Auke Bay Laboratories (ABL)

MARINE ECOLOGY & STOCK ASSESSMENT PROGRAM

Growth Rate Potential of Juvenile Chum Salmon on the Eastern Bering Sea Shelf

Spatial and temporal variation in growing conditions for juvenile salmon may determine the survival of salmon after their first year at sea. To assess this aspect of habitat quality, a spatially explicit bioenergetics model was used to predict juvenile chum salmon (*Oncorhynchus keta*) growth rate potential (GRP) on the eastern Bering Sea shelf during years with cold and warm spring sea surface temperatures (SSTs). Annual averages of juvenile chum salmon GRP were generally lower among years and regions with cold spring SSTs. In addition, juvenile chum salmon GRP was generally higher in offshore than in nearshore regions of the eastern Bering Sea shelf during years with warm SSTs; however, the distribution (catch per unit effort) of juvenile chum salmon was not significantly ($P < 0.05$) related to GRP.

Shifts from warm to cold SSTs in the northern region do not appear to affect summer abundance of juvenile Yukon River chum salmon, whereas the abundance of juvenile Kuskokwim River chum salmon drops precipitously during years with cold SSTs. From this result, we hypothesize that size-selective predation is highest on juvenile Kuskokwim chum salmon during cold years, but that predation is not as great a factor for juvenile Yukon River chum salmon. Although not addressed in this study, we also hypothesize that the smaller Yukon River chum salmon captured during years with cold SSTs likely incur higher size-selective mortality during winter.

By Ed Farley

Juvenile Pink and Chum Salmon Distribution, Diet, and Growth in the Northern Bering and Chukchi Seas

Loss of nonseasonal sea ice and a general warming trend in the Bering Sea has altered the composition, distribution, and abundance of marine organisms inhabiting the region. Juvenile pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon were found in significant numbers throughout the Chukchi Sea and Bering Strait regions during early autumn 2007, reflecting significant utilization of Arctic marine habitat by Pacific salmon.

Linear models of juvenile pink and chum salmon body size corrected for Day of Year were parameterized to estimate daily growth rates and habitat-specific differences in body size using 6 years of survey data. Model results revealed that juvenile pink salmon inhabiting the eastern Bering Sea grew at an average rate of 1.17 mm per day and juvenile chum salmon grew at a rate of 1.21 mm per day. The U.S. Bering-Aleutian Salmon International Study (BASIS) survey area was expanded northward to include the Chukchi Sea during 2007, where larger juvenile pink and chum salmon were found in higher abundances relative to pink and chum salmon inhabiting the eastern Bering Sea. Food habits analyses revealed that juvenile pink and chum salmon fed upon high energy prey in the Chukchi Sea, and that the majority of chum salmon encountered there were from either Alaskan or Russian stocks.

By Jamal Moss

Energy Density and Length of Juvenile Pink Salmon in the Eastern Bering Sea from 2004 to 2007

Juvenile pink salmon were examined in the eastern Bering Sea from 2004 to 2007 to assess the influence of ocean temperature on whole body energy content (WBEC), length, and diet. Fish were collected during the U.S. BASIS surveys in the eastern Bering Sea. Warmer spring and summer sea surface temperatures prevailed from 2004 to 2005 on the eastern Bering Sea shelf, whereas cooler spring and summer sea surface temperatures occurred from 2006 to 2007. Juvenile pink salmon changed diet between the warm and cool years. Walleye pollock (*Theragra chalcogramma*) dominated the diet (> 50% wet mass) in warm years, while walleye pollock were nearly absent from the diet in cool years. Juvenile pink salmon lengths were significantly longer in warm years but WBEC was significantly lower. We interpret our results to indicate that length is not always a reliable measure of energy status.

By Alex Andrews

Geographical Variation in Carbon and Nitrogen Stable Isotope Ratios in Spiny Dogfish in the Northeastern Pacific Ocean

Spiny dogfish (*Squalus acanthias*) biomass has increased in the Gulf of Alaska, yet little is known about the ecological niche that dogfish fill in this ecosystem. Trophic position is an important indicator of the ecological role of an organism. To explore the trophic position of dogfish we analyzed the nitrogen and carbon stable isotope ratios of 60 dogfish from five locations between Washington State and the Gulf of Alaska. The mean $\delta 15N$ values for dogfish ranged from 12.0‰ (central Gulf of Alaska) to 13.4‰ (Howe Sound, British Columbia) and the mean $\delta 13C$ values ranged from –21.3‰ (Yakutat Bay, Alaska) to –17.9‰ (Puget Sound, Washington). Sites to the north tended to be significantly depleted in the heavy isotopes of both nitrogen and carbon. The differences in nitrogen isotope ratios among sites were attributed to potential changes in dogfish feeding behavior and trophic position.

Differences in carbon isotope ratios suggested that dogfish utilize different food webs along the northeastern Pacific Ocean shelf. Additionally it was hypothesized that feeding differentially in offshore versus inshore food webs or targeting pelagic versus benthic prey species may explain the isotopic variability. These results are preliminary and require additional tests before conclusions can be made about the trophic position of dogfish in this region.

Future work will explore stable isotope variability at lower trophic levels to test the hypothesis that entire food webs are isotopically shifted owing to differences in isotopic fractionation at the base of the food web. Also, trophic level differences among dogfish size classes and between sexes will be explored among a greater diversity of locations to better describe the ecological consequences of increased biomass of dogfish in the northeastern Pacific Ocean.

By Alex Andrews

Stable Isotopic Variability Along Spiny Dogfish Spines: Implications For Retrospective Ecological Studies

Spiny dogfish are an abundant and commercially important species of fish off both the Atlantic and Pacific coasts of North

America. They are opportunistic feeders and have a varied diet that can include many fish species, especially small forage fish such as herring, capelin, and sand lance, as well as crustaceans, worms, euphausiids, gelatinous zooplankton, and cephalopods. The purpose of our present study is to investigate the utility of the second dorsal spine in providing multiyear information on the feeding habits of dogfish using stable isotope (C and N) analysis.

The outer dentine and enamel layers of a spine from three dogfish (caught off the coast of British Columbia) were analyzed to obtain their stable nitrogen and carbon isotope composition (δ15N and δ13C, respectively). Each sample had annuli from multiple years, allowing possible seasonal migrations to be averaged over samples. The δ15N ranged from a low of 11.6‰ to a high of 14.9‰ over the three spines and δ13C ranged from -11.5‰ to -18.4‰. The variable isotopic signatures along the spine indicate that the method may be used to assess ecological changes. Stable isotope measurements of the dogfish spines could be a valuable means of determining long-term changes in habitat usage and feeding ecology.

By Alex Andrews

Growth and Survival of Sockeye Salmon from Karluk Lake and River in Relation to Climatic and Oceanic Regimes and Indices, 1922–2000

ABL staff examined whether the relationship between climate and salmon production was linked through the effect of climate on growth of sockeye salmon (*O. nerka*) at sea. Smolt length and juvenile, immature, and maturing growth rates were estimated from increments on scales of adult sockeye salmon that returned to the Karluk River and Lake system on Kodiak Island, Alaska, over 77 years, 1924 –2000.

Survival was higher during the warm climate regimes and lower during the cool regime. Growth was not correlated with survival, as estimated from the residuals of the Ricker stock-recruitment model. Juvenile growth was correlated with an atmospheric forcing index and immature growth was correlated with the amount of coastal precipitation, but the magnitude of winter and spring coastal downwelling in the Gulf of Alaska and the Pacific Northwest atmospheric patterns that influence the directional bifurcation of the Pacific Current were not related to the growth of Karluk sockeye salmon. However, indices of sea surface temperature, coastal precipitation, and atmospheric circulation in the eastern North Pacific were correlated with the survival of Karluk sockeye salmon. Winter and spring precipitation and atmospheric circulation are possible processes linking survival to climate variation in Karluk sockeye salmon.

By Ellen Martinson

Alaska Sockeye Salmon Scale Patterns as Indicators of Climatic and Oceanic Shifts in the North Pacific Ocean, 1922–2000

Climate regime shifts can alter the community structure of marine species in the North Pacific Ocean. In this study, we used a regime shift detection algorithm to determine whether regime shifts are recorded as shifts in the mean fish length indices at the smolt, juvenile, immature, and mature life stages based on measurements of increments on scales of adult age-2.2 sockeye salmon that returned to the Karluk River, Alaska, over a 77-year time period (1924–2000).

Fish length was expected to increase with cool-to-warm climate shifts (1926, 1958, 1977, and 1998) and decrease with warm-to-cool climate shifts (1943, 1947, 1971, and 1989). Regime shifts were not consistently observed as statistical shifts in the time series of fish length indices. At contemporaneous lags, shifts in the mean temperature of the North Pacific were detected as shifts in length in 1958 (+), but not in 1926 (+), 1943 (-), 1971 (-), and 1977 (+). Shifts in the atmospheric circulation and sea level pressure of the North Pacific were detected as negative shifts in length in 1989 (-), but not in 1926 (+), 1947 (-), 1977 (+), 1998 (+). Shifts in length indices were associated with the 1957-58 El Niño, the warm-to-cool shift in 1989, and preceded the 1976–77 climate shift in the North Pacific Ocean. Fish length indices from salmon scales may be useful predictors for major and more recent shifts in the status of the ecosystem of the North Pacific Ocean.

By Ellen Martinson

Groundfish Stock Assessments

Scientists from ABL's MESA Program completed eight full stock assessments and updated one assessment for nine species/species groups of Alaska groundfish. Full assessments included Alaska sablefish, Bering Sea/Aleutian Islands sharks, and the following assessments for the Gulf of Alaska: Pacific ocean perch, northern rockfish, pelagic shelf rockfish, rougheye and blackspotted rockfish, shortraker rockfish and "other slope rockfish," and sharks. A short stock assessment update was also done for Alaska grenadiers. 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 were 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 total allowable catch) for these species in 2010. More information about these assessments is available in the Resource Ecology and Fishery Management (REFM) Division's "Groundfish Stock Assessments for 2010 Fishery Quota Recommendations" report in this issue.

By Dave Clausen

Catch Efficiency of Longlines for Shortraker and Rougheye Rockfish in Alaska

Populations of rockfish (*Sebastes* spp.) can be difficult to assess with bottom-trawl survey gear because the species often inhabit untrawlable rocky habitats. Conversely, longline gear can be set in most bottom habitats and is used to assess abundance of many benthic fish species. Several factors besides abundance, however, can affect catch rate and consequently diffuse the relationship between catch rate and density, making catch rates a less reliable tool for assessing abundance trends. Because the relationship between actual fish densities and catch rates can be affected by so many factors, it is important to characterize the relationship when using catch rates as an index.

To evaluate shortraker and rougheye rockfish catchability on longline gear, ABL scientists compared longline catch rates to observations of density from a manned submersible at 19 sites in Southeast Alaska based on field studies originally conducted in 1994 and 1997. Densities of shortraker rockfish ranged from 0 to 12,616 fish per km². Densities of rougheye rockfish ranged from 0 to 24,222 fish per km². Linear regressions between density and longline catch rates were not significant for either species, but a positive trend was evident for rougheye rockfish. The estimate of rougheye rockfish catchability from this study was about 18% of the stock assessment estimated catchability. Simply obtaining a comparable value (the same order of magnitude) lends credence to both estimates.

When longline gear was observed from the submersible, the proportion of fish free-swimming near the longline increased through the duration of the set, indicating that rockfish were attracted to the line faster than they were caught. Rockfish behavior and soak time may account for the lack of strong correlations between catch rates and densities, although other factors such as environmental conditions and sample size may also have affected our results. Future research should be aimed at describing the catching process for these rockfish in Alaska to further investigate the reliability of longline survey rates as an index of abundance.

By Cara Rodgveller, Mike Sigler, Dana Hanselman, and Dan Ito

Environmental Monitoring/Climatology: Auke Bay Annual Summary, 2009

Following the dismal spring, summer, and fall of 2008, Auke Bay experienced a notably pleasant 2009. The 2009 summer's warm temperatures and low precipitation levels, although not exceptional were much more pleasant than that of 2008 (Table 1).

Above average air temperatures were experienced from late April through November. Much of this period was accompanied by lower than average precipitation and periods of high incoming solar radiation. Incoming solar radiation has a large impact on the local air and sea surface temperatures and personal perceptions of pleasant weather conditions. Daily solar insolation may vary 4- to 5-fold within a 2-day period. Periods of high insolation are associated with high air temperature and high sea surface temperatures in late May, early June, early July and early August, much of September and even portions of October (Fig. 1).

Sea surface temperatures (SSTs) (Fig. 1) at the Auke Bay Marine Station were below average through the winter and early spring (January – April) then warmed to above average conditions in late May, June, and July. The remainder of the summer had below average SSTs, and the fall had near average SSTs. Although climate models for the eastern Pacific Ocean project the current mild El Niño will last through late spring 2010, its effects have not extended much beyond southern California. The Gulf of Alaska has remained cool with only small patches of warmer than average surface waters.

Beginning in late November 2009, the Auke Bay Marine Station was able to download and archive incoming solar radiation data from the automated weather station at the end of the Auke Bay Marine Station pier. The raw data can be obtained on the web through the U.S. Geological Survey (USGS) Emergency Distribution Net Work (EDDN) at http://eddn.usgs.gov/msgaccess.html. The EDDN provides access to a number of

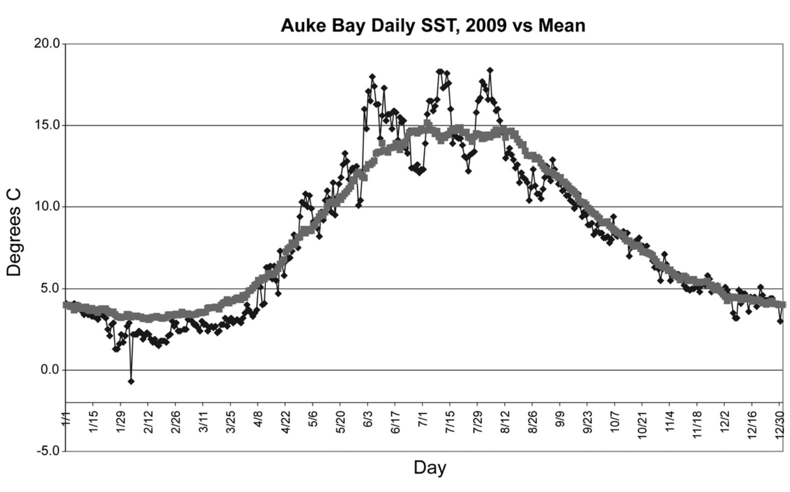

Figure 1. Comparison of 2009 Auke Bay sea surface temperatures to the mean.

Table 1. Monthly Auke Bay weather records for 2008, 2009, and average (1963 to present).

	2008	2009	Average
Median Air Temperature (°F)			
Jan	26.77	25.97	26.17
Feb	27.84	29.34	30.25
Mar	36.00	31.03	34.50
Apr	39.27	39.98	41.34
May	49.27	49.52	46.83
Jun	52.40	56.37	55.09
Jul	53.73	61.58	56.64
Aug	54.62	56.66	56.85
Sep	49.60	51.23	50.77
Oct	41.47	43.37	42.96
Nov	35.50	35.42	33.47
Dec	23.81	28.79	29.18
Precipitation (inches)			
Jan	4.70	9.65	4.86
Feb	3.87	2.87	3.81
Mar	3.25	2.93	3.38
Apr	4.85	2.21	2.92
May	2.53	3.26	3.81
Jun	2.67	2.61	4.08
Jul	8.28	2.69	5.47
Aug	5.58	9.16	6.55
Sep	12.29	7.64	9.05
Oct	11.65	6.70	8.60
Nov	4.70	5.88	5.37
Dec	4.43	3.58	5.10
Snowfall (inches)			
Jan	23.80	72.4	28.39
Feb	38.61	21.1	17.56
Mar	12.31	19.2	11.72
Apr	9.70	3.00	2.21
May	0.00	0.00	0.00
Jun	0.00	0.00	0.00
Jul	0.00	0.00	0.00
Aug	0.00	0.00	0.00
Sep	0.00	0.00	0.01
Oct	3.30	0.00	0.67
Nov	2.60	11.80	12.29
Dec	28.60	8.20	19.25
Sea Surface Temperature (°F)			
Jan	37.76	37.51	38.53
Feb	37.22	35.74	37.90
Mar	38.12	37.06	38.80
Apr	41.18	42.55	43.23
May	49.82	51.42	50.16
Jun	54.91	58.93	56.44
Jul	54.09	59.63	58.05
Aug	53.44	56.22	57.06
Sep	49.77	50.65	51.51
Oct	44.55	45.70	45.91
Nov	41.82	41.40	41.92
Dec	39.75	40.46	39.72

automated weather stations that report via environmental satellites to NOAA, the U.S. Geological Survey, and other science agencies. Unfortunately, the EDDN system only archives raw data for 6 months. The Auke Bay Marine Station Data Collection reports hourly the status of its battery, air temperature, accumulated precipitation, barometric pressure, incident solar radiation, sea surface temperature, and tidal height.

We plan to download the Auke Bay Marine Station data weekly for studies related to eel grass growth.

