DIVISION/LABORATORY REPORTS

AUKE BAY LABORATORY (ABL)

MARINE SALMON INTERACTIONS PROGRAM

Southeast Alaska Coastal Monitoring: An Overview of Long-term Research on the Early Marine Ecology of Juvenile Salmon

The primary goal of the Southeast Coastal Monitoring Project (SECM) is to build and maintain a time series of biophysical oceanographic indices related to the seasonal growth, distribution, abundance, and habitat utilization of juvenile Pacific salmon (*Oncorhynchus* spp.) stocks. Since 1997, SECM researchers annually have measured seasonal biophysical parameters in conjunction with marine sampling of juvenile salmon. The research occurs monthly from May to August along a seaward migration corridor in neritic waters (3–65 km offshore) centered near Icy Strait in the northern region of southeastern Alaska. A series of 13 stations have been consistently sampled each year, and catches of juvenile salmon and ecologically related species were enumerated, measured, and processed after each haul.

Principal results from the research include information on marine habitat utilization patterns, stock-specific migration, hatchery and wild fish interactions, neritic carrying capacity, predation on juvenile salmon, and the use of juvenile salmon abundance indices to forecast adult salmon returns. Juvenile salmon occupied the epipelagic habitats transitionally; they were absent in May, occurred in high abundance in June or July, then abundance declined in August. Recovered marked stocks of juvenile salmon indicated stock-specific utilization of marine habitats, both for stream-type chinook salmon (*O. tshawytscha*) of Columbia River Basin origin and chum salmon (*O. keta*) of Southeast Alaska hatchery origin.

The composition of hatchery chum salmon from the two major enhancement facilities in the region in catches from Icy Strait generally amounted to more than 50% each year in June and July and less than 25% in August. Despite the high prevalence of hatchery chum salmon, results from a bioenergetics approach indicate that hatchery and wild chum salmon consumed only a small percentage of the available standing crop of zooplankton. Ecological interactions observed between juvenile salmon and their predators indicated that 7 of 21 predator species consumed juvenile salmon. Of these juvenile salmon predators, average interannual rates of predation ranged from less than 1% to about 30%.

Biophysical parameters and juvenile pink salmon (*O. gorbuscha*) indices were compared to the total commercial harvest of adult pink salmon in Southeast Alaska the following year. Juvenile pink salmon abundance proved to be highly correlated with adult pink salmon harvest and shows promise as a forecasting tool. This correlation of high juvenile pink salmon abundance in June and July to adult harvest may suggest that early marine conditions prior to these months govern survival. Long-term annual monitoring may help to better identify relationships between environmental change and salmon production, and improve our understanding of the coastal Alaska marine ecosystem.

By Joseph Orsi

Seasonal Variation in Whole Body Energy Content of Juvenile Coho Salmon in Marine Waters of Northern Southeast Alaska

Our study examined seasonal variation in whole body energy content (WBEC, cal/g dry weight) of juvenile coho salmon (*O. kisutch*) from neritic habitat in the marine waters of northern Southeast Alaska. This process study is one component of SECM, which for the last 8 years has monitored biophysical parameters that influence habitat use, marine growth, predation, stock interactions, year-class strength, and ocean carrying capacity of juvenile salmon. Juvenile coho salmon were sampled in 2001 during SECM rope trawl operations at stations in Icy Strait and Upper Chatham Strait (lat. 58˚N, long. 135˚W) from June to September. Mean WBEC was calculated from bomb calorimetry measurements of up to 10 specimens collected in each of four monthly intervals (n = 38).

Seasonal variation in WBECs occurred among juvenile coho salmon. The mean WBEC differed significantly by month (ANOVA, P = 0.000, df = 3) and were 4785.1, 4757.9, 4697.2, and 5245.7 cal/g dry weight for June, July, August, and September, respectively. Tukey's pairwise comparisons identified significantly higher mean WBEC for September than for the three previous months. This result suggests that WBEC for juvenile coho salmon increases seasonally as the coho migrate to

the open ocean, entering the Gulf of Alaska in the fall. Such seasonal WBEC values should be incorporated into bioenergetics models that include a temporal aspect and be used when evaluating habitat quality of juvenile salmon. Furthermore, earlier samples of juvenile coho salmon (e.g., from May) should be examined to reflect condition immediately after saltwater entry and to provide a broader picture of the seasonal variation in WBEC of juvenile coho salmon.

By Emily Fergusson

Endangered Species Research at Little Port Walter

October 2004 marked the end of a successful season of intensive field investigations at the Little Port Walter Research Station. Activity at the station this year included research focused on inbreeding and outbreeding depression as related to the recovery of endangered stocks of steelhead trout (*O. mykiss*) and evaluating the possibility of using lakes as long-term refugia for endangered populations of steelhead.

In 2004, we conducted the sixth successive spawning of the 1996 captive brood and successfully propagated 80 families representing eight lines of steelhead and rainbow trout crosses. The 1996 brood was generated from captures of wild steelhead in Sashin Creek and wild resident rainbow trout in Sashin Lake that originated from a transplant of Sashin Creek steelhead in 1926. We currently are evaluating differences between the two populations relating to important life history characters such as smolt production, early maturation, growth, and marine survival. Using the second generation progeny, we also are able to evaluate the effects of one generation of sibling mating (which has a high probability of occurrence in small, endangered populations) on survival potential in the wild for inbred progeny of both steelhead and rainbow lines.

Results from 2004 provide convincing evidence that even inbreeding levels as low as 0.25, which are not unusual in small captive populations, can have disastrous effects on the ability of the affected population to survive in the wild. These results have significant implications relating to the demographic risk of extinction faced by small populations and the use of captive broodstocks in restoration efforts.

By Frank Thrower

OCEAN CARRYING CAPACITY PROGRAM

Distribution, Migration, and Relative Abundance of Juvenile Salmon in the Eastern Bering Sea

Scientists from the ABL Ocean Carrying Capacity (OCC) program conducted research cruises to survey juvenile Pacific salmon in the eastern Bering Sea during 2000–03. The research is part of the Bering-Aleutian Salmon International Survey (BASIS), a Bering Sea ecosystem study that includes member nations (Canada, Russian, Japan, and United States) of the North Pacific Anadromous Fish Commission (NPAFC). The BASIS study was developed to clarify the mechanisms of biological response by salmon to the conditions caused by climate change.

The goal of OCC's BASIS research is to understand mechanisms underlying the effects of environment on the distribution, migration, and growth of juvenile salmon along the eastern Bering Sea shelf. Specific objectives of the OCC research cruises are to determine migration and distribution of juvenile salmon stocks, measure early marine growth, and determine relative abundance.

Results indicate that 1) juvenile salmon are widely distributed across the eastern Bering Sea shelf, 2) species-specific distributional patterns of juvenile salmon can exist, 3) distributional patterns are likely related to principal prey sources (e.g., age-0 pollock for juvenile sockeye (*O. nerka*) and chum salmon, larval and juvenile sand lance for juvenile chinook), and 4) oceanographic characteristics can influence distribution and migration pathways (e.g., juvenile salmon appear to avoid areas of intense coccolithophore blooms). Size and relative abundance of juvenile sockeye and chum salmon was greatest during 2002 and 2003. Age-1.0 juvenile sockeye salmon tended to comprise the largest component of catch during fall surveys.

By Edward Farley

Eastern Bering Sea (BASIS) Coastal Research

Scientists from OCC program conducted a research cruise in the eastern Bering Sea during August–October 2004 as part of BASIS. The cruise was to study early marine distribution, migration, and growth of juvenile Pacific salmon (*Oncorhynchus* spp.) and associated marine species on the eastern Bering Sea shelf. A total of 8,970

salmon were captured, including juvenile pink (*O. gorbuscha*; 20.9%), chum (*O. keta*; 19.4%), sockeye (*O. nerka*; 42.6%), coho (*O. kisutch*; 3.9%), and chinook (*O. tshawytscha*; 5.3%) salmon. Less than 9% of the catch consisted of immature and mature chum, sockeye, and chinook salmon. A total of 2,837,503 other marine fish species were captured during the survey, including age-0 walleye pollock (*Theragra chalcogramma*; 91.6%) and Pacific herring (*Clupea pallasi*; 6.9%). The catch also included less than 1% each for crested sculpin (*Blepsias bilobus*), sturgeon poacher (*Podothecus acipenserinus*), Bering wolffish (*Anarhichas orientalis*), Pacific sandfish (*Trichodon trichodon*), capelin (*Mallotus villosus*), Pacific cod (*Gadus macrocephalus*), prowfish (*Zaprora silenus*), Pacific sand lance (*Ammodytes hexapterus*), northern rock sole (*Lepidopsetta peracuata*), lamprey (Petromyzontidae), sablefish (*Anoplopoma fimbria*), Atka mackerel (*Pleurogrammus monopterygius*), starry flounder (*Platichthys stellatus*), rainbow smelt (*Osmerus mordax*), rock greenling (*Hexagrammos lagocephalus*), salmon shark (*Lamna ditropis*), saffron cod (*Eleginus gracilis*), ninespine stickleback (*Pungitus pungitus*), yellowfin sole (*Limanda aspera*), rockfish (*Sebastes* spp), plain sculpin (*Myoxocephalus jaok*), Bering poacher (*Occella dodecaedron*), antlered sculpin (*Enophrys diceraus*), Greenland halibut (*Reinhardtius hippoglossoides*), snake prickleback (*Lumpenus sagitta*), and ribbed sculpin (*Triglops pingeli*).

By Ed Farley

GLOBEC Field Survey

A Global Ocean Ecosystem Dynamics (GLOBEC) cruise was conducted in October–November 2004 to investigate the relationships between physical and biological oceanographic processes that affect the distribution and biology of juvenile Pacific salmon in the Gulf of Alaska. Measurements focused on the spatial pattern of salmon distribution, oceanographic properties, and the distribution of zooplankton along selected transects. The survey included six transects beginning with the Cape Kumlik transect, located southeast of Kodiak Island and ending with the Cape Douglas transect, located northwest of Afognak Island. Transects were perpendicular to shore and extended from nearshore across the continental shelf to oceanic waters beyond the 200-m shelf break.

The survey was conducted aboard the commercial fishing vessel *Great Pacific*. Fish samples were collected using a 198-m long midwater rope trawl with hexagonal mesh wings and body. Salmon and other fishes were sorted by species and counted. Standard biological measurements including fork length, body weight, and sex were made. Scale samples from the preferred area (to document age and growth) were taken from juvenile and immature salmon, and a subset of juvenile salmon was frozen whole for laboratory analyses of food habits, genetic origin, and the reading of hatchery thermal marks on otoliths.

Oceanographic measurements were made at trawl stations immediately prior to each trawl haul and included temperature, salinity, oxygen concentration, photosynthetically available radiation (PAR), chlorophyll fluorescence, and optical transmittance. Plankton samples were collected using a Bongo net frame fitted with 505-µm and 330-µm mesh nets that were towed obliquely relative to the surface. A thermosalinograph, nutrient sampler, and fluorometer provided continuous measurements of near-surface temperature, salinity, nutrients, and fluorescence. Satellite-tracked drifting buoys were deployed at designated trawl stations to measure the strength and direction of the current along the continental shelf.

