CHESAPEAKE BAY 2006

WEATHER EXTREMES LEAD TO TYPICAL CONDITIONS

Produced by the Chesapeake Bay Program's Monitoring and Analysis Subcommittee

This newsletter describes the summer ecological conditions in Chesapeake Bay, focusing on the forecasts that Chesapeake Bay Program scientists determined in May 2006. With oscillating periods of low and high flow, the annual freshwater flow to the Bay averaged out to normal. How did this affect dissolved oxygen in the mainstem, harmful algal blooms in the Potomac River and aquatic grass in the upper, mid and lower Bay?

OSCILLATING PERIODS OF DRY AND WET CONDITIONS

J. Thomas, UMCES

Brown marshes in Blackwater NWR reflect the dry spring conditions.

Although the total annual freshwater flow to Chesapeake Bay was near normal in 2006, a dry spring and wet summer characterized this past year (Figure 1). While flow is typically high in the spring and tapers off through summer, 2006 was characterized by an unusually dry spring ending with a late June rain event that led to a rapid increase in river flow and nutrient and sediment loads. A second wet period occurred in late August as a result of the remnants from Hurricane Ernesto.

The oscillating summer conditions led to record low and high nutrient and sediment loads to the Bay during different months. The United States Geological Survey monitors flow and nutrient and loads from nine tributaries (Susquehanna, Patuxent,Potomac, Rappahannock, Mattaponi, Pamunkey, James, Appomattox, and Choptank Rivers), which drain 78% of the Bay's watershed.

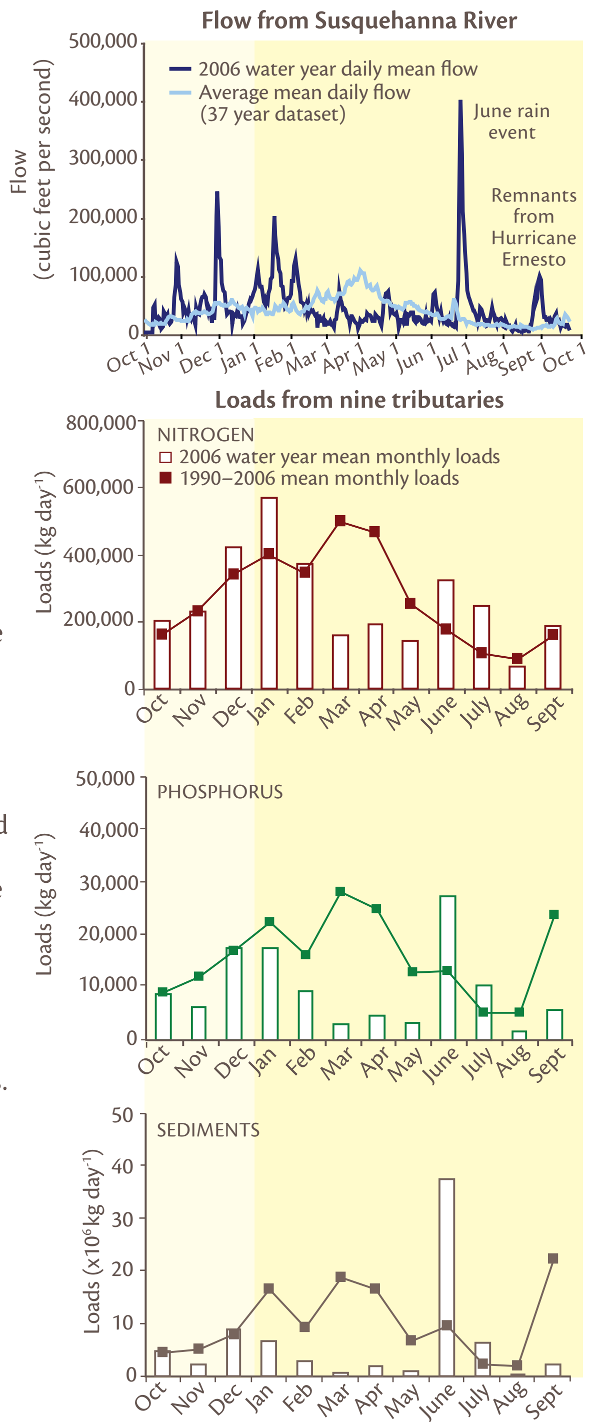


Figure 1: Stream flow from the Susquehanna River and loads from nine tributaries for the 2006 water year (October through September). Yellow shades represent 2005/2006. Data are from U.S. Geological Survey, provisional and subject to revision.