By Bruce Wing

2009 Sablefish Longline Survey

The AFSC has conducted an annual longline survey of sablefish and other groundfish in Alaska from 1987 to 2009. The survey is a joint effort involving the AFSC's Auke Bay Laboratories 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 2009, the thirty-first 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 30 May – 26 August 2009 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*), shortspine thornyhead (*Sebastolobus alascanus*), arrowtooth flounder (*Atheresthes stomias*), and Pacific cod (*Gadus macrocephalus*). A total of 74,444 sablefish were caught during the survey. Sablefish, shortspine thornyhead, Greenland turbot (*Reinhardtius hippoglossoides*), and lingcod (*Ophiodon elongatus*), were tagged and released during the survey. Length-weight data and otoliths were collected from 1,860 sablefish. Killer whales (*Orcinus orca*) took fish from the longline at 10 stations in the Bering Sea region, 2 stations in the western Gulf of Alaska, and 1 station in the central Gulf of Alaska. This was the highest killer whale depredation in the survey ever observed in the Bering Sea and severely affected catches in this region. Sperm whales (*Physeter macrocephalus*) were often present during haul back and were observed depredating on longlines at five stations in the eastern Gulf and five stations in the central Gulf of Alaska. These numbers represent a high incidence of sperm whale interactions in the central Gulf, but the number observed in the eastern Gulf was much lower than that experienced in 2008.

Several special projects were conducted during the 2009 longline survey. Lingcod were tagged with archival temperature/depth tags in the West Yakutat and central Gulf of Alaska regions. Photographs of sperm whales observed during the survey were taken for contribution to the Southeast Alaska Sperm Whale Avoidance Project (SEASWAP) sperm whale catalog. A NOAA Hollings Scholar intern conducted a hooking injury project for sablefish. During this project, tagged sablefish were examined for prior hooking injuries and injury location and severity were recorded. This information, along with data from a previous tagging study, will be used to help understand mortality that occurs as a result of hooking injury.

A 2-day experiment was conducted near Yakutat on 21-22 July to test new methods for quantifying sperm whale depredation rates. Acoustic recorders were deployed during survey operations to passively collect the acoustic recording of sperm whale sounds during gear retrieval. Sperm whales use echolocation signals for navigation and detecting objects underwater. A "creak" is a rapid series of clicks in short succession which may indicate that a whale is homing in on a prey item. Enumerating the number of "creaks" that occur during hauling operations may provide a quantitative means of evaluating sperm whale depredation on the longline catches.

By Chris Lunsford

MARINE SALMON INTERACTIONS PROGRAM

North Pacific Anadromous Fish Commission 17th Annual Meeting in Niigata, Japan

Representatives of Canada, Japan, Republic of Korea, Russia, and the United States, the primary states of origin for salmon stocks in the North Pacific Ocean, met in Niigata, Japan, 2-6 November 2009, for the 17th Annual Meeting of the North Pacific Anadromous Fish Commission (NPAFC).

NPAFC agencies responsible for the planning and execution of enforcement activities met to coordinate enforcement efforts to detect and deter illegal, unregulated, and unreported (IUU) fishing in the Convention Area. Joint long-range aircraft patrols and coordination with each Party's enforcement vessels are used to detect illegal fishing. Member countries conducted 188 ship patrol days and 279 aerial patrol hours in the Convention Area in 2009. This year, no NPAFC Parties sighted any vessels suspected of illegal fishing, although Taiwan (NPAFC observer) sighted one vessel with driftnets deployed. This year's results may reflect a reduction in IUU fishing in the North Pacific and may be a result of significant increase in patrol efforts in recent years. Due to the continued threat of high-seas fishing for salmon in the Convention Area, all Parties reaffirmed their commitment to maintain 2010 enforcement activities at high levels as a deterrent to the threat of potential unauthorized fishing activities.

Scientific research by NPAFC Parties in 2009 focused on trends in marine production of salmon stocks, their population structure, and diversity in North Pacific marine ecosystems. NPAFC scientists also met to further their understanding of climate change impacts on salmon stocks and their ecosystems. Cooperative research by NPAFC scientists over the past several years has covered a broad range of issues helping to answer many perplexing questions about salmon abundance. The NPAFC cooperative research program Bering-Aleutian Salmon International Survey (BASIS) documented ocean and atmospheric changes and other biological and ecological dynamics affecting salmonid production. Results of many studies on these issues reported at a recent BASIS symposium are now available in Bulletin Number 5 at the NPAFC website (www.npafc.org).

Other research issues considered included 26 new scientific documents submitted by the Parties for review and discussion by the Committee on Science, Research, and Statistics (CSRS). These documents included reports on new genetic and otolith marking techniques used to identify the origins of salmon and the intermixing of the stocks in the Pacific Ocean, new high-tech tags used to track migratory behavior of salmon on the high seas, reports providing information on long-term data-sets from specific parts of the North Pacific, and forecasting techniques for predicting strength of returning salmon runs to specific areas.

Reports by Russian scientists based on extensive ocean surveys in 2008-09 tracking the abundance of juvenile and immature pink salmon originating from 2007 brood parents accurately predicted the record return of this species to several subdistricts of Russian Far East waters. A report by U.S. scientists also documented development of a forecast model that accurately forecast the commercial harvest of pink salmon in most years in Southeast Alaska.

In 2007, the NPAFC was awarded a grant from the Gordon and Betty Moore Foundation in support of a long-term, integrated research and monitoring plan for Pacific salmon. This plan synthesizes past research and identifies critical areas for new research to understand impacts of future climate and ocean changes on the population dynamics of Pacific salmon. The project has been completed and the final report, "A long-term research and monitoring plan (LRMP) for Pacific salmon (*Oncorhynchus* spp.) in the North Pacific Ocean," is available from the NPAFC website.

Unprecedented high catches of Pacific salmon continue in most areas of the North Pacific. Only at the southeastern part of their range off British Columbia, Washington, Oregon, and California and in some Western Alaska river systems do Pacific salmon stocks remain in low abundance. The previous all-time record harvest of salmon from around the Pacific Rim was 1.02 million metric tons (t) in 2007, with over 80% composed of pink and chum salmon. Based on preliminary analysis by NPAFC Parties, the 2009 salmon harvest is likely to exceed the previous record and may reach 1.1 million t. Russia's record salmon catch alone in 2009 was 540,000 t.

There were 22 U.S. delegates at the Niigata meeting. Doug Mecum, Acting Alaska Regional Administrator, was head of the U.S Delegation. Alaska Fisheries Science Center delegates included Loh-Lee Low, the U.S Point of Contact for CSRS, and Auke Bay Laboratories scientists Ed Farley, Bill Heard, and Jeff Guyon. Acting Assistant Administrator for Fisheries Jim Balsiger of the United States was elected by the Commission as the next NPAFC President.

By Bill Heard

Pacific Salmon Commission Transboundary Technical Committee Meetings

Fishery scientists from Alaska and Canada met in Juneau, Alaska, 23-25 November 2009 as part of the Pacific Salmon Commission (PSC) Transboundary Technical Committee to review and discuss research and management activities on the Taku, Stikine, and Alsek Rivers during 2009. Catch and management summaries by species and system were presented for Chinook, sockeye and coho salmon. The activities include smolt estimation through mark recapture and coded-wire tagging, adult weir counts, foot and aerial surveys, collection of genetic samples for baseline GSI work, and harvest data relevant to overage/underage treaty agreements. In addition, committee chairs presented an update on the funding process for the PSC Northern Fund in 2010. Funds from this source went directly to pre-approved continuing NOAA/ABL projects for Northern Boundary Sockeye, Southeast Coastal Monitoring, and a small allotment to support UAF/ABL work at Auke Creek. On the final day, a detailed presentation was made by Blair Holtby from Canada on improving the escapement goals and population modeling of Taku River coho salmon. He utilized a variety of data sources including the NOAA/Alaska Department of Fish and Game (ADF&G) Auke Creek time series on coho salmon to provide an analysis of the Taku River population. This provided the foundation for lively discussions of plans to improve the estimation of smolt numbers and stock population characteristics in order to ultimately improve marine survival and escapement goal evaluations.

Concurrent to the management summary, the enhancement subcommittee reviewed and summarized sockeye enhancement activity on the Taku and Stikine Rivers. Enhancement of sockeye salmon, now with formalized plans for each river has been technically challenging and controversial. The plans tie enhancement directly to harvest sharing agreements, so there is a large investment in planning and monitoring enhancement activity. This review included information about the egg and fry survival rates of gametes taken from Tatsamenie (Taku) and Tahltan (Stikene) Lakes where the bulk of enhanced production is on either river. Gametes are brought to Snettisham Hatchery in the United States, otolith-marked during incubation, reared for a very short period, then planted back into their respective lakes. Technical issues arose with the methodology for brood stock collections, holding of adults for egg takes, and use of virus-free water for onsite extended rearing to minimize losses to infectious hematopoietic necrosis virus (IHNV). Additional enhancement work focused on smaller systems on the Taku River to help fill production gaps created by poor returns to the Tatsamenie. On the Stikine River, a Tuya Lake migration barrier which has been an impediment to further enhancement was at least partially breached with a successfully engineered blasting effort in 2009.

By John Joyce

HABITAT & MARINE CHEMISTRY PROGRAM

Humpback Whales in Seymour Canal, Southeast Alaska: Numbers and Forage Base

As part of continuing research on the effect of predation on Pacific herring, an estimated 240 humpack whales were observed in November (Fig. 2), with 210 photographically identified between Juneau and Seymour Canal. These observations are an extension of work in Sitka, Lynn Canal, and Prince William Sound to determine the forage base of humpback whales in fall and winter and whether they are impacting herring stocks, possibly to detrimental levels. John Moran (ABL) in collaboration with Jan Straley of the University of Alaska Southeast completed a 10-day research cruise to Seymour Canal during mid-November 2009. The large concentration of humpback whales at this time of year is consistent with earlier work by Straley where well over 100 whales have been present in a 40-km stretch of Seymour Canal in November for a number of years. These late-season humpbacks are not new to Seymour; Straley has been keeping track of them since 1979. Why are they there? Seymour Canal has high concentrations of euphausiids. Researchers with ABL's Habitat and Marine Chemistry Program are trying to understand why the area is so productive by looking at parameters such as oceanographic features, euphausiid energetics, and predator abundance.

Research from Seymour Canal will complement humpback whale foraging data

Figure 2. A humpback whale "flick feeding" in Seymour Canal. With the breakdown of the thermocline in November, euphausiids were present at the surface simplifying prey identification. Photo by John Moran.

collected in Prince William Sound, Lynn Canal, and Sitka Sound. In Prince William Sound and Lynn Canal, herring have been identified as the primary prey for humpbacks. Sitka Sound has both euphausiids and abundant herring stocks. Euphausiid-filled Seymour Canal provides some contrast on how these late season whales are using different foraging strategies to fuel up before migrating to lower latitude breeding areas.

Direct observations of whale predation are often difficult to assess, and prey type is often inferred from acoustic signal. However, recent analysis of fatty acid and stable isotope analysis from whale blubber and prey samples confirm our field observations—whales in Prince William Sound are feeding at a higher trophic level on herring. The impact of whale predation on the struggling herring stocks of Prince William Sound and Lynn Canal is not trivial. For example, whales in Prince William Sound have the capacity to consume between 18% and 32% of the current spawning stock biomass between September and March; basically they have replaced a former commercial fishery. No commercial fishery for herring has been permitted in Lynn Canal since the 1970s, and only two fisheries have been permitted in Prince William Sound in the last 17 years.

By John Moran

Nearshore Fish Assemblages in the Chukchi Sea Near Barrow, Alaska

The Arctic is one of the most rapidly changing ecosystems in the world, yet a large void exists in information on essential fish habitats and what species and life stages use these habitats. Rapid change in the Arctic ecosystem is well documented: the year 2007 was the warmest on record for the Arctic, and the minimum extent of sea ice in 2009 was the third lowest since the start of satellite measurements in 1979. Loss of sea ice from global warming threatens marine life and habitat (e.g., increased coastal erosion) and has the potential to open up formerly inaccessible areas to oil and gas exploration, vessel traffic, mining, and commercial fishing. Increased human activity translates into increased risk to fish and habitat from development and oil spills. Recent increases in domestic energy costs have increased the demand for oil and gas exploration and development in the Arctic. The U.S. Minerals Management Service estimates that the Beaufort Sea, Chukchi Sea, and North Aleutian Basin have recoverable resources ranging from 2.8 to 65.8 billion barrels of oil and 11.4 to 305 trillion cubic feet of natural gas. Because information is nonexistent or outdated for fishes in the Arctic, ABL with support from the North Slope Borough sampled nearshore fish assemblages at six sites in the Chukchi Sea in August 2007, 2008, and 2009, and September 2009. At each site, fish were captured with a beach seine (<5 m deep) (Fig. 3) and with a small bottom trawl at two depths (5 m and 8 m; < 1.5 km from shore). In addition, baseline hydrocarbon samples were collected with passive samplers and sediment collections.

A total of 15,030 fishes representing 20 species were captured in 24 beach seine hauls, and 3,221 fishes representing 23 species were captured in 48 trawl tows. Species composition and catch differed dramatically by gear type and time of sampling (i.e., among years and within 2009). Total seine catch was dominated by capelin (75%), whereas total trawl catch was dominated by Arctic cod (48%). Among years (August only), capelin accounted for 96%, 4%, and 27% of the total catch for both gear types, whereas Arctic cod accounted for <1%,

Figure 3. Capturing nearshore fishes along the Chukchi Sea using a beach seine. Photo by Scott Johnson.

46%, and <1% of the total catch. Other fish captured that are important forage or subsistence species were Pacific sand lance, saffron cod, and rainbow smelt. In 2009, catch and species richness was much greater in September (7,861 fishes, 20 species) than in August (2,633 fishes, 13 species). Differences in catch and species composition may be attributed to differences in habitat use, environmental conditions among years, and time of sampling. For example, Arctic cod dominated the total catch in August 2008 compared to August 2007 and 2009; ice persisted longer in 2008 (about mid-August) and water temperature (mean = 1.8°C) was much cooler than in 2007 (mean = 9.1°C) or 2009 (mean = 6.2°C).

Sites established in this study will provide a long-term and large-scale baseline in an area under rapid change. The Arctic is probably the world's fastest changing and least understood ocean. Continued monitoring of nearshore fish populations in the Arctic is warranted; a reorganization of community structure is likely as new fish species are expected to migrate to the Arctic with unknown consequences to existing stocks and food webs. The nearshore must be included in any research effort in the Arctic; several species that are important forage fish or subsistence species (e.g., capelin, rainbow smelt) are found almost entirely in nearshore waters. As with other areas of concern in the Arctic (e.g., offshore fish assessments, marine mammals, loss of sea ice), nearshore fish assemblages and habitat needs a continuum of study, perhaps decades, to begin to be understood.

By Scott Johnson and John Thedinga

Fisheries Monitoring & Analysis (FMA) Division

OBSERVER ACTIVITIES IN 2009

During 2009, 734 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 267 vessels and at 19 processing facilities for a total of 35,681 observer days. This is a reduction in effort from our high in 2008 of 39,463 observer days. The high level of effort in 2008 was caused by a spike in activity following the increase in observer coverage requirements mandated by Amendment 80 to the Bering Sea/Aleutian Islands Fishery Management Plan implemented that year. The decline of effort in 2009 was likely due to several causes, including the decrease of some fish quotas and substantial market changes given the turmoil in the financial markets.

Figure 1. Trainers Paul McCluskey (back left) and Amie Olson (front left) accompany observer candidates on tours of fishing vessels at Fisherman's Terminal in Seattle. Photo by FMA staff.

New observer candidates (Fig. 1) 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 2009, the FMA Division provided training for 54 new observers in Seattle and 107 new observers in Anchorage 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. 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 352 observers in Seattle and 107 observers in Anchorage. The 2009 workforce comprised 39% new observers and 61% experienced observers. This was an increase in returning observers when compared to 2008, when 48% of the workforce was composed of experienced observers.

After each deployment, observers meet with a staff member for debriefing to finalize the data collected. There were 145 debriefings in Anchorage and, due to a larger debriefing staff, 489 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 addition to their normal training duties, FMA staff provided a 2-day safety training class for AFSC interns and RACE Division staff members. Cold-water survival techniques and how to respond to at-sea emergencies were covered through classroom instruction and hands-on drills. The training was customized to the needs identified by the RACE Division and satisfied the safety training refresher requirements for RACE staff who participate in at-sea surveys.

In preparation for the 2010 fishing season, extensive work was performed modifying and updating the 2010 Observer Sampling Manual and the database that captures and stores observer data. 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 amounts of a specific collection, or the need for a new data collection may arise. One of the changes implemented for 2010 is the electronic capture of seabird sighting and interaction data. These data were previously documented on paper forms only. Over 20 new database tables were created to support the electronic capture of the seabird data. New paper data forms were created for documentation of these raw data in the field. While FMA has collected these data for several years, the change to electronic capture required substantial revisions to the Observer Sampling Manual to describe the protocols for data documentation and entry to FMA's custom at-sea software.

