AUKE BAY LABORATORIES (ABL)

HABITAT ASSESSMENT & MARINE CHEMISTRY PROGRAM

Nearshore Fishes of Alaska: An Online Atlas

The Essential Fish Habitat (EFH) task at Auke Bay Laboratories (ABL), using traditional nearshore fish assessments, has now linked years of catch data to the ShoreZone map database. The EFH task has been studying the distribution, relative abundance, and habitat use of commercially important and forage fish species in nearshore waters of Alaska since 1998. Shallow nearshore waters are some of the most productive habitats in Alaska; many Fisheries Management Plan species use nearshore habitats at some point in their life cycle. Alaska has more than 50% of the U.S. coastline; most of this coastline is pristine, but all of it is vulnerable to environmental perturbations and increasing stress from shoreline development. Determining fish utilization of coastal habitats is needed to target which habitats are essential and should be protected.

Nine years of nearshore catch data have been entered into a Fish Atlas database, which is now linked to an existing Arc IMS Alaska ShoreZone Web site at *http://www.fakr.noaa.gov/maps/szintro.htm*. This work has been completed in cooperation with NOAA's National Marine Fisheries Service (NMFS) Alaska Regional Office. The online Fish Atlas will be periodically updated as more information becomes available, as will the ShoreZone database as more mapping and analysis are completed throughout the state.

Presently, the Fish Atlas database contains information on fish assemblages from 68 locations in southeastern Alaska, Prince William Sound, the Aleutian Islands, and the Arctic. At each location, up to four habitat types were sampled, including sand or gravel beaches with no rooted vegetation, cobble beaches with understory kelps (Laminariales), soft bottom (sand, silt, mud) beaches with eelgrass, and steep bedrock outcrops. Nearly 600,000 fish representing 98 species have been captured in 803 beach seine hauls. Some of the most abundant species captured, mostly as juveniles, include walleye pollock, Pacific sand lance, Pacific herring, and salmon.

The ShoreZone/Fish Atlas Web site contains detailed information on shoreline geomorphology, fish distribution, habitat use, fish and site photos, and other biological information (e.g., taxonomic lists, rare species). Scientists, resource managers, and the public will be able to search the Fish Atlas by specific location, habitat type, or fish species, and download data from search results.

The online Fish Atlas 1) provides a quick reference for identifying species occurring in areas designated for development or impacted by human disturbance (e.g., oil spill); 2) allows resource managers to track long-term and large-scale changes in fish distribution and habitat use related to global climate change; and 3) helps resource managers prepare biological opinions and identify habitats essential to different life stages of commercially important and forage fish species. The atlas is available online at *http://www.fakr.noaa.gov/habitat/fishatlas/*.

By Scott Johnson

Aerial Imagery and Mapping of Alaska's Coastline

Aerial imagery and mapping are key to coastal habitat assessments. With more than 50,000 km of shoreline in Alaska, it is physically impossible to assess all of it in a workable period of time. The first task is to establish a baseline that maps and characterizes the coastline; several agencies have committed to accomplishing this by using the ShoreZone classification system. Through partnerships with federal, state, and nonprofit organizations, about 28,000 km (or nearly half of Alaska's coastline) have been inventoried using the ShoreZone classification system (Fig. 1). The shoreline is photographed continuously on a minus tide, and the geo-referenced imagery is analyzed later for physical geomorphology and for biological resource characteristics (e.g., kelp beds, eelgrass beds). The project combines several methods: 1) collection of aerial videographic and still photography, 2) coastal resource mapping, 3) ground work at a limited number of shore stations, and 4) a Web-based Arc IMS database that is available to managers and the public. ShoreZone has proven to be a valuable management tool for oil spill contingency planning, permitting for coastal development, mariculture, and nearshore research, and can be used in the future to track climate change impacts on coastal nearshore resources. The Alaska Regional Office and ABL have been collaborating to complete the mapping of southeastern Alaska.

Southeastern Alaska represents a challenge for habitat research, possessing over half of Alaska's coastline with its unique combination of fjords,

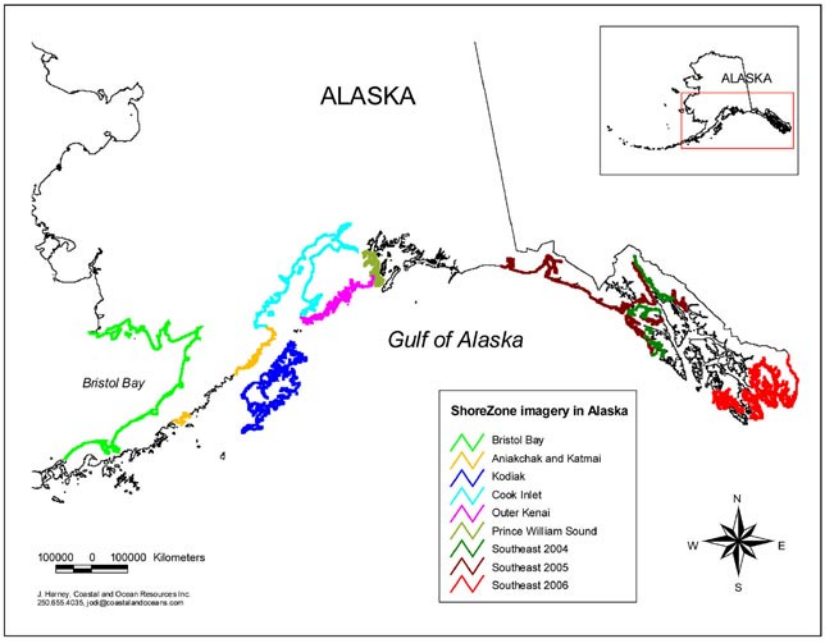

Figure 1. Map showing Alaska coastline inventoried using the ShoreZone classification system.

bays, inlets, estuaries, and at least 1,000 named islands. Between 2004 and 2005, over 6,000 km were mapped in the northern regions of southeastern Alaska from Icy Bay to Sitka Sound and the inside waters from Skagway to Juneau, Gustavus, and Tenakee Inlet. Fiscal Year 2006 marks a pivotal year, with more than 7,000 km imaged in southern southeastern Alaska, focusing on the Ketchikan, Craig, and Prince of Wales areas. With more than 40% of southeastern Alaska surveyed and with continued funding, completion of southeastern Alaska survey work will be a reality in the future. To view our progress, visit the following Web sites at *http://www.fakr.noaa.gov/maps/szintro.htm* or *http://www.coastalaska.net/*.

By Mandy Lindeberg

Pacific Sandfish in Southeastern Alaska

Forage fish are an important component in Alaska's marine ecosystems and coastal areas. Forage fish are a critical food source for numerous groundfish, marine mammals, and seabirds. Little is known, however, about the life history characteristics or habitat of many forage fish species in Alaska, including Pacific sandfish (*Trichodon trichodon*) (Fig. 2). Sandfish are thought to spawn on rocky intertidal shorelines, and their larvae are thought to develop in shallow nearshore areas. Adults burrow into sand, usually at depths shallower than 150 m, and can reach a maximum size of about 300 mm.

Pacific sandfish are commonly found in nearshore waters of the southeastern Bering Sea and the Gulf of Alaska. There is no commercial fishery for sandfish in Alaska, but sailfin sandfish (*Arctoscopus japonicus*) are commercially fished and cultured in Japan and Korea. In particular, information is scarce on the biology and habitat of sandfish, especially for southeastern Alaska. Shoreline development and global climate change (e.g., increased water temperature and sea level) may adversely affect sandfish populations because of their relatively specialized nearshore spawning sites and 1-year incubation period.

To provide new information on the general biology of Pacific sandfish including habitat preference, age, size, and diet, we captured sandfish with a beach seine in July and March and with a midwater trawl in May near The Brothers Islands in southeastern Alaska (Fig. 3). We seined 10 sites in summer (July 2001-03) and in winter (March 2002-04) in a variety of nearshore habitat types, including steep bedrock outcroppings, rocky bottoms with understory kelps (e.g., *Laminaria*), eelgrass, and sand beaches. We also captured sandfish with a midwater rope trawl in Frederick Sound and in Pybus Bay. We aged fish with otoliths and analyzed stomach contents to describe their diet.

We captured a total of 15,431 sandfish of a variety of ages. During spring we captured subadult and adult sandfish (age 4, 5, and 6); during summer we captured mostly juveniles (98% age 1), and during

Figure 2. An adult Pacific sandfish captured in southeastern Alaska. Photo by Mandy Lindeberg.

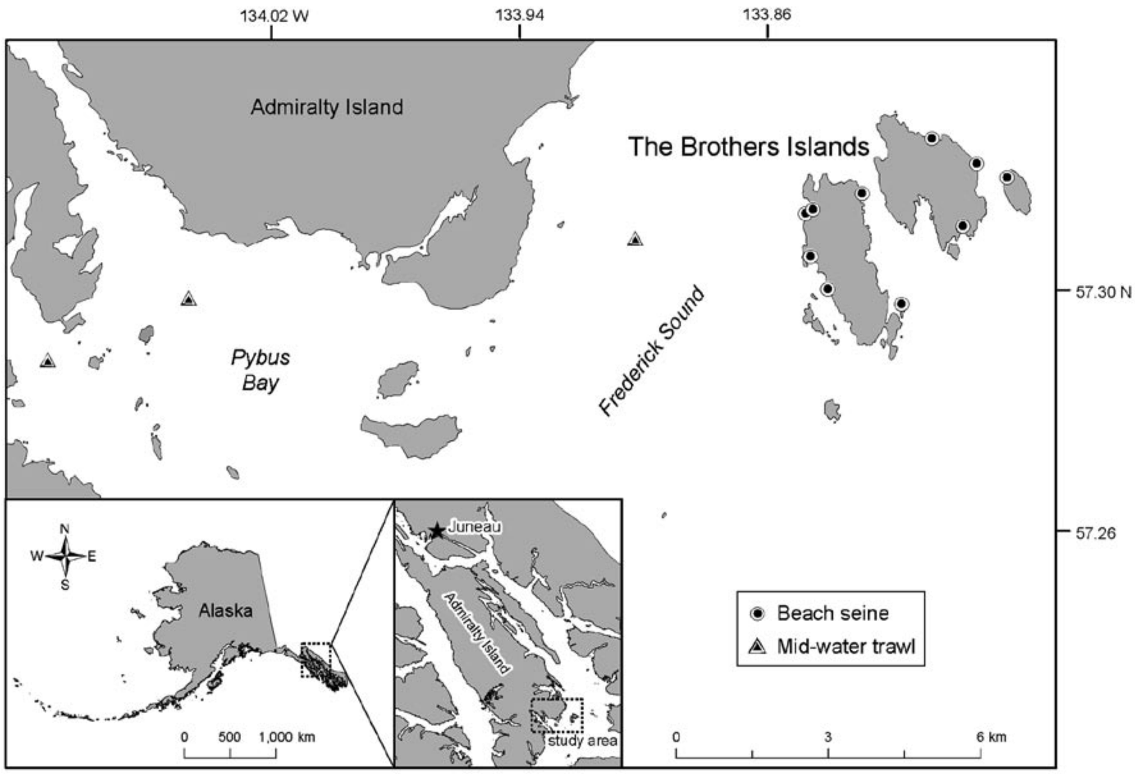

Figure 3. Location of sites sampled for Pacific sandfish (*Trichodon trichodon*) near The Brothers Islands, southeastern Alaska, 2001-04.

winter we caught only larval sandfish. We captured most (99%) fish with a seine, including 1,027 fish in July (mean fork length (FL) = 86 mm) and 14,231 larvae in March (mean total length = 16.2 mm). Most of these fish were adjacent to steep bedrock outcroppings with attached kelp. We also observed large schools of juvenile sandfish actively feeding near the surface during the day near these areas. We caught juvenile sandfish along with young of the year (YOY) walleye pollock, YOY Pacific cod, YOY Pacific herring, and juvenile chum salmon. Apparently, sandfish exhibit schooling behavior as larvae and juveniles and co-occur with a variety of forage species, sometimes preying on those that are of consumable size. The few adult sandfish captured with a seine were found exclusively in low gradient, sandy habitat.

We caught 173 adult and subadult fish with a trawl. Mean FL of the trawl-caught fish was 150 mm and most were at depths between 14 and 64 m and at least 400 m offshore. Notably absent in any of our catches were age-2 and age-3 fish. Sandfish may segregate into different habitat types depending on age and size, which may explain the absence of some age groups in our catches.

Diet of sandfish differed by fish size. Adult and subadult sandfish ate mostly fish, whereas juvenile sandfish ate mostly decapods. For juvenile sandfish, fish (mostly gadids) made up 50% of the stomach content weight in 2001, but only 7% in 2002. The annual difference may be explained by the relative abundance of YOY gadids—gadid abundance was over six times greater in 2001 than in 2002.

Because of the relative high abundance of larval and juvenile sandfish in the shallow nearshore waters of The Brothers Islands, this area appears to be an important spawning and nursery area for sandfish. The length of time that larvae remain in shallow nearshore areas, however, appears to be limited because we captured no age-0 fish in July. The dependence of sandfish upon nearshore areas for spawning, egg incubation, and larval rearing, coupled with the greater sensitivity to pollutants of early life stages than of adults, warrant the protection of nearshore areas from shoreline development and pollutants to maintain healthy sandfish populations.

By John Thedinga

MARINE ECOLOGY & STOCK ASSESSMENT (MESA) PROGRAM

Surface Trawling for Young-of-the-Year Rockfish, Young-of-the-Year Sablefish, and Juvenile Salmon in Offshore Waters of the Eastern Gulf of Alaska

During the period 11-21 August 2006, ABL used the Alaska Department of Fish and Game (ADF&G) research vessel *Medeia* to conduct research directed at diel sampling of epipelagic ichthyofauna in offshore waters of the eastern Gulf of Alaska. The general objective of this cruise was to evaluate procedures for establishing a trawl indexing survey for young-of-the-year (YOY) rockfish and sablefish and for juvenile salmon in offshore waters of southeastern Alaska. The project was a continuation of similar research conducted in mid-August 2005. Specific objectives included: 1) conducting an experiment to determine if surface trawling at night is more effective than surface trawling in daytime for capturing YOY rockfish, YOY sablefish, and juvenile salmon; 2) determining the spatial distribution of these three taxa at selected stations along transects off the northern region of southeastern Alaska; and 3) collecting physical oceanographic data coincident with the trawl hauls and vessel track to investigate the relationship between oceanographic conditions and the distribution and abundance of fish captured in the trawl. Three ABL programs collaborated on this study: Marine Ecology and Stock Assessment (formerly ABL's Groundfish Program), Marine Salmon Interactions, and Ocean Carrying Capacity.

Day and night surface trawl sampling with a Nordic 264 rope trawl was successfully completed by the *Medeia* at each of the six planned stations. These stations were located up to 75 km offshore in southeastern Alaska along two transects: Icy Point and Cape Edward. Catches totaled nearly 10,000 fish representing 25 species in 35 hauls. Catch in numbers for the target species of the study were YOY rockfish, 6,283; YOY sablefish, 276; and juvenile salmon, 206. Young-of-the-year rockfish species identification will be made in the laboratory at a later date based on retained samples. Juvenile salmon catch numbers were pink salmon, 154; chum salmon, 44; coho salmon, 5; and sockeye salmon, 5. Relatively high catches of YOY rockfish were found in several hauls at stations along both transects. The largest catch of YOY rockfish in a single haul was about 3,700 fish, which appears to be the most YOY rockfish ever taken in a pelagic research haul in Alaska. The large numbers of YOY rockfish encountered in this cruise may be an indication of an abundant year class in this region.

There was a marked difference in the catches between day and night. Day tows yielded much higher catches of the target species. In particular, 6,283 YOY rockfish were caught in the day, versus only 21 at night. For salmon, 184 were caught in the day, as compared to 22 at night, and the predominance of day catches held true for each salmon species. These results suggest that for the Nordic 264 rope trawl in 2006, daytime surface tows may have been more effective at sampling these species than were surface tows at night.

The 2006 results were very different than results of ABL's 2005 *Medeia* surface trawling cruise. This was true despite the fact that both cruises were conducted during almost the same dates in August, and they each sampled the same stations along the Icy Point and Cape Edward transects. In contrast to the large catches of YOY rockfish in 2006, a total of only 11 YOY rockfish were caught in 2005. The results of the day-night comparison for salmon were opposite between cruises; in 2006, salmon catches were predominantly in the day, whereas in 2005 they were mostly at night. Also, unusual species not commonly found as far north as Alaska, such as Humboldt squid and Pacific sardines, were caught in 2005 but not in 2006. These differences may be explained by the variable oceanographic conditions encountered in each year's cruise, especially water temperatures. Summer 2005 was unusually warm in the eastern Gulf of Alaska, and average water temperatures near the surface at stations along our transects were 2.4°C higher than in 2006.

Two piggyback projects also occurred on the cruise: 1) one day was spent doing exploratory surface trawls in nearshore waters near Icy Point in an unsuccessful attempt to locate spiny dogfish for food habits and tagging studies, and 2) two days were spent in inside waters of northern Southeast Alaska (Icy and Chatham Straits) sampling standard stations for ABL's Southeast Alaska Coastal Monitoring project. This sampling was scheduled at the last minute because the NOAA ship *John N. Cobb*, which normally does this work, was unavailable due to mechanical problems.

