

**Bering Sea Integrated Ecosystem Research Project: B75 Correlative Biomass Dynamics Model**

**Project #:** B75

**Title:** Correlative Biomass Dynamics Model

**Principal Investigator(s) and Recipient Organization(s):**

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**Contract Period and Amount of Funding:**

August 1, 2007 to September 30, 2012

**Report Period:**

1 April 2009 through 30 September 2009

**Report Date:**

1 October 2009

**Lead Author of Report:**

Gordon H. Kruse

**Proposed timeline and milestones within report period:**

**Work Plan**

**Project:** Correlative biomass dynamics model

**Co-PIs:** Gordon Kruse, Franz Mueter

<i>What</i>	<i>Who</i>	<i>Start</i>	<i>End</i>	<i>Other key dates</i>
<b>2009</b>				
Recruiting Ph.D. student	Kruse	started	Jun 1 '09	

**Project Summary:**

This study will develop a multi-species biomass dynamics model to examine multi-species interactions among a group of species that show evidence of covariation in productivity. The model will include 3-5 species or functional groups, based on results of retrospective analyses from BSIERP Project B68 and considerations of species' life-history characteristics (diet, habitat requirements, timing of spawning, etc.). In addition to species interaction terms (e.g., competition and predation), we will extend the model to include shared climate effects on productivity and on the strength and magnitude of predation or competitive interactions among groups. The hypotheses investigated by this study include:

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1. Climate-induced changes in physical forcing will modify the availability and partitioning of food for all trophic levels through bottom-up processes. Specifically:
  - a. Earlier sea ice retreat expected as a result of warming will result in a later (May-June), warm-water spring phytoplankton bloom, increased coupling with zooplankton and greater pelagic secondary productivity. Benthic secondary productivity will decrease.
2. Climate and ocean conditions influencing water temperature, circulation patterns and domain boundaries impact fish reproduction, survival and distribution, the intensity of predator-prey relationships and the location of zoogeographic provinces through bottom-up processes. Specifically:
  - e. Expected decreases in benthic productivity will negatively affect feeding and survival of small flatfish and crab thereby lowering population levels.
3. Later spring phytoplankton blooms as a result of early ice retreat will increase zooplankton production, thereby resulting in increased abundances of piscivorous fish (pollock, cod and arrowtooth flounder) and a community controlled by top-down processes [Oscillating Control Hypothesis] with possible trophic consequences, specifically:
  - a. Competition with abundant, piscivorous fish species for forage species will lead to a decline in murre, kittiwakes and fur seals.
  - c. In a top-down control community, fishing will reduce the degree of top-down control of forage species (including juvenile pollock) by adult pollock, cod and arrowtooth flounder. Owing to light exploitation rates, top-down control by arrowtooth flounder will increase, as will their level of competition with piscivorous fish, seabirds and marine mammals. As a result of these two processes, arrowtooth flounder will determine ultimate community composition, such that the climax community will be arrowtooth flounder-dominated (similar to the Gulf of Alaska).

### **Progress Summary:**

Our sole milestone for this reporting period was to recruit a PhD student for the project. We successfully recruited Tadayasu Uchimaya. Tadayasu holds a BA in Applied Economics from Hosei University, BS in Biology, Fisheries, and Wildlife Biology (also, second major in Natural Resources and Environmental Science) from Kansas State University, and a MS in Fisheries from the University of Alaska Fairbanks. Tadayasu joined our program in fall semester 2009. During fall semester 2009, Tadayasu is taking a graduate course in Marine Ecosystems, being co-taught by Gordon Kruse and thesis credits.

### **Lessons learned and project adjustments:**

We successfully recruited the PhD student for fall 2009 on schedule. Although successful, we had few applicants for the position, despite aggressive advertising. We are extremely fortunate to attract an outstanding PhD candidate, but recruiting difficulties for quantitative fisheries students continues to be difficult, and we look forward to further discussions with others about how to address this problem in the future.

