PROGRESS REPORT:

Harmful Algal Bloom Dynamics in the Gulf of Maine

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Introduction

Paralytic Shellfish Poisoning is a significant ailment which is caused by consumption of shellfish which have accumulated dinoflagellates containing saxitoxin. These toxic dinoflagellates are a type of eukaryotic algae which cause a phenomenon called harmful algal bloom (HAB) or "Red Tide" when they occur in large numbers. In the Gulf of Maine, HABs are caused mainly by the phytoplankton species *Alexandrium fundyense* (Anderson et al., 2005a). *Alexandrium* blooms occur during the summer months, and can have a devastating effect on the New England shellfish economy. Some of the many factors which affect the development of HABs are wind, ocean current, temperature, salinity, and the presence of "dormant" *Alexandrium* called cysts (Townsend et al., 2005; Anderson et al., 2005b). Another possible factor, which will be examined in this project, is the interaction between *Alexandrium* and other phytoplankton species. The great number of factors involved facilitates the need for a more comprehensive nutrient-plankton model and for the use of a supercomputer.

Progress Summary

During the second week of the NSF-sponsored SuperMe program, I read several background documents which were recommended by Dr. Chai (listed under "References" in this document, and summarized above). I took notes on the background material, highlighting in particular the equations and initial values pertaining to *Alexandrium fundyense*, which I would later incorporate into a box model using Stella software. After completing the bundled tutorials in order to familiarize myself with the software, I reproduced a simple model of the Gulf of Maine ecosystem given to me by Dr. Chai. This model included interactions between phytoplankton, zooplankton, nutrient content, and the light levels in the Gulf of Maine. I then added the

Alexandrium species to the model using species-specific parameters. Further complexity was added to the model by incorporating other environmental variables (specifically temperature and salinity).

Problems Encountered

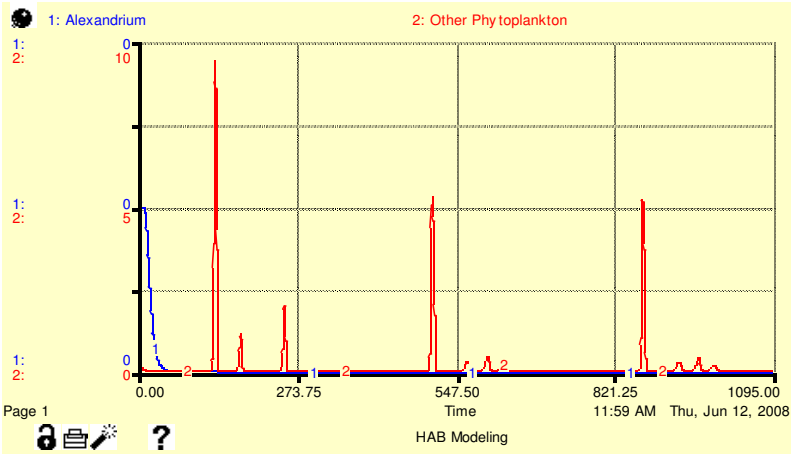

Figure 1: Example of a Stella model output in which *Alexandrium fundyense* fails while the other phytoplankton dominate.

When the Stella model is run, the *Alexandrium fundyense* group and the "other phytoplankton" group cannot yet cycle concurrently. It seems that one group will dominate, thriving and producing blooms over a multi-year period while the other group fails after the first year (Fig. 1). The group that dominates is reversed by changing the initial parameters for growth by only a small amount. There is a likelihood that this illustrates a delicate balance between species in the Gulf of Maine, but my current assumption is that this phenomenon is caused simply by faults in the model that should be eliminated over the next week. Possible faults in the model include lack of parameters or lack of precision in values used. Next week, I will address these issues by adding real-time data from the GoMOOS website for temperature and salinity, and by incorporating more accurate equations and rate constants for *Alexandrium fundyense* from the background papers. Perhaps an ideal ratio between species parameters exists, which may be identifiable running sensitivity tests. Ideally the model should exhibit reoccurring blooms from both the *Alexandrium fundyense* and "other phytoplankton" groups, as is observed in the Gulf of Maine.

Overall Assessment of the Project

Currently the project is moving ahead as scheduled. The next step will be to improve the light and nutrient equations for the model using real-time Gulf of Maine data from the GoMOOS website and algorithms given in the reading material. In the next week, I aim to produce a working Stella model which includes both *Alexandrium fundyense* and other the phytoplankton species as well as incorporating Gulf of Maine data for light, water temperature, salinity, and nutrient content. Later I will take part in building a three-dimensional model with a post-doc under Dr. Chai. I will then compare the 2- and 3-D models and analyze the output for interactions between species.

References

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