By Dave Clausen and Alex Wertheimer

Juvenile Sablefish Sampling in Saint John Baptist Bay

The juvenile sablefish tagging cruise took place on the *John N. Cobb* in Saint John Baptist Bay, from 14 to 20 May 2006. The goal of the cruise was to tag and release 1,000 juvenile sablefish with numerical spaghetti tags and 80 sabelfish with surgically implanted electronic archival tags. Juvenile sablefish catches were low in 2006, and only 88 juvenile sablefish were captured with 174 rod hours. Of these fish, 20 received spaghetti tags, and 66 were implanted with electronic archival tags. Juvenile sablefish ranged in size from approximately 270 to 360 cm FL. Archival tags were placed in individuals that were longer than 295 cm FL.

Electronic archival tags were programmed to continuously record temperature and depth and will be recovered as sablefish recruit to the commercial fishery. Temperature and depth profiles of prerecruit juvenile sablefish will provide a valuable tool for gathering information on the geographic distribution and vertical habitat of juvenile sablefish in Alaska waters. To date, a total of 388 electronic archival tags have been released in age 0+ and age 1+ juvenile sablefish from the 2003 (235 tagged), 2004 (87 tagged), and 2005 (66 tagged) year classes in Saint John Baptist Bay. These tagged sablefish should begin to recruit in the commercial fishery at age 4 and 5 in 2007 and 2008, respectively.

By Dean Courtney

Harbor Seal Foraging Ecology Study in Glacier Bay National Park

Glacier Bay National Park historically has supported one of the largest breeding populations of harbor seals in Alaska. Harbor seals are an important apex predator and are the most numerous marine mammal in the park; however, harbor seal numbers have declined by 63%-75% in the park since 1992. The magnitude and rate of decline exceed all reported declines of harbor seals in Alaska, with the exception of Tugidak Island. Little is known with respect to the foraging ecology, life-history, movements, behavior, and trends in available prey of harbor seals in Glacier Bay, so it is difficult to discern the causal factors contributing to the decline. Therefore, a multi-agency collaborative study began in 2005 between the National Park Service, ADF&G, and ABL aimed at addressing harbor seal declines in Glacier Bay.

Central to understanding the foraging ecology of harbor seals is identifying the spatial and temporal distribution of available prey, and which areas of the park represent critical foraging habitat. The objectives of our study are to 1) determine the location of important foraging habitat of seals, 2) determine foraging areas of seals relative to boat traffic and protected waters, 3) determine prey availability in areas where individual seals forage, and 4) determine prey availability near the two primary haul-out areas, a glacial ice haulout in Johns Hopkins Inlet and a terrestrial haulout in the Beardslee Islands.

To assess prey availability, annual hydroacoustic surveys of waters in the vicinity of haulouts and foraging areas have been conducted. Auke Bay Laboratory has played a primary role in these surveys by supplying acoustic equipment, expertise, and analysis. Standardized large-scale acoustic surveys were conducted in 2005 and 2006 using a box pattern. These surveys were replicated three times every other week from May through August in Johns Hopkins Inlet and around the Beardslee Islands to determine seasonal dynamics of available prey near these haulouts. Random adaptive fine-scale acoustic surveys were also conducted to estimate prey availability in foraging areas of individually tagged harbor seals.

The acoustic hardware used to disperse and collect acoustic data consisted of a 38-kHz split beam system towed in a tow body at a depth of 2 m and a speed of 6-7 knots. Nautical area scattering coefficient (NASC), average, maximum, and minimum depths, and total area surveyed will be calculated in order to analyze prey concentrations. Echoview is the acoustic analytical software used to manipulate the data, tabulate depths and survey areas, and calculate the NASC values used. Field collection of hydroacoustic data will be continued in 2007.

Preliminary hydroacoustic analysis of the 2005-06 data for the Beardslee Islands shows dense aggregations of small schooling fish from the surface to 70 m at irregular intervals throughout the area. In contrast, Johns Hopkins Inlet had diffuse layers of prey available at 80-100 m and from 250 m to the bottom with a maximum of depth of 320 m. Preliminary data for tagged animals show seals that haul out in the Beardslee Islands with its higher density of prey, travel shorter distances, and rarely leave the island complex. However, seals that haul out in Johns Hopkins Inlet, where the prey concentrations are less dense and more scattered, have to travel greater distances to forage. In some cases, seals tagged in Johns Hopkins Inlet traveled over 100 km to forage.

Acoustic surveys will provide future information related to seasonal prey availability and density, which are central to understanding the variability in movement of seals between haulouts and throughout the park. Ultimately, the locations of harbor seal foraging and haul-out areas will be integrated with data from time depth recorders attached to the animals, hydroacoustic data, and tagged animal data. The integrated data will provide information on foraging behavior in relation to prey availability and may shed light as to why harbor seals are declining in Glacier Bay National Park.

By David Csepp

2006 Sablefish Longline Survey

The AFSC has conducted an annual longline survey of sablefish and other groundfish in Alaska since 1987. The survey is a joint effort involving two divisions of the AFSC: ABL and the 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 2006, the 28th longline survey of the upper continental slope of the Gulf of Alaska and eastern Aleutian Islands was conducted. One hundred-forty-eight longline hauls (sets) were completed between 4 June and 1 September 2006 by the chartered fishing vessel *Alaskan Leader*. Sixteen kilometers of groundline were set each day, containing 7,200 hooks baited with squid.

Sablefish was the most frequently caught species, followed by giant grenadier, shortspine thornyhead, and Pacific cod. A total of 87,032 sablefish were caught during the survey. Sablefish, shortspine thornyhead, and Greenland turbot were tagged and released during the survey. Length-weight data and otoliths were collected from approximately 2,400 sablefish. Killer whales took fish from the longline at several stations in the Aleutian Islands and in the western Gulf of Alaska near Dutch Harbor, where these whales have frequently impacted survey operations in past years. Sperm whales were often present during haul back and were observed depredating on the longline at multiple stations in the eastern and central Gulf of Alaska.

Several special projects were conducted during the 2006 longline survey. Corals caught on the line were collected for identification and sample preservation. A seabird occurrence study was conducted for the fifth year, which helps to address where and when certain seabird species occur in Alaska waters. Spiny dogfish were sampled during the west Yakutat and central Gulf legs for biological studies conducted by graduate students from the University of Alaska Fairbanks and the University of Washington. A giant grenadier reproductive biology study was conducted during the Southeast leg, and maturity samples of these fish were taken for histological analysis. A marine mammal observer was on board during the first two survey legs in the Aleutian Islands and the western Gulf of Alaska to collect photo identification of resident killer whales that were observed depredating on the gear. A second marine mammal observer studied sperm whale depredation in the eastern and central Gulf of Alaska. Photo identification, dive behavior observations, and biopsy samples were collected. Finally, a 2-day experiment was conducted off Yakutat to collect genetic tissues of rougheye rockfish and to investigate depth distribution patterns of "light" and "dark" color phases of rougheye rockfish.

By Chris Lunsford

OCEAN CARRYING CAPACITY PROGRAM

Environmental Monitoring at Auke Bay

Daily records of Auke Bay climate and sea surface temperatures were maintained through 30 September 2006. Summer 2006 continued to be significantly wetter than average, with near record rainfalls in August and September. Air temperatures were generally below average during most of the summer, reflecting the generally overcast and rainy conditions in August and September. Although there is a perception that this past year has been unusually wet and cold, the data indicates that most of the spring and summer have been wetter, but slightly warmer than average. Analyses summarizing data through December 2004 show a trend toward increasing temperatures and increasing precipitation. Temperatures and precipitation in 2005 and 2006 have continued the trend.

By Bruce Wing

MARINE SALMON INTERACTIONS PROGRAM

Trophic Interactions among Wild and Hatchery Juvenile Chum Salmon in Taku Inlet

The Early Ocean Salmon (EOS) task of the Marine Salmon Interactions Program at ABL continued work on a collaborative investigation of the ecological interactions of hatchery and wild juvenile chum salmon in Taku Inlet near Juneau. This research is funded by the Southeast Sustainable Salmon Fund to address concern about the recent decline of wild chum salmon in the Taku River, which coincided with increased production of enhanced stocks of chum salmon in nearby waters. Cooperating agencies and institutions include the University of Alaska Juneau Center for Fisheries and Ocean Sciences, ADF&G, and Douglas Island Pink and Chum Hatchery (DIPAC). The DIPAC hatchery releases chum salmon juveniles at several locations near Taku Inlet in May during the wild fry out-migration; all of these hatchery releases are marked with thermally-induced patterns on their otoliths. Collaborating researchers sampled wild chum and DIPAC hatchery chum salmon juveniles that utilize Taku Inlet, using beach seines in littoral habitat and tow nets in nearshore habitat at sampling stations in inner, middle, and outer Taku Inlet from late April to late June in 2004 and 2005.

The EOS component of the Taku project is assessing trophic interactions of juveniles as a potential cause for declining wild adult chum salmon returning to the Taku River. Mortality of Pacific salmon during their marine life history is highest during this early period and may be related to competition for food. The university component of the Taku project is examining juvenile chum salmon abundance and distribution and found that hatchery fish comprised greater than 90% of catches in the outer inlet, but only 10% of catches in the inner inlet. Hatchery fish were also larger than wild fish, but smaller hatchery fish spent more time in the inlet than larger individuals.

We are examining diet and energy content of these wild and hatchery chum salmon juveniles, which were preserved for stomach analyses or frozen for calorimetry, to determine energy content. Sample processing is complete and analysis is under way for 2004, the first of the two project years; sample processing for the 2005 collections is ongoing. Otoliths were extracted and examined for hatchery thermal marks, then subsamples representing wild and hatchery stocks were processed for diets (n = 486) and calorimetry (n = 571). We also determined a baseline energy content for hatchery chum salmon (n = 63) upon their release in May and diet and energy content for both stocks from summer trawl catches in Icy Strait (n = 114) to compare condition of the fish as they approach the Gulf of Alaska (GOA).

Hatchery chum salmon were initially larger and had greater energy content (cal/g wet weight) than wild fish; however, energy values converged by mid-June in outer Taku Inlet, and wild fish in Icy Strait were in similar condition as hatchery fish. Multivariate analysis of 54 prey measures indicated that diets of the two groups were distinct throughout the season in all inlet locations and converged in Icy Strait. Further analysis is needed to determine if the diet partitioning and energetic differences in Taku Inlet are related to high densities of hatchery fish residing short term in outer Taku Inlet. If density-dependent interactions are affecting wild chum salmon in the inlet, the negative effects must occur very rapidly because juvenile survivors enter the GOA with no apparent disadvantage.

By Molly Sturdevant and Alex Wertheimer

Little Port Walter 2006 Chinook Salmon Return

Chinook salmon produced as part of the ABL research at the Little Port Walter (LPW) Marine Research Station contributed strongly to the commercial and sport fisheries during 2006 in Southeast Alaska. Commercial and sport catches totaled nearly 3,600 LPW Chinook salmon. Numerical expansions for fishery sampling fractions for many of the individual tag recoveries are not yet available, so this number is likely a minimum estimate. Of particular note is the large number of LPW Chinook salmon caught in the Juneau sport fishery during the Golden North Salmon Derby. Of the 514 Chinook salmon landed in the derby, 63, or roughly 12%, of the Chinook salmon caught were produced at LPW. This is likely the highest single source contribution for Chinook salmon to the local fishery.

In addition, LPW Chinook salmon represented a large percentage of all tagged Chinook salmon from Southeast Alaska facilities that were recovered in Southeast Alaska commercial fisheries. The catch rate for these fish was as high as 25% during particular troll and net openings in Southeast Alaska. The high rate of recoveries not only provides data for ABL research on distribution of hatchery and wild stocks, but also gives fishery managers important information regarding the catch and distribution of Alaska origin fish. These data help to optimize harvest strategies in order to maximize exploitation of hatchery stocks, and thereby increase the number of Chinook salmon that may be caught and retained under the Pacific Salmon Treaty between the United States and Canada.

The preliminary total escapement of Chinook salmon to LPW in 2006 is estimated to be 2,700-2,800 fish. Capture for returning adult Chinook salmon began on 29 June with the installation and deployment of the LPW floating fish aggregating device (FAD). Fish capture and processing began on 30 June with a catch of nearly 300 Chinook salmon. During the first week of capture we were able to capture and either hold or process almost 1,000 returning Chinook salmon.

As part of the Chinook salmon research on hatchery-produced and wild fish, Miles Johnson, an intern with the Hollings Scholarship Program, carried out a project to increase understanding of the relationship between the arrival timing and maturation timing in the LPW hatchery stocks and their donor wild stocks. With the assistance of LPW biologists, he tagged 1,541 large, returning adult Chinook salmon with Floy Tags over the time period from 30 June to 10 August. The holding pens, which used freshwater lens technology, reached maximum holding capacity at 1,600 fish on 17 July. The FAD accounted for almost 2,200 Chinook salmon captured in 2006.

The FAD effectiveness at capturing fish diminishes by the end of July, due to water flow gradients between the outfall of Sashin Creek and the culture water used as an attractant near the FAD location and other factors such as fish behavior. After July, fish aggregate at the creek mouth and swim closer to the surface and thus may be less susceptible to the FAD. Fouling of the FAD netting may also decrease its effectiveness. The presence of seals actively hunting in the FAD and weir areas may also have affected our ability to capture adult salmon. The FAD catches were supplemented with fish recovered from the creek mouth using a drop seine. A few Chinook salmon were also captured with sport and other gear.

More precise estimates of the LPW escapement will come from the removal and decoding of all coded wire tags recovered from Chinook salmon during October and November 2006. Returning Chinook salmon were processed to provide fertilized eggs for a project funded by the U.S. section of the Pacific Salmon Commission (PSC) studying the effects of ventral fin marking of juvenile Chinook salmon. Additional information from these fish on distribution, exploitation rate, and age and size at maturation will be used for further analysis as part of another U.S. PSC-funded project comparing these same parameters between wild Alaska Chinook salmon stocks and the LPW hatchery stocks derived from these wild stocks.

By John Joyce

Auke Creek 2006 Adult Pink Salmon Migration

Pink salmon spawn throughout the Auke Lake system in the tributaries to Auke Lake, Auke Creek, and in the intertidal area where the creek enters seawater. Pink salmon were counted at Auke Creek in 1967 and 1968, and each year since 1971. Annual counts of pink salmon at Auke Creek show the interannual variability common in this fish. Pink salmon escapements at Auke Creek ranged from 650 to 28,000 fish over the last 40 years, and it was not unusual to see a 5- to 10-fold increase or decrease in consecutive even- and odd-year brood lines.

A total of 13,198 wild pink salmon returned to Auke Creek in 2006, the largest even-year run since 1994. These fish were produced by the 2004 brood-year spawners, the progeny of which emigrated to the ocean as juveniles in 2005. In 2006, pink salmon were counted daily at the fish-counting weir at Auke Creek from the fourth week of July through mid-September, which is within the normal range of timing at Auke Creek. The run was characterized by several peaks of high daily counts at approximate weekly intervals beginning the first week of August. This was a departure from the historic pattern of pink salmon migrations at Auke Creek, with migrations that usually peaked in mid-August and mid-September.

The overall midpoint of the 2006 run was 18 August, which along with 1983 and 1992 was the earliest on record for Auke Creek. The average midpoint of adult migration for 1967-2005 was on 30 August, and during the 1960s and 1970s the midpoint of the run was in September. Prespawning mortality of adult pink salmon in Auke Creek was high, and estimates from daily recovery of fish at the fish counting weir showed that approximately 50% of the females died before spawning.

In even- and odd-numbered years there are two distinct runs of pink salmon at Auke Creek, referred to as the early and late runs. Because all returning fish are individually handled and counted by sex at the fish counting weir, it is possible to estimate the number of fish in both runs. Based on the increase in the proportion of silver-colored females with deciduous scales, 31 August was considered the start of the late run in 2006. At that time, early-run females were ready to spawn while late-run females were not, and fish could be easily distinguished when handled during counting. The early and late runs for 2006 were 10,685 and 2,513 fish.

The larger proportion of fish in the early run continued the pattern of greater abundance of that component, which became apparent in the mid-1980s. Before then the late even- and odd-year runs dominated the total returns of pink salmon at Auke Creek and averaged 73% of the total return. Before the mid-1980s there were often large numbers of fish into the third or fourth weeks of September. Since the mid 1980s, in both even- and odd-year runs, the average late component of the run averaged about 30%, and the run often dwindled to low numbers and ended during the second week of the month. It appears that the late September component of the Auke Creek pink salmon run continues to decrease.

By Jerry Taylor

FISHERIES MONITORING & ANALYSIS (FMA) DIVISION

FMA STAFFING CHANGES

Several staff changes took place in the Fisheries Monitoring and Analysis (FMA) Division this quarter. Doug Turnbull joined our staff as lead for the Information Monitoring Technologies program. Doug comes to FMA from the Office of Science and Technology at NMFS Headquarters in Silver Spring, Maryland, where he served as the data administrator. Jennifer Cahalan also joined us as a Pacific States Marine Fisheries Commission contract employee; she will be providing statistical and analytical support. Jennifer formerly worked for the Quantitative Assessment unit of the Science Division of the Washington Department of Fish and Wildlife. Two former North Pacific groundfish observers also took positions with FMA: Marlon Concepcion works with the debriefing team, and Neil Riley works in the Information Monitoring Technologies program. Last, Todd Loomis resigned from our Anchorage office to pursue other interests outside of government. Todd made a number of significant contributions over his years and we wish him well in his new endeavors.