In addition to the standard data collections, observers may also collect data for specific research projects. This year we added a new research project to collect whole starry flounder for investigations into the amounts and possible seasonality of antifreeze in the blood of starry flounders.

It is important to note that anytime FMA makes a change to the database it requires us to upgrade the data entry application installed on vessel computers. Tracking down vessels over a large expanse of the earth and installing the application is a necessary and critical part of maintaining smooth operations. When fishing starts, we need people, databases, and applications in place and ready to go.

As the FMA Division moves into 2010, staff will be busy reviewing newly collected observer data sent from the field and assisting observers with questions. Staff will also focus on finalizing the data collected in 2009.

By Allison Barns, Mike Moon, and Ren Narita

Habitat & Ecological Processes Research (HEPR)

Report of the Bering Sea Project (BEST/BSIERP) Principal Investigators' Meeting

Principal investigators of the Bering Sea Project (BEST/BSIERP) met to discuss and exchange research findings on 13-15 October 2009 in Girdwood, Alaska. About one hundred scientists attended the meeting. The goals of the meeting were to present summary results organized around related projects, to organize focal group discussions, and to build a road map for synthesis of Bering Sea Project results. Participants presented key research findings on the following topics: physical oceanography, iron and nutrients, benthos, ice algae and primary production, zooplankton, ichthyoplankton, fish surveys, fish and ocean conditions, seabirds and whales, patch dynamics, local and traditional knowledge and subsistence, lower trophic level models, upper trophic level models, competing models, data management, and outreach. Thanks to everyone who contributed to this interesting and productive meeting.

By Mike Sigler

Essential Fish Habitat Proposals Reviewed

Proposals for FY 2010 essential fish habitat (EFH) funding recently were solicited from Alaska Fisheries Science Center and NMFS Alaska Regional Office staff. Project selection for EFH research is based on research priorities from the EFH Research Implementation Plan for Alaska. Approximately $500,000 is spent on about ten EFH research projects each year.

Table 1. Projects recommended for essential fish habitat funding for FY 2010.

Budget ($)	Principal Investigators	Title
$ 32,900	Malecha, Shotwell, Amman	Recruitment and response to damage of an Alaskan gorgonian coral
$ 64,700	Rooper	Collection of field data to support modeling bottom trawling impacts and subsequent recovery rates of sponges and corals in the Aleutian Islands, Alaska
$ 48,804	Stone, Waller, Mondragon	Reproductive ecology of the red tree coral (*Primnoa pacifica*)
$ 9,500	Johnson, Eagleton	Nearshore fish assemblages in coastal areas facing development in Upper Cook Inlet and Prince William Sound, Alaska
$ 42,800	Laurel, Ryer, Parrish, Knoth, Urban	Productivity, habitat utilization and recruitment dynamics of Pacific cod
$ 96,300	Yeung, Yang	Northern Bering Sea habitat suitability for benthic-feeding flatfishes
$ 112,250	Rooper, Hoff, Wilkins	Identification of high relief living structures in the Gulf of Alaska slope areas
$ 19,000	Harris	Reproductive biology of Pacific sand lance near Juneau, Alaska: spawn timing and location and larval distribution
$ 48,000	Ryer, Long, Spencer	Recruitment, post-settlement processes and habitat utilization by Tanner crab (*Chionoecetes bairdi*)
$ 43,450	Knoth, Conrath, Urban, Laurel, Worton	Seasonal habitat use and overwintering habits of juvenile Pacific cod (*Gadus macrocephalus*) in coastal nursery areas
$ 103,500	Hoff	Skate nursery habitat mapping in the Aleutian Islands
$ 96,900	Johnson, Thedinga	The nearshore ecosystem of the Arctic: an inventory of biological and physical characteristics in a rapidly changing environment

Research priorities are
1. Potential impacts on coastal areas facing development
2. Characterization of habitat utilization and productivity
3. Sensitivity, impact, and recovery of disturbed benthic habitat
4. Validation and improvement of habitat impacts model
5. Seafloor mapping

The Habitat and Ecological Processes Research (HEPR) team completed a scientific rating of the 2010 proposals in early December. Alaska Regional Office Acting Deputy Regional Administrator Jon Kurland and HEPR Program Leader Mike Sigler agreed on rankings based on the scientific review and management priorities. Like last year, habitat recovery rate proposals were given higher management priority. The management prioritization generally followed the science ranking but a few changes were made to reflect the relevance of the proposals for fishery management decisions.

Ten projects were recommended for funding in the order shown in Table 1. Three projects are continuing EFH studies and seven are new studies. Of the 10 projects, 3 are recovery rate studies (1 continuing and 2 new). If more than $517,700 (subtotal of first 10 projects) is available for EFH studies, a recommendation for additional projects to fund will be made.

By Mike Sigler

Figure 1. Adult female northern fur seal and dependent pup on St. Paul Island, Alaska. Photo by Louise Taylor.

National Marine Mammal Laboratory (NMML)

ALASKA ECOSYSTEMS PROGRAM

Alaska Northern Fur Seal Demographic Research, 2009

At their peak in the 1950s, northern fur seal (*Callorhinus ursinus*) rookeries on St. Paul and St. George Islands in the Bering Sea produced over 400,000 pups annually. An experimental harvest of females in the 1960s, intended to reduce resource competition and increase reproductive rates, was followed by a post-harvest population decline, a period of relative stability, and a more recent decline that has occurred at an annual rate of 5.2% since 1998. Understanding the demographic mechanism underlying the decline is an important part of unraveling the ecological causes for this most recent downturn.

The Alaska Ecosystems Program (AEP) initiated a tagging program on St. Paul Island in 2007, began resighting studies in 2008, and continued tagging and resighting efforts in 2009. Resightings of tagged fur seals are focused on the north end of Polovina Cliffs rookery on St. Paul Island, one of the few locations offering favorable vantage points for detecting and reading flipper tags without recapturing the seals. Past captures at this location have been motivated by various objectives, so a combination of tag types exists. Not all tags are designed to maximize tag retention or readability needed for demographic research.

Captures at Polovina Cliffs rookery in November 2007 and 2008 included 133 juvenile and adult females that were captured for pregnancy diagnosis by ultrasonography. These animals were tagged with a conspicuous large Allflex tag and a VHF radio tag in either flipper. While the large Allflex tags are the most visible and easily read of the tags, they also are lost at a higher rate than the smaller tags deployed primarily to estimate demographic parameters. The VHF tags do not have permanent lettering for resighting purposes, and their transmitters functioned for only 1 year. As such, we expect animals with these tags to provide more limited demographic information than the additional 143 juvenile and adult females tagged specifically in those years to address demographic questions. In addition, a small number of females were tagged in studies prior to 2007.

In July and August 2009, the resighting effort was led by our collaborators at Oregon State University: master's student Erin Kunisch and her assistants Stephen Meck and Brett Miller. They identified 218 tagged females on the beach at Polovina Cliffs. Nearly 90% of these females were observed interacting with a pup, indicating a true mother-pup bond (Fig. 1) and a likely maximum bound on annual pupping rate (assuming that some of the tagged females that were not seen were alive and their pupping status, although unknown, was more likely to be negative). Of the tagged females known to be alive in 2008, 75% were seen in summer 2009, which is a minimum estimate of annual survival (assuming that some were not seen and that some had lost their tags). Our estimation of both pupping and survival rates relies on capture-mark-recapture statistical methodology and requires multiple years of observations to make inferences about the animals not seen in a given year. Our resighting effort in future years will provide corrections to the biases in these preliminary estimates.

Demographic research on northern fur seals at the Pribilof Islands is expanding. Tagging efforts were significantly increased during fall 2009 with a large deployment of tags on fur seal pups and initiation of a tagging program at South Rookery on St. George Island. On St. Paul Island, a field team of 9-12 scientists tagged 478 female pups and 156 juvenile and adult females at the intensive study site at Polovina Cliffs, resulting in a total of 470 tags deployed on adult females on St. Paul Island during 2007-09. For ageing studies, teeth were collected from 164 anesthetized animals in 2008-09, including 107 of the juvenile and adult females tagged in 2009. Ten of these adult females also received satellite transmitters to monitor overwinter movements. On St. George Island, a crew of 9-12 scientists tagged 1,964 pups of both sexes, as well as 91 juvenile and adult females, 83 of which had a tooth removed for ageing studies. Males generally start reappearing on shore at an earlier age than females do (ages 2-3 instead of ages 5-7), so the tagging of male pups will allow an initial assessment of pup survival in 2012.

By Ward Testa, Rolf Ream, and Tom Gelatt

CETACEAN ASSESSMENT & ECOLOGY PROGRAM

Aerial Surveys to Study Bowhead Whale Feeding Ecology

The Bowhead Whale Feeding Ecology Study (BOWFEST) was initiated in May 2007 through an interagency agreement (IA) between the Minerals Management Service (MMS) and the National Marine Mammal Laboratory (NMML). The $5 million IA covered a 5-year period of study, which included field seasons in 2007, 2008, and 2009. Currently, the MMS is granting NMML an additional $3 million to continue the study for two more field seasons, with the whole program to be completed in 2012. The study has been conducted by NMML scientists and (through grants and contracts from NMML) by scientists at the Woods Hole Oceanographic Institution, University of Rhode Island, University of Alaska Fairbanks, University of Washington, Oregon State University, and North Slope Borough Department of Wildlife Management (NSB DWM). Fieldwork has been coordinated with the NSB, MMS, Alaska Eskimo Whaling Commission, Barrow Whaling Captains' Association, and Alaska Department of Fish and Game.

BOWFEST focuses on late summer oceanography and prey densities relative to bowhead whale (*Balaena mysticetus*) distribution north and east of Point Barrow, between the Alaska coast and latitude 72°N and between longitudes 152°W and 157°W. Aerial surveys, boat-based surveys, and acoustic monitoring provide information on the spatial and temporal distribution of bowhead whales in the study area.

The aerial survey component of BOWFEST is designed to document patterns and variability in the timing and locations of bowhead whales. In addition, aerial photography provides information on residence times (through reidentification of individual animals) and sizes of whales (through photogrammetry). With the consideration of acoustic mooring locations, preset oceanographic transects, bathymetric gradients, and distance from the base of operations (Barrow), a two-part study area and aerial-trackline sampling scheme was devised with an intensely surveyed inner area and reduced coverage in the outer area (Fig. 2). Using a NOAA Twin Otter, NMML scientists conducted aerial surveys on 6 days (30.6 flight hours) between 23 August and 11 September 2007, 8 days (42.7 hours) between 27 August and 16 September 2008, and 5 days (18.0 hours) between 29 August and 18 September 2009. Options for flying were greatly limited by fog, low cloud ceilings, and high winds. During these surveys, there were 10 sightings of bowheads (approximately 40 whales) in 2007, 56 sightings (approximately 163 whales) in 2008, and 25 sightings (approximately 52 whales) in 2009. In 2007, nearly all the bowheads appeared to be feeding as indicated by mud plumes and multiple swim directions; however, aerial observers could recognize feeding activity in only 4 of the 56 bowhead sightings in 2008 and 5 of the 25 sightings in 2009. Examination of the photographs will provide more precise records of how many whales were feeding as evidenced by mud on the body, open mouths, and the presence of feces. "Traveling" was the most commonly recorded behavior, indicating that bowheads were most likely migrating through the study area. Most of the bowhead sightings were along a coastal tangent marked by the 20-m isobath (an estimated 85% (77 of 91) of the sightings were in water between 10 and 35 m deep or along a projection of this line to the west).

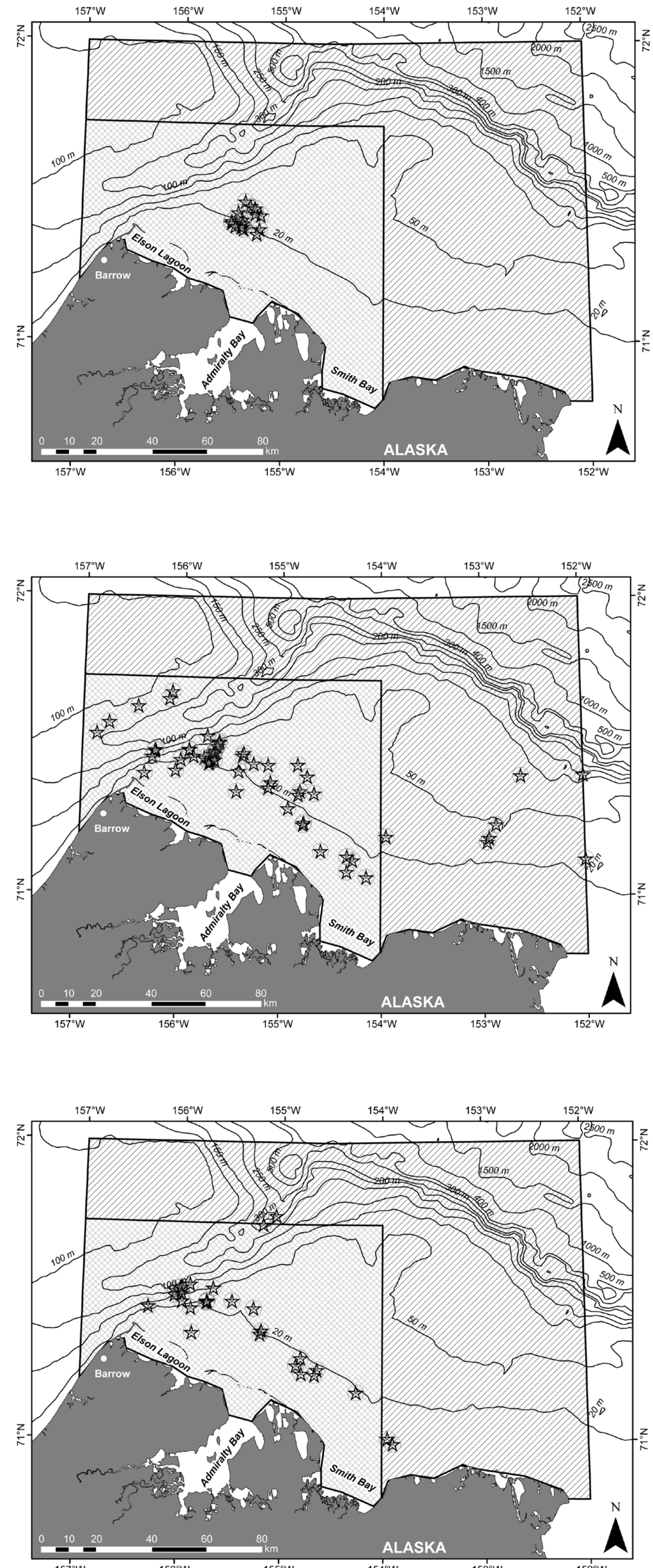

Figure 2. Sightings of bowhead whales near Barrow, Alaska, in 2007, 2008, and 2009 during aerial surveys to study the whales' feeding ecology. The inner (more intensely covered) survey area is indicated with crosshatchings; the outer (less surveyed) area is indicated by diagonal lines.

Results of this research program show that in late summer (mid-August to mid-September), bowheads are generally on a westward feeding migration through the study area, predominately along the 20-m isobath, and that most of the whales near Barrow are feeding on krill. Prey densities increase on the shelf after upwelling, favorable east winds are followed by weak or southerly winds. This “krill trap” likely contributes to the high proportion of feeding whales seen in this area. A good understanding of bowhead behavior and distribution, as exemplified by this study, is needed to minimize potential impacts from petroleum development activities, possible commercial fishing in the future, and the anticipated increase in vessel traffic associated with diminishing arctic sea ice.

By David Rugh and Julie Mocklin

Resource Assessment & Conservation Engineering (RACE) Division

GROUNDFISH ASSESSMENT PROGRAM

Tracking Red King Crab Seasonal Movements in the Eastern Bering Sea

In December 2009, a total of 135 adult male red king crab (*Paralithodes camtschaticus*) were tagged with electronic archival tags and released in the eastern Bering Sea for the purpose of tracking their seasonal migrations. The tagging was conducted off the fishing vessel *Arctic Fury* which was chartered for the 1-week period immediately following the 2009 commercial red king crab fishery. The archival tags were programmed to collect measurements of depth at 1-minute intervals and temperature at 30-minute intervals. Archival tags were attached to traditional spaghetti tags which were looped though the isthmus muscle of the crab (Fig. 1). The isthmus tagging procedure on red king crab has been utilized by the Alaska Department of Fish and Game (ADF&G) for more than 30 years to allow for tag retention through the molting stage. Tag returns are expected when the commercial crab fishery begins again in fall/winter of 2010.

This cooperative project is designed to resolve an important question relevant to the management of red king crab. Male red king crab perform seasonal migrations in Bristol Bay that extend from offshore feeding areas occupied in summer and fall to relatively shallow, inshore mating areas occupied in spring. It is currently unknown, however, whether all mature males participate in this migration or just males that will not molt (“skip-molt males”). This distinction is important because a primary strategy for managing the commercial fishery is to adjust the harvest rate to preserve a sufficient number of males to mate all mature females, based on the assumption that all mature males participate in mating each year. We intend to test this assumption by determining the annual migratory trajectories of both individuals that are likely to molt (old shell) and those that are unlikely to molt (new shell).

