TITLE:

A spatial model of upper-trophic level interactions in the eastern Bering Sea

PRINCIPAL INVESTIGATOR: Pat Livingston

PERIOD OF RESEARCH: August 1996 - September 1998

Progress

We have completely parameterized a multispecies virtual population analysis (MSVPA) model which characterizes the predation interactions between major groundfish populations and one marine mammal predator, northern fur seal, in the eastern Bering Sea for the time period 1979-1995. Development of this model was scheduled for our first and second years of work. This model will provide us with starting values of juvenile walleye pollock abundance and estimates of prey suitabilities for our spatial model of upper trophic level interactions. The final year of work is to be spent on parameterizing and initial validation of the spatial model. We have thus far obtained and adapted computer code for the model, familiarized ourselves with its operation, and begun the search for the appropriate data for inclusion into the model.

Scientific Accomplishments

We have spent the majority of research effort for this project during the past year on validating and documenting the MSVPA model, a crucial step that was not included in our original proposal. Validation of the model included a sensitivity analysis of the model to perturbation of key input parameters, analysis of the varying assumptions that can be made about the values of other food available to predators, and statistical analysis of the variability in estimates of prey suitability. The results from these analyses are now being documented in a draft report of the eastern Bering Sea MSVPA model and its results, which will be sent out for review upon completion and published as a NMFS processed report and later as chapters in a doctoral dissertation, and as peer-reviewed publications.

Key outputs of the MSVPA model are time series of age-0 and age-1 walleye pollock abundance. These time series are estimates of the abundance of juvenile pollock prior to predation, whereas the time series of abundance available from adult survey and traditional stock assessment methods provide estimates of pollock abundance upon recruitment to the fishery, at ages 3 and older. If we are to understand the effects of climate on survival of early life stages, we need to have estimates of post-larval pollock that more accurately reflect abundance prior to predation as juveniles. This model is an important tool which provides these estimates by using data on ration and predation rates on juvenile pollock by groundfish and other important predators and backcalculating juvenile pollock population sizes from known adult population sizes for a series of years. Other SEBSCC PI’s have used these juvenile abundance time series to relate them to population changes of their species, such as northern fur seals. These juvenile pollock time series do indicate possible climate-related changes in pollock recruitment (Livingston and Jurado-Molina, in review), and could be evaluated further in this regard using more detailed indices of the physical environment that could be important to survival of early life history stages of pollock. Ultimately, this model is a necessary piece of the work that needs to be done to understand the relative roles of climate, predation, and human influences on pollock abundance trends.

Sensitivity analysis of the Bering Sea MSVPA this past year revealed which input parameters were most important in determining the values of selected key output variables. For example, model input perturbations of ration and parameters determining population size of arrowtooth flounder, walleye pollock and Pacific cod were the most significant variables explaining changes in model estimates of age 1 walleye pollock population size. Perturbations in inputs parameters for predators such as Greenland turbot, northern fur seal, and yellowfin sole were not important in explaining changes in age 1 walleye pollock population size. These analyses give us information as to which predators contribute most to the predation mortality of a particular groundfish species. This will help guide future modeling and field sampling plans on these species interactions.

Several years of predation data derived from field samples are entered into the model for each predator. A suitability coefficient is estimated by the model for each predator age, prey age, and quarter of the year combination using all years of predation data. However, it is important to check the stability of the estimates of these suitability coefficients from one year to the next as a check of the appropriateness of the functional feeding response used in the model and as a way to check if the field sampling effort was sufficient in a particular year. An analysis of the stability of the suitability coefficients has just been carried out and is now being included in a draft report that will be reviewed and published as a NMFS processed report.

Applications

Publications

Livingston, P.A. and J. Jurado-Molina. In review. A multispecies virtual population analysis model of the eastern Bering Sea. Submitted to ICES mar. Sci. Symp. Series.
Jurado-Molina, J. In prep. A description and analysis of the eastern Bering Sea multispecies virtual population analysis model. NOAA/NMFS Processed Report.

Presentations

Jurado-Molina, J. 1997. A multispecies approach to stock assessment in the Bering Sea. Presented Nov. 1997 as a Quantitative Seminar of the School of Fisheries , University of Washington, Seattle, WA.
Jurado-Molina, J. 1998. A multispecies approach to stock assessment in the Bering Sea. Presented April, 1998 at the Graduate Symposium in Fish Populations and Management, School of Fisheries, University of Washington, Seattle, WA.

Posters

Livingston, P.A. and J. Jurado-Molina. 1997. A multispecies virtual population analysis model of the eastern Bering Sea. Poster presented at: 1997 ICES Recruitment Symposium, Baltimore, MD.

Steps to Completion:

This year we will parameterize the spatial model of upper trophic level predation in the eastern Bering Sea. This will involve getting area specific data for bottom temperature, pollock catch, survey, and other biological information. We will also be doing a retrospective analysis of walleye pollock distribution by season in the eastern Bering Sea in a cold, warm, and average year in order to derive migration matrices for pollock, a necessary input to the model. Preliminary searches for existing data in this regard show that there will likely be large data gaps in knowledge on seasonal pollock distribution. Because of the time lag involved in first receiving the SEBSCC funds and contracting for a graduate student to perform some of the work, we are approximately one year behind schedule. We do not require further funding since we will be spending 1998 SEBSCC funds received for the work to be performed in 1999. Since we are still in initial phases of parameterizing the spatial model it is difficult to know how time consuming this phase will be. We anticipate there will be some obstacles in deriving area specific inputs either due to lack of sufficient data or to the extra effort involved in deriving such estimates. However, we hope to have a parameterized spatial model and begun some initial validation work by the end of 1999. **Revised Milestones**.

Activity	**FY 97**	**FY 98**	**FY 99**
Complete MSVPA for inputs to spatial model	X	X	-
Adapt BORMICON code to southeastern Bering Sea	-	X	-
Parameterize growth, feeding, and migration submodels	-	X	X
Initial model validation	-	-	X