

Alaska Sea Grant College Program Annual Report 2005

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Impacts

Progress Reports for 2006-2008 Projects

R/31-15 Analysis of the Collapse of the Kodiak Red King Crab Stock and Fishery

Gordon Kruse, Ph.D., Fishery Division, SFOS/UAF

Tom Weingartner, Ph.D., Institute of Marine Science, SFOS/UAF

While Alaska Sea Grant funding for the project did not kick-off until early 2006, we include it in this report because the PIs began work on the project in 2005 with leveraged funding from the North Pacific Research Board. The PIs held community meetings in Kodiak to describe the project and solicit feedback from fishermen who participated in the ill-fated crab fishery.

R/54-02 Developing Microencapsulated Fish Oil Powder from Alaska Salmon Oil for Nutraceutical Markets

Subramaniam Sathivel, Ph.D., Fishery Industrial Technology Center, SFOS/UAF

This project did not begin until early 2006. Sathivel has manufactured a prototype microencapsulated product that has attracted the attention of at least one seafood processor. A sample of the test product is currently being packaged.

Progress Reports for 2004-2006 Projects

R/101-04 Sea Ice Biota off Barrow, Alaska: An Important Food Source for Higher Trophic Levels in Coastal Alaskan Waters?

Rolf Gradinger, Ph.D., Institute of Marine Science, SFOS/UAF

Bodil Bluhm, Ph.D., Institute of Marine Science, SFOS/UAF

Mette Nielson, M.S. student, Institute of Marine Science, SFOS/UAF

Researchers Rolf Gradinger and Bodil Bluhm, and Alaska Sea Grant graduate student Mette Nielson of the University of Alaska Fairbanks Institute of Marine Science, collected amphipods and algae off the coast of Barrow, Alaska. They traced the isotopic signatures (^{13}C , ^{15}N) of the food sources and those of the amphipods themselves. From this information, they constructed models that show the relative contribution of ice-derived carbon to the nutrient needs of amphipods and to the overall health of the environment. Their findings confirm the importance of sea ice and that the sea ice role in the nutrient balance is declining, something that may lead to the unraveling of the arctic food web. Such knowledge is proving useful as researchers and coastal communities seek to improve predictions of how the environment may change in the face of an ever-warmer climate. The researchers are working closely with Alaska Native residents of the arctic coast and other scientists working in the region, delivering presentations on their work and forming collaborations with residents and other scientists. In turn, the scientists gained insight into the region's traditional ecological knowledge.

R/31-10 Effects of Hybridization between Seasonally Distinct Pink Salmon Subpopulations: A Model for Outbreeding Depression in Pacific Salmon (Phase 1)

Anthony Gharrett, Ph.D., Fisheries Division, SFOS/UAF
William Smoker, Ph.D., Fisheries Division, SFOS/UAF
Carrie Hoover, M.S. student, Fisheries Division, SFOS/UAF
Jesse Echave, M.S. student, Fisheries Division, SFOS/UAF

Researchers carried out 20-year studies on hybridization between locally adapted and translocated pink salmon stocks. They concluded that translocation of pink salmon stocks can result in outbreeding depression and reduce survival of local natural spawning populations. The results will be used by the Alaska Department of Fish and Game in making decisions on stock transfers. Carrie Hoover graduated in December 2005 and is currently employed by the Alaska Department of Fish and Game.

R/31-11 Multispecies Assessment Models for Fisheries Management

Terrance Quinn II, Ph.D., Fisheries Division, SFOS/UAF
Kray Van Kirk, M.S. student, SFOS/UAF

This is a collaborative project with Dr. Jeremy Collie and Rhode Island Sea Grant. The goal is to construct statistically valid multispecies models for the Gulf of Alaska, Georges Bank, and the North Sea, to further national goals of sustainable fisheries and healthy ecosystems.

Graduate student Van Kirk has obtained all necessary data on catch, surveys, food habits, and age and length structure for arrowtooth flounder, Pacific cod, and walleye pollock in the Gulf of Alaska. He is processing the food habits data for use in the model and writing up documentation for data sources and data processing.

R/95-04 Paralytic Shellfish Poisoning: Bacteria as Regulators of *Alexandrium* Growth and Toxin Synthesis

F. Gerald Plumley, Ph.D., Bermuda Biological Station
Andrew Lang, Ph.D., Institute of Marine Science, SFOS/UAF
Andrew Krohn, M.S. student, Institute of Marine Science, SFOS/UAF
Renee Raudonis, M.S. student, Institute of Marine Science, SFOS/UAF

Paralytic shellfish poisoning (PSP) is a significant threat in Alaska. It affects recreational, subsistence, and commercial harvests of seafood, and impacts the economy of the state in terms of lost revenue for commercial harvests, added health care costs, and reduced spending by recreational users. Each year, people become ill after eating PSP-infected shellfish usually collected by recreational and subsistence users from untested beaches. Occasionally, people have died after eating PSP-contaminated seafood. Alaska Sea Grant's involvement with PSP research extends back to 1993, when molecular geneticist Gerald Plumley, of the University of Alaska Fairbanks Institute of Marine Science, launched a decade-long effort to identify and characterize the genes involved in the cellular production of saxitoxin, the etiological agent of paralytic shellfish poisoning. This project represented a high-risk, high-reward undertaking. The initial work focused on bacteria, as these prokaryotic cells had been reported to produce saxitoxin. Researchers devoted considerable time to the effort, only

to show that these bacteria produce saxitoxin imposters and not true saxitoxins. Although negative data are never as exciting as positive data, the work was important, as it appears to have provided the final nail in the long-standing hypothesis that bacteria produce saxitoxins. As research progressed, Plumley, aided by numerous graduate students over the years, developed Tn5 mutagenesis strategies for bacteria that live in close associations with the dinoflagellates that produce saxitoxins. The strategy was used to identify bacterial genes involved in bacterial-dinoflagellate interactions.

Subsequent work focused on cyanobacteria. These algae initially proved difficult to grow at levels and rates suitable for molecular biological protocols, but the problems were solved and we were subsequently able to demonstrate that the algae are not readily tractable to reverse molecular genetic techniques (e.g., Tn5 mutagenesis). While the research again provided a negative result, it was nonetheless useful; their findings will help direct others toward more productive areas of research. The researchers continued to pursue other strategies with saxitoxin-producing strains of cyanobacteria and are now focused on genome mapping as a practical strategy for identification of the saxitoxin genes. Major accomplishments include (1) Providing strong evidence that bacteria associated with saxitoxin-producing strains of *Alexandrium lusitanicum* do not synthesize saxitoxins, but rather, synthesize compounds that have been misidentified as saxitoxins; (2) Development of Tn5 mutagenesis strategy for a bacterium, *Pseudomonas stutzeri*, that has been reported to form symbiotic associations with *Alexandrium lusitanicum*; (3) Identification and preliminary characterization of a histidine kinase gene in *Pseudomonas stutzeri* that plays a role in antibiotic sensitivity and, putatively, a role in regulating growth in response to co-culture with *Alexandrium lusitanicum*; (4) Development of protocols and methods for growing saxitoxin-producing strains of cyanobacteria, extracting DNA, and preliminary development of DNA libraries for genome mapping as a strategy to identify the genes involved in saxitoxin synthesis; and (5) Graduation of two fine M.S. students since 2003.

October 2005

A portion of our work has focused on identification of the genes responsible for saxitoxin production. As a “simple” genetic system, we have analyzed several toxic strains of *Anabaena circinalis*, but with emphasis on strain ACBU02. Restriction digestion and PFGE revealed a genome size of ~3.45 Mb, considerably smaller than other filamentous cyanobacterial genomes. End sequence analysis of 36 members of three random clone libraries of ACBU02 DNA constructed from HindIII, EcoRI, and NotI fragments resulted in 56,573 bp of DNA sequence data that revealed an overall GC content of 40.5% and a high level of gene conservation relative to other *Anabaena* spp. However, these analyses also revealed that ACBU02 has undergone substantial reorganization of its chromosomal gene order relative to *Anabaena* sp. PCC 7120. Several genes common to other cyanobacteria, but absent from PCC 7120, are also present in ACBU02, suggestive of substantial horizontal transfer events. Over-representation of eight GC-rich, 8-bp palindromes, including NotI and HIP1 sites, was observed in ACBU02 DNA at frequencies 7–58X those predicted for random DNA. The genome contains an unexpectedly high number of NotI sites localized in GC-rich

regions with characteristics of “junk DNA” rather than within microsatellites or other repeat elements.

Anabaena circinalis ACBU02 has been established as an axenic culture. This breakthrough has allowed us to reexamine the possibility of creating a Tn5 mutagenesis strategy for identification of the saxitoxin genes. Very recent, and still preliminary findings, indicate that a Tn5 mutagenesis (along with appropriate complementation protocols) have been developed. Briefly, appropriate helper and cargo plasmids (bearing DNA methylase genes and antibiotic resistance determinants, respectively, appropriate for ACBU02) have been optimized for reverse molecular genetic analysis of *A. circinalis* ACBU02. Matings with *E. coli* carrying Tn5 vectors with Kmr determinants are rapid and generate several hundred transconjugants per experiment that can be individually selected on agar plates containing Km. Transconjugants can be grown in small volumes (30 mL or less), providing ample material for cryopreservation of aliquots, with the remainder of each sample subjected to toxin analysis via HPLC. Initial screening of mutants at 10X coverage will take an estimated 24 days, calculated under the assumptions that the genome size is ~3.45 MB, the size is ~20,000 bp (i.e., 20 genes X 1,000 bp/gene), and an HPLC protocol requires 20 min/run. Lethal mutations will reduce the time frame; however, the need to periodically run standards will compensate. DNA flanking the Tn5 insertion site can be recovered as either PCR fragments (using outward facing primers) or as plasmids (i.e., the Tn5 element contains an *E. coli* origin of replication that can be maintained with flanking DNA based on digestion/ligation with one of four restriction enzymes). Analysis of DNA at Tn5-generated mutation sites will allow unambiguous identification of the genes involved in saxitoxin synthesis in the cyanobacterium as well as in *Alexandrium tamarensense* and *Alexandrium catenella*, the causative agent of PSP in Alaska.

We have now constructed *Pseudomonas* SF/PS strains with disruptions in all three of the genes in the previously described operon. The three mutant strains were created by deleting large amounts of the respective gene sequences. These mutants are being examined for their growth properties relating to cation-dependent antibiotic resistance. In *Pseudomonas* SF/PS and *P. aeruginosa*, ompR and envZ are neighboring genes. *Pseudomonas* SF/PS, however, contains the additional gene (orf3) downstream of ompR and envZ. This third gene encodes four different conserved protein domains, one MASE1 (membrane-associated sensor) domain, three PAS domains, and one each of GGDEF and EAL domains. The architecture of these conserved domains in the protein defines a family of conserved hypothetical proteins encoded in some bacterial genomes. *P. aeruginosa* contains a predicted protein with this architecture, located directly downstream of the genes encoding the His-Asp phosphorelay PhoP-PhoQ proteins. PhoQ has been extensively studied in *Salmonella* where it is known to be a membrane-based sensor of extracellular Mg²⁺ and Ca²⁺, and in *P. aeruginosa* the PhoP-PhoQ system responds to Mg²⁺ concentration and regulates antibiotic resistance. These observations suggest a functional link between the particular domain architecture found in this orf3, divalent cations (Mg²⁺ and Ca²⁺), and antibiotic resistance.

As mentioned in a previous report, three other genes from the bacterium have been sequenced to define the relationship of this bacterium to other species of *Pseudomonas*. This bacterium was originally classified as *P. stutzeri*, but the comparisons of the sequences from the 16S rRNA, rpoD, and gyrB genes indicate that this bacterium is more closely related to *P. pseudoalcaligenes* than it is to *P. stutzeri*.

