Bering Sea Integrated Ecosystem Research Project: BSIERP 74 – Competing fur seal-seabird-pollock model

Project #: BSIERP B74

Title: Competing fur seal-seabird-pollock model

Principal Investigator(s) and Recipient Organization(s): Marc Mangel, MRAG Americas.
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Contract Period and Amount of Funding: 1 April 2008-30 Sept 2011 & $356,536

Report Period: 1 October 2008-31 March 2009

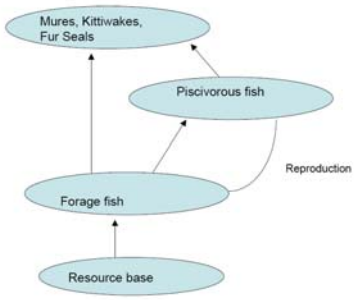
Report Date: 25 March 2009

Lead Author of Report: Marc Mangel

Proposed timeline and milestones within report period:

Event	*Completion*
•Initiate project	October 2008
•Model 1: Coupling Diet Choice and Central Place Foraging	February 2009
•Model 1 Sensitivity Analysis	August 2009

Project Summary: The core goal of our project is to develop models that allow us to assess the importance of facultative behavior by murres, kittiwakes, and fur-seals in a situation in which they are predators of piscivorous and forage fish, so that they are both competitors and predators of one trophic group and competitors with the fishery for both trophic groups, as in the food web shown below:



Progress Summary: We have met all milestones in the project period (work begun on 1 October 2008 by M. Mangel (PI); W. Satterthwaite (Co-investigator) joined the project on 1 Feb 09; K. Richerson (Assistant) aids in data collection and analysis).

•Ultimately, other components of the BSIERP will provide the spatially-explicit dynamics of resource base, forage fish, and piscivorous fish to use as modules in our analysis of the behavior of upper trophic level predators (UTLPs). In the meantime, we have developed simple place holder models.

• We adapted the model of Murray, A.G. and J.S. Parslow (The analysis of alternative formulations in a simple model of a coastal ecosystem. Ecological Modelling 119:149-166 (1999)) to characterize the development of the resource base following the retreat of the ice.

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•We assume Lotka-Volterra competition between the forage fish, which have both unique and shared time dependent carrying capacities.

•We assume more complicated dynamics for the piscivorous fish, in which populations grow, remain stable, or decline according to whether accumulated energy exceeds, just meets, or falls below energetic requirements.

•We combine central place foraging and diet choice in a rate maximizing setting to predict the consumption of the UTLPs and to determine their effects on the forage and piscivorous fish.

•To date, our model can predict patch and diet choice for a single predator in a system with multiple spatial patches, each with its own dynamics for two forage and two piscivorous fish species.

Lessons learned and project adjustments:

• We have decided that Lotka-Volterra competition is not appropriate for the forage fish, and are in the midst of investigating alternatives that include dynamics of size and numbers and which allow for either continuous reproduction or reproduction only at the end of the season. The 1999 FMP for the Bering Sea identifies the spawning seasons for most of the species that we are considering. None of these species has year-round spawning and there is difference in the initiation and duration of spawning across species. This calls for a model in which populations are updated through recruitment at different times in the year.

Integration activity: In addition to participation in the regular conference calls of both PIs and modelers, we have initiated contact with various field people to ensure that our models are relevant and integrated with their work. These include David Irons, Kathy Kuletz, Heather Renner (all for seabirds, B63, B64, and B65) and Andrew Trites (for fur seals, B67).

Education and Outreach: Nothing to report at this time

Next year's Work plan (not part of the 5 page target length): At the end of your progress report, please update your work plan for the coming year. In particular, add detail for 2009. Contact Mike Sigler if you have any questions in regards to your work plan. Follow this template:

BSIERP B74 Competing fur seal-seabird-pollock model, Marc Mangel, marc.mangel@gmail.com, 831-234-2970

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2009-2012 Tasks, Assignments, Timeline

What	*Who*	*Start (2009)*	*Other key dates*
Update forage fish competition equations, allowing for seasonal reproduction and more than two competitors	Mangel	March 2009	Complete June 2009
Expand model of predators beyond a single individual, allowing intra- and inter-specific interactions with other top predators to affect resource return in a patch	Satterthwaite	March 2009	Complete June 2009
Add age structure to fish populations and annual reproduction of predators	Mangel & Satterthwaite	May 2009	Complete August 2009
System-specific model parameterization and sensitivity analysis	Satterthwaite, Richerson & Mangel	August 2009	Complete October 2009
Comparison of model outputs with FEAST and field data	Satterthwaite & Mangel	October 2009	Complete April 2010
Development of State Dependent Life History Model (SDLH)	Satterthwaite & Mangel	October 2009	Complete October 2010
Results and sensitivity analysis of SDLH, comparison with behavioral foraging model, FEAST, and data	Satterthwaite & Mangel	October 2010	Complete April 2011
Completion of manuscripts	Satterthwaite & Mangel	Ongoing	Complete September 2011

BEHAVIORAL MODELING (M.54) Timeline

Event	**Completion**
•Initiate project	October 2008
•Model 1: Coupling Diet Choice and Central Place Foraging	February 2009
•Model 1 Sensitivity Analysis	August 2009
•Model 2: Prey field age structure added to Model 1	October 2009
•Comparison of Model Results with FEAST and field Data	April 2010
•Development of State Dependent Life History Model (SDLH)	October 2010
•Results and Sensitivity Analysis of SDLH Model	April 2011
•Completion of Papers Comparing FEAST, Behavioral Foraging Model & Data	