J. Thomas, UMCES

Sediment rushes into a local waterway after June rains hit the Bay area.

NITROGEN

- Loads were much lower than normal* in March, April and May.
- March loads were lowest on record.
- July loads were highest on record.

(–normal conditions are the range between the 25th and 75th percentile.)*

PHOSPHORUS

- Loads were lower than normal* in March, April, May and August.
- Loads in March and May were lowest on record.
- Phosphorus loads are strongly dependent upon sediment loads.

SEDIMENT

- Loads were lower than normal* in March, April and May.
- March loads were lowest on record.
- July loads were the second highest on record.

SPRING CONDITIONS LEAD TO BELOW AVERAGE ANOXIA

The volume of anoxic (dissolved oxygen ≤ 0.2 mg L^{-1}), or oxygen-deprived, water during the 2006 summer was better than average, but still worse than the long-term goal of zero anoxia. In June, Chesapeake Bay Program scientists predicted that the average summer anoxic volume in the mainstem would be 1.08 km^3. The forecast was based on the quantity of nutrients that entered the Bay during the preceding five months. The anoxic volume during June and early July was well below average, then increased at the end of July, reaching the long term average for that time of year (Figure 2). Anoxic volume then decreased until it reached zero during September. The observed average anoxic volume for the summer was 0.93 km^3 or slightly less than the forecasted volume (Figure 3 and 4).

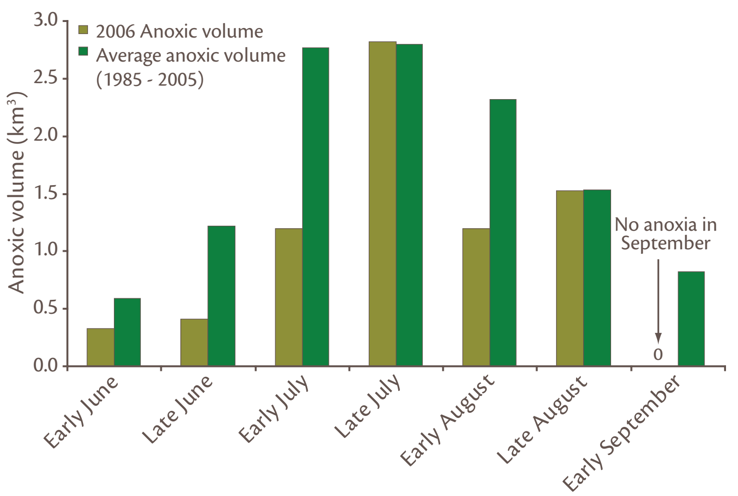


Figure 2: 2006 bimonthly average anoxic volumes compared to the total bimonthly average from 1985-2005. By September, no anoxic water could be detected in the mainstem.