R/97-01 A Model System to Examine Delayed Effects of Pollution Exposure

Michael Stekoll, Ph.D., Fisheries Division, SFOS/UAF
Corinne Hicken, M.S. student, Fisheries Division, SFOS/UAF

Two oil exposure experiments were begun. The first had only two replicates because only two females were fecund. The second experiment had five replicates, and the data from that experiment is included in the extra information. There was a significantly higher incidence of pericardial and yolk-sac edema in zebrafish exposed to the 50%, 75%, and 100% oil doses (ANOVA, $p < 0.05$). Also, time to 50% hatch was accelerated in the intermediate 5%, 25%, and 50% oil doses (ANOVA, $p < 0.05$). This result was unexpected, and has not been reported in any known literature.

R/31-12 Larval Advection and Retention of Alaskan Dungeness Crab: Interactions in Phylogeography and Stock Structure

Tom Shirley, Ph.D., University of Texas
Wongyu Park, Ph.D. student, Fisheries Division, SFOS/UAF

Wongyu Park received Alaska Sea Grant funding through a Center for Global Change Student Fellowship in 2003 (GC/03-01) and has continued his research under this project. Larvae collections in Glacier Bay were made biweekly at five stations both in and outside the upper bay between May 27 and September 9, 2004, for a total of nine sampling trips. Variances in larval occurrence timing was observed; larvae collected from colder waters were in earlier stages, while those collected in warmer waters were in later stages. Larval abundance of Dungeness crabs were highest at the station that reported the highest adult population.

R/51-03 Quality Inspection of Alaska Salmon Using Two Portable Odor Detection Devices

Alexandra Oliveira, Ph.D., Fishery Industrial Technology Center, SFOS/UAF
Charles Crapo, Ph.D., Fishery Industrial Technology Center, SFOS/UAF
Brian Himelbloom, Ph.D., Fishery Industrial Technology Center, SFOS/UAF
Jiraporn Chantarachoti, M.S. student, Fishery Industrial Technology Center, SFOS/UAF

Alexandra Oliveira, an Alaska Sea Grant researcher at the University of Alaska Fairbanks Fishery Industrial Technology Center, together with master's degree student Jiraporn Chantarachoti, and aided by Alaska Sea Grant seafood quality specialist Chuck Crapo and FITC seafood microbiologist Brian Himelbloom, tested commercially available electronic noses to see how they might be used to boost seafood quality in Alaska's processing plants. Two commercial sensors, the zNose and Cyranose 320, were evaluated. The portable devices are similar in some respects to breathalyzer machines used to detect alcohol on the breath of a suspected drunk driver. Initially the devices were used to detect ethanol, a type of alcohol associated with spoiled canned

salmon. Later, the devices also were to be used to test for other chemicals associated with spoilage and to evaluate the freshness of salmon being delivered by fishermen to the processing plant. Researchers in the study established detection parameters for the devices that will help processors cut costs and improve the quality of finished products. While numerous problems were found with the zNose, the researchers found that correct odor classifications were detected 85-92% of the time by the Cyranose 320 when used to “sniff” pink salmon belly cavity odors. A manuscript detailing the technical findings was published in the *Journal of Food Science*. Chantarachoti was awarded the best student oral presentation during the 2005 AAAS Alaska Chapter meeting in Kodiak, Alaska. Chantarachoti also presented her findings on the ethanol levels found in canned salmon samples at the National AAAS meeting in 2005. In addition, she presented these findings at the 2005 Institute of Food Technologists Annual Meeting in New Orleans, and successfully defended her thesis in June 2006.

R/54-01 Developing Protein Powder and Edible Coating for Salmon from Underutilized Arrowtooth Flounder

Subramaniam Sathivel, Ph.D., Fishery Industrial Technology Center, SFOS/UAF

Charles Crapo, Ph.D., Fishery Industrial Technology Center, SFOS/UAF

Brian Himelbloom, Ph.D., Fishery Industrial Technology Center, SFOS/UAF

Mary Patterson, Undergraduate student, Fishery Industrial Technology Center, SFOS/UAF

The Gulf of Alaska contains more than 2.8 million tons of arrowtooth flounder. But commercial harvests are low because the flesh turns to mush when cooked. Alaska Sea Grant-funded scientist Subramaniam Sathivel of the University of Alaska Fairbanks Fishery Industrial Technology Center and undergraduate student Mary Patterson, together with Alaska Sea Grant seafood quality specialist Chuck Crapo and FITC seafood microbiologist Brian Himelbloom, conducted research to turn arrowtooth flounder flesh into a powder that can be used to make tasty breadings, spreads, and other coatings for salmon. Scientists produced protein powder from the flounder and evaluated attributes such as appearance, function, nutrition, and shelf life. Based on these results, a manuscript was published in 2004 in the *Journal of Food Science*.

In 2005 follow-up research, scientists prepared edible coatings and further evaluated the coating's properties. These findings also have been submitted to the *Journal of Food Science*. Patterson was selected as a finalist in the Institute of Food Technologists undergraduate research paper competition held during the 2004 Institute of Food Technologists and Food Exposition. Her presentation, “Developing Arrowtooth Flounder Protein Powder Mayonnaise” was awarded honorable mention. Finally, researchers plan additional studies to evaluate the powder coatings as coverings on salmon fillets.

During 2005, portions of objectives two and three—(2) preparing an edible coating from the arrowtooth flounder protein powder and characterizing its properties, and (3) evaluating the quality of protein-coated salmon fillets during storage—have been completed and a manuscript has been published in the *Journal of Food Science*. An abstract of Mary Patterson's paper was submitted for the Phi Tau Sigma Undergraduate Paper Competition and was selected as one of the finalists.

At the time this report was filed, researchers had begun working with two Kodiak processors to test prototype arrowtooth coatings on salmon filets. The Alaska Fisheries Development Foundation also has expressed interest in advancing this product in markets within China.

R/72-01 Combining Traditional Ecological Knowledge with Fisheries Science to Facilitate and Guide Partnered Management and Studies on Anadromous Whitefish

Gordon Haas, Ph.D., Fisheries Division, SFOS/UAF
David Runfola, M.S. student, Fisheries Division, SFOS/UAF

Whitefish are an important subsistence food for many rural Alaskans. Alaska has eight species of whitefish, from the large sheefish, which can reach several feet in length and weigh 60 pounds, to the pygmy whitefish, which rarely exceeds eight inches in length and weighs just a few ounces. As a group, whitefish are not well understood by fisheries managers. However, Alaska's Native people know a great deal about whitefish, and Alaska Sea Grant-funded scientists have tapped into that knowledge. Alaska Sea Grant researcher Gordon Haas from the University of Alaska Fairbanks, Institute of Marine Science, and graduate student David Runfola collaborated with Native subsistence fishermen on the Yukon River delta to gather local traditional ecological knowledge of whitefish. Runfola has conducted traditional ecological knowledge interviews with seven individuals and spent time in the field with some of them. Each interview subject was considered by their communities to possess extensive knowledge of local whitefish fisheries and traditional subsistence harvest strategies. Subjects provided observations in the course of the interviews that gave insights into unknown or poorly understood biology and life history for a number of whitefish and other fish species. They also described traditional harvest strategies and management of local fisheries, and voiced their own concerns and thoughts regarding current management issues and changes in whitefish populations.

A/161-01 Education Services

Kurt Byers, Alaska Sea Grant College Program, SFOS/UAF

Education Services produced seven new books, several revised editions of pre-existing publications, and 11 new brochures and booklets, ranging from very technical, resource management subjects to information aimed at children and the general public. Returning our publications staff to full strength, we hired Jen Gunderson to fill our vacant publications specialist position.

In collaboration with the Marine Advisory Program, we published the first in a new educational newsletter series, *Alaska Seas and Coasts*. Each issue highlights a single important marine resource topic, the first of which was the status of Steller sea lions. Founding National Sea Grant director, Dr. Bob Abel, said that this issue is "...just one example of a superbly interesting and informative document [from Alaska Sea Grant]. I hope you won't mind my using it as a strong reference in my northern ocean-related lectures."

Our 2005 media relations efforts yielded 11 Arctic Science Journeys Radio programs, 17 news releases and media advisories, and a feature article on shellfish farming, which appeared in *Alaska Business Monthly* magazine, widely read by top Alaska business and government people. An article on the collapse of Alaska's red king crab stocks appeared in the January 2006 issue of *Alaska Business Monthly*. The University of Minnesota Center for Advanced Research on Language Acquisition selected several Arctic Science Journeys Radio stories to use for teaching English as a second language.

We launched a new media outreach and visibility effort through sponsorship of Fish Radio, a highly respected, independently produced radio program on Alaska commercial fisheries, which targets thousands of our commercial fisheries constituents. In addition, several Fish Radio stories focused on Alaska Sea Grant work, including interviews with Alaska Sea Grant personnel. Fish Radio stories also appear weekly in newspapers across the state.

On the publications and video distribution front, we created the national Sea Grant network's first-ever sales and marketing coordinator staff position, filled by Kathy Kurtenbach. Upon hiring, her efforts resulted in a nearly instant significant increase in distribution of our educational materials and sales revenue.

Education Service and Administration staff developed a publications ordering and invoicing database, which went on line in spring 2005. The new database enables quicker processing of orders, easier tracking of sales, easy solicitation of publication and video buyer feedback for impact and quality evaluation purposes, and more accessibility to publications data by all staff.

Our Web site page count exceeded 1,600, and we embarked on a complete redesign of our site, including the seamless melding of the Marine Advisory Web site with the main Alaska Sea Grant Web site, and the creation of a marine education resources section.

On the international level, we coordinated the Lowell Wakefield Fisheries Symposium, Biology, Assessment, and Management of North Pacific Rockfishes, held at the American Fisheries Society national conference in Anchorage. And we became a major sponsor of the Fisheries Policy Forum at the annual ComFish Alaska Trade Show and Fisheries Policy Forum in Kodiak, gaining exceptional visibility with a concentration of key commercial fisheries constituents from industry and government.

Alaska Sea Grant produced a promotional brochure for the Alaska Ocean Observing System (AOOS). The brochure won a top national prize for design and content. Other books and videos accounted for 11 national awards for design and content in 2005 competitions.

Education Services continued development of marine education resources Web pages—including draft content for home page and structure of subpages. Education

Services also continued involvement with National Ocean Sciences Bowl, maintaining and updating the Alaska-NOSB Web site.

A/152-22 Fisheries Extension Enhancement (FEE) for Alaska: Two Projects—Fisheries in Transition and Capacity Building for Environmental Monitors

Brian Allee, Ph.D., Director, Alaska Sea Grant College Program, SFOS/UAF

Paula Cullenberg, Leader, Alaska Sea Grant Marine Advisory Program, SFOS/UAF

The Fisheries in Transition project is a joint effort of two new Alaska Sea Grant Marine Advisory (MAP) agents hired under the National Sea Grant Fishery Extension Enhancement initiative. They, along with existing agents and specialists, provided coastal fishermen with information and assistance to make positive changes in their industry. This effort began in 2004 and over the past two years, these efforts have built a well-rounded extension program responsive to the ongoing and future needs of the Alaska seafood industry.

- Technical assistance to the seafood industry in areas such as seafood processing training and product development, marine safety training, direct marketing resources, and business management is a traditional MAP extension function. In 2005, Torie Baker continued to oversee development of the Alaska salmon curriculum and led the logistics of the USDA Trade Adjustment Assistance Program (TAA) technical assistance training program. TAA is a federal price and technical assistance support program for U.S. commodities negatively impacted by foreign imports. In Alaska, with the largest number of program applicants nationally for TAA, delivering this mandatory in-person business assistance required coordinating nine MAP faculty to provide instruction to nearly 4,900 Alaska fishermen via 234 workshops in 80 remote Alaska communities. MAP accomplished this in a five-month period, as required by the program filing deadlines, and workshop evaluations from 2,300 participants continue to inform MAP program priorities. This success led to the two-year extension of the program to the current Trade Adjustment Assistance Intensive Technical Assistance (ITA) program for Alaska fishermen. As part of this program, FEE agents along with other agents have developed tools, resources, workshops, and training classes on fisheries financial planning and business management offered regionally and statewide. This 2-year project will engage over 4,500 fishermen who previously applied for TAA benefits in expanded training opportunities in the areas of direct marketing, boat operation efficiencies, etc. Baker and Sunny Rice are co-PI's for the Alaska ITA program.
- The fishing fleets in Alaska are reflecting national population aging trends. MAP is responding specifically to constituency requests for guidance in business transfer and estate planning. Working with a group of professional fishermen, financial planners, bankers, insurance agents, agency personnel, and lawyers, Rice has written *How to Make a Directed Transfer of Your Fishing Business*, a topical guide based on a similar series for farmers by University of Minnesota Extension. Alaska Sea Grant published the guide in August 2006. A workshop

featuring Rice and four contributors was taught in Petersburg in January 2006. Similar workshops will take place at the Pacific Marine Expo in Seattle in November 2006 and throughout next winter in Dillingham, Cordova, Anchorage, and Kodiak.