During the survey, 31 trawl stations were completed, and a total of 3,549 salmon were captured. Juvenile salmon were distributed along the shelf; salmon species represented in the catch were pink (63.5%), chum (28.2%), sockeye (6.9%), coho (1.4%), and chinook (<1%) salmon. Immature salmon were located on the shelf and offshore. Species of immature salmon represented in the catch were chum (<1%) and chinook (<1%) salmon. No mature salmon were caught.

By Jamal Moss

HABITAT INVESTIGATIONS PROGRAM

Overwintering Herring Survey

One hypothesis for the seasonal use of terrestrial haulouts by Steller sea lions to rest and care for their young is that prey are seasonally available in adjacent waters. Dense, overwintering aggregations of Pacific herring near Benjamin Island, a seasonal sea lion haulout in southeastern Alaska, are an example of this. Peaks in sea lion attendance between October and December correspond with peaks in herring biomass near the haulout. Sea lion scat analyses

indicate that herring are the most commonly consumed prey item between October and December, followed by walleye pollock. Concurrently, herring, which undergo seasonal cycles in whole-body energy content, are most energy-rich in the fall and early winter. The combination of large biomass and high energy content of herring in the winter results in herring accounting for 96% of the prey-derived energy available near Benjamin Island.

Another aspect of foraging energetics is the effort associated with foraging. During the winter, herring aggregate in dense schools on the seafloor, which facilitates a reduction in pursuit by sea lions (Fig. 1). How easy it is for sea lions to find these aggregations influences the net benefits from foraging trips. Predictability of prey aggregations, both in time and location, decreases search time and improves foraging profitability . Monthly prey surveys conducted between June 2001 and May 2004 indicate that overwintering herring aggregations occur consistently each year near Benjamin Island. Prey distribution in one month was a good indicator of prey distribution the same month the following year, but only during the winter months; this was due to the formation of large schools of herring in consistent locations within the study area.

During winter 2004–05, we are conducting prey surveys on weekly and daily intervals to examine predictability of herring schools on shorter time scales. Results from this fine-scale study will provide further insight into the energetic benefit sea lions derive from Pacific herring and the balance between predation avoidance by herring and the costs associated with searching by sea lions.

By J.J. Vollenweider and Ron Heintz

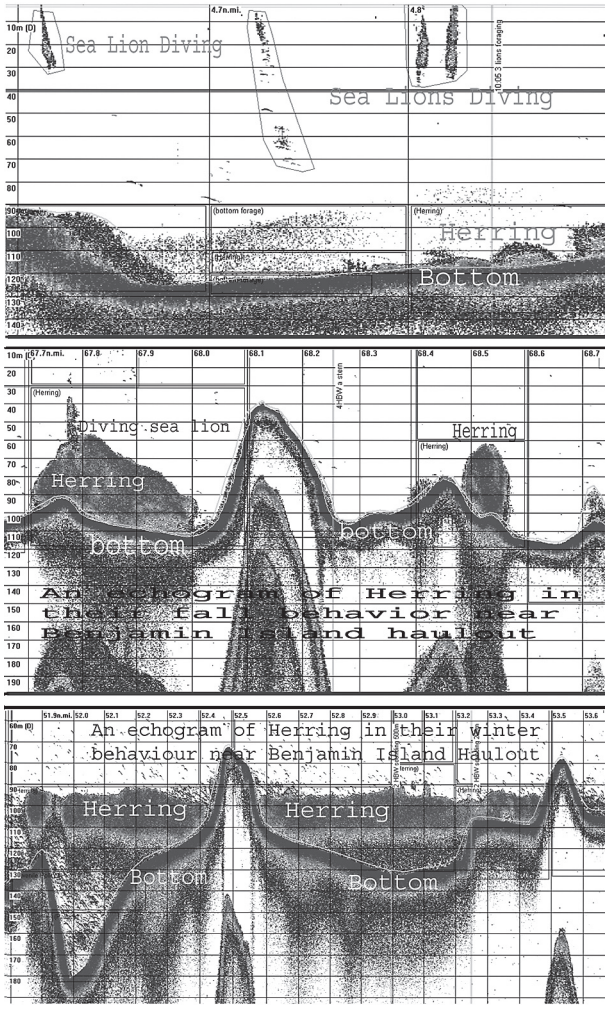

Figure 1. Acoustic echograms of herring concentrations near the Benjamin Island haulout showing sea lion diving behavior and herring behavior during fall and winter.

GROUNDFISH ASSESSMENT PROGRAM

Energetic Importance of Various Fish Species As Prey for Steller Sea Lion in Southeast Alaska

The relative importance of various fish species as prey for Steller sea lions in southeastern Alaska was estimated by applying energetic models to samples of sea lion scat. Relative importance of prey species contribution to the total energy consumed by sea lions was compared to results from frequency of occurrence analysis, a technique commonly used to examine pinniped diets. Sea lion scats from the Benjamin Island haulout were collected simultaneously with collections of fish prey species in adjacent waters every 3 months during 2001–02. Biomass of prey was reconstructed from the bones in the scat and combined with prey energy content to calculate the seasonal energy in sea lion diet by prey species. The model was calculated using biomass-variable (BV) reconstruction, which assumes that scats represent random biomass of consumed prey.

Pooled over all seasons, the model indicated that Pacific salmon was the most important energy source for sea lions, followed by Pacific herring, skate, Pacific cod, and mature walleye pollock (Table 1). In contrast, frequency of occurrence analysis indicated that herring was the most important prey item, followed by three size classes of pollock (mature, juvenile, and young-of-year (YOY)), and skates. The most important prey species varied amongst seasons, however. For example, in October 2001, herring and pollock were consumed in the

Table 1. Comparison of he relative importance of the Steller sea lion (*Eumetopias jubatus*) prey species as determined by frequency of occurrence (FO) and energy methods. Of the 41 prey species identified in sea lion scat, the top 5 species resulting from the energetics model are presented.

Prey Species	FO Rank	Energy Rank
Pacific salmon	1	6
Pacific herring	2	1
Skates	3	5
Pacific cod	4	7
Mature walleye pollock	5	2

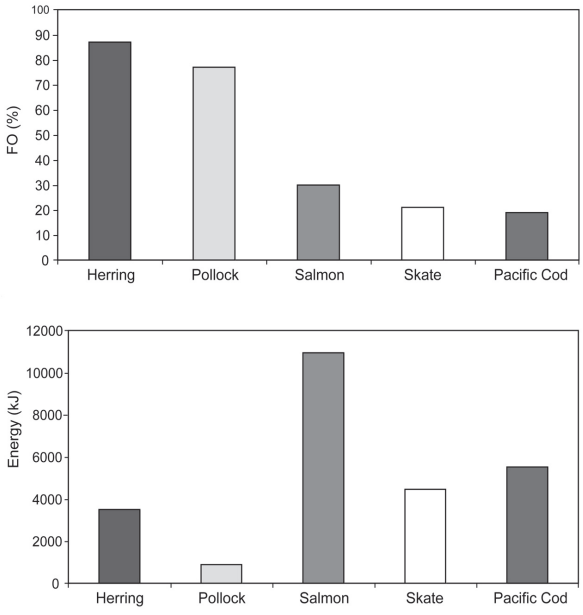

Figure 2. Relative values of prey consumed by Steller sea lions shown as frequency of occurrence (FO) and energy (kJ).

highest numbers; however, they were less important sources of energy than salmon, cod, and skates (Fig. 2). Our model of Steller sea lion energy consumption increases the utility of scat data beyond providing a numerical abundance of prey in sea lion diet to that which is most important to predators, the sources of dietary energy.

By J.J. Vollenweider, M. Sigler, D. Csepp, and J. Womble

NATIONAL MARINE MAMMAL LABORATORY (NMML)

ALASKA ECOSYSTEM RESEARCH PROGRAM

Conferences and Symposiums

Scientists from the Alaska Ecosystems Program (AEP) attended the Sea Lions of the World symposium hosted by Alaska Sea Grant held in Anchorage, Alaska, in early October. The symposium was an excellent format for the exchange of ideas and included researchers from around the world. Staff from the AEP presented four oral presentations and three posters, including "Regional variation of juvenile Steller sea lion (*Eumetopias jubatus*) growth rates in Alaska" by B. Fadely, T.S. Gelatt, L.D. Rea, J.C. King, and T.R. Loughlin; "Movement and dive behavior of foraging juvenile Steller sea lions (*Eumetopias jubatus*) associated with pelagic eddies" by J.T. Sterling, B. Fadely, and T.R. Loughlin; "Attendance patterns of juvenile Steller sea lions (*Eumetopias jubatus*) in the Gulf of Alaska and Aleutian Islands derived from satellite dive recorders (SDRs)" by K.A. Call, B. Fadely, and A. Greig; "Spatially explicit foraging ecology of juvenile Steller sea lions (*Eumetopias jubatus*)" by M.E. Lander, T.R. Loughlin, and M.L. Logsdon; "Status of the Western Steller sea lion population in 2004" by L. Fritz, C. Stinchcomb, T.R. Loughlin, and W. Perryman; and "A critical review of the regime shift- "junk food" hypothesis for the decline of the Western stock of Steller sea lion" by L. Fritz and S. Hinkley.

Rolf Ream attended the PICES conference in Honolulu, Hawaii, in mid October where he presented work investigating oceanographic influences on northern fur seal migratory movements. Brian Fadely gave an oral presentation at the Marine Mammals of the Holarctic III conference in the Ukraine.

Field Work

During the northern fur seal breeding season (August) AEP personnel captured 39 adult female fur seals on the Pribilof Islands, Alaska. All animals were outfitted with satellite transmitters, and 28 females with time depth recorders. The data derived from these instruments provides locations of repeated female foraging trips and details their dive behavior. In early and mid-October, 33 of the 39 animals were successfully recaptured and the instruments recovered. The main focus of this project

is to investigate adult female site fidelity and assess the variability in foraging ground location within and between individuals. Initial results indicate that the number of repeated foraging trips varied by individual and ranges from four to eight trips tracked over the length of deployments. Foraging ground location fidelity also varies among and between individuals, rookeries, and islands.

Personnel from the AEP in collaboration with researchers from the University of Alaska and Dalhousie University, Nova Scotia, were awarded a North Pacific Research Board grant to investigate female northern fur seal foraging strategies in the Bering Sea and North Pacific Ocean. Twenty adult females were captured in mid-November on St. Paul Island and are the first cohort of the study. Morphometric measurements and body condition information were collected to assess female health. In addition, animals were outfitted with satellite instruments to track their movements on the annual migration. Longitudinal studies of adult female fur seals through their annual cycles (pupping, lactation, and annual migration) combined with studies of their pups throughout the lactation period will provide important insight regarding both female and pup body condition, female reproduction success, and habitat use during the breeding season and the winter migration.

By Kate Call

CETACEAN ASSESSMENT & ECOLOGY PROGRAM

International Whaling Commission Workshop

The International Whaling Commission (IWC) held a workshop on habitat degradation, 12-15 November 2004, in Siena, Italy. The meeting had approximately 50 participants. The goals of the workshop were to 1) determine and help develop a framework and methodology to assess the significance of changes in cetacean habitats, and 2) facilitate the eventual development of a research plan to evaluate and quantify cetacean habitat degradation in specific case studies. The workshop was funded by the Government of Austria, the Environmental Investigation Agency, ASMS Ocean Care, and the World Wide Fund for Nature. A workshop report will be presented at the 57th Annual Meeting of the IWC Scientific Committee in Ulsan, Republic of Korea, 30 May – 10 June 2005.

