

Project #: B68

Title: Correlative Biomass Dynamics Model

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

Co-PI: Dr. Gordon Kruse
Co-PI: Dr. Franz Mueter
School of Fisheries and Ocean Sciences, Juneau Center
University of Alaska Fairbanks
11120 Glacier Highway
Juneau, Alaska 99801-8677

Contract Period and Amount of Funding:

August 1, 2007 to September 30, 2012
\$299,451

Report Period:

1 April 2008 through 30 September 2008

Report Date:

October 1, 2008

Lead Author of Report:

Gordon H. Kruse

Proposed timeline and milestones within report period:

N/A – Work is not planned to begin on this project until September 2009.

Project Summary: This study will use a multi-species biomass dynamics model (Collie and DeLong 1999) to examine multi-species interactions among a group of species that show clear evidence of covariation in productivity. The model will include 3-5 species or species groups (functional groups), based on the results of the correlation analyses and multivariate analyses (B68) and on the life-history characteristics of each species (diet, habitat requirements, timing of spawning, etc.). In addition to interaction terms among species, such as competition and predation, we will extend the model of Collie and DeLong (1999) to include shared climate effects on productivity and on the strength and magnitude of predator-prey or competitive interactions among groups, based on the results in (2). For example, the model may include a gadid group, a shelf flatfish group, and a crab group, with an ice or temperature variable that affects the productivity of cod and flatfishes in opposite ways. Alternative models will be constructed with interaction terms that are allowed to vary as a function of climate variability. The model will be fit to existing biomass indices and fisheries history to retrospectively assess if and how climate variability has affected the interactions among selected groups of species. Such models have not been constructed for the eastern Bering Sea and provide a useful intermediate step between the statistical models on climate-productivity relationships described above and complex multi-species age-structured models or ecosystem models.

Using available biological and environmental time series, as well as life history information about predator-prey and competitive interactions among 3-5 species or species groups, we will build a alternative multi-species biomass dynamics models to examine the BSIERP hypothesis that 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 the possible trophic consequences. If true, this hypothesis has at least two major consequences: (1) competition with

abundant, piscivorous fish species for forage species will lead to a decline in fur seals, murrens and kittiwakes, and (2) 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:

This project is scheduled to begin in September 2009. Therefore, no progress was planned during this reporting period. The delayed start is necessary to allow the modeling effort to be informed by preliminary results from project B68 Trophic Interactions - Retrospective Analysis. Progress for project B68 is provided in a separate progress report.

Integration activity:

We (Mueter) have had regular interactions with the modeling group through the July EMC meeting in Seattle, meetings with Fairbanks-based modelers in August (Hedstrom, Gibson), and through personal communications. At the EMC meeting we discussed the need for summarizing model output at the same spatial and temporal scales at which retrospective indices are computed to facilitate comparisons and model evaluation. In subsequent discussions with modeling team members, it became apparent that it would be more efficient to make model output available for *post-hoc* comparisons, rather than computing indices comparable to those from the retrospective analyses within the model. We have also participated in most of the monthly lead PI calls.

Education and Outreach: We have participated in a number of outreach activities related to the BSIERP project:

- Mueter prepared a presentation comparing several northern hemisphere ecosystems, including the Bering Sea, for the Ocean Science Meeting in Orlando, Florida (March 2008, presented by co-author George Hunt).
- Mueter was interviewed about responses of fish populations in the Bering Sea to climate variability by Ken Weiss from the LA Times for an article on climate warming and marine fishes (Article has not yet appeared in print).
- Mueter provided testimony on the impacts of climate change on fish and fisheries to a panel convened by the Aspen Institute in Fairbanks (August 12/13). A copy of the presentation was provided to Nora Deans.
- Mueter participated in the ESSAS (Ecosystem Studies of the Sub Arctic Seas) Annual Meeting in Halifax, Nova Scotia (Sep 13-16) and provided information on BSIERP to the ESSAS Steering Committee, which was considering an application from BSIERP to be formally affiliated with ESSAS.
- Kruse prepared a section on status of knowledge and proposed mechanisms linking climate change to the production of red king crab, Tanner crab and snow crab for a PICES Scientific Report, titled "Forecasting Climate Impacts on Future Production of Commercially Exploited Fish and Shellfish". The report, resulting from workshops sponsored by PICES and NPRB, will be published later in 2008.
- Kruse gave an invited presentation on potential impacts of climate change on red king crabs in the eastern Bering Sea at the "Effects of Climate Change on the World's Oceans" Symposium in Gijon, Spain, in May 2008.
- An article on climate change and Alaska's fisheries, written by Kruse, appeared in the May 2008 issue of Alaska Seas and Coasts, published by Alaska Sea Grant and the Marine Advisory Program of the University of Alaska Fairbanks.

- Kruse was interviewed and quoted in a newspaper article in the Fairbanks Daily News Miner (July 13, 2008) on the effects of climate change on marine ecosystems of Alaska.
- Alaska Sea Grant announced the 25th Lowell Wakefield Symposium to be held in March 2009 on Biology and Management of Exploited Crab Populations under Climate Change. The symposium steering committee is chaired by Kruse.
- Kruse participated in the Annual Science Conference of the International Council for the Exploration of the Sea (ICES) in September 2009.

Next year's Work plan:

Project B68, Trophic Interactions - Retrospective analysis

Co-PIs: Gordon Kruse, Franz Mueter; Contact: Gordon Kruse, Gordon.Kruse@uaf.edu, 907-796-2052

Oct 2008-2012 Tasks, Assignments, Timeline

<i>What</i>	<i>Who</i>	<i>Start</i>	<i>End</i>	<i>Other key dates</i>
<u>2008</u>				
No work planned	Kruse, Mueter	Oct	Nov	<i>October</i> : PI meeting, Girdwood; <i>October</i> : PICES meeting
<u>2009</u>				
Recruiting PhD student	Kruse	Started	Sep	<i>January</i> : Alaska Marine Science Symposium
	Kruse, Mueter	Mar	Mar	<i>March</i> : Report to NPRB <i>September</i> : Report to NPRB; <i>October</i> : PICES Annual meeting
<u>2010</u>				
Select species/taxa for modeling based on retrospective analyses	Kruse, Student, Mueter	Jan	Apr	
Conceptual model development, coding	Kruse, Student, Mueter	Jan	Aug	<i>September</i> : Report to NPRB <i>October</i> : PICES Annual meeting
Compiling/updating groundfish & crab data (SAFE)	Student, Kruse	Dec	Dec	
<u>2011</u>				
Provide compiled data to Ken Coyle (if not included in B68)	Student, Kruse, Mueter	Jan	Jan	<i>January</i> : Presentation at AMSS <i>March</i> : Report to NPRB
Fit model to data, refine model, develop alternative models	Student, Kruse, Mueter	Jan	Aug	
Model evaluation/selection, compare results to retrospective analysis	Student, Kruse, Mueter	May	Dec	<i>September</i> : Report to NPRB <i>October</i> : PICES Annual meeting
<u>2012</u>				
Synthesis/Final Report	Student, Kruse, Mueter	Jan	Jul	<i>January</i> : Presentation at AMSS <i>April</i> : Report to NPRB <i>July</i> : Final report
Manuscript preparation	Student, Kruse, Mueter	Jan	Jul	