- Fishing business recordkeeping materials have been available through MAP for many years. A 1988 MAP publication providing business spreadsheets designed exclusively for fishermen is being updated into an interactive electronic (Excel) format. Baker is developing an electronic tool for creating business plans in collaboration with University of Minnesota Extension, bankers, and fishermen. These products will be produced and introduced in business bookkeeping workshops in late 2006 or early 2007. A simpler version for single-fishery business and users without computer access will be produced in paper form early in 2007.
- MAP produced a 50-page sourcebook for fishing businesses and processors listing agency, nonprofit, and commercial resources entitled *Business Resource Guide for Alaska Fishermen: A Source Book of Marine-Related Services and Information* in hard copy and a searchable Web-based directory. Alaska Sea Grant published the guide in 2006.
- Reducing the number of commercial fishing fatalities and injuries on Alaska waters through education and training has long been a MAP program priority. Several MAP faculty are certified USCG onboard safety drill instructors. In collaboration with the Alaska Marine Safety Education Association, Baker has taught three onboard safety drill and diver 18-hour certification training courses to over 40 fishermen, recreational boaters, and educators in the Cordova region.
- MAP materials on general fishing skills are being used extensively in local trainings. For example, Baker partnered three times in 2005 with a local gear store to teach net mending and hanging. The MAP publication *Gillnet Hanging* and a similar Oregon Sea Grant publication are the class texts. Sixty fishermen and crew have participated in these five-day courses; a number of young high school students took the course resulting in summer employment. By general request, a fourth class is being offered in October 2006 and another will be held in spring 2007 in Petersburg. Similarly, at the request of a local fisherman, Rice hosted a speaker from the National Weather Service in Petersburg to explain marine weather forecasting in a workshop in January 2005 titled *Weather for Mariners*.
- Bycatch issues in Alaska fisheries are various and unique. One of the biggest success stories in seabird conservation took place in 2005 in the offshore Alaska longline fisheries with the development of streamer lines to prevent diving birds from attacking baited hooks. MAP produced an internationally distributed streamer line deployment training video *Off the Hook* in cooperation with Washington Sea Grant researchers. With the use of streamer lines now in

regulation for larger vessels, additional research was needed to determine appropriate deterrents for smaller nearshore vessels. Rice and Baker conducted a two-year collaborative statewide seabird bycatch avoidance demonstration project, working with longline fishermen to develop and test small boat methods. Collaborators included fishermen from throughout Alaska, Washington Sea Grant staff, U.S. Fish and Wildlife Service managers, and NMFS staff. Rice presented a project report to the North Pacific Fishery Management Council in June 2006 to inform discussion on regulation changes. Results of this work have been extended to the scientific community through posters presented at the Alaska Marine Science Symposium and at the annual meeting of the Pacific Seabird Group in early 2006. Rice presented an overview of the project to graduate students at the UAF School of Fisheries and Ocean Sciences in April 2006. Baker briefed National Sea Grant, NOAA line officers, two congressional staffers, and several national NGO staff in Washington, D.C., in March 2006. Baker and Rice continue to monitor the progress of proposed regulation changes at the North Pacific Fishery Management Council, and will provide additional research with the small boat fleet as needed.

- As a direct result of Rice and Baker's work with small vessels in this area, funding was extended from the U.S. Fish and Wildlife Service to cover the design, production, and free distribution of lightweight streamer lines. These lines were designed specifically for the small boat longline fleet as a result of collaborative research with fishermen. Collaboration continued with NMFS, Washington Sea Grant, U.S. Fish and Wildlife Service, and Pacific States Marine Fisheries Commission as well. As of March 2006, 449 lines have been distributed through a coastal network of distribution points identified by the FEE agents, along with a sheet of tips from fishermen for using the lines, compiled by Rice.
- Whale depredation on black cod longline gear has been an increasing event in some Alaska waters. Reporting on the work of University of Alaska Southeast scientist Jan Straley and MAP faculty researcher Kate Wynne, MAP hosted presentations on sperm whale and longline interaction research in Anchorage, Homer, Petersburg, and Cordova in early 2006. While there is not a bycatch concern in this fishery, fishermen are interested in preventing depredation of black cod by sperm whales. Nearly 80 people attended the presentations. As a result, both researchers reported high level discussions with longline fishermen that have further informed their work.
- Direct marketing of seafood by fishermen is increasing in Alaska. MAP has been on the leading edge of this growing trend since the mid-1990s. Along with providing quality handling and marketing training workshops, one of the cornerstone publications widely used is MAP's *Alaska Fishermen's Direct Marketing Manual*, produced in cooperation with Washington and Oregon Sea Grant. Now in its second edition, the manual has been used in seafood quality and direct marketing workshops in Cordova, Valdez, Petersburg, Dillingham,

Kenai, Wrangell, and King Salmon. These workshops continue to be available upon request. In 2005, Alaska and Washington Sea Grant collaborated to update and reprint the *Alaska Fishermen's Direct Marketing Manual*.

- MAP trainers have taught more seafood processing sanitation, HACCP, and Better Process School classes than anyone else in the nation. These classes are seasonally offered in communities in response to demand. Over the last two years, Baker and Rice have arranged five trainings for a total of 38 participants in their regions. “Just in Time” quality and handling training workshops for the processing sector, co-sponsored with the Alaska Seafood Marketing Institute, continue to be offered by MAP faculty partnering with other trainers. Community seafood processing teaching materials and classes include units in
 - Halibut handling, processing, and packaging.
 - Quality handling of salmon—chilling, reducing gaping and bruising, quick delivery times.
 - Processing and packaging salmon fillets.
 - Extracting roe.
- Starting in 2005, Baker established an annual onboard salmon quality handling seminar series for fishermen coinciding with the beginning of the local salmon harvest seasons in Prince William Sound. Baker has included several guest speakers addressing effects of rigor, bleeding techniques, chilling and slush systems, thermal tracking of seafood shipments and bacterial contamination. This continued in 2006, when Rice added similar seminars in two Southeast Alaska ports.
- Translating regulatory intent into fishermen’s language is another way MAP is assisting harvesters to decide about adding direct marketing to their operations. In cooperation with agency regulators, other direct marketers and seafood processing trainers, Baker has authored a MAP Sea Gram titled, *Getting Ready for a DEC Inspection: Tips for the Small Vessel Direct Marketer Who Is Processing Onboard*. At the request of a local fishermen’s association, this year Baker authored an article on vessel cleaning and sanitation distributed to over 900 area fishermen.
- Research and development of information for fishermen so that they may optimally utilize the anticipated reemergence of harvestable quantities of cold-water prawns (*P. borealis* and related species) and other species in Alaska waters is an identified need. Rice is planning a workshop addressing the loss of pink shrimp markets for Southeast Alaska in November 2006. Similarly, other species such as dog and salmon shark are being reviewed as appropriate. Baker hosted a UAF researcher in a public lecture on the history of dog shark fisheries worldwide, management challenges, and life cycle/reproduction dynamics. Fifty-two people attended the presentation.

- Communities are seeking ways to diversify seafood market opportunities with infrastructure enhancement. In 2005, Rice joined with the Petersburg Economic Development Council and helped successfully secure construction funding for a community cold storage facility for use by local processors and direct marketers. Funding was provided through a grant from the Alaska Department of Commerce, Community, and Economic Development, and by the voters of Petersburg through their Economic Development Fund. In August 2006, the cold storage facility was completed and ready to freeze and store fish. Rice chairs the Cold Storage Oversight Subcommittee, which sets operating policies and management hiring. Similarly, Baker is serving on the board of directors of a “community kitchen” project in Cordova which will include a cold storage and value-added processing facility for locally harvested seafood; she is bringing university-wide resources to help complete an economic and plant feasibility study this fall.
- Building diversified leadership within the processing and harvesting sectors is of vital importance to the future of the Alaska seafood industry, but is recognized as challenging. Processing work in Alaska is seasonal and fast paced and harvesters are often involved in several seasonal fisheries dispersed over remote geographic areas. In early 2006 MAP, in partnership with state officials, instituted a processor management training initiative. The Alaska Seafood Processing Leadership Institute (ASPLI) is a three-week industry-sponsored training program taught by MAP faculty covering value-added processing, marketing, international logistics, and plant management. Breaking new training ground, Rice and Baker are currently working with a harvesting sector steering committee to develop a fishing association sponsored leadership summit for young fishermen in January 2006 in Anchorage. As current fisheries leaders retire, younger fishermen need to acquire leadership capacity. The focus of this conference will be familiarization with communication, networking, and fishing business leadership skills, as well as gaining specific understanding of Alaska fisheries management and policy development.
- Program leadership building is a priority within MAP. In 2005, two MAP faculty members, including Baker, participated in the inaugural National Sea Grant Extension Academy in Washington, D.C., and Pensacola, Florida. As a result of her participation, Baker was asked to join the committee planning the national FEE meeting in Jacksonville, Florida, in November 2006, where she is coordinating the conference poster and products session for an estimated 150 attendees and presenting on Alaska direct marketing.
- Alaska, Washington, and Oregon fishing fleets and processors intermix in seasonal cycles throughout the Alaska and Pacific Northwest coasts; the region’s Sea Grant programs also share a long history of cooperative research and extension activities. For example, Rice, Baker, and Liz Brown, the Dillingham MAP agent, participated in the regional meeting of West Coast FEE agents in Astoria, Oregon, hosted by Oregon Sea Grant in July 2005. All three agents have

subsequently utilized that professional network extensively on topics such as rockfish release techniques, cod pot viability, and uses of fishermen focus groups.

- MAP faculty members regularly participate in symposium coordination at national and regional professional conferences such as the annual American Fisheries Society national conference and the National Seafood Technologist Conference. Baker and Brown participated in this year's planning committee for National Sea Grant's AFS symposium, and Baker is coordinating a symposium poster that has been accepted, on TAA extension activities in Alaska, Washington, and Oregon as a response to fishery changes.
- Alaska Ocean Observing System (AOOS) outreach and extension activities for area stakeholders are being developed in 2006 in cooperation with MAP. FEE faculty members have joined with AOOS staff to guide AOOS region extension activities in Prince William Sound, Bering Sea, and Southeastern Alaska. Baker facilitated a distance delivered roll-out of the AOOS Web site for Prince William Sound this spring by linking four regional sites via audio and a common Internet link, and she organized user feedback to AOOS Web designers. Baker and Program Leader Paula Cullenberg are serving as coordinators.
- Because of its relationship with university and other researchers, MAP is able to provide venues for scientific reporting of marine research of interest to the general public. Regional examples of MAP initiatives and partnerships include weekly community lecture series in Dutch Harbor and Cordova, where a combined number of 120 lectures by marine researchers were attended by over 1,200 people in winter 2005-2006. Rice began a similar project in 2006 in Petersburg. In partnership with the Petersburg Marine Mammal Center, she helped host the Petersburg Summer Science Series. Marine mammal and other researchers and professionals provided talks to the general public in one weekend series and at several brown-bag lunch sessions.
- Alaska Natives and other longtime residents are a vital component of marine literacy outreach activities; MAP faculty are broadly involved in supporting inclusion of Native and local ways of knowing in management and research initiatives. MAP faculty members serve on national and regional committees involved in management of marine resources of importance to subsistence lifestyles. In early 2006, Baker assisted a local Native organization in devising a week-long curriculum for training research field technicians prior to the field season. This training included scientific protocols and practical survival skills, as well as culturally appropriate conduct. She taught an Alaska fisheries management orientation unit for the training.
- As ecosystem-based fisheries management becomes a reality, MAP seeks innovative uses of technology to increase communication among scientists, researchers, and managers. In a novel project, this year Baker led Prince William

Sound researchers and managers to compile a Web-based project inventory of over 100 ongoing local marine-related projects including project descriptions, contact information, collaborators, and project duration. The inventory is being revised biannually and used as a resource clearinghouse among the research community.