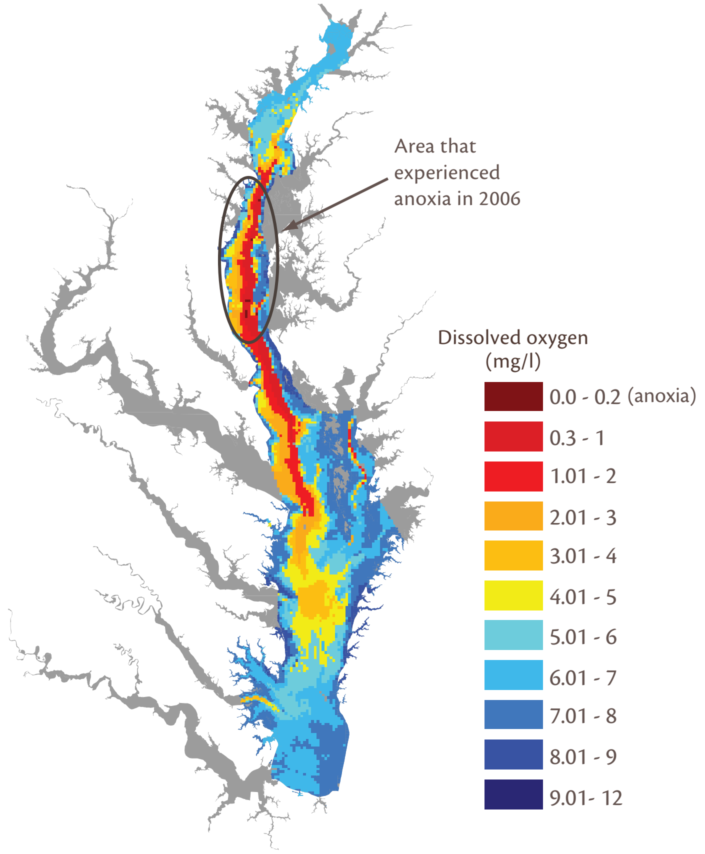


Figure 4: Map of average dissolved oxygen in the mainstem for summer 2006.

The small anoxic volume at the beginning of July may have been due to the record flows the Bay experienced at the end of June. During this time of year there is a boundary, called the pycnocline, between fresher surface water and saltier deep waters. This boundary cuts off the supply of oxygenated water to the deeper waters of the Bay. The large volume of freshwater from the late June flow apparently pushed the pycnocline deeper than normal, thereby reducing the volume of deep waters that could become anoxic.

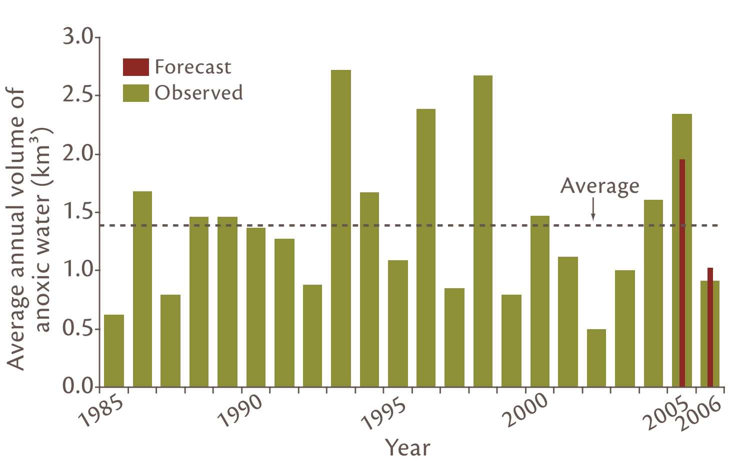


Figure 3: Average annual anoxic volume with 2005 and 2006 forecasted volumes.

Although the forecast focuses on mainstem anoxia, dissolved oxygen (DO) is also measured in the shallow regions of the Bay and its tributaries. Shallow water DO follows a similar pattern to the mainstem in that most low DO events occur in the warm summer months (Figure 5). However, shallow water DO tends to be more dynamic than in the mainstem, with anoxic events occurring on a daily rather than monthly time scale (one cause of shallow water anoxia is discussed on the following page). The minimum DO threshold for shallow waters has been set at 3.2 mg L^{-1}, an amount needed by the living resources that inhabit shallow water.

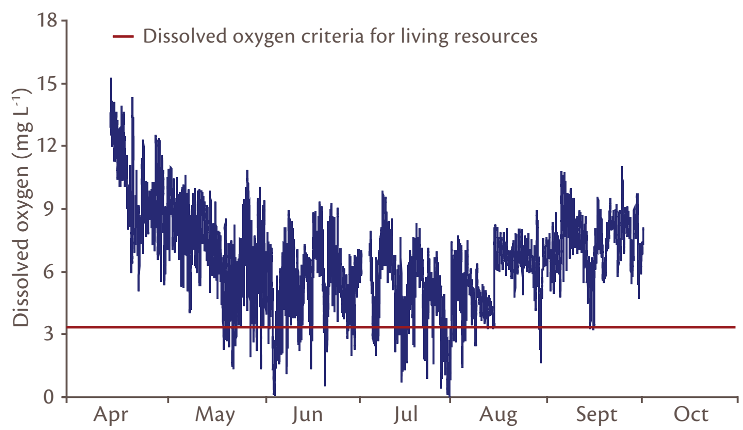


Figure 5: Dissolved oxygen at Piney Point, Maryland, on the Potomac River's northern shore. Data from Maryland Department of Natural Resources.