By Nancy Friday

Computer-Based Video Analysis of Cook Inlet Beluga Whale Counts

Biologists Christy Sims and Rod Hobbs of the Cetacean Assessment and Ecology Program (CAEP) have developed a computer program to analyze aerial video of beluga whale groups. During aerial surveys of Cook Inlet each June, from three to eight video censuses are made of each beluga group encountered. Over the course of each survey, 15-20 groups are recorded, resulting in more than a hundred video clips to analyze. In previous years, beluga images in each video clip were transposed manually onto acetate sheets, with one sheet representing each half second of video. The number of whales, the maximum image size of each whale, and the up and down time for each surfacing was recorded. Working 8 hours per day, 5 days per week, for 4 to 5 months, a team of recorders spent over 800 hours viewing video and transcribing it onto approximately 600-800 acetate sheets.

In spring 2004, Sims and Hobbs began searching for computer software to analyze video clips. Once they identified a suitable software system, they worked with Steven Hentel, a programmer from the University of Washington, to develop the necessary subroutines and data management systems to duplicate the previous "hand count" system. Although not in its final form, the current version of the program allowed Sims, assisted by NMML biologist Janice Waite, to complete the analysis of the 2004 Cook Inlet survey data in 6 weeks during a total of 150-200 hours.

The current program manages a database of video clips on a computer and allows the analyst to view the clips, identify individual belugas, track beluga images, mark the up and down times for all surfacings, and measure the image sizes with a few mouse clicks. The program stores the resulting data and then outputs the data to a text file that can be opened in a spreadsheet for further analysis. At this point, the program does not identify beluga images, but much of the tedious viewing and reviewing—frame by frame in slow motion—has been eliminated. The computer program will enable NMML to provide an annual abundance estimate for the Cook Inlet beluga population within 2 months of completing the June survey, compared to the 6 months required in previous years.

By Rod Hobbs

POLAR ECOSYSTEMS PROGRAM

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

The movements and diving behaviors of two young-of-the-year, female bearded seals (*Erignathus barbatus*), in Kotzebue Sound, Alaska, were determined remotely from satellite-linked dive recorders (SDRs). This represents the first time that bearded seals have been tracked in U.S. waters. 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 (ADF&G), and the AFSC's Polar Ecosystems Program, and was funded, in part, by a tribal wildlife grant from the U.S. Fish and Wildlife Service.

Bearded seals are an important Alaska Native subsistence resource. They are also a key ecological component of arctic marine ecosystems and, because they are sensitive to suitable sea ice conditions, they may be particularly vulnerable to climatic change. However, little is known of their seasonal movements, habitat use, or diving behavior. This project was designed as a cooperative effort between biologists and local Kotzebue-area hunters, and it is intended to combine local knowledge about the distribution and habits of bearded seals with the field techniques and analysis expertise of biologists.

The first of two field seasons was conducted in October 2004. The two seals were captured in large-mesh nets set in the shallow, open waters near Kotzebue. Upon release, one seal remained close to the coast of inner Kotzebue Sound and the other moved into the deeper waters of the Chukchi Sea (Fig. 1). Despite their different habitats, they exhibited similar patterns in the use of their surroundings. Each seal tended to remain in a small area, presumably foraging, for a number of days (i.e., 3-18), before moving to a new location, often more than 150 km away. Further analyses of these data will include investigations of the potential effects of bathymetry, ice concentration, and ice extent on their movements and diving behavior. This first season has shown that it is possible to reliably and safely capture and instrument bearded seals in this area. In our second season, planned for September and October 2005, we intend to instrument a larger number of animals to better estimate the movements and behaviors of these animals.

By Michael Cameron

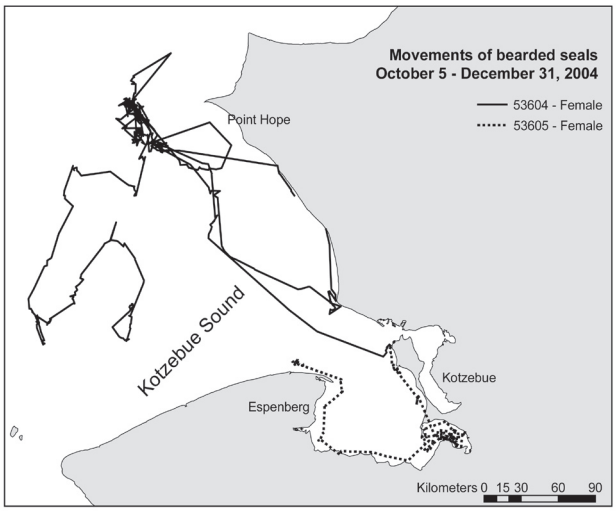

Figure 1. Movements of bearded seals released near Kotzebue, Alaska.

Review of Genetic Research on Harbor Seal Population Structure

The National Marine Fisheries Service (NMFS) and the Alaska Native Harbor Seal Commission (ANHSC), through their joint Harbor Seal Comanagement Committee, requested an independent scientific peer review of recent NMFS research on the genetic structure of harbor seal populations in Alaska. The purpose of this independent review was to evaluate new science that has implications for stock assessment and management. The American Institute of Biological Sciences (AIBS), Scientific Peer Advisory and Review Service was contracted to identify and recruit reviewers with appropriate expertise, solicit reviews, and convened a panel meeting on 12-14 October 2004 in Juneau, Alaska. Five individuals were recruited to review the research, two of whom were requested to submit their reports anonymously. The other three reviewers participated in the panel meeting prior to completing their reports. At the panel meeting, the authors of the research gave an extensive presentation of the genetics research, which was followed by an interactive question and answer period with the panel reviewers.

All three reviewers remarked at the panel meeting that the presentations and the interactive sessions greatly increased their understanding of the research and its management context. Much of the discussion between the reviewers and authors centered on suggestions on how to more clearly present the analysis. Many of the reviewers' concerns pertained to the application of the Boundary Rank analysis, a new method for stock identification, the performance of which is not yet well known. The panel reviewers came to appreciate the overall result that there likely are more stocks of harbor seals in

Alaska than currently recognized. A report of the review process, including the individual reviewers' critiques, was prepared by AIBS for use by the Harbor Seal Co-management Committee in their consideration of appropriate stock structure and boundaries.

By Peter Boveng

RESOURCE ASSESSMENT & CONSERVATION ENGINEERING (RACE) DIVISION

GROUNDFISH ASSESSEMENT PROGRAM

The Effect of Autotrawl Systems on the Performance of a Survey Trawl

Three aspects of survey bottom trawl performance 1) trawl geometry (i.e., net spread, door spread, headrope height) 2) footrope distance off bottom and 3) bridle distance off-bottom were compared among hauls using either of two autotrawl systems (equal tension and net symmetry) and also with towing cables of equal length and locked winches. The effects of environmental conditions, vessel heave, crabbing (vessel heading offset from vessel course over ground), and bottom current on the trawl performance when using the three trawling modes were investigated. The means and standard deviations of trawl geometry measures (Fig. 1) were not significantly different between the autotrawl and locked-winch systems. Bottom trawls performed better when either autotrawl system was used, versus trawling with locked winches, resulting in reduced variance and increased symmetry of the footrope bottom contact (Fig. 1). The equal tension autotrawl system was most effective in counteracting effects of environmental conditions on footrope bottom contact. Footrope bottom contact was most influenced by environmental conditions while towing with locked winches. Both of the autotrawl systems also reduced the variance and increased the symmetry of bridle bottom contact.

Autotrawl systems proved to be effective at decreasing the effects of environmental factors on some aspects of trawl performance and, as a result, have the potential to reduce among-haul variance in catchability of survey trawls (Fig. 2). Therefore, by incorporating an autotrawl system into standard survey procedures, precision of survey estimates of relative abundance may be improved.

By Stan Kotwicki, Kenneth Weinberg, and David Somerton

Estimating Capture Probability of a Survey Bottom Trawl for Bering Sea Skates and Other Fishes

Capture probabilities for skates, three species of flatfish, and seven other species were estimated for the 83-112 Eastern bottom trawl used to conduct the eastern Bering Sea bottom trawl survey. Capture probability data were collected by towing with an experimental trawl that consisted of a standard survey trawl with an auxiliary net attached beneath the footrope of the survey trawl. It was assumed that the auxiliary net caught all fish escaping under the survey trawl footrope. Capture probability was then estimated for each 1 cm of fish length as ratio of fish caught in the survey trawl to the sum

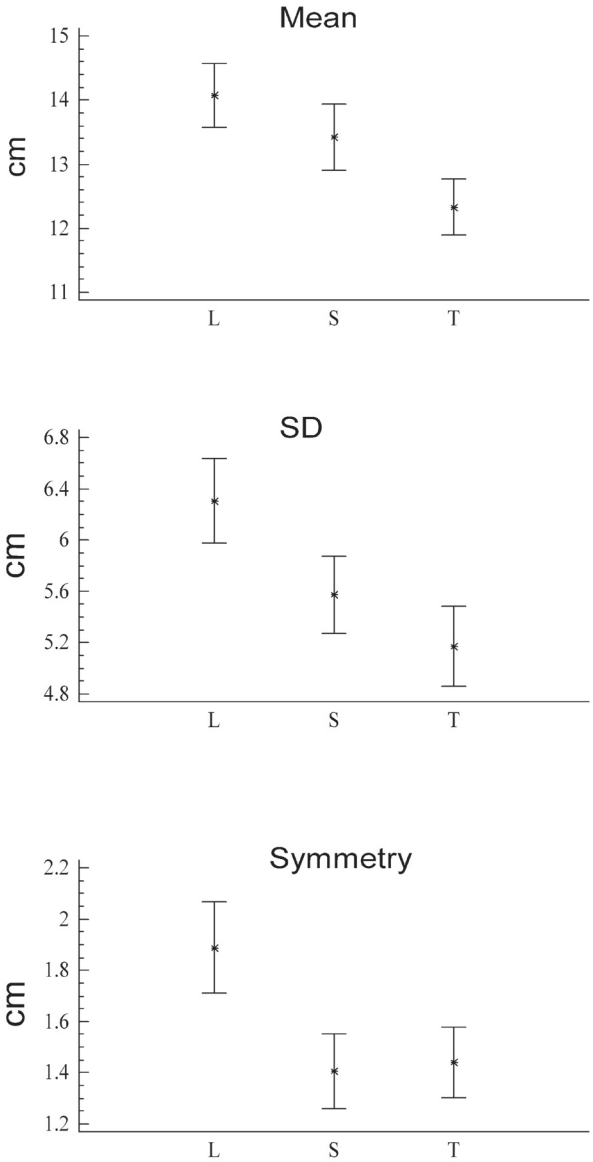

Figure 1. Means and standard errors of the footrope distance off-bottom, standard deviation of the footrope distance off-bottom, and footrope symmetry for the locked winches (L), symmetry (S), and tension (T) treatments.