Final Reports

A/152-04 Assortment Analysis of Hong Kong Seafood Products

Quentin Fong, Ph.D., Alaska Sea Grant Marine Advisory Program, SFOS/UAF
Chuck Crapo, Ph.D., Alaska Sea Grant Marine Advisory Program, SFOS/UAF

Attributes of seafood items and products with seafood as main ingredients from five supermarket chains (39 stores) were recorded in November and December 2001, 2002, and 2003. The recorded attributes consist of brand (e.g., Amoy shrimp Hagow), product form (e.g., frozen fillet), country of origin, packaging (e.g., boxed), price, and unit weight. This information is being used to help producers of seafood products in the United States and U.S.-affiliated territories understand price points and retail packaging requirements, and to assess branding strategies of potential competitors in the Hong Kong market. With concurrent projects in Hong Kong and China, the results of this project will help Alaskan and U.S. exporters determine what strategies to pursue in developing markets in Hong Kong and the southern areas of China.

A/152-05 Herring Market Survey

Quentin Fong, Ph.D., Alaska Sea Grant Marine Advisory Program, SFOS/UAF
Terry Johnson, Alaska Sea Grant Marine Advisory Program, SFOS/UAF

A scientific mail survey identified consumption patterns, price, and quality preferences among users of herring products in Belgium, Germany, and France. Overall results indicate two main product form preferences in two market segments. In one market, raw pickled herring with butterfly flaps containing 18 to 20% fat were preferred. In this segment, a size preference of 4/6 flaps or 6/10 flaps per kilogram was found. In the canned herring segment, the preference was for lower fat content, less than 16%, and an assortment of different sized flaps.

A/152-06 Technology Transfer to Enhance Seafood Plant Productivity

Ed Kolbe, Food Innovation Center, Oregon State University

Experiments at seafood processing plants showed that freezing times were reduced by 30% with freeze-friendly packaging, air flow balance through blast freezers, and fan speed reduction to increase energy efficiency, plant productivity, and product improvement. A manuscript will soon be published as a book by Alaska Sea Grant, targeting seafood processors.

A/152-13 Development of Voluntary Guidelines for Marine Wildlife Viewing

Terry Johnson, Alaska Sea Grant Marine Advisory Program, SFOS/UAF

As of June 2005, Johnson delivered presentations on the project to develop voluntary guidelines for marine wildlife viewing to constituencies (charter operators, guides, sea kayakers, tour operators, and tour employees, and the general public) in Anchorage, Seward, Homer, Kodiak, Petersburg, and Juneau. More than 135 people attended.

R/101-02 Generalized Models of Local Depletion for Walleye Pollock in Steller Sea Lion Critical Habitat

Terrance Quinn, Ph.D., Fisheries Division, SFOS/UAF

Brian Battaile, Ph.D. student, Fisheries Division, SFOS/UAF

Brian Battaile received his Ph.D. in spring 2005. The major result from the DeLury analysis is that statistically significant local depletion of pollock was detected in many areas of the Bering Sea. Cumulative depletion over a season was inversely related to initial biomass, total catch, and total effort, indicating that depletion is detected more easily in areas of low abundance and consequently lower catch and effort, a surprising result. Estimates of depletion are much smaller than the overall depletion from annual stock assessments, suggesting that hyperstability in commercial catch-per-unit-effort is present and that estimates are relative indices of depletion, not absolute quantities. Analysis also suggests that measures taken in 1999 and beyond to disperse fishing effort in time and space may have been effective in reducing local depletion, and that pollock may repopulate an exploited area in a relatively short time period of weeks.

The final work on this project is being completed. Three publications have been prepared to date, of which two are in the review or publishing process. These three publications constitute three of four chapters of Brian Battaile's dissertation. The fourth chapter of Battaile's dissertation is a Bayesian hierarchical model that builds on results from the DeLury model in chapter 3. A key feature of the model is the use of spatial autocorrelation to link different spatial units together in a unified analysis.

R/101-03 The Seasonal and Biochemical Nutritional Variance in Pollock as a Food for Marine Mammals

Michael Castellini, Ph.D., Institute of Marine Science, SFOS/UAF

Susan Inglis, Ph.D. student, Institute of Marine Science, SFOS/UAF

Pinniped metabolic needs vary seasonally, and surveys have shown that the distribution and abundance of fish stocks also vary spatially and temporally. Thus, pinniped species have to meet their energetic demands while foraging on a nutritionally changing prey base. Also, Steller sea lions forage both day and night and little is known about the prey available during these night foraging periods.

We collected Steller sea lion prey samples around a rookery in the central Gulf of Alaska to study the potential variation in prey base nutrition. Midwater trawl surveys were conducted at night within a 10 nm radius of the Chiswell Island rookery/haul out.

Surveys were timed to parallel key metabolic periods for the sea lions (pupping/breeding, post breeding/molting, winter).

The results of the trawl surveys indicate that walleye pollock is the dominant prey species for Steller sea lions at Chiswell Island. Pacific herring and other energy dense fish such as eulachon, capelin, and juvenile sablefish are also available in smaller quantities.

All fish species in this survey exhibited some seasonal variability in energy content, demonstrating the dynamic nature of prey quality. Energy density of the prey base was lowest in April and continued to improve over the summer with the highest energy density values recorded in November. Energetic demands for sea lions are highest in the spring and winter (Winship et al. 2002). Thus, the increasing energy density of the prey base in November provides the population with a good energy source for winter months. Seasonal aggregations of energy dense fish such as eulachon supplement the prey base in the spring.

Preliminary findings from the hydro acoustic backscatter results indicate significant fish biomass in the upper 50 meters of the water column during the evening surveys in April and August. This suggests that there is an accessible prey base for juvenile Steller sea lions and females nursing pups in April and August.

Amino acid and mineral composition of the prey appear to be adequate based on general medical mammal references. However specific nutritional requirements beyond energy based components are not well understood in pinnipeds, making it difficult to accurately evaluate prey quality for these animals. Further study on protein and mineral requirements for pinnipeds is strongly recommended.

Williams (2005) found that the average maintenance caloric requirements for an adult female Steller sea lion (non lactating or pregnant) was 10,570 kcal/day. Based on our findings this would be equivalent to approximately 20 (400 g) adult pollock from the Chiswell Island stocks.

Results from stable isotope analysis on the fish samples indicate that muscle tissue and whole homogenized fish tissue from the same sample have significantly different isotopic signatures. The delta 13C values were significantly greater in the whole fish analysis. Thus, comparisons between stable isotope signatures for fish species should be tissue specific.

Further Data Analysis

The results from this analysis will be correlated with fish biomass estimates from the hydro acoustic surveys, diet composition from scat analysis, and results on metabolic requirements in sea lions to more thoroughly evaluate the prey base for the Chiswell Island Steller sea lion population.

These results will be correlated with fish biomass estimates and diet composition data as part of a habitat assessment of Chiswell Island haulouts and rookeries for Steller sea lions.

The results from this project provide important resource management information on the prey base available to the Chiswell Island Steller sea lion population during metabolically demanding life history stages (pupping, breeding, and molting). This population of Steller sea lions is very well monitored temporally. Thus, these results will assist in a broader understanding of the dynamics of fish variability in tissue quality and geographical location, and how that relates to changing marine mammal metabolic requirements and foraging behavior.

This project is also one of only a few studies to focus on individual protein and mineral components when assessing prey quality. We know very little about protein and mineral requirements for pinnipeds. This study reports on the individual amino acids and mineral elements available to these animals in the wild.

There have been numerous studies conducted to report stable isotope signatures for different species of fish in Alaska. The tissues used to represent the whole fish in these studies vary, with some using muscle only and others whole fish homogenate. These values are often used to compare signatures from different geographical locations. The results from the isotope analysis conducted in this study provide a direct comparison between whole fish homogenate and muscle tissue isotope signatures from the same sample.

The data will be the focus of a chapter in Susan Inglis' Ph.D. thesis. They will be published in a peer-reviewed journal and will also be part of a synthesis paper produced by the Alaska SeaLife Center. Preliminary results have been published in an Alaska SeaLife Center document for the NMFS on Steller Sea Lion Research. This project was partially funded by a NMFS Grant to the Alaska SeaLife Center. The results from this project will be correlated with other Alaska SeaLife Center projects designed to assess Steller sea lion health and habitat at Chiswell Islands, Alaska .

R/31-08 Understanding the Role of Marine-Derived Nutrients in Population Dynamics of Sockeye Salmon

Milo Adkison, Ph.D., Fisheries Division, SFOS/UAF

Tadayasu Uchiyama, M.S. student, Fisheries Division, SFOS/UAF

The student has completed all required coursework. Stable isotope measurements have been done on 500+ sockeye smolts from 34 lakes in Alaska, with more in progress. Geographic and morphometric data of 46 lakes in the study area have been compiled. Preliminary results: (1) Principal component analysis indicated a correlation between the $\delta^{15}\text{N}$ of the smolts, the escapement per lake area, and the altitude of the lake. (2) A correlation was also found between the $\delta^{13}\text{C}$ of the smolts and the geographic location of the lake (the longitude).

R/33-02 Humpback Whale Entanglement Rates in Fishing Gear in Southeast Alaska

Susan Hills, Ph.D., Institute of Marine Science, SFOS/UA
Janice Straley, M.S., Department of Natural Sciences, UAS
Janet Doherty-Neilson, M.S. student, SFOS/UA

Humpback whales in Southeast Alaska increasingly share their environment with large cruise ships, fishermen, recreational boats, float-equipped airplanes, and other craft. In recent years, an increasing number of Southeast Alaska humpback whales have been reported entangled in commercial fishing gear. In 2003, Alaska Sea Grant began support of University of Alaska Fairbanks graduate student Janet Doherty-Neilson as she worked with the National Park Service to establish a photographic baseline of individual whales and look for scars from entanglement in fishing gear. In 2004, Alaska Sea Grant formalized this effort by joining with the Park Service to fully fund Doherty-Neilson's research proposal submitted jointly with Sue Hills of the University of Alaska Fairbanks School of Fisheries and Ocean Sciences and Janice Straley of the University of Alaska Southeast. In this 2005 follow-on study, Doherty calculated the rate of nonlethal entanglement. In conjunction with existing information on whale demographics, the study enabled her to identify vulnerable segments of the humpback population. Doherty-Neilson also described the location of scarred and unscarred whales in relation to fishing activities.

The entanglement rate was found to be proportional to the entanglement rate in the Gulf of Maine, where whale-fisheries interactions have been identified as a substantial management concern. The study has raised awareness among fishermen, resource managers, and the public to an issue not previously thought to be of concern. It has prompted the National Park Service to consider steps to mitigate. Neilson's information will be used in a ten-nation collaborative by the National Oceanic and Atmospheric Administration to assess the abundance and health status of humpbacks throughout the Pacific. Doherty is a full-time employee of the National Park Service.

R/95-03 Identification of Cyanobacterial "Saxitoxin Genes"

F. Gerald Plumley, Ph.D., Bermuda Biological Station
Andrew Krohn, M.S. student, SFOS/UA

The goal of this project was to identify and characterize the genes involved in the synthesis of saxitoxin. The initial objective during this funding cycle was to generate pBAC libraries from saxitoxin-producing strains of cyanobacteria. The lab has obtained seven strains of *Anabaena circinalis* and one strain of *Aphizomenon flos-aquae* for this project. Progress has been made on several fronts but much work remains.

Researchers found that each of the toxic strains of cyanobacteria had unique properties, including growth rates, DNA methylation systems, and ease of DNA extraction. Given the inherent differences in these strains, which were not correlated with saxitoxin synthesis, researchers decided to focus on a single toxin-producing strain from Australia, *Anabaena circinalis* ACBU02.

