AUKE BAY LABORATORIES (ABL)

HABITAT ASSESSMENT & MARINE CHEMISTRY PROGRAM

Parasites of Fishes in the Vicinity of Steller Sea Lion Habitat in Alaska

Fish serve as intermediate hosts for a number of larval parasites that have the potential of maturing in marine mammals such as Steller sea lions (*Eumetopias jubatus*). Members of the Auke Bay Laboratories (ABL) Habitat Assessment and Marine Chemistry Program examined the prevalence of parasites from 229 fish collected between March and July 2002 near two islands used by Steller sea lions in Southeast Alaska and four island habitats in the Aleutian Islands. Even though the fish samples near the Southeast Alaska haulouts were composed of eight species of forage fish and the Aleutian Islands catch was dominated by juveniles of four commercially harvested species, the parasite species identified from the fish were similar at all locations. Twenty-two species of parasites were found in the fish from the four Aleutian Islands habitats: two protozoa, one monogenetic trematode, seven digenetic trematodes, four each of cestodes and nematodes, and two each of acanthocephalans and copepods. Eleven of the 20 parasite taxa identified were in their larval stage in the fish hosts; several of these larval stages have been described from mammalian final hosts.

Four species of parasites were statistically more prevalent ($P < 0.05$) in the Southeast Alaska samples: *Pleistophora* sp., *Lecithaster gibbosus*, *Tubulovesicula lindbergi*, and *Phyllobothrium* sp. In contrast, seven species of parasites were statistically more prevalent in the Aleutian Island samples: *Steganoderma formosum*, *Abothrium gadi*, *Anisakis* sp., *Hysterothylacium aduncum*, *Pseudoterranova* sp., *Corynosoma* sp., and *Echinorhynchus gadi*. The larval nematodes *Anisakis* sp. and *Pseudoterranova* sp. were found in 95% and 54%, respectively, of the Aleutian Islands samples and are potentially pathogenic to marine mammals.

These results suggest that a few of these parasites may serve as sources of indirect information about the habitat of the fish hosts. The greater prevalence of the two species of larval nematodes in the Aleutian Islands probably reflects the greater number of final hosts (sea lions), and changes in host intensity of these two species of nematodes often mirror changes in the density of marine mammals. The larval acanthocephalan *Corynosoma strumosum* was present in 20% of the Aleutian Islands samples but was detected in less than 3% of the Southeast Alaska samples, suggesting that amphipods are a less prevalent part of the diet among benthic-feeding fishes in Southeast Alaska. The protozoan *Pleistophora* sp. was present in significantly greater proportions among walleye pollock, *Theragra chalcogramma,* (21%) and Pacific cod, *Gadus macrocephalus,* (23%) from Southeast Alaska, in contrast to 5% and 0% among these fish species in the Aleutian Islands, and may serve as a stock separation marker for these fish. This is the first time most of these host-parasite associations have been reported in Alaska waters.

By Adam Moles

MARINE SALMON INTERACTIONS PROGRAM

Pink Salmon Forecast Information Provided to the Southeast Alaska Region

ABL researchers presented data and results from the Southeast Alaska Coastal Monitoring (SECM) project and provided adult pink salmon forecast information at the Purse Seine Task Force meeting in Petersburg, Alaska, on 28 November 2006. The task force meeting is an annual event sponsored by the Alaska Department of Fish and Game (ADF&G), the commercial purse seine fishing fleet, fishing in-

Figure 1. Catch rates of juvenile pink salmon, obtained from Auke Bay Laboratories' Southeast Alaska Coastal Monitoring surveys, are currently being used to forecast adult returns to the region.

dustry processor representatives, and other resource stakeholders from Southeast Alaska communities. At the meeting ADF&G scientists presented an overview of the current commercial pink salmon fishing year, and ADF&G and ABL personnel provided forecasts of the pink salmon harvest in the Southeast Alaska region for 2007 (Fig. 1). An accurate forecast has major economic consequences to the industry because it enables processors and fisherman to devote the proper amount of resources to the anticipated harvest, which has an average exvessel value of about $20 million to the region.

ABL is in a good position to make a pink salmon forecast to the region because of a historical time series of biophysical data collected by the SECM Project. Our SECM research, which focuses on juvenile salmon and their associated epipelagic species and oceanographic parameters, occurs from May to August as juvenile salmon migrate seaward to the Gulf of Alaska from southeastern Alaska. From this information, which now comprises a 10-year time series of data, ABL researchers generated a harvest forecast of 40 million pink salmon to the region for 2007. Important parameters used in this forecast are peak monthly average catch-per-haul of juvenile pink salmon and spring ocean temperatures. In 2006, for the first time, ADF&G scientists incorporated SECM data to improve their forecast, which previously relied exclusively on running averages of past harvest levels. Prior forecasting of pink salmon harvests by ABL researchers, using SECM data for Southeast Alaska, were quite accurate in 2004 and 2005; however, in 2006 the forecast was well above the actual harvest. Possible explanations for the poor returns to the region in 2006 were the anomalously warm ocean conditions observed in the region in 2005 and the presence of unusual competitor and predator species, such as Pacific sardines, Humboldt squid, and blue sharks in the Gulf of Alaska. After the task force meeting, pink salmon forecast information given by ABL researchers was featured in a radio broadcast that aired on Petersburg public radio station KFSK on 8 December 2006.

By Joe Orsi, Alex Wertheimer, Molly Sturdevant, and Emily Fergusson

Evaluating the Effects of Ventral Fin Clips in Marine Survival of Chinook Salmon

The U.S. section of the Chinook Technical Committee of the Pacific Salmon Commission provides funding to evaluate the effects of ventral fin clips on marine survival schedules of Alaska stream-type Chinook salmon. This project will provide information to address concerns over the deterioration of the coded-wire tag (CWT) system as a tool for coast-wide management of Chinook salmon. At the Little Port Walter (LPW) Marine Research Station on lower Baranof Island in Southeast Alaska, ABL researchers have studied two stocks of Chinook salmon since the late 1970s. The research involves two brood years (BY) (2005BY and 2006BY) from the two stocks, originally from the Chickamin River and the Unuk River. The stocks are maintained separately through the use of CWTs.

For the 2005BY, gametes from returning adult Chinook salmon from both stocks were collected, fertilized, and seeded in incubators at LPW in August 2005. In April 2006, the salmon fry were transferred to freshwater vertical raceways. In September and October 2006, a total of 135,107 Chinook salmon (37,144 Chickamin stock and 97,963 Unuk stock) were fin-clipped and tagged with CWTs at LPW. Two different mark types were applied to 2005BY smolts: 1) adipose fin clip and CWT (66,845 fish), and 2) adipose fin clip, ventral (pelvic) fin clip, and CWT (68,262 fish). For Chickamin River stock, the mean fork length was 107.5 mm and the mean weight was 15.5 g. For Unuk River stock, the mean fork length was 109.7 mm and the mean weight was 17.2 g. After tagging/clipping, the fish were returned to vertical raceways for overwinter freshwater rearing. The 2005BY smolts will be released into the LPW estuary in May 2007.

For the 2006BY, gametes from returning adults of Chinook salmon of Chickamin River stock and Unuk River stock were collected, fertilized, and seeded in incubators at LPW in August 2006. Egg picking occurred in mid-November 2006. Live eyed eggs in good condition numbered 364,441 for Unuk River stock and 205,262 for Chickamin River stock, which should provide adequate numbers of 2006BY smolts (162,000 Unuk River stock and 54,000 Chickamin River stock) for fin clipping and tagging in the second year of this project. In April 2007, the fry will be transferred to freshwater vertical raceways and tagging/fin clipping will occur in September 2007. Three different mark types will be

applied to 2006BY smolts: 1) adipose fin clip and CWT, 2) adipose fin clip, ventral (pelvic) fin clip, and CWT, and 3) ventral (pelvic) fin clip and CWT.

The different tag/clip groups will allow determination of the survival differences relative to type of fin clip. These groups will be evaluated for age-specific distribution, exploitation, and hatchery return rates, and cohort reconstruction will be used to determine if mortality schedules are similar between age groups. If the ventral fin clip does not affect distribution or ocean survival after age 2, then it could be an acceptable external mark to estimate stock-age-fishery specific exploitation rates for untagged fish and could be used for indicator stock marking.

By Adrian Celewycz

Russian Far East Hatchery Workshop

An International Scientific Workshop "Current Issues Facing Salmon Hatcheries in the Russian Far East" was held at Petropavlovsk-Kamchatsky, Russia, from 30 November to 1 December 2006. The hatchery workshop was part of the broader Russian Academy of Science Conference *Conservation of Kamchatka Marine and Terrestrial Biodiversity*.

The workshop was hosted by several international conservation organizations including the World Wildlife Fund for Nature, the United Nations Development Program-Global Ecological Facility Project on Conservation and Sustainable Use of Kamchatka Salmonids, the State of the Salmon Program of the Wild Salmon Center, and Ecotrust. A total of 22 papers were presented by Russian, U.S., and Chinese scientists over the 2-day workshop. Following the presentation of papers, an open forum was held for public testimony and comment about Pacific salmonid resources and hatchery programs in the Far East. The open forum was characterized by several spirited pro-and-con commentaries concerning Russian salmon hatcheries and issues related to salmon resource management and conservation. After the workshop a 1-day field trip was organized for a visit to the modern Malkinsky Hatchery on a tributary of the Bolshaya River, which drains into the Okhotsk Sea.

Papers presented at the workshop included overviews on the history of salmon hatcheries in different regions of the Russian Far East beginning in the early 1900s. Many of the early hatcheries were poorly designed, used inappropriate science, and were unsuccessful. Some are still in operation. Currently there are 53 salmon hatcheries in the Russian Far East according to the following regional breakdowns: 28 hatcheries on Sakhalin Island (including 9 new hatcheries nearing completion); 6 hatcheries in the Kurile Islands; 7 hatcheries in the Khaborvsk Region (including 5 on the Amur River 200-1,500 km upstream from the mouth); 2 hatcheries in the Primorye Region along the Okhotsk Sea coast; 4 hatcheries in the Magadan Region; and 6 hatcheries on the Kamchatka Peninsula (2 on the west coast, and 4 on the Pacific side). There are also two Chinese chum salmon hatcheries on tributaries of the Amur River near Harbin, China.

In 2005, Russian Far East hatcheries released 677 million juvenile salmon. The vast percentages of these releases were chum (56%) and pink (41%) salmon. Smaller quantities of sockeye (1.4%), coho (1.0%), masu (0.5%), and Chinook (0.1%) salmon were also released. More than 84% of all the releases occurred in the Sakhalin-Kurile Islands region. Commercial fisheries in the Sakhalin-Kurile region harvested 135,000 t of pink salmon in 2005, with an estimated 18% of the catch coming from hatcheries. Chum salmon harvest in this region was 10,755 t in 2005, with an estimated 66% of the catch coming from local hatcheries. Two of the most successful Russian salmon hatcheries, the Kurilsky and Reidovy hatcheries on Iturup Island in the Kurile Islands group, in recent years had return rates of pink salmon from 6% to 10% of the number of juveniles released. These levels of efficiency were possible only after short-term rearing of juveniles to 0.8-1.2 g before release and favorable temperatures of coastal waters (generally warmer) at the time of release.

Most hatcheries in the Khaborvsk (Amur River), Primorye, Magadan, and Kamchatka regions do not have sufficient adult returns to the hatchery to meet egg requirements, and many still take eggs from wild stocks to try to make up the difference. Several Russian scientists expressed concern over operational procedures at many of their hatcheries, including the lack of adequate evaluation. Under the existing system, successes of artificial production and efficiencies at many hatcheries are based not on adult returns or contributions to fisheries but on the numbers of eggs incubated and numbers of juveniles released.

Currently there are numerous proposals to build new Far East hatcheries in Russia, usually by private

companies. A major concern by some scientists over privatization of new hatcheries is that the company, by building the hatchery, gains fishing rights in ecologically favorable areas at the expense of traditional fisheries. Other proposals were made by Russian scientists to: 1) establish a unified database of all Far East hatcheries that includes detailed statistics on juveniles released, including release timing, origin, and biological characteristics of spawners used in hatcheries, return rates including fisheries contributions, and information on early life history of juveniles after release; 2) provide for marking of all juveniles released from hatcheries using best methods and organize wide-scale identification of marked hatchery fish in commercial fisheries; 3) ban the transfer of eggs between hatcheries as well as the collecting of eggs from spawners that do not belong to the rivers of hatchery location; and 4) enforce strict requirement and control measures for documentation of planning, development, and approval of construction of new hatcheries.

Developing a unified database for Russian hatcheries and applying these recommendations would provide a basis for assessments for either improving less efficient hatcheries, changing their specializations, or closing them down. Additionally, these steps would provide a better framework for the rationale and approval for building any new hatcheries.

United States scientists gave reports on: 1) a generalized assessment on the state of North Pacific salmon hatcheries; 2) an economic assessment of augmentation hatcheries designed to continue commercial harvest on the Columbia River; 3) growth and survival of salmon in response to competition and climate change; and 4) ecological implications for interactions between wild and hatchery salmon. In an overview of Alaska's salmon hatchery program, Bill Heard from ABL pointed out that the Alaska program already has in place policies and guidelines and is based on many of the recommended changes that some Russian scientists were proposing for their hatcheries.

An issue that permeated much of the workshop discussions on hatcheries and salmon management in the Russian Far East was the pervasive role of illegal poaching of adult salmon on spawning grounds. Poaching for roe to sell on black markets may well be the greatest single threat to the health and well-being of many Russian salmon stocks. In areas with high unemployment or low income, one or two small buckets of roe might be the equivalent of a month's wages.

According to one source, because poaching is so lucrative it comes in many forms: from lone villagers trying to make ends meet, to local gangs, to large bands of highly organized and armed professionals. One scientist said that some groups use small children to collect roe because they cannot be prosecuted. Russia's Far East Federal District in 2003 reported 135 metric tons (t) of illegally caught salmon caviar. On the field trip to the Malkinsky Hatchery the hatchery manager reported that 80-85% of Chinook salmon returning to the hatchery were males, because females are taken by poachers before they can reach the hatchery. During the open forum discussions, arguments were made by some individuals that building any new hatcheries would only be "feeding the poachers".

By Bill Heard

ABL Staff Participate in Committee on Scientific Research and Statistics at NPAFC Fourteenth Annual Meeting

The North Pacific Anadromous Fish Commission (NPAFC) held its Fourteenth Annual Meeting from 23 to 27 October 2006 in Vancouver, British Columbia, with representatives from Canada, Japan, the Republic of Korea, Russia, and the United States participating (see page 8). These five nations represent the primary states of origin for salmonid stocks in the North Pacific Ocean and adjacent seas. The NPAFC promotes the conservation of Pacific salmon and serves as a venue for coordination of scientific research on these fishes and on marine ecosystem studies where salmon live. Parties from the NPAFC also maintain aggressive enforcement programs to prevent illegal gill net fishing for salmon in the far reaches of the North Pacific Ocean.