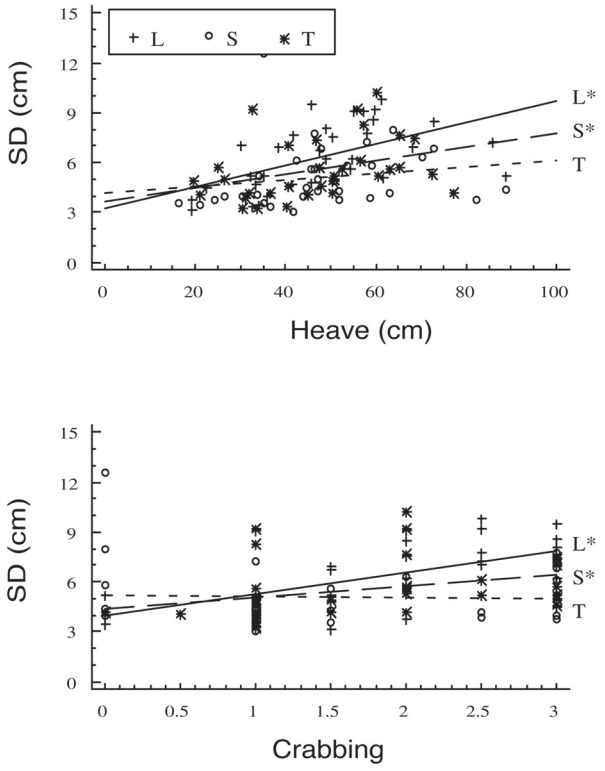

Figure 2. Comparison of regression lines illustrating the relationship between the standard deviation (SD) of the footrope distance off-bottom and heave and crabbing for locked winches (L), symmetry (S), and tension (T) treatments. Treatments in which the environmental variable had a statistically significant effect on the SD are identified with an asterisk (*).

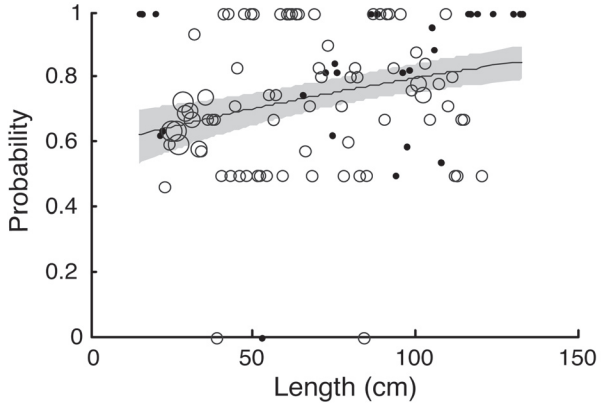

Figure 3. Probability of capture estimated by the parametric model is shown along with 95% bootstrapped confidence regions. Circles represent observed capture probabilities. Size of the circle is proportional to number of fish observed in each centimeter length bin.

of fish caught in both survey trawl and auxiliary net. Four competing models describing different capture processes were fitted to the data using the maximum likelihood method and the best model was chosen by likelihood ratio test. Capture probability for skates (*Bathyraja* spp.) increased monotonically with length from ~ 0.65 for 30-cm skates to ~0.8 for skates > 100 cm (Fig. 3). Capture probability for flatfish (arrowtooth flounder (*Atheresthes stomias*), rex sole (*Glyptocephalus zachirus*), and Pacific halibut (*Hippoglossus stenolepis*)), sturgeon poacher (*Podothecus acipenserinus*), wattled eelpout (*Lycodes palearis*), and great sculpin (*Myoxocephalus polyacanthocephalus*) was constant across lengths and close to unity > 0.97. Capture probability was constant, but significantly lower than 1 for sawback poacher (*Leptagonus frenatus*) (0.89), searcher (*Bathymaster signatus*) (0.94) and spinyhead sculpin (*Dasycottus setiger*) (0.69). For spectacled sculpin (*Triglops scepticus*) capture probability was 1.00 for fish smaller than 15 cm, but decreased for larger fish.

By Stan Kotwicki and Kenneth Weinberg

Effect of Net Spread on Capture Efficiency of a Demersal Survey Trawl Used on the Eastern Bering Sea Shelf

Relative abundance estimates generated from the NMFS annual groundfish trawl surveys in the eastern Bering Sea shelf are based on mean catch per area swept. In the calculation of these estimates, the capture efficiency is assumed to be constant with net spread, which increases with depth throughout the depth range of the survey area and also varies substantially with bottom type and currents. The validity of this assumption was tested using a linear model of catch-per-unit-towed distance versus net spread and depth that was fit to 14 years of survey data for seven species. Catch rates decreased significantly with increasing net spreads for six of the seven species despite the larger area swept at greater net spreads. The magnitude of the downward trends varied considerably by species. Purple sea star (*Asterias amurensis*) and northern rock sole (*Lepidopsetta polyxystra*) exhibited the strongest negative relationships between catch rate and net spread, while Alaska plaice (*Pleuronectes quadrituberculatus*) exhibited the weakest relationship.

We attribute this decrease in catch to a decrease in capture efficiency, which is primarily due to increased escapement under the footrope. Calibrated bottom contact sensors indicate that footrope clearance with the bottom increases with net spread (Fig. 4). The current assumption of constant capture efficiency at all net spreads may result in biased size distributions and sex ratios for species displaying size and sex segregation by depth. This assumption may also have negative implications for the assessment of highly patchily distributed species as well as those whose depth distribution is a function of changing environmental conditions.

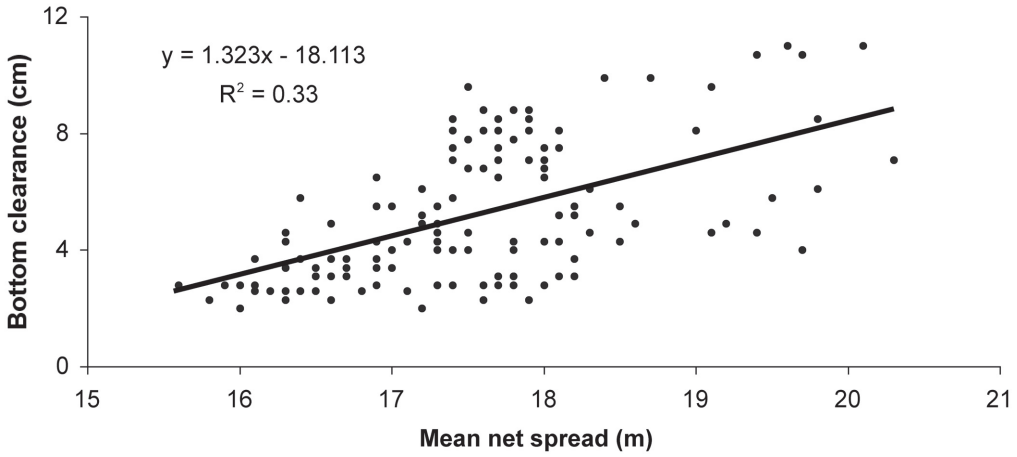

Figure 4. Relationship between mean net spread and the clearance between the footrope and bottom for the 83-112 Eastern trawl. The clearance increases with increasing net spread, possibly allowing some fish to escape under the footrope. Data were collected on board the chartered fishing vessel *Arcturus* during the NMFS annual eastern Bering Sea demersal trawl survey in 2004. N=136.

Controlling trawl geometry by means of restrictor cables on the warps is a feasible method to address this problem.

By Paul von Szalay

Feeding Habits of Two Congener Species, Dark And Black Rockfish, in the Western Gulf of Alaska

Dark rockfish (*Sebastes ciliatus*) are often caught by commercial jig operations targeting black rockfish (*S. melanops*) in the Gulf of Alaska. Rockfish feeding ecology research in Southeast Alaska in summer 1980-82 found differences in the diets of black rockfish and both color morphs of dusky rockfish. (These studies preceded the redescription of light and dark dusky rockfish color morphs into two distinct species, dark and dusky (*S. variabilis*) rockfish.) Black rockfish were found to be primarily piscivorous predators, feeding on Pacific sand lance (*Ammodytes hexapterus*), while dusky rockfish primarily fed on invertebrate zooplankton such as brachyuran crab larvae.

In July 2001, 434 dark rockfish were caught as bycatch on an ADF&G black rockfish hook-and-line survey conducted in the area around Sanak Island and Sandman Reef in the western Gulf of Alaska. Individual fish were weighed, sexed, and measured, and the otoliths were removed to examine their age, growth, and natural mortality. Stomach samples were also collected from both dark and black rockfish when the two species were caught at the same stations to look for differences in diet and investigate niche overlap. The following results of this study were presented in November at the 2004 annual meeting of the Alaska Chapter of the American Fisheries Society in Sitka.

Stomachs from 207 fish were analyzed, 98 collected from black rockfish and 109 from dark rock-

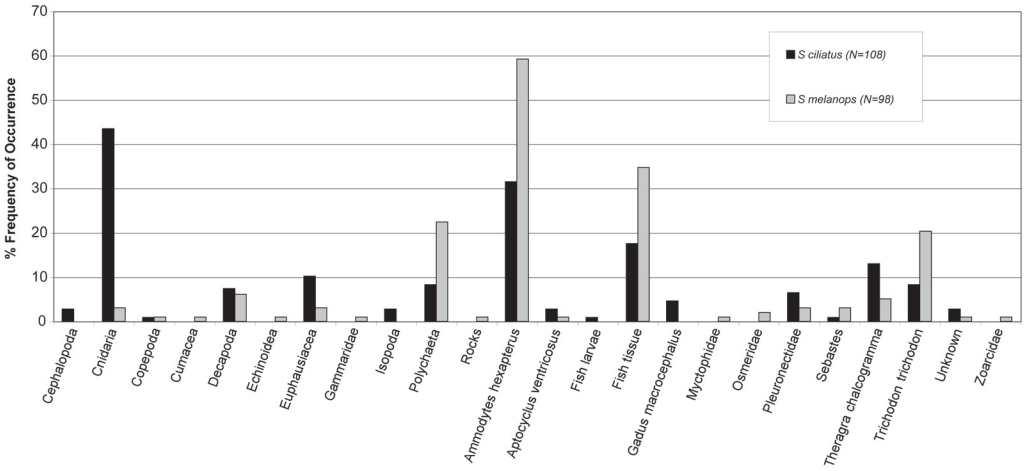

Figure 5. Frequency of occurrence of prey items found in dark and black rockfish caught near Sanak Island and Sandman Reef in the western Gulf of Alaska.

fish. Both species had an abundance of Pacific sand lance and Pacific sandfish (*Trichodon trichodon*) in their stomachs, although the frequency of occurrence of these fish prey species was greater in black rockfish stomachs (59.2% and 20.4%, respectively) than in dark rockfish stomachs (31.5% and 8.3%). Juvenile walleye pollock occurred more frequently in the diet of dark rockfish (13.0%) than black rockfish (5.1%), while Pacific cod occurred only in dark rockfish, illustrating a wider variety of forage fish prey in the dark rockfish diet. Polychaete worms were the most frequently observed invertebrates in the diet of black rockfish, while cnidarians and euphasiids were the most frequent invertebrate prey for dark rockfish. Crab larvae were also present in the stomachs of both predators and, while not a major contributor to the black rockfish diet, were the fifth most important prey species of dark rockfish based on frequency of occurrence (Fig. 5).

The proportion of black rockfish feeding exclusively on forage fish was higher than that of dark rockfish (66% vs. 35%), while more dark than black rockfish fed exclusively on invertebrates (41% vs. 4%). Dark rockfish stomachs more frequently contained both fish and invertebrate prey items, supporting the previous conclusion that black rockfish are primarily piscivorous predators.