Figure 1. A red king crab with an attached archival tag that will collect depth and temperature data. Photo by Jan Haaga.

Migration trajectories will be constructed from daily position estimates which, in turn, will be obtained from depth data collected by the archival tags. Since red king crab always stay in contact with the bottom, the depth data include a record of tidal height fluctuations which spatially vary in amplitude and timing throughout Bristol Bay. Daily positions will be determined by comparing the records of tag depth to tide heights predicted by a tidal simulation model for elements of a spatial grid in a process known as tidal pattern matching. Migration trajectories will then be constructed from the daily positions using cubic-spline smoothing. The comparison of migratory tracks between old- and new-shell males should indicate whether or not all males participate in the breeding migration.

By Dan Nichol and Dave Somerton

Groundfish Systematics

James Orr and Duane Stevenson are continuing and expanding their work on the taxonomy and systematics of fishes. Their most recent work involves several families of fishes including skates, snailfishes, rockfishes, sand lance, eelpouts, and manefishes (Fig. 2) . With Jerry Hoff, Ingrid Spies, and John McEachran (Texas A&M University), their skate work has continued with a taxonomic revision of a group of four species that range across the North Pacific Ocean, including the Alaska skate and a new species from the western Aleutian Islands. The species all were identified using both morphological and molecular data. Orr and Stevenson both participated in annual meetings of the American Society of Ichthyologists and Herpetologists and the Gilbert Ichthyological Society, where they presented papers on new species of snailfishes, reproductive parasitism between snailfishes and king crabs, the ecology of deepwater eelpouts, and the identification of skates by fisheries observers in Alaska. Both will also participate in a workshop with other experts from around the world on the biodiversity of deep-sea fishes at Harvard’s Museum of Comparative Zoology this spring.

Orr’s research on snailfishes continues with the submission of a manuscript on two new species of *Paraliparis* (Fig. 3), with Zach Baldwin, formerly a University of Washington (UW) undergraduate intern; the descriptions of new species of *Careproctus*, including one of the most commonly found species in the Bering Sea, based on morphology and genetics,

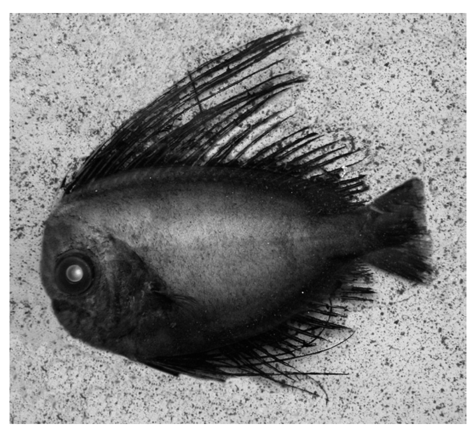

Figure 2. The bigmouth manefish (*Caristius macropus*), found in the mesopelagic waters of the Bering Sea and Gulf of Alaska, is the subject of an ongoing taxonomic revision. Photo by David Csepp.

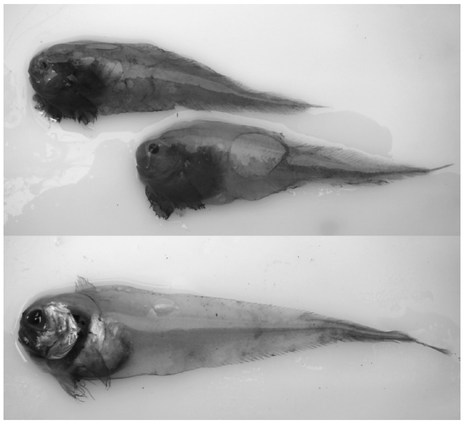

Figure 3. The pectoral snailfish (*Paraliparis pectoralis)* (top two), and the broadfin snailfish (*P. ulochir*) (bottom), two species of Bering Sea snailfishes used in a comparative study of the neuro-sensory anatomy of snailfishes from the Antarctic and subarctic regions. Photos by Jay Orr.

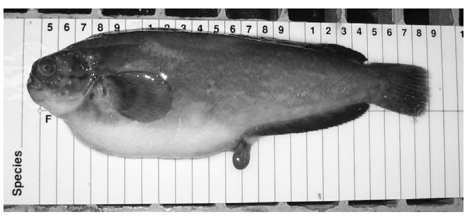

Figure 4. Osteological characteristics of the prowfish (*Zaprora silenus*) may provide information on the evolutionary history of eelpouts, pricklebacks, ronquils, and other fishes. Photo by Raul Ramirez.

with Yoshiaki Kai (Kyoto University); and the publication of a study of the nervous and sensory systems of *Paraliparis* with Mike Lanoo (Indiana University) and Joe Eastman (Ohio University). Also underway is molecular research on the snailfish species parasitizing king crabs, with Amelia Whitcomb, Dave Somerton, and Stevenson. Forrest Bowers (ADF&G) generously assisted by collecting snailfish eggs at a Dutch Harbor crab processing plant. Orr's work with Sharon Hawkins of Auke Bay Laboratories on *Sebastes melanostictus* and *S. aleutianus* (the blackspotted and rougheye rockfishes) was published, and the results of the work are being applied in the development of efficient at-sea methods of distinguishing the two species. Also, with Hawkins, Kai, and Katugin (VINRO, Russia), Orr is examining the morphology and genetics of sand lance across the North Pacific, where at least one additional species will be recognized. Following the completion of a morphological assessment of the relationships of deep-sea anglerfishes, with senior author Ted Pietsch (UW), Orr participated with him in a molecular assessment led by Misaki Miya of Japan, which is now in press.

Stevenson's most recent research on eelpouts has focused on a clarification of the *Lycodes diapterus* species complex, in collaboration with Boris Sheiko (Russian Academy of Sciences, St. Petersburg). His earlier revision of the eelpout genus *Bothrocara* has led to an examination of the distribution, growth, and food habits of the two common species of *Bothrocara* in the Bering Sea, in collaboration with Rick Hibpshman, now in press. His participation in midwater surveys of the northern Gulf of Alaska has resulted in the publication of several species range extensions as well as a paper on the distribution and abundance of midwater fishes in the region with AFSC scientist Nate Raring (currently in review). Stevenson's work on a worldwide revision of the family Caristiidae, with Chris Kenaley (UW), Karsten Hartel (Harvard University), and Ralf Britz (British Museum of Natural History) is progressing, and will include descriptions of several new species. He has also just finished an examination of skate bycatch in the groundfish fisheries of Alaska, along with Kristy Lewis (FMA Division), currently in press, and begun an investigation on the osteology and development of the prowfish (*Zaprora silenus*) (Fig. 4) along with Eric Hilton (Virginia Institute of Marine Science).

By Jay Orr

Habitat Research Group Takes Delivery of Two Long-Range Sidescan Sonar Systems

The broad scope of the Congressional essential fish habitat (EFH) mandate requires an efficient process for describing and mapping the habitat needs of all Federally managed species. In 2004, the Government awarded a $3.6 million contract to L-3 Klein Associates, Salem, New Hampshire, for two long-range sidescan sonar systems (LRSSS) for fisheries research. These prototypes are capable of very broad coverage at high speeds, as compared to conventional towed systems. This capability increases the area of seabed that can be mapped per survey day, thereby improving vessel productivity.

The LRSSS is a towed underwater platform (towfish) with multiple acoustic, environmental, and navigational sensors which, combined with topside processing electronics, efficiently collects, processes, and archives quantitative data to characterize the seabed for EFH research. The subsurface unit (SSU) generates coregistered, high-resolution, dynamically focused multibeam sidescan imagery, multibeam echosounder bathymetry, and 38 kHz single-beam echosounder data. Auxiliary sensors provide full attitude instrumentation and continuously monitor towfish altitude, depth, and speed over ground; water temperature; sound speed; and the concentrations of dissolved organics, chlorophyll-a, and total particulates in the tow path. The SSU is also configurable for hull-mounted operations,

John Roscigno, L-3 Ocean Systems Director of Advanced Programs, and FISHPAC chief scientist Bob McConnaughey during the final inspection of two long-range sidescan sonar systems at the L-3 facility in Sylmar, California. Photo by Mike Webb.

such as may be required for use in shallow water. The topside subsystems coordinate manipulation, storage, and display of raw and processed data, while also supporting operator control of towfish pitch, roll, and angle of attack when under way. Specialized software developed for the project geocodes and merges the backscatter and bathymetry data, normalizes backscatter data across the swath by correcting for radiometric and geometric effects, then generates 20 different summary statistics and full-swath mosaics of the data for operator-specified grids of the seafloor.

Delivery of the two systems was originally scheduled for February 2006, but was delayed until December 2009 because of technical difficulties affecting key performance requirements. Several major design changes occurred, and over 250 individual tests and inspection procedures were performed in the factory and at sea to characterize the LRSSS prior to delivery. The NOAA project team, consisting of Lloyd Huff (University of New Hampshire Center for Coastal and Ocean Mapping), Bob McConnaughey (AFSC) and Mike Webb (NOAA Marine Operations Center – Pacific), worked closely with the manufacturer and the NOAA contracting officer to complete the procurement.

Immediate plans include formal training in LRSSS operation and post-acquisition processing methods to be provided by the manufacturer. Sea trials will be conducted in local waters, and miscellaneous system improvements will be completed during 2010 in preparation for an integrated ocean mapping cruise in the eastern Bering Sea (EBS).

This FISHPAC-project cruise will 1) investigate the utility of acoustic backscatter for characterizing the EFH using a variety of sonar systems (including the LRSSS), 2) determine the most cost-effective sonar methodology for large-scale mapping of EFH in the EBS, 3) evaluate the mechanism of association between groundfish and surficial sediments, and 4) provide hydrographic-quality bathymetry data to the NOAA Pacific Hydrographic Branch for updating nautical charts in areas with outdated or nonexistent information.

By Bob McConnaughey

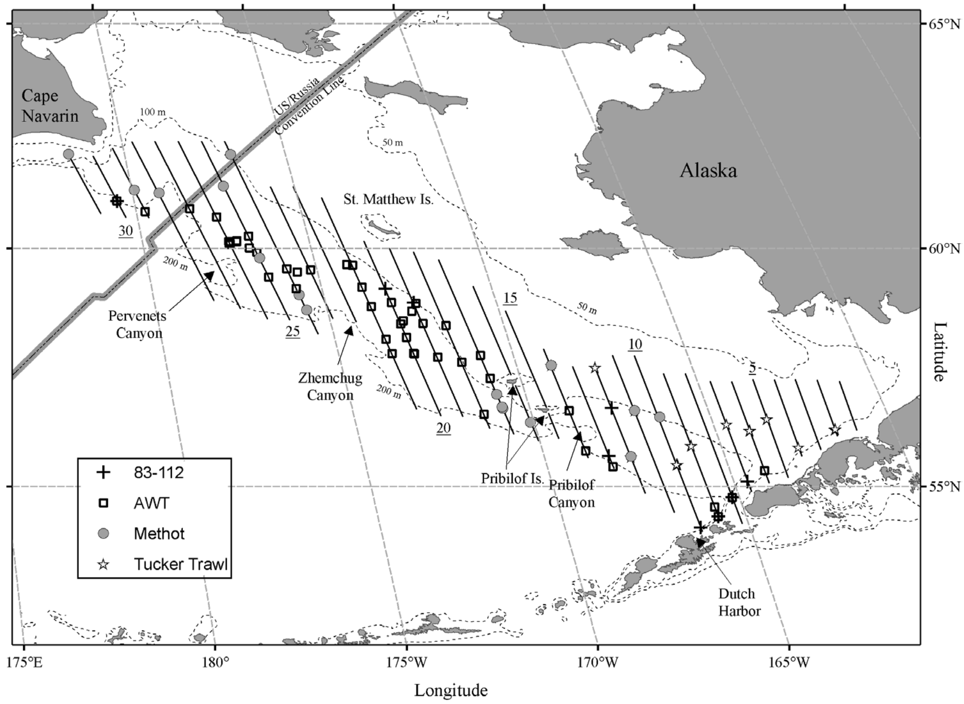

Figure 5. Transect lines with locations of midwater (Aleutian wing trawl (AWT), and Methot trawls), bottom trawls (83-112), and Tucker trawls during the summer 2009 echo integration-trawl survey of walleye pollock on the Bering Sea shelf. Transect numbers are underlined.

MIDWATER ASSESSMENT & CONSERVATION ENGINEERING PROGRAM

Echo Integration-Trawl Survey of Walleye Pollock in the Eastern Bering Sea

Midwater Assessment & Conservation Engineering Program (MACE) MACE scientists completed an echo integration-trawl (EIT) survey of walleye pollock (*Theragra chalcogramma*) on the eastern Bering Sea shelf between 9 June and 7 August aboard the NOAA ship *Oscar Dyson*. The main purpose of the survey, which has been conducted since 1979, was to estimate the midwater abundance of walleye pollock.

The 2009 survey was conducted westward from Bristol Bay, Alaska, to the Cape Navarin region of Russia along north-south transects spaced at 20 nautical miles (nmi) apart (Fig. 5). During daylight hours, acoustic backscatter data were collected along transects at five individual echosounder frequencies (18, 38, 70, 120, and 200 kHz). Opportunistic midwater and bottom trawls were conducted to classify the backscatter attributed to walleye pollock and other organisms. Physical oceanographic data were also collected. Walleye pollock abundance estimates were based on the area scattering detected at 38 kHz. Nighttime activities included collection of additional physical oceanographic data and trawl hauls, and work with other specialized sampling devices (e.g., a lowered echosounding system to measure target strength, and the Simrad ME-70 multibeam sonar to characterize the seafloor and describe small-scale spatial patterns of the dominant scatterers). Additional sampling in support of the Bering Sea Integrated Ecosystem Research Program (BSIERP) included conductivity-temeperature-depth (CTD) casts with fluorometer and oxygen samples, XBT casts, and underway water sample collections (salinity, chlorophyll fluorescence, oxygen, nutrients) to calibrate the shipboard seawater monitoring system. Daytime Methot and Tucker trawl hauls were also conducted to assess the density of Bering Sea euphausiids in midwater and where acoustic estimates were not possible near the seafloor and sea surface. Protocols were developed to measure lengths of euphausiid individuals at sea using a dissecting scope and a modified flatbed scanner.

Temperature profile measurements indicated that 2009 was another cold summer. The range of ocean surface temperatures observed in 2009 (0.9°-8.9°C) was similar to that observed in 2008 (0.7°-8.3°C), and colder than that observed in 2007 (2.0°-10.9°C). Bottom temperatures

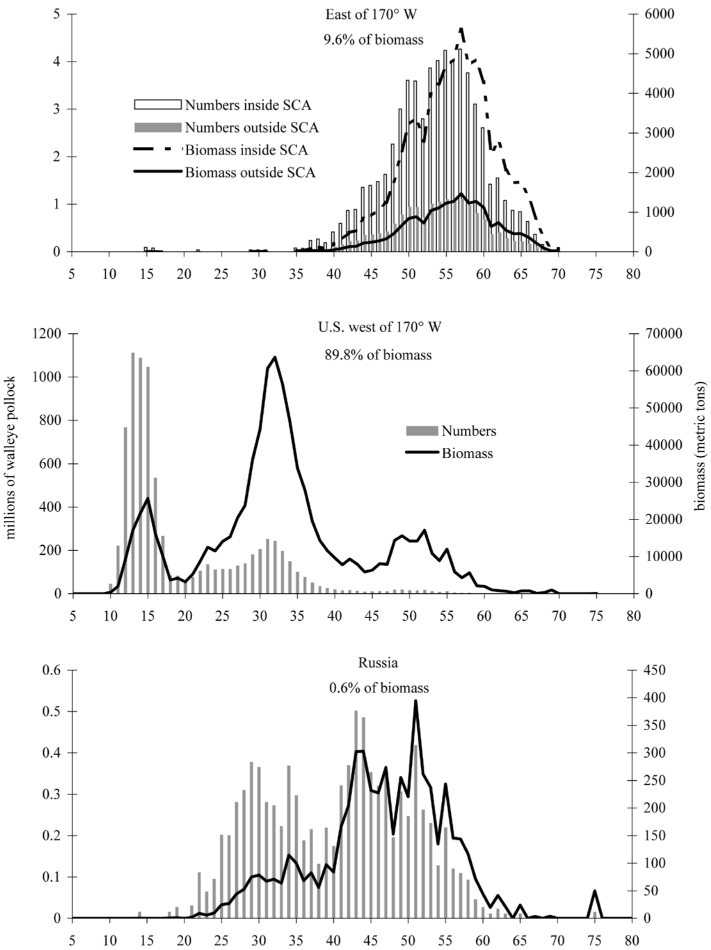

Figure 6. Population numbers and biomass at length estimated for walleye pollock between 16 m from the surface and 3 m off the bottom from the summer Bering Sea shelf acoustic-trawl survey in three geographic regions.