The NPAFC Commissioners for the United States included Jim Balsiger from NOAA's National Marine Fisheries Service, Alan Austerman from the State of Alaska, and Gary Smith from the State of Washington. Jim Balsiger was head of the U.S. delegation. The Committee on Scientific Research and Statistics (CSRS), the commission's principal forum for international cooperation in research, met during the annual meeting to consider a wide range of issues concerning Pacific salmon stocks and research activities by member parties. Loh-Lee Low

from the AFSC served as principal spokesperson for the 20-member U.S. CSRS contingent. During the CSRS deliberations, Bill Heard, Ed Farley, and Jack Helle reviewed relevant research activities conducted in 2005 by Auke Bay Laboratories.

Several CSRS special working groups also met and developed detailed reports on Stock Assessment, Salmon Marking, Stock Identification, and BASIS (Bering-Aleutian Salmon International Survey). Dick Wilmot of ABL served on the Stock Identification Working Group, and Jack Helle and Ed Farley served on the BASIS Working Group with Jack Helle as chair. Ed Farley was appointed chairperson to help plan and organize a special symposium to be held in the United States in 2008 that will review in detail results from the first 5 years of coordinated BASIS research among the parties.

Consistent with the NPAFC 2006-10 Science Plan, much of the discussion during CSRS and working group meetings centered around broad scientific issues related to the important roles that anadromous stocks and their ecologically related species play in North Pacific marine ecosystems. For example, the commercial catches of salmon by member parties in 2005 were the second highest in recent history, totaling 971,380 t. Pink salmon accounted for 50% of the catch by weight, followed by chum, sockeye, coho, Chinook, and cherry (masu) salmon. The largest catches were reported by the United States (Alaska), Russia, and Japan. This reflects generally healthy northern populations of Asian and North American salmon. However, the United States expressed heightened concern about lower than expected returns of North American steelhead and some southern populations of salmon.

The United States delegation submitted a new proposal to the CSRS to develop a comprehensive Pacific-wide genetic baseline for steelhead. Such a baseline would help fisheries managers to better understand ocean distribution patterns of North American and Asian populations and how warming of North Pacific Ocean surface waters affects marine distribution and survival of specific steelhead populations. Eleven of fifteen population segments of steelhead in the states of Washington, Oregon, Idaho, and California are at some degree of risk under the U.S. Endangered Species Act.

Preliminary catch estimates for favorable salmon returns in Russia in 2006 were similar to the large catches recorded in 2005. Alaska catches in 2006, however, showed major fluctuations in abundance. Returns of pink salmon in Southeast Alaska were much lower than forecasted while chum salmon returns were strong. Pink salmon returns in British Columbia were also far below expected levels in 2006. Complicating these fluctuations in abundance are the ongoing consequences of climate change on oceanographic and biophysical conditions affecting salmon production in marine ecosystems.

Possibly related to fluctuations during 2006 were findings from a Japanese research cruise in the western North Pacific Ocean and the Gulf of Alaska during winter January-March 2006. Due to extremely stormy sea conditions, winter research cruises in these waters are uncommon but are badly needed to better understand how biophysical conditions function during this period. During the Japanese cruise, immature pink and chum salmon were caught by surface trawls from the research vessel *Kaiyo Maru* and analyzed by scientists for total lipid content (TLC) in muscle tissues. Average TLC values for ocean age-1 chum and pink salmon in the western North Pacific Ocean were twice as high as those for salmon in the Gulf of Alaska. Low TLC values for pink salmon in the gulf during this temporal window include values for the same populations of salmon that recorded unexpectedly low adult returns in Southeast Alaska and British Columbia later in 2006. While not conclusive, the Japanese data suggest that less favorable conditions in the Gulf of Alaska than in the western North Pacific Ocean contributed to the unexpected low returns of pink salmon in parts of Alaska and British Columbia.

An overarching goal of cooperative international NPAFC research is to provide better scientific information on the status and trends in marine production of anadromous stocks of salmonids, identify the roles these stocks play in marine ecosystems, and examine the extent to which anadromous stocks, which return to coastal regions, can be used as indicators of conditions in North Pacific marine ecosystems.

By Bill Heard

FISHERIES MONITORING & ANALYSIS (FMA) DIVISION

Personal Locator Beacons Added to FMA Safety Program in 2007

As part of the Fisheries Monitoring and Analysis (FMA) Division's North Pacific Observer Program

Figure 1. Brian Mason, FMA staff, dons an immersion suit to demonstrate the use of a Personal Locator Beacon for water rescue.

(NPGOP), approximately 400 fishery observers spend up to 90 consecutive days each year at sea or at processing plants collecting data used for management of the Alaskan groundfish fisheries. The majority of this work is performed in one of the most dangerous working environments in the United States. Working conditions can be cold, wet, dark, and hectic. The weather conditions can be treacherous. In every case, all observers at sea face the possibility of a major at-sea emergency.

At-sea emergencies occur each year, but in the history of the NPGOP there has been only one observer fatality with the sinking of the *Aleutian Enterprise* in 1990. However, in several cases observers and crewmembers have found it necessary to abandon ship. In the cold waters of the North Pacific, abandoning a vessel is an extreme measure, and rapid rescue is paramount to survival. Commercial fishing vessels carrying observers have a variety of required safety equipment on board, such as the vessel radio and Emergency Position-Indicating Radio Beacon (EPIRB). However, in an emergency requiring abandoning ship, that equipment may be inaccessible or otherwise left behind.

In 2002, the 180-foot vessel *Galaxy* suffered an extensive fire at sea. The captain fought through smoke and flames to enter the wheelhouse to send a Mayday call. However, the fire spread rapidly, and the captain was able to send only a short Mayday call. Soon after the call was sent, all of the vessel's electronic systems were destroyed in the fire. All personnel onboard, 26 people including the observer, eventually had to abandon ship. Several crewmembers made it into the vessel's life rafts, but others did not. The observer was among several who could not make it to a life raft and she, along with a crewman, drifted in the sea away from the vessel. Fortunately, three nearby vessels came to aid and rescued many of the crew and the observer from the sea. Four people perished in the accident.

Given the high potential of danger at sea, safety is a key focus of FMA operations and training (see *Quarterly Report*, April-May-June 2006). In keeping with its emphasis on safety, the FMA Division recently added the Personal Locator Beacon (PLB) to observer's safety gear effective January 2007 (Fig. 1). A PLB is a small, portable device, which when activated emits a signal giving the units location and indicating the person possessing the device is in imminent danger and needs rescue. Each observer will be equipped with a PLB, with funding for the initial purchase made available through the National Observer Program.

When activated, the signal from the PLB is transmitted by satellite to the NOAA Search and Rescue Satellite Aided Tracking (SARSAT) Mission Control Center. Signals transmitted from sea are relayed to the U.S. Coast Guard for response action. A feature of the FMA's PLBs is that they transmit the Global Positioning System coordinates of the unit's position, accurate to within 100 m. Each PLB has a unique identification number to allow tracking of the PLB and thus the location of the individual in possession of the PLB.

PLBs are registered individually in the NOAA SARSAT database. Emergency contact informa-

tion for individuals carrying PLBs is recorded in the database and provides search and rescue teams with necessary contact information regarding the PLB's possessor, vessel description, and the number of persons onboard. The contact information also helps in identifying any false alarms that may be activated avoiding unnecessary deployment of rescue personnel.

Providing PLBs to observers in the North Pacific presents some logistical challenges because of the large number of observers deployed (up to 230 at one time) and the need to have precise information regarding the possessor of each PLB. This challenge is addressed by utilizing database technology to track all FMA PLBs and to provide automatic daily reports to each observer's employer.

PLBs transmit a 406 MHz signal that can be detected by satellites usually within 5 minutes of the first transmission. They are powered by a lithium battery capable of 24 hours of transmission at -20°C. The FMA's PLB model weighs 12 ounces and is small enough to be worn on a belt clip or attached to an immersion suit.

PLBs were approved by the Federal Communications Commission for use by the general public beginning in July 2003. Prior to this authorization, PLBs could be used only by residents of Alaska in a program designed to assess the functionality of PLBs and their effects on search and rescue operations. The program was highly successful with nearly 400 lives saved and very few false alerts generated. PLBs are now used by hikers, climbers, boaters, and many others active in remote settings nationwide.

FMA staff train observers to use PLBs and emphasize that activating one is comparable to sending a Mayday signal. Thus, each observer understands their responsibility to use these tools judiciously. They are also trained to keep the PLB with them in an emergency. Then, if they become separated from the vicinity of the vessel and the vessel's EPIRB, as typically occurs when personnel must abandon ship, their chances for rescue will be greatly improved.

The PLB is an important new safety tool, but it is only one component of the FMA's safety program. The program provides other required safety gear such as hard hats, personal flotation devices, immersion suits, as well as extensive safety training. The training curriculum covers handling at-sea emergencies such as man overboard, near-drowning, fire, flooding, and abandoning ship. In training, observers practice donning immersion suits, entering the water, and boarding a life raft from the water. The addition of the PLBs adds a new dimension to our comprehensive observer safety program. We expect our safety efforts to continue to evolve as safety tools, technologies, and education continue to improve. In the dangerous at-sea environment in which observers work, we cannot stress this aspect of their work enough.

By Allison Barns

NATIONAL MARINE MAMMAL LABORATORY (NMML)

NMML DIRECTORATE

Workshops to Identify Critical Information Gaps About Marine Mammals in Areas of Interest to the Oil/Gas Industry

In anticipation of considerable new oil and gas exploration and development in Alaska, two workshops were convened by the Department of Interior, Minerals Management Service (MMS), to identify research priorities for assessment of potential impacts on marine mammals of oil and gas leasing in the Chukchi Sea and Bristol Bay. The National Marine Mammal Laboratory (NMML) made strong contributions to both workshops; Laboratory Director John Bengtson and Deputy Director Robyn Angliss attended both workshops, as did senior staff from the Polar Ecosystem Program (Peter Boveng) and the Cetacean Ecology and Assessment Program (Phil Clapham). The workshops resulted in proposed research for inclusion in the MMS Environmental Studies Plan, which will fill critical gaps in knowledge about the density, distribution, foraging requirements, and response to industrial activities, of ice seals, fur seals, sea lions, and cetaceans. (See research feature article in this issue for related information.)

Evaluation of Unmanned Aerial Systems (UAS) for Cetacean Monitoring

The oil and gas industry must conduct monitoring of marine mammals when involved in offshore activities that have the potential to impact marine mammals, particularly bowhead whales. Aerial line transect surveys are one traditional method of conducting the monitoring. Due to concerns about human safety in small aircraft in some remote Arctic

areas (such as over the Chukchi Sea), the oil and gas industry has proposed to use unmanned aerial systems (UAS) in lieu of manned surveys.

In December, Angliss observed two evaluations of UAS for use in surveying for cetaceans. In both cases, surveys were conducted in Puget Sound, Washington, using an InSitu ScanEagle platform carrying a camera that streams video to a monitor where objects can be seen and recorded by human observers. Surveys were conducted over man-made targets (anchored kayaks and buoys) and were flown at various altitudes and in various weather conditions. The evaluations were necessary first steps in assessing the utility of the system as a monitoring tool. Additional evaluations of the UAS that involve surveys of cetaceans and direct comparisons between sightings from a UAS and sightings from a manned aircraft are needed.

By Robyn Angliss

Outreach and Education

In November and December 2006, Harriet Huber, NMML representative to the AFSC Committee for Outreach, Education, and Diversity, helped to develop a curriculum for third grade teachers in Seattle based on the story of Springer, an orphaned orca whale, reunited with her pod by a consortium of agencies lead by NOAA.

Springer, part of the northern resident pod of orca whales, was found alone in the ferry lanes in Seattle in winter 2002. She was successfully translocated back to her pod in summer 2002. The curriculum includes a picture book on the Springer story, a video on the translocation produced by NOAA, background information on Springer and Luna (separated from the southern resident pod), northern and southern resident ranges, games to teach about food webs and bioaccumulation, a web-based elementary research project, maps, photos, a visit from a NMML scientist, and a visit to the NMML marine mammal museum. The curriculum is being developed as a pilot project to be tested in three Seattle schools between February and May 2007.

By Harriet Huber

ALASKA ECOSYSTEMS PROGRAM

Winter Behavior Studies of Young Northern Fur Seals

In fall 2006, the Alaska Ecosystems Program embarked on the second year of a study examining the winter migration patterns of northern fur seal pups from four breeding sites in Alaska and California. The Eastern Pacific stock of northern fur seals is continuing to decline and is listed as depleted under the Marine Mammal Protection Act (MMPA). However this decline is not ubiquitous among all Alaska rookeries. While the population on the Pribilof Islands has shown a downward trend, the small rookery at Bogoslof Island has increased at approximately 12% each year for almost 10 years.

In October-November 2006, 47 satellite tags and 20 satellite-dive tags were deployed on pups prior to weaning in order to assess interannual variation in winter migratory routes and foraging behavior (Fig. 1). There are three fur seal rookeries in Alaska: St. Paul and St. George Islands in the Pribilof Islands and Bogoslof Island in the Aleutian Islands chain. Twenty-five pups were equipped with satellite transmitters at St. Paul, 18 at St. George and 15 at Bogoslof Island. As part of collaborative work with NMML's California Current Ecosystem Program, nine pups were also equipped at San Miguel Island, California. (See California Current Ecosystem Program report below.) Pups captured from Alaskan populations had average body masses of 14.7 kg (Bogoslof, Oct.), 17.3 kg (St. Paul, Nov.) and 17.0 kg (St. George, Nov). Pups at San Miguel Island tagged in November, however, exhibited considerably smaller body masses at an average 12.6 kg. The satellite tags have been programmed to transmit for up to 400 days to cover the return to breeding sites next fall.

In addition to the pup work, a new study was initiated to also investigate winter migration routes of juvenile age (1 and 2 year-old) northern fur seals from the Eastern Pacific Stock. Typically, fur seals

Figure 1. Northern fur seal pup from St. Paul Island with satellite tag used for tracking attached to its back. The tags are attached with marine epoxy and fall off during the annual molt.

do not return to the breeding rookeries in large numbers until they are sexually mature. Therefore, little is known about the behavior of the population segments that have survived their first year at sea but are not yet breeders. Thirty satellite transmitters were deployed between 30 September and 13 October 2006. Ten transmitters were deployed on Bogoslof Island (5 males and 5 females), and 20 transmitters were deployed on St. Paul Island (7 males and 13 females). Twenty-five of the thirty transmitters were still transmitting as of 10 January 2007. All of the animals are currently south of the Aleutian chain, and several are as far south as lat. 40°N.

As with the pups, this information will help us understand the habitat preferences and influence of oceanographic and environmental variables on animal behavior.

By Mary-Anne Lea, Tonya Zeppelin and Tom Gelatt

POLAR ECOSYSTEMS PROGRAM

Habitat Use and Seasonal Movements of Bearded Seals in Kotzebue Sound

In October 2006, five male and four female young-of the-year bearded seals, *Erignathus barbatus*, were captured in Kotzebue Sound, Alaska, and instrumented with satellite-linked dive recorders (SDRs) (Fig. 2). Together with an additional 9 female and 8 males tagged in 2004 and 2005, these 26 bearded seals are the first to be instrumented with SDRs in Alaska. The project was part of a cooperative effort with the Native village of Kotzebue, the University of Alaska, Fairbanks, the Alaska Department of Fish and Game, and the NMML Polar Ecosystems Program, and was funded in part by a tribal wildlife grant from the U.S. Fish and Wildlife Service. It is intended to combine local knowledge about the distribution and habits of bearded seals with the field techniques and analysis expertise of biologists.