Niche overlap between the two species was examined. Niche breadth was calculated for each species using Levin's calculation, where a value of zero defines all prey items as from a single prey category, while a value of 1 represents prey items are equally distributed from all prey categories. Black rockfish, with a value of 0.09, demonstrated a very narrow niche, while dark rockfish's niche was broader (value = 0.22). Schoener's Index of diet overlap between the two species was calculated to be 0.62. Values for this index range from zero, no overlap in diet, to a maximum value of 1, indicating equal proportions of all prey items. These results indicate that black and dark rockfish compete for similar prey resources, although black rockfish exhibit a more specialized diet.

By Liz Chilton

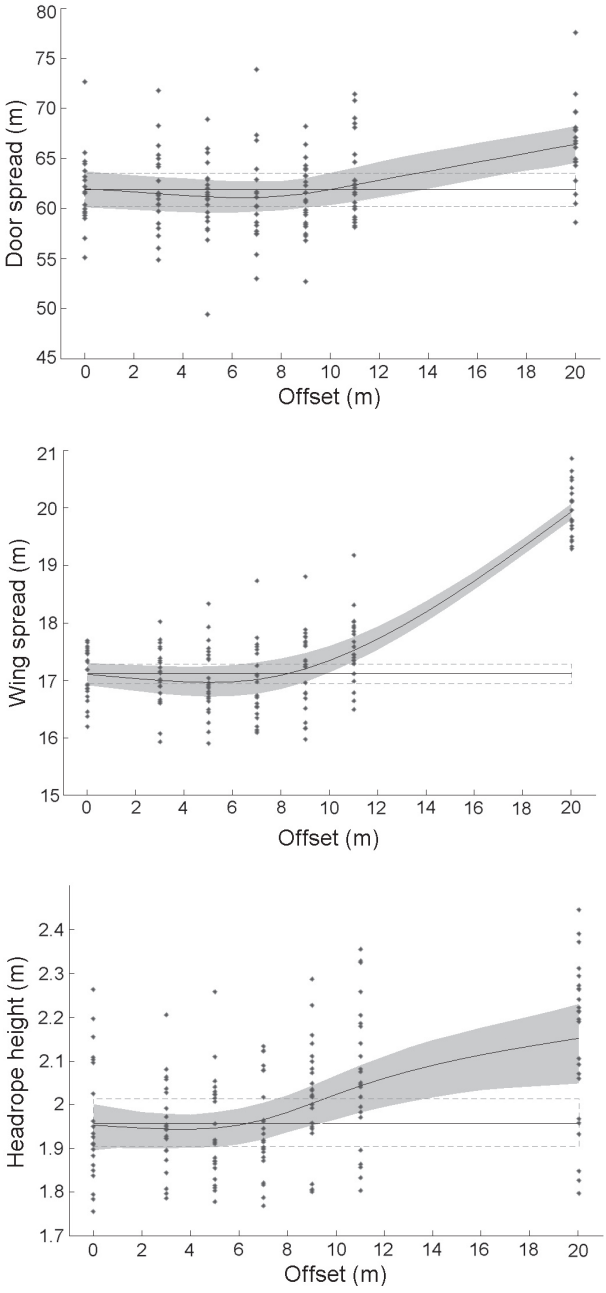

Figure 6. Mean door spread, wing spread, and headrope height is shown (+) plotted against offset increment. The means for all values of offset increment were fit with a cubic spline function (solid curve). Bootstrapped 95% confidence bounds are shown with shading. Also shown are the mean door spread, wing spread, and headrope height considering only treatments with zero offset (solid horizontal line) and the bootstrapped 95% confidence bounds (dashed horizontal lines).

Effect of Unequal Trawl Warps on Trawl Geometry

Survey standardization procedures can reduce the variability in trawl catch efficiency, thus producing more precise estimates of biomass. One such procedure, towing with equal amounts of trawl warp when using locked winches was experimentally investigated for its importance in determining optimal trawl geometry and for evaluating the effectiveness of the recent NMFS national protocol on accurate measurement of trawl warps, which states that warp length differences between the port and starboard sides cannot exceed 4% of the distance between otter doors measured along the bridles and footrope. Trawl performance data from repetitive

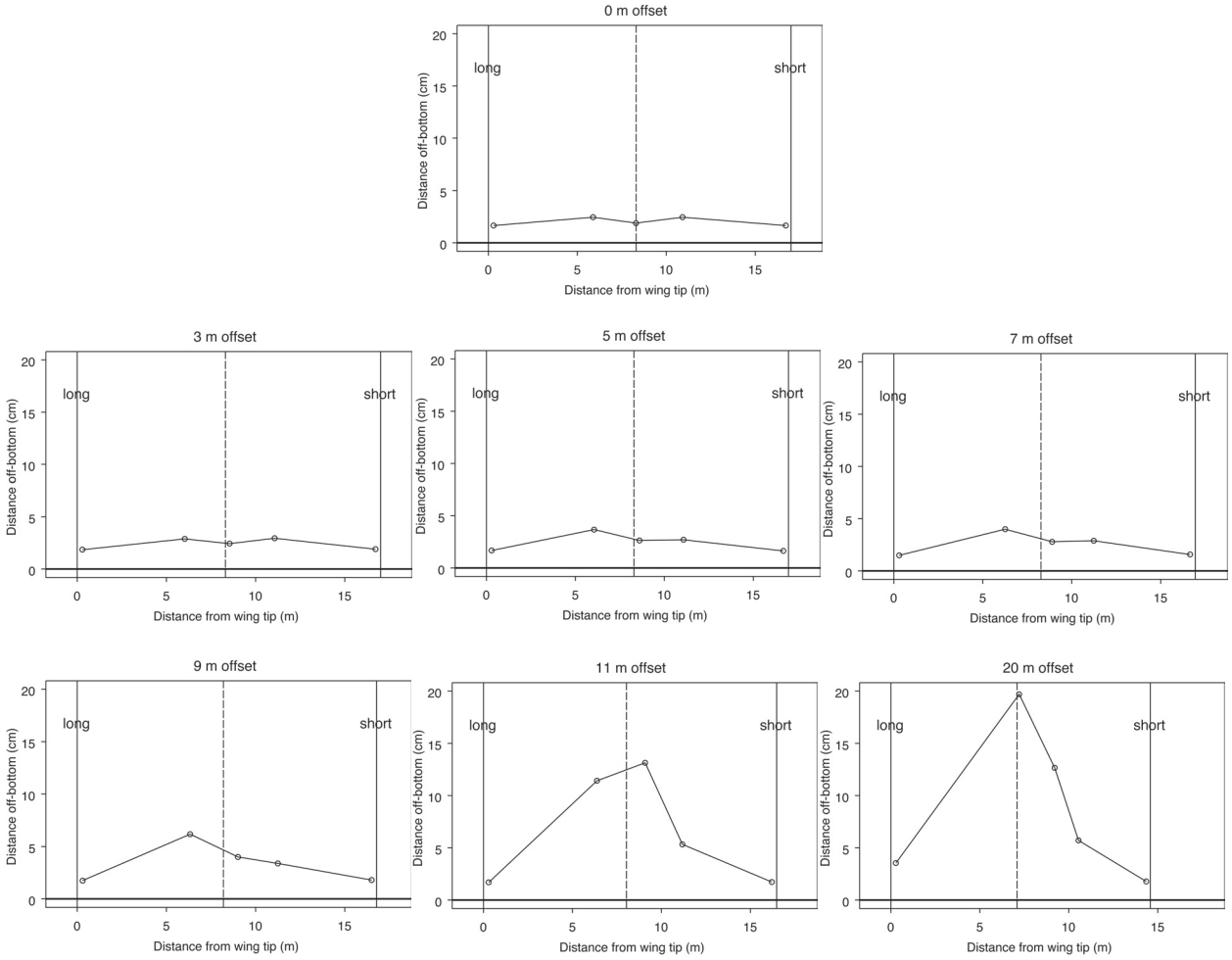

Figure 7. Mean off-bottom distances in cm at the five bottom contact sensor positions along the footrope (circles) are shown for each warp offset. The positions are projected onto the wing tip to wing tip plane to depict the footrope as it would appear looking into the net from the direction of travel. The vertical solid lines indicate the positions of the wing tips on the long warp and short warp sides of the trawl. The dashed line indicates the midpoint between wing tips. Note that the projection considers the reduction in effective net width with increasing offset.

towing with warp differentials of 0, 3, 5, 7, 9, 11, and 20 m were analyzed for their effect on three determinants of flatfish catch efficiency: footrope distance off bottom, bridle length in contact with the bottom, and area swept by the net. Results indicated that the distortion of the trawl caused by asymmetry in trawl warp length could have a negative influence on flatfish catch efficiency, although determining the degree of impact would require further experimentation utilizing catch data. At a 7-m difference in warp length, the NMFS 4% threshold value for the 83-112 Eastern survey trawl used in this study, no effect was found on the acoustic-based measures of door spread, wing spread, and headrope height off bottom (Fig. 6). However, the sensitivity of the trawl to 7 m of warp offset could be seen as footrope distances off bottom increased slightly, particularly in the center region of the net where flatfish escapement is highest (Fig. 7) and the width of the bridle path responsible for flatfish herding was reduced (Fig. 8), as was the effective net width (Fig. 9). For this survey trawl, a NMFS threshold value of 4% should be considered a maximum. A more conservative value (< 4%) would likely reduce potential bias in estimates of relative abundance caused by large differences in warp length approaching 7 m.

By Ken Weinberg

MIDWATER ASSESSMENT & CONSERVATION ENGINEERING PROGRAM

Members of the Midwater Assessment and Conservation Engineering (MACE) Program participated in a Simrad EK/ER60 acoustic system user meeting with Simrad representatives Lars Andersen and Jeff Condiotty at the Center on 19 November 2004. Scientists from the Northwest Fisheries

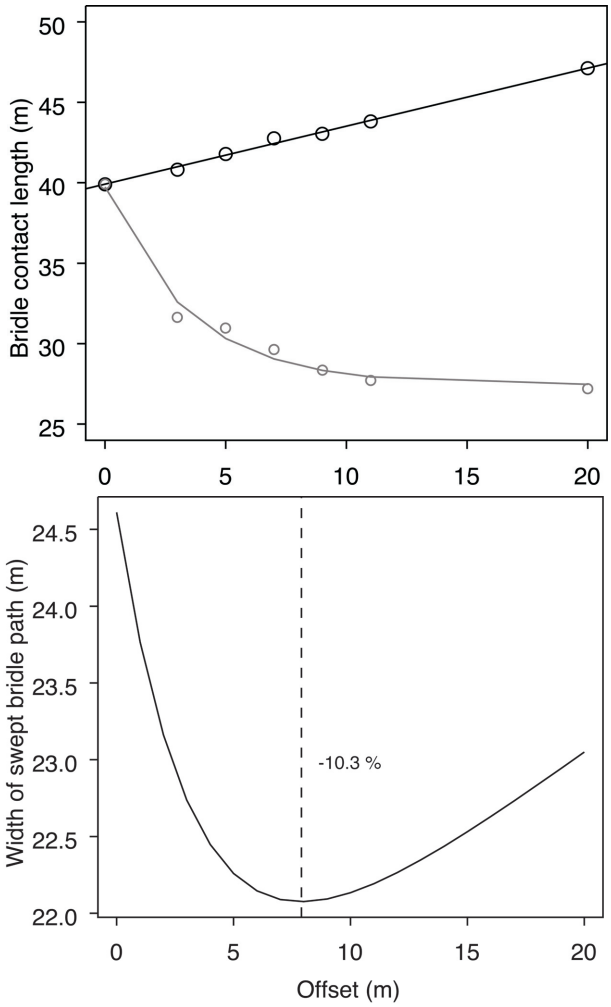

Figure 8. The length of the bridle <1 cm from the bottom is shown plotted against the offset increment in meters for both the short warp (gray line) and long warp (black line) sides of the trawl (top). Assuming that the angle of attack is the same for the long and short sides of the trawl, the width of the swept bridle path as a function of warp offset is represented in the lower panel.