SPECIAL PROJECTS: USER INFORMATION NEEDS

SHORT-TERM PROJECTS

This quarter, we address both the short- and long-term information needs of our data users. For short-term (1-2 years) information needs, we assign observers to complete special data collection projects that include tasks additional to normal observer duties. The process for developing special projects starts in March each year when we solicit requests from interested parties for implementation in the following fishing year. The FMA Division has conducted special projects for AFSC scientists, NMFS Alaska Regional Office fishery managers, staff from various other fisheries agencies, and, on occasion, other interested parties including graduate students. We set our deadline for special project requests at the end of August, which gives us time to review each project, fine tune it with the requester as necessary, develop training materials, and then provide training for the observers who will be assigned with the project when deployed. We strive to accept and complete all projects requested, but this is dependent on the volume of requests and the demands the projects place on observers who already are tasked with normal catch sampling duties. When we cannot accept all requests, we work through the AFSC Division Directors to set priorities.

To assess the efficacy of special projects, we ask observers to complete a post-deployment questionnaire developed for each project. The questionnaires are designed to assess any impact the project may have had on their normal duties and provide observers the opportunity to offer suggestions and comments. This feedback is reviewed by staff and used to help improve future data collections.

Data collected for special projects address a range of needs. Titles from the 2006 projects are a good illustration: Spiny Dogfish Maturity, Octopi Sex and Weight, At-Sea Offal Discharge, Skate Vertebrae Collection (Aleutian, Bering, and Whitebrow), Pacific Cod Maturity, Salmon Genetics, Atka Mackerel Tag Reporting, Atka Mackerel Spawning, Trawl Gear Measurements, Seabird Attraction to Trawler Discharge Plumes, Monitoring Additional Sources of Seabird Mortality on Trawlers, Hook Spacing, Northern Rock Sole Maturity, Skate Lengths, and Atka Mackerel Testes Collection. We expect these projects to continue to evolve, and we will strive to continue to meet the changing data needs.

LONG-TERM PROJECTS

The work required to meet the long-term need of data users can be more substantial, particularly when changes impact our data collection and processing systems. Such complex changes generally result from identifying and discussing the long-term needs and agreeing to them well in advance of implementation. We encourage all users to discuss their long-term needs with FMA senior staff. Long-term data collection projects differ from the special short-term projects noted above because they result in significant changes to the standard suite of duties assigned to observers for the foreseeable future.

In considering long-term changes to our data collections, we assess the practicality of collecting the needed information aboard commercial fishing vessels. Based on our assessment, we often make changes to data collections in consultation with the requester. Sometimes we establish a short-term special project to evaluate the feasibility of a potential long-term change. Recommendations for changes are reviewed by FMA managers before implementation.

Our preparatory work for each fishing year incorporates feedback received from observers, staff, and data users on the various aspects of our data collections. During the data quality control processes, FMA staff compile notes on misconceptions and data errors encountered. When particular problems are documented for multiple observers we evaluate our training materials and make appropriate improvements.

Changing data collection procedures and incorporating feedback requires close coordination among staff and the contractors who prepare observers for deployment. A substantial amount of the training is conducted by the North Pacific Fisheries Observer Training Center (OTC) at the University of Alaska, Anchorage. Twice a year, OTC and FMA training staff meet to plan and prepare observer training materials. These coordination meetings allow observer trainers to review common errors, new sampling policies, and the newest version of the observer sampling manual. During the meetings, the trainers develop lesson plans and training materials. Because the fishing year begins in January, new training materials must be completed by late November so that they are available for presentation to the first wave of observers who train in December.

In summary, the FMA Division has processes for addressing both long- and short-term data needs of our data users. Early identification of such needs helps us plan for incorporating new collections into our data systems and determine new protocols for training observers for the coming fishing year.

By Allison Barns, Jennifer Ferdinand, Martin Loefflad, and Brian Mason

HABITAT & ECOLOGICAL PROCESSES RESEARCH (HEPR)

LOSS OF SEA ICE WORKSHOP

On 19 July 2006, the AFSC's new Habitat and Ecological Processes Research (HEPR) Program convened a workshop to review an implementation plan for a permanent, long-term research program directed at determining the impacts of the loss of sea ice on the Bering and Chukchi Seas. The workshop purpose was to provide AFSC scientists the opportunity to review the draft before the plan is finalized. Three independent but interrelated research themes have been identified for the Loss of Sea Ice (LOSI) program, which focus on loss of sea ice in different regions and seasons.

- Theme 1 - Enhanced forecast capabilities through a focus on winter preconditioning and the influence of winter ocean conditions on the spawning distributions of commercially important fish and shellfish species;

- Theme 2 - Enhanced forecast model capabilities through a focus on ice edge processes including the development of spring bloom and the foraging behavior and movement of ice dependent seals;

- Theme 3: Enhanced knowledge of stock status and trends through expanded assessments and comparative approaches with focus on benthic-pelagic coupling.

The LOSI implementation plan will be finalized in fall 2006. The HEPR Program is working with AFSC Leadership and NOAA's National Marine Fisheries Service headquarters to fund the research themes outlined in the LOSI implementation plan.

LOSI Workshop Participants

Jennifer Ferdinand	(FMA)
Ron Felthoven	(REFM)
Anne Hollowed	(REFM)
Dan Ito	(REFM)
Kerim Aydin	(REFM)
Janet Duffy-Anderson	(RACE)
Phyllis Stabeno	(PMEL)
Pat Livingston	(REFM)
Buck Stockhausen	(REFM)
Chris Wilson	(RACE)
Jim Ianelli	(REFM)
Michael Cameron	(NMML)
Peter Boveng	(NMML)
Russ Nelson	(RACE)
Dave Rugh	(NMML)
Dave Somerton	(RACE)
Jim Coe	(OCD)
Bernard Megrey	(RACE)
Mike Sigler	(HEPR)
Jamal Moss	(ABL)
Lisa Eisner	(ABL)

If successful, the HEPR Program will seek integrated proposals from the AFSC and the Pacific Marine Environmental Laboratory (PMEL) to implement the plan in spring 2009.

The impetus for the LOSI program stemmed from recent observations that the depth-averaged temperature of the eastern Bering Sea is warming and results of the Arctic Impact Assessment that indicate that climate change will have profound impacts on managed species in the Bering Sea. Scientists expect that in the next 50 years, these shifts will alter the spatial distribution and abundance of managed species in the Bering Sea, resulting in major changes to the Alaskan economy and the Bering Sea ecosystem. A research program targeting impacts of loss of sea ice is needed to study this unprecedented change within the historical record. Without a program in place now, the opportunity to monitor these changes will be foregone, and NOAA will be far less able to meet agency responsibilities for management of fish and marine mammal species.

Planning for a Loss of Sea Ice program in the Bering Sea was initiated by a series of intra- and interagency workshops. The workshops brought together an interdisciplinary group of scientists to discuss and review ideas for implementing research on the effects of climate on sea ice formation in the Bering Sea and its associated impact on living marine resources and habitat. The core elements of a joint AFSC/PMEL LOSI program were outlined in a proposal developed in April 2005 by the Fisheries-Oceanography Coordinated Investigations (EcoFOCI) program and elaborated in reports on HEPR workshops conducted in June 2005, September 2005, and May 2006. Recognizing that efforts to understand the role of sea ice in the Bering Sea ecosystem would require an interagency coordinated effort employing the unique capabilities of each contributing agency also led to the formation of the Bering Sea Ecosystem Interagency Working Group (BIAW). The BIAW represents the North Pacific Research Board, National Science Foundation's Bering Sea Ecosystem Study, U. S. Geological Survey, U. S. Fish and Wildlife Service, Alaska Ocean Observing System, University of Alaska Fairbanks, U.S. Arctic Research Commission, the AFSC, and PMEL.

EFH Workshop Participants

Dan Ito	(REFM)
Kerim Aydin	(REFM)
Craig Rose	(RACE)
Buck Stockhausen	(REFM)
Mark Carls	(ABL)
Matt Eagleton	(AKRO)
Bob Stone	(ABL)
Mitch Lorenz	(ABL)
Bob McConnaughey	(RACE)
Jennifer Ferdinand	(FMA)
Bern Megrey	(RACE)
Jon Heifetz	(ABL)
Alan Haynie	(REFM)
Ron Felthoven	(REFM)
Ron Heintz	(ABL)
Mike Sigler	(HEPR)

Essential Fish Habitat Workshop

On 19 July 2006, the Habitat and Ecological Processes Research (HEPR) Program convened a workshop to review the NOAA Essential Fish Habitat (EFH) Research Plan for Alaska for FY 2007–11. The goal of the workshop was to provide AFSC scientists the opportunity to review the draft before the plan was finalized. The plan identified three research priorities.

- Coastal areas facing development;
- Characterization of habitat utilization and productivity;
- Sensitivity, impact, and recovery of disturbed benthic habitat.

The EFH plan has been finalized and approved by the AFSC Science Director and Alaska Regional Office Administrator. A copy is available on the AFSC Web site at *http://www.afsc.noaa.gov/HEPR/docs/EFH_researchplan.pdf*.

By Michael Sigler

NATIONAL MARINE MAMMAL LABORATORY (NMML)

CETACEAN ASSESSMENT & ECOLOGY PROGRAM

Disappearing Right Whales and the Secrets of Soviet Whaling

Recently, the National Marine Mammal Laboratory (NMML) came into possession of a collection of internal reports written by Soviet scientists working aboard whaling factory ships in the North Pacific. At the time that these reports were written, the U.S.S.R. was engaged in a massive worldwide campaign of illegal whaling, which began in 1947 and continued until introduction of the International Whaling Commission's (IWC) International Observer Scheme in 1972. During this period, in the Southern Hemisphere alone, the Soviets killed almost 100,000 whales that they did not report to the IWC; this included more than 48,000 humpbacks (of which 25,000 were killed in just 2 years). Illegal catches in the Northern Hemisphere (primarily in the North Pacific) were smaller, but still very substantial, and were equally or more damaging to some of the whale populations concerned.

Consequently, the Soviet scientific reports were highly secret and were intended solely for Soviet governmental consumption. They did not become available until after the Cold War, when they were provided to Bob Brownell (Southwest Fisheries Science Center) by the former Soviet biologist Fred Berzin. Berzin was the director of the marine mammal program at the Pacific Research and Fisheries Center (TINRO) in Vladivostok and the overall scientific leader for the whaling operations. The reports have now been translated for NMML by the Russian whale biologist Yulia Ivashchenko, whose broad knowledge of Russian, English, whale biology, and the mechanics of Soviet whaling was ideally suited to this task.

The Soviet reports make grim and very sad reading. They document the decline of many populations of whales due to the unrestrained illegal exploitation, and they state over and over the warnings of the authors that high levels of catches cannot be sustained without seriously depleting or even extirpating certain stocks. From the repeated laments of the authors from year to year, it is apparent that these warnings, and all other scientific advice that conflicted with the Soviet government's production targets, were routinely ignored by the authorities.

The decline of whale populations in the North Pacific and elsewhere as a result of illegal catches was in part an inevitable result of the Soviet system of industrial planning. The government set annual targets for quantities of whale products to be obtained from the hunt and paid factory fleet crews a bonus only if these targets were exceeded[1]. But, when this occurred (as it did in many of the earlier years), the following year's whaling plan would contain targets that had been ratcheted up to match the production level of the previous season. Consequently, whaling crews were forced to kill more and more whales to obtain their bonuses, and the populations concerned inevitably crashed under the pressure of over-exploitation.

The reports document dramatic declines in abundance, disappearances of whales from previously populous feeding and breeding areas, and a continual decline in the average size and age of animals in the catch as the over-exploitation reached critical levels. The fleets took everything, regardless of size, age, or reproductive status, and this disregard for the sustainability of the populations concerned became increasingly pronounced as whales became harder to find. Indeed, in 1971, the year before the International Observer Scheme came into effect, more than 45% of the mature female sperm whales killed were lactating (i.e., accompanied by a calf); as Fred Berzin noted in one of the reports, this was essentially equivalent to the birth rate.

When the International Observer Scheme was finally introduced in 1972, it was accompanied by a relaxation of the IWC regulation regarding the minimum length for sperm whale catches (from 11.6 to 9.2 m). This decision was made because of a concern by the IWC that too many males were being caught and, therefore, that the length limit should be lowered to encourage more catches of females. Tragically, this conclusion was based largely upon falsified data from the USSR, which had been greatly over-reporting catches of males to cover up long-standing over-hunting of females. Ironically, therefore, the Soviets—now prevented from illegal hunting by the presence of international observers aboard their factory ships—were suddenly permitted to continue the exploitation of this prime reproductive portion of the population. As Fred Berzin noted in his report for 1977, "The result of this was that some breeding areas for sperm whales became deserts."

The most notable example of the damage inflicted in the North Pacific is that of the right whale. By 1963, the eastern population of this species was showing signs of a slow recovery from the intensive historical whaling, which had begun in 1835. However, the remnant population was virtually extirpated by a Soviet catch of 372 whales between 1963 and 1967; most of these animals were taken in the southeastern Bering Sea and in an area south of Kodiak.

Recently, Yulia and I had an opportunity in Russia to meet with Nikolai Doroshenko, a biologist who was aboard the factory ship *Vladivostok* when they made the right whale catches. We asked him what percentage of the whales they encountered he thought they had succeeded in catching; the reply was "Pretty close to 100%."

No biological data were taken—the KGB Commissars aboard the factory ships were aware of the extreme sensitivity of these takes and prohibited the biologists from even examining or measuring the carcasses. (In one case elsewhere the scientists

Former Soviet biologist Nikolai Doroshenko explains details of North Pacific right whale catches to Yulia Ivashchenko in St. Petersburg in September 2006. Doroshenko worked aboard the factory ship *Vladivostok* in the 1960s. Photo by Phil Clapham.

[1] Initially, blubber was the only product derived from the catch; the rest of a carcass was discarded because the refrigeration capacity of the first factory ship, the *Aleut*, was small. With the introduction of the larger factory ships *Vladivostok* and *Dalniy Vostok*, both blubber and meat were processed and stored, and sometimes bonemeal was also prepared. Meat was separated into that fit for human consumption and that which could be fed only to animals; interestingly, all sperm whale meat was in the latter category.

Soviet floating factory *Slava*, circa 1965. Photographer unknown.

were actually locked in a cabin while the whales were being processed!) However, it is known that all right whales were targeted, including lactating females and nursing calves.

The significance of these illegal catches in the recovery history of the eastern North Pacific right whale stock is difficult to overstate. That the Soviets succeeded in killing virtually all of the right whales they encountered explains much about the apparent status of this population today. In recent years, right whale sightings have been so rare in this region that single records merited publication. The discovery by a NMML cruise in August 2004 of an aggregation of at least 17 right whales represented the single largest sighting since the Soviet catches 40 years before. Considering the intensity of the marine mammal surveys in the region over the past three decades, it is evident that right whales remain rare throughout their historical range in the eastern North Pacific, and few, if any, biologists would argue that the current population numbers more than a few tens of animals. It seems quite likely that the 372 whales killed by the Soviets comprised the bulk of the then-extant population, which was itself a remnant of a much larger stock that had been extensively exploited beginning in 1835. Today, the eastern North Pacific right whale is arguably the most endangered population of whales anywhere in the world—a direct result of the illegal whaling documented in the Soviet reports.

The collected reports have been edited by Ivashchenko, Brownell and myself, and are currently being prepared for publication as a NOAA Tech. Memo. In the meantime, they are available in a single volume from the NMML Library.

By Phil Clapham

August 2006 Survey of Belugas in Cook Inlet

NMFS biologists conducted an aerial survey of the beluga whale population in upper Cook Inlet, Alaska, 16-17 August 2006. The survey (10.1 flight hours) provided thorough coverage of all coastal areas north of East and West Forelands in the upper inlet (Fig. 1). Consistent with NMFS surveys conducted since 1993, the August 2006 survey was flown in a high-wing, twin-engine aircraft at an altitude of 244 m (800 ft) and a speed of 185 km/hr (100 kt). The survey in August 2006 was different from most previous surveys in that it was done in a Twin Otter aircraft, instead of an Aero Commander, and paired, independent searches were not conducted. Tracklines were flown both parallel to the coast (1.4 km offshore) and across the inlet. When beluga groups were encountered, a series of aerial passes was made with two observers each making four or more independent counts. The primary intent of the survey was to document whale groups in video cameras for an analysis of age structure (white adults relative to dark juveniles).