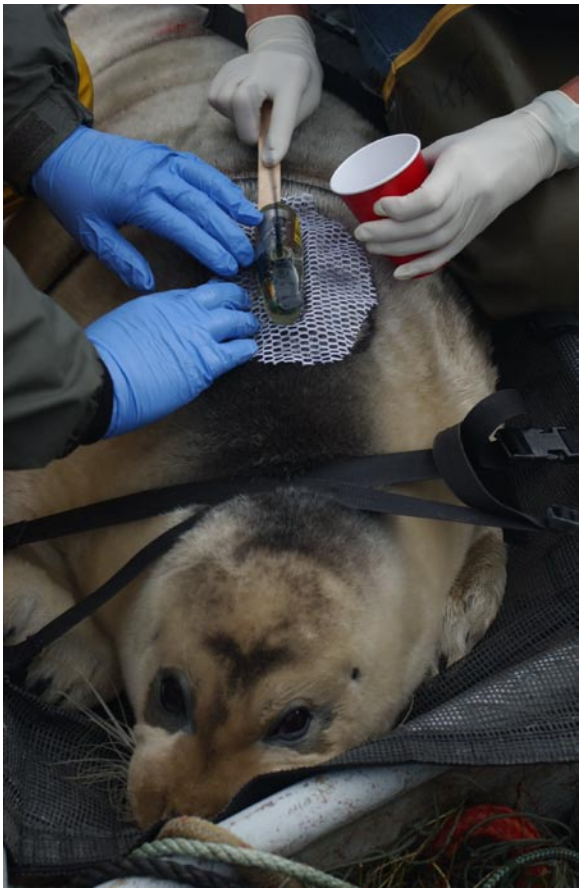


Figure 2. (Top) Researchers glue a satellite-linked dive recorder to a bearded seal pup. (Bottom) Closeup of a young-of-the-year bearded seal pup just before release.

Bearded seals are an important Alaska Native subsistence resource and live and reproduce in pack ice habitat. They are also a key ecological component of arctic marine ecosystems and, because they are sensitive to suitable sea ice conditions, may be particularly vulnerable to climatic change. However, little is known of their seasonal movements, habitat use, or diving behavior. The SDRs, which fall off when the seals molt in the spring, provide information on the animals' movements and can be used to identify important habitats, describe foraging behavior, and improve abundance estimation techniques.

Seals were captured in large-mesh nets set in the shallow, open waters near Kotzebue. Soon after being released, most animals left Kotzebue Sound. Pups occupied areas as far north as Wainwright, Alaska, as far south as St. Lawrence Island, Alaska, and west beyond the Gulf of Anadyr, Russia (Fig. 3.) Analyses of diving data indicate that most dives lasted from 4 to 6 minutes and, while most pups

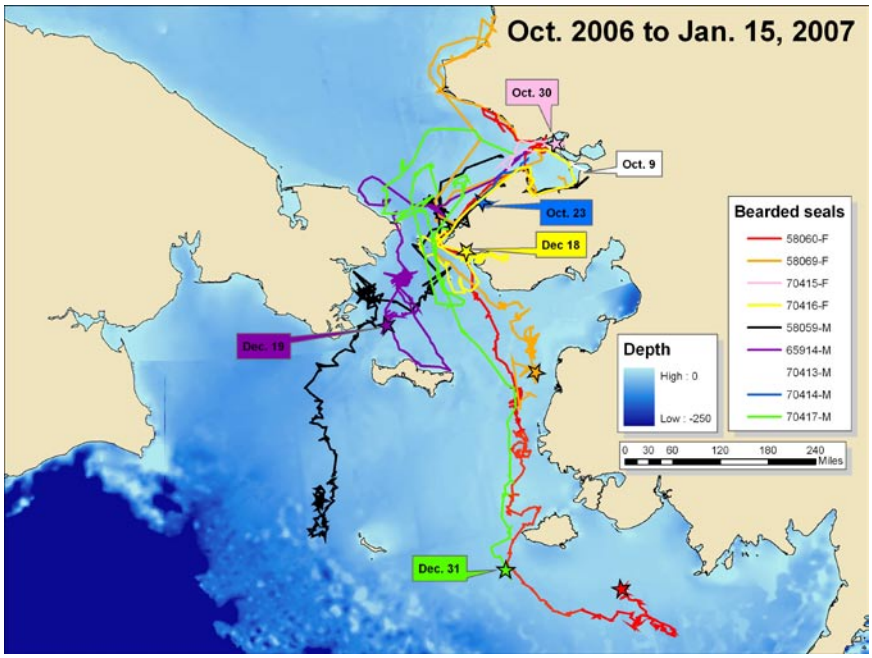


Figure 3. Map of the current tracks of bearded seals instrumented in 2006. Callouts indicate the last know position at the given date.

spent almost half of their total time near the seafloor, the amount of time spent at the bottom varied between individuals and with the season and time of day. Haul-out time also varied with season and time of day. Movement and diving data are still being recorded from instrumented animals. Five of the seals in 2006 had SDRs that also record water temperature and salinity throughout a dive. Correlating these environmental characteristics, as well as bathymetry, ice concentration, and ice extent, with diving behavior will further improve our understanding of the important foraging habitats of young bearded seals.

By Michael Cameron

Workshops and Meetings

Staff from the Polar Ecosystems Program (PEP) participated in several workshops and comanagement meetings during the past quarter. In a meeting with the Ice Seal Committee (ISC), an Alaska Native organization representing subsistence hunters of ice seals, PEP members reported on results from satellite telemetry studies of bearded, spotted, ribbon and ringed seals, and participated in the signing of a new comanagement agreement between NMFS and the ISC.

Another new marine mammal comanagement agreement was signed with the Aleut Marine Mammal Commission (AMMC). PEP staff provided an update on harbor seal research to the AMMC annual board meeting.

By Peter Boveng

CETACEAN ASSESSMENT & ECOLOGY PROGRAM

Decline of Beluga Whales in Cook Inlet

On 29 March 2006, NMFS formally initiated a status review of the Cook Inlet (Alaska) beluga whale population to incorporate new scientific findings available since the publication of the last scientific review in 2000. This current status review, published in December 2006, is now available as an AFSC Processed Report (*http://www.afsc.noaa.gov/Publications/ProcRpt/PR%202006-16.pdf*)

Findings of this review indicate a 92% probability that the Cook Inlet beluga population is failing to increase at a rate of at least 2% per year as a healthy cetacean population would. Furthermore, there is a 60% probability that the population is declining and will continue to decline.

In January 2007, the abundance estimate from the 2006 aerial survey was completed. The result was an estimated 302 whales (CV 16% and a 95% confidence interval between 222 and 410). Although this estimate is larger than the estimate of 278 for 2005, it is still below the average of 370 for the years 1999-2004. A trend line fit to the estimates for 1999 to

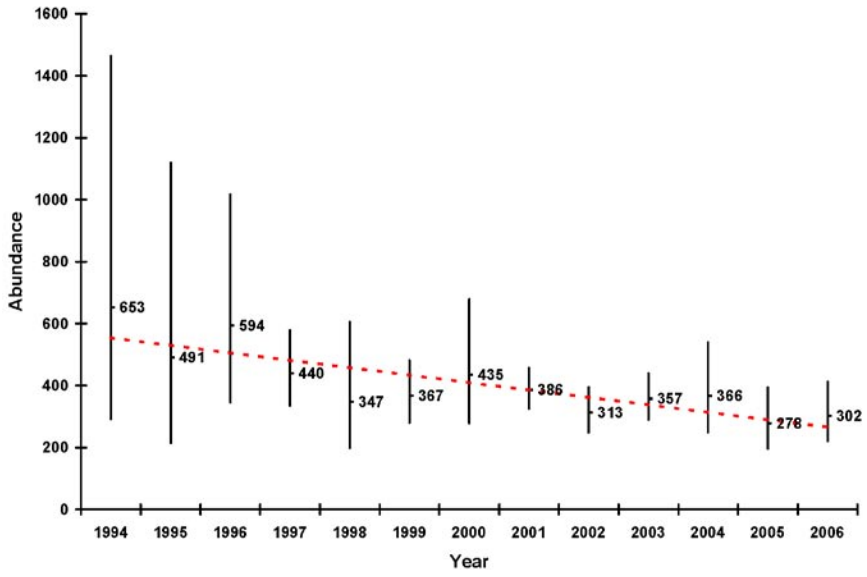


Figure 4. Time series of abundance estimates for the Cook Inlet beluga population, 1994-2006. Dotted trend line shows an annual rate of decline of 5.6%.

2006 yielded an average rate of decline of 4.1% per year (SE = 0.0165) which is significantly different from a constant population level at the 5% level.

Prior to 1999 a subsistence harvest averaging 70 beluga per year between 1994 and 1998 was thought to be the cause of the observed decline of this population. Since 1999 the population has failed to increase and may have continued to decline. Including abundance estimates from the time series before 1999 produced an annual rate of decline of 5.6% for 1994 to 2006 (Fig. 4).

These findings will be reviewed by the NMFS Alaska Regional Office to assess whether there should be a proposal to list the population as threatened or endangered under the Endangered Species Act.

By Kim Shelden and Rod Hobbs

Satellite Telemetry Describes First Migratory Movement of South Pacific Humpback Whales to Their Feeding Grounds

In August, NMML scientists Alex Zerbini and Phil Clapham were involved in setting up a satellite tagging project for humpback whales in the Cook Islands (South Pacific). The work was conducted in collaboration with Nan Hauser (Cook Islands Whale Research), the South Pacific Whale Research Consortium, and the Greenland Institute of Natural Resources. NMML provided three Argos-monitored satellite tags and methodological expertise; the tags were deployed by Hauser and her field team, which included Ygor Geyer from Zerbini's Brazilian research group. Two tags were attached to humpback whales (both mature females); one functioned for only a few days, while the other worked for 2 weeks while the whale remained in the vicinity of the southern Cook Islands. However, the latter tag suddenly came to life again in late December (after over 3 months' silence) and has continued to report positions every 3 days (Fig. 5) The whale has moved more than 3,000 km south of the Cook Islands and is currently continuing to migrate south into Antarctic waters. This represents the first documented migratory movement of any humpback whale in the South Pacific and the first connection of any kind between the Cook Islands and a high-latitude feeding ground. As such, it contributes important information regarding population structure and migratory destinations.

By Alex Zerbini and Phil Clapham

Field Work

Members of the Cetacean Assessment and Ecology Program traveled to Carmel, California, in December to begin the census of the eastern Pacific stock of gray whales at Granite Canyon. During the week, the survey site was set up and contract observers were trained. The contract observers will conduct the bulk of the survey with participants from NMML returning for double counts and other calibration activities in January.

By Paul Wade

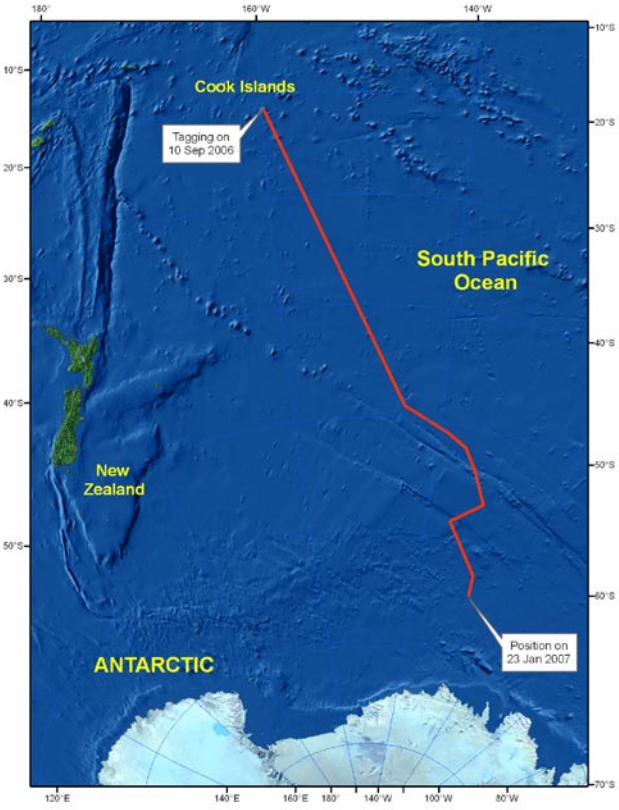


Figure 5. Track of a humpback whale monitored with satellite telemetry from the Cook Islands to the Antarctic.

CALIFORNIA CURRENT ECOSYSTEM PROGRAM

In early October members of the California Current Ecosystem Program returned from San Miguel Island, where they had branded California sea lion pups and tagged northern fur seal pups. During their field work there they found the northern fur seal pup weights to be significantly less than the long-term average, indicating that the pups had grown more slowly than normal in the 3 months since birth. The pups subsequently weaned and departed the island in late October and November. In November and December higher than normal numbers of fur seal pups were reported to the Southwest and Northwest Regions' Stranding Networks. Most of the pups were alive but emaciated at the time of stranding along the coasts of central and northern California, Oregon, and Washington. The Marine Mammal Center in San Francisco admitted 29 fur seal pups during November and December. Although some died, most have responded well to rehabilitation and a steady diet of squid and herring. Pups which died after admission to the Marine Mammal Center showed no significant pathology at the time of death. It is unclear what caused the low growth of pups on the island, but it appears there will be very low survival of pups from the 2006 cohort produced at San Miguel Island.

In November 2006, 10 adult female California sea lions were instrumented with satellite telemetry instruments and dive recorders at San Miguel Island. During the same period, 12 adult females were instrumented at nearby San Nicolas Island by Carey Kuhn of the University of California, Santa Cruz. This is the second year of a 2-year project to describe the movements of reproductive females in the two largest populations of California sea lions in U.S. waters. Although the two islands lie within 60 miles of each other, preliminary results from deployments in 2005 indicate that there may be segregation of foraging areas by females from the two colonies. Initial positions show San Miguel females dispersing northwest of San Miguel Island, traveling as far north as Monterey Bay and the Farallon Islands on foraging trips that last 3-5 days. Females are traveling along the coast and over the shelf but also occur over the slope and offshore. Females from San Nicolas Island remain mostly in the California Bight and in and around the Channel Islands. We will recover the instruments from the current deployment in January 2007 and will begin analyses of the data.

Seven California sea lion pups between 5 and 6 months old were instrumented with satellite telemetry instruments at San Miguel Island. This is the final stage of a study investigating the development of foraging behavior of juvenile California sea lions at San Miguel Island. The goal of this study is to describe the development of diving in California sea lion pups and to determine when pups begin independently feeding. Five of the pups were paired with instrumented females to investigate mother and pup foraging behavior.

Blood and hair samples were collected from pup and adult female sea lions and fur seals for stable isotope analysis. Unlike fecal samples, the diet of a predator can be assessed over different time scales (and not just the last feeding trip) using stable isotopes. Isotopic measurements of multiple tissues (e.g., serum, plasma, and red blood cells from blood and fur) from the same individual can provide dietary information on various temporal scales because of the differing metabolic rates of each tissue. Results from these data will be examined to discern differences in the foraging ecology of individuals, between sexes, and among age groups.

