COASTAL CURRENTS IN THE GULF OF MAINE:
A MECHANISM FOR ALGAL BLOOM TRANSPORT
RYAN PEABODY AND COLLIN ROESLER
RUSACK COASTAL STUDIES FELLOWSHIP
BOWDOIN COLLEGE, BRUNSWICK, MAINE

Abstract
Blooms of Alexandrium fundyense in the Gulf of Maine cause paralytic shellfish poisoning annually along the coast. In order to understand how these populations are transported, we must quantify the advection patterns in the Gulf of Maine current system. Over a decade of hourly observations of hydrographic properties are available from the Northeastern Regional Association of Coastal and Ocean Observing Systems (NERACOS) buoy array. Daily climatologies of current velocity profiles computed from hourly observations... Tidal velocities were filtered out and data were transposed into cross and along-shore velocity components, and fitted to a periodic function to create a model for water speeds along the coast of Maine at Buoy A (Massachusetts Bay). The climatology shows flows that are generally downcoast and fastest in summer surface waters. The transport model will then be used to estimate the advection of phytoplankton populations along the coast and to compare those estimates with observed patterns.

Introduction
Summer coastal circulation in the Gulf of Maine is downcoast (Figure 1). However, the seasonal climatology or year to year variations have not been quantified. Additionally, the degree to which coastal flow connects the Eastern and Western Maine Coastal Currents (seen above) is not fully understood. These patterns will provide an estimate of advection times for phytoplankton population and the ability to identify underlying forcings that control both current coastal circulation and Alexandrium dynamics.

Methods
Hourly velocities for February 2002 in the along-shore direction at Buoy A are dominated by the predominant twice-daily tidal motions of water (Figure 2). To understand how water masses move over time, it is necessary to remove tidal components and examine the “residual” current flow. A model to remove tidal velocity involved interpolation of hourly observations to minute resolution followed by averaging over the 24 hour, 48 minute tidal period (Figure 3). When applied to tidal data constructed from NOAA provided tidal constituents (black) it proved very effective at filtering out tidal signals (red).

Results
Daily climatologies at each depth were compiled by rotating velocities into cross and along-shore velocity components and computing the median current velocity for every day of the calendar year (Figure 4). A cosine function was then fit to each depth to provide a quantified estimate of baseline flow, peak flow, and the date that peak flow occurred. The quiver plot shows current direction at magnitude at 2 m depth. Current flow is downcoast in the summer across the water column, punctuated by shifts toward southeastern flow. These disappear when the pattern is fit to a curve. In winter flows slow and shift toward the east.

Conclusions
The model for summer circulation proposed by Pettigrew is supported by these data. Residual current flow at Buoy A is predominantly downcoast and accelerates from spring to summer. However, in fall and winter this flow slows and reverses, a phenomenon unaccounted for in previous models of circulation. Surface currents exhibit more variability than bottom currents on a year to year basis. It is possible that years in which harmful algal blooms occurred (2004, 2005) could also be years in which distinctive velocity anomalies occurred.

Further work
Buoy B, E, and I will also be examined over the next year to construct a better model of current flow around the coast of the Gulf of Maine. Temperature and salinity data will be used to determine the nature of the climatological forcings driving yearly shifts in circulation and the source of the interannual anomalies. Using past work on harmful algal blooms in the Gulf of Maine, it may be possible to use this model to shed light on the movements of HABs in the Gulf of Maine.

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References