Belugas were found near the mouth of the Susitna River (median counts of 116 whales on one day and 47 on the second day), in Knik Arm (10 belugas on the first day and 95 on the second), and in Turnagain Arm near Bird Point (2 belugas seen on the second day). These sighting locations were fairly typical of the distribution seen each June except that it was unusual to find no whales in Chickaloon Bay. The density of the whale group seen near the Susitna River on 17 August was one of the highest ever observed; but on the next day, belugas were in small, somewhat dispersed groups in this area. Meanwhile there was nearly a tenfold increase in whales at the far end of Knik Arm indicating that many whales

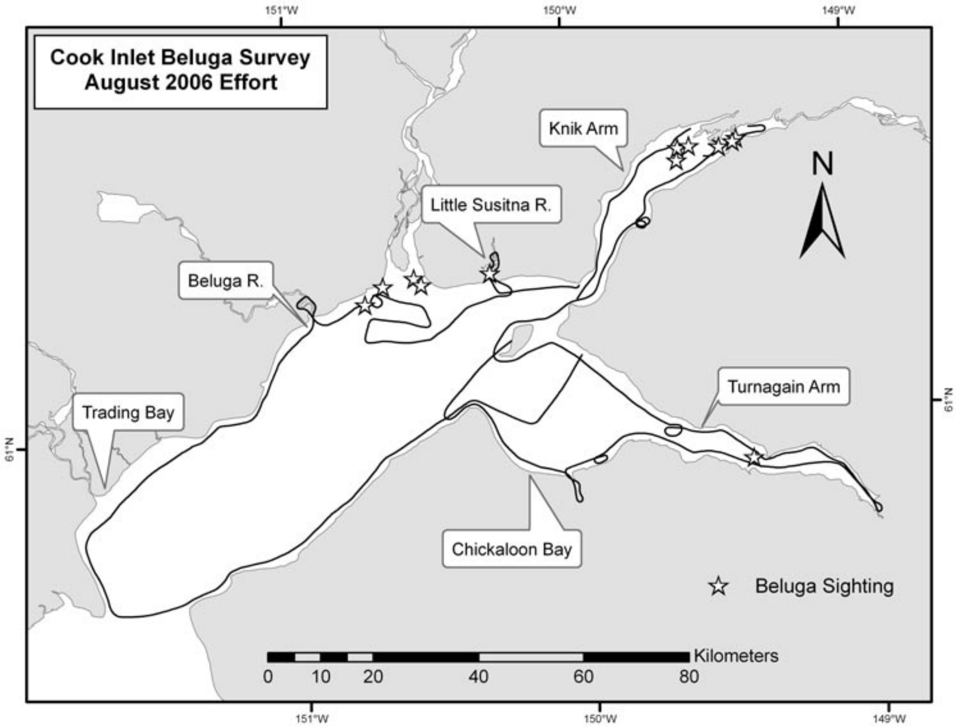

Figure 1. On-effort tracklines and beluga sightings for upper Cook Inlet on 16-17 August 2006.

had moved from the Susitna River to Knik Arm. The daily median estimates (a quick index of relative abundance not corrected for missed whales) were 126 for 16 August and 143 for 17 August. The latter count compares favorably with the index count for June 2006 (153 belugas) but is below the similar count done in August 2005 (236 belugas on 11 August and 277 on 12 August).

By Dave Rugh, Kim Goetz, and Christy Sims

ALASKA ECOSYSTEMS PROGRAM

Recent Work on Steller Sea Lions and Northern Fur Seals

The Alaska Ecosystems Program (AEP) is responsible for investigating hypotheses for the decline of Steller sea lions and northern fur seals in Alaska. In past years, the field work throughout summer and fall has seen a greater emphasis on sea lion work as compared to fur seal projects. However, summer and fall of 2006 were unique with nearly all field work attributed to northern fur seals. There are two explanations for this. First, a recent lawsuit filed by the Humane Society of the United States effectively halted all Steller sea lion field work as of 31 May 2006 until the agency completes an Environmental Impact Statement. Second, 2006 was the year of our biennial fur seal pup estimate survey on the Pribilof Islands and also included two large projects examining fur seal behavior.

In July-September 2006, AEP's Steller sea lion research effort was limited (by the court-ordered cessation of all permitted Steller sea lion research) to the field camps at Beach 4 and 7 on Marmot Island (near Kodiak, Alaska). Five researchers (Kathryn Chumbley, Erin Kunisch, Rhonda Dasher, Mary Malley, and Robin Solfisburg) spent July overlooking rookeries on the island collecting information on attendance, pup production, population demography, behavior, and sightings of permanently-marked animals. Maximum pup counts on the island totaled 428 in July 2006, which is similar to the 433 counted in late June 2005. A total of 58 unique, permanently-marked sea lions were observed: 48 were originally marked as pups in 1987 (n=1) or between 2000 and 2004 (n=47) on Marmot Island, 4 on Sugarloaf Island, 1 on Forrester Island in Southeast Alaska, and 1 on St. George Reef in northern California; the remaining 4 were captured and marked as juveniles as part of foraging studies. Of the 26 marked females age 4 or older observed on Marmot Island, 4 were observed nursing a pup born in 2006, while 1 was observed nursing a juvenile most likely born in 2005. The remaining 21 marked, mature females were not seen with a pup in 2006.

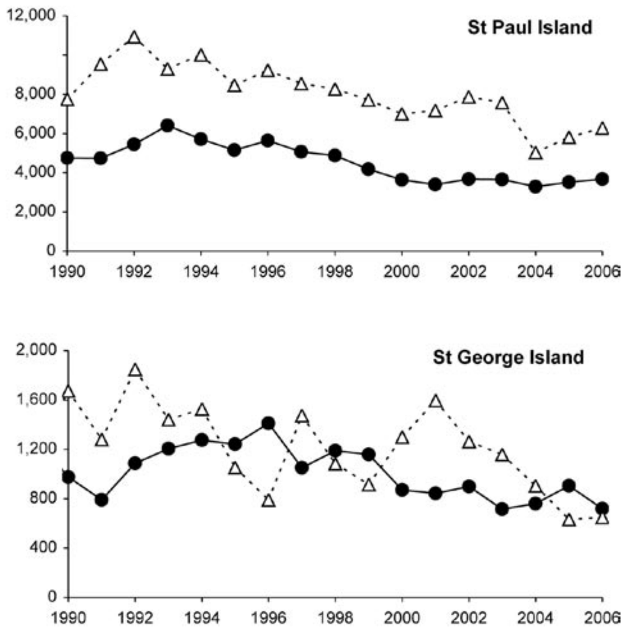

Figure 1. Temporal dynamics of the counts of adult male northern fur seals on St. Paul and St. George Islands, 1990-2006, showing territorial males with females (filled circles) and idle males (territorial without females and nonterritorial combined) (triangles).

During 2006, the AEP conducted population monitoring of northern fur seals in Alaska. The number of territorial and idle fur seal bulls on the Pribilof Islands has been counted regularly since 1911. This occurs in mid-July each year and has provided one metric of the population trend during and since the years of substantial commercial harvest. Counts of adult males occurred during 2006 on St. Paul Island, St. George Island, and Bogoslof Island. Counts of territorial males with females ("harem" males) on St. George decreased by over 20% compared to 2005, while idle males increased in comparison to last year (about 2.4%). On St. Paul, the idle males increased by 7.5% and the "harem" males increased by 4.2% (Fig. 1). Overall, the total number of adult males counted on the Pribilof Islands was 11,322, representing an increase of 4.0% from 2005. The total number of territorial males with females remained about the same for the Pribilof Islands, declining about 0.7%. On Bogoslof Island, 1,200 (compared to 1,123 in 2005) adult male northern fur seals were counted.

The second component of northern fur seal population monitoring involved pup production estimates. The number of pups born in the Pribilof Islands is estimated every 2 years using mark-recapture methods. The project requires up to 15 people working for a week or more to mark in excess of 10,000 pups. Pup production data were obtained during August on St. Paul Island and St. George Island and are currently being analyzed to determine the final estimates for each island.

Behavioral work included the final field season of the collaborative COFFS (Consequences of Fur Seal Foraging Strategies) project, funded by the North Pacific Research Board, which focuses on adult female behavior during the nursing period and over winter. This project, a collaboration between AEP staff, the University of Alaska Fairbanks, and Dalhousie University, compares the behavior of fur seals in the decreasing St. Paul Island population with a smaller but increasing population at Bogoslof Island in the eastern Aleutian Islands. Twenty adult females and their pups were captured at each island in July for physiological studies of condition and to attach satellite transmitters and dive recorders. During October, the pairs were recaptured to retrieve the instruments and to repeat the measurements of condition.

Finally, the program finished the first full season of a 2-year project examining the over-winter behavior of newly weaned fur seal pups. In October-November of 2005, 99 satellite tags were attached to pups at all four North American rookeries (St. Paul and St. George Islands, Bogoslof Island, and San Miguel Island, California) before they began their over-winter migration. An additional 70 tags are now being deployed to complete the field work of that particular project.

By Rolf Ream, Lowell Fritz, and Tom Gelatt

POLAR ECOSYSTEMS PROGRAM

Researchers Census Harbor Seals in the Gulf of Alaska

NMML's Polar Ecosystems Program conducts aerial surveys of harbor seals in Alaska every August during the molt when seals spend much of their time out of the water. For logistical purposes, Alaska is divided into five regions and one region is surveyed each year. The five regions are: the Gulf of Alaska (surveyed this year) (Fig. 1), northern Southeast Alaska (2007), southern Southeast Alaska (2008), Aleutian Islands (2009), and the north side of the Alaska Peninsula and Bristol Bay (2010). The 2006 surveys were conducted 5-17 August and used 12 aircraft and 12 researchers from NMML, the Alaska Department of Fish and Game, the Alaska Sea Life Center, and the Coastal and Marine

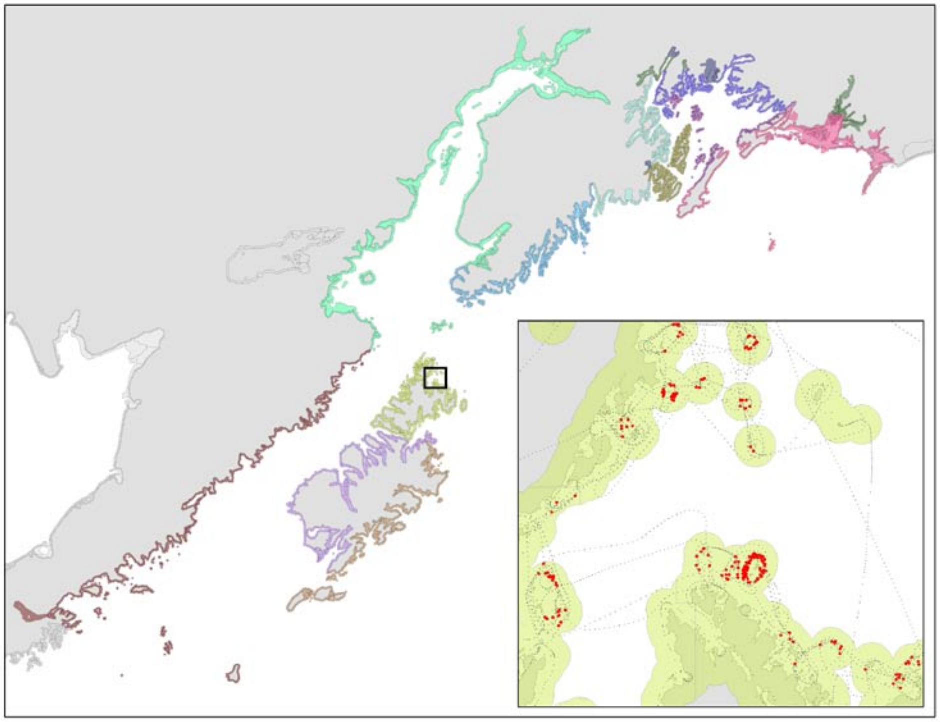

Figure 1. Map of the Gulf of Alaska region showing the twelve survey areas (by unique color/shading). The inset shows the locations of select coastal polygons (i.e., suitable harbor seal habitat), and photographs (red dots) taken at harbor seal haulouts on Kodiak Island. The gray dotted lines show the flight tracks of the survey plane(s).

Resources Centre (Cork, Ireland). We utilized four NOAA and eight charter aircraft. Five planes and crew were based in Cordova, four in Kodiak, two in Homer, and one in Moose Pass (near Seward).

All surveys were conducted within 2 hours of low tide. Observers spent the first few days flying reconnaissance, which entailed searching for haul-out sites along the entire coastline within each area. With new and historic sites mapped, surveys were flown daily from site-to-site to maximize the number of counts at each haulout. Each plane's movement was recorded using a GPS while observers kept track of effort. Digital cameras provided a time stamp for each image so that it could later be geo-referenced. Most photographs were taken hand-held from oblique angles at elevations of 500-1,000 feet. Sites where seals were hauled out on ice were photographed using a down-looking digital camera linked to a GPS. This year, weather conditions were unusually poor, particularly in Prince William Sound, where several flights were cancelled due to precipitation and low visibility. Despite the weather, at least four replicate surveys were conducted at most, if not all, of the larger seal haulouts. Analyses have shown that the larger haulouts (>20 seals) account for the vast majority of variability in counts across days. Image processing and counting will occur at NMML over the next several months.

The 2006 surveys were conducted under a new protocol designed to improve the spatial and temporal resolution of our surveys, data management, and workflow. The entire range of harbor seals in Alaska was divided into fixed areas ("polygons") for documentation of seal counts and survey effort. In past surveys, seal haulouts and counts were accurately associated with geographic coordinates, but it was often difficult to manage the documentation of locations where seals were absent (i.e., to distinguish between true zeros and haulouts that were missed). Geo-referenced photographs, and the seals counted in them, can now be assigned to a particular polygon, and observers can easily confirm whether each polygon has been completely surveyed. This approach allows observers to focus on sighting seals and enhances continuity in the technique across years when observers and pilots may change. For archival purposes, the coordinates calculated for each image are stored within the metadata of each image file. As the seals within images are counted (using Adobe Photoshop® and Adobe Bridge® CS2), abundance estimates will also be stored within the metadata of each image as custom XMP fields. Storing the survey data within the image metadata eliminates the need for an intermediate spreadsheet or database and thus reduces error. Prior to analysis, these metadata can be extracted in a batch process and stored directly to a SQL server database. Various analytical programs can then access the survey data directly from the SQL database.

By Dave Withrow, Josh London, and John Jansen

RESOURCE ASSESSMENT & CONSERVATION ENGINEERING (RACE) DIVISION

GROUNDFISH ASSESSMENT

Bottom Trawl Survey of the Eastern Bering Sea Completed

The 2006 annual crab and groundfish bottom trawl survey of the eastern Bering Sea (EBS) continental shelf was completed on 28 July. Two chartered commercial fishing vessels, operated 60 days each, were used to deploy National Marine Fisheries Service (NMFS) research nets at 405 stations over a survey area that represents approximately 500,000 square kilometers. Derived estimates of fish biomass, population size, and size and age composition are key inputs to stock assessment analyses used by the North Pacific Fishery Management Council (NPFMC) in the annual setting of allowable biological catch (ABC) and total allowable catch (TAC) for commercial groundfish in the EBS such as walleye pollock, Pacific cod, and various flatfish species. Current biomass and population estimates from the 2006 EBS crab and groundfish bottom trawl survey were presented at the Crab Plan Team Meeting, 13-15 September, and at the Groundfish Plan Team Meeting, 19-22 September.

Groundfish Assessment Program Summer Interns

Sam Galle, NOAA Hollings Scholar, recently finished a summer internship with Lyle Britt investigating how flatfish locate, track, and capture prey. By analyzing high-speed video of feeding events and calculating the visual acuity, ocular movement ranges, and retinal mosaic patterns within the eyes of English sole (*Parophrys vetulus*) and starry flounder (*Platichthys stellatus*), Sam found that the dorsal and ventral eyes of these species had very different morphological arrangements and were used for different roles in prey capture. This discovery may be the first instance in which a vertebrate has been found to possess asymmetrical morphological constructs within the visual system. After additional analysis is completed, Sam hopes to publish his findings.

Cara Murphy, Western Washington University student, participated in an AFSC paid internship during summer 2006. Cara worked with RACE groundfish scientist Stan Kotwicki on the design and development of a new Oracle database for storage of light intensity data collected during RACE groundfish surveys. Her work was very successful and the database is in final stages of development. Cara also created 3-dimensional (3D) maps of light intensity data from EBS trawl surveys using ArcScene – ArcGIS software for presenting 3D data. She will continue to cooperate with the AFSC during her senior year in college. She will use light intensity data to describe the relationship between satellite data (chlorophyll a, primary productivity, diffuse attenuation coefficient) and “in situ” observations of light levels in the Bering Sea. We wish her best of luck in her future endeavors.

By Robert Lauth

Correlating Trawl Catch and Acoustic Data in the Eastern Bering Sea

The commercial fishing vessels chartered for the annual EBS bottom trawl survey in recent years have installed Simrad ES-60 echosounders, which are capable of collecting scientific-quality acoustic backscatter data. Because the operation of these echosounders during the survey provides a large amount of inexpensive and continuous backscatter data between trawl stations, it is of interest to investigate whether these acoustic data could be used to improve the precision of the walleye pollock (*Theragra chalcogramma*) trawl index of abundance estimates through incorporation of acoustic data in the estimation methodology.

Catch and acoustic backscatter data collected from over 400 stations executed during the 2005 field season were analyzed to estimate the correlation between trawl-based and acoustic-based estimates of fish abundance in various layers above the seafloor. Initial comparisons of the trawl- and acoustic-derived values revealed good correlations, with the best correlation evident for the walleye pollock layer observed between the bottom and the headrope ($R^2 = 0.61$). The pattern of correlation for those layers above the headrope was characterized by a monotonic decline with increasing height, indicative of a lack of vertical herding response among pollock. By comparison, there was no observed correlation ($R^2 = 0.02$) between trawl and acoustic data for Pacific cod (*Gadus macrocephalus*), the only other significant source of fish acoustic backscatter. Further work will focus on the potential reasons for the discrepancy in the strength of the trawl-acoustic relationship between pollock and cod as well as the factors that may adversely affect the correlation between trawl and acoustic data in general.