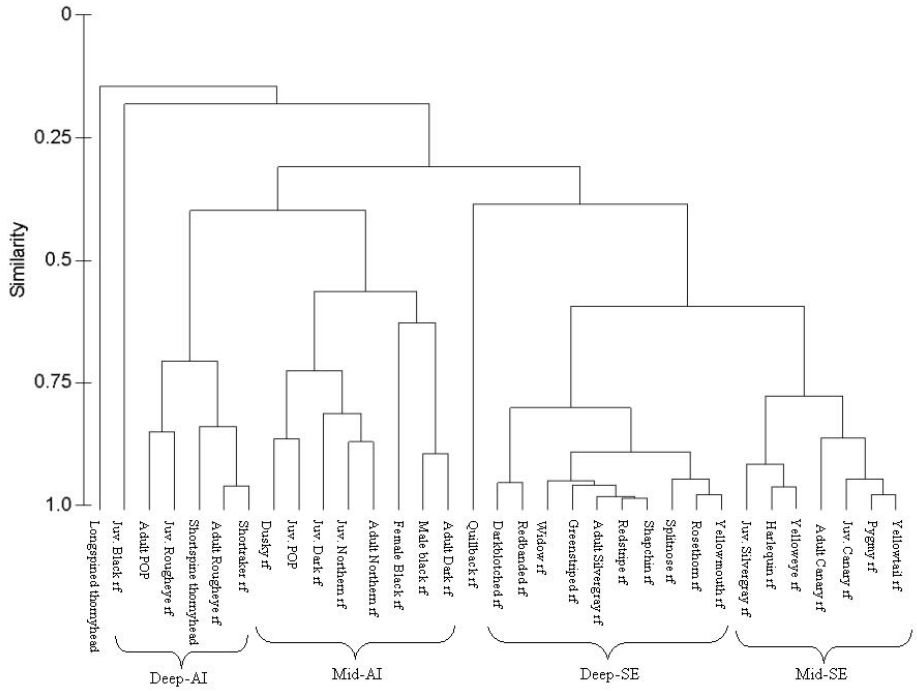


Figure 1. Plot of hierarchical tree showing relative similarity amongst rockfish species-subgroups the result of cluster analysis. The y-axis indicates linkage distance, or larger clusters of increasing dissimilarity, among species derived from the multinomial overlap indices among species-group pairs along the three environmental gradients (depth, position and temperature).

In November 2006, nine adult female northern fur seals and nine pups were instrumented with satellite telemetry instruments at San Miguel Island. This is the second year of a collaborative study between NMML's Alaska Ecosystem and the California Current Ecosystem Programs. The goal of the study is to describe the migratory movements of adult females and pups throughout the range of northern fur seals in the eastern north Pacific and annual variability in migration patterns. Preliminary data show that pups from San Miguel Island dispersed from the island in late November and traveled northward along the coast. By December, most of the pups were located north of San Francisco, California. The adult females have moved northward also, traveling along the slope and offshore. By December, the females were farther offshore than the pups but in the same area, north of San Francisco Bay.

By Robert DeLong

RESOURCE ASSESSMENT & CONSERVATION ENGINEERING (RACE) DIVISION

GROUNDFISH ASSESSMENT PROGRAM

Rockfish Assemblage Analysis

During fall 2007 a retrospective analysis of trawl survey data was completed to identify assemblages of rockfish in the Gulf of Alaska and Aleutian Islands. The analysis used nontraditional method for identifying assemblages by first calculating catch-weighted mean depth, temperature and position (and associated variance) for each rockfish species commonly captured in the trawl survey. These distributions across environmental variables were then used to calculate an overlap index between species pairs based on niche theory. Clustering of the overlap index between species pairs resulted in four distinct assemblages of rockfish species found on the continental shelf and slope of Alaska (Fig. 1).

The assemblages were sharply divided along gradients of depth and position and, to a lesser extent, along temperature gradients (Fig. 2). The major divisions indicate an assemblage inhabiting mid-depths on the upper slope and shelf and a deeper assemblage distributed with a dividing line at ap-

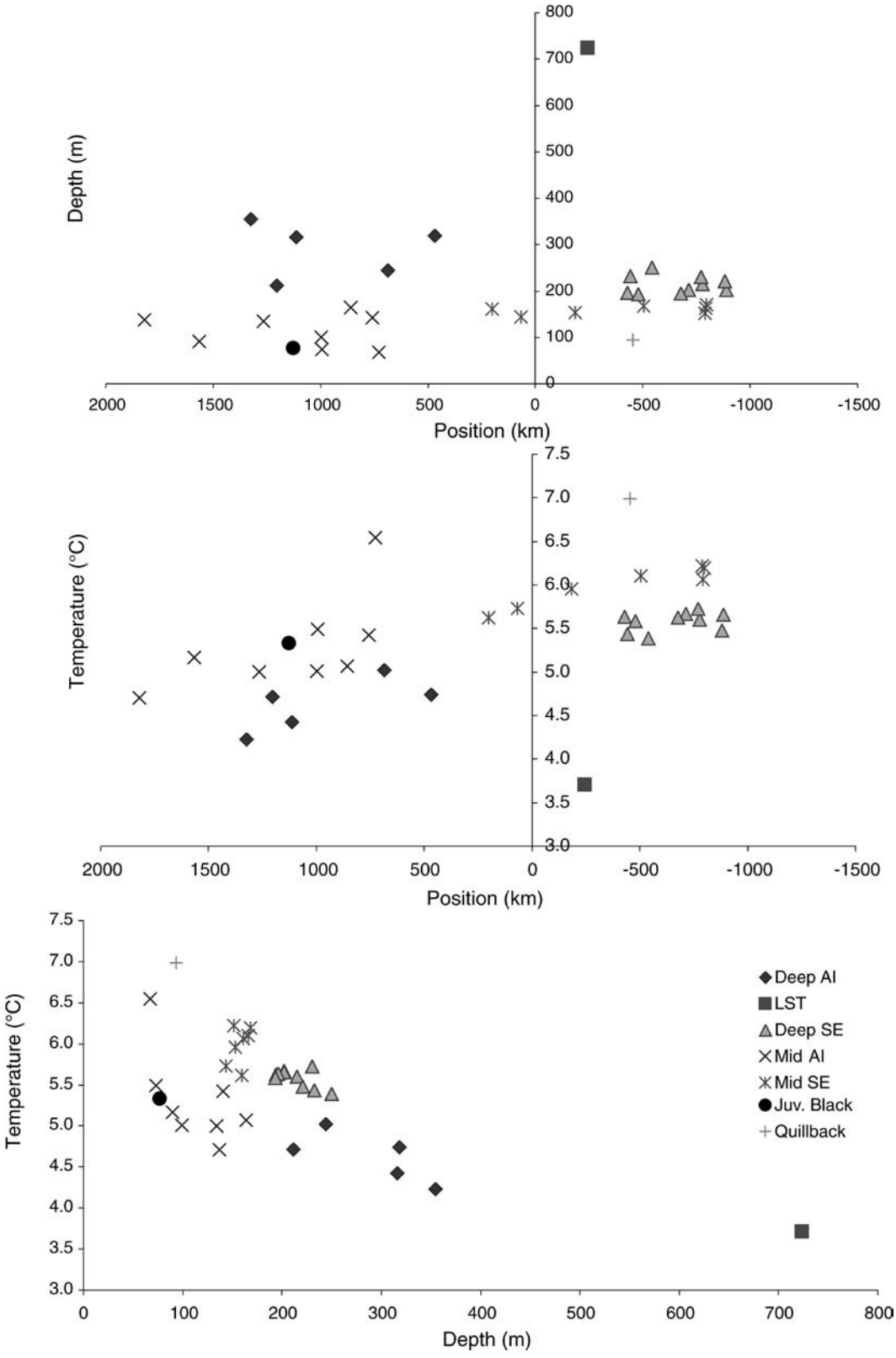


Figure 2. Plots of CPUE-weighted mean values of environmental variables for each rockfish species-subgroup (n = 33). Position is the distance from Hinchinbrook Island, Alaska, with positive values west of this central point in the trawl surveys and negative values in southeast Alaska. Dashed lines indicate natural break points in the weighted mean values of the environmental variables.

proximately 180 m. In addition to the depth division, another noticeable transition was between species centered in southeastern Alaska and those found in the north Gulf of Alaska and the Aleutian Islands. The distribution of species over environmental gradients was correlated to their frequency of co-occurrence in trawl catches, indicating those species with similar environmental preferences were more likely to be captured together.

The method of defining rockfish assemblages by determining the natural distributions of each species group along environmental gradients and examining the potential overlap among species distributions is different than commonly utilized methods that cluster trawl survey catches or stations with similar catch constituents. However, the method used here provided similar results to other studies and, because it is based on an ecological framework, it may be more robust for prediction and management purposes.

By Chris Rooper

Life History Traits of the Rosethorn Rockfish

The rosethorn rockfish, *Sebastes helvomaculatus*, is a common scorpaenid inhabiting the west coast of North America from near the Coronado Islands, California (32°34'N, 117°22'W) to Cape Yakataga, Alaska (59°38'N, 142°34'W) in the north and the Shumagin Islands, Alaska (54°22'N, 160°01'W) to the west. Adults inhabit depths from 22 to 507 m and are found in transition zones between mud and hard substrate, often resting on mud in areas protected by boulders or cobble.

Life history studies conducted by the RACE Division's Groundfish Assessment Program record a maximum observed size of 420 mm fork length (FL) and 1,200 g in a female specimen. Age composition and growth were estimated from sectioned sagittal otoliths of 194 fish collected in 1995. Ages ranged from 6 to 64 years (mean = 21.6 years). Growth was slow and was best described by the von Bertalanffy growth model. Growth rates for males and females were similar with females reaching a slightly larger asymptotic size.

Gonads from 82 specimens were collected throughout 1995. The length at 50% maturity was 228 mm FL for males and 208 mm FL for females. The rate of natural mortality (M) was estimated to be 0.04 using the the gonadosomatic index (GSI) method, as compared to a value of 0.07 using the catch curve and maximum age methods.

Reproductive observations for rosethorn rockfish showed an annual cycle with group synchronous development producing only one brood per year. Mating probably occurs from December to April off Oregon and Washington, as evidenced by the GSI, which peaked in November for males (Fig. 3) and then declined through June during an extended mating season. In females, the GSI peaked in May and declined through August (Fig. 4). Embryos were found in the ovaries 20 April (early embryonic stages), 9 May (mid-to late embryonic stages), and 10 June (late embryonic stages). Parturition occurs in May and June.

By Frank Shaw

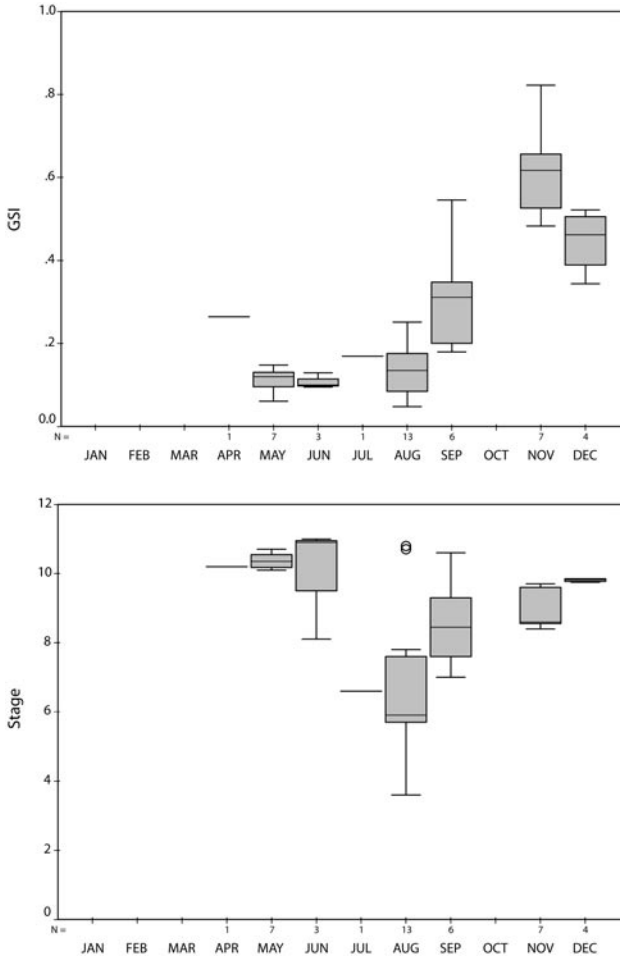


Figure 3. Box plots of the gonadosomatic index (GSI) and testis class by month for male rosethorn rockfish. The box is the interquartile range. The whiskers are the high and low values excluding outliers (o). The line across the box is the median.

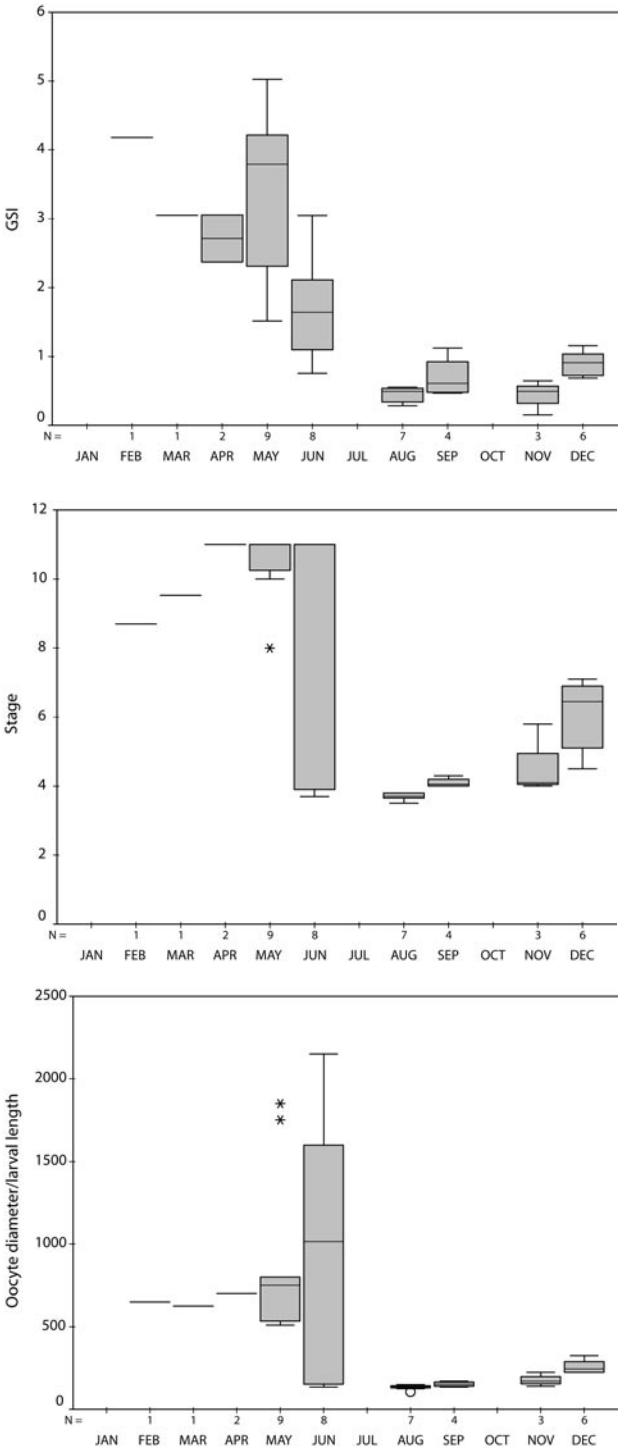


Figure 4. Box plots of the gonadosomatic index (GSI), ovary class, and oocyte/larval size by month for female rosethorn rockfish. The box is the interquartile range. The whiskers are the high and low values excluding outliers (o) and extreme values (*). The line across the box is the median.

