Analyzing Algal Bloom Distribution and Modeling Its Productivity in Harpswell Sound

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Introduction
Harpswell Sound, in eastern Casco Bay, Maine, experiences annual paralytic shellfish poisoning events each spring and appears to be a sentinel site for the region. Blooms of the toxic dinoflagellate phytoplankton species *Alexandrium Fundyense* cause these events, known colloquially as red tides. To further understand the seasonal growth of this species, this project was an investigation of the factors that affect the biomass and productivity of all phytoplankton in Harpswell Sound as observed through measurements taken during the Spring and Summer of 2013.

Methods
Scientific boat cruises were conducted approximately weekly throughout late May through early July. At 9 stations throughout the sound (Fig. 1), the profiling package consisting of a CTD and a multichannel chlorophyll fluorometer was deployed, yielding measurements of water properties like salinity, temperature, and chlorophyll across all depths. A Li-COR PAR sensor was used at each station to determine light availability through the water column and to compute the depth of the euphotic zone.

Water samples were taken at several depths at Station 4 and at the surface of Station 9 (Fig. 1). Samples were either filtered or used for a growth experiment in the laboratory. The growth experiments involved incubating the water samples taken from the depth of maximum biomass at the buoy site. Subsamples were inoculated with varying amounts of nutrients (0 to 20μM) and grown under varying levels of irradiance. The phytoplankton concentration was measured every 12 hours using a Millipore Scepter 2.0 Cell Counter.

Results

Spatial Distribution

**Figure 2:** Distribution of A. temperature (C), B. salinity (ppt) and C. chlorophyll (mg/m³) with respect to depth (y-axis) and distance from the Mountain Road Bridge (x-axis) for June 4, 2013. Lombos Hole is the shallowest station and the location of one of three blooms. Another bloom is located near the buoy site and the most concentrated bloom at the mouth of the bay underneath fresh plume from the Kennebec River. This is a typical pattern for the spring-summer time period.

Temporal Evolution

**Figure 3:** Contour of calibrated chlorophyll fluorescence (mg/m³) with respect to time (x-axis) and depth (y-axis) at the buoy site (Station 4). Concentration increased at this site with each subsequent cruise with a subsurface bloom developing just above the pycnocline at ~ 5m and minimal concentrations in the surface freshened layer.

Primary Production Model

**Figure 4:** Model of the temporal evolution of primary productivity at the buoy site. Primary production is in units of g C/ h (representing an average hour of an average day during daylight). The gray line indicates the depth of 1% surface PAR, the approximate boundary between the euphotic and aphotic zones. The subsurface maximum in production occurs at approximately 2.5 m depth, above the biomass maximum.

Taxonomy by Pigmentation

**Figure 5:** Temporal contour of the ratio of chlorophyll fluorescence in response to excitation at 532 nm to 440 nm. Since diatoms contain fucoxanthin, which has a weaker absorption at 532 nm compared to peridinin, dinoflagellates will fluorescence relative more in response to excitation at 532 nm. Thus areas with the fluorescence ratio exceeding 1 (yellow to red) are likely dinoflagellate dominated (containing *Alexandrium* as well) and areas with the fluorescence ratio less than 1 (blue to cyan) are likely diatom dominated. Two cycles of species transition are observed; the bloom observed on July 18 above 8 m is predicted to be diatom dominated, which is consistent with the diatom *Skeletonema* observed microscopically from samples.

Growth Experiments

**Figure 6:** Maximal specific growth rates determined from the incubations throughout the summer. Error bars indicate the range of growth rates calculated for each experimental treatment. The maximum growth rate calculated for each experiment appears to increase with each subsequent date, which matches the productivity model’s predictions.

Summary

- Canonical spring phytoplankton bloom observed to peak towards July
- Multiple transitions in phytoplankton community as biomass increases
- Pattern of multiple blooms observed along Sound, highest concentrations located offshore, suggesting advection into Sound
- Lombos Hole favorable location for accumulation
- Monospecific bloom of diatom *Skeletonema* during July 18 sampling may be due to influx of silicate
- Future work to include developing methods to (1) differentiate growth patterns of different species and (2) incorporating nutrients into model

References


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