

## Pollock Conservation Cooperative Research Center 2009 Awards

Project title: Present and future impacts of ocean acidification on juvenile walleye pollock metabolic processes and growth rates

Principal investigator: Jeremy Mathis

Award: \$56,793

Abstract:

The ocean plays a critical role in the global carbon cycle: the amount of carbon stored in the ocean is roughly 50 times greater than that in the atmosphere. At the surface, the ocean interacts constantly with the atmosphere to absorb and release carbon dioxide. Once absorbed, a carbon atom will remain in the ocean for hundreds of years, circulating from the ocean's surface to its depths and back to the surface again. With the rise of atmospheric CO<sub>2</sub> concentrations from the pre-industrial level of 280 parts per million to 385 parts per million in 2008, the amount of carbon in the ocean has increased substantially and rapidly. This carbon dioxide has combined with water to form carbonic acid, making ocean surface water 30 percent more acidic on average. Depending on the extent of future CO<sub>2</sub> emissions and other factors, the Intergovernmental Panel on climate change (2007) predicts that ocean acidity could increase by 150 percent by 2100.

Potential impacts of ocean acidification on harvested species like pollock are uncertain. One area of concern is acidosis, or the build-up of carbonic acid in body fluids, which can disrupt growth, respiration and reproduction. Despite our lack of knowledge, the trend of ocean acidification is undeniably concerning, especially considering the devastating consequences that acid rain had on freshwater ecosystems during the 20th century. Furthermore, the ocean is currently undergoing other potentially dangerous changes, including warming, sea level rise, pollution and overfishing. The rapid pace at which these changes are occurring, and the fact that they are happening simultaneously, threatens to disrupt the ocean's well-balanced physical, chemical and biological processes faster than they can adapt. Changes in ocean pH may have an affect on reproductive success and early development of pollock in the marine environment. This could lead to devastating effects on the economic viability of this important fishery as well as the ecosystems of the Bering Sea and Gulf of Alaska. Decreasing pollock stocks could have a cascading impact through the food web, affecting the sustainability of higher tropic level organisms like the Steller Sea Lion. In order to gain some insights into this area we propose to answer the following questions; (i) Does acidification show a significant effect on standard metabolic rate of larval pollock? (ii) Which metabolic enzymes (PK, LDH, and CS) does ocean acidification significantly effect, and how? (iii) What is the current and future state of ocean acidification in the Gulf of Alaska and in the Bering Sea, particularly in areas of pollock recruitment? Our hypotheses for this study are that; (i) There will be a significant increase in the standard metabolic rate of larval pollock when exposed to lower pH. (ii) There will be a significant upregulation of metabolic enzymes as the environmental pH decreases. (iii) In the past two decades the pH of the World's Ocean has dropped by 0.1 – 0.25 pH units. It is likely that a similar drop in pH has occurred in the Bering Sea and Gulf of Alaska. Increasing levels of atmospheric CO<sub>2</sub> will likely exacerbate this problem during the next decade and beyond. This project will combine laboratory analyses of pollock incubated at lower pHs as well as the synthesis of pH data throughout the Bering Sea and Gulf of Alaska. The project will be conducted by

Elena Fernandez, a Master's student at UAF who worked on a similar project involving lyre crabs which produced some startling results.

Project title: Feeding patterns, prey selection, and potential dietary overlap of age-0 pelagic juveniles of Walleye pollock (*Theragra chalcogramma*) and Pacific cod (*Gadus macrocephalus*) during a cold summer in the eastern Bering Sea

Principal investigator: Nicola Hillgruber

Award: \$56,394

Abstract:

The goal of this study is to examine feeding patterns of pelagic late larval and early juvenile walleye pollock (*Theragra chalcogramma*) and Pacific cod (*Gadus macrocephalus*), collected in early summer of an exceptionally cold year (2008) on a large scale station grid ranging from Unimak Pass to the vicinity of St. Lawrence Island in the eastern Bering Sea. Previous studies have found that growth, and thus feeding success, during the first summer of marine fishes are important conditions for overwinter survival and, subsequently, recruitment success. This proposed study will benefit greatly from available data on summer zooplankton abundance, composition, and biomass, and on fish energy content, which were collected as part of the Bering Ecosystem Studies (BEST) and the Bering Sea Integrated Research Project (BSIERP), respectively; however, to date no funding is available to examine the feeding patterns of these co-occurring, economically and ecologically important groundfish species. The proposed study will form the basis for a M.S. thesis at the School of Fisheries and Ocean Sciences. As such, the proposed study will directly follow the PCCRC guideline by supporting research and education on pollock and other groundfish species; specifically, we will address priority 2 *Alaska pollock Stock Dynamics* by examining the relationship of secondary production on pollock (and cod) recruitment. Results from this study will provide first insight into resource allocation and the potential for dietary overlap and may allow the assessment of the probability of food competition between early pelagic life stages of walleye pollock and Pacific cod in early summer during an exceptionally cold year in the eastern Bering Sea.