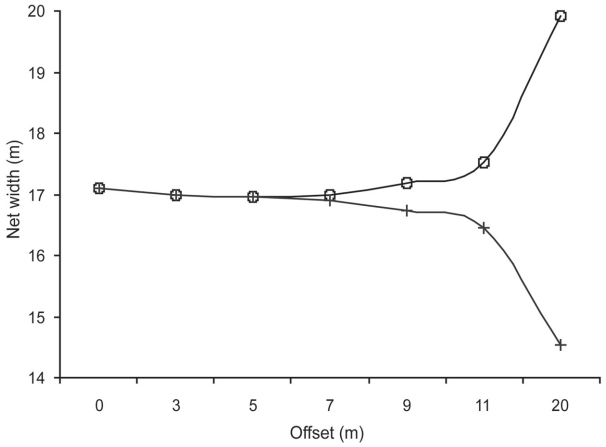

Figure 9. The mean distance between wing tips measured acoustically (O) during the experimental tows (net width) and the calculated effective net width (+) are shown plotted against the offset increment in meters. Note that there is little difference between the two measures of net width until the offset increment is increased to 9 m.

Science Center, University of Alaska, University of Washington, Canada Department of Fisheries and Oceans, and Sonardata Ltd. (Australia) also participated. Lars Andersen summarized features of the latest Simrad ER60 software and responded to questions submitted earlier by EK/ER60 users. Participants discussed: 1) potential improvements to the software; 2) results of comparisons between the older EK500 acoustic system and the new EK60; 3) test results from users that suggested an EK60 performance instability; 4) relative merits of different single target detection algorithms in scientific fisheries acoustic systems; and 5) other emerging technologies that Simrad is developing for fisheries acoustics applications. A summary report of the meeting is available to subscribers of a NMFS-sponsored EK60 user list server.

Alex De Robertis and Dan Twohig of the MACE Program participated in acoustic testing of the new NOAA fisheries research vessel, *Oscar Dyson* from 9 to 17 December. The *Oscar Dyson* has been designed and built to conform to international standards for underwater-radiated noise to minimize fish avoidance reactions to the vessel. As part of acceptance testing prior to delivery, the *Oscar Dyson* underwent acoustic testing conducted by the U.S. Navy to confirm that the underwater-radiated vessel noise levels meet the design requirements. During the Navy noise tests, De Robertis took measurements from hull-mounted hydrophones to identify sounds produced by the vessel. These baseline hydrophone measurements were compared to vibration and far-field noise measurements made simultaneously at the noise range. They will be compared with future measurements to identify changes in the underwater-radiated noise signature produced by the *Oscar Dyson* over its service life.

By Taina Honkalehto

RECRUITMENT PROCESSES PROGRAM

In response to reports of extremely high numbers of age-0 juvenile walleye pollock caught during RACE summer acoustic surveys in the Chiniak Bay area of Alaska, scientists from the Recruitment Processes Program collaborated with the Shellfish Assessment Program to collect data from several fall 2004 cruises to look at the extent of the age-0 pollock distribution and collected samples to examine condition of these fish. The samples were obtained

opportunistically because no fieldwork targeting juvenile pollock had been planned.

The first set of samples were obtained during a September cruise on the NOAA ship *Miller Freeman* from the inner continental shelf bordering the southern shore of Kodiak Island (5 tows) and in the vicinity of Sutwik Island (4 tows). The sample size was small, but there was no indication that the abundance of fish near Sutwik Island was large relative to catches at the same locations during September 2000, 2001, and 2003. The samples off Kodiak were collected by targeting echo-layers, which complicates comparisons with other data. However, there was no indication of anomalous fish size (mean standard length = 87 mm, range = 50-117 mm). The second set of samples were collected during the autumn shrimp survey conducted by the ADF&G. Ninety-two hauls were set in stations in Chiniak and Marmot Bays, Shelikof Strait, and bays along the Alaska Peninsula from Wide Bay to Sand Point. Approximately 300 fishes from 20 stations were collected, and 2,832 fishes from 73 stations were measured. Two large concentrations of age-0 pollock were found, one in Wide Bay and the other in Marmot Bay. However, there was no indication that high abundances of age-0 pollock were widespread.

By Kevin Bailey, Matthew Wilson, and Michael Litzow

RESOURCE ECOLOGY & FISHERIES MANAGEMENT (REFM) DIVISION

STATUS OF STOCKS & MULTISPECIES ASSESSMENT PROGRAM

Groundfish Stock Assessments for 2005 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., 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 (e.g., 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.

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 level (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. 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 BSAI to be less than 2 million t) are met. The following rule applies for all Federally managed groundfish species in a given year: Catch $\leq$ TAC $\leq$ ABC $<$ OFL.

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

A change in the timing requirements for conducting assessments was implemented in 2004. Based on an analysis conducted by scientists at the AFSC in coordination with the NMFS Alaska Regional Office, it was found that for longer-lived species, management advice on quotas could be based on biennial assessments. This cycle was designed to coincide with the current AFSC survey regularity (e.g., in the GOA the groundfish trawl survey is conducted in odd-numbered years). This meant

that for a number of stocks in the GOA, ABC recommendations are based on analyses presented in 2003. Additionally, in order to extend the public review period for TAC specifications, ABC and OFL recommendations were provided for both 2005 and 2006 at the December 2004 Council meeting.

Presently, the main species of groundfish are all above their target stock size (B_{msy}), and 2004 catch levels were below maximum permissible ABC levels (Figs. 1 and 2). Fisheries for these groundfish species, during 2001-03, yielded 2.1 million metric tons (t) annually, valued at $615 million. Abundance of the major stocks of walleye pollock and Pacific cod are high, but subject to variability due to recruitment fluctuations. Virtually all flatfish resources (e.g., rock sole, yellowfin sole, Alaska plaice, and arrowtooth flounder) are at high and healthy levels. Atka mackerel abundance is increasing and above average levels. Rockfish species comprise 5%-8% of the groundfish complex biomass and are at healthy and stable levels. For the main stocks with age-structured analyses, the biomass trends compared with the average levels since 1978 are shown in Figures 3 and 4 for the GOA and BSAI, respectively. These figures suggest that stock conditions are fairly evenly split between those that are above average and below in the past few years.

Gulf of Alaska

The sum of the recommended ABCs for 2005 is 539,263 t, a 6% increase from the 2004 total. In the GOA, full assessments were presented for ***walleye pollock***, ***Pacific cod***, ***rex sole***, ***shortraker/rougheye rockfish***, ***Dusky rockfish***, and ***sablefish*** whereas other stocks were based on modified projections from last year's assessments (i.e., under the new biennial cycle). The largest percentage increase was from ***pollock*** (+27%), followed by ***deep water flatfish*** (+12%), ***arrowtooth flounder*** (+11%), ***Pacific ocean perch*** (+2%), ***pelagic shelf rockfish*** (+2%) and ***northern rockfish*** (+5%). The species with ABCs that declined relative to 2004 are ***Pacific cod*** (-6%), ***sablefish*** (-4%), ***flathead sole*** (-13%), and ***demersal shelf rockfish*** (-9%). Full assessments for all GOA stocks will be prepared next year since data from the 2005 summer bottom trawl survey are anticipated.

Data limitations pose assessment difficulties for less abundant (minor) rockfish species. Together with other nontarget species, such as sharks, skates, sculpins, and octopus, accurately assessing the vulnerability of these species represents a major challenge for the agency. Effort to monitor the status of nontarget species has improved, and steps have been taken to ensure that adequate data collection programs are in place in advance of directed fishery development. In 2004, the Plan Teams and Council reviewed an update on the status report for GOA skates and made further conservation moves by separating "big" and "longnose" skate species from the aggregate complex known as "skates." GOA-wide OFLs and area-specific ABCs and TACs were thus established for "big" and "longnose" skates separate-

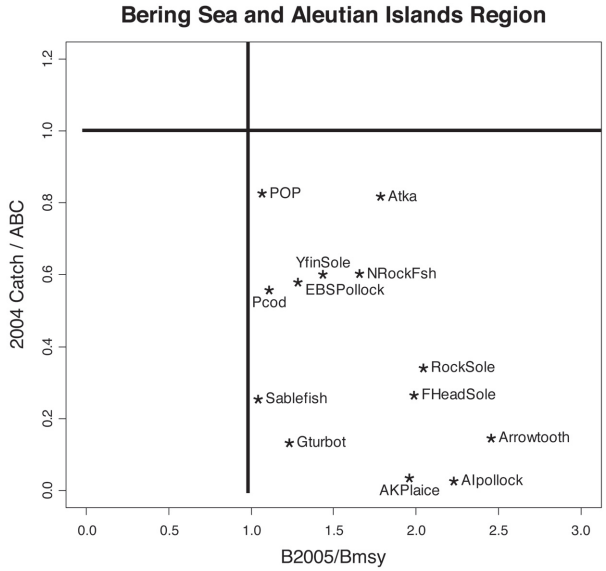

Figure 1. Relative 2005 spawning stock size compared to B_{msy} (taken to be $B_{35\%}$ for all species except EBS pollock) versus relative 2004 catch levels compared to 2004 maximum permissible ABC levels for BSAI stocks.

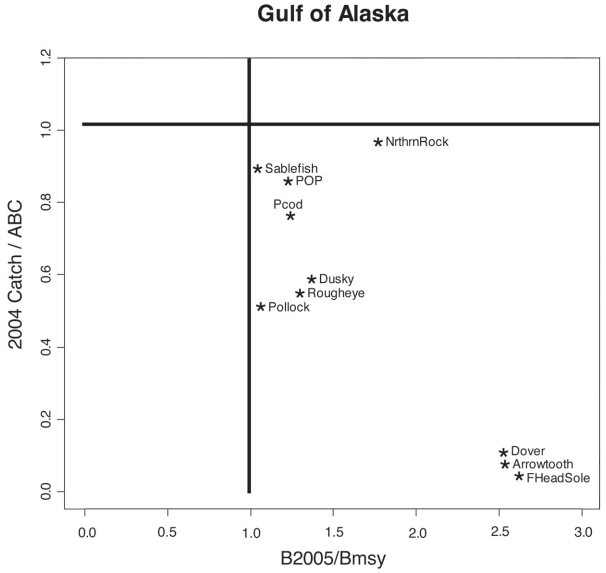

Figure 2. Relative 2005 spawning stock size compared to B_{msy} (taken to be $B_{35\%}$ for all species except EBS pollock) versus relative 2004 catch levels compared to 2004 maximum permissible ABC levels for GOA stocks.

ly. For the "other" skates (combined *bathyraja* spp.) complex, OFL, ABC, and TAC remain GOA-wide. Similarly, AFSC scientists developed a new assessment of shortraker and rougheye rockfish. This resulted in specific conservation recommendations to limit fishing mortality for each species. The Council recommended breaking out shortraker rockfish and rougheye rockfish from the combined management category. Consequently, OFLs, ABCs and TACs are specified for these rockfish species separately.

