

**Implications for the future:
Plans for data analysis relevant to potential MWRA outfall effects**

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MWRA (Massachusetts Water Resources Authority) is required to monitor for environmental effects of its outfall, which discharges secondary-treated sewage effluent through a diffuser 15 km offshore in Massachusetts Bay. Monitoring results have addressed many of the early concerns about the outfall by demonstrating only minor outfall effects, as expected given the good levels of treatment, initial dilution, and oceanic dispersion, and other benefits of relocating the outfall from Boston Harbor to Massachusetts Bay (which happened on September 6, 2000).

One of the major concerns that remains is: could the outfall stimulate *Alexandrium*? Before 2005, *Alexandrium* was too rare to test this concern. The last toxicity event associated with *Alexandrium* was recorded in 1993. Nonetheless, MWRA had a standing "rapid response plan" in place and when the first signs of the 2005 bloom were observed MWRA initiated the intensive sampling program:

- May 4: Maine shellfish department reports widespread though low PSP toxicity.
- May 5: New Hampshire shellfish department reports high PSP toxicity, indicative of a bloom offshore.
- May 7: GoMOOS buoy data shows the nor'easter pushing water into Mass Bay.
- May 10: Woods Hole Oceanographic Institution (WHOI) wide-area survey finds the bloom strongest in Mass Bay.
- May 11: MWRA begins weekly surveys for *Alexandrium*, coordinating with WHOI.

All told, from early May to early July, MWRA conducted 11 surveys focused on the *Alexandrium* bloom. These were complemented by 14 surveys by WHOI, 4 surveys by Center for Coastal Studies, and 1 survey by University of Massachusetts at Dartmouth. The common goal of all groups studying the bloom was to determine the extent and duration of the bloom, and to communicate results quickly between researchers and managers.

MWRA participated in that effort but additionally looked for evidence that the outfall might have stimulated *Alexandrium*. At this stage of the data synthesis there is no obvious evidence for an outfall effect, but we are looking closely at the data for relevant patterns and conditions:

- Were cells abundant "downstream" of the outfall?
- Were cells more abundant at the depth of the outfall plume?
- Did cells linger near the outfall, even as the bloom declined regionally in July?
- Did *Alexandrium* become more abundant relative to other phytoplankton?

Does modeling fail to fit observed abundance without invoking faster growth?
Were cells nutrient depleted?
Is the outfall an important source of nutrients relative to other sources?
Did low silicate limit growth of diatoms?
Could cells grow fast enough to outpace oceanic dispersion?

Although the bloom of 2005 presented the first opportunity to test for outfall effects, it is ironic that the bloom may have been TOO strong and too fast-moving for this analysis. The water motion that brought the cells into the bay was so strong and fast that it swamped normal circulation and smeared the normal signature of the outfall plume. Patches of abundant cells were so dynamic that it was hard to tell precisely where they had come from. These add to the challenge of interpretation but the groups involved in sampling are continuing to work together to analyze the data.

In 2006, MWRA remains vigilant to news of cells coming from the north, and has been taking samples to detect any early bloom that might be inoculated by local cysts. So far, the season has been quiet.