Overview of the 2005 *Alexandrium* bloom: A regional perspective

Donald M. Anderson[1], Bruce A. Keafer[1], Dennis J. McGillicuddy[2]

[1]Biology Department, Woods Hole Oceanographic Institution, Woods Hole, MA 02543
[2]Applied Ocean Physics and Engineering Dept., Woods Hole Oceanographic Institution, Woods Hole, MA 02543

Blooms of the toxic dinoflagellate *Alexandrium fundyense* are responsible for outbreaks of paralytic shellfish poisoning (PSP) in the Gulf of Maine. This organism has been studied extensively, most recently through the five-year ECOHAB-Gulf of Maine program, a multi-investigator, multidisciplinary study that utilized laboratory experiments, field observations, satellite remote sensing, moored instrument measurements, and numerical models to investigate *A. fundyense* bloom dynamics and patterns of PSP toxicity. This talk will summarize ECOHAB-GOM data and the conceptual models that have been formulated to explain these observations. Data will also be presented on the extensive 2005 bloom that closed shellfish beds from central Maine to Massachusetts, including Nantucket Island, portions of Martha's Vineyard, and 40,000 km^2 of offshore federal waters.

Initial observations suggest that several factors contributed to the 2005 bloom. Abundant rainfall and heavy snowmelt substantially increased the amount of fresh water entering the Gulf of Maine at a critical phase of the bloom season. We hypothesize that this provided micro-nutrients, increased stratification, and augmented alongshore transport that led to high cell abundances and a broad, region-wide dispersal of the organism. Warm temperatures in western waters would have favored *A. fundyense* growth in that region. In addition, several storms with strong winds out of the northeast occurred when cells were abundant and in locations where the wind-driven surface currents could advect them into Massachusetts Bay and keep them there, leading to high cell concentrations and toxicity. Another contributing factor may have been the high abundance of newly deposited cysts in western Gulf of Maine sediments, as documented in a fall 2004 survey. The cyst abundance in 2004 showed a 10-fold increase over an earlier 1997 survey. Post-bloom surveys in the fall, 2005 showed that cysts are present in very low abundances in the southern region, while the cyst abundances along the mid-Maine coast are reduced by about half (vs. 2004). The cyst abundance within Massachusetts waters are quite low, and suggest that localized, in situ bloom development within Massachusetts Bay or southern waters is unlikely. On the other hand, there are still a significant number of cysts in western Gulf sediments – five times as many as there were in 1997, and only slightly less than were there in 2004, so there is potential for another regional event in 2006. Variability in cyst abundance may be an important factor in the inter-annual and inter-decadal bloom dynamics in the western Gulf of Maine.

In retrospect, the factors leading to the 2005 bloom were unusual in several respects (cyst abundance, runoff volume, major storms). A confluence of such factors should be viewed as a rare event – i.e., an event of similar magnitude is not likely in the near future. Nevertheless, we may have entered a "new regime" with more frequent and more intense toxicity in western Maine and southern New England, based on historical patterns and the high levels of cysts observed in the region. Superimposed on this "new regime", we should expect considerable interannual variability in blooms, driven by a variety of both small- and large-scale forcings.