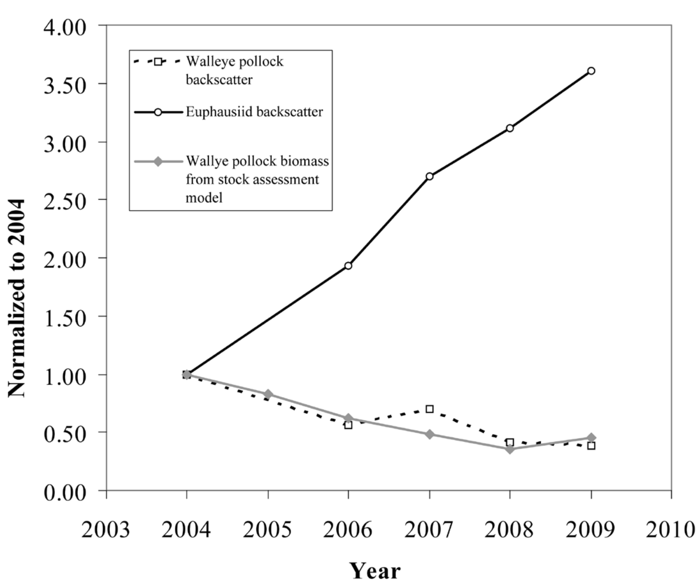

Figure 7. Bering Sea summer euphausiid backscatter at 120 kHz and walleye pollock backscatter at 38 kHz from the EIT 2004-09 surveys. Age 3+ walleye pollock biomass estimated by the stock assessment model (SAFE Table 1.22, December 2009). Each time series has been normalized to its value in 2004. The 2009 results are preliminary.

were coldest on the inner shelf north of St. Matthew Island to about 178°W, and warmest just north of Unimak Island.

Catch composition for midwater and bottom hauls indicated that walleye pollock was the most abundant fish species captured by weight. The next most abundant fish species was Pacific ocean perch (*Sebastes alutus*), which were primarily captured in two hauls, one near Akutan Island and one on the east edge of Pribilof Canyon.

Walleye pollock were largely concentrated west of 170°W in U.S. waters (Fig. 5). Estimated walleye pollock abundance (to within 3 m of bottom) was relatively low compared to 2008 and prior surveys. The 2009 biomass in the U.S. EEZ (Exclusive Economic Zone) was 0.924 million metric tons (t); the estimated 2008 biomass was 0.997 million t, and the 2007 biomass was 1.77 million t. The estimated pollock biomass in Russia was 0.005 million t, which represented only 0.6% of the total surveyed biomass. In 2008 about 3% and in 2007 about 6% of the total midwater biomass was in Russia.

Walleye pollock fork length (FL) composition differed by geographic area (Fig. 6). Fish between 35 and 70 cm with few smaller juveniles composed the biomass east of 170° (9.6% of total biomass). Pollock <19 cm FL (age-1 or 2008 year class) and 19-38 cm FL (ages 2-3) were the most numerous west of 170°W (89.8% of total biomass). The walleye pollock length composition for the fish observed in Russia ranged from 13 to 75 cm, but the majority of fish were between 20 and 60 cm.

An index of euphausiid abundance for the Bering Sea shelf for summers 2004-09 was generated from EIT survey backscatter at four frequencies (18, 38, 120, and 200 kHz) and from Methot trawl data (Fig. 7). The time series show that euphausiid backscatter has increased more than three-fold whereas declines were seen in both the midwater (EIT) walleye pollock backscatter and the age 3+ pollock biomass estimated by the stock assessment model. These euphausiid (prey) and pollock (predator) abundance trends may be related, or they may be independent responses to changes in environmental conditions.

Size and shape descriptors for juvenile walleye pollock aggregations (depth, height, width, surface area, volume, and the ratio of surface area to volume) were examined using the multibeam data. These data were analyzed as a function of fish lengths representing ages 1-, 2-, and 3-year olds. Preliminary results show that age-1 pollock formed the shallowest schools, and mixed age groups exhibited the most variation in school structure.

By Taina Honkalehto

KODIAK LABORATORY

Gulf of Alaska Small-mesh Trawl Survey, 2009

The annual small mesh trawl survey for shrimp and forage fish was conducted jointly by scientists from the RACE Division and the ADF&G in October 2009. The ADF&G research vessel *Resolution* conducted 134 tows which focused on the bays around Kodiak Island and also bays along the Alaska Peninsula including Pavlof Bay (Fig. 8).

The October 2009 survey was the most recent example of collaborative shrimp research by the two agencies dating back to 1971. Prior to 1971, the AFSC conducted exploratory shrimp surveys throughout the Gulf of Alaska and eastern Aleutian Islands.

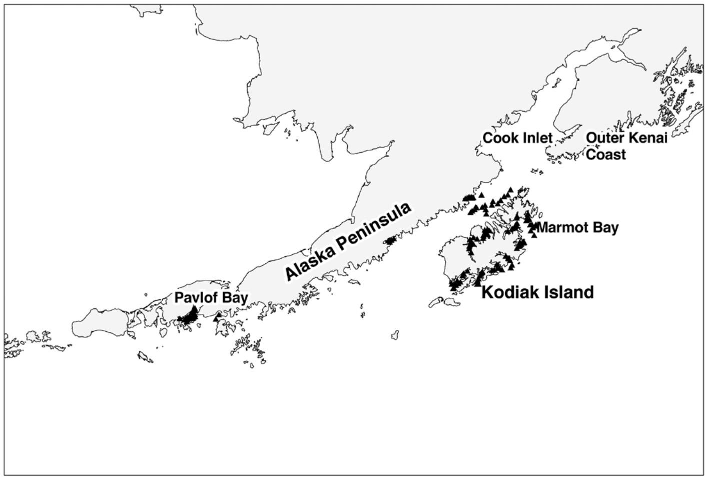

Figure 8. Haul locations (triangles) in the central and western Gulf of Alaska showing haul locations from the 2009 small mesh survey.

As a result of those surveys, a major shrimp fishery developed in the 1970s, and the ADF&G then became actively involved in small mesh surveys as well. With the subsequent decline of the fishery in the 1980s, survey efforts declined; the RACE Division limited its survey efforts to Pavlof Bay, while the ADF&G continued surveys in Prince William Sound, Kodiak, and the Gulf of Alaska as far west as the Shumagin Islands. Currently, the RACE Division has withdrawn from directly conducting small mesh surveys but supports ADF&G surveys with personnel and financial support.

The length of the small-mesh time series makes it an important source of information on the changes to the marine ecosystem that have occurred in the North Pacific. For example, the time series was instrumental in documenting the transition from a community rich in shrimp and capelin to a community rich in groundfish following the 1976-77 regime shift tied to the Pacific Decadal Oscillation (PDO). Results showed declining capelin (*Mallotus villosus*) and pink shrimp (*Pandalus borealis*) catch per unit effort (CPUE) and increases in arrowtooth flounder (*Atheresthes stomias*) and Pacific cod (*Gadus macrocephalus*) CPUE following the regime shift. In most parts of the survey area, results of the 2009 survey found these basic trends continued.

This community shift is perhaps best illustrated by the catch time series from Pavlof Bay on the south coast of the Alaska Peninsula (Fig. 9), the most consistently sampled bay in the survey area. The 2009 survey in Pavlof showed little change in the overall composition of the post-regime shift community where pink shrimp and capelin remain at low levels and flatfish and cod playing a predominant role in the marine community. The long-term response to the 1976-77 regime shift, however, has not been uniform across the surveyed region. The CPUE trends from Inner Marmot Bay on the northeast Kodiak archipelago are quite different from those found in Pavlof Bay (Fig. 9). Both bays saw dramatic shifts in community composition following the 1976-77 PDO regime shift, but in Marmot Bay shrimp catch rates stabilized at a much higher level (CPUE in 2009 of 12.5 kg km^{-1}) compared to Pavlof Bay where CPUE has remained at historically low levels (CPUE in 2009 of 3.8 kg km^{-1}). The reason for the differences in community organization between these two bays is poorly understood but may relate to bathymetry differences. Pavlof Bay is generally shallower and warmer than Inner Marmot Bay.

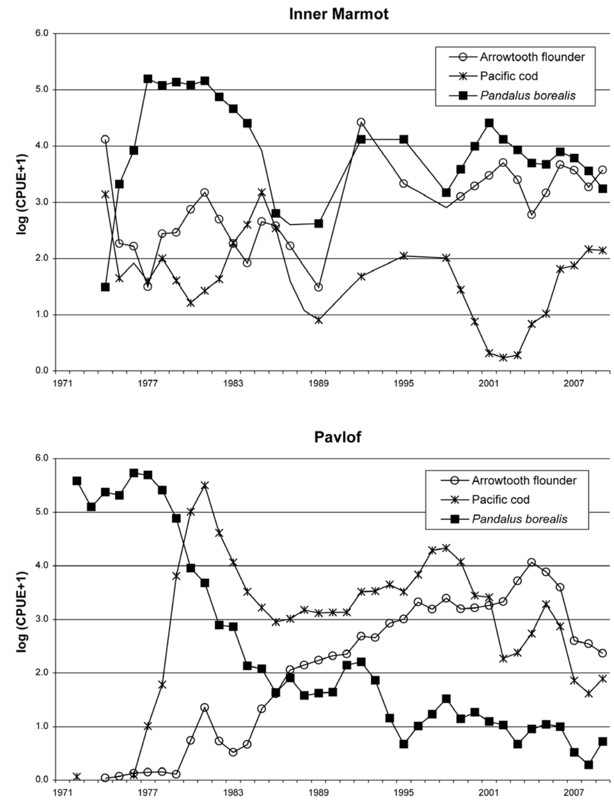

Figure 9. Catch trends (3 year running average) of arrowtooth flounder, Pacific cod and northern shrimp (*Pandalus borealis)* from Inner Marmot Bay near Kodiak and Pavlof Bay on the south coast of the Alaska Peninsula in the western Gulf of Alaska.

Figure 10. Aaren Ellsworth, Sherry Barker, and Colin Hakkinson sort the shrimp catch on board the ADF&G research vessel *Resolution*. The white bin contains juvenile walleye pollock. Photo by Dan Urban.

Also of note, the 2009 survey saw an approximately 30% increase in flathead sole and arrowtooth flounder in the bays around Kodiak compared to the 2007 survey which also targeted those bays. At the same time, some hauls contained over 50% pandalid shrimp, something not seen in recent years (Fig. 10). The smooth pink shrimp (*P. jordani*), a lower-latitude species which had been widespread in the past several small mesh surveys, virtually disappeared from the catch in 2009. The low catch rate may be in response to cooler water temperatures recorded recently.

Future work for the small mesh survey project includes completion of metadata for the 200-plus surveys in the database, the real-time integration of the ADF&G and AFSC databases including survey data from Cook Inlet and the outer Kenai coast not currently part of the dataset, and the inclusion of data recovered through a NOAA grant.

By Dan Urban

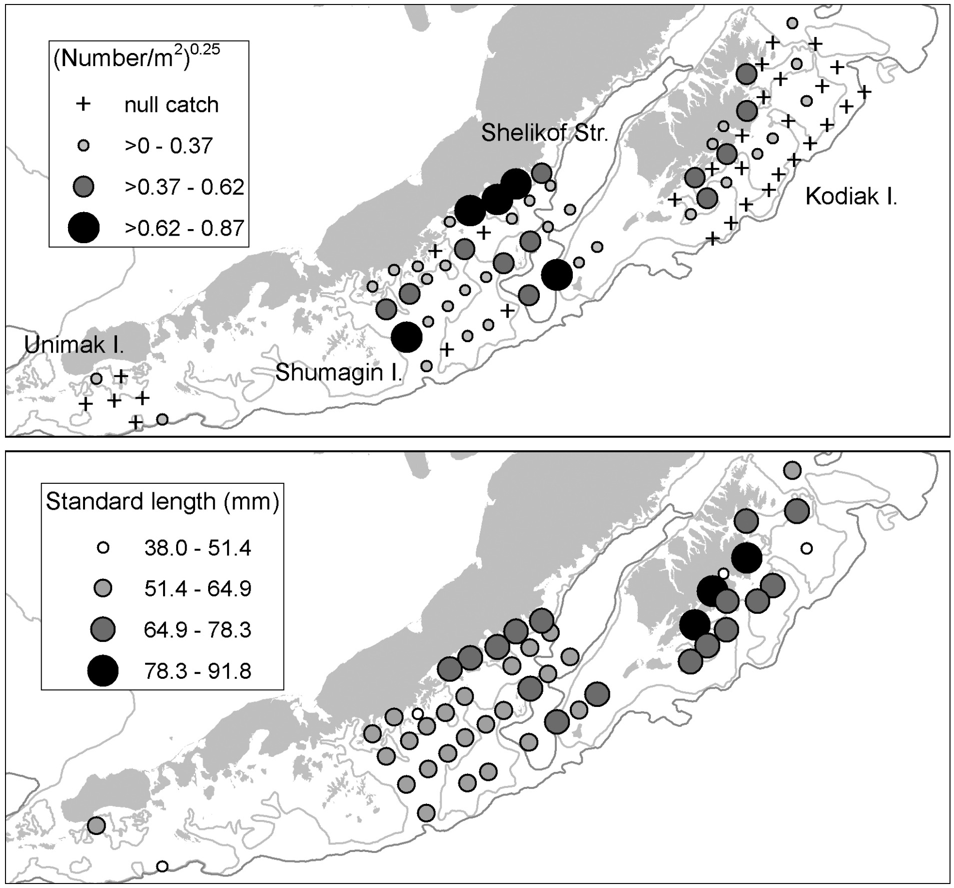

Figure 11. Standardized, power-transformed abundance (top) and mean standard length (bottom) of age-0 walleye pollock in the western Gulf of Alaska during late summer 2009.

RECRUITMENT PROCESSES PROGRAM

Age-0 Walleye Pollock EcoFOCI Late-Summer Survey, Gulf of Alaska

Scientists from the Recruitment Processes Program studied age-0 walleye pollock in the Gulf of Alaska during late summer 2009 aboard the NOAA ship *Miller Freeman*. Predetermined midwater collection sites formed grids over the continental shelf near Kodiak Island and between Shelikof Strait and the Shumagin Islands; additional prospective sampling occurred at seven sites near Unimak Island (Fig. 11). The cruise objective was to obtain a third year (2005, 2007, 2009) of data for comparing the food availability and food quality for age-0 walleye pollock in the Kodiak and Shelikof-Shumagin regions. A secondary objective was to extend a time series of age-0 walleye pollock abundance at index sites within the Shelikof-Shumagin area.

A total of 7,807 age-0 walleye pollock were collected at 48 of the 79 sites (61% frequency of occurrence, FO). The standard length of all measured individuals (30 – 113 mm) averaged 68 mm. Highest abundances occurred at northeastern and near-shore sites within the Shelikof-Shumagin area (89% FO) (Fig. 11, top). Preliminary mean abundance at index sites was higher in 2009 than in 2001 and 2003, but lower than in 2000, 2005, and 2007. Within the Kodiak Island nursery (39% FO), most fish were collected near shore. Few fish were collected near Unimak Island (29% FO). On average, the largest age-0 walleye pollock were collected near Kodiak Island in the upper reaches of Chiniak and Barnabus sea valleys; from there, mean length decreased offshore and southwestward (Fig. 11, bottom). Fish stomach contents are currently being examined and will be compared to the density and taxonomic composition in zooplankton samples.

By Matt Wilson

2009 RUSALCA Chukchi Sea Cruise

The 2009 Russian American Long Term Census of the Arctic (RUSALCA) took place from 22 August to 30 September beginning and ending in Nome, Alaska, aboard the Russian research vessel *Professor Khromov* (Fig. 12) The RUSALCA Program is a result of a 2003 memorandum of understanding for World Ocean and Polar Regions Studies between NOAA and the Russian Academy of Sciences. The NOAA Arctic Research Office and Ocean Explorer Program are the primary contributors of funding and logistic support. The first cruise was conducted in 2004.

The 2009 cruise was divided into two legs. On the first leg, 22-31 August, eight oceanographic moorings were replaced extending across the Bering Strait from the United States to Russia. The second leg, 3-30 September, was a multidisciplinary research cruise carrying approximately 45 scientists from the United States, Russia, and South Korea. The following data or samples were collected: CTD, ocean currents, nutrient pathways, sediments, side-scan sonar (seafloor mapping), remotely operated vehicle (ROV) video, epibenthic invertebrates and infauna, zooplankton, ichthyoplankton, and juvenile and adult demersal fishes. In addition, a special study was added after the cruise began to examine seafloor flux of methane from thawing sub-sea permafrost.

Two field teams assessed arctic fishes using three gear types. The Fish Ecology Project Team was composed of Brenda Holladay and Christy Gleason (University of Alaska, Fairbanks), and Morgan Busby (AFSC) (Fig. 13). We used a 60-cm 505 mesh bongo net to collect ichthyoplankton (planktonic fish eggs and larvae) and a small mesh bottom trawl (3-m plumb-staff beam trawl) to collect juvenile and small adult demersal fishes. The beam trawl collected 10,323 fish, with at least 41 species represented. The bongo was towed at 31

Figure 12. The Russian research vessel *Professor Khromov* at sea. Image courtesy of 2009 RUSALCA Expedition, RAS-NOAA.