AFSC scientists expanded their efforts to incorporate issues identified in the ecosystem considerations chapter into their assessments. Simple food webs that focused on a particular assessed species were prepared for several species. The GOA walleye pollock assessment provided a preliminary assessment of the key predators of pollock in the GOA. Arrowtooth flounder, Pacific halibut, Pacific cod, and Steller sea lions were key predators of pollock. Detailed analyses of time trends in predator size-at-age revealed that pollock may be a limiting resource for species dependent on older age groups of pollock, while no evidence of prey limitation was evident in species that rely on younger age groups of pollock.

Bering Sea/Aleutian Islands

Total BSAI groundfish biomass for 2005 (17.5 million t) is down slightly from last year. Overall, the status of the stocks continues to appear favorable, although some stocks are declining due to poor recruitment in recent years. The sum of the ABCs for 2005, as recommended by the Scientific and Statistical Committee (SSC), is about 3.0 million t, approximately 575,000 t less than the sum of the 2004 ABCs. The Council recommended a 2005 ***EBS pollock*** ABC of 1.96 million t, a value below the maximum permissible level. The Council recommended a TAC for this species of 1,478,500 t. The Council reviewed and accepted a new age-structured analysis of ***Aleutian Islands pollock***. For precautionary reasons, they recommended ABC and TAC levels of 29,400 t and 19,000 t, respectively, which is well below the maximum permissible ABC level of 43,200 t. The 2004 bottom trawl survey resulted in a ***BSAI Pacific cod*** biomass estimate that is down 1% from the 2003 estimate and near the minimum for the time series. Due to a declining trend in abundance, the Council recommended a 2005 ABC of 206,000 t, below the maximum permissible level of 227,000 t. The TAC was recommended to equal the ABC for Pacific cod. The ***sablefish*** survey abundance index decreased 5% from 2003 and follows an 8% decrease between 2002 and 2003. Spawning biomass is projected to decrease slightly (2%) from 2004 to 2005. The Council-recommended ABC and TAC for the Bering Sea was 2,440 t; for the Aleutian Islands the Council recommended an ABC (=TAC) level of 2,620 t. BSAI ***yellowfin sole*** biomass increased 13% from last year, which resulted in an ABC recommendation of 124,000 t and a TAC of 90,686 t. For ***Greenland turbot,*** assessment uncertainties and stock structure issues led to a conservative ABC recommendation of 3,930, well below the maximum permissible value of 15,500 t. ***Arrowtooth flounder*** biomass remains high, and the recommended ABC was 108,000 t while the TAC was only 12,000 t (for bycatch purposes). This year's EBS bottom trawl survey resulted in a ***northern rock sole*** biomass estimate that was 18% higher than last year. Nevertheless, the stock is expected to decline, as are several other flatfish stocks, due to low recruitment in recent years. The recommended ABC was 132,000 t, and the TAC was 41,500 t. ***BSAI Pacific ocean perch*** biomass estimates suggests a moderately increasing trend, given

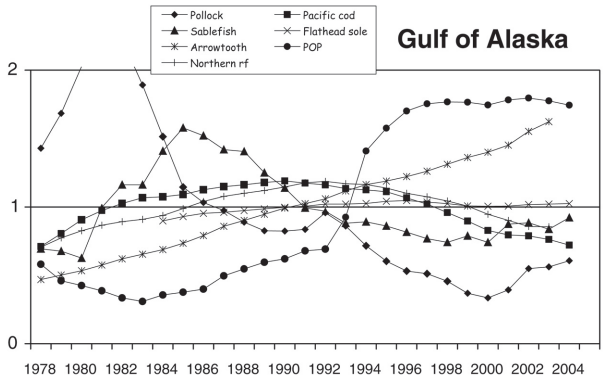

Figure 3. Biomass trends for Gulf of Alaska (GOA) stocks relative to their mean level, 1978-2004.

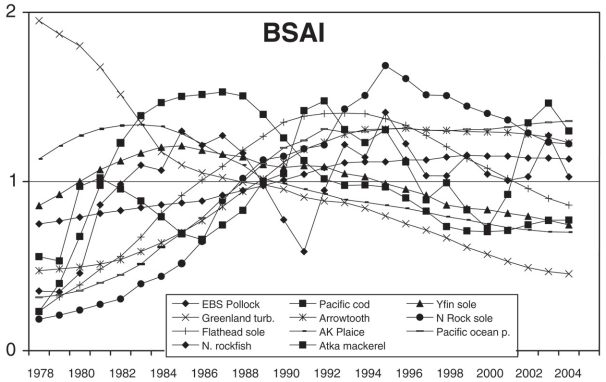

Figure 4. Biomass trends for Bering Sea and Aleutian Islands (BSAI) stocks relative to their mean level, 1978-2004.

the new Aleutian Islands survey data. The 2005 ABC recommendation increased to 14,600 t from the 2004 level of 13,300 t. The 2005 ABC recommendations for ***northern rockfish*** also substantively increased to 8,260 t from the 2004 level of 6,880 t. For the past 2 years, ***shortraker*** and ***rougheye*** rockfish species have been split to species-specific ABC recommendations. The 2005 ABC recommendations have increased by 14% from last year's levels, giving 596 t and 223 t for shortraker rockfish and rougheye rockfish, respectively. The recommended 2005 ABC of 124,000 t for ***Atka mackerel*** is up substantially (86%) compared to the 2004 level, due to new survey data and indications of recent strong year classes. The TAC recommendation for Atka mackerel was 63,000 t.

By Jim Ianelli

Atka Mackerel Tag Recovery Cruise 2004 in the Aleutian Islands, Alaska

The first objective of the Center's Atka mackerel tag release-recovery studies is to determine the efficacy of trawl exclusion zones as a management tool to maintain prey abundance 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, we released roughly 32,000 tags in Seguam Pass: 14,520 near Tanaga Island and 14,700 near Amchitka Island. A recovery charter recovered tagged fish in Seguam Pass and Tanaga Island and Amchitka Island areas.

The 2004 cruise lasted approximately 16 days, starting in Dutch Harbor, Alaska, on 7 October and ending in Adak, Alaska, on 23 October. A total of 66 tows were conducted: 32 tows in Seguam Pass, 20 tows near Amchitka Island, and 14 tows near Tanaga Island. A total of 1,485 t of Atka mackerel were examined for tags. Of these, 836 t were caught in Seguam Pass, 336 t were caught near Amchitka Island, and 313 t were caught near Tanaga Island.

During the cruise, a total of six tagged Atka mackerel were recovered: two in Seguam Pass, three near Amchitka Island, and one near Tanaga Island. Tag recovery rates were estimated by seeding the catch with tagged fish. Recovery rates were high, ranging from 90% to 100% depending on area and stratum. 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, 655 biological samples and 10,283 sexed length data were collected.

The surprisingly low number of tags recovered in all areas may have been due to the large recruitment of age-3 and -4 Atka mackerel into the population during 2003 and 2004. Budget constraints prevented the release of tagged fish during this year, so the tagged population released in the previous years was most likely diluted by incoming year classes of untagged smaller fish. 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 the Atka mackerel population dynamics.

Bob Lauth from the Center's RACE Division participated in the recovery cruise and used the fishing vessel *Seafisher* as a platform for his video drop camera system. The video drop camera was used for locating Atka mackerel nesting sites and documenting the location, depth, and habitat-type at nesting sites. There were 9 camera drops in Seguam Pass, 11 around Amchitka Island, and 3 near Tanaga Island for a total of 23 camera drops.

Real-time video feed and winch control were used to navigate the towed video camera to avoid hanging up while the vessel and camera drifted over the bottom. Video feed was recorded with GPS (global positioning system) overlay and a digital video recording device, and the drop camera was also equipped to record depth and temperature. Camera drops lasted from 10 to 60 minutes and ranged from 70 to 170 m depth.

By Kimberly Rand and Susanne McDermott

RESOURCE ECOLOGY AND ECOSYSTEM MODELING PROGRAM

Fish Stomach Collection and Analysis

Laboratory analysis was performed on 4,519 groundfish stomachs from the eastern Bering Sea, 39 from the Gulf of Alaska, and 74 from the Aleutian Islands region. During this quarter, no stomachs were returned by observers, and no stomachs were collected aboard research vessels in the Bering Sea or the Gulf of Alaska. A total of 17,746 records were added to the groundfish food habits database.

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

Seabird-Fishery Interactions Research

Interactions between commercial fishing vessels and scavenging seabirds have received increasing attention in recent years. Seabird-fishery studies in the North Pacific have focused almost exclusively on the danger to birds of accidental entanglement in fishing gear. However, studies from other oceans, particularly the North Atlantic, have demonstrated that fisheries discards and offal can positively affect seabird populations. In November 2004, we launched a new project to take an ecosystem approach to seabird-fisheries interactions in Alaskan waters. The ultimate goal is to integrate into population models for target seabird species, both the positive and negative impacts of fisheries, and to integrate these effects across multiple fisheries. The first step in the process is to map in time and space the availability to seabirds of fisheries discards and offal. Future steps will link food availability to estimated population level changes. The project is supported in part by a National Research Council postdoctoral fellowship to Dr. Ann Edwards, a recent graduate of the University of Washington, Department of Zoology.

By Shannon Fitzgerald

Spatial Distribution of Walleye Pollock in the Eastern Bering Sea

In collaboration with other AFSC scientists, Troy Buckley has been looking at spatial distribution patterns of walleye pollock in the eastern Bering Sea (EBS). The large biomass of walleye pollock in the EBS is supported by occasional recruitment of very large year classes. Hypotheses developed to link recruitment variability with climate and oceanographic conditions explain only a limited portion of the variability. Environment-recruitment relationships can be obscured by combining groups of fish with asynchronous population trajectories.

We examined the distribution of year classes over time based on age-specific catch-per-unit-effort from summer bottom trawl surveys of the EBS shelf from 1982 to 2004. The patterns in distribution of large year classes were easiest to discern because of their large signal-to-noise ratio. The distribution of the '78 and '89 year classes exhibited a high abundance in both the northwest and southeast regions of the EBS shelf, but the '82 and '84 year classes exhibited a high abundance only in the northwest region (Fig. 5). Consequently, the total number of adult walleye pollock in the northwest and southeast regions appears to fluctuate asynchronously. It is interesting that during the period from 1987 to 1990 when the '82 and '84 year classes were very abundant in the northwest region, there did not appear to be any density-dependent shift into the southeast region. Recognition of the spatial distribution of walleye pollock year classes within the EBS management area might enhance our ability to understand the relationship between environmental factors and recruitment.