SHALLOW WATER HABITAT AFFECTED BY DEEP WATER ANOXIA

A combination of harmful algal blooms and low dissolved oxygen (DO) led to fish kills in several Chesapeake Bay tributaries this summer. In the Potomac River, more than 8,000 fish, including spot, shad, striped bass, yellow perch and cownose rays died due to a combination of low DO and fish toxins released by a bloom of the harmful algae *Karlodinium veneficum* (Figure 6). While elevated nutrient levels are likely responsible for causing the harmful algal bloom and ultimately the low dissolved oxygen, a sequence of wind events facilitated low DO deep water moving into the shallows where the fish kill occurred. The process leading to deep waters moving into the shallow is known as a seiche event. A seiche is an oscillating wave caused by atmospheric or seismic activity. In this case, the seiche was caused by sustained northeasterly winds that piled surface water into shallow areas of the Potomac River, pushing deeper waters to the other side of the Bay (Figure 6a). The wind abruptly changed direction on June 2 (Figure 6b), releasing the surface water wave and causing low dissolved oxygen deep water to slosh back into the shallow areas (Figure 6c). The impacts of this weather event can be seen in the temperature, salinity and DO concentrations at the Piney Point, Maryland, continuous monitoring station (Figure 6). The combination of low DO, algal toxins and in part, some fish trapped in a pound net that could not avoid the conditions, was all believed to contribute to the fish kill.

A similar fish kill occurred in the Corsica River for the second year in a row. A combination of karlotoxins and a crash in dissolved oxygen from decomposition of the algal bloom led to a kill of 2,000 fish, mostly white perch. The 2005 event, in comparison, killed 30,000–50,000 fish (www.dnr.state.md.us/Bay/hab).

MD DNR

2005 Corsica River fish kill.

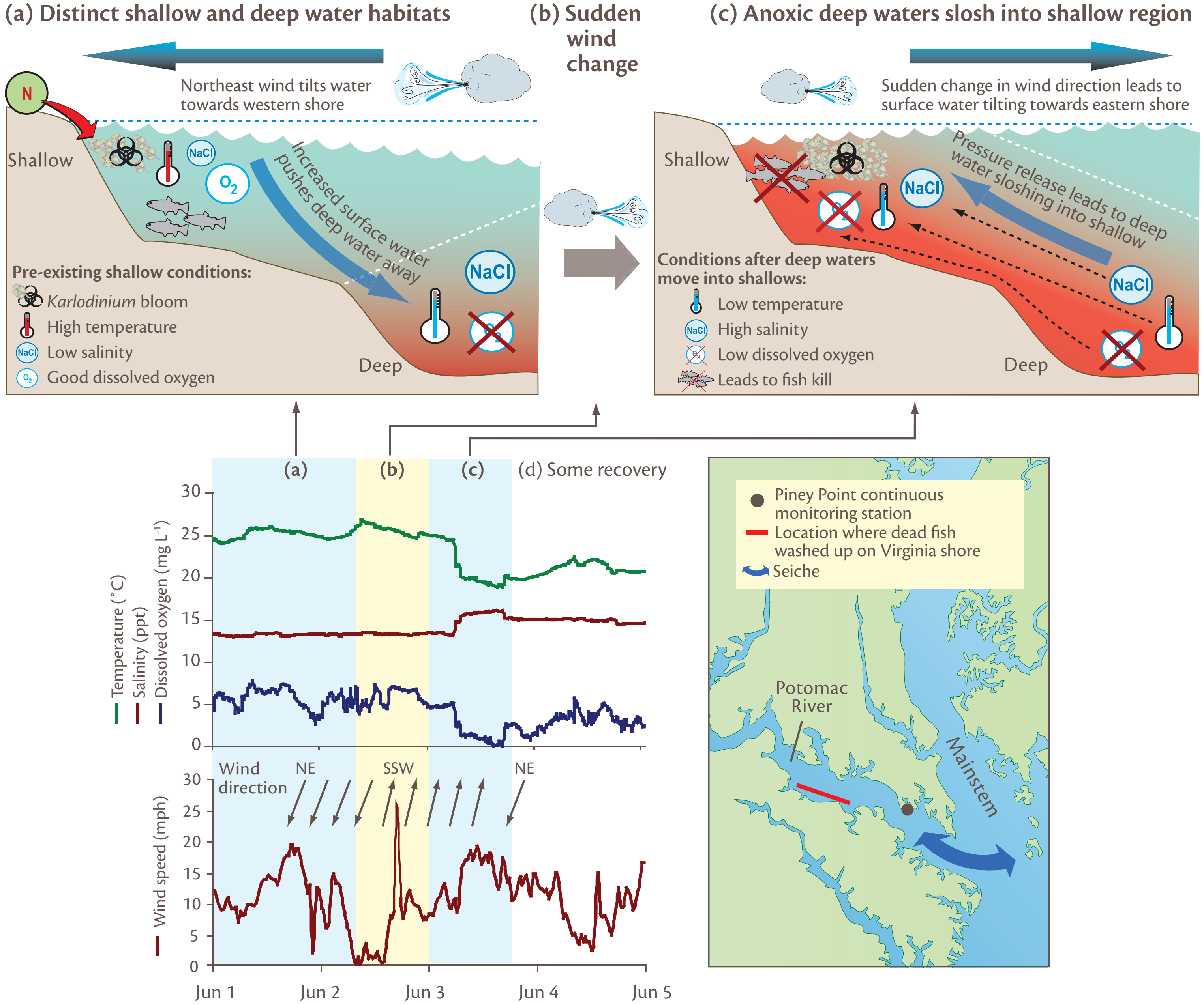
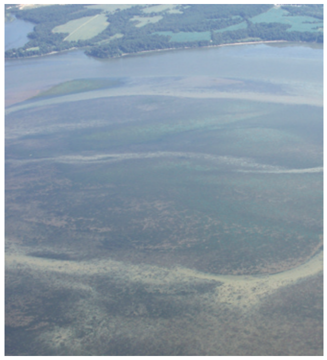