By Paul von Szalay

Bottom Trawl Survey of Aleutian Islands Region Completed

The fourth in the series of biennial bottom trawl surveys of Aleutian Islands (AI) region groundfish resources was conducted from 1 June through 11 August 2006. The full series of periodic AI surveys dates back to 1980. Prior to establishing a biennial schedule in 2000, these surveys had been conducted mostly on a triennial schedule by the RACE Division. Surveys conducted prior to 1991 were cooperative efforts involving U.S. and Japanese vessels and scientists. Since 1991 they have been planned and conducted entirely by the RACE Division. The primary objective of the surveys is to provide a standardized time series of data to assess, describe, and monitor the distribution, abundance, and biological condition of AI region groundfish and invertebrate stocks. Additional objectives are to collect environmental data, such as surface-to-bottom water temperature profiles, and to make special collections of biological specimens and data requested by AFSC scientists and cooperating research groups.

The 2006 AI triennial survey area stretches over 900 nautical miles (nmi) from the Islands of Four Mountains (long. 170°W) to Stalemate Bank (long. 170°E), including stations on Petrel Bank. In addition, the region between 165° and 170°W along the north side of the archipelago is included as the Southern Bering Sea subarea. Stations range in depth from nearshore to 500 m. Sampling was conducted aboard the chartered commercial trawlers *Sea Storm*, which was under charter for 70 days, and the *Gladiator*, which was chartered for 50 days. Sampling began near the Akutan Pass and progressed westward to Adak during the first 25-day leg. For safety considerations, the westernmost portion of the survey was completed at the beginning of the second leg, leaving the central portion for the final leg when the *Sea Storm* was operating alone. Stations were allocated among 45 depth and geographic strata and were preselected randomly from a grid of potential sites overlaying the survey area. If untrawlable bottom, swift currents, or conflicts with active commercial fishing prevented sampling a station, a nearby alternate station was selected. Of 366 stations assigned to the vessels, 358 stations were successfully completed, ranging in depth from 32 to 484 m.

Over the total survey area, the most abundant species in 2006 were, Atka mackerel, Pacific ocean perch, northern rockfish, giant grenadier, arrowtooth flounder, walleye pollock, and Pacific cod in order of abundance. Increases in survey-wide estimated biomass since 2004 were observed for Pacific ocean perch by 16% to 667,000 metric tons (t); northern rockfish by 15% to 218,000 t; and arrowtooth flounder by 94% to 184,000 t. Survey-

Large mixed catches of northern rockfish and Atka mackerel are common during bottom trawl surveys of the Aleutian Islands region. Photo by Nancy Roberson.

Figure 1. The FISHPAC field party consisted of scientists, engineers, and technicians from the RACE Division's Habitat Research Team, the NOAA ship *Fairweather*, the University of New Hampshire Center for Coastal and Ocean Mapping, the U.S. Navy, and L-3 Communications Klein Associates. This was the first venture for the *Fairweather* into the Bering Sea since reactivation for hydrographic surveying and multimission research in Alaska.

wide biomass estimates decreased for Atka mackerel by 36% to 741,000 t; giant grenadier by 22% to 193,000 t; pollock by 69% to 113,000 t; and cod by 19% to 93,000 t. Results have been supplied to stock assessment authors for updating assessment reports for the NPFMC.

Biological data and specimens were collected from a wide variety of groundfish and invertebrates. More than 96,000 length observations were recorded from 52 species. Length and individual weight measurements were recorded from almost 10,600 fish from 50 species. Over 7,800 pairs of otoliths were collected from 20 species, including 3 species of sculpin that were sampled for the first time this year.

By Mark Wilkins

FISHPAC Habitat Mapping Experiment on the NOAA Ship *Fairweather*

The broad scope of the Magnuson-Stevens Fisheries Conservation Management Act's essential fish habitat (EFH) mandate requires an efficient process for describing and mapping the habitat needs of federally managed species. For example, research indicates surficial sediments affect the distribution and abundance of many groundfish species, yet traditional sampling with grabs and cores is impractical over areas as large as the Bering Sea shelf. Acoustic tools, on the other hand, are suitable for large-scale surveying and show great promise as a substitute for direct-sampling methods, but they have not been proven for EFH purposes.

A multidisciplinary research team lead by RACE Division habitat scientists recently completed a dedicated multimission cruise in the eastern Bering Sea on the NOAA ship *Fairweather* (Fig. 1). The scientific objective of the FISHPAC cruise was to evaluate the utility of acoustic backscatter data for characterizing EFH, while simultaneously comparing the performance of five different sonar systems. The five systems included two hull-mounted multibeam echosounders on the *Fairweather*, a high-resolution interferometric side scan sonar, and a prototype long-range side scan sonar (LRSSS) with an independent single beam echosounder.

Teams with NOAA and the U.S. Navy installed most of the scientific equipment for the Bering Sea cruise when the *Fairweather* was in the port of Kodiak, Alaska, 13-17 July. Final mobilization in Dutch Harbor began 26 July, and the ship departed Dutch Harbor on 5 August after completing winch repairs and local gear trials. The vessel returned to Dutch Harbor on 20 August for demobilization and crew changes.

The survey area consisted of six 140 nautical mile (nmi) tracklines on the Bering Sea shelf, with

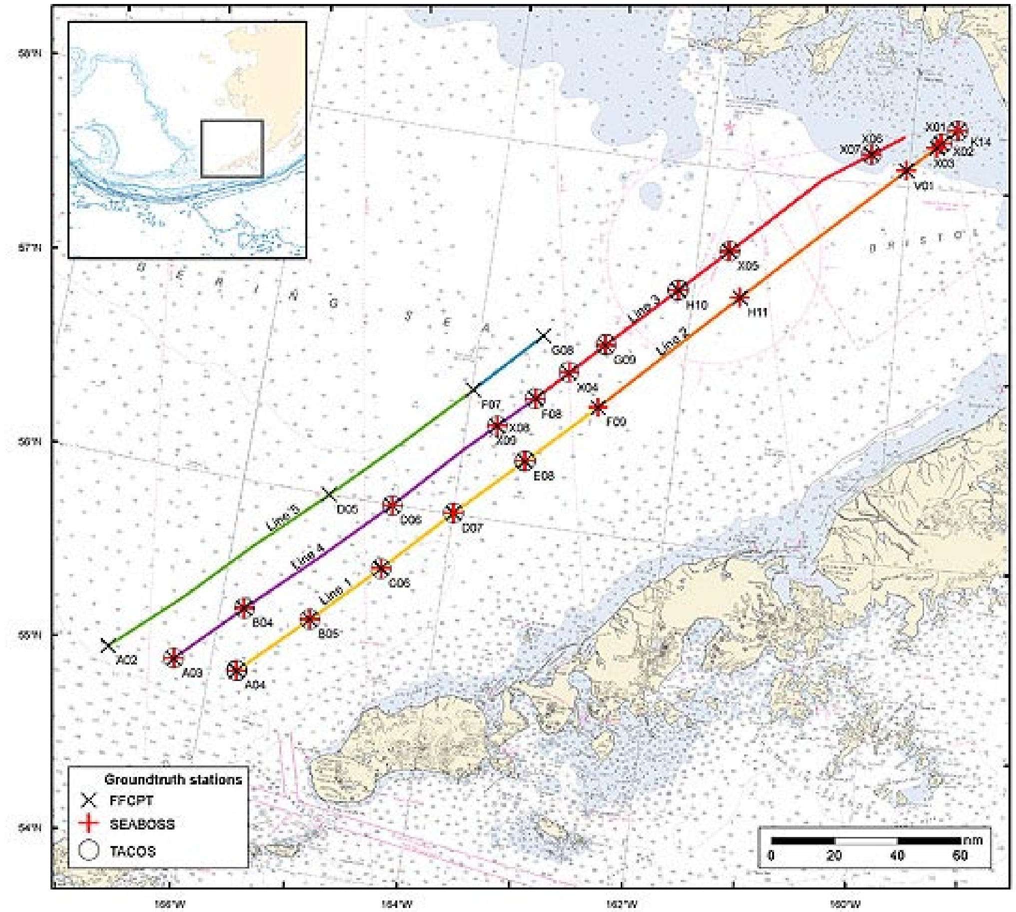

Figure 2. Summary of FISHPAC survey activities in the eastern Bering Sea. A free-fall cone penetrometer (FFCPT), a grab sampler with still and video cameras attached (SEABOSS), and a towed digital video system (TACOS) were used to characterize the seabed at selected locations.

vertices at fixed RACE bottom trawl survey stations (Fig. 2). The tracklines were selected to span strong gradients of groundfish abundance as determined from many years of historical survey data. Each trackline was traversed three times for acoustic data collection and groundtruthing operations. In addition to acoustic backscatter and bathymetry data, light intensities, chlorophyll-a and particulate measurements, as well as sound velocities were collected with instruments mounted on the towfish. Groundtruthing consisted of grab samples for sediments and infauna, penetrometer tests of sediment properties, and video tows at locations selected from side scan imagery. A total of 2,000 nmi were surveyed, and 25 groundtruthing stations were occupied. Statistical analyses will be used to identify the most cost-effective sonar system and operational guidelines for seabed mapping in the Bering Sea will be produced. The best performing system will be used to map and characterize the seabed of the Bering Sea shelf beginning in summer 2008. These data will then be used to update quantitative models describing the groundfish-habitat relationships in that area. Validity of these models will be examined with follow-up bottom-trawl sampling at selected new locations along the tracklines.

In addition to the scientific and technical benefits to EFH research, data collected during this cruise will also be used to update nautical charts in areas with outdated or nonexistent bathymetric information. The cruise was also an opportunity for design engineers to test the prototype LRSSS in a production environment. The LRSSS is a towed system capable of very broad coverage at somewhat reduced resolution and is being built to address NOAA's need for more cost-effective survey tools. Additionally, the cruise supported a film team collecting footage for the NOAA 200th anniversary celebration, and the *Fairweather* surveyed an Atka mackerel spawning area near Dutch Harbor in support of ongoing RACE research.

By Bob McConnaughey

Groundfish Systematics Research

James Orr and Duane Stevenson continue working on the taxonomy and systematics of several families of fishes, most recently skates, snailfishes, rockfishes, sculpins, eelpouts, manefishes, and deep-sea anglerfishes. Both participated in meetings of the American Society of Ichthyologists and Herpetologists in New Orleans and the Charles Henry Gilbert Ichthyological Society in Newport, Oregon, where they presented papers on skate distribution and systematics. Orr's work with Sharon Hawkins of Auke Bay Laboratories (ABL) on the recognition, identification, and nomenclature of *Sebastes melanostictus* will be completed with the examination of important Japanese type specimens, which will be examined during an extended stay as a visiting professor to Kyoto in 2007. Stevenson's paper synonymizing the name *Stlegicottus xenogrammus* with *Rastrinus scutiger* is in press, and he presented a paper on his work at the annual meeting of the Gilbert Ichthyological Society. His range extension and review of the morphology of *Caristius* in the eastern North Pacific with lead author Dave Csepp of ABL is in press.

By James Orr

Groundfish Stock Assessment Support

Estimates of abundance and size composition from results of the 2006 Aleutian Islands Bottom Trawl Survey were provided to the Plan Team and Resource Ecology & Fisheries Managment (REFM) Division stock assessment staff in the first week of October for inclusion in their groundfish population models for the 2006 NPFMC SAFE Report.

MIDWATER ASSESSMENT & CONSERVATION ENGINEERING (MACE)

Gulf of Alaska, East Kodiak Fishery Interaction Experiment

Members of the RACE Division's Midwater Assessment and Conservation Engineering (MACE) Program and the REFM Division's Fisheries Interaction Team (FIT) collaborated in an acoustic-trawl experiment for the fifth year aboard the NOAA ship *Miller Freeman* off the east side of Kodiak Island in Chiniak and Barnabas Troughs from 13 August through 5 September. The principal objective of the study was to describe the spatio-temporal variability in walleye pollock and capelin (*Mallotus villosus*) abundance and distribution patterns in the two troughs over a period of several weeks before and during the commercial pollock fishery. This work is part of a larger effort designed to evaluate the effect of commercial fishing activity on the prey availability of walleye pollock and other forage fish species to endangered Steller sea lions (*Eumetopias jubatus*).

Both troughs were surveyed from near-shore to the shelf-break along parallel transects spaced 3 nmi apart (Fig. 1). Various midwater and bottom trawls were used to confirm the species composition of the acoustic backscattering and collect other biological information. Oceanographic data were collected, including underway sea surface temperature and fluorometry, water column profiles, and drifter deployments.

Five survey passes of each trough were completed. Most of the acoustic backscattering was attributed to three principal groups: age-0 pollock/capelin mix, adult pollock, and age-1 pollock. Adult pollock were generally detected as on-bottom schools ("carpet"). Age-1 pollock or other aggregations composed of both age-0 pollock (5-11 cm standard length (SL)) and capelin were found in midwater. Adult pollock were generally distributed within the northern half of Barnabas Trough and throughout Chiniak Trough. Age-1 pollock (18-25 cm fork length (FL)) were generally more abundant in Barnabas than in Chiniak. They were typically found above the adults in midwater. Relatively large, dense aggregations of age-0 pollock/capelin were broadly distributed throughout Chiniak Trough and predominantly in the southern portion of Barnabas Trough. Unlike the deeper dwelling adults, the age-0 pollock/capelin mix often extended over relatively shallow bottom depths of less than 100 m. A single, shallow area where adult pollock were found was located near the mouth of Ugak Bay. The presence of relatively large numbers of age-0 pollock during the survey was similar to what was observed in 2004. Daytime trawl catches often caught more age-0 pollock than capelin, although the selectivity of the midwater trawl to these species is unknown so it is uncertain whether the different catch rates for these two species groups accurately reflects their relative abundance in the water column. Adult pollock were generally large. Adult size compositions based on trawl catches had length modes that ranged between 45-62 cm FL.

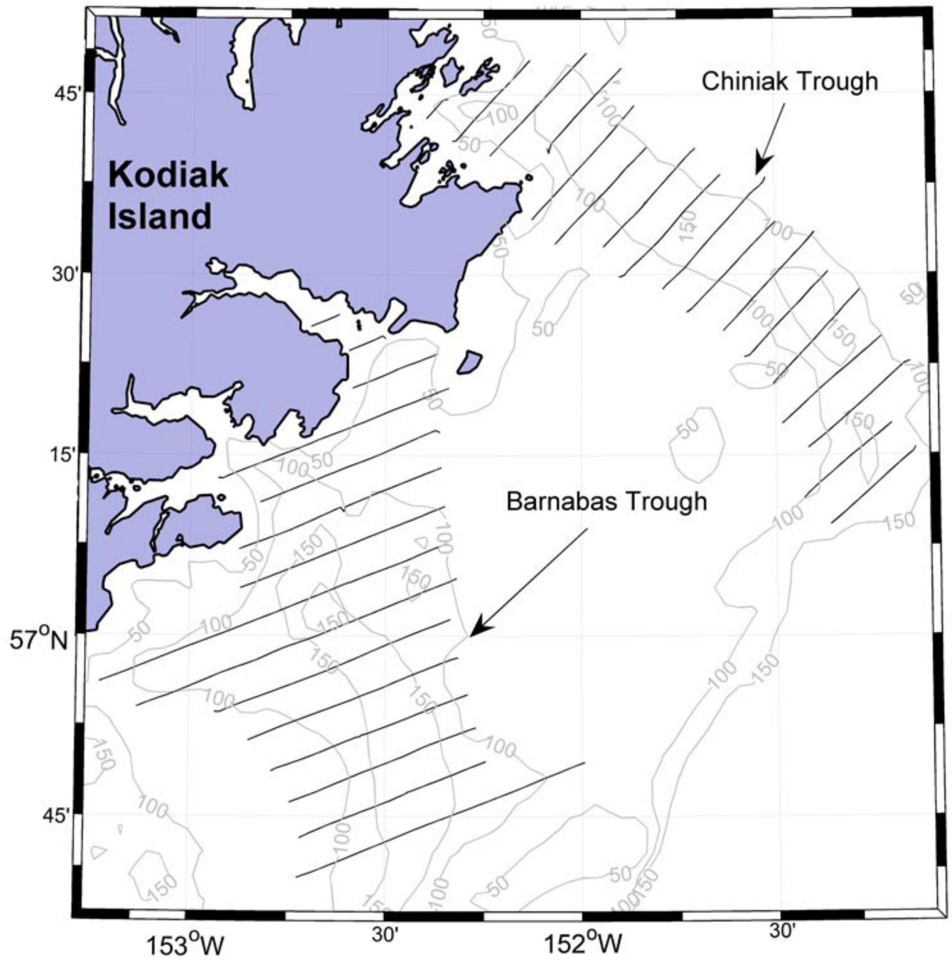

Figure 1. Chiniak Trough and Barnabus Trough off the east side of Kodiak Island, Alaska, showing acoustic-trawl survey transects for the Fisheries Interaction Team experiment.

Size composition of age-1 pollock had prominent length modes near 20-21 cm FL.

A total of 589 marine mammal sightings of groups or individuals were made during the survey. A northern right whale was sighted in the outer region of Barnabas Trough on 1 September 2006. Humpback whale sightings occurred in both troughs. Sightings of fin whales occurred in the outer portion of Barnabas and Chiniak Troughs, and gray whales were reported in Barnabas Trough in the vicinity of Ugak Bay. Other marine mammal sightings included Dall porpoises, Steller sea lions, and harbor seals. As in earlier surveys, an oceanographic front was observed in the middle of Barnabas Trough.