Stock Assessment Support

Mark Wilkins met with colleagues from agencies along the Pacific coast in Seattle on 16 October to discuss whether additional data can be assembled for yelloweye rockfish stock assessments from existing studies. The low abundance of yelloweye rockfish along the Pacific coast of the continental United States has impacted rockfish harvests in the area. This meeting was followed up via teleconference on 5 December. The multi-agency group was unable to direct stock assessment authors to any significant additional information but offered suggestions to enhance data collection from future surveys through the International Pacific Halibut Commission and cooperating agencies.

Mark Wilkins, Michael Martin, Chris Rooper, and Mark Zimmermann attended a 17 November meeting with scientists from the Center's Resource Ecology and Fisheries Management (REFM) Division, Auke Bay Laboratories (ABL), and the Northwest Fisheries Science Center (NWFSC) to discuss how to respond to criticism arising from a Committee of Independent Experts (CIE) review of the Gulf of Alaska rockfish stock assessments. The points that initiated concern were regarding the practice of applying estimates of mean catch rates from bottom trawl surveys to portions of the survey area that are untrawlable. Several projects were outlined that had potential to address the points raised by the reviewer. We have formed a team within the Groundfish Assessment Program to start working on these concerns and to cooperate with stock assessment scientists to evaluate and work out the problems.

By Mark Wilkins

FISHPAC Project Delivers Bathymetry Data for Nautical Chart Updates

The FISHPAC project is a cooperative effort between RACE Division scientists and other NOAA line offices concerned with nautical charting. A multimission cruise aboard the NOAA ship *Fairweather* in summer 2006 had both fisheries and hydrographic surveying objectives (see *Quarterly Report*, July-August-September 2006). The primary purpose of the cruise was to evaluate the utility of acoustic backscatter for fish habitat characterization and to determine the most cost-effective acoustic system for mapping seabed habitats.

Equally important was the objective to provide hydrographic-quality bathymetry data to the NOAA Pacific Hydrographic Branch (PHB) for

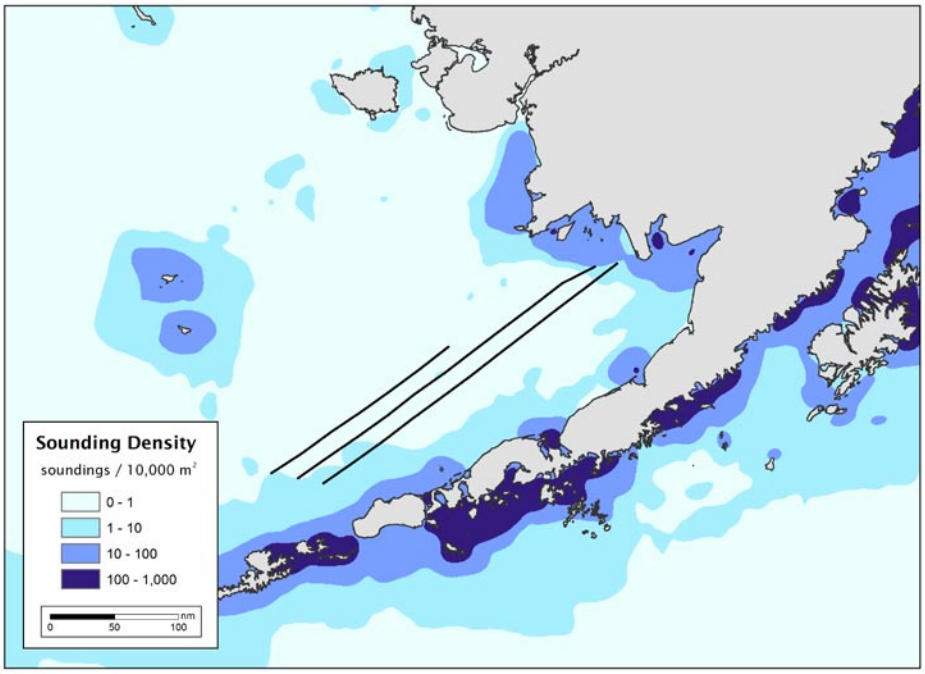


Figure 5. NOAA nautical chart sounding density in the eastern Bering Sea region surveyed during the FISHPAC Bristol Bay Habitat Mapping cruise on the NOAA ship *Fairweather*. Note sparse soundings data surrounding the three survey tracklines.

updating nautical charts in areas with outdated or nonexistent information (Fig. 5). The role played by the NOAA Corps Benthic Mapping Specialist was integral to this effort. LT(jg) Jay Lomnicky is jointly assigned to the RACE Habitat Research Team and the PHB, in direct support of NOAA's Matrix Management Initiative. This position is intended to coordinate efforts between NMFS and the Office of Coast Survey and is the first such "cross-over" billet for a hydrographic officer. The overall responsibility is to apply hydrographic and mapping skills in support of fisheries research while, at the same time, assuring that data acquisition and processing meet hydrographic standards. During the Bristol Bay Habitat Mapping cruise on the *Fairweather*, over 2,000 nautical miles were surveyed with multiple acoustic systems during three passes over preplanned transects. From these data approximately 920 nmi of unique trackline data were acquired using the *Fairweather* 's two multibeam echosounders. These bathymetry data have been processed by LT(jg) Lomnicky and ship's personnel, and have been formally submitted to PHB for nautical chart updates. Backscatter data from these (and other) systems are currently being processed at the NOAA – University of New Hampshire Joint Hydrographic Center. The final product from this effort will be fully corrected backscatter data that are applicable to the fisheries research objectives.

By Bob McConnaughey

NEWPORT LABORATORY: FISHERIES BEHAVIORAL ECOLOGY PROGRAM

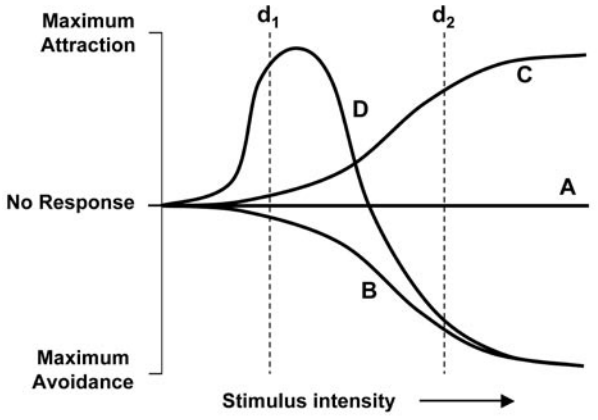
Potential Biases in Fish Surveys Conducted With Underwater Vehicles: Evaluating the Role of Fish Behavior

Use of underwater vehicles including submersibles, ROVs and towed camera systems to assess the abundance and distribution of fishes has increased rapidly over the last several decades, particularly in deep water and in structurally complex seafloor habitats where surveys with traditional sampling gear are unsatisfactory. It is often assumed that visual survey data have less inherent bias than sampling with conventional extractive gear. To evaluate the potential biases created by behavioral responses of fishes to underwater vehicles, Program members Allan Stoner and Cliff Ryer, along with Steve Parker (Oregon Department of Fish & Wildlife), Waldo Wakefield (NWFSC), and Peter Auster

(University of Connecticut) compiled published information and personal observations on 46 demersal marine fish taxa. Integration of the data showed that almost all of those fishes respond to underwater vehicles under certain circumstances. The responses are context specific, depending upon operational variables including vehicle type, speed, light and sound levels. Direct responses were common. Some fishes respond indirectly, by attraction to sediment disturbance and prey species gathered in artificial lights. Whether or not movements or changes in behavior affect survey bias is more difficult to assess.

A simple conceptual model (Fig. 6) was developed to evaluate relationships between stimulus intensity, distances from the vehicle where reactions occur, and survey bias. Largest bias is caused by attraction or avoidance that occurs outside the field of view provided by cameras or observers. While light level and vehicle speed have been explored experimentally in a few cases, much remains to be learned about how reactions and biases vary among species and age groups, among different vehicles, and under different operating conditions. Given the poor understanding of survey bias, we recommend that surveys be conducted using methods that minimize variation in vehicle operation and that vehicle time is devoted specifically to manipulations of operating conditions to evaluate bias quantitatively. There is no good substitute for direct field observations on fish behavior, distribution and abundance; and survey design and accuracy can be improved through experimentation.

By Allan Stoner



Response type	Distance from vehicle	
	d_1	d_2
A	No bias	No bias
B	Small bias	Lg. negative bias
C	Small bias	Lg. positive bias
D	Lg. positive bias	Lg. negative bias

Figure 6. Basic responses of fishes to stimuli (i.e., light and sound) created by underwater survey vehicles shown as a function of stimulus intensity. Four response types are shown: no response (A), increasing avoidance (B), increasing attraction (C), and attraction at low stimulus intensity followed by avoidance (D). The table shows the likelihood of survey bias caused by responses occurring at two different distances (d) from the survey vehicle. It is assumed that the observers or cameras on the vehicle have a range of view substantially shorter than the distances at which lights and sound can be detected by the fish.

RESOURCE ECOLOGY & FISHERIES MANAGEMENT (REFM) DIVISION

RESOURCE ECOLOGY & ECOSYSTEM MODELING PROGRAM

Fish Stomach Collection and Lab Analysis

Laboratory analysis was performed on 2,193 groundfish stomachs from the eastern Bering Sea and on 1,018 groundfish stomachs from the Gulf of Alaska. During this quarter, 2,265 Bering Sea samples and 69 Gulf of Alaska samples were collected by fisheries observers. A total of 9,666 records were added to the groundfish food habits database.

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

Multispecies and Ecosystem Modeling

Food habits data is a key input into the Resource Ecology & Ecosystem Modeling (REEM) Program's multispecies and ecosystem modeling efforts. These modeling efforts rely on diet composition matrices in order to produce yearly estimates of predation mortality for key species such as walleye pollock. To help discern the relative role of predation on year-class strength, past modeling has used quarter-specific age transition keys to estimate predation on age-0 and age-1 pollock. However, pollock grow rapidly during the summer foraging season, suggesting that quarterly resolution on age-transition may be insufficient for separating out age-specific effects. An examination of the length frequency of pollock cannibalism (% by fork length

of pollock in the stomachs of pollock) shows a clear split between cannibalism on age-0 and age-1 fish during the summer, with the size (fork length) of the split increasing rapidly throughout the growing season as age-0 fish increase as a percentage of pollock diet. Algorithms for including this variable (i.e., split-length by month) in the input data for Multi-Species Virtual Population Analysis (MSVPA) and ecosystem models are currently under active development.

By Kerim Aydin and Jesus Jurado-Molina

Ecosystem Indicators

The Ecosystem Considerations section of the Stock Assessment and Fishery Evaluation (SAFE) was updated again in 2006 and includes an ecosystem assessment, updated status and trend indices, and ecosystem-based management indices and information. The report is made available to the North Pacific Fishery Management Council (NPFMC) and its family (i.e., plan team members, Scientific and Statistical Committee, and Advisory Panel), stock assessment scientists, and the public in the fall of each year. This information is often used in stock assessments and in various reports that are provided to management. A bulleted list of important highlights and recent trends in climate, biology, and fishing impacts is included in a brief executive summary. New indices included in the report this year include a zooplankton index for the Gulf of Alaska and socioeconomic indicators. A new website has been developed that provides access to the contributions as well as to data time series summarized in the report: *http://access.afsc.noaa.gov/reem/ecoweb/index.cfm*.

Major environmental trends this year included the reversion to relatively cold conditions in the Bering Sea during the winter of 2005-06, which resulted in an extensive cold pool in summer 2006. This cold trend, however, was regional in nature, and a continued warming trend with reduced ice extent has been documented through much of the Arctic. Temperature conditions in the Gulf of Alaska were the warmest on record in 2005 (information for 2006 was not available). A major conclusion from the analysis of various trends is that no apparent adverse effects of fishing on the ecosystems have been documented to date. Concerns about high bycatches of salmon in the Bering Sea pollock fishery remain, however, and these are being addressed by the NPFMC.

By Jennifer Boldt

Ecosystem Assessment

The integration of multispecies and ecosystem modeling results into the SAFE report was substantially expanded in 2006, especially in the ecosystem assessment and Bering Sea walleye pollock ecosystem considerations sections. In particular, forage fish biomass trends from bottom trawl surveys for the last 24 years in the Bering Sea were summed using catchability coefficients ('q') calculated from the Bering Sea ecosystem model. The results show two notable features: first, forage fish seemed to show an "ecosystem response" to decreased pollock biomass in the early 1990s, with the decrease in pollock being followed by an increase in shrimp, capelin, and other forage species. This increase may be due to prey release or alternating climate conditions favoring different suites of species. More notably in terms of assessing current conditions, forage fish biomass seems to have dropped abruptly after 1998, and the last 7 years (1999-2006) have shown the lowest biomass of nonpollock forage since the time series began. Another trend of note in the Bering Sea has been the increase in arrowtooth flounder in recent years; analysis of this trend, particularly with respect to its impact on pollock, is ongoing.

By Kerim Aydin

Seabird Interactions

In the 2003 Biological Opinion on the total allowable catch setting process for short-tailed albatross, *Phoebastria albatrus*, NMFS was required to "…work on a safe and reliable means of assessing short-tailed albatross interactions/collisions with trawl vessel gear to 1) document whether take occurs, and if so, 2) estimate the rate of such take…" To date, no observers have reported collisions between short-tailed albatross and trawl gear. Observers do not, however, directly monitor trawl gear during the towing process.

We initiated several collaborative studies to look at the possibility of these interactions through fishery characterization, risk assessments, and decision analysis. One such study was recently completed by Stephanie Zador, Andre Punt, and Julia Parrish of

Table 1. The year in which the recovery goal of 750 pairs (1,500 breeding birds) is reached with 0.75 probability given assumptions regarding fishing mortality from all sources of mortality, *S'*, and the fraction of the mortality due to trawling in Alaska, z. Population projections (n = 1,000) were conducted for each.

	S' = 0.93		*S'* = 0.95		*S'* = 0.97		*S'* = 0.99	
	z = 0.01	*z* = 0.05	*z* = 0.01	*z* = 0.05	*z* = 0.01	*z* = 0.05	*z* = 0.01	*z* = 0.05
0 albatross taken; closure of trawl fishery	2022	2022	2019	2019	2017	2017	2016	2016
1 albatross taken	2022	2022	2019	2019	2017	2017	2016	2016
5 albatross taken	2023	2022	2019	2019	2018	2017	2016	2016
10 albatross taken	2023	2023	2020	2019	2018	2018	2016	2016
20 albatross taken	2025	2024	2021	2020	2018	2018	2017	2017
50 albatross taken	2032	2030	2024	2024	2021	2020	2019	2019

the University of Washington. They conducted a decision analysis that explores the effects of trawl-related fisheries mortality on achieving the population recovery goals for the short-tailed albatross. In their study, "Bayesian inference was used to assign probabilities to alternative plausible rates of fishing mortality and to conduct population projections with different levels of trawl mortality to determine their effects on achieving the population recovery goals. The analyses of the impact of trawl mortality on the Torishima short-tailed albatross population suggests that exceeding the current expected incidental take in the Alaska groundfish trawl fishery, two in any five year period, by as much as a factor of 10 would have little impact on when the proposed recovery goals for the species are achieved." An example of their findings is noted in Table 1 excerpted from their paper.