Before focusing on ACBU02, researchers confirmed saxitoxin synthesis in this strain (in collaboration with Dave Kulis from WHOI), and noted large amounts of C1 and C2 (roughly 90% of total toxin) with only moderate amounts of GTX2,3, dcGTX2,3, and STX.

Researchers previously reported problems with DNA purification, which have subsequently been solved. They find that pretreatment of ACBU02 with sarkosyl/saline solution followed by prolonged treatment with SDS/proteinase K works exceptionally well. Pulse field gel electrophoresis (PFGE) of non-digested DNA indicates the DNA to be of exceptional quality, with chromosomal bands of about 3.4 and 3.2 Mbp. The researchers remain fascinated by the observation that chromosomal DNA is represented by two bands when resolved by PFGE, suggesting that there are two replicons (presumably two chromosomes) in ACBU02. Work is under way to determine if these two PFGE bands represent different conformations (e.g., super-coiled vs. nicked) of a single chromosome. They also find that a large megaplasmid is present in ACBU02, but only when cells are at specific culture stages (i.e., near the end of log phase). This megaplasmid is estimated by PFGE to be approximately 240 Kbp. It has long been hypothesized that saxitoxin genes would be borne on mobile DNA elements, for instance plasmids. These findings, both of a plasmid and the observation that it seemingly has the ability to integrate/excise from the chromosome, are exciting.

Researchers have also analyzed the DNA of ACBU02 by PFGE following digestion with restriction enzymes. Among many interesting findings, they note in particular that NotI cleaved DNA of a nontoxic strain, *Anabaena* PCC 7120, only 16 times in silico while it cleaved ACBU02 DNA numerous times: 10 fragments were > 50 kB, representing approximately half the genome, while there were many small fragments < 30 kB. End sequences obtained from cloned NotI inserts indicate that many NotI sites are localized in junk DNA rather than in microsatellites or repeat elements. Researchers were initially surprised to see junk DNA in a prokaryote, but subsequently learned that other filamentous cyanobacteria, whose genomes are currently being sequenced, also have considerable junk DNA. These cyanobacteria do not synthesize saxitoxins, so it is not reasonable at this point to correlate the presence of junk DNA with the saxitoxin genes.

Problems were previously reported in generating DNA libraries from toxic cyanobacteria. This problem has now been solved. Small-fragment (about 5 Kbp) libraries have been created in pUC from HindIII and EcoRI (and NotI, see above) digestion products, and a pWEB::TNC cosmid library with > 10,000 members was recently generated from randomly sheared/packaged fragments (approximated 40 Kbp). This cosmid library, should it prove robust, would provide approximately 50 X coverage of the ACBU02 genome. End sequence analysis of the small-fragment and cosmid libraries has thus far revealed a high level of conservation among genes found in other *Anabaena* strains. However, ACBU02 has undergone substantial reorganization of chromosomal gene order relative to PCC 7120.

RR/04-01 Larval Ecology and Settlement Dynamics of Dungeness Crab in an Alaskan Marine Reserve

Ginny Eckert, Ph.D., UAS Department of Natural Sciences
Heidi Herter, M.S. student, SFOS/UAF

Commercial fishing of Dungeness crab was closed in Glacier Bay in 1999, helping to create one of the largest marine reserves in the United States. Today, a greater abundance and biomass of male Dungeness crabs exists; however, future productivity depends on larval recruitment, the subject of this study. More than 1,000 samples of late-stage larvae were collected during the 2004 and 2005 field seasons. Early results indicate significantly greater abundances of late-stage larvae at high tides than at low tides, suggesting that late-stage larvae may be transported to nearshore areas with flooding tides and that selective tidal stream transport may play a role in late-stage larvae supply to Glacier Bay.

Late-stage larval abundance was overwhelmingly greater in surface traps than in bottom traps in both years, indicating that late-stage larvae may be transported into Glacier Bay. Daily late-stage larvae abundance also varied significantly between surface traps at all sites in both years with significantly more late-stage larvae found in Bartlett Cove than at the other two sites. A gradient in late-stage larval supply may exist for this area with the greatest supply of late-stage larvae occurring near the mouth of Glacier Bay and progressively fewer late-stage larvae supplied to areas farther up the bay.

Light trap samples collected at high and low tides in 2005 remain to be analyzed, as do 2005 settlement bag samples. Late-stage larvae supply data from 2004 and 2005 will be compared with long-term surveys of adult Dungeness crab abundances at these sites (using adult survey data from USGS) to indicate potential effects of larval dispersal and recruitment on adult distributions in Glacier Bay. In future analyses, we will also attempt to cross-correlate pulsed events in late-stage larvae supply with physical parameters including variations in sea surface temperature, tidal amplitude, and wind events and make inferences as to the mechanisms behind shoreward transport of late-stage larvae to Glacier Bay.

Heidi Herter, the graduate student funded by this project, has completed her graduate study plan, and has advanced to candidacy. She is planning to complete a draft of her thesis by September 1, 2006, and defend in October 2006. She traveled to California in November 2005 to give an oral presentation of this work at the Western Society of Naturalists annual meeting (travel funded by Alaska Sea Grant).

RR/04-02 Early Life History of Eulachon (*Thaleichthys pacificus*): Age Validation and Growth in Berners Bay, Alaska

Nicola Hillgruber, Ph.D., Fisheries Division, SFOS/UAF
Andrew Eller, M.S. student, SFOS/UAF

Field sampling was conducted during two years, 2004 and 2005. A total of eight stations were established between the head of Berners Bay and Cascade Point running

perpendicular to the freshwater plume of the Antler River and Lace/Berners River discharge. Sampling in the estuary was conducted weekly, beginning in early June and continuing through early August. Preliminary results indicate large abundances of jellyfishes in Berners Bay that coincided with larval emigration. Smelt larvae appeared to primarily inhabit the surface layers of the river plume. During late spring and early summer when larvae first entered the estuary, maximum larval densities of 7.74 per cubic meter occurred along the west side of the bay. Eulachon larvae were captured in surface waters of the estuary into early August. Larvae completed growth past transformation into the juvenile stage between August and December.

RR/04-07 Essential Habitats in our Arctic Front Yard: Nearshore Benthic Community Structure

Katrin Iken, Ph.D., Institute of Marine Science, SFOS/UAF

Brenda Konar, Ph.D., Global Undersea Research Unit, SFOS/UAF

Due to rough seas and malfunctioning equipment, the 2004 test of a new sonar, called Didson, to identify and map seafloor boulder habitat and associated kelp assemblages in Camden Bay, Alaska, was unsuccessful. A no-cost extension was granted so researchers could go back to Camden Bay in 2005 and accomplish the objectives of the proposal with improvements to the operations based on this year's experience.

Iken and Mitch Osborne from the U.S. Fish and Wildlife Service (USFWS) returned in summer 2005 and were successful in using the Didson sonar to locate boulders and boulder patch assemblages. They were very visible with the Didson, giving good images of their size and distribution. On one occasion, Iken and Osborne could even see a kelp growing on one rock. They chose three sites and used scuba to collect sample rocks for analysis. Algae species were identified and measured. The invertebrates were preserved in formalin and then sorted into larger taxonomic groups at UAF (by an undergrad intern). Through a mini-grant from ArcOD the PIs will be able to have the inverts analyzed to species or lowest possible taxon level by Susan Schonberg, who is the taxonomic expert for the region. She is in the process of analyzing them and she said that she already found a few unusual species she had not seen before in samples from the Beaufort Sea. A final list of the inverts was expected by the middle of September 2005. Iken will give an oral presentation on this during the NaGISA conference in Japan in October.

Community outreach was done in the nearby coastal Native village of Kaktovik. Children were shown the invertebrate collection and several actually started sorting samples with the researchers.

RR/04-08 Community Composition, Population Dynamics, and Nutritional Status of Intertidal Clams in Kachemak Bay, Alaska, in Relation to Oceanographic Conditions

Katrin Iken, Ph.D., Institute of Marine Science, SFOS/UAF

Carrie Belben-Parris, M.S. student, Institute of Marine Science, SFOS/UAF

Data collection for determining community composition, size-frequency distribution, abundance and biomass of intertidal clams for the summer 2004 sample season was completed and is awaiting further data analysis. Clam sampling for summer 2005 commenced on June 20, 2005. Stable isotope analysis on clam tissues as well as POM and benthic diatoms has been completed. Results identify filter-feeding clam and deposit feeding clam species. While feeding strategies are consistent over the different sampling areas, isotope signals show slight shifts among regions. Final data analysis occurred in fall 2005.

Biochemical analysis of clams collected during the 2004 field season is nearly finished. All biochemical analyses were completed by the end of September 2005. Variability within species and sites is very high and it was planned to sample a larger number of replicates during the 2005 sampling to confirm spatial and seasonal trends in biochemical composition.

A volunteer from the Native village of Port Graham successfully collected water samples monthly for the duration of one year. The water samples were to be analyzed starting at the end of July and continuing through September 2005. Monthly samples from Jakolof Bay and China Poot were not taken due to lack of supplies and personnel; however, samples were taken during the summer monthly sampling periods at each of these sites. Grain size analysis was planned to be completed in fall 2005.

This project supported Carrie Belben-Parris for her master's thesis project within the Graduate Program in Marine Science and Limnology at UAF. It provided the means for sampling and sample analysis. The project also supported a member of the Native tribe in Port Graham to collect monthly samples during winter. This provided an important involvement of the local community and included discussions with tribal members to identify sampling locations based on their traditional ecological knowledge.

Clam nutrition

Previous research in Kachemak Bay indicates that chlorophyll *a* concentrations are low near the mouth and head of Kachemak Bay and are higher in the middle of the bay. My research is indicating that there exists a gradient in chlorophyll *a* concentrations, where the concentrations are higher at the mouth of the bay and gradually decrease toward the head. Data collected through research conducted by the Kachemak Bay National Estuary Research Reserve support my findings. Chlorophyll *a* concentrations are a measure of the amount of phytoplankton in the water column. Phytoplankton serve as an important food source for many subsistence and commercially important species including a variety of fish and clams. Alaska Natives have depended on intertidal clams for a subsistence food item and have noticed a drastic decline in the abundance of

clams within the last 30 years. This decline does not seem to correspond with harvest pressures observed in Kachemak Bay.

One of my hypotheses to explain the disappearance of clams is that the clams are not getting enough food needed for energy to put into spawning efforts. The evidence that a chlorophyll *a* concentration gradient exists in Kachemak Bay is important because the areas where chlorophyll *a* concentrations are higher are adjacent to areas where the decline in intertidal clams are the most drastic. Investigation into a possible food source for these clams in the areas of decline indicate that they are feeding on a different food source. In other words, they are not obtaining food from the water column; instead, they get their food from the sediment. In addition, these communities are composed of entirely different species from 30 years ago and are different from the beaches where commercial and subsistence clams are currently harvested. Researchers are currently working on biochemical analysis of clam tissue to determine overall health of the clams in order to determine if they get enough energy to spawn. More research needs to be done to investigate spawning success of the intertidal clams in Kachemak Bay. Investigating the decline in subsistence clams can help Alaska Natives determine why the decline took place and perhaps work to bring clam abundances up to a manageable level.

RR/04-09 Spawning Distribution and Habitat of Sockeye Salmon (*Oncorhynchus nerka*) in the Chilkat River Drainage

Nicola Hillgruber, Ph.D., Fisheries Division, SFOS/UAf

Brian Elliot, M.S. student, Fisheries Division, SFOS/UAf

Sockeye salmon *Oncorhynchus nerka* in the Chilkat River drainage use diverse and wide-ranging spawning and rearing areas. Spawning distribution has previously been estimated based on scale pattern analysis only, which provides reliable albeit limited information. To date the full extent of sockeye salmon spawning habitat in the Chilkat River drainage is unknown.

During two field seasons, 2003 and 2004, we implanted 324 radio transmitters in sockeye salmon entering the lower Chilkat River. Fish were tracked throughout the Chilkat drainage using stationary tracking towers, aerial surveys, and boat tracking. We used radio telemetry during this study to satisfy several objectives:

1. Estimate spawning proportions in the Chilkat River drainage.
2. Identify spawning areas in the Chilkat River drainage not previously classified by ADF&G.
3. Estimate fishery interception and migration mortality rates.
4. Identify migratory patterns and estimate swimming speeds.
5. Test the counting efficiency of the Chilkat Lake weir.