Figure 13. Fish Ecology Team: Brenda Holladay (left), Morgan Busby (center), Christy Gleason (right). Image courtesy of 2009 RUSALCA Expedition, RAS-NOAA.

stations. The beam trawl was deployed at 22 of the biological stations. Catherine (Kitty) Mecklenburg (California Academy of Sciences) and Natalia Chernova (Zoological Institute, St. Petersburg, Russia) composed the Fish Diversity (Adult) Fish Team which was assisted by the Fish Ecology Team. They deployed an otter trawl net at 26 stations collecting 11,578 fish, with more than 46 species represented.

Additional information and images can be found on the web at http://oceanexplorer.noaa.gov/explorations/09arctic/welcome.html

By Morgan Busby

Resource Ecology & Fisheries Management (REFM) Division

RESOURCE ECOLOGY AND ECOSYSTEM MODELING PROGRAM

Fish Stomach Collection and Lab Analysis

During the fourth quarter of 2009, fisheries observers collected 709 stomach samples from the eastern Bering Sea. In the laboratory, Resource Ecology and Ecosystem Modeling (REEM) Program staff analyzed stomach samples from 6 predator species from the eastern Bering Sea (n = 583), 3 predator species from the Aleutian Islands (n = 29), and 16 predator species from the Gulf of Alaska (n = 1,125). In total, 4,077 records were added to the REEM food habits database.

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

Ecosystem Indicators

REEM staff completed the Ecosystem Considerations appendix to the stock assessment and fisheries evaluation (SAFE) report to the North Pacific Fishery Management Council (NPFMC) and presented the appendix to the NPFMC Bering Sea/Aleutian Islands and Gulf of Alaska Plan Teams, the Scientific and Statistical Committee, and the Advisory Panel. For this year's report, updates were made to 40 indicators, and two new contributions were added. One new contribution focused on quantifying the area disturbed by trawl fishing gear in the eastern Bering Sea (Fig. 1). This analysis showed that the maximum total area of seafloor potentially disturbed by trawls varied around 120,000 km^2 in the early 1990s and decreased in the late 1990s to approximately 90,000 km^2. The area disturbed remained relatively stable in the 2000s with a slight increase in 2007-08. The second new contribution described the spatial distribution of groundfish stocks in the eastern Bering Sea. The authors demonstrated that both the latitudinal and depth distribution of the demersal community on the eastern Bering Sea shelf have shown clear directional trends over the last three decades, indicating significant distributional shifts to the north and into shallower waters. Although the average distribution shifted slightly south after the very warm years of 2004-05, there was little evidence that recent cold temperatures in 2006-08 have led to a commensurate reversal of the long-term northward shifts.

By Stephani Zador

Ecosystem Modeling

This year REEM staff added information of fish guilds to the Ecosystem Considerations appendix section of the SAFE report to the NPFMC. The status and trends of eastern Bering Sea (EBS) and Gulf of Alaska (GOA) feeding guilds were analyzed by incorporating current stock assessment and survey results within the framework of existing food web models. EBS biomass trends were

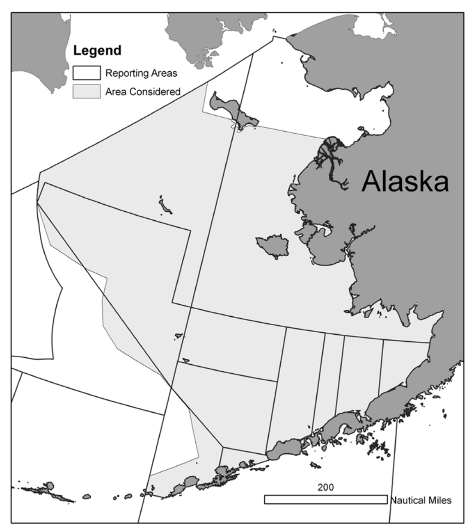

Figure 1. Map of eastern Bering Sea area considered when estimating percent area potentially disturbed by trawl fishing gear.

summed stock assessment model estimates or scaled survey data, where available, for each species within the guild. If neither time series were available, the species was assumed to have a constant biomass equal to the mid-1990s estimated levels.

The GOA ecosystem model was forced by stock assessment model estimates where available for each species within the guild and fit to survey time series, catch data, groundfish diet data, and the mid-1990s mass balance for all other species. Current EBS status (2004-09) mean biomass, catch, and exploitation rates have been within +/- one standard deviation of 1977-2009 levels for all guilds except pelagic foragers (biomass below mean, exploitation rate above mean) and structural epifauna (biomass above mean). Apex predators and pelagic foragers had decreasing trends in biomass, catch, and exploitation rates, while benthic foragers had increasing catch and exploitation rate trends. The apex predator trends were driven largely by a decrease in Pacific cod biomass and catch. The pelagic foragers guild was dominated by walleye pollock (77% of guild biomass in 2009), whose decrease with general declines in other forage species has brought the biomass of this group to overall low levels. Exploitation rate was over one standard deviation above the mean from 2004-07, however the decreased catches in 2008 and 2009 have decreased the pelagic foragers exploitation rate back towards its long-term mean. Increasing trends in benthic forager catch and exploitation rate reflect increased allowable biological catches (ABCs) for flatfish species allowable under the 2.0 million metric ton (t) optimum yield cap with decreased pollock ABCs.

Current GOA mean biomass was more than one standard deviation above 1977-2009 mean levels for apex predators and benthic foragers, and the biomass trend is increasing for benthic foragers. The apex predator guild was driven by the stock assessment-estimated high biomass of arrowtooth flounder, and to a lesser extent for Pacific halibut and Pacific cod, while the benthic forager guild was driven by a stock assessment-estimated increase in flathead sole and survey trends for increasing skates and flatfish. In contrast, pelagic foragers recent mean biomass is nearly one standard deviation below the long-term mean, driven by the stock assessment estimated decline in pollock. Catch for pelagic foragers remains within one standard deviation of the long-term mean, while exploitation rates have trended down. GOA shrimp are above long-term mean biomass, due to a long-term trend, which agrees with trawl survey results.

By Sarah Gaichas and Kerim Aydin

Figure 2. Stomach contents from a Northern Fulmar including plastic fragments, nurdles, rocks, squid beaks, and seed pod. Photo courtesy of Hannah Nevins, Oikonos.

Figure 3. Sorting out all of the plastic fragments ingested by a Northern Fulmar. Photo courtesy of Hannah Nevins, Oikonos.

Seabird Coordinated Studies

The Seabird Coordinated Studies group, in partnership with fisheries observers, the Fisheries Monitoring and Analysis (FMA) Division and the nonprofit group Oikonos, for several years has been involved with salvaging seabirds caught as bycatch in Alaska groundfish fisheries, sending them to a necropsy lab, and then having the stomach contents analyzed for food habits (Fig. 2) and plastics (Fig. 3). Preliminary examination of 30 albatross (19 Laysan and 11 Black-footed) and 43 Northern Fulmars has been accomplished to date. We've found much more natural prey in the stomachs than had been expected for bycaught birds. In addition, food items introduced by the fishery also appear to be readily identifiable. This will allow for important information to be gained on the natural feeding strategy of these birds in the region. The Bering Sea albatross samples will provide information from an oceanic region not previously represented. Most comprehensive North Pacific albatross diet studies, utilizing stomach samples, are based on samples collected during the breeding season from the Hawaiian Archipelago or from bycaught birds taken in the North Pacific Transition Zone. Examination of the northern fulmar samples also reveals more natural prey than anticipated. Northern Fulmars make up the majority of bycaught birds in the Bering Sea region. The large sample size of birds returned by observers should ultimately allow for a detailed study of potential regional and seasonal variations in the natural diet of this species.

By Shannon Fitzgerald

ECONOMICS & SOCIAL SCIENCES RESEARCH PROGRAM

Developing a Multiregional Computable General Equilibrium Model (MRCGE) for Alaska and West Coast Fisheries

Many of the vessels operating in Alaska fisheries are owned and crewed by residents of West Coast states, especially Washington and Oregon. Some of these vessels also participate in West Coast fisheries during the year. Expenditures made by these vessels generate income in port and may also have multiplier and spillover effects in other regions. If one assumes that all expenditures made by vessels from a given region are made locally, one will significantly overestimate economic impacts associated with a fishery. Taking account of the regional distribution of actual expenditures made by fishing vessels in Alaska, West Coast states, and elsewhere will enhance our ability to model the overall economic impacts of Alaska fisheries and West Coast fisheries. The major task under this project is constructing a Multiregional Computable General Equilibrium Model (MRCGE) of the Alaska and West Coast economies with explicit detail of the two regions' fishery sectors. The investigators will use IMPLAN (a regional economics model) and data available from the Alaska Department of Labor and Workforce Development to estimate the interregional flows of goods, services, and factors of production. The core of the MRCGE will consist of a CGE model previously developed by the investigators for the Alaska region. Reports produced under that project provide detailed estimates of the interregional distribution of expenditures for intermediate goods and services made by Alaska-based vessels. These data will be combined with data currently being developed by the Northwest Fisheries Science Center (NWFSC) for the IO-PAC model of West Coast fishery sectors. IO-PAC is an IMPLAN-based regional input-output model that includes detailed, survey-based estimates of expenditures by West Coast fishing vessels.

To date the following tasks have been completed under the project. First, available regional data (a Social Accounting Matrix) associated with the Alaska CGE model was assembled. This data includes estimates of costs and interregional expenditures made by Alaska fishing vessels and processors for intermediate inputs and labor and will form the core of the Alaska portion of the MRCGE model. Second, we have prepared a preliminary version of the West Coast IO-PAC model from the NWFSC. IO-PAC is an IMPLAN-based IO model of the combined three-state West Coast region. Data from IO-PAC will be used to form the core of the West Coast portion of the MRCGE model. Third, we investigated whether the latest IMPLAN data (version 3) is compatible for pre-2007 IMPLAN data for the purposes of interregional trade flow estimation (finding that only post-2006 data can be used with version 3 for trade flow estimation). Fourth, we examined previous MRCGE models which will be modified to develop equations and GAMS codes for the present MRCGE project.

The next steps of the project include 1) developing a West Coast social accounting matrix; 2) developing a West Coast CGE; 3) estimating interregional flows of goods, services, and factors of production; and 4) developing an MRCGE by combining the two single-region CGEs and by incorporating the information on the interregional flows of goods and factors of production.

by Edward Waters, Chang Seung, and Jerry Leonard

Chinook Salmon Bycatch Economic Data Collection Program: Phase 1 Action

Final action was taken by the North Pacific Fishery Management Council (Council) in December on a new economic data collection program for the Bering Sea pollock fishery. After the Council passed Amendment 91 to the Bering Sea Aleutian Islands (BSAI) Fisheries Management Plan (FMP) in April to limit Chinook salmon bycatch by the pollock fishery, AFSC economists wrote a discussion paper on options for expanded economic data collection to better evaluate the impacts of Amendment 91. Over a series of Council, data collection, and public meetings in 2009, the components of the data collection program were revised and draft data collection forms were developed. At its October meeting, the Council clarified its purpose and need statement, requesting that the data collection program be split into two phases so that some elements of the collection program will be in place as soon as possible, but data collection can be expanded as appropriate after the features of the incentive plan agreement(s) (IPA) are presented to NMFS in late 2010.

The current data collection program will have several key components. First, the value and quantity of any compensated transfers of salmon bycatch (as well as the quantity of pollock transfers) will be reported to NMFS. Second, vessels will indicate when they are moving primarily because of salmon bycatch. Third, an annual skipper survey will be completed by vessel operators that will improve NMFS and the Council's understanding of the fleet's experience with salmon bycatch each season. Finally, vessels will report their fuel costs, which will allow improved understanding of the costs of different vessels moving to avoid salmon bycatch. Jointly, these data will provide an improved understanding of how Amendment 91 and any IPA developed impacts salmon bycatch in the pollock fishery.

By Alan Haynie

Plan Team Economics Workgroup

Following recommendations from the September 2009 Joint Groundfish Plan Team meeting at the AFSC, economists serving on all four of the NPFMC Plan Teams formed an ad hoc economics workgroup to develop and carry out initiatives for improving the incorporation of socioeconomic information and analyses in the plan team process. Economics & Social Sciences Research (ESSR) Program economists Mike Dalton, Brian Garber-Yonts, and Alan Haynie, in addition to NMFS Alaska Regional Office economist Scott Miller, Professor Joshua Greenberg of University of Alaska Fairbanks, and NPFMC staff member Jane DiCosimo make up the workgroup. The group met 13 November 2009 to identify and prioritize initiatives to be completed over the next year to most constructively contribute to the Plan Team process. Examples of planned workgroup initiatives for 2010 include:

Directly provide economic information important to the Plan Team process.

- Provide recommendations and supporting analyses to stock assessment authors to incorporate economic information from the Economic SAFE documents into species stock assessment chapters.

- Collaborate with stock assessment authors to incorporate information regarding key regulations (e.g., rationalization, area closures, whale predation, ABCs) and associated changes in fishing practices into stock assessments.

- Identify current trends in seafood markets/prices, processing and harvest sector consolidation, and permit or quota prices, where applicable and where information is available.

Refine methods for economic analysis to better inform the plan team process and other economic analysis done by the Region or Council.

- Conduct additional economic analysis and provide ongoing peer-review input for economic analyses for inclusion in the Economic SAFE reports.

- Provide peer review and discussion for the examination and consideration of economic methods for application to management problems.

- Provide a forum for the consideration of the role of non-economic social sciences in the Plan Team process.

Provide resources to help noneconomists on the plan team and elsewhere to better utilize and understand economic data in the Economic SAFE and other economic information that is commonly presented in the Council process.

- Write an overview of how to better understand the role of economics in the plan team process.

- Work with Plan Team and others to help ensure that fisheries managers have the knowledge and tools available to interpret economic data.

By Brian Garber-Yonts, Mike Dalton and Alan Haynie

STATUS OF STOCKS & MULTISPECIES ASSESSMENT PROGRAM

Groundfish Stock Assessments for 2010: Fishery Quota Recommendations

The 2009 cycle of stock assessment reporting concluded in early December, and recommendations were put forward for Alaska groundfish catch levels for 2010. The information provided by the AFSC fisheries surveys, observer data, and analysis again assisted the NPFMC in their annual decision-making process. The preparation of the stock assessment and fishery evaluation (SAFE) reports this year covered more than 54 sections and totaled more than 3,000 thousand pages.

These reports contain analyses summarizing the information about the individual stocks and species groups, and include ABC and overfishing level (OFL) recommendations for future years. The authors of these reports (mostly NMFS scientists) presented their findings to the NPFMC's Groundfish Plan Teams in September and November. At these meetings, the reports are reviewed and recommendations for ABC levels are compiled into two SAFE report volumes (one each for the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) regions), along with Plan Team recommendations for ABC, which may differ from author recommendations. The compiled reports are then submitted to the NPFMC Scientific and Statistical Committee (SSC) for further review. The SSC makes the final ABC recommendation to the Council and the Council's Advisory Panel of industry representatives makes TAC recommendations. 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 2.0 million t) are met.

The following rule applies for all Federally managed groundfish species in a given year:

Catch ≤ TAC ≤ ABC < OFL

In practice, catch is often much less than TAC, and TAC is often much less than ABC. The multispecies management system is, therefore, based on the premise that no individual components are overfished or below stock sizes that are considered detrimental to the ecosystem. The most recent stock assessments can be obtained on the AFSC website at http://www.afsc.noaa.gov/refm/stocks/assessments.htm.

The Midwater Assessment Conservation Engineering (MACE) Program of the Center's RACE Division conducted two major surveys in 2009: the winter echo-integration trawl survey in Shelikof Strait and nearby areas and the entire shelf region of the eastern Bering Sea (EBS) (with extensions into the Russian exclusive economic zone (EEZ)) to assess the summer abundance of walleye pollock and other species. Scientists from the AFSC's Auke Bay Laboratories (ABL) conducted the annual longline survey, 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 BSAI regions. The groundfish assessment group also conducted the standard summer-trawl survey for the EBS shelf area and the entire Gulf of Alaska in summer 2009.

The Ecosystem Considerations chapter was updated, and the 225 page document details an overall picture of the ecosystem status. A new format for presenting time series information for diverse indicators was developed (Fig. 4). This format allows comparisons between indicators and provides context of current status relative to observed variability.

The following summarizes the chapter highlights observed for the BSAI regions:

- The Bering Sea remained cold in 2009. It is predicted that the upcoming El Niño will have relatively dramatic impacts on North Pacific air-sea interactions. By late winter/early spring 2010, a return towards average temperatures is projected on the EBS shelf.

- Coccolithophores bloomed in the EBS this year. Cloud cover prevented documentation of the full course of this bloom.

- The modest recent drop in total apex predator biomass was due to the assessed decline in Pacific cod biomass. Fur seals and several bird species show either declining or stable trends. Productivity in bird populations has increased, indicating a possible density-dependent response.