By Chris Wilson, Anne Hollowed, Libby Logerwell, and Paul Walline

RECRUITMENT PROCESSES PROGRAM

Field Season Activities and Conferences

Members of the Recruitment Processes Program had a busy summer in the field and on shore. Steven Porter led the EcoEcoFOCI Bering Sea summer ichthyoplankton survey (21-28 June) aboard the Japanese research vessel *Oshoro Maru*. The objective of the survey was to continue the long-term acquisition of biological and physical data relating to the summer abundance of walleye pollock larvae and juveniles in the eastern Bering Sea shelf region. AFSC scientists have been collaborating with scientists from Hokkaido University for over 10 years, and this time series has been a valuable tool to examine recent changes in the Bering Sea ecosystem.

Janet Duffy-Anderson led an ichthyoplankton and juvenile flatfish survey in the Bering Sea on the *Miller Freeman* (Cruise MF06-10) 8-13 September.

Figure 1. Juvenile rex sole captured with a beam trawl during MF06-10. Photo by Janet Duffy-Anderson.

Figure 2. Juvenile arrowtooth flounder captured with a beam trawl during MF06-10. Photo by Janet Duffy-Anderson.

The survey sampled from Bristol Bay to Unimak Island, Alaska. They also examined the depth-discrete patterns in presettling late-stage flatfish at selected locations, and used a 3-m plumb staff beam trawl to conduct bottom sampling for juvenile flatfishes (Figs. 1 and 2) in presumed nursery areas. Annette Dougherty accompanied Pacific Marine Environmental Laboratory (PMEL) staff on the second leg of Cruise MF06-10 from 24 September to 9 October. During the cruise, PMEL recovered and redeployed four biophysical moorings in the eastern Bering Sea that form the backbone of NOAA's observation system for the region. In addition, Annette helped collect samples of larval fish and zooplankton along the 70-m isobath from St. Matthew Island south to Bristol Bay.

Recruitment Processes scientists also attended several important scientific conferences during the summer, sharing with other scientists the results of their recent projects. Morgan Busby, Rachael Cartwright, Bernard Megrey, and Steven Porter attended the American Fisheries Society meetings in Lake Placid, New York, 10 – 14 September, where they presented "Oceanography, ichthyoplankton, and juvenile fish assemblages of the Bering Strait and Chukchi Sea, summer 2004," "Description of early life history stages of northern sculpin (*Icelinus borealis*)," and "The effect of early and late hatching on the escape response of walleye pollock larvae," respectively. Bernard Megrey presented "GeoModeler-Integration of a nutrient-phytoplankton-zooplankton (NPZ) model and an individual-based model (IBM) with a geographic information system (GIS)" at the ICES meetings in Maastricht, Netherlands 19 – 23 September. Ann Matarese, and Deborah Blood, Morgan Busby, and Rachael Cartwright organized and led the Gilbert Ichthyological Society meetings 22 – 24 September in Newport, Oregon. Busby presented his paper referenced above, and Cartwright presented "Illustration: A Scientific Communication."

By Jeffrey Napp

Gilbert Ichthyological Society (GIS)

The eighteenth annual meeting of the Gilbert Ichthyological Society (GIS) was held at the Hatfield Marine Science Center in Newport, Oregon, 22-24 September 2006. Charles Henry Gilbert (1859-1928) was a pioneer ichthyologist and fishery biologist of particular significance to natural history of the western United States. He collected and studied fishes from Central America north to Alaska and described many new species. Later he became "the" expert on Pacific salmon and was a noted conservationist of the Northwest. Scientists in the RACE Division organized the 2006 meeting: Ann Matarese (GIS President), Duane Stevenson (GIS Secretary), Debbie Blood, Morgan Busby, Rachael Cartwright, and Jay Orr. Scientists from California, Oregon, Washington, and Alaska, representing academia and research organizations, as well as students, presented talks on their current ichthyological research. The opening speaker was John Briggs, world expert on marine biogeography. The keynote speaker was Susan Sogard (Southwest Fisheries Science Center) who presented "Why larval rockfishes are way cool."

By Ann Matarese

NEWPORT LABORATORY: FISHERIES BEHAVIORAL ECOLOGY PROGRAM

Fisheries Behavioral Ecology Program Initiates Research with Pacific Cod

Pacific cod represent a commercially and ecologically important groundfish in Alaska waters.

From the late 1970s to the early 1980s, Pacific cod populations experienced rapid growth, and currently rank second in amount and value landed in the groundfish fishery. Extreme year classes in the Gulf of Alaska have been linked with environmental events such as El Niño Southern Oscillation, but the specific mechanisms of recruitment variation are poorly understood for this species. In 2006, the Fisheries Behavioral Ecology Program (FBEP) began a multiyear research program to examine the growth, survival, behavior and habitat associations of Pacific cod during their early life history.

Egg stages: In April 2006, Alisa Abookire (AFSC Kodiak Laboratory) coordinated the collection, fertilization and shipment of Pacific cod eggs (Fig. 1) from Chiniak Bay, Alaska, to FBEP's laboratory in Newport, Oregon. Eggs were divided and acclimated among replicate tanks to provide five temperature treatments (0˚, 2˚, 4˚, 6˚, 8˚ C). Using this experimental framework, eggs were allowed to develop so that we could address two components: 1) temperature-mediated development rates of Pacific cod eggs in the Gulf of Alaska and 2) mechanisms that drive such patterns.

The first component has direct application for both estimating daily egg production in Alaska waters and for developing individual based models (IBMs) of early life history stages. Dry mass, morphometric measures, egg staging, and mortality rates were derived on a degree-day based sampling schedule. Hatch duration was also measured by counting and removing newly hatched larvae from egg incubators every 2-3 days. Results showed that peak hatch dates can range from 18 to 50 days

Figure 1. Pacific cod eggs (~1 mm diameter) at 4°C – 5 days post-fertilization. Photo by Benjamin Laurel.

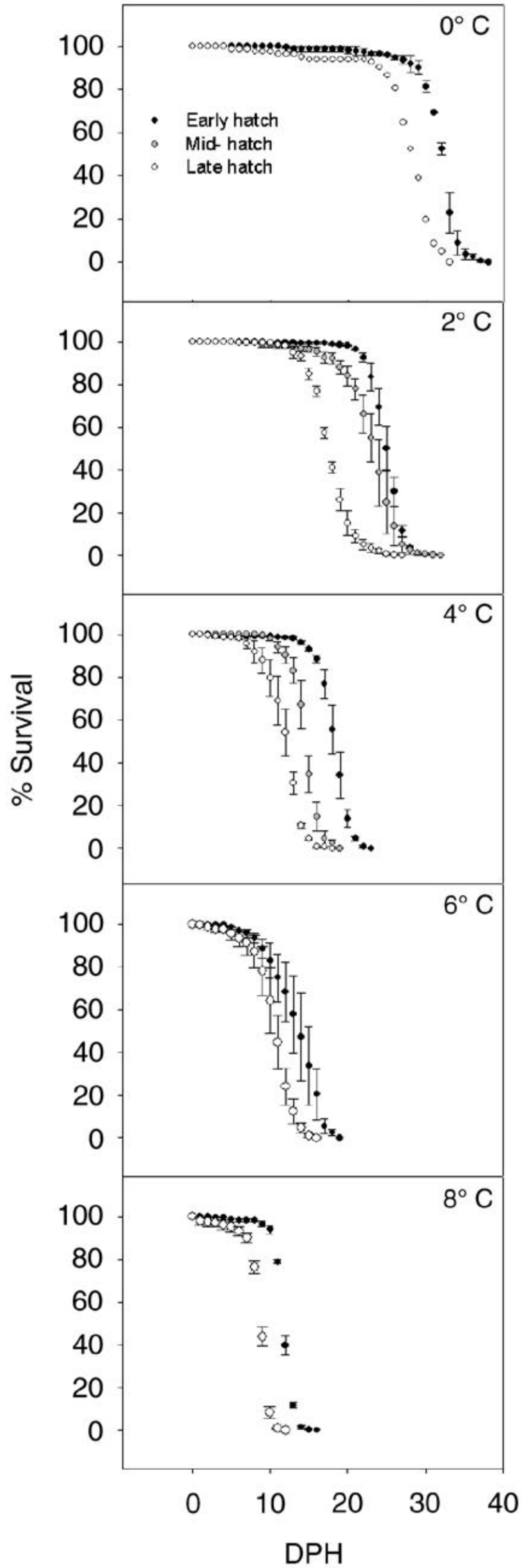

Figure 2. Mortality rates of unfed early-, mid- and late-hatched (days post hatch (DPH)) Pacific cod larvae as a function of temperature (0°-8°C).

post fertilization (DPF) at 8°C and 0°C, respectively. Pacific cod eggs survived and hatched at all the temperatures tested, but hatching success was significantly lower at 0°C relative to temperatures greater than or equal to 2°C.

How temperature affects egg development is being examined by lipid/fatty acid analysis. The most important source of stored energy in fish eggs are lipids, generally in the form of triacylglycerols (TAGs). However, cod species, such as Atlantic cod, are often TAG-deficient, thereby putting a dual demand on phospholipids (PL) for both energy and structure during embryonal development. We suspect temperature will be an important factor in how efficiently PL is catabolized and subsequently available for construction of essential cellular membranes. Lipid extractions and data analysis are being assisted by graduate student Louise Copeman.

Larvae: The effects of temperature were further examined during the prefeeding larval stage (Fig. 2) and (Fig. 3). In this experiment, we measured the consequences of early and late hatching at varying temperatures using larvae hatched from the previous egg experiments. Larvae hatched from these experiments were separated into early (0-3 DPF), mid (4-6 DPF) and late (7-9 DPF) hatching to follow their growth and survival trajectories to 50% mortality. This point in cumulative mortality is often referred to as the "Point of No Return" (PNR), the period at which remaining larvae are too weak to feed even if prey were available. Temperature-mediated PNR relationships are shown in Figure 2 for early and late hatching larvae. In all temperature treatments, the early hatching fish were smaller but had more lipid reserves and survived longer in the absence of food than late hatching fish.

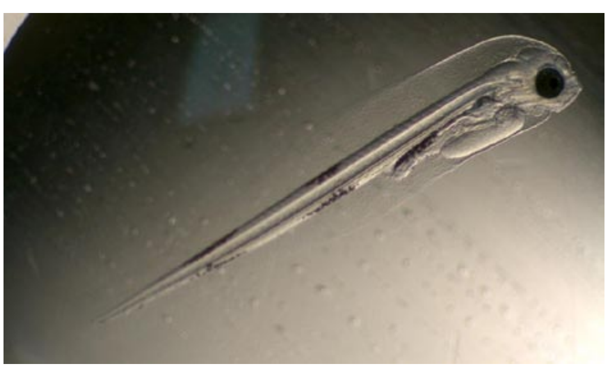

Figure 3. Pacific cod larva (4.2 mm TL) at 8°C – 2 days post-hatch. Photo by Benjamin Laurel.

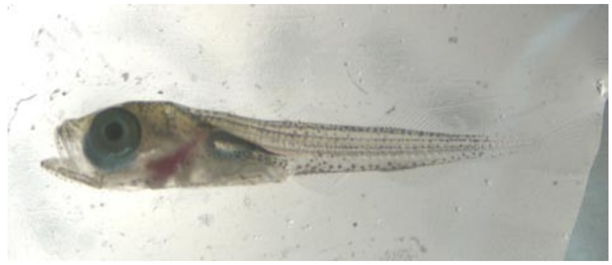

Figure 4. Pelagic juvenile Pacific cod (12 mm TL) at 8°C – 53 days post-hatch. Photo by Benjamin Laurel.

Pelagic juveniles: Some of the larvae hatched from the initial egg experiments were reared to pelagic juveniles (~12-18 mm total length (TL)) (Fig. 4) to better understand the larviculture protocols for future experiments as well as initiate temperature-mediated growth trials for juveniles. These initial efforts proved to be successful—Pacific cod larvae grew well on enriched rotifers and were able to be weaned onto microparticulate food without using live *Artemia* as a transitional diet (*Artemia* are attractive to marine larvae but low in nutritional quality). FBEP scientist Tom Hurst is using these weaned juvenile cod to examine temperature-mediated growth rates during this developmental stage.

Demersal juveniles: Several members of FBEP traveled to Kodiak Island to initiate field work on age-0 juvenile cod (Fig. 5). In July, Ben Laurel, Al Stoner, Mara Spencer and Paul Iseri used seines, small pots, and baited cameras to perfect survey and handling techniques, as well as examine habitat associations. Of the three gear-types, seines and baited cameras proved to be the best means of surveying cod, especially when used in tandem; seines provided physical samples for collections, whereas the baited cameras sampled areas where the seine was unable to operate (e.g., deep water and rocky areas). In late August, Tom Hurst joined the field team during a second trip to broaden the spatial and temporal scope of the survey. Preliminary analysis of field data indicate that shallow, nearshore macrophytes (i.e., *Laminaria* and eelgrass in <5 m of wa-

Figure 5. A juvenile cod collected in a *Laminaria* bed around Kodiak Island during July. Photo by Benjamin Laurel.

ter) support high numbers of juvenile cod, but that aggregations of juvenile cod are also found in open habitats at greater depths (i.e., 10-60 m, particularly as the juveniles grow to less vulnerable sizes). The broad size range of fish during August (41-131 mm TL) and regional size variation are research topics that FBEP will expand in the future, possibly assisted by daily increment analysis of otoliths.

Juvenile cod collected in Kodiak were successfully transported to the Newport laboratory, where they are now being used in a series of habitat and growth experiments. Al Stoner is also examining the behavior of juvenile Pacific cod around baited gear to complement the baited camera work in the field.

By Benjamin Laurel

Modeling Vital Rates of Pacific Cod Larvae and Juveniles With Climate Change

With a grant from the North Pacific Research Board (NPRB), laboratory data will be used to develop spatially-explicit models of growth potential for Pacific cod larvae and juveniles in the Bering Sea with respect to climate change. Models will incorporate field data (available and modeled) on larval and juvenile distributions, temperature and primary productivity (SeaWiFS/MODIS Aqua data). The overall model structure is being constructed in such a way that it can be refined and improved as additional experimental and field data are gathered. NPRB Co-PIs Lorenzo Ciannelli and Mike Behrenfeld of Oregon State University are working closely with FBEP members in leading these modeling efforts.

By Benjamin Laurel

RESOURCE ECOLOGY & FISHERIES MANAGEMENT (REFM) DIVISION

RESOURCE ECOLOGY & ECOSYSTEM MODELING PROGRAM

Fish Stomach Collection and Lab Analysis

Laboratory analysis was performed on 1,475 groundfish stomachs from the eastern Bering Sea (EBS), and 837 groundfish stomachs from the Gulf of Alaska. During this quarter, 780 stomachs were analyzed during research surveys in the Bering Sea, and 1,402 stomachs were analyzed during surveys in the Aleutian Islands region. Also during this quarter, 2,688 stomachs were collected during the Bering Sea survey, and 1,000 stomachs were collected during the Aleutian Islands survey. In addition, fisheries observers collected 708 stomach samples from the Bering Sea and 302 stomachs from the Gulf of Alaska. A total of 13,797 records were added to the groundfish food habits database.

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

Ecosystem Modeling

Modelers from the Resource Ecology & Ecosystem Modeling (REEM) Program recently collaborated with researchers from REFM's Stock Assessment & Multispecies Assessment (SSMA) program and the University of Washington (UW) to incorporate trophic interactions within a Management Strategy Evaluation (MSE) for Gulf of Alaska pollock. REEM is providing information on potential changes in pollock mortality under different ecosystem conditions in a streamlined format that allows SSMA and UW scientists to minimize computational complexity within the MSE.

This summer, we distilled results from thousands of Gulf of Alaska ecosystem model runs into functional relationships between pollock mortality and predator biomass, which considered different levels of pollock biomass and ecosystem-wide primary productivity. Preliminary results show fairly strong relationships between the biomass of a handful of key predators and total pollock mortality. The relationship is especially strong between juvenile pollock mortality and arrowtooth flounder biomass (Fig. 1). In general, these results suggest that pollock mortality increases with predator biomass more quickly and to a higher level when pollock biomass is relatively low (red lines), and that individual predators affect pollock mortality to a lesser extent when pollock biomass is high (green line). However, at low and intermediate pollock biomass (red and blue lines), ecosystem productivity can influence the relationship as well. For example, the thin blue line demonstrates that under conditions of low primary productivity, pollock mortality may increase quickly with predator biomass even though pollock biomass is at an intermediate level. Under conditions of higher ecosystem primary productivity, these results suggest that pollock mortality increases less quickly with increasing predator biomass (thick blue line). REEM modelers will continue to refine this work in collaboration with SSMA and UW to provide a full range of ecosystem interactions for analysis within the Gulf of Alaska pollock MSE.