By Shannon Fitzgerald

ECONOMICS & SOCIAL SCIENCES RESEARCH PROGRAM

Comprehensive Socioeconomic Data Collection for All Alaskan Fisheries

During the June 2006 North Pacific Fishery Management Council (NPFMC) meeting, the Council tasked the NPFMC staff to develop a discussion paper on comprehensive collection of socioeconomic information from all fisheries under federal jurisdiction. That paper, written in collaboration with Economics & Social Sciences Research (ESSR) Program scientists, was presented at the October 2006 Council meeting in Dutch Harbor, Alaska, and proposed a core set of cost, earnings, and community information to be collected from all sectors of the relevant fisheries. In response, the Council approved a motion requesting the AFSC to coordinate a workgroup of social science and economic analysts and researchers to further develop the discussion paper and a set of draft survey instruments to be presented at the April 2007 meeting. The ESSR Program solicited invitations to a broad set of federal and state agency specialists to participate in the workgroup and convened a conference call to initiate the workgroup on 15 November. A candidate set of questions is currently being formulated by ESSR staff based on consultation with the working group and will be developed into draft data forms during the next quarter.

By Brian Garber-Yonts

Estimating the Value of a Community Development Quota Fishing Right

An important element of groundfish management in the U.S. North Pacific is the existence of community development quotas (CDQs), which provide community development corporations with the right to fish in a number of fisheries in Alaska.

The pollock fishery is the largest of these fisheries, for which 10% of total allowable catch (TAC) is set aside for CDQs. The CDQs can be fished by the communities or as is more common in practice, they can be leased by Native corporations to vessels active in the fishery.

From 1992 to 1998, the pollock fishery was a limited entry fishery without individual quotas. After the passage of the American Fisheries Act (AFA) in 1998, the fishery was organized in a system of cooperatives that function like an individual transferable quota (ITQ) system. This system dramatically changed the usage of the CDQ right, altering it from an individual quota in a limited-access fishery to special type of quota in a quota-based fishery; the quota is special because spatial and bycatch closures that apply to all other vessels often do not apply to the CDQ fishery. Thus the CDQ right has become a "super quota" that can be used in locations and at times where regular quota cannot.

One change that has occurred since the implementation of the AFA is that CDQ rights are used almost exclusively by catcher processors. Before the AFA, some catcher vessels utilized quota before the official start of the season to find fish before the race for fish began.

During the summer of 2006, UW economics graduate student Edwin Wong worked as an intern at the AFSC to help organize data from the Alaska state and NMFS CDQ programs. We are currently examining the changing value and usage of the CDQ fishing right in the pollock fishery from 1992 to 2005. This analysis will provide insight into both the value created by quota markets and the costs of area closures. Particularly because we do not have cost information for the pollock fishery, the CDQ market provides a unique opportunity to understand the profits generated in the fishery and costs imposed by spatial regulation. In future work on this project we will also examine the more recent development of CDQ markets in other fisheries.

By Alan Haynie

BSAI Crab EDR Validation Audit

As required by the congressional authorization and NPFMC motion for the economic data collection component of BSAI crab rationalization, a detailed validation review of the information collected in the historical and 2005 annual economic data reports (EDRs) was initiated during summer 2006. The principal objective of the validation exercise is to assess and quantify the measurement error associated with the EDR instruments. A further objective is to provide an incentive to EDR submitters to maintain accuracy and rigor in reporting cost and earnings information. As such, the validation review included both random audits, based on a statistical sample of the EDR population, and for-cause audits of EDRs identified on the basis of missing variables or outliers in reported information. The accounting firm Aldrich, Kilbride and Tatone, LLC (AKT) was selected by the Pacific States Fishery Management Commission (PSMFC) to conduct detailed audits of the EDRs submitted by vessel and processing plant owners in the BSAI crab fisheries.

In October 2006, ESSR Program staff completed a review of the EDR data and developed the analytical basis and protocols for selection of EDRs for random and for-cause audits. To improve the efficiency of the audit process, the sampling frame for the random audit was identified as the population of vessel/plant owners stratified by sector, remaining in the fishery as of June 2005. With a 15% sampling rate, the random audit sample included 33 catcher vessels, three floating or onshore processors and one catcher processor. An additional 18 submitters were identified for for-cause audits. The selected owners were contacted by the accounting firm via phone and mail and provided with a list of variables for which substantiating information was requested. The initial deadline for submission was specified as 3 November, but given the start of the crab fishing season, more than half of those contacted requested extensions. As of 20 December, AKT was still awaiting records from most of the random and for-cause audit subjects. An audit report will be submitted by AKT to the PSMFC during second quarter 2007.

By Brian Garber-Yonts

Online Economic Data Reporting

To improve the efficiency of the BSAI Crab EDR collection, both in terms of data processing by the PSMFC and ESSR Program staff, as well as simplifying the submission of data and reducing the time burden for EDR filers, we have initiated a project to develop a web-based EDR. A request for proposal (RFP) was released by the PSMFC and a contractor selected to develop the database and web interface in December. The online EDR is expected to be operational for the 2006-07 crab EDR data collection period beginning in April 2007. The on-

line crab EDR will serve as a template for development of further social and economic data collection initiatives pending approval by the Council.

By Brian Garber-Yonts

Southwest and Gulf Coast Data Collection Projects: Optimal Sample Sizes Computed for Vessel Classes

In order to conduct two ongoing regional economic data collection projects in the Southwest and Gulf Coast Regions of Alaska, we needed to develop an appropriate sampling methodology. Since the majority of gross revenue within each vessel class comes from a few number of boats, a simple random sampling (SRS) of vessels would only include a small portion of the total exvessel values, and therefore, would be misleading. Thus, for the two projects, an unequal probability sampling (UPS) method without replacement was implemented. Specifically, two tasks need to be accomplished 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. Using the sampling procedures already developed, we conducted the first task which computed the optimal sample sizes for three vessel classes in each of the two data collection projects. In this process we used 2005 Commercial Fisheries Entry Commission (CFEC) exvessel revenue data, and assumed an allowed error of 10% in population estimates and a 95% confidence level. The resulting sample sizes were found out to be smaller than those derived from SRS sampling. The next step is to conduct the second task in which we will identify the specific vessels that will be included in the "mail-out" sample of the three vessel classes, using Pareto sampling.

By Chang Seung

Paper Reduction Act (PRA) Packet Prepared for Southwest Data Collection Project

The Paper Reduction Act (PRA) packet for the Southwest region data collection project has been prepared (see *Quarterly Report*, April-May-June 2006). One of the most important documents that needed to be included in the packet is the supporting statement (SS), which describes the methodologies that we will use to obtain the data. In the SS, we provided justifications for collecting the data, explained how the data will be collected, provided burden hours and annualized costs, and provided other necessary information. In particular, we described what efforts we exercised, or will exercise, to maximize the response rates. These efforts include focus group meetings, simplification of questions, and use of a modified Dillman method in which four contacts will be made to increase response rates. The four contacts that we will use are advance letter, initial mailing letter, postcard reminder, and follow-up phone call for the mail survey of vessel owners. We prepared these letters, postcard reminder, and phone scripts. For telephone interviews with local businesses and fish processors, we developed phone scripts. With these efforts to maximize the response rate, it is expected that the response rates for the mail survey of vessel owners and phone interviews with local businesses (including fish processors) will be around 55% and 65%, respectively.

By Chang Seung

Alaska Fisheries and Global Trade

Products from Alaska's fisheries are consumed around the world. Global demand for these products is an important source of income to U.S. fishermen, processors, and traders. The U.S. Census Bureau monitors exports and imports of a wide set of commodities, and it publishes information on the current U.S. trade deficit, which according to Census Bureau data, set a new record last year. Furthermore, the Census Bureau and Bureau of Economic Analysis released new information on January 10, 2007, that estimates the U.S. trade deficit, at least for goods through November 2006, is even larger than last year.

The new information (*http://www.census.gov/foreign-trade/www*) estimates the U.S. trade deficit for goods in November 2006 was $65.5 billion, with a cumulative deficit for the year through that month of $758.4 billion. Corresponding values for 2005 were $71.4 billion, and $703.1 billion, respectively. The trade deficit for goods with China was, by far, the largest of all countries in both years. In 2006, the cumulative trade deficit for goods with China through November was $213.5 billion, up from $185.3 billion in 2005. The cumulative deficit with Japan was the next largest, with values of $75.8 billion and $81.0 billion, in 2005 and 2006 respectively, followed by Canada with values in these years of $70.0 billion and $67.5 billion.

Seafood products from Alaska are thus a benefit to the nation by helping to reduce the U.S. trade deficit, and in fact, Japan, China, and Canada are the largest international consumers of Alaska seafood. In addition, the processing that takes place in Alaska, Washington, other states, and at sea, creates what economists call "value added" because labor, from fishermen and other people, is combined with capital, such as fishing vessels and processing plants, to earn a monetary return from investments. From the point of view of public finance, the economic base of capital and labor is an important source of tax revenue. ESSR economists use a sophisticated set of statistical tools and computer models to analyze trends relevant to fisheries management. A new frontier for these methods is to examine how global demand for seafood affects Alaska's fisheries.

The U.S. Merchandise Trade Statistics provide detailed information on the amount, in both kilograms and dollars, of important commodity groups that are directly related to Alaska fisheries, such as Alaska pollock, the world's largest fishery in volume, and Bering Sea king crab, which at one time was incredibly lucrative and is still a major global fishery. These statistics are available in an electronic format to AFSC economists through the U.S. Department of Commerce International Trade Administration's Trade Policy Information System (*http://trade.gov*). This electronic format enables rapid retrieval, and modern computer software is used to visually display the trade statistics.

For spatial analysis, trade statistics identify the U.S. customs district where seafood products were exported. For example, Anchorage is the only customs district in Alaska. After Anchorage, Seattle is the most important export location for Alaska seafood products, but in addition to Washington state, these products leave the United States from many coastal and border states, and even from Puerto Rico. However, the trade statistics only identify countries, or trade partners, that import seafood products, and normally, no additional spatial information is available. In most cases, the location of each country's largest port is used as a proxy for the true entry point. Where possible, the location of a port or district was obtained from the electronic World Port Index, published by the National Imagery and Mapping Agency (NIMA), and available through the U.S. Geological Survey (*http://www.usgs.gov*). In other cases, using the largest port may be a problem, because of identification, or other issues. For example, many small Pacific Islands import Alaska king crab. In such cases, another port, or in landlocked countries, the capital or largest city is used.

Trade statistics are associated with latitude and longitude of each customs district in the United States and the location of each trade partner. From this geographical information, a spatial network of trade flows was estimated for seafood products, from the Bering Sea or Gulf of Alaska, to the U.S customs district for export, and finally to the foreign country that imports, either for consumption or for export. The latter, however, is not presented, because this information is not available in the U.S. Merchandise Trade Statistics. However, this database is particularly useful because its time series are available back to 1983 for Alaska pollock and king crab.

Spatial information about trade patterns over time for Alaska seafood products was compiled in a geographical information system (GIS) by ESSR staff. The visual display of information in a dynamic GIS is accomplished using animated maps (*http://www.afsc.noaa.gov/REFM/Socioeconomics/Projects/AFGT.php*). These maps show in each year where Alaska seafood products left the United States and the location of countries that received the products. In addition to Alaska pollock and king crab, dynamic GIS maps were developed for four other important Alaska fisheries that are represented in the U.S. Merchandise Trade Statistics: Atka mackerel, Pacific ocean perch (POP), sablefish, and yellowfin sole. The time series available for these four are shorter than those for Alaska pollock or king crab. While Atka mackerel and yellowfin sole are mainly caught off Alaska, profitable and high-value sablefish fisheries operate from the Gulf of Alaska, along the West Coast, all the way to Southern California. Fisheries for POP, an important rockfish species, are also widely distributed, from the Bering Sea to Southern California. The animated maps show POP and sablefish exports for all U.S. fisheries.

Each of the animated maps displays trade flows in thousands of kilograms (metric tons). On each map, black circles identify the locations of U.S. customs districts that exported seafood products. The size of a circle in a given year corresponds to the total weight of products that was exported in that year from the customs district to all global trade partners. Red circles identify the major port or city in countries that imported the product type, and

again, the size of each red circle corresponds to the total weight of seafood products that was imported by a particular country from all U.S. locations in a given year. Finally, the total amount of each product that was moved in a given year between a particular customs district and its trade partner is represented by a colored line, with darker and wider lines indicating greater trade flows.

Information presented in these maps is reproduced from data in the U.S. Merchandise Trade Statistics. Questions about the quality of these data are referred to the document at *http://www.census.gov/foreign-trade/aip/quality_profile01142003.pdf*, or to the Foreign Trade Statistics Division of the U.S. Census Bureau (*http://www.census.gov*).

By Michael Dalton

STATUS OF STOCKS & MULTISPECIES ASSESSMENT PROGRAM

Groundfish Stock Assessments for 2007

FISHERY QUOTA RECOMMENDATIONS

The Alaska groundfish management system is based on extensive data available from the NMFS Observer Program and dedicated research cruises. Catch of target and prohibited species (e.g., Pacific salmon, crab, herring, and Pacific halibut) are estimated at sea or in processing plants to provide real time information to ensure that fisheries do not exceed total allowable catches (TACs) or violate other fishery restrictions (like time-area closures). Dedicated research cruises coupled with observer data make it possible to build detailed population dynamics models. Results of these modeling activities are used to determine the status of individual species and make recommendations for future catch levels.

Establishing TACs involves annual evaluation of the best available scientific information through a series of documents and public meetings. The first step begins with the preparation of stock assessment and fishery evaluation (SAFE) reports. These reports contain analyses summarizing the information about the individual stocks and groups and include acceptable biological catch (ABC) and overfishing levels (OFL) recommendations for future years. The authors of these reports, generally NMFS scientists, present their findings to the North Pacific Fishery Management Council's (NPFMC) groundfish Plan Teams in September and November of each year. At these meetings, the reports are reviewed and recommendations for ABC levels are compiled into two SAFE report volumes (one each for the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) regions) along with Plan Team recommendations for ABC, which may differ from author recommendations. The compiled reports are then submitted to the NPFMC Scientific and Statistical Committee (SSC) for further review. The SSC makes the final ABC recommendation to the Council and the Council's Advisory Panel of Industry representatives makes TAC recommendations. Finally, the recommended TAC levels are adjusted (for some species) by the Council to ensure that other constraints (e.g., limiting the sum of all TACs in the Bering Sea and Aleutian Islands to be less than 2 million metric tons (t)) are met. The following rule applies for all federally managed groundfish species in a given year:

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

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

In 2006 the Resource Assessment and Conservation Engineering (RACE) Division's groundfish assessment group conducted a summer bottom trawl survey in the Aleutian Islands (the previous such survey was in 2004). This survey, together with past estimates, indicate that groundfish biomass levels have increased from slightly below 2 million t (1991-2000 survey averages; all groundfish) to just over 2.7 million t average biomass from the 2002, 2004, and 2006 surveys. The predominant species in this region include Atka mackerel (32% of the total biomass) and Pacific ocean perch (22% of the total biomass) based on average levels from the Aleutian Islands surveys from 1991 to 2006. Pollock represent only about 9% of the biomass based on the survey followed by northern rockfish (7%), Pacific cod (6%) and giant grenadier (6%). Arrowtooth flounder has averaged only 4% of the biomass estimated in the Aleutian Islands but has shown a marked increase since the 1991, 1994, 1997,

and 2000 average level of 55 thousand t to over 122 thousand t average biomass for 2002, 2004, and 2006. In 2006, the number of survey tows was reduced by about 15% of normal due to budget constraints, however the area covered by the Aleutian Islands survey was maintained.