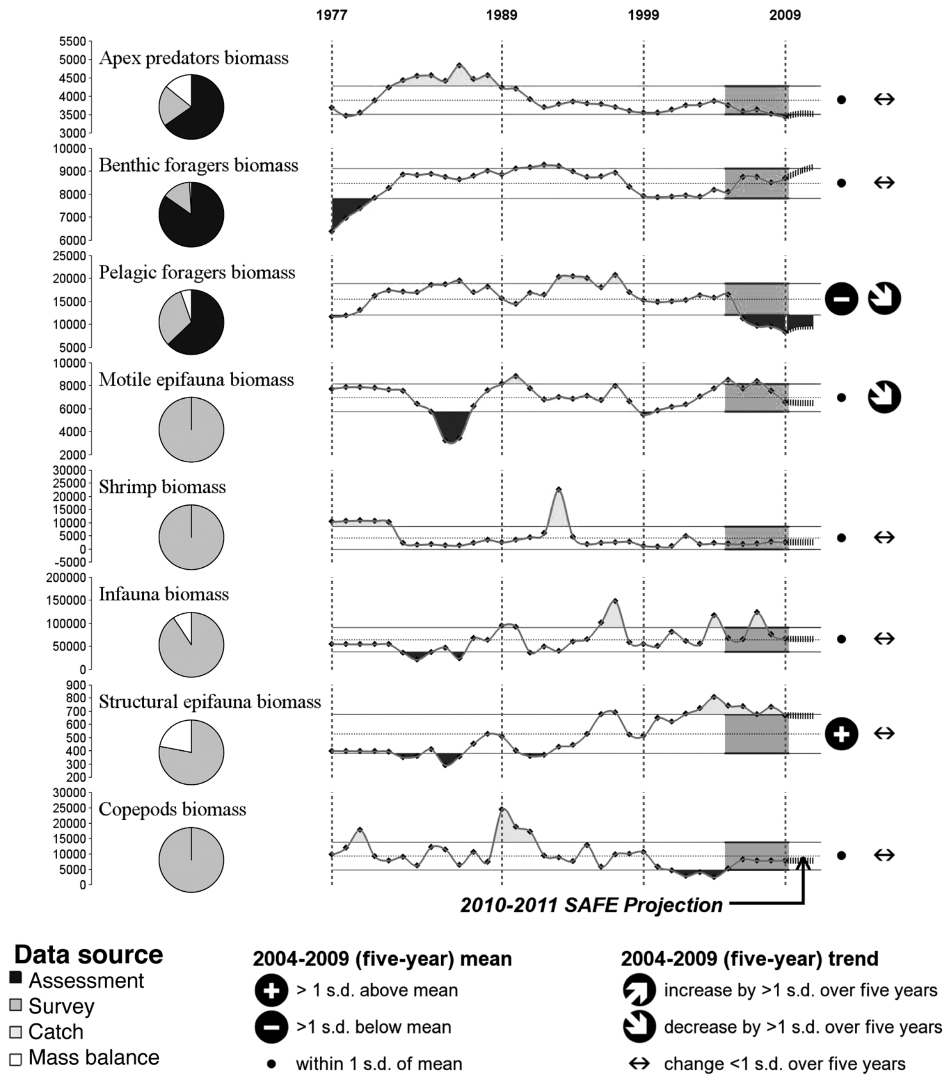

Figure 4. A new style of presenting time-series of a variety of ecosystem indicators used for the Ecosystem Considerations chapter of the SAFE reports for 2010.

- Pelagic foragers (forage fish) biomass remains lower than it has been at any time since 1982. This is primarily driven by declines in pollock biomass but also by low relative survey biomasses for several forage fish.

- Jellyfish biomass in the bottom trawl survey jumped from low values in recent years to a high value comparable to the late 1990s.

- A shift of groundfish survey biomass to the northwest occurred over the last several years. The shift persisted even through recent colder years.

- Structural epifauna (e.g., habitat areas of particular concern biota) biomass from surveys shows increases in total, primarily driven by increases in survey biomass of urochordates. Changes in survey methodology may be partly responsible for this trend.

- Catches of all guilds except pelagic foragers remain within 1 standard deviation (s.d.) of the 1977-2009 averages. 2009 pelagic forager catch is lowest since 1977 (due to declines in pollock catch).

- Fishing exploitation rates of all guilds remain within 1 s.d. of the 1977-2009 averages. The exploitation rate of pelagic foragers was greater than 1 s.d. above its long-term average during 2005-07, but decreased within the range in 2008-09 due to the decrease in pollock fishing mortality as governed by its management control rule.

- Very few indicator trends are currently tracked or available for the Aleutian Islands.

And for the Gulf of Alaska:

- La Niña conditions prevailed in winter 2008-09, shifting to El Niño in winter 2009-10. In spring 2009, the eddy kinetic energy in the GOA was estimated to be lower than average, reducing cross-shelf transport. Conditions east of the Alaska Peninsula were less stormy with more transport through shallow Aleutian passes. A weak and broad Alaska Current in Southeast Alaska led to shallow, mixed layer depths along the continental shelf.

- A new evaluation of GOA bottom trawl survey temperatures-at-depth for 2007 and 2009 indicated a reversed pattern of surface warming compared to surveys from 1993 to 2005. In the two recent surveys, the surface temperature cooled markedly with a temperature inversion at the 100-m depth contour, with cooler water above warmer water at depth. The pattern was observed throughout the GOA on both surveys but not in earlier years.

- Mesozooplankton abundance peaked relatively late and persisted longer than average in 2008, a cold year.

- Southeast Alaska herring are increasing, with 2005 and 2008 estimated to have the highest spawning biomass in 25 years and some indications of older spawning fish.

- Alaska Department of Fish and Game trawl surveys were dominated by flatfish but with a decrease in total biomass in 2007-08, mostly due to a decline in flathead sole and arrowtooth flounder. Mean distributions of rockfish were farther north and east and more contracted in 2007 relative to prior years, suggesting a recent shift.

- The apex predator guild is driven by high biomass of arrowtooth flounder, while the benthic forager guild is driven by an increase in flathead sole, rex sole,

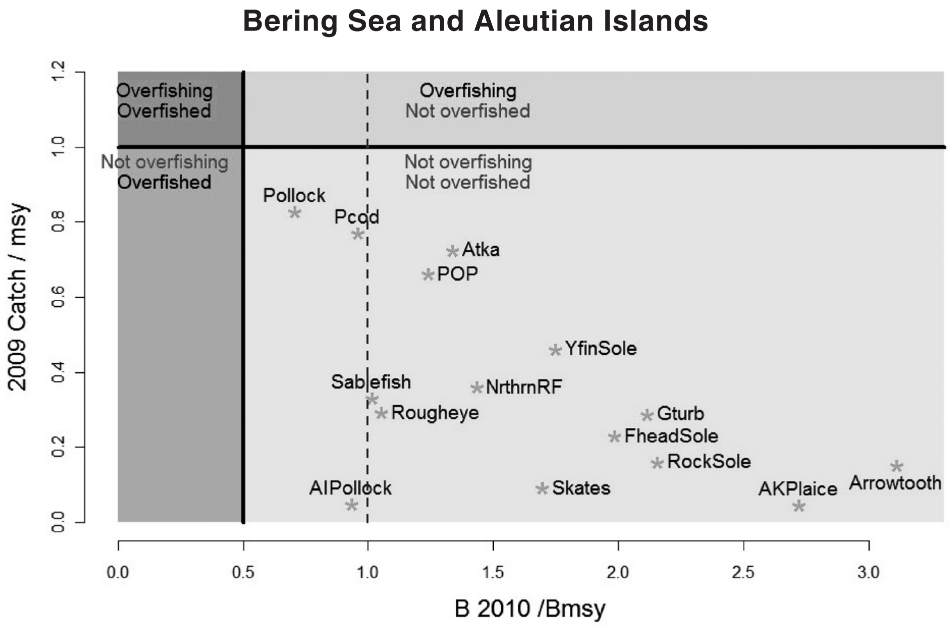

Figure 5. Summary status of age-structured BSAI species relative to 2009 catch levels (vertical axis) and projected 2010 spawning biomass relative to B_{msy} levels. Note that the 2009 MSY level is defined as the 2009 catch at F_{msy}.

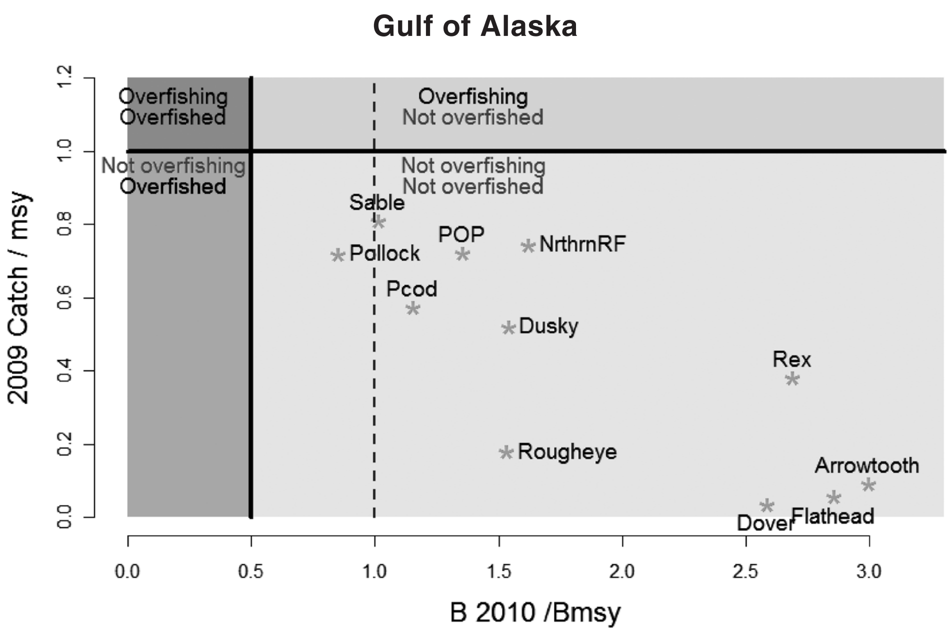

Figure 6. Summary status of age-structured GOA species relative to 2009 catch levels (vertical axis) and projected 2010 spawning biomass relative to B_{msy} levels. Note that the 2009 MSY level is defined as the 2009 catch at F_{msy}.

and skates. In contrast, pelagic foragers recent mean biomass is low, driven by the decline in pollock. GOA shrimp are above long-term mean biomass, due to a long-term trend which agrees with trawl survey results. Numbers for Steller sea lion nonpups were slightly up in the eastern GOA, flat in the central GOA, and slightly up in the western GOA.

- Guild analysis combining 2009 stock assessments and surveys in an ecosystem model shows high current biomass for apex predators and benthic foragers, and an increasing trend for benthic foragers. Catch of apex predators and benthic foragers shows increasing trends in recent years, with similar increases in exploitation rates for these guilds. Common trends were seen in cod and pollock bottom trawl survey data.

- GOA total catch remained close to the long-term mean in 2008. Bottom trawl effort trended up from its 2005 low, pelagic trawl effort trended down, while longline and pot effort showed no clear recent trends. Discards have increased in the GOA from a low point in 2005, but remain below the long-term mean. The number of vessels fishing in Alaska has been declining but stabilized in 2008.

Presently, projections of 2010 spawning biomass for the main groundfish stocks are estimated to be near or above their target stock size (B_{msy}), while the 2009 catch levels were below F_{msy} levels for both the BSAI and GOA regions (Figs. 5 and 6). Fisheries for these groundfish species during 2008 landed 1.65 million t valued at approximately $2.4 billion after primary processing. This harvest 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 declined in 2009 from previous years but totaled about 860 thousand t. Many of the flatfish stocks (e.g., rock sole, Alaska plaice, and arrowtooth flounder) continue at high levels but catches remain relatively low. Yellowfin sole abundance is high but a larger fraction of the ABC is caught compared to other flatfish stocks in the EBS. Atka mackerel abundance is variable, but apparently strong incoming year classes have the stock at above-average levels. Rockfish species make up 5%-8% of the groundfish complex biomass and are generally increasing based on recent surveys (Fig. 7). Below are summaries of stock assessment results by area and species or species group.

GULF OF ALASKA (GOA)

In the GOA, assessments for 22 stocks or stock groups were completed. Since the AFSC's RACE Division completed a full groundfish survey in 2009, full assessments were completed for all fishery management plan (FMP) species.

The sum of the ABCs increased by 9% (49,444 t) compared with last year. This is primarily driven by increases of 34,800 t (70%) for pollock and 23,800 t (43%) for Pacific cod. The sablefish ABC declined by 790 t (-7%), while the deepwater flatfish group increased by 2,978 t (32%) and flathead sole by 958 t (2%). Arrowtooth flounder was down by 5,630 t (2%). Pacific ocean perch (POP) increased by 2,473 t (16%), and other species (in aggregate) increased by 535 t (8%). The ABC for northern rockfish increased by 738 t (17%), while the demersal shelf rockfish ABC dropped by 18%, and other slope rockfish decreased by 13%. Big skates remained relatively constant, while longnose skates declined slightly. No groundfish stocks in the GOA are overfished nor experiencing overfishing.

The sum of the recommended ABCs for 2010 is 565,500 t which represents an 11% increase from the 2009 total. The largest contributor to this increase was due to declines in Pacific cod and pollock (Table 1).

For some stocks, the Council recommended that TACs be set below the ABC levels. In particular, the federal quota for Pacific cod was adjusted downwards by about 25% to account for expected removals in the state-waters fishery. The TACs for the shallow-water flatfish group (Western (W) and Central (C) GOA), flathead sole (W and C GOA), arrowtooth flounder (GOA-wide) and other slope rockfish (East Yakutat/Southeast Outside) were all set below ABCs to ensure bycatch levels for prohibited species (mainly Pacific halibut) were maintained below allowable limits. The TAC for Atka mackerel was recommended to be well below the ABC and set simply to meet incidental catch needs in other fisheries. Brief summaries of each GOA species or species group follow.

GOA Pollock: The 2009 biomass estimate of Shelikof Strait pollock ≥43 cm (a proxy for spawning biomass) increased by 60% from the 2007 estimate, apparently due to above average recruitment to the spawning population. The model was unable to fit all the 2009 survey estimates simultaneously. Both the NMFS bottom trawl survey and the ADF&G surveys showed large increases in biomass in 2009, while the Shelikof Strait echo integration-trawl (EIT) survey showed only a slight increase and remains close to historically low levels. For a pollock population to increase by the amount indicated by the NMFS bottom trawl survey, recruitment to the population would have to have been very large. However, available data (including the length information from the NMFS and the ADF&G surveys) suggests that recruitment is lower. The initial model estimate for the 2007 year class is 1.7 times average recruitment and appeared to be abundant in both the Shumagin area and Shelikof Strait in the 2008 EIT surveys.

Three key elements were included as an extra measure of precaution for the GOA pollock fishery due to assessment uncertainty: 1) the NMFS bottom trawl survey was treated as an absolute abundance index; 2) the recommended harvest rate is below the maximum level permissible; and 3) for projection to 2010 numbers-at-age, the 2007 year class was set equal to the mean value. These conservative elements reduce the recommended ABC to approximately 50% of the model point estimate. However, they seem warranted given the above average estimate of the 2007 year class, inconsistencies in the 2009 survey data, and the continued low spawning biomass in Shelikof Strait and other spawning areas.

GOA Pacific Cod: Extensive work on the GOA Pacific cod model continued in 2009, in particular with efforts to reconcile apparent discrepancies in age data that have become available in recent years. The results produced an estimated 2010 spawning biomass of 117,600 t, or 40% of unfished spawning biomass, compared to the B_{MSY} proxy of 102,000 t. The estimated stock biomass increased relative to the 2008 assessment, due in large part to a large biomass estimate in the 2009 GOA trawl survey. Spawning biomass was projected to increase dramatically in subsequent years due to a number of strong, young year classes in the population.

GOA/BSAI Sablefish: The survey abundance index increased 2% from 2008 to 2009, following a 16% decrease from 2006 to 2008. Similar to last year, the fishery abundance index was up 5% from 2007 to 2008 (2009 data will become available in early 2010). The spawning biomass is projected to decline from 2010 to 2012, and then stabilize. The GOA 2009 trawl survey estimate was 2% lower than the 2007 estimate, and the 2010 spawning biomass is estimated to be about 35% of unfished biomass. This compares with levels during 1998 - 2001 of about 29%. The 2000 year class appears to be larger than the 1997 year class, and these two year classes compose the bulk of the spawning biomass.

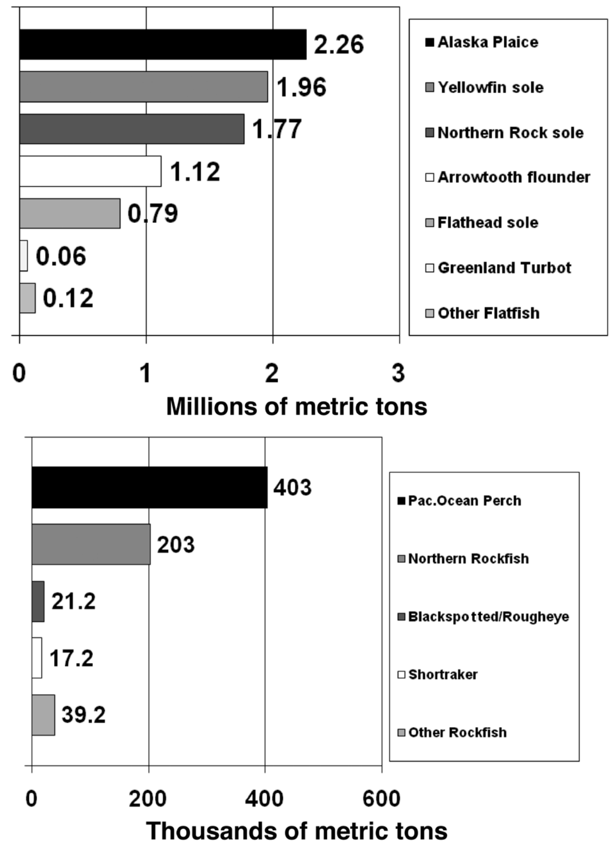

Figure 7. Species biomass breakout for flatfish as a group (top panel) and rockfish (bottom panel) for the BSAI region.