By Troy Buckley

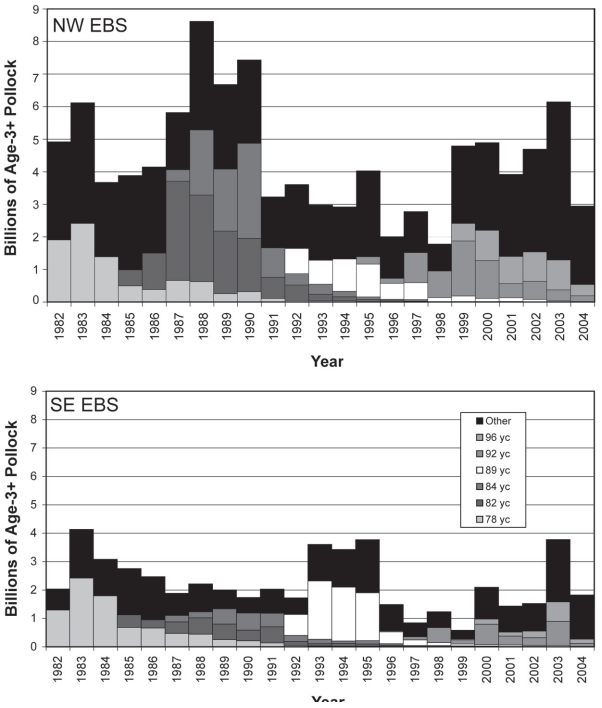

Figure 5. The number of walleye pollock, age-3 and older, in the NW and SE regions of the EBS shelf as found by the summer bottom trawl survey from 1982 through 2003. The contribution of large year classes (78, 82, 84, 89, 92, and 96) in each region are indicated in each year.

U.S. NORTH PACIFIC GROUNDFISH OBSERVER PROGRAM

Fisheries Observer Conference

Members of the North Pacific Groundfish Observer Program (NPGOP) traveled to Sydney, Australia, in November 2004 for the Fourth International Fisheries Observer Conference. Conference participants included observer program staff members, observers, and other interested parties from all over the world. The conference facilitated discussion of the roles of observer programs and various aspects of the use of at-sea observers. The NPGOP has played a key role in this biennial conference series since its inception in 1998 as the Canada-U.S. Observer Program Workshop.

The Fourth International Fisheries Observer Conference marked the first time the conference was not held on the North American continent. The presentations represented a diverse group from around the world. Globally, observer programs provide a variety of functions specific to the particular management needs for the fishery observed. While the various programs are diverse, there are certain common issues such as safety, observer support, technological approaches to monitoring, conflict with the observed fishermen and techniques to resolve these conflicts, sample design, and other important issues. The NPGOP stands out in the global arena as a longstanding quality program with high levels of coverage and substantial industry support.

Five oral presentations and four posters were presented by NPGOP staff and were well received by conference attendees. The presentations were "Observer Sampling Bias Causes, Consequences and Solutions" by W. Karp and J. Ferdinand; "The Role of Fisheries Law Enforcement in Providing Acceptable Working Conditions for Observers" by M. Loefflad; "The North Pacific Groundfish Observer Program's Staff to Sea Program" by T. Loomis; "Inseason Advising in the North Pacific Groundfish Observer Program" by J. Miles; and "A Career Path for Observers--Cadre Staff Positions" by K. Waco and J. Ferdinand.

The posters were "Preparing an Observer Program Manual" by J. Ferdinand, S. Leach, J. Miles, and L. Thompson; "Debriefing in the North Pacific Groundfish Observer Program" by K. Kruse (presented by K. Waco); "Developing an Appropriate Safety Training Program" by B. Mason (presented by J. Miles); and "The North Pacific Groundfish Observer Program's Data Quality Control System" by K. McCauley, G. Campbell, J. Ferdinand, M. Loefflad, and W. Karp.

2005 Observer Sampling Manual Available

Observer Program staff finalized the observer sampling manual for 2005 (available online at *www.afsc.noaa.gov/refm/observers/Manual_pages/MANUAL_pdfs/manual2005.pdf*). The sampling manual is updated annually with improved data collection instructions and protocols to meet new data requests. Staff also finalized new training and briefing materials designed to prepare observers for the 2005 fishing year.

Observer safety is an important part of training and briefing. For 2005, a major revision of the Observer Program's vessel safety checklist was completed. The checklist is completed by every observer on each boat they are deployed on. The list identifies critical safety equipment required onboard and prompts observers to inspect the condition of the equipment. The Observer Program received suggestions for improving the checklist after presenting the 2004 checklist to the North Pacific Fishery Management Council's Observer Advisory Committee. The program also incorporated suggestions requested from approximately fifty individuals and groups who fish in the North Pacific. The checklist and its instructions can be found in the observer sampling manual.

Information and Monitoring Technologies

Members of the Information and Monitoring Technologies staff are developing improvements to the at-sea software application observers use to enter data for near real-time transmission to NMFS. The application also supports text message communications with Observer Program staff. The custom-made application was developed by NPGOP staff and first implemented in 1997. Improvements to the application will increase flexibility for the future, ensure long-term viability, and broaden compatibility. Changes will be necessary to regulatory requirements for industry to provide computer equipment supporting the at-sea application. Project implementation is expected in fall 2005.

Field Operations

During 2004, two Observer Program staff tested brailers for collecting catch samples on trawl catcher vessels (see *Quarterly Report*, January-February-March 2004 issue). A brailer is a nylon meshed, collapsible bag used to collect a sample of catch from the trawl. Based on staff recommendations, NPGOP Kodiak field station manager Rob Swanson, worked with the brailer manufacturer to produce an improved brailer design. We expect to deploy Rob in the flatfish fishery in early 2005 to test the modified design. If the new brailer is an effective sampling tool, we plan to complete more expansive tests during the Gulf of Alaska fisheries in summer 2005.

Operations and Administration

Observer Program subtasks work in close coordination to ensure that qualified and well trained observers are deployed in various groundfish fisheries of the North Pacific. Through planning and coordination with our end users, the Observer Program works to keep each year's data collections relevant to the needs of many internal and external clients. In addition to general data collections, the Observer Program also completes a number of projects designed to meet certain specialized needs. The Observer Program ensures that our information systems are updated and current with technological changes to better obtain fisheries-dependent information within the timeframes, and of the quality, that the clients of the Observer Program need.

During 2004, 719 observers were trained, briefed, and equipped for deployment to fishing and processing vessels and shoreside plants in the Gulf of Alaska, Bering Sea, and Aleutian Islands. They sampled aboard 317 fishing and processing vessels and at 21 shoreside processing plants for a total of 36,624 days. These observers were trained or briefed in two locations. The University of Alaska Anchorage (UAA) Observer Training Center briefed 426 observers with prior experience and another 63 first-time observers were trained there, while the AFSC Observer Program in Seattle briefed 213 observers and trained 17 first-time observers. Fifty-five observers were excused from briefing because they had just completed a cruise successfully and were returning immediately to the field. The 2004 observer workforce comprised 10% new observers and 90% experienced observers.

The Observer Program conducted a total of 685 debriefings during 2004. Twelve debriefings were held in Kodiak, 305 in Anchorage, and 368 in Seattle.

By Allison Barns

ECONOMIC & SOCIAL SCIENCES RESEARCH PROGRAM

NOAA Fisheries Economics and Social Science Workshop

Members of the Economic and Social Sciences Research Program represented the AFSC at the NOAA Fisheries Economics and Social Science Workshop in New Orleans, 26-28 October. Ron Felthoven (and coauthor Catherine Morrison Paul) received first and third place awards in the scientific research category for papers on fishing capacity and productivity. Jennifer Sepez, Heather Lazrus, Christina Package, Bryan Tilt, and Ismael Vaccaro placed second in the regulatory analysis category for their paper on fishing communities.

Courtney Carothers presented "Commercial Fishing Crew Demographics of the North Pacific" by C. Carothers and J. Sepez, which analyzed the ADF&G crew member license database in order to create a demographic profile (age, gender, residency, nationality, citizenship, and year-to-year license longevity) of the people who crew on North Pacific commercial fishing vessels.

Ron Felthoven presented "Multi-Output Non-Frontier Measures of Fishing Capacity and Utilization" and "Directions for Productivity Measurement in Fisheries" by R. Felthoven and C. Morrison Paul. These papers each describe development of new methodologies to measure fishing capacity and productivity in fisheries using commonly available data.

Alan Haynie organized and led a special session on the "Economics of Spatial Fisheries Management." Alan also gave a talk based on his joint work with David Layton, entitled "Estimating the Economic Impact of the Steller Sea Lion Conservation Area."

Dan Lew presented "The Economic Value of Steller Sea Lion Protection." The presentation provided information on Steller sea lion biology, population trends, and ESA listing status; the policy importance of understanding public preferences for

Steller sea lion protection, and efforts to collect information about these public preferences through a nationwide public survey.

Christina Package presented "Fishing Communities of the North Pacific, Volume I: Alaska" by J. Sepez, H. Lazrus, C. Package, B. Tilt, and I. Vaccaro which focused on the community profiling effort by the AFSC. The presentation outlined the content of the profiles, which include the demographics of the community, history, economy, governance, facilities, and participation in commercial, recreational, and subsistence fisheries.

Economic Data Collection Programs

Center economists continued working with Alaska Regional Office and Pacific States Marine Fisheries Commission (PSMFC) staff to implement the economic data collection program that will be an integral part of the BSAI Crab Rationalization Program. During this quarter, they conducted pretests of the economic data reports that will be required by crab harvesters and processors and developed a scope of work under which PSMFC will collect the data.

Conference Papers

Chang Seung presented two papers in the 2004 National IMPLAN Conference held in Shepherdstown, West Virginia, on 6-8 October. One paper was entitled "The Fisheries Economic Assessment Model (FEAM)", which is an analytical tool used to estimate economic impacts of commercial fisheries on the West Coast and in Alaska. By greatly multiplying the possible number of harvesting and processing sector types and combinations, FEAM expands on the capabilities of IMPLAN for analyzing the economic impacts of commercial and recreational fishing activities. The second paper titled "A Review of Regional Economic Models for Alaska Fisheries" is the first formal study to provide a thorough evaluation of the regional economic models available for regional impact analysis for fisheries. This review gives a comprehensive and thorough evaluation of the existing regional economic impact models. Although the review is written for Alaska fisheries, the methodologies reviewed are applicable to fisheries in other U.S. regions.

By Ron Felthoven

AGE & GROWTH PROGRAM

Estimated production figures for 1 January 2004 through 31 December 2004

Species	Number Aged
Flathead sole	287
Alaska plaice	236
Northern rocksole	1,152
Yellowfin sole	1,359
Arrowtooth flounder	4,636
Longhead dab	223
Walleye pollock	14,899
Pacific cod	2,134
Sablefish	2,460
Atka mackerel	1,100
Pacific ocean perch	1,719
Northern rockfish	2,198
Rougheye rockfish	669
Redstripe rockfish	363
Light dusky rockfish	1,480
Dark dusky rockfish	120

Total production figures were 35,035 with 10,682 test ages and 237 examined and determined to be unageable. These figures represent a record high over the last 15 years for which statistics are available.

Charles Hutchinson presented his Master's Thesis defense at the University of Washington and has completed all requirements for his degree. The title of his thesis is "Using radioisotopes in the age determination of shortraker (*Sebastes borealis*) and canary (*Sebastes pinniger*) rockfish."

By Dan Kimura