We found that the majority of tagged sockeye salmon were spawning in lakes, while river-spawning fish utilized off-channel areas, tributary rivers, and main channel areas. There appeared to be no relationship between spawning destination and tagging date, e.g., salmon spawning in the Little Salmon River had the shortest distance to migrate

yet entered the Chilkat River before all other groups. We estimated that in 2003 and 2004 a total of 82% and 84% of tagged fish were successfully reaching spawning locations. Non-spawning fish either stopped along their migration routes or were intercepted by the subsistence fishery in the Chilkat River.

Results from this study provide important information not only for the management of stock-specific harvest of sockeye salmon in the upper Lynn Canal but might also be used to improve the management of the Chilkat Bald Eagle Preserve.

RR/05-03 *Vibrio parahaemolyticus* testing in Prince William Sound

Ray RaLonde, Ph.D., Alaska Sea Grant Marine Advisory Program

Unusually warm ocean waters in summer 2004 triggered Alaska's first outbreak of *Vibrio parahaemolyticus* (*Vp*), a naturally occurring bacterium that is the leading cause of seafood illness in the United States. *Vp* had never been found in Alaska shellfish because cold waters inhibit the marine bacteria. The bacterium is more commonly found in the much warmer Gulf of Mexico. However, the 2004 outbreak was the third largest in U.S. history in terms of people getting sick, and 1,500 times more virulent than strains common to Puget Sound, Washington. The unprecedented outbreak came on the heels of dramatically warmer coastal Alaska waters, and infected farmed oysters primarily in Prince William Sound. About 62 people who consumed Alaska-grown oysters were diagnosed with severe gastrointestinal illness. The incident caused alarm in the shellfish industry and required immediate action.

With funding from Alaska Sea Grant, Marine Advisory aquaculture specialist Ray RaLonde purchased and immediately set up a network of temperature data loggers in deep (70–100 feet) and shallow water on farms across the state as a way to detect ocean conditions that could indicate the presence of *Vp*. RaLonde also advised farmers to sink their product into colder waters where *Vp* would be unable to thrive. RaLonde was interviewed for local, state, and national newspaper and radio stories on the subject.

While farms were temporarily prevented from marketing product, the movement of shellfish to deeper waters prevented an economic catastrophe for the state's shellfish farms. Continuous ocean temperature monitoring enabled farmers to maintain their product in cold waters, and provided a data set for a planned research project.

The state-federal study of the people who became ill was published in the *New England Journal of Medicine* (353:1463-1470, 2005). The investigation confirmed *Vp* as the cause of the illness. Importantly, the confirmation extended by 1,000 km the northernmost site where oysters have caused illness due to *Vp*.

The following year, RaLonde led a study to prove the effectiveness of keeping shellfish at depth to avoid contact with *Vp*. RaLonde leveraged \$3,200 from Alaska Sea Grant and the Marine Advisory Program into an additional \$12,000 from the Alaska Department of Environmental Conservation and the University of Alaska President's Fund to test shellfish for *Vp*. Shellfish harvested from deep waters on farms were

compared with shellfish in warmer surface waters. Information from the data loggers installed the year before was instrumental in establishing study parameters and tracking temperature trends throughout the study. Eight shellfish farms took part in the study. Test results show that shellfish at depth had *Vp* levels approximately one-tenth those at the surface. The effort validated the importance of keeping shellfish in deep cold water to avoid contact with *Vp*. The practice is now standard operating procedure for Alaska shellfish farms.

“The *Vp* outbreak in Alaska was totally unanticipated and presented an unprecedented public health challenge to the industry and regulatory agencies. Ray RaLonde identified a practical solution of sinking oysters below the thermocline, persuaded the industry and DEC to adopt this approach and assembled a team of scientists to evaluate the effectiveness of this approach within a single year. This is probably the best model of developing a timely proactive approach to address an emerging pathogen issue to date in the National Shellfish Sanitation Program.”—Dr. Angelo DePaola, research microbiologist, Food and Drug Administration Gulf Coast Seafood Laboratory, Dauphin Island, Alabama.

Also in 2005, RaLonde led a study with multiple investigators to survey coastal waters to determine how pervasive *Vp* had become. Shellfish, algae, sediments, even sea otter fecal material were tested. Key partners in the study were the Food and Drug Administration’s Gulf Coast Seafood Laboratory, U.S. Forest Service, Alaska SeaLife Center, and the Alaska Department of Fish and Game. Results showed that *Vp* had become well established throughout Prince William Sound. Scientists also discovered the presence of another *Vp* strain in Southeast Alaska waters.

We now know that yearly monitoring is needed to respond to future *Vp* outbreaks. As a direct result of Alaska Sea Grant activities in this area, the U.S. Department of Agriculture awarded \$168,000 through its Cooperative States Research Education and Extension program to microbiologist Brian Himelbloom at the UAF Fishery Industrial Technology Center. The funds have allowed Himelbloom to upgrade his laboratory facilities to conduct genetic testing via PcR (polymerase chain reaction), needed to identify and quantify strains of *Vp*. This grant gives researchers in Alaska the ability to conduct analyses that previously could only be done outside the state by the Food and Drug Administration.

Appendices

a. Management Team and Staff Composition

Management Team Composition

Management Team Member	Position	FTEs devoted to Sea Grant
Brian Allee	Director	0.35
Paula Cullenberg	Associate Director	0.59
Kurt Byers	Education Services Manager	0.65
Michele Frandsen	Program Manager	0.8

Alaska Sea Grant Staff Composition

Sea Grant Staffing	No. individuals	No. FTEs funded by Sea Grant \$	No. FTEs funded by non-Sea Grant \$
Administrative	7.25	0.82	6.43
Education Services	9.5	4.65	4.85
Extension	13.25	3.35	10
Education	20	14	7

b. Program Development Projects

Project title	PI	Federal funds	Matching funds
Aleutian Life Forum support	Reid Brewer	10,000	
Rural Teachers In-Service	Peter Stortz	9,693	
<i>Vibrio parahaemolyticus</i> testing in Prince William Sound	Ray RaLonde	7,000	
Developing a fisheries undergraduate research laboratory	Nate Bickford	9,600	
Effects of food density on larval survival of blue king crab, <i>Paralithodes platypus</i>	Brad Stevens and Loren Buck	20,000	

c. List of Partners

Total partners = 392

Federal	Re- gional	Local & State	NGOs	International	Industry/ Business	Academic Institutions	SG Programs	Other
Alaska Regional Marine Research Program		Alaska Coastal Management Program Division of Governmental Coordination	Alaska Aerospace Development Corporation	Commander Islands Nature Protection Association	Alaska Aqua Farms	Alaska Pacific University	Hawaii Sea Grant	Alaska Business Monthly
Environmen- tal Entrepren- eurship Program for Minority Serving Institutions		Alaska Commercial Fisheries Entry Commission	Alaska Association of Harbormasters and Port Administrators	Danish Institute for Fisheries Research	Alaska Seafood Interna- tional	Alaska Vocational Technical Education Center	Oregon Sea Grant	Alaska Fisherman's Journal
Kachemak Bay National Estuarine Research Reserve		Alaska Commercial Fishing and Agriculture Bank	Alaska Center for the Environment	Ecole des Mines de Paris, Centre de Geostatistic	Alaska Tide Book Company	Bermuda Biological Station for Research	Rhode Island Sea Grant	Alaska Public Radio
Minerals Management Service		Alaska Department of Commerce, Community and Economic Development	Alaska Community Action on Toxics	Fisheries and Oceans Canada	Al-Lou's Fish	California State University	Washing- ton Sea Grant	AlaskaOne Public Television
National Park Service Subsistence Division		Alaska Department of Education and Early Development	Alaska Conservation Foundation	Food and Agriculture Organization, United Nations	Alutiiq Pride Shellfish Hatchery	Clatsop Community College		Alutiiq Museum
National Science Foundation		Alaska Department of Environmental Conservation	Alaska Driggers Association	French Research Institute for Exploitation of the Sea (IFREMER)	Amazon book- sellers	Cornell University School of Ornithology		Anchorage Daily News
NOAA Coastal Ocean Program		Alaska Department of Fish and Game	Alaska Fisheries Development Foundation	International Bering Sea Forum	Barnes and Noble book- sellers	Indiana State University		Aquaculture International
NOAA Fisheries Auke Bay Laboratory		Alaska Department of Natural Resources Division of Oil and Gas	Alaska Fishing Industry Relief Mission	International Bird Rescue and Research Center	Boat U.S.	Kenai Peninsula College		Associated Press

Partners (cont.)

Federal	Re- gional	Local & State	NGOs	International	Industry/ Business	Academic Institutions	SG Programs	Other
NOAA Fisheries Kodiak Fisheries Research Center		Alaska Department of Transportation	Alaska Forum for Environmental Responsibility	International Pacific Halibut Commission	Bristol Bay Economic Development Corporation	Oregon State University		Coast Magazine
NOAA Fisheries National Marine Mammal Laboratory		Alaska Division of Emergency Services	Alaska Groundfish Data Bank	Kamchatka Institute of Ecology and Nature Protection	Calista Corporation	Prince William Sound Community College		Imaginarium Science Discovery Center
NOAA Fisheries Northeast Fisheries Science Center		Alaska Division of Governmental Coordination Coastal Zone Management Program	Alaska Marine Conservation Council	Natural Resource Management	Cook Inlet Books	Queen's University, Ontario, Canada		Intrafish.com
NOAA Fisheries Office of Protected Species Alaska Region		Alaska Division of Homeland Security and Emergency Management	Alaska Marine Safety Education Association	Marine Research Institute, Norway	Dancing Salmon Fisheries	Scripps Institution of Oceanography		Monterey Bay Aquarium
NOAA Fisheries Pacific Marine Environmental Laboratory		Alaska Fisheries Revitalization Strategy	Alaska Natural History Association	North Pacific Marine Science Organization (PICES)	Digital Observer, Inc	Seattle Community College		National Fisherman
NOAA Fisheries, Restricted Access Management, Alaska Region		Alaska Legislative Salmon Industry Task Force	Alaska Natural Resource and Outdoor Education	Pacific Fisheries Research Center (TINRO-Center), Russia	EDAW Inc.	Sheldon Jackson College		National Public Radio
NOAA National Ocean Service Coast Survey		Alaska Office of Boating Safety	Alaska Ocean Observing System	Petroleum Environmental Network–China	Englund Marine Supply Fish Expo Inc.	Texas A&M University		Oregon Coast Aquarium
NOAA National Tsunami Hazard Mitigation Program		Alaska Sea Otter and Steller Sea Lion Commission	Alaska Oceans Network	Sakhalin Environment Watch	Enviro-Pak Smoking Ovens	University of Alaska Arctic Region Super-computing Center		Pacific Fishing

Partners (cont.)

Federal	Re-regional	Local & State	NGOs	International	Industry/Business	Academic Institutions	SG Programs	Other
North Pacific Fishery Management Council		Alaska Seafood Marketing Institute	Alaska Oceans Program	Simon Fraser University School of Resource and Environmental Management	Favco Seafood	University of Alaska Anchorage		Pratt Museum
North Pacific Research Board		Alaska SeaLife Center	Alaska Science and Technology Foundation	University of British Columbia Marine Mammal Research Unit	Fleet Refrigeration	University of Alaska Fairbanks		Prince William Sound Science Center
Smithsonian Institution Arctic Studies Center		Alaska Small Business Development Center	Alaska Science Consortium		Graystar Pacific Seafood Ltd.	University of Alaska Southeast		Reuters News Agency
U.S. Centers for Disease Control, National Institute for Occupational Safety and Health		Anchorage International Airport	Alaska Shellfish Growers Association	University of Cape Town	Great Alaskan Seafood Company	University of California		Sea Technology
U.S. Department of Agriculture		Anchorage School District	Alaska Underwater Science Foundation	World Conservation Union	Hearthside Books	University of Hawaii		Seattle Aquarium
U.S. Department of Education, Educational Resources Information Center		City of Craig	Alaska Wildlife Alliance		Iceberg Seafood Company	University of Minnesota Extension Service		Western Foundation of Vertebrate Zoology
U.S. Environmental Protection Agency, Indian General Assistance Programs (IGAP)		City of Fairbanks	Aldo Leopold Wilderness Research Institute		Icicle Seafoods Inc.	University of Rhode Island		Worldcatch .com
U.S. Fish and Wildlife Service		City/Borough of Juneau School District	Aleut Corporation		Indian Valley Meats	University of Washington		
U.S. Food and Drug Administration		Cordova High School	Aleutian Pribilof Island Association		Jellett Biotek Ltd.	University of Wisconsin		
U.S. Forest Service		Dillingham Planning Commission	Aleutian Pribilof Island Community Development Association		Joma Wild Seafoods	Utah State University Department of Economics		

Partners (cont.)