Project title: Continuing to increase experiential learning opportunities for undergraduate students in fisheries at the University of Alaska Fairbanks

Principal investigator: Amanda Rosenberger

Award: \$39,502

Abstract:

The goal of this proposed project is to continue the successful PCCRC-funded initiative to expand the active learning program in the Fisheries Division of the University of Alaska Fairbanks (UAF) School of Fisheries and Ocean Sciences (SFOS). Within Alaska's unique environment, this program gives undergraduate students opportunities to participate in fisheries research and management in occupational and research settings, expand student's professional development through mentorship, encourage pursuit of graduate studies, and better prepare them for their future careers in fisheries. We propose: (1) to continue to give undergraduate students occupational experience in fisheries management and research settings through cooperation with Alaska agencies, industry, and Alaska Native corporations; (2) to continue to provide PCCRC-sponsored research and mentoring opportunities for undergraduate students within UAF SFOS Oceanography and Marine Biology programs; (3) host the 2nd annual PCCRC sponsored undergraduate symposium that will highlight student research and hands-on learning experiences and provide opportunities for students to present their research results in professional settings (society meetings). Recognizing that Alaska's resources and its fishing and seafood industries are the most vibrant, healthy, and sustainable in the world, it is critical that we provide students with the training to serve the health of these fisheries and meet the challenges of future environmental and institutional changes. The funding we request provides support for education and training of undergraduates in fisheries, contributing to life-long learning of students whose work will play a vital role in the long term health of Alaska's precious fisheries resources.

Project title: Impact of health and maternal investment on survival of endangered Steller sea lion pups

Principal investigator: Shannon Atkinson

Award: \$66,609

Abstract:

There is a well-established link between the mammalian immune and endocrine systems. These finely tuned interactions are required for the survival and health of an individual and are regulated by circulating hormones, which are in turn influenced by nutrition, body condition and a host of environmental factors. The overall goal of this project is to determine if changes in maternal investment, body condition, and circulating hormone levels results in measurable changes in the health and survival of Steller sea lion (SSL) pups, as measured through the immune system. As part of an ongoing long-term monitoring and research effort, researchers observe the Chiswell Island rookery via a remotely-operated video system, which provides an in-depth assessment of maternal investment as well as pup well-being and survival. During three breeding seasons (2005, 2007, and 2008) pups ranging in age from 5 to 38 days old were measured, weighed, and permanently marked allowing for identification of mother-pup pairs, determination of exact pup ages, and assessment of maternal investment. Blood samples were collected from 61 pups (24 female, 37 male) for the measurements of a suite of blood-borne components, including complete blood cell counts, lymphocyte proliferation, serum chemistries, contaminants, and circulating levels of IL-6. Some of these measurements have been made, however this proposal requests funding for the remaining endocrine and immune assays. Serum will be used to determine circulating levels of adrenocorticotrophic hormone (ACTH), ghrelin, cortisol, aldosterone, leptin, and thyroid hormones. The complete suite of measurements will allow a comprehensive evaluation of health parameters that will be used to compare with the level of maternal investment and survival of SSL pups.

Project title: Consummate and consumed predators: assessing killer whale predation on juvenile Steller sea lions in the Gulf of Alaska.

Principal investigator: Jo-Ann Mellish

Award: \$5,000

Abstract:

This project addresses **PCCRC Priority #1**, and will allow us to directly quantify predation on juvenile Steller sea lions in the Gulf of Alaska. We have deployed newly developed, satellite linked Life History Transmitters in 15 juvenile Steller sea lions to date, with an additional 12 animals scheduled for 2008 / 2009 under existing funding. Life History Transmitters allow the determination of individual animal survival and allow distinction of predation from non-traumatic causes of mortality, from satellite transmitted post-mortems. Data returns from four of 15 initial deployments prove the viability of the concept, and suggest that predation by killer whales may be the single greatest cause of juvenile sea lion mortality, and that more than 50% of females may be consumed by predators before primiparity. Placing our preliminary findings into the context of a conceptual framework we have developed to integrate bottom up and top down effects, suggests that implications of this level of predation on recovery of the species may be profound, and may require changes more substantial than those that in the past likely contributed to current population status. Here we request support for the vital continuation of satellite monitoring for LHX tag data returns.

Project title: Workshop on spatial structure and dynamics of walleye pollock in the Bering Sea

Principal investigator: Terrence Quinn II

Award: \$55,559

Abstract:

We propose to hold a 4-day workshop in summer 2009 to synthesize relevant information and modeling of the spatial structure and dynamics of the walleye pollock population in the Bering Sea. The synthesis is needed to address issues related to ecosystem effects of one of the world's largest fisheries on a finer temporal and spatial scale than is currently available. The workshop will review information from scientific surveys and commercial fishing vessels about the spatial distribution of pollock and identify relevant factors that influence the distribution seasonally and annually. Advances in spatial modeling of the dynamics of fish populations will be presented to determine if they are relevant to improving the current pollock stock assessment model and management practices (e.g., refined spatial allocations of TAC). Finally, these reviews will be used to determine if a directed field study such as a mark-recapture study is needed to enhance current knowledge of movement patterns and changes in abundance.