

North Pacific Research Board Semiannual Progress Reports
Project # 607

Title: Modeling study on the response of lower trophic level production to climate

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Project Summary:

The most prominent climate trends resulting from global climate warming in the southeastern Bering Sea, reduced sea ice cover and rising seawater temperature, have profound impacts on lower trophic level production and fishery production. Some explanatory hypotheses relating sea ice variability to marine ecosystems have been proposed, such as the Oscillating Control Hypothesis (OCH, Hunt et al. 2002), but have not been studied through a coupled ice-ocean ecosystem model yet. This study aims to establish a coupled ice-ocean ecosystem model including both pelagic and sea ice habitats, based on the existing pelagic ecosystem model (Jin et al. 2006b) for the Bering Sea and the ice-ocean ecosystem model (Jin et al. 2006a) for offshore Barrow. We will conduct sensitivity studies of the impact of physical and biological process variations on primary production, nutrient cycling, phytoplankton species composition, and carbon export to benthos. We will provide recommendations on how, when and which observations should be made to ensure effective improvement in understanding of the Bering Sea ecosystem. Historical observations from the NOAA mooring site M2 are being used to construct a multi-year (1958-2005) model run. The long time series of biogeochemical model results will be used to elucidate the lower trophic level productivity response to climate changes.

Progress Summary:

Based on our success using a coupled ice-ocean model to describe the ice-associated blooms in 1997 and 1999 (Jin et al., 2007), we continued with model runs from 1970 to present. We have worked on validating the long-term model performance and investigating the linkage of the lower trophic level production to decadal climate effects on the regional ecosystem and fishery production.

Model results are validated favorably with the following observations: 1) temperature, salinity, fluorometer data at 12m, 24m and 44m at NOAA/PMEL mooring M2 from 1995-2005; 2) daily SeaWiFS chl a data (1997-2005). While the quantity of variability

of the primary production did not show an increase/decrease trend in the past three decades, there exists a shift of dominant phytoplankton species coincident of the Pacific Decadal Oscillation (PDO) index. The modeled annual primary production was dominated by ice algae before the 1976/77 regime shift, and by open water species of diatom and flagellates thereafter with only occasional ice algal blooms. Fish catches in the eastern Bering Sea showed mixed response to the climate changes. Among the 12 dominant economic fish species, only Walleye pollock and Yellowfin sole showed significant correlations with the PDO index in certain regions. This indicates that a more complicated system analysis is necessary to fully understand the response of higher trophic level production to climate changes.

A graduate student was hired to work on the statistics in the summer semester of 2007. We are in progress to write a manuscript on the broad model validation and statistical research.

Outreach and education:

- A graduate student was hired to work on statistics of the model variables, climate index and fishery catch data in summer 2007.
- Jin, Deal and Lee (in Korea) are planning to chair a session in the 2008 Ocean Science Meeting in Orlando on March 2-7. Session title is "Ecosystems in sea ice influenced areas: observations and modeling studies" (Session statement will appear on AGU web site soon)

Updates of our project web site: <http://www.frontier.iarc.uaf.edu/nprb2006/>

Reference

Jin, M., C. Deal, J. Wang, V. Alexander, R. Gradinger, S. Saitoh, T. Iida, Z. Wan, and P. Stabeno 2007. **Ice-associated phytoplankton blooms in the southeastern Bering Sea.** *Geophysical Research Letters*, 34, L06612, doi:10.1029/2006GL028849.