By Sarah Gaichas

Ecosystem Indicators

The Ecosystem Considerations report is a section of the Stock Assessment and Fishery Evaluation document, produced annually by the AFSC for the North Pacific Fishery Management Council. It is utilized to advance our understanding of marine ecosystem dynamics and deliver ecological, oceanographic, and climatic indices to stock assessment scientists and managers. The report includes an ecosystem assessment, updated status and trend indices, and ecosystem-based management indices and information for the Bering Sea (BS), Aleutian Islands (AI) and the Gulf of Alaska (GOA) ecosystems. Integration of information regarding ecosystem status and trends and the use of models to predict possible future ecosystem states using an indicator approach constitutes the framework of a BS/AI and GOA ecosystem assessment. Annual updates of historical trend and present status of various ecosystem indicators are performed by internal development and update of indicators and communicating with the diverse scientific community that is involved in climate, protected species, sustainable fisheries, and ecosystem research. The purpose of the third section, "Ecosystem-based Management Indices and Information," is to provide either early signals of direct human effects on ecosystem components that might warrant management intervention or to provide evidence of the efficacy of previous management actions. The information in the Ecosystem Considerations report is utilized by the NMFS Alaska Regional Office and the Council to evaluate the environmental impacts of various fishery management plan alternatives. The Ecosystem Considerations report was updated in September 2006 and will be updated again in November 2006.

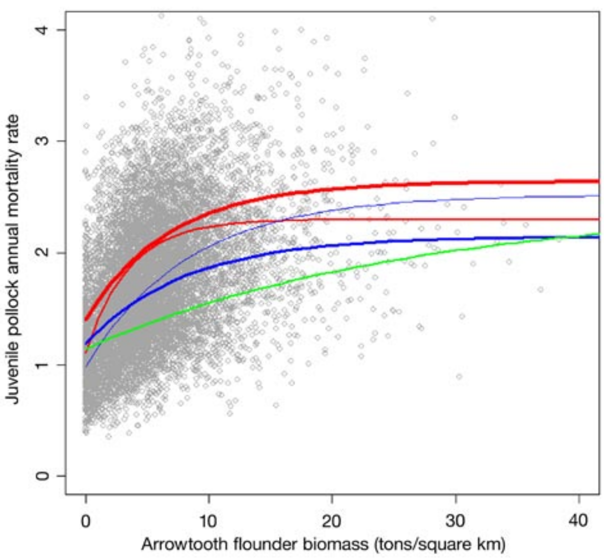

Figure 1. Relationship between arrowtooth flounder biomass and juvenile pollock mortality from 9,845 simulations with the Gulf of Alaska ecosystem model. Each point is the output of an individual model run. Each line represents the best fit relationship between flounder biomass and pollock mortality under different levels of pollock biomass and overall ecosystem production. Red lines indicate low pollock biomass (below the stock assessment reference point indicating 25% of unfished biomass), blue lines indicate intermediate pollock biomass, and the green line indicates high pollock biomass (above the stock assessment reference point indicating unfished biomass). Thickness of lines represents overall ecosystem production. Thinner red and blue lines indicate primary productivity at or lower than estimated current levels, and thicker lines indicate higher primary productivity than estimated current levels. Primary productivity had no impact on the relationship when pollock biomass was high (single green line).

An example of an updated and reanalyzed index is the trophic level of the catch (TL). The trophic level of the catch and the Fishery in Balance (FIB) indices have been monitored in the BS, AI, and GOA ecosystems to determine if fisheries have been "fishing-down" the food web by removing top-level predators and subsequently targeting lower trophic level prey. The FIB index was developed by Pauly et al. (2000) to ascertain whether trophic level catch trends are a reflection of deliberate choice or of a fishing-down the food web effect. This index declines only when catches do not increase as expected when moving down the food web (i.e., lower trophic levels are more biologically productive), relative to an initial baseline year. Although there has been a general increase in the amount of catch since the late 1960s in all three areas of Alaska, the trophic level of the catch has been high and relatively stable over the last 25 years. Unlike other regions in which this index has been calculated, such as the Northwest Atlantic, the FIB index and the trophic level of the

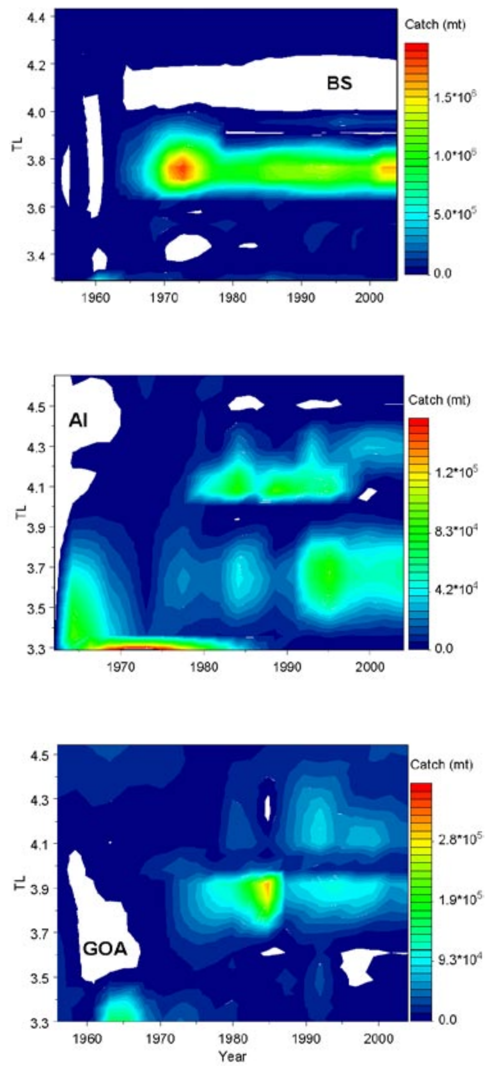

Figure 2. Total catch of all species plotted as color contours by trophic level and year for the Bering Sea, Aleutian Islands, and Gulf of Alaska. The main catches and their approximate trophic levels are labeled on the left side of the graphs. Note: all scales are different for each ecosystem.

catch in the EBS, AI, and GOA have been relatively constant and suggest an ecological balance in the catch patterns.

The single metrics of TL or FIB indices, however, may hide details about fishing events. We, therefore, plotted the trophic level of catches in the BS, AI, and GOA contoured by species (Fig. 2). This further examination supports the idea that fishing-down the food web is not occurring in Alaska, and there does not appear to be a serial addition of lower-trophic-level fisheries in the BS or GOA. In the AI, a decline in the overall trophic level of the catch may have been obscured by episodic fishing events. Catches of Atka mackerel began increasing in the mid-1980s. Pollock catches were relatively high in the 1980s and 1990s, but declined after 1998, at which point cod catches were much higher than they had been prior to 1992. The increase in cod catches may have offset any decrease in the observed trophic level of the catch as would have been expected with the generally increasing trend in Atka mackerel catches and decreasing catches of pollock over time. In general, it appears that fishing events are episodic in the AI and GOA, and pollock dominate catches in the BS.

By Jennifer Boldt

Seabird Interactions

Through coordination and collaboration, the AFSC Seabird Fishery Interactions research addressed several components of its research over the summer. Dr. Ann Edwards' National Research Council appointment was extended into a third year so that we can further investigate whether a fishery signal can be detected in albatross populations. Several papers are in preparation on work completed to date. Seabird mitigation work for trawl vessels proceeded. One of two contracts with the fishing industry to develop first-generation seabird mitigation gear was completed. The second contract will be finished in the fall. Meanwhile, the Washington Sea Grant Program is working on data collected during experiments in 2005 on the vessels using the gear developed through these contracts, which were funded by the National Cooperative Research Program.

Two analyses relevant to the short-tailed albatross biological opinion are close to completion. Supported by National Seabird Program funding, Stephani Zador, Dr. Julia Parrish, and Dr. Andre Punt, University of Washington, are working on a trawl fleet risk assessment for short-tailed albatross interactions and a threshold analysis for short-tailed albatross incidental takes. A tremendous amount of seabird survey work was completed over the summer months by AFSC staff on groundfish charter vessels and by USFWS staff who joined AFSC cruises. Finally, Michael Perez of the National Marine Mammal Laboratory analyzed seabird bycatch information provided by groundfish observers and developed estimates of seabird bycatch by fishery and region. Those estimates are being prepared for distribution.

By Shannon Fitzgerald

ECONOMICS & SOCIAL SCIENCES RESEARCH PROGRAM

Fishing Communities Project Evaluates Scale and Methods

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and other legal mandates, NMFS has been conducting basic social science research on fishing communities. The research must cover large geographic scales and address a broad array of analytical issues. These conditions are in tension with the traditional ethnographic methods of anthropology and the MSA's focus on the community as a unit of analysis. This dilemma forces NOAA social scientists to examine the scales at which they work and the methods that are appropriate for different geographic scales.

AFSC social scientist Dr. Jennifer Sepez published an article in the applied anthropology journal *Human Organization* on these issues. The article was written with coauthors Karma Norman, of the Northwest Fisheries Science Center (NWFSC), Amanda Poole, a graduate student in Environmental Anthropology at the University of Washington, and Bryan Tilt, Assistant Professor of Anthropology at Oregon State University. The article describes how social scientists at the AFSC and NWFSC navigated these conflicting imperatives by adopting large-scale community profiling using social and fishing indicators informed by ethnographic site visits, and by advocating a "nested-scale" analytical framework that imbricates the community level analytical unit with macrolevel considerations related to regional and global forces and microlevel dynamics related to intracommunity heterogeneity.

The article appears as Sepez, J. K Norman, A. Poole and B. Tilt. 2006. Fish Scales: Scale and Method in Social Science Research for North Pacific and West Coast Fishing Communities. *Human Organization* 65(3)280-293. AFSC community profiles for North Pacific Fishing Communities located in Alaska are available on the AFSC Web site at *http://www.afsc.noaa.gov/REFM/Socioeconomics/Projects/CPU.htm* and a draft version of the joint AFSC/NWFSC profiles for North Pacific and West Coast fishing communities in Washington, Oregon, California and other U.S. states is online at *http://www.nwfsc.noaa.gov/research/divisions/sd/communityprofiles/index.cfm*.

By Jennifer Sepez

The Demand for Halibut Sport Fishing Trips in Alaska

The National Marine Fisheries Service is responsible for managing the Alaska halibut sport fishery. The Alaska halibut sport fishery is large. In 2000, for instance, over 400,000 halibut were harvested by sport anglers in the state. In recent years, several regulatory changes have been proposed that could significantly impact the sport fishery. In August 2003, a guideline harvest limit (GHL) policy was implemented to regulate the Pacific halibut guided recreational fishery in Alaska. This policy sets a limit on the amount of halibut that can be harvested by the guided recreational fishery and establishes a process for the North Pacific Fishery Management Council to initiate harvest restrictions in the event that the limit is met or exceeded. Numerous harvest restrictions may be adopted by the Council in the event the GHL is surpassed, including reducing the allowable catch. Catch by noncharter boat recreational halibut anglers are not subject to the GHL and are accommodated through reductions in the commercial TAC. To assess the impacts of pending and potential regulatory changes on sport angler behavior, it is necessary to have estimates of the baseline demand for halibut fishing trips and an understanding of the factors that affect it.

To this end, a project is currently under way to develop and implement a survey that collects information about saltwater recreational fishing trips in Alaska. The project consists of three major phases. The first phase involves developing and pretesting the survey instrument. This phase includes testing the survey instrument using focus groups, cognitive interviews, and a formal pretest survey implementation. These activities were completed in 2006. It is currently undergoing final revisions and will be implemented through a mail survey of Alaskan sport anglers during the second phase of the project. The survey implementation will follow a modified Dillman Tailored Design Method to maximize response. In the final phase of the project, data will be analyzed and results reported.

By Dan Lew

Experimental Design Construction for Stated Preference Choice Experiments

Stated preference choice experiments, which involve respondents choosing between alternatives that differ in attributes, have been used primarily in the marketing literature to understand consumer preferences for market goods. In recent years, however, their usefulness for gaining insights into preferences for non-market goods has become apparent, and stated preference researchers are increasingly turning to choice experiments to value public goods. Choice experiments were first applied to value public goods in a study of recreational opportunities in Canada. Since then, several studies have used choice experiment approaches to estimate use values for activities like hunting, climbing, and recreational fishing. Choice experiments have also been used to estimate nonconsumptive use values associated with forests in the United Kingdom, forest loss due to global climate change, and Woodland caribou habitat in Canada.

A typical choice experiment involves presenting respondents with two or more choice questions, each having a set of alternatives that differ in attributes. For each question, respondents are asked to select the alternative they like best. The choice responses are used to estimate a preference function that depends upon the levels of the attributes.

In constructing choice experiment questions, researchers must determine the set of attributes and attribute levels that respondents see in each question. This is a critical judgment, as a poor experimental design can preclude estimating important marginal effects, or conversely, a good design can significantly increase the precision of estimated parameters or provide justification for reducing the sample size. The latter is particularly important in light of how expensive, carefully-constructed, and tested stated preference surveys are.

Research is currently under way by Dan Lew within REFM to determine ways to improve stated preference choice question experimental designs to enable efficient estimation of all relevant effects. Preliminary results from Dan's research were presented at the Association of Environmental and Resource Economists sessions at the 2006 annual conference of the American Agricultural Economics Association meeting in Long Beach, California, in July 2006.

By Dan Lew

Sampling Procedures Developed for Data Collection Projects

Effort continues on developing an appropriate sampling methodology for ongoing regional economic data collection projects. Because the majority of gross revenue within each harvesting sector comes from a few number of boats, a simple random sampling of boats would only include a small portion of the total exvessel values, and therefore, would be misleading. Therefore, an unequal probability sampling (UPS) method without replacement will be used. The objective of implementing the sampling task is to estimate the employment and labor income information for each of three disaggregated harvesting sectors using the exvessel revenue information provided by the Alaska Commercial Fisheries Entry Commission earnings data.

Since each sector will be used as a separate economic sector in the IMPLAN model (a regional economics model), we face three separate problems for three different sectors in sampling. For each sector, we will implement a UPS without replacement. In the literature, many methods exist for conducting UPS without replacement. One critical weakness with most of these methods is that the variance estimation is very difficult because the structure of the 2nd order inclusion probabilities is complicated. One method that overcomes this problem is Poisson sampling. However, a problem with Poisson sampling is that the sample size is a random variable, which increases the variability of the estimates produced. An alternative method similar to Poisson sampling but that overcomes its weaknesses is Pareto sampling (which yields a fixed sample size). In this project, there are two tasks that we need to accomplish to estimate the population parameters using the UPS. First, the optimal sample size needs to be determined. Second, once the optimal sample size is determined, the population parameters and confidence intervals need to be estimated. For the first task, we will use the Poisson *variance* (not Poisson sampling). For the second task, we will use a Pareto sampling method. In determining the optimal sample size, we will use information on an auxiliary variable (ex-vessel revenue). To estimate the population parameters, we will use actual response sample information on the variables of interest (employment and labor income). With inputs from experts in UPS sampling, a document detailing these sampling procedures has been completed and an

Excel program has been developed to show these procedures using an example data (2002 exvessel value data for small boat sector).

By Chang Seung

Estimating Interregional Economic Effects of Vessels in Alaska and West Coast Fisheries

Many vessels operating in Alaska fisheries are owned and crewed by residents of Washington and Oregon. Some of these vessels also participate in West Coast fisheries during the year. While much of the income earned by these vessels leaves Alaska, expenditures made elsewhere will generate positive economic impacts for that region and may also have spillover effects. It has been demonstrated that assuming all commodities and services are locally supplied will significantly overestimate regional impacts. Understanding the location of expenditures made by the vessels, both in Alaska and elsewhere, will enhance our understanding of the overall economic impacts of Alaska fisheries.

Standard regional economic models focus on a single region. These models generally fail to capture economic impacts transmitted outside that region and also do not account for spillover effects in the study region resulting from events occurring outside. An interregional or multiregional model can more fully measure the impacts of a region's fisheries, including those impacts occurring in regions that supply commodities or factors of production to industries in the study region, or that demand the goods and services produced there. An interregional model would be especially useful in the case of Alaska, where most intermediate goods are imported and much of the factor income leaks out of the region to nonresident vessel owners and crew members. This type of model could also be used to track the impact of expenditures by vessel owners and crew members who are also active in other regions' fisheries. However, developing an interregional model involves the daunting task of estimating interregional flows of commodity inputs and factor services. Acquiring this information has traditionally been very challenging due to an absence of interregional trade flow statistics. Consequently, to date, only one published study employed an interregional or multiregional model to estimate economic impacts of fisheries.

Our project will estimate the distribution and magnitude of intra-regional and inter-regional economic impacts generated by vessels participating in both Alaska fisheries and in fisheries off the U.S. West Coast. Recently, Alaska Department of Labor and Workforce Development has created useable data for estimating nonresident labor use by Alaska industries, including seafood processing and some commercial fishing. Data on the ownership of vessels used in Alaska and West Coast fisheries also exists, and annual catch by these vessels is available from PacFIN and NORPAC data systems. Information on the cost structures of vessels participating in the two fisheries will be gathered from the literature and key industry informants. Results of a cost and earnings survey of West Coast groundfish trawlers that is currently being administered by t he NWFSC may be available to assist this project. This project will develop a multiregional social accounting matrix (SAM) model of Alaska and West Coast fisheries using these data combined with IMPLAN regional models constructed for Alaska and the U.S West Coast (i.e., Washington and possibly Oregon). IMPLAN Version 3.0 (beta version) will include an inter-regional trade modeling capability that will facilitate the estimation of commodity trade flows between the two regions. The investigators in this project recently developed a single-region Alaska SAM model to examine the economic impact of Alaska fisheries. This project will build on that effort to develop an updated interregional SAM model.