Federal	Re- gional	Local & State	NGOs	International	Industry/ Business	Academic Institutions	SG Programs	Other
U.S. Geological Survey		Fairbanks North Star Borough School District	American Fisheries Society		Joycraft Marine Safety Equipment	Virginia Institute of Marine Science		
		Governor's Ocean Policy Cabinet	Arctic Yukon Kuskokwim Sustainable Salmon Initiative		Kenai Fjords Tours	Washington State University School of Biological Science		
		Kodiak Chamber of Commerce	At-Sea Processors Association		Kodiak ComFish Alaska	Western Washington University		
		Lower Kuskokwim School District	Barrow Arctic Science Consortium		Kodiak Fish Company	Woods Hole Oceanog- raphic Institution		
		Matanuska- Susitna Borough School District	Bering Sea Fishermen's Association		LGL Limited	University of Puget Sound Slater Museum of Natural History		
		North Pacific Fisheries Observer Training Center	Bristol Bay Native Association		McDowell Group			
		North Slope Borough	Bristol Bay Science and Research Institute		Mikunda, Cottrell & Co.			
		Port of Valdez	Center for Alaskan Coastal Studies		Nor'west- erly Food Technol- ogy Services			
		Unalaska City School District	Center for Marine Conservation		North Pacific Proces- sors Inc.			
		Unalaska Parks, Culture and Recreation Center	Central Bering Sea Fishermen's Association		Northern Econo- mics Inc.			
			Central Council: Tlingit and Haida Indian Tribes of Alaska		Ocean Beauty Seafoods Inc.			
			Chignik Salmon Cooperative		Orca Book and Sound			
			Coastal Villages Region Fund		Organiza- tional Learning Tools Inc.			

Partners (cont.)

Federal	Re- gional	Local & State	NGOs	International	Industry/ Business	Academic Institutions	SG Programs	Other
			Consortium for Oceanographic Research and Education (CORE)		Pacific Star Seafoods			
			Cordova District Fishermen United		Peter Pan Seafoods, Inc.			
			CyberLynx (homeschool program)		Resource Analysts International			
			Douglas Island Pink and Chum Inc.		ResourceE con, Inc.			
			Ecological Society of America		Robert Hale Book-sellers			
			Ecotrust		Rose Fisheries			
			Educational Training Co.		Roseann Dunham Book-keeping			
			Exxon Valdez Trustee Council		Sea Crest Seafood Market Developers			
			Fundy Fixed Gear Council		SeaFisk Consulting			
			Greenpeace USA Inc.		Silver Lining Seafood			
			Gulf of Alaska Coastal Communities Coalition		Sitka Sound Seafoods			
			Gulf of Alaska Monitoring Program		Solomon Gulch Hatchery			
			Interior Distance Education of Alaska		Sound Metrics Corp.			
			Kachemak Shellfish Mariculture Association		Switlik Parachute Co.			
			Kenai River Professional Guide Association		Taku Smokeries			

Partners (cont.)

Federal	Re- gional	Local & State	NGOs	International	Industry/ Business	Academic Institutions	SG Programs	Other
			Kenai River Sportfishing Association		TDX Corporation			
			Kuskokwim River Fishermen's Management Working Group		Title Wave Books			
			Made in Alaska		Trillium Technology Solutions, LLC			
			Maine Island Trail Association		UniSea Inc.			
			National Association of Government Communicators		Wells Fargo Bank			
			National Fish and Wildlife Foundation		West Marine			
			National Food Processors Association		Wild Salmon Direct			
			Native American Fish and Wildlife Society Alaska Region		Wizard Works			
			New England Trawl Systems		Wrangell Insurance Center			
			North Gulf Oceanic Society					
			Northwest Urban Indian Community					
			Norton Sound Economic Development Corporation					
			Ocean Advocates					
			Oceana					
			Oceans Blue Program					
			Olga-Moser Bay Seafood Producers Alliance					
			Pacific Environment					
			Pacific Fisheries Technologists					
			Pacific Seabird Group					
			Pacific Seafood Processors Association					

Partners (cont.)

Federal	Re- gional	Local & State	NGOs	International	Industry/ Business	Academic Institutions	SG Programs	Other
			Pacific Environment					
			Pacific Fisheries Technologists					
			Pacific Seabird Group					
			Pacific Seafood Processors Association					
			Pacific States Marine Fisheries Commission					
			People for Puget Sound					
			Pribilof Island Collaborative					
			Prince of Wales Island Citizen's Advisory Council					
			Prince of Wales Island Community Holding Corporation					
			Prince William Sound Aquaculture Corporation					
			Qaalugin Tribe					
			Qutekcak Native Tribe					
			Raven Correspondence School					
			Regional Seafood Development Association					
			Seafood HACCP Alliance					
			Shipping Safety Partnership					
			Sitka WhaleFest					
			Southeast Alaska Inter-Tribal Fish and Wildlife Commission					
			Southwest Alaska Municipal Conference					
			The Mountaineers					
			The Nature Conservancy					

Partners (cont.)

Federal	Re- gional	Local & State	NGOs	International	Industry/ Business	Academic Institutions	SG Programs	Other
			U.S. Global Ocean Ecosystems Dynamics (GLOBEC)					
			Unalaska Native Fisherman Association					
			United Fishermen of Alaska					
			United Fishermen's Marketing Association					
			Western Regional Aquaculture Center					
			Yukon Delta Fisheries Development Association					
			Yukon River Drainage Fisheries Association					
41		52	120	31	63	47	4	34

d. Leveraged Funds

Principal investigator	Title	Funding agency	End date	Dollar amount
Allee, Brian	Biological Field Techniques for Lithodid Crabs Book Production	Alaska Dept. Fish & Game	30-Jun-05	33,221
Allee, Brian	Conference on National Standard 8	NOAA	30-Sep-05	50,000
Allee, Brian	Alaska Crab Enhancement and Rehabilitation Workshop	Kodiak Island Borough	31-Mar-06	10,000
Allee, Brian	Alaska Crab Enhancement and Rehabilitation Workshop	North Pacific Research Board	31-Mar-06	5,000
Allee, Brian	Alaska Crab Enhancement and Rehabilitation Workshop	City of Kodiak	31-Mar-06	10,000
Allee, Brian	Alaska Crab Enhancement and Rehabilitation Workshop	APICDA	31-Mar-06	1,500
Allee, Brian	Alaska Crab Enhancement and Rehabilitation Workshop	Alaska Crab Coalition	31-Mar-06	500
Allee, Brian	Alaska Crab Enhancement and Rehabilitation Workshop	Gulf of Alaska Coastal Coalition	31-Mar-06	500
Allee, Brian	Alaska Crab Enhancement and Rehabilitation Workshop	Central Bering Sea Fishermen's Association	31-Mar-06	1,000
Allee, Brian	Copper River Salmon Workshop No. 1: Elevating our collective knowledge to a common level	Ecotrust	31-Mar-06	7,000
Allee, Brian	Northern Harbors and Small Ports Book Production	Alaska Dept. Transportation	31-Dec-05	30,000
Allee, Brian	Produce Gulf of Alaska Book	Alaska Dept. Fish & Game	30-Jun-05	49,383
Allee, Brian	Wakefield '05 ADFG Participant Support	Alaska Dept. Fish & Game	31-Dec-05	10,000
Allee, Brian	Wakefield '05 Support	American Fisheries Society	31-Dec-05	10,000
Allee, Brian	Wakefield '05 Participant Support	NOAA Fisheries	31-Dec-05	10,000
Allee, Brian	Wakefield '05 NPFMC Participant Support	North Pacific Fisheries Management Council	31-Dec-05	10,000
Allee, Brian	Wakefield '06 ADFG Participant Support	Alaska Dept. Fish & Game	30-Jun-06	12,219
Allee, Brian	Wakefield '06 Participant Support	NOAA Fisheries	31-Dec-06	5,000
Alexander, Vera and Kurt Byers	Production of PICES History book	National Science Foundation	31-Apr-05	18,000
Long, Kristine, Chuck Crapo, and Joan Braddock	Food Preparation and Marketing for Alaska Consumers	Cooperative State Research Services/USDA	31-Aug-06	286,128
Crapo, Chuck	Just in Time Seafood Training	Alaska Seafood Marketing Inst., Alaska Department of Commerce, Community, and Economic Development	30-Jun-06	30,000

Leveraged Funds (cont.)

Principal investigator	Title	Funding agency	End date	Dollar amount
Cullenberg, Paula	Conference on National Standard 8: Year 2	NOAA	31-Mar-07	50,000
Cullenberg, Paula	Coordination of Seabird Deterrent Gear Tests by Longline Fishermen in Southeast Alaska and PWS	US Fish & Wildlife Service	10-Jul-08	176,988
Cullenberg, Paula	Marine Safety Training in Unalaska	Alaska Marine Safety Education Association	30-Jun-05	20,850
Cullenberg, Paula	Seafood Processing and Marketing Training Program for Western Alaska	PCCRC	31-Dec-06	65,937
Cullenberg, Paula	Social Vulnerability to Climate Change in the Alaskan Coastal Zone	NOAA	31-Jul-10	1,370,000
Cullenberg, Paula	Support for a Marine Advisory Program agent, based in Nome, to serve the Bering Strait Region	Norton Sound Economic Development Corporation	31-May-09	118,000
Cullenberg, Paula, Torie Baker, and Sunny Rice	USDA Trade Adjustment Assistance Intensive Technical Assistance (TAA-ITA) Program for Alaska Resident Salmon Permit Holders and Crewmembers FY 06-07	Washington State University	14-Sep-07	500,000
Cullenberg, Paula and Reid Brewer	Marine Safety Training in Unalaska	Alaska Marine Safety Education Association,	30-Jun-06	10,490
Cullenberg, Paula, William Butler	Trade Adjustment Act: MAP	Washington State University	14-Sep-05	754,539
Cullenberg, Paula, Terry Johnson, and Quentin Fong	Development and Delivery of a Fisheries Business Technical Assistance Program for Alaskans	Alaska Department of Commerce, Community, and Economic Development	30-Jun-06	520,000
Fong, Quentin	Outreach and Extension in Aquaculture, Agriculture and Agroforestry for Socially Disadvantaged Farmers in Micronesia, Hawaii, and Alaska	University of Hawaii, Hilo	14-Sep-07	21,727
Fong, Quentin	Bridging Gaps to Insure Long Term Viability of Small Tropical Mariculture Ventures in Hawaii and U.S.-Affiliated Islands	University of Hawaii, Hilo	15-Aug-06	97,108
Fong, Quentin	Salmon Marketing Techniques	USDA	15-Aug-05	81,247
McLean, Deborah and Paula Cullenberg	Increase Participation of Alaska Natives in NOAA Sciences, BBC NOAA EPP/MSI	NOAA	30-Sep-06	58,906
McLean, Deborah and Paula Cullenberg	Watershed and Community Mapping of the Nushagak-Mulchatna Drainage	NOAA	31-Dec-06	299,260
RaLonde, Ray	<i>Vibrio parahaemolyticus</i> Applied Research for Alaskan Oyster Farms	UA President's Special Projects	1-Apr-06	5,000

Leveraged Funds (cont.)

