska: Can marine ecosystem indicators be used as predictive tools for management?” by Joe Orsi, Emily Fergusson, and Molly Sturdevant.

The workshop followed the NPAFC annual meeting (also in Nanaimo) that was attended by ABL’s Ed Farley, Jeff Guyon, and Bill Heard. Many concepts were shared at the workshop, with one being that a cohort of salmon needs favorable conditions during both nearshore periods (early marine growth) and later ocean periods (winter feeding conditions) to foster high survival. Another concept was that decadal global climate change can override micro-ecosystem conditions, such as favorable early marine growth, particularly in terms of salmon exceeding temperature tolerances during their early ocean residence period in their southern ranges. Finally, the concept that stocks on a coast-wide basis do respond to localized freshwater/marine conditions was evidenced by the clustering of similar ocean survivals of some stock groups over discrete regions. The Workshop Proceedings will be published in the NPAFC Technical Report Series in early 2012.

By Joe Orsi, Ed Farley, and Bill Heard

International Flatfish Symposium

The Recruitment Processes Program contributed several presentations at the recent 8th International Flatfish Symposium held in IJmuiden, the Netherlands, 5-11 November 2011. Summaries of two presentations are presented below. Proceedings from the meeting will be published in a special issue of the *Journal of Sea Research*. The Alaska Fisheries Science Center and the International Pacific Halibut Commission are pleased to be co-hosting the next symposium in 2014 in Seattle, Washington.

International Workshop on Climate and Oceanic Fisheries

Anne Hollowed was invited to participate in the International Workshop on Climate and Oceanic Fisheries held in Rarotonga, Cook Islands, 3-6 October. This workshop was funded by the Asia-Pacific Network for Global Change Research, the Australian Government, the Cook Islands Meteorological Service, the Intergovernmental Oceanographic Commission (IOC) - UNESCO, the Secretariat of the Pacific Community, the University of Auckland, and the World Meteorological Organization. The meeting organizers brought together meteorologists, oceanographers, and fisheries scientists to

- review knowledge on the effects of climate variability and discuss the possible effects of climate change on the world’s oceans and oceanic fisheries;
- evaluate the implications of climate change for plans to optimize the use of oceanic fisheries for economic development, food security, and livelihoods;
- identify fisheries risk assessment or management evaluation tools that incorporate climate variability to improve the sustainable management of oceanic fisheries; and
- recommend the adaptation and management measures needed to reduce the threats of climate change to oceanic fisheries and capitalize on the opportunities.

Anne Hollowed presented a talk entitled “21st Century Climate Change Impacts on Marine Fisheries.” Her presentation reviewed emerging efforts within the marine science community to develop mechanistic scenarios to project bio-physical couplings in marine ecosystems and expected changes in anthropogenic trends in marine resource use. She provided an overview of the modeling approaches being employed by the global research community and discussed the costs and benefits of different modeling approaches.

An outcome of the meeting is that the World Meteorological Organization will explore the possibility of creating initiatives for the formation of a global climate database to facilitate collaborations between meteorologists, oceanographers, and fisheries scientists to understand the relative influence of climatic variation (seasonal, inter-annual, decadal, and longer variability), climate change (more long-term changes in climate associated with anthropogenic activities), and the effects of fishing on the potential for sustained harvests from the world’s valuable oceanic fisheries. Selected papers from the meeting will be published in a special issue of the journal *Climate Change*.

By Anne Hollowed

PICES 2011 Annual Meeting

Center staff including Pat Livingston, Anne Hollowed, Libby Logerwell, Phil Mundy, Kris Cieciel, and Rolf Ream attended the PICES 2011 Annual Meeting, held 14-23 October in Khabarovsk, Russia, with the theme "Mechanisms of Marine Ecosystem Reorganization in the North Pacific Ocean" (*www.pices.int/meetings/annual/PICES-2011/2011-scientific_program.aspx*). The North Pacific Marine Science Organization (PICES) (*www.pices.int*) is an intergovernmental scientific organization established in 1992, which promotes and coordinates marine research in the North Pacific Ocean and adjacent seas. Currently, PICES members include Canada, Japan, People's Republic of China, Republic of Korea, the Russian Federation, and the United States.

Pat Livingston chaired the PICES Finance and Administration Committee and presented the committee's recommendations to the PICES Governing Council. During the 2011 PICES annual meeting, the PICES Governing Council approved the formation of a joint initiative with the International Council for the Exploration of the Sea (ICES) (*www.ices.dk/*), focused on understanding climate change effects on marine ecosystems (CCME). Anne Hollowed will serve as one of the co-chairs of this new group.

The vision for this new ICES/PICES joint research initiative is for ICES and PICES to become the leading international organizations providing science and advice related to the effects of climate change and variability on marine resources and ecosystems. Members of this initiative will develop the scientific basis for evaluating the vulnerability, status, and sustainability of marine systems under changing climate conditions. Collaborative research within ICES and PICES will help form and maintain a network of regional interdisciplinary teams that will share research approaches on a global scale to provide data and understanding at the spatial and temporal scales needed to monitor, assess, and project climate change impacts on marine ecosystems. The first milestone for this new group will be to convene theme session 4 of the upcoming PICES/ICES/IOC (Intergovernmental Oceanographic Commission) symposium in Yeosu, Korea, on effects of climate change on the world's oceans. As part of this new effort, Anne Hollowed will co-convene an ecosystem studies of sub-arctic seas ICES/PICES theme session on subarctic-arctic interactions: ecological consequences, during the ICES annual science meeting in Bergen in 2012.

During the 2011 PICES annual meeting, Kristin Cieciel participated as a U.S. representative for the PICES working group 26: jellyfish blooms around the North Pacific Rim: causes and consequences. The goals of the 3-year working group, composed of 20 members from six nations, are to promote international collaboration and information exchange, assess and determine impacts of jellyfish on marine ecosystems and socio-economies, elucidate the role of jellyfish in coastal and marine food webs, evaluate methods for predicting blooms, and provide jellyfish metrics as indicators of ecosystem change. Cieciel represents the eastern Bering Sea and Gulf of Alaska geographic areas in terms of ongoing jellyfish research.

Phil Mundy attended the PICES annual meeting to serve as co-chair of a standing committee, MONITOR, and as chair of its advisory panel on the continuous plankton recorder (CPR). MONITOR developed and maintains the international CPR effort to document inter-annual changes in Pacific Ocean plankton assemblages along commercial shipping lanes between Canada and Japan and along a U.S. domestic route between Anchorage, Alaska, and Tacoma, Washington, with Canadian sample processing and deployment support. MONITOR is also an international coordinating body for Pacific Ocean observing systems in Korea, China, Japan, Russia, the United States, and Canada. The data from ocean observing systems support ocean circulation models that increasingly advise design of biological sampling projects, such as fish stock assessment surveys. MONITOR sponsored a session of scientific papers on the subject "How well do our models really work and what data do we need to check and improve them?" with papers from all member countries, including several from NOAA. The abstracts for this session and the more than two hundred oral presentations, workshops and posters provide a comprehensive snapshot of North Pacific marine science from physics to fish, birds, and mammals.

By Phil Mundy, Anne Hollowed, Kristin Cieciel, and Pat Livingston

Members of this initiative will develop the scientific basis for evaluating the vulnerability, status, and sustainability of marine systems under changing climate conditions.