RACE's Midwater Assessment and Conservation Engineering (MACE) group conducted three major surveys in 2006: the winter echo-integration trawl (EIT) survey in the Shelikof Strait and nearby areas, the winter Bogoslof Island region survey of spawning pollock from the Aleutian Basin, and the entire shelf region of the EBS to assess the summer abundance of pollock and other species. Auke Bay Laboratory scientists from the Marine Ecology and Stock Assessment (MESA) Program conducted the annual longline survey which is designed primarily for sablefish but also produces data used in Greenland turbot and some rockfish assessments. This survey covers the slope regions of the GOA along with segments of the Bering Sea and Aleutian Islands regions. The RACE Division's groundfish assessment group also conducted the standard summer-trawl survey for the EBS shelf area. Due to budget limitations, the planned 2006 EBS slope survey was cancelled. Data from these main survey efforts are critical for groundfish stock assessments.

Ecosystem considerations sections were enhanced within individual assessment sections in addition to the 360 page document detailing an overall picture of the ecosystem status, available on the AFSC web site at *http://www.afsc.noaa.gov/refm/docs/2006/EcoChpt.pdf*. This report plays an ever increasing role in evaluating quota recommendations and ecosystem considerations are continually being enhanced within the individual species-specific stock assessment report sections.

Presently, projections of 2007 spawning biomass for the main groundfish stocks are estimated to be above their target stock size (B_{msy}) and the 2006 catch levels were below F_{msy} levels for both the BSAI and GOA regions (Figs. 1 and 2). Fisheries for these groundfish species during 2005 yielded 2.1 million t valued at approximately $2.0 billion after primary processing. The main pollock stock remains high and again yielded catches just over 1.5 million t. Virtually all flatfish resources (e.g., rock sole, yellowfin sole, Alaska plaice, and arrowtooth flounder) are at high levels, but catches remain relatively low. Atka mackerel abundance continues to be at above-average levels. Rockfish species comprise 5%-8% of the groundfish complex biomass and are generally increasing based on recent surveys.

GULF OF ALASKA (GOA)

In the GOA, assessments were presented for 17 stocks and assemblages and an extensive appendix on the status of "Other species groups" was also prepared. This appendix was prepared at the request of the Council for regulatory analyses that are un-

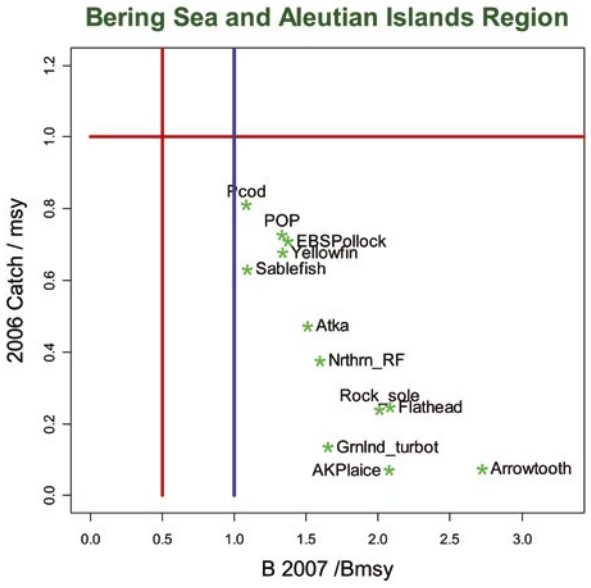


Figure 1. Relative 2007 spawning stock size compared to B_{msy} (taken to be $B_{35\%}$ for all species except EBS pollock) versus relative 2006 catch levels compared to 2006 F_{msy} levels for BSAI stocks.

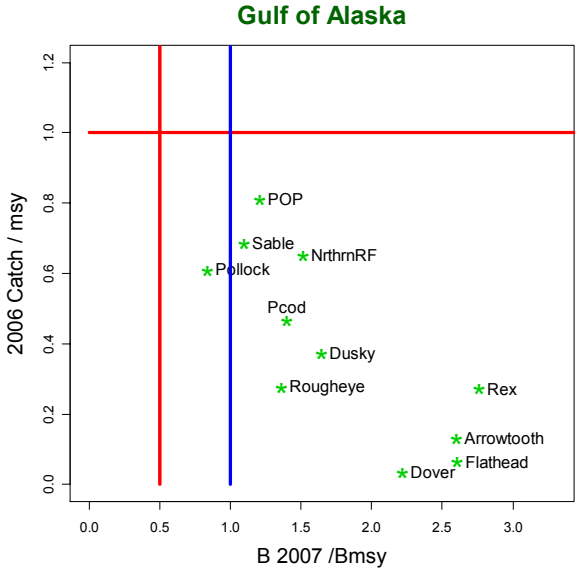


Figure 2. Relative 2007 spawning stock size compared to B_{msy} (taken to be $B_{35\%}$ for GOA stocks) versus relative 2006 catch levels compared to 2006 F_{msy} levels for GOA stocks.

derway so that revised specification processes can be evaluated.

The sum of the recommended ABCs for 2007 is 490,327 t which represents a 2% decrease from the 2006 total. Since new survey data were unavailable for GOA stocks, a number of assessments consisted of projections from the 2005 SAFE reports (with updated catches). However, full assessments were completed for GOA pollock, Pacific cod, sablefish, and northern rockfish. Brief summaries of each GOA species or species group follows.

GOA Pollock: The 2006 winter Shelikof Strait EIT survey was 13% less than the 2005 estimate. The model estimate of spawning biomass in 2007 is 160,670 t, which is 29% of unfished spawning biomass and below $B_{40\%}$ (220,000 t). Projections incorporating uncertainty in the stock assessment indicate that there is very low probability that the pollock stock will drop below critical levels in the near future.

A new analysis conducted with the GOA ecosystem model compared estimates of predation mortality and fishing mortality relative to population production in order to determine whether total mortality exceeded production. The results suggested that high predation mortality plus conservative fishing mortality might exceed GOA pollock production at present, and that this condition may have been in place since the late 1980s or early 1990s. Although this analysis was considered preliminary by the ecosystem assessment authors, it provides additional support for continued precautionary management of GOA pollock. Management Strategy Evaluation (MSE) analyses on GOA pollock continues. Alternative operating model configurations for the MSE are being derived from ecosystem modeling so that the potential for adjustments to ABC recommendations can be evaluated.

GOA Pacific Cod: The current assessment estimate of spawning biomass for 2007 is 126,903 t, up about 9% from last year's estimate for 2006 and above the $B_{40\%}$ value of 103,000 t. The short-term trend in ABC indicates declines since the 2001-03 year classes are almost certainly below average. To stabilize these somewhat (and to allow for further model developments to occur) the ABC was recommended to be the same as in 2006: 68,859 t. This compares with a maximum permissible value from the model of 81,200 t.

GOA/BSAI Sablefish: The present assessment departs from previous years' assessments by using a split-sex age-structured model and incorporating Gulf of Alaska trawl survey lengths and biomass estimates for depths of 500 m or less. The split-sex model approach is appropriate given the differences in growth and maturity between males and females. Data from the trawl survey was included to improve estimates of recruitment, since trawl surveys tend to catch smaller fish than the longline survey.

The longline survey abundance index increased 8% from 2005 level but showed a 2.5% decrease from 2004 to 2005, while the fishery abundance index decreased by 4%. Spawning biomass is currently about 38% of the estimated unfished level and is projected to drop slightly in the near term (Fig. 3). The Council-recommended 2007 ABC was 20,100 t, compared to 21,000 t for 2006.

GOA Flatfish: Arrowtooth flounder 2005 survey biomass estimate (for the western and central GOA) was 1.65 million t compared to 479,000 t for Pacific halibut and 661,000 t for all other flatfish species in this region. The 2007 ABC recommendation for arrowtooth flounder increased 3% from the 2006 value to 184,000 t. As is the case for most flatfish species in the GOA, arrowtooth flounder continue to be lightly exploited with a 2006 catch of 14,400 t. The other flatfish management groups and 2007 ABCs were: deepwater flatfish—8,707 t (compared to 2006 catch of 389 t); shallow-water flatfish—51,450 t (compared to 2006 catch of 7,605 t); flathead sole—39,110 t (compared to 2006 catch

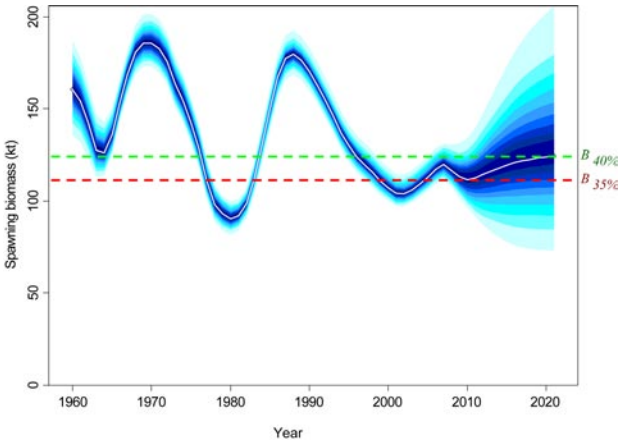


Figure 3. Female spawning biomass trends for Alaska-wide sablefish including projections, 1960-2020. Shading represents relative uncertainty levels.

level of 2,644 t); and rex sole—9,100 t (compared to 2006 catch level of 3,380 t).

GOA Rockfish: For Pacific ocean perch, the 2007 ABC increased by 3% to 14,261 t based on projections from the previous year's model. For northern rockfish, a completely revised assessment was presented and the 2007 ABC dropped from the 2006 value of 5,091 t to 4,938 t. The summary of GOA rockfish ABCs relative to the 2006 levels are given (in t) below:

Species	2006 ABC	2007 ABC	Change
Other slope rockfish	4,152	4,154	0%
Northern rockfish	5,091	4,938	-3%
Pacific ocean perch	14,261	14,636	3%
Shortraker	843	843	0%
Rougheye	983	988	1%
Pelagic shelf rockfish	5,436	5,542	2%
Demersal shelf rockfish	410	410	0%
Thornyhead rockfish	2,209	2,209	0%
Total	33,385	33,720	1%

BERING SEA/ALEUTIAN ISLANDS (BSAI)

The sum of the ABCs for 2007, as recommended by the Scientific and Statistical Committee, is just over about 2.7 million t, 10% lower than the sum of the 2006 ABCs. This drop was driven by the large reduction in ABC from EBS pollock (1.93 million t in 2006 compared to 1.394 million t in 2007). In 2007, an additional summer EIT survey of the EBS shelf region is tentatively planned along with the winter Bogoslof region EIT survey. The purpose of this extra survey is two-fold—to evaluate the condition of pollock stocks during a period of recent relatively rapid declines and to allow for intership calibrations between the NOAA ships *Miller Freeman* and *Oscar Dyson*. The standard summer bottom trawl survey is also planned. These surveys (budget outlook permitting) will provide critical information for developing 2007 assessments and further management recommendations. Summaries of each stock/assemblage group are presented as follows.

EBS Pollock: The 2006 bottom-trawl survey estimate of the pollock stock in this region was close to expected based on projected declines from 2005. However, the 2006 EIT survey was about 30% lower than expected which exacerbated estimates of the level and rate of decline estimated since 2003 (Fig. 4).

The Council recommended a 2007 ABC of 1.394 million t which was used for setting the TAC (also set at 1,394,000 t). This ABC level was reduced from 1.512 million t due to concerns over the continued decline in biomass and increasing trends in harvest rates, uncertainty in incoming year-class strength and unexpected shifts in spatial distribution. Projections for 2007 indicate that the decline will ease by 2008 as the apparently above-average 2005 year class ages.

AI Pollock: The Council accepted the age-structured analysis and based on new survey and age composition data, recommended the maximum permissible Tier 3 ABC levels of 44,500 t. However, due to current regulations, the TAC is set to 19,000 t. The success of the AFSC cooperative research program to survey the Aleutian Islands during the winter (when pollock fishing traditionally occurred in this region) has been heralded as a promising approach to undertake fine-scale area and temporal management to address Steller sea lion recovery concerns. This approach allows for directed pollock

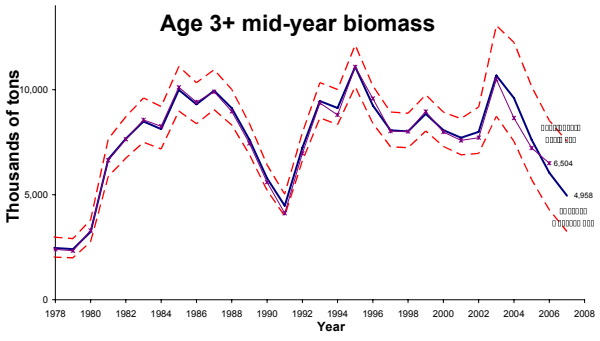


Figure 4. Estimated age 3+ EBS mid-year pollock biomass under, 1978-2007. Approximate upper and lower 95% confidence limits are shown by dashed lines. Superimposed is the estimate of mid-year age 3+ biomass from last year's assessment.

fishing while also minimizing the potential interaction effects with Steller sea lions. In 2006, the project extended over 6 weeks and provided eight synoptic surveys during this period. This allowed for unique quantification of diurnal and within season pollock movement patterns.

Bogoslof Island Pollock: An updated age-structured assessment was presented based on the one developed in 2005. This year the authors explored the effect of Donut Hole catches in the 1980s on the stock assessment results. They assumed that 75% of the Donut Hole catches came from the Bogoslof stock, which is in accord with past practices of international pollock workshops (which used a range from 60% to 80%). Little is known about the actual degree of interchange between Bogoslof fish and central BS and EBS pollock. The 2007 ABC was specified as in previous years which (based on the most recent survey estimate) results in a value of 5,220 t. The Council sets the TAC for this area to 10 t to account for bycatch in other directed fisheries.

BSAI Pacific Cod: The 2006 EBS shelf bottom-trawl survey estimate (518,000 t) for Pacific cod, down about 14% compared to the 2005 estimate. The assessment evaluated an array of model configurations including a number of enhancements over previous analyses. Regardless of configuration, the models indicated that a series of poor year classes (2000-2004) are imminent and contribute to the projected declines. The Council-selected model resulted in an ABC (and TAC, not counting state-waters allocation) of 176,000 t compared to the 2005 level of 194,000 t.