Principal investigator	Title	Funding agency	End date	Dollar amount
RaLonde, Ray	<i>Vibrio parahaemolyticus</i> Applied Research for Alaskan Oyster Farms	Alaska Dept. Environmental Conservation	31-Aug-05	7,000
Sugai, Susan	NOSB Participant Support 2004-2005	Consortium for Oceanographic Research & Education	30-Jul-05	19,250
Sugai, Susan	NOSB Participant Support 2005-2006	Consortium for Oceanographic Research & Education	30-Jul-06	19,250
Sugai, Susan	NOSB Support	UA Foundation	30-Jun-07	12,000
Sugai, Susan	NOSB Western Alaska Support	PCCRC	30-Sep-05	6,625
Sugai, Susan and Deborah Mercy	Enhancing Rural High School Involvement in North Pacific Resource Issues through Participation in Alaska Regional NOSB	North Pacific Research Board	30-May-07	100,000
Wiesenburg, Denis and Brian Allee	Converting Alaska Fish Byproducts into Value Added Ingredients and Products	USDA Agricultural Research Service	29-Sep-06	2,045,216
Wynne, Kate	Harbor Seal Population and Diet Assessments: 2004	Alaska Dept. Fish & Game	31-Mar-05	5,150
Wynne, Kate	Predation on Northern Fur Seals in the Pribilof Islands: A Baseline Study Phase1: Traditional Knowledge Survey and Local Fisheries Interactions	UA Foundation	30-Nov-06	66,479
Wynne, Kate	Scientific Oversight of Steller Sea Lion Research Conducted by the Aleutians East Borough	Aleutians East Borough	30-Jun-06	74,698
Wynne, Kate	Shallow Water Nearshore Fish Assemblages	PCCRC	31-Mar-06	6,000
Wynne, Kate and Susan Sugai	Addressing Scientific and Coastal Community Informational Needs Relating to Steller Sea Lions	NOAA	30-Sep-06	475,000
Wynne, Kate, Robert Foy, and Charles Buck	2004 Gulf Apex Predator-Prey Study (GAP)	NOAA	31-May-06	2,400,580

e. Publications List

Peer-Reviewed Journal Articles/Book Chapters

- Battaile, B., T.J. Quinn II, D. Ackley, and G. Tromble. 2005. Catch estimation algorithm for the walleye pollock *Theragra chalcogramma* fishery and comparison to similar National Marine Fisheries Service databases. *Alaska Fishery Research Bulletin* 11(1):1–14.
- Brown, E.J., B. Finney, and S. Hills. 2005. Effects of commercial otter trawling on benthic communities in the southeastern Bering Sea. *American Fisheries Society Symposium* 41:439–460.
- Matala, A.P., A.K. Gray, A.J. Gharrett, and M.S. Love. 2005. Microsatellite variation indicates population genetic structure of bocaccio. *North American Journal of Fisheries Management* 24:1189–1202.
- Sands, N.J., and O.A. Mathisen. 2005. Ecosystem modeling of species interactions affecting sockeye salmon production in Iliamna Lake, Bristol Bay, Alaska. *Verh. Internat. Verein. Limnol.* 29:437–447.
- Sathivel, S. 2005. Chitosan and protein coatings affect yield, moisture loss, and lipid oxidation of pink salmon (*Oncorhynchus gorbuscha*) fillets during frozen storage. *Journal of Food Science* 70:455–458.
- Sathivel, S., P.J. Bechtel, J.K. Babbitt, W. Prinyawiwatkul, and M. Patterson. 2005. Functional, nutritional, and rheological properties of protein powders from arrowtooth flounder and their applications in mayonnaise. *Journal of Food Science* 70(2):57–61.
- Shotwell, S.K., M.D. Adkison, and D.H. Hanselman. 2005. Accounting for climate variability in forecasting Pacific salmon in data-limited situations. In: G.H. Kruse et al. (eds.), *Fisheries assessment and management in data-limited situations*. Alaska Sea Grant College Program, pp. 871–900.

Proceedings/Symposia

- Kruse, G.H., V.F. Gallucci, D.E. Hay, R.I. Perry, R.M. Peterman, T.C. Shirley, P.D. Spencer, B. Wilson, and D. Woodby, eds. 2005. *Fisheries assessment and management in data-limited situations*. Alaska Sea Grant College Program.
- Cullenberg, P., ed. 2005. *Managing fisheries—empowering communities: Workshop proceedings*. Alaska Sea Grant College Program.

Theses/Dissertations

- Battaile, B.C. 2005. A walleye pollock (*Theragra chalcogramma*) depletion estimator for the Eastern Bering Sea. Ph.D. dissertation, University of Alaska Fairbanks. 180 pp.
- Calvert, E.L. 2005. Kelp beds as fish and invertebrate habitat in Southeastern Alaska. Master's thesis, University of Alaska Fairbanks. 113 pp.
- Hoover, C.L. 2005. Effects of outbreeding depression on meristics and bilateral asymmetry in hybrids of spatially separated populations of pink salmon (*Oncorhynchus gorbuscha*). Master's thesis, University of Alaska Fairbanks. 36 pp.
- Krohn, A.L. 2005. Genome analysis of a saxitoxin-producing cyanobacterium. Master's thesis, University of Alaska Fairbanks. 133 pp.
- Vollenweider, J.J. 2005. Variability in Steller sea lion (*Eumetopias jubatus*) prey quality in Southeastern Alaska. Master's thesis, University of Alaska Fairbanks. 87 pp.

Videos/CDs/DVDs

- Mercy, D. 2005. Alaska Tsunami National Ocean Sciences Bowl, 2005. Alaska Sea Grant Marine Advisory Program. 9:51 min.
- Mercy, D. 2005. Keeping your net wet. Trade Adjustment Assistance. Alaska Sea Grant Marine Advisory Program. 14 min.
- Mercy, D. 2005. Keeping your net wet. Yup'ik version. Trade Adjustment Assistance. Alaska Sea Grant Marine Advisory Program. 21 min.

Handbooks/Manuals/Guides

- Donaldson, W.E., and S.C. Byersdorfer. 2005. Biological field techniques for lithodid crabs. Alaska Sea Grant College Program.
- Garza, D. 2005. Common edible seaweeds in the Gulf of Alaska. Alaska Sea Grant College Program.
- Jensen, S.C., and J. Dzigan. 2005. Beating the odds on northern waters: A guide to fishing safety. 5th edn. Alaska Sea Grant College Program.
- Pennington, H. 2005. Marine survival equipment and maintenance. 2nd edn. Alaska Sea Grant College Program.

News Releases

- Alaska Sea Grant to help Gulf Coast fishermen
- Alaska seabird has natural mosquito defense
- American Fisheries Society Annual Meeting
- Annual Aleutian Life Forum kicks off Chinese connection
- Copper River Salmon Workshop No. 1
- Edwards memorial planned
- Fairbanks seniors visit SFOS
- Fishermen's Direct Marketing Manual
- Fishing industry research donations top \$5 million
- Follow the hidden ocean explorers!
- Government/industry partnership helps small fishing vessels meet federal and state seabird regulations
- Jewett named Fulbright
- Juneau-Douglas captures science bowl
- Kruse to chair PICES committee
- Kruse to chair NPFMC Scientific and Statistical Committee
- MAP aquaculture specialist spotlighted (UAF home page multimedia presentation)
- Marine mammal scientist named SFOS associate dean
- Metlakatla oysters debut in Fairbanks
- NPFMC moves to protect Aleutian seafloor habitat
- Pacific rockfish scientists to share research
- Pink and Chum Salmon Workshop Feb. 23–25
- Researchers to map Beaufort Sea, Cook Inlet currents
- Scientists discover new species in Arctic Ocean
- Scientists speak at Environment Forum
- Sea Grant publications and videos win awards
- Sea Grant video featured in first Alaska Ocean Film Festival
- Sea Grant/NOAA Fisheries sponsor conference
- SFOS attends Marine Science in Alaska Symposium
- SFOS explores hidden ocean
- SFOS research featured in Polar Biology
- SFOS researchers find new uses for salmon byproducts
- SFOS staff recognized
- State of the salmon
- Steiner helps form Shipping Safety Partnership
- Subramaniam Sathivel organizes symposium on the applications of chitosan in seafood
- Tom Shirley quoted in bottom trawling story
- Tsunami video to air on Alaska Public TV
- UAF scientists release humpback whale entangled in fishing gear
- United Nations, Pakistan thank Steiner

Newsletters/Periodicals

- Wynne, K., ed. 2005. Alaska's Steller sea lions: Boom to bust—and back? Alaska Seas & Coasts 1:1–12. Fishlines Newsletter (12 issues).
- Johnson, T., ed. 2005. Charter Log, Issue 44. Alaska Sea Grant Marine Advisory Program.
- Johnson, T., ed. 2005. Charter Log, Issue 45. Alaska Sea Grant College Program.

Other

2005 Annual report.

2005 Bookstore catalog.

Alaska Sea Grant College Program. 2005. 2006 Alaska coastal calendar.

Alaska Sea Grant College Program. 2005. Alaska oyster recipe bookmark.

Alaska Tide Book Company and Alaska Sea Grant College Program. 2005. 2006 Tide tables: Western Alaska.

Alaska Tide Book Company and Alaska Sea Grant College Program. 2005. 2006 Tide tables: Southcentral Alaska.

Alaska Tide Book Company and Alaska Sea Grant College Program. 2005. 2006 Tide tables: Southeastern Alaska.

Brown, L. 2005. Common mistakes in HACCP: Government agencies. Alaska Sea Grant College Program.

Brown, L. 2005. Common mistakes in HACCP: Hot smoked salmon. Alaska Sea Grant College Program.

Brown, L. 2005. Common mistakes in HACCP: Sanitation standard operating procedure. Alaska Sea Grant College Program.

Johnson, T. 2005. Preventing and treating seasickness. Alaska Sea Grant College Program.

Mundy, P.R., ed. 2005. The Gulf of Alaska: Biology and oceanography. Alaska Sea Grant College Program.

Tjossem, S. 2005. The journey to PICES: Scientific cooperation in the North Pacific. Alaska Sea Grant College Program.

Publication Categories

Category	No. products
Peer-reviewed journal articles/book chapters	7
Technical reports	0
Proceedings/Symposia	2
Theses/Dissertations	5
Videos/CDs/DVDs	3
Handbooks/Manuals/Guides	4
News Releases	39
Newsletters/Periodicals	15
Other	13

f. Students Supported

Category	No. new students	No. continuing students	No. degrees awarded
Sea Grant-supported master's	2	10	3
Sea Grant-supported Ph.D.	1	5	1
Sea Grant-supported undergraduates	3		

g. Program Awards and Honors

Product Awards

Publication	Author	Organization	Award
<i>Advances in Seafood Byproducts</i>	P. Bechtel	National Association of Government Communicators	First place
<i>The Bering Sea and Aleutian Islands</i>	T. Johnson	Communications Concepts	APEX Award of Excellence
<i>The Bering Sea and Aleutian Islands</i>	T. Johnson	Association for Communication Excellence	Gold Award production
<i>The Bering Sea and Aleutian Islands</i>	T. Johnson	Association for Communication Excellence	Gold Award graphic design
<i>The Bering Sea and Aleutian Islands</i>	T. Johnson	National Association of Government Communicators	Second Place
<i>Field Guide to Bird Nests and Eggs of Alaska's Coastal Tundra</i>	T. Bowman	National Association of Government Communicators	First Place
<i>Life on the Beach</i> video		National Association of Government Communicators	First Place
<i>Visions of Undersea Alaska Engagement Calendar</i>		National Association of Government Communicators	First Place
<i>Ocean Fury: Tsunamis in Alaska</i>		National Association of Government Communicators	First Place Animation: Third Place documentary
<i>Ocean Fury: Tsunamis in Alaska</i>		Association for Communication Excellence	Gold Award script

Professional Awards

	Award recipient	Organization	Award
	Kurt Byers, Terry Johnson, Sue Keller, Kathy Kurtenbach, Doug Schneider	Association for Communication Excellence	Outstanding Professional Skill Award for Publishing
	Rick Steiner	International Who's Who of Professionals	Listed
	Rick Steiner	United Nations and the Pakistan government	Commendation for serving as Chief Technical Advisor to Government of Pakistan on natural resource damage after <i>Tasman Spirit</i> oil spill