### **Integration activity:**

We (Mueter) have participated in most of the monthly lead PI teleconferences. Also, because we are the PIs (Mueter lead, Kruse co-PI) for BSIERP Project 68 (Trophic Interactions – Retrospective Analysis), these two projects are fully integrated. Results from B68 will be directly used to inform this project (B75) in terms of species or species groups to include in the biomass dynamics model, potential interactions to consider in the model, and possible environmental influences on these interactions. To better integrate these two projects with other fish components and modeling efforts, Mueter participated via WebEx in the

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August 11-13 meeting of the Fish Component and Modelers Meeting. To further integrate “competing” modeling activities, we are currently preparing a joint presentation for the BI meeting in Girdwood with the Behavioral Foraging project (Mangel, Satterthwaite) and the MSE project (Punt, Ianelli).

### Education and Outreach:

We have participated in several outreach activities related to the BSIERP project during this reporting period:

- Gordon Kruse chairs the Editorial Committee for the 25th Lowell Wakefield Symposium on “Biology and Management of Exploited Crab Populations under Climate Change” that was held in Anchorage, AK, during March 10-13, 2009. Submitted manuscripts are currently undergoing peer review. Publication of the symposium proceedings is planned for 2010.
- On August 13, 2009, both Gordon Kruse and Franz Mueter were interviewed by Marc Kagan, video director and producer for NOAA, for a film on climate change and its effects on fish, crabs and other species in the marine ecosystems of Alaska. Gordon spoke primarily about apparent population-level responses of Bering Sea fishes and invertebrates to climate change. Franz spoke about changes in distribution of fish and shellfish in the eastern Bering Sea and other climate effects on the Bering Sea ecosystem, based in part on results from the retrospective analyses.
- On September 9, 2009, Gordon Kruse was invited to give the following presentation: *Climate Change and Marine Protected Areas: A Fisheries Perspective from Alaska*. Invited presentation to the Marine Protected Areas Federal Advisory Committee (FAC), September 9, 2009, Anchorage, Alaska. Kruse also served on a panel of experts to field questions from the MPA FAC for two hours. This was reported on the evening news on KTUU (Anchorage) on September 9, 2009. Kruse reported on climate change effects on groundfish, crabs, herring, and other marine species and their implications to the design of marine protected areas, particularly in the Bering Sea.
- On June 18, Franz Mueter co-chaired (with Earl Dawe, DFO, St. Johns, Newfoundland) a workshop on gadid-crustacean interactions in subarctic ecosystems at the ESSAS Annual Meeting in Seattle. He presented an overview (with Siddeek Shareef and Jie Zheng) of gadid and crustacean fisheries and dynamics in the Gulf of Alaska and eastern Bering Sea. Gordon Kruse also participated in this workshop.
- Franz Mueter was invited to give a presentation to a Climate Change seminar in Fairbanks on September 30 and spoke about potential effects of future climate changes on the distribution of fish and shellfish and on the productivity of the eastern Bering Sea ecosystem. His presentation was entitled “*Climate effects on Bering Sea food webs and fisheries*” and used the BSIERP PowerPoint template. A copy of the presentation will be submitted with the B68 report.

### Next year’s Work plan

**BSIERP B75, Correlative Biomass Dynamics Model, Dr. Gordon Kruse ([Gordon.Kruse@alaska.edu](mailto:Gordon.Kruse@alaska.edu), 907-796-5447)**

### 2009-2010 Tasks, Assignments, Timeline

<i>What</i>	<i>Who</i>	<i>Start ( 2009)</i>	<i>Other key dates</i>
Select initial species/taxa for modeling, based on retrospective	Kruse, Uchimaya, Mueter	Oct 1	Continue through May 31, 2010

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analysis and life history review. Biomass dynamics models are difficult to successfully parameterize, so we are likely to begin with 3 species, with an eye toward expanding to 5 species or species functional groups			
Development of conceptual model	Kruse, Uchimaya, Mueter	Oct 1	Continue through May 31, 2010
Start coding a simplified version of the model	Uchimaya, Mueter	Jan 1	
Compiling and updating groundfish and crab data	Uchimaya, Kruse, Mueter	Dec 1	Feb 1