GOA Flatfish: A number of GOA flatfish assessments were prepared and applied new 2009 survey data to a variety of age-structured models (and model configurations). Briefly, the highlights were that arrowtooth flounder appears to remain at high levels but has stabilized rather than is increasing. For Dover sole (the main component of deepwater flatfish) six alternative model configurations were presented which explored selectivity parameterizations. The Dover sole survey numbers were stable, and abundance remains high relative to catches. Rex sole abundance appears to be trending upwards, consistent with new survey data. The flathead sole survey estimate declined slightly from 2007, but overall the stock continues to increase slightly from 1990s levels.

GOA Rockfish: Similar to the flatfish assessments, a number of model improvements and alternative assumptions were tested and implemented. This includes a careful rationale to adopt dome-shaped selectivity for the POP stock, a more consistent treatment of sample-sizes (inversely proportional to variance assumptions) for the northern rockfish model, continued

Table 1. The 2009 catch levels compared to the 2009 and 2010 ABC specifications and change in ABC (in metric tons (t)) for the groundfish species types for the Gulf of Alaska.

		ABC			
Species	2009 Catch	2009	2010	Change	
Pollock	42,297	49,900	84,745	Up 34,845	(+ 70%)
Pacific cod	38,401	55,300	79,100	Up 23,800	(+ 43%)
Sablefish	10,698	11,160	10,370	Down 790	(– 7%)
Flatfish	16,657	125,617	119,583	Down 6,034	(– 5%)
Arrowtooth flounder	24,438	221,512	215,882	Down 5,630	(– 3%)
Rockfish	22,408	33,005	35,773	Up 2,768	(+ 8%)
Atka mackerel	2,221	4,700	4,700	same	(0%)
Skates	3,935	8,321	8,273	Down 48	(– 1%)
Other Species	2,327	6,540	7,075	Up 535	(+ 8%)
Total	163,382	516,055	565,501	Up 49,446	(+ 11%)

consideration of the species split of the rougheye rockfish complex (which includes blackspotted rockfish), and refinements to evaluating uncertainties in catch time series for dusky rockfish. For demersal shelf rockfish (primarily yelloweye rockfish), an underwater survey covered part of the habitat and provided an update on abundance estimates.

GOA Skates and "Other Species": Refinements to these sections were presented based on full assessments presented in 2008. These include revised catch time series (particularly for sharks), updates on issues facing management for these species groups. Essentially, the philosophy continues to be that ABCs and OFLs remain at low levels until better information becomes available to manage these species.

BERING SEA/ALEUTIAN ISLANDS (BSAI)

The sum of the ABCs for 2010, as recommended by the Scientific and Statistical Committee, is just over 2.12 million t, about 3% lower than the sum of the 2009 ABC values.

EBS Pollock: Updated analyses of survey and fishery data show a less optimistic increase compared to predictions from the 2008 assessment. While the form of the model remained the same, an improved method for projecting future weight at age was developed and accepted for application. The age-3 and older biomass has been declining since 2003, and the 2010 biomass is the lowest since 1980. Spawning biomass has been declining since 2004, but the current assessment indicates that 2009 should be a turning point, and the 2010 spawning biomass should increase by about 13%. The spawning biomass is projected to be near B_{msy} by 2012.

Walleye pollock in the eastern Bering Sea typically have been monitored with regular annual bottom trawl and biennial acoustic surveys. However, 2009 marked the fourth consecutive year that both surveys were conducted. The results of the 2009 bottom trawl survey suggested that pollock abundance was slightly higher than expectations (but was lower than the 2008 value). However, the acoustic survey data indicated that pollock abundance was lower than expected based on expectations from the 2008 assessment. Combining these results and recent fishery observer information in an integrated analysis indicated that a lower catch limit of 813,000 t for 2010 was appropriate given the new information. (Previous analysis indicated that the stock and management control rule would be above 1.0 million t for 2010.) The Council reviewed and discussed the assessment prepared by AFSC scientists at the December meeting and was satisfied that the updated information and downward revision of the ABC was appropriate.

The prognosis for 2010 and beyond is for improved stock levels because the 2006 year class remains above average, and early indications are that the 2008 year class may also be high (based on the acoustic survey). While survey data continue to play a critical role for advising fisheries management, the Bering Sea Integrated Ecosystem Research Program (BSIERP) continues and is due to complete fieldwork in late 2010. This project is multifaceted and an important component will serve to evaluate current management practices in light of new information on ecosystem processes.

AI Pollock: There were no new data for this assessment, and the last Aleutian Islands survey was in 2006. The stock is estimated to be near $B_{30\%}$.

BSAI Pacific Cod: As with the GOA Pacific cod model, extensive work on the BSAI Pacific cod model continued in 2009, in particular with efforts to reconcile apparent discrepancies in age data that have become available in recent years. The results produced an estimated 2010 spawning biomass of 345,000 t or 34% of unfished spawning biomass, compared to the B_{MSY} proxy of 360,000 t. The estimated stock biomass decreased slightly relative to the 2008 assessment. Spawning biomass was projected to increase in subsequent years due to strong year classes spawned in 2006 and 2008.

BSAI Flathead Sole: Estimates of stock biomass for BSAI flathead sole in 2009 from the groundfish surveys continued on a steady decline seen in recent years following a peak in 2006. Part of this decline was attributed to the effects of colder water temperatures on survey catchability, rather than actual changes in abundance. Estimates of total biomass and spawning biomass from the assessment model, however, also exhibited declining trends in abundance, although with shallower slopes than that for the survey biomass estimates. Model estimates of recruitment indicated higher than average recruitment occurred in 2001 and 2003, while estimates for recruitment in 2004-06 were lower than average. BSAI flathead sole in 2009 continued to be lightly exploited by the fishery ($F/F_{35\%}$ < 0.2). Although the stock appears to be in a declining phase, stock biomass is high relative to the reference level ($B/B_{35\%}$ ~ 2), and there is no evidence that the stock is overfished or that overfishing is occurring.

BSAI Yellowfin Sole: The 2009 groundfish trawl survey biomass estimate of 1,739,000 t was a 17% decrease from the 2008 estimate. As noted above for flathead sole, colder temperatures are suspected to negatively influence survey catchability for many shelf flatfish species. The estimates of female spawning biomass from the stock assessment model indicate a declining trend since a peak value in 1994 with the 2009 estimate at 605,000 t, 70% of the peak value. Recruitment is estimated to have only six year classes out of the past 24 years which are at or above the long-term average. The Bering Sea yellowfin sole fishery is the largest flatfish fishery in the world, and exploitation rates have averaged 0.05 from 1978 to 2009, with a 2009 catch of about 100,000 t. Although the stock appears to be in a slowly declining phase, stock biomass is high relative to the reference level (B/B_{msy} ~ 1.8), and there is no evidence that the stock is overfished or that overfishing is occurring.

BSAI Northern Rock Sole: The 2009 groundfish trawl survey biomass estimate of 1,539,000 t was a 25% decrease from the 2008 estimate and is suspected to be a function of decreasing catchability with colder water temperatures rather than stock decline. The estimates of female spawning biomass from the stock assessment model indicate a stable trend from 2008 and are expected to increase in the near future as fish from strong recruitment in 2001-03 begin to mature. The stock remains lightly exploited in 2009 (4% exploitation fraction) with a total catch of nearly 50,000 t. The stock is projected to increase in the near future, and the stock biomass is high relative to the reference level (B/B_{msy} ~ 2). There is no evidence that the stock is overfished or that overfishing is occurring.

BSAI Alaska Plaice: The 2009 groundfish trawl survey biomass estimate of 530,000 t was a 4% increase from the 2008 value. The stock has been very lightly exploited for the past two decades, and its stock condition closely follows natural processes. The stock is expected to increase in the near future due to strong recruitment observed from the 2001 and 2002 year classes. The estimated 2010 female spawning biomass of 487,000 t is well above the $B_{40\%}$ level of 205,000 t. Alaska plaice are neither overfished nor is overfishing occurring.

BSAI Arrowtooth Flounder: Although the 2009 groundfish trawl survey biomass estimate of 453,000 t was a 23% decrease from the 2008 value, the combined arrowtooth flounder/Kamchatka flounder stock size is estimated to be increasing. Recent strong recruitment from the early part of the decade should contribute to higher abundance levels in the near future. Although there is increasing interest in harvesting the fish of this management complex, the current catch levels represent a small fraction of the available annual ABC. (The 2009 catch of 26,700 t was only 17% of the 2009 ABC). The projected 2010 female spawning biomass is more than 2.5 times the $B_{40\%}$ level. Arrowtooth flounder are neither overfished nor is overfishing occurring.

BSAI Greenland Turbot: The 2009 assessment added additional size-at-age data and was implemented with the most recent version of stock synthesis software. The EBS shelf bottom-trawl survey data indicates that over the past few years recruitment is improving after an extended period where small Greenland turbot were relatively rare. The adult stock inhabits deep areas of the slope region and likely extends beyond the U.S. zone. Current abundance levels are low, and harvest levels have been set accordingly.

BSAI Rockfish: The rockfish stock assessments this year consisted of executive summaries since no new information from surveys were available. Full assessments for these stocks will be completed when the Aleutian Islands survey is conducted, likely in 2010 pending funds.

***BSAI Atka Mackerel*:** Bering Sea/Aleutian Islands Atka mackerel are at a moderate level of abundance after declining from a period of peak biomass due to several strong year classes. The projected female spawning biomass for 2010 under an $F_{40\%}$ harvest strategy is estimated at 111,000 t, which is 47% of unfished spawning biomass. The 2010 estimate of spawning biomass is down about 16% from last year's estimate for 2009. The projected age 3+ biomass at the beginning of 2010 is estimated at 389,000 t, down about 5% from last year's estimate for 2009. This is due to a decrease (-29% from 2008 assessment) in the estimated magnitude of the 2004 year class, and an increase (+120%) in the 2006 year class after the addition of the 2008 fishery age data into the model. Since there has been no Aleutian Islands bottom trawl survey since 2006, determination of the magnitude of incoming year classes has been dependent on fishery age data. As such, there is concern that the fishery could target on incoming year classes, which for 2010 have only been seen once or never in a fishery-independent survey. The projected 2010 yield (maximum permissible ABC) at $F_{40\%}$ = 0.42 is 74,000 t, down about 12% from last year's estimate for 2009.

By Jim Ianelli, Grant Thompson, William Stockhausen, Tom Wilderbuer, and Sandra Lowe

AGE & GROWTH PROGRAM

New Age & Growth Prioritization System (AGPS) is Launched

The need to improve age-structured stock assessments and develop a framework for ecosystem fisheries management continually places greater demands on the Age and Growth Program to age otoliths and other hard structures. Age and Growth Program staff age more than 30,000 otoliths per year from observer and survey collections as part of the production numbers that support annual age-structured stock assessments. With research cruises expanding the geographical boundaries of traditional surveys, enhancements to assessments using historical otolith collections, special research projects that require sample ages, and research in age validation and growth studies, the demand for ageing has outpaced the available resource capabilities of the program.

Consequently, to balance the demand for ageing requests and available Age and Growth program capabilities and resources, the Age and Growth Prioritization System (AGPS) was developed. The AGPS is a web-based ageing request and prioritization system intended to provide a systematic process of compiling and prioritizing ageing requests that are processed each year by staff of the Age and Growth Program. For the end user who submits an ageing request, the AGPS is an easy to use web-page interface that tracks and notifies the requestor throughout the process, from submission to final prioritization. For the

Age & Growth Program Production Numbers: Estimated production figures for 1 January – 31 December 2009. Total production figures were 32,441 with 7,884 test ages and 446 examined and determined to be unageable.	
Species	Specimens Aged
Alaska plaice	353
Arctic cod	1,205
Atka mackerel	1,252
Bering flounder	547
Bigmouth sculpin	40
Blackspotted rockfish	390
Dusky rockfish	515
Flathead sole	1,055
Greenland turbot	1,627
Northern rock sole	1,122
Northern rockfish	1,083
Pacific cod	3,801
Pacific ocean perch	1,619
Quillback rockfish	52
Rex sole	1,589
Rougheye rockfish	654
Sablefish	2,393
Shortraker rockfish	1,202
Walleye pollock	10,561
Yellowfin sole	1,381

Age and Growth Program, the AGPS provides a mechanism to balance limited program resources to the growing number of agency and external requests for hard structure ageing. For the Center the AGPS provides a process of prioritizing ageing request in a fair and transparent manner that serves NOAA's mission directives.

By Tom Helser

Validating Ageing Methods

Validating the true age of fish is critical for stock assessments. The main method used by the AFSC's Age and Growth Program to determine the age of fish is to count growth bands in otoliths. One method used to validate the age of long-lived fish uses radiocarbon levels in otoliths as a cross-reference. Atmospheric radiocarbon (C-14) from atomic bomb testing during the 1950s and 1960s led to a substantial increase in marine C-14 levels during those years. Radiocarbon incorporated into the otoliths of known-age fish alive during that time can be measured for different species of fish, producing a reference chronology that can be compared to radiocarbon levels in fish aged by reading growth bands. Ages are considered accurate and valid if the C-14 increase in the test specimens matches the timing and magnitude of the C-14 increase in the reference chronology, as illustrated for Gulf of Alaska Dover sole test specimens compared to a halibut reference chronology in Figure 8. In comparison, Bering Sea yellowfin sole test specimens are asynchronous with the Gulf of Alaska Pacific halibut reference chronology and are therefore either aged incorrectly, or more likely, require a reference chronology specific to the Bering Sea.

Other validation methods are required for fish that hatched after the era of bomb testing. A promising new method for short-lived species relates the stable oxygen isotope (O-18) signature from otoliths to seasonal variation in water temperature, a well understood principle in calcified marine structures. Preliminary results with Pacific cod otoliths (Fig. 9) show that the O-18 signature varies seasonally with water temperature and supports the age obtained by counting growth bands in otoliths. This and other new approaches are being explored to assess ageing bias and to validate ages used in stock assessments for the more than 25,000 otoliths aged each year by the AFSC Age and Growth Program.

By Craig Kastelle

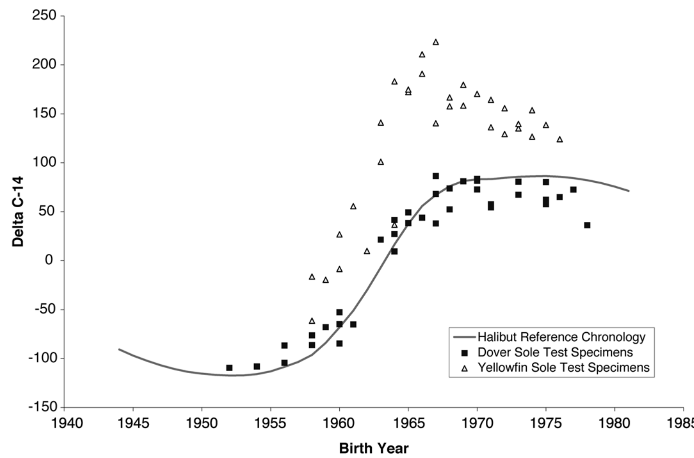

Figure 8. Gulf of Alaska Dover sole and eastern Bering Sea yellowfin sole test specimens are compared to a Gulf of Alaska Pacific halibut reference chronology.

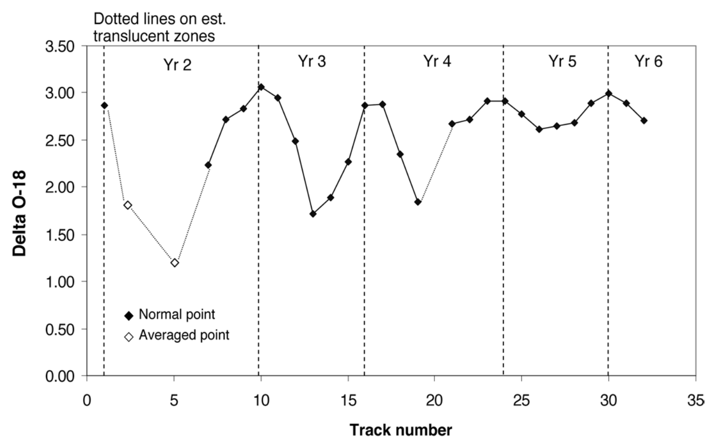

Figure 9. Stable oxygen isotopes (O-18) as a function of distance from otolith core of a 6-year-old Pacific cod illustrates seasonal variation likely coincident with water temperature. Dotted vertical line represents estimated otolith location corresponding to visible growth bands.