BSAI Flatfish: Combined, the five main species groups of flatfish continue to trend upwards with a 14% increase from the 2005 level and now represent about 45% of all groundfish biomass. This year the Council accepted that the estimates of F_{msy} and the associated uncertainty were adequately estimated (based on fitting a stock-recruitment relationship within the integrated assessment model) for yellowfin sole and northern rock sole. This results in management under Tier 1 and implies somewhat higher ABCs than estimated under Tier 3 methods. For example, the 2007 yellowfin sole ABC under Tier 1 is estimated at 225,000 t while under Tier 3, the value is 136,000 t (the 2006 Tier 3 ABC was 121,000 t). Nonetheless, the 2007 yellowfin sole

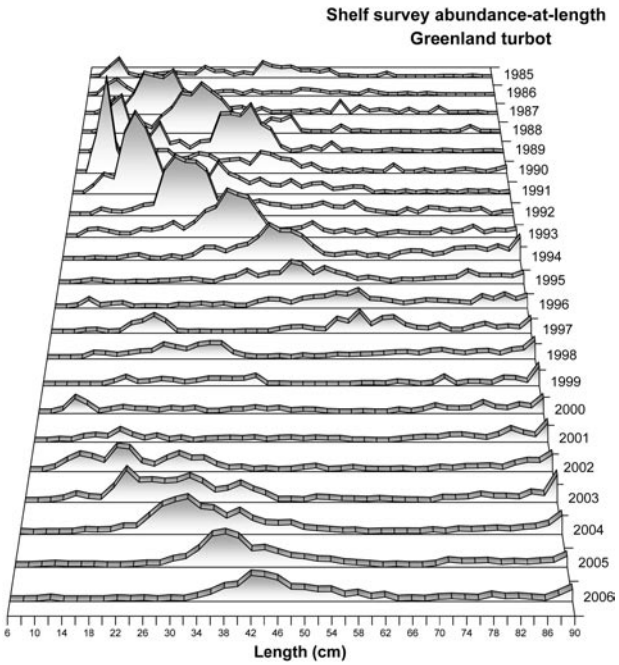


Figure 5. Abundance-at-length (cm) for Greenland turbot observed from the summer NMFS shelf trawl surveys, 1985-2006 (sexes combined, all strata except for 1986 where only strata 1-6 were sampled).

TAC was set to 136,000 t. The arrowtooth flounder 2007 ABC increased 16% to 158,000 t which led to a TAC of only 20,000 t. Northern rock sole 2007 ABC increased by 57% (since it shifted to Tier 1) to 198,000 t but the TAC was set at 55,000 t. The flathead sole ABC increased by 32% to 79,200 t while the Council set the TAC to 30,000 t. Alaska plaice 2007 ABC was stable (up 1%) at a value of 190,000 t and a 2007 TAC of 25,000 t. The other flatfish assemblage 2007 ABC increased 18% to 21,400 t but the TAC was set to 10,000 t.

BSAI Greenland Turbot: The data and model for 2006 was revamped. A new version of the software was used (stock synthesis 2) and a number of components of the model were re-evaluated. Additionally, the recent length frequency data from the shelf survey indicates that a recruitment event has occurred recently (Fig. 5). A number of issues remain with this assessment, in particular the fact that this species tends to be distributed in more northerly regions and the degree of mixing between other regions (e.g., north of the U.S. convention line) is unknown. Assessment uncertainties and stock structure issues have led the Council to recommend conservative ABC levels, which for 2007 is 2,440 t, well below the maximum permissible value of 12,680 t.

BSAI Rockfish: In the past year, rockfish stock assessments received a review by the NMFS Center of Independent Experts (CIE), and also a workshop on modeling approaches for rockfish was conducted. These led to improvements to this year's assessments and some important changes. For example, the BSAI Pacific ocean perch assessment includes a model estimate for natural mortality, resulting in an upward revision from 0.05 to 0.06. Based on recommendations from the CIE, the initial age composition was assumed to be in equilibrium with an unfished population, instead of reflecting variation in recruitment strength for each cohort, as previously assumed. This results in a 2007 Pacific ocean perch ABC of 21,900 t, an increase of 48% higher than the 2006 level. For northern rockfish the 2007 ABC decreased by 4% relative to the 2006 value to 8,190 t. The shortraker rockfish 2007 ABC recommendations decreased by 27% from last year's levels giving 424 t. The ABC for rougheye rockfish dropped from 224 t to 202 t while other rockfish dropped from 1,400 t to 999 t.

BSAI Atka Mackerel: New information from the fishery and surveys resulted in slightly different model results compared to the 2005 assessment. In particular, the revised estimates of age structure resulted in projected 2007 age 3+ biomass estimates of 364,200 t, down about 18% from last year's estimate for 2006. The projected female spawning biomass for 2007 is estimated at 129,900 t, roughly 55% of unfished spawning biomass and above $B_{40\%}$ level (95,000 t). The 2007 ABC recommendation is 74,000 t, down from the 2006 level of 110,000 t.

By Jim Ianelli and Anne Hollowed (REFM) and Phil Rigby (ABL)

Atka Mackerel Tag Recovery Cruise 2006 in the Aleutian Islands

The Fishery Interaction Team (FIT) conducted an Atka mackerel tag recovery cruise in the Seguam pass and Kiska Island areas of the Aleutian Islands, Alaska. The first objective of our 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. Trawl exclusion zones were established around sea lion rookeries as a precautionary measure to protect critical sea lion habitat, including local populations of prey such as Atka mackerel. Localized fishing may affect Atka mackerel abundance and distribution near sea lion rookeries. Tagging experiments are being used to estimate abundance and movement between areas open and closed to the Atka mackerel fishery.

During the years 1999-2003, NMFS released roughly 32,000 tagged fish in Seguam Pass, 14,520 near Tanaga Island and 14,700 near Amchitka Island. In July 2006 approximately 7,900 fish were released near the Kiska Island area, and 7,200 fish near the Seguam Pass area. This FIT recovery charter recovered tagged fish in Seguam Pass and the Kiska Island area.

The cruise lasted for 22 days, beginning on 11 October in Dutch Harbor, Alaska, and ending in Dutch Harbor on 2 November. A total of 75 tows were conducted with 44 tows in Seguam Pass (Fig. 6) and 31 tows near Kiska Island (Fig. 7). A total of 1,786 t of Atka mackerel were examined for tags. Approximately 1,006 t were caught in Seguam Pass and 780 t were caught near Kiska Island. During the cruise a total of 59 tagged Atka mackerel were recovered, 4 in Seguam Pass and 55 near Kiska Island. Tag reporting rates were estimated by seeding the catch with tagged fish. Reporting rates were high and averaged approximately 94% for single-tagged fish and 100% for double-tagged fish. In addition to tag recoveries, catch composition was determined, and sexed length frequencies and biological samples were collected for every haul. Biological samples consisted of gonads, stomachs, and age structures from randomly selected fish. During the course of the cruise, 620 biological samples and 11,394 sexed length data were collected.

Figure 8 illustrates the percent length frequency distributions for Atka mackerel during the 2006 recovery cruise in Seguam Pass and the Kiska Island area. The length-frequency distribution of fish at Seguam Pass was similar for both sexes and unimodal at 40-41 cm. The length distribution of fish in the Kiska Island area was a unimodal distribution at 37 cm for males and 36 cm for females. There seemed to be a slightly greater proportion of males at Kiska than at Seguam Pass where there was a slightly greater percentage of females. During this cruise we recorded length frequencies for males in spawning color separately to identify spawning habitat. It appeared that in October the proportion of males in spawning color was overall small with a unimodal distribution of 39 cm at Seguam Pass. There were

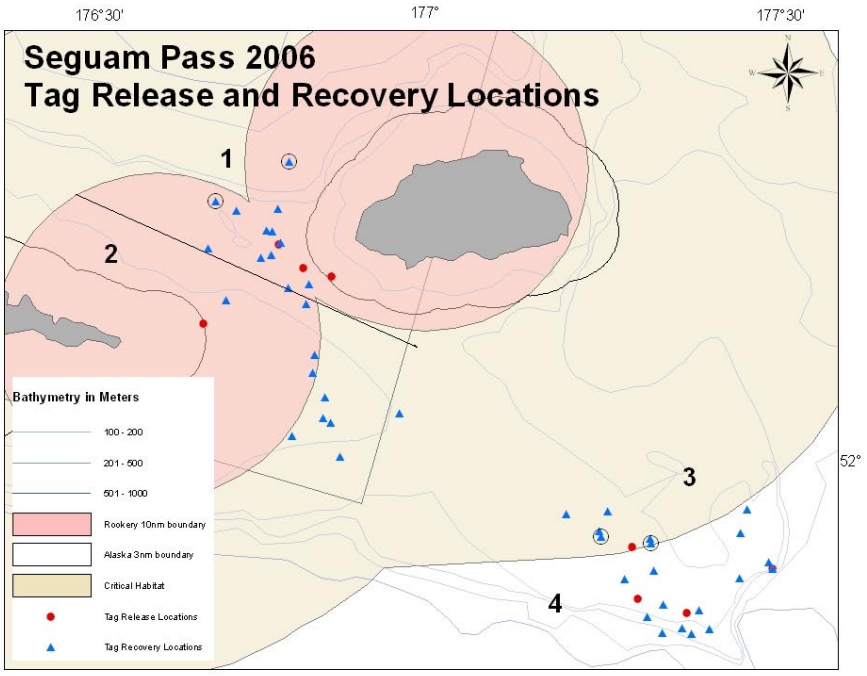


Figure 6. Tag release and recovery haul locations near Seguam Pass. Strata 1, 2 and 3 are inside the trawl exclusion zone and stratum 4 is outside the trawl exclusion zone. Hauls in which tags were recovered are circled in black.

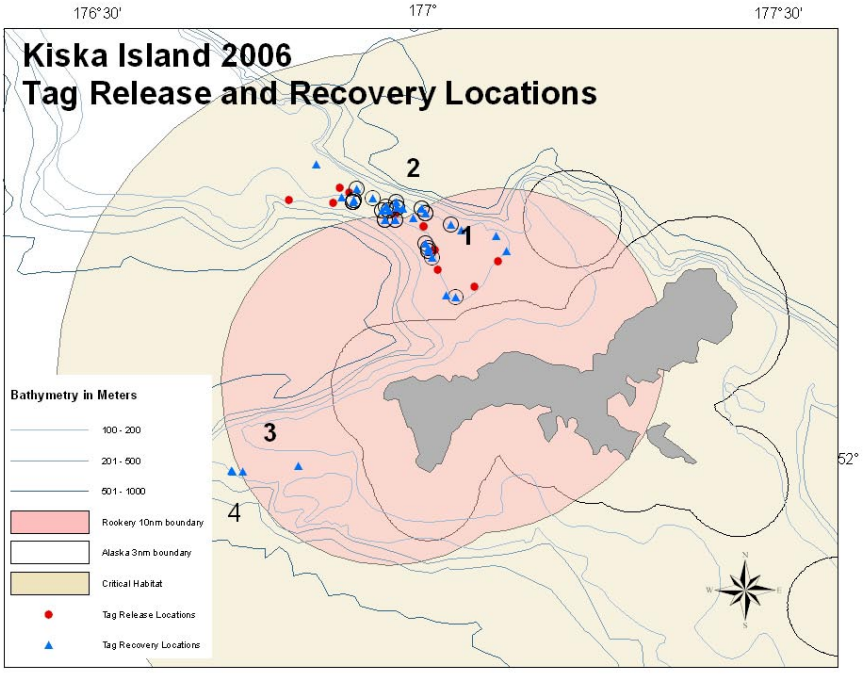


Figure 7. Tag release and recovery haul locations near Kiska Island. Strata 1 and 3 are inside the trawl exclusion zone and strata 2 and 4 are outside the trawl exclusion zone. Hauls in which tags were recovered are circled in black.

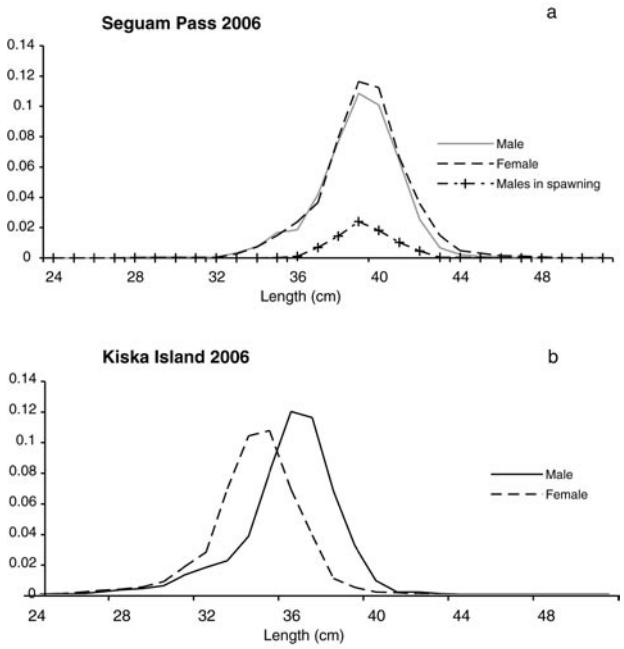


Figure 8. Percent length frequency distributions by sex for Atka mackerel during the recovery cruise in 2006 in Seguam Pass (3a) and the Kiska Island area (3b). There were too few males in spawning color in the Kiska Island area to include in this graph.

very few males in spawning color at the Kiska Island area, therefore those data are not shown.

The length frequency data, species composition data, and biological samples collected during this cruise will give us insight into the population structure and will be used for studies on Atka mackerel reproductive ecology and food habits. Some of this information will be incorporated into an integrated tagging model as auxiliary information modeling Atka mackerel population dynamics.

By Susanne McDermott, Libby Logerwell and Kim Rand

AGE & GROWTH PROGRAM

New Online Database

If you are a direct user of age data from the Age and Growth Program, you may be interested in a new online database, designed to show the progress of samples as they are processed by age readers. The database allows users to track their requests and to make the internal operations of the Age and Growth Program more transparent. The site can be found using the link *http://www.afsc.noaa.gov/REFM/Age/ageingrequests.htm*. When queried, this database will display three groups of samples:

1. The first group is "Requests in Queue." These are samples which have been requested, but have not been started by age readers.

2. The second group is "Currently Ageing." These are samples in the process of being read. It is possible to view the total sample sizes and the sample size that has been read. Users are reminded that samples must be tested by a second age reader, and the test results reconciled before samples are released.

3. The third group is "Released Collections." These are samples that have completed processing and have been released to the users. This list includes recently released samples and samples that have been released during the previous calendar year.

Estimated production figures for the 1 January through 31 December 2006.

Species	Specimens Aged
Flathead sole	1,888
Alaska plaice	339
Dover sole	838
Northern rock sole	921
Yellowfin sole	1,617
Walleye pollock	9,431
Pacific cod	4,682
Sablefish	2,389
Atka mackerel	1,467
Pacific ocean perch	2,378
Northern rockfish	817
Rougheye rockfish	4,766
Dusky rockfish	476
Dark rockfish	50
Great sculpin	400

Total production figures were 32,459 with 8,023 test ages and 352 examined and determined to be unageable.

By Dan Kimura