The implementation of this project will include the following steps:

1. Gather data on the residence of owners and crews of vessels operating in Alaska and U.S. West Coast fisheries from NOAA permits databases and other sources.

2. Gather annual catch data by these vessels from PacFIN and NORPAC data systems.

3. Gather information on vessel cost structures and the locus of input purchases by vessels participating in the two fisheries. Major sources of data will include relevant literature and interviews with key industry informants. Results of a cost and earnings survey of West Coast trawlers currently being administered by NWFSC may be available to assist this task.

4. Generate regional economic models of Alaska and the U.S. West Coast (Washington and Oregon) economies using IMPLAN. The models will incorporate the latest representative economic data available for both regions.

5. Estimate the value of commodities, services, labor and capital flowing between Alaska and the West Coast using IMPLAN and the models developed in Step 4. The focus will be on those factors, commodities, and services of particular importance to commercial fisheries-related economic activity.

6. Develop a multiregional social accounting matrix (SAM) model of Alaska and West Coast economies using fisheries data, trade estimates and IMPLAN regional models developed in steps 1–5.

7. Use the multiregional SAM model to estimate economic impacts of commercial fishing and related activities on Alaska and the U.S. West Coast.

Understanding the location and magnitude of effects generated by these vessels, both in Alaska and elsewhere, will enhance our understanding of the overall economic impacts of Alaska fisheries. After this project is completed, the investigators will conduct (possibly jointly with a NWFSC economist) a potential follow-on project. In the follow-on project, a more comprehensive data gathering program will be implemented to resolve economic data issues identified in steps 1–3 above. These data will be used to validate the interregional SAM model and would be available for the development of an advanced model such as an interregional computable general equilibrium (CGE) model.

By Chang Seung

STATUS OF STOCKS & MULTISPECIES ASSESSMENT PROGRAM

SSMA Workshop on Tagging and Spatially Explicit Models

The Status of Stocks and Multispecies Assessment (SSMA) Program held an inter-divisional and inter-agency workshop on tagging studies and the status of spatially explicit stock assessment models. Participants included fisheries scientists and economists from REFM, RACE, ABL, industry, and the University of Alaska Fairbanks (UAF). Participants developed ideas to address the over arching question "How does climate influence spawning location, larval dispersal, and selection of feeding locations of a core group of managed species?" Target species selected for study included pollock, Pacific cod, rock sole, and crab. This report focuses on reports from presentations on research on tagging studies and spatial modeling.

Dr. Robert Foy (UAF) reported on North Pacific Research Board-funded pollock tagging experiments. Dr. Foy deployed an experimental net equipped with a "swimming pool" cod end in spring 2006. The net was fragile and proved inadequate for sampling pollock spawning concentrations. He is working with David King (RACE Division) to develop a sturdier version of the net that will be deployed this fall on pollock schools off the coast of Kodiak Island (Fig. 1). Dr. Foy also reported on survival rates of pollock sampled in the spring. Results indicated mortality rates were high during the first 72 hours after capture, after that time pollock survival was high.

Dan Nichol (RACE) and Peter Munro (REFM) described results of recent cod tagging experiments. Dan also described a new technology (F-RAFOS) that emits low frequency sound from moorings. Continuous records of fish location can be estimated by tagging fish with receivers that record sound at different frequencies. Locations are determined by triangulation if the fish swims within listening distance from the transmitters. The group agreed that the combination of F-RAFOS technology and traditional mark recapture methods were desirable. F-RAFOS tags provide detailed information on the location of a small number of individuals, traditional tags provide information on the potential variability in fish movement. Analytical methods are already being developed for combining data on individual fish tracks (as would be provided by F-RAFOS data) with traditional mark-recapture data. The two independent data sources are brought together in likelihood models for estimating movement rates. F-RAFOS and traditional mark-recapture data are expected to work synergistically to provide much better estimates of movement rates than either method would allow independently.

Figure 1. Prototype net for sampling walleye pollock for future tagging experiments. Photo by David King.

Sara Miller (UAF), Grant Thompson (REFM), and James Ianelli (REFM) reported on sampling designs and analytical techniques that could be used to assess fish movement from tagging data. Sara reported that movement probabilities of walleye pollock could be resolved with reasonable power using mark recovery methods. Grant Thompson discussed a new analytical technique he developed that provided estimates of the distance of fish above the bottom when records of fish depth were collected from archival tags. Jim Ianelli and Vidar Wespestad (Resource Analysts International) reported on cooperative efforts to collect acoustic and oceanographic data from fishing vessels.

Michael Canino (RACE) presented results from a recent analysis of the stock structure of Pacific cod. Preliminary results of a microsatellite study show a significant genetic difference between Asian and North American cod stocks. Examination of North American cod revealed structure at local scales.

The meeting concluded with a general discussion of analytical techniques for modeling fish movements. In addition to the modeling approaches discussed earlier in the day, participants noted that the Atlantis modeling approach may hold promise. Economists also recommended examining recent modeling efforts led by Dan Holland in the New England region. Participants agreed to work together to form proposals for the development of spatially explicit stock assessments and ecosystem models.

By Anne Hollowed and Peter Munro

Pollock and Flatfish Recruitment Workshop

The SSMA program organized an interdivisional meeting in August to discuss the status of knowledge of processes underlying recruitment of walleye pollock and flatfish. Scientists from the Center's Resource Ecology and Ecosystem Modeling program, the Recruitment Processes (EcoFOCI) program, the Ocean Carrying Capacity program, Auke Bay Laboratories' Marine Ecology and Stock Assessment program, and the Pacific Marine Environmental Laboratory attended. The purpose of this meeting was to discuss: recent results in recruitment research, new and existing techniques for forecasting recruitment of managed species, and techniques for incorporating ecosystem indicators into stock assessments.

A major portion of the meeting was devoted to review of the EcoFOCI recruitment prediction for walleye pollock. The history of its development, its current state, and future improvements were discussed. Participants recognized that accurate recruitment prediction is the best measure of our understanding of mechanisms underlying recruitment success for pollock. In addition, it was noted that predicting future fish production contributes to NOAA's mission to understand ecosystem processes and forecast future states of nature. The current performance of the EcoFOCI prediction is moderate, indicating that our understanding is incomplete. EcoFOCI will continue development and testing of its pollock Individual-Based Model (IBM) model incorporating juvenile life history (and predation mortality) into the model and will begin development of a new prediction scheme that follows a year class through time, much like hurricane prediction follows the storm along its path and predicts its intended target. EcoFOCI investigators presented information prepared for a white paper summarizing the history, status, and future steps for the walleye pollock recruitment prediction. SSMA and EcoFOCI staff will continue to work collaboratively to couple techniques for incorporating recruitment forecasts in stock assessments.

Participants reviewed field and laboratory information supporting hypotheses that explore the use of retrospective and forecasting tools for other species compared to pollock. In the case of flatfish, several lines of evidence indicated that cross-shelf transport of eggs and larvae might be a critical factor influencing recruitment success. In the case of pollock, the processes influencing recruitment appear to be more complex. Complex behavior may influence the distance larvae move and their response to the local environment. Future research might focus on developing models of larval behaviors that reduce movement to bring simulated transport models into alignment with observed larval distributions. It was also noted that knowledge of population structure might be needed for successful predictions. For example, individuals from different regions may have different local adaptations or social facilitation. Participants noted that improvements in pollock recruitment forecasting may be realized by incorporating processes influencing juvenile predation, including seabird predation. Participants also recommended renewed efforts to assess larval condition. It was noted that new indices of environmental forcing could be developed from new modeling tools (e.g., indices of the frequency and intensity of eddies).

Participants reviewed the performance of a variety of retrospective modeling studies including: correlative modeling, individual based models, neural networks, multivariate analyses, and modeling processes on a stage-specific basis. It was noted that each approach had different strengths and that applying a variety of techniques should be continued. No single approach emerged as the best approach. Participants recommended that scientists active in field and modeling activities in support of recruitment forecasting should continue to meet on an annual or semi-annual basis.

Participants considered how the forecasts would be used to inform managers. It was noted that there is growing interest in issues of long-term ecosystem responses to fishing or climate change. These issues require forecasts of future fish production over 10-50 years. The accuracy of these predictions will depend on correctly linking fish responses to changes in spawning biomass and climate-induced changes to ecosystems. It was also noted that there is increased interest in reviews of the suitability of harvest control rules under different states of nature. SSMA scientists provided examples of analytical techniques used to perform Management Strategy Evaluations. Recruitment forecasts would be used to develop scenarios regarding future states of nature. At a broader scope, the Center is striving to develop whole ecosystem models to assess the impacts of fishing on the ecosystem. Forecasts from these models also depend on accurate prediction of climate impacts on key processes such as consumption rates, predation probabilities, and prey growth rates.

Contributed by Anne Hollowed, Kerim Aydin, Jeff Napp, Bern Megrey and Allen Macklin

DisMELS: A Dispersal Model for Early Life History Stages

Dispersal of eggs and larvae by oceanographic currents is a critical factor in the process of recruitment for marine populations. Scientists in REFM have shown that the scope for recruitment of several flatfish species in the eastern Bering Sea is fairly well correlated with the final locations of drifters simulated using a simple surface wind drift current model (OSCURS). Other scientists at the AFSC, however, have shown that the eggs and larvae of some flatfish species are not located primarily at the surface but are concentrated below the surface and may even change depths depending on whether it's day or night (i.e., they undergo diel vertical migrations). In an effort to incorporate more aspects of early life history behavior into simulations of dispersal of flatfish (and other species) eggs and larvae, William Stockhausen in REFM is developing DisMELS, a dispersal model for early life history stages.

DisMELS is a new tool being developed to incorporate the behavior of early life history stages of marine fishes and invertebrates into computer simulations for the dispersal of eggs and larvae from natal sites. The tool consists of a series of graphical user interfaces (GUIs) that allows a user to easily set up and run individual-based models, as well as an application programming interface (API) that

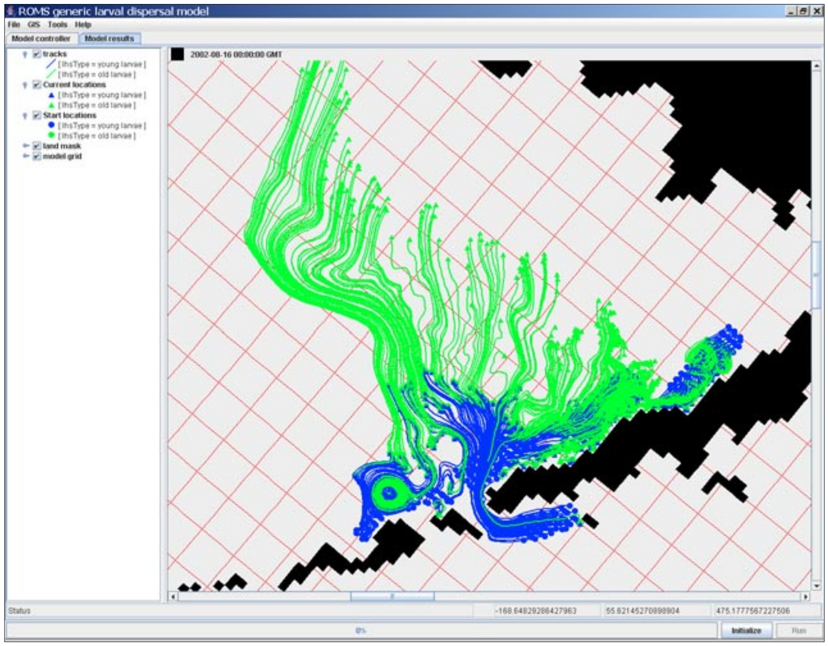

Figure 2. A screenshot of the DisMELS graphical user interface after running a dispersal simulation, showing the “spaghetti” of tracks of individual simulated larvae. Red squares encompass 5x5 grid cells (~10 km on a side) used in the NEP ROMS oceanographic model; black areas signify land. Several hundred northern rock sole “early stage larvae” were released from five “spawning areas” (blue dots indicate release positions) along the Alaskan Peninsula and tracked for 60 days. Upon reaching ~8mm size, “early stage larvae” (tracks in blue) became “late stage larvae” (tracks in green) and started undergoing vertical diel migrations between 10-20m depth (nighttime) and 30-40m depth (daytime). Green triangles indicate positions of “late stage larvae” after 60 days.

allows a user to create his/her own stage-based behavioral models for use in the dispersal simulations (Fig. 2). Currently, one “generic” behavioral model is available that allows the user to specify preferred daytime and nighttime depth ranges, vertical swimming speed, and growth and mortality rates for each early life history stage to be included in a simulation. Ontogenetic changes in behavior can be incorporated by defining parameter values for successive stages and setting the conditions under which an individual changes from one life history stage to the following stage. Precomputed oceanographic currents, temperature and salinity fields are required to drive the dispersal simulations. Currently, output from the ROMS (Regional Oceanographic Modeling System) model for the northeast Pacific (NEP ROMS) and other ROMS models can be used to drive dispersal simulations.

In an initial application of DisMELS, Stockhausen and Janet Duffy-Anderson (Recruitment Processess Program) are developing dispersal models for northern rock sole in the eastern Bering Sea.

By William Stockhausen

First Cooperative Aleutian Islands Atka Mackerel Tagging Cruise with the North Pacific Fisheries Foundation a Success!

The Fisheries Interaction Team (FIT) conducted an Atka mackerel tagging cruise aboard the charted fishing vessel *Pacific Explorer* in the Aleutian Islands at Seguam Pass and near Kiska Island 5-21 July 2006. The objective of our ongoing tag release-recovery study is to determine the efficacy of trawl exclusion zones as a management tool to maintain prey abundance/availability for Steller sea lions at local scales. Tagging experiments are being used to estimate abundance and movement between areas open and closed to the Atka mackerel fishery.

This was our first cruise in collaboration with the North Pacific Fisheries Foundation (NPFF), a nonprofit organization formed by members of the fishing industry to support research essential to the conservation and management of North Pacific Atka mackerel and other fishery resources. Kimberly Rand (FIT/University of Washington Joint Institute for the Study of the Atmosphere and Ocean) and

Left: Scientists and vessel crew with the Fisheries Interaction Team tagging cruise transferring live Atka mackerel from the trawl net into holding tanks. Center: John Hargrove (NPFF scientist), Rob Freyer (UW intern) and Dan Cooper preparing to tag an Atka mackerel. Photos by Teresa A’mar.

Left: Teresa A’mar (UW graduate student) placing an Atka mackerel into the cradle used to hold fish while a tag is inserted. Below: An Atka mackerel fitted with a spaghetti tag. The fish was released immediately through the white tube shown in the background. Photos by Dan Cooper.

John Hargrove (former FIT intern) were hired as scientists by the NPFF.

Atka mackerel were collected by short duration trawl hauls, placed in live tanks, and then measured, tagged, and released. Approximately 8,000 Atka mackerel were tagged and released during this cruise at Kiska Island, and 7,200 fish were tagged and released near Seguam Island. Atka mackerel sex ratio and length frequency were also estimated for each haul, along with gonads, stomachs, and otoliths from 10 fish per haul. Temperature, salinity, and fluorescence were recorded continuously, and chlorophyll samples were also collected.

Several additional projects were completed during the cruise. Rob Freyer (UW intern) deployed a plankton net as part of his undergraduate capstone research project studying Atka mackerel prey and diet. Measurements were taken for a sexual dimorphism study by Jared Guthridge (University of Alaska graduate student) which may provide a nonlethal method of sex determination. Three yellow Irish lords (*Hemilepidotus jordani*) were collected for comparative fish skeletons to use in studies of fish bones from coastal archaeological sites in the Aleutian Islands. Twenty-one Pacific cod stomachs were collected and preserved for food habits analysis.

Future Atka mackerel fisheries will recover fish tagged during this cruise. Dedicated tag recovery cruises will provide recovery effort inside areas closed to the Atka mackerel fleet. A recovery cruise aboard the fishing trawler *Seafisher* is planned for October of this year.

By Dan Cooper and Libby Logerwell

AGE & GROWTH PROGRAM

Program Activities

The Age and Growth Program had two visitors during the quarter. Sonia Fang, a Pomona College sophomore intern, visited during July, to study fish ageing with Delsa Anderl. Sonia also aged Atka mackerel, but the focus of her study was California grunion, *Leuresthes tenuis*. Results from this study have been documented in a student poster.

Our second visitor was Sergio Vitale, an Italian government scientist, who spent 26 June through 27 July with the Age and Growth Laboratory studying the ageing of *Hoplostethus mediterraneus* and *Diplodus vulgaris* using otoliths. It was agreed these species may be older than previously aged in the scientific literature and that further collaboration should proceed to attempt age validation using radiometric methods.

Production Figures

Estimated production figures for 1 January through September 30 2006.	
Species	**Specimens Aged**
Flathead sole	1,888
Alaska plaice	339
Dover sole	838
Northern rock sole	921
Yellowfin sole	1,181
Walleye pollock	8,648
Pacific cod	3,812
Sablefish	2,389
Atka mackerel	1,467
Pacific ocean perch	1,824
Northern rockfish	817
Rougheye rockfish	3,638
Dusky rockfish	476
Dark rockfish	50
Great sculpin	400

Total production figures were 28,688 with 6,979 test ages and 298 examined and determined to be unageable.

By Dan Kimura