Figure 6: Summary of conditions that led to June fish kill in the lower Potomac River and continuous monitoring data from Piney Point, Maryland. Data from MD DNR.

AQUATIC GRASSES SHOW RESILIENCE TO RAIN EVENTS

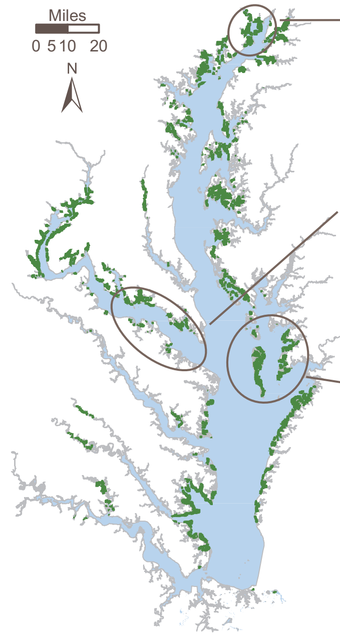
Preliminary survey results indicate that the distribution of aquatic grasses was not severely affected by this year's extreme weather conditions. In the northern Bay, aquatic grass beds have expanded considerably in recent years and may have led to improved resilience to turbidity caused by rain events.

In spring of this year, aquatic grasses in the northern Bay, lower Potomac River and Tangier Sound regions were forecasted to increase slightly. Current survey results suggest that the forecasts were not always accurate. The beds in the Susquehanna Flats increased more than expected and the beds in the Potomac River had mixed results (Figure 7). The aquatic grass in Tangier Sound may have recovered slightly this year from last year's dieback. Full survey results will be available in early 2007.



M. Trice, MD DNR

The aquatic grass beds in the upper Bay were resilient to summer storm events.



There was larger than predicted growth in Susquehanna Flats.

While it was predicted that aquatic grass would increase slightly in the lower Potomac River, there were mixed results. The beds along the northern shoreline increased, but the beds along the southern shoreline decreased.

Although conclusive results cannot be made, aquatic grass in Tangier Sound seem to be making a comeback after the 2005 dieback from high water temperatures. The forecast predicted a slight recovery from the dieback.

Figure 7: Fall 2006 field observations of aquatic grass with 2005 distribution.

LATE START TO HARMFUL ALGAL BLOOM

Harmful algal blooms (HABs), predominantly *Microcystis aeruginosa*, have been occurring in the mid-reaches of the Potomac River for over 20 years. For the past two years, bloom extent, onset and duration have been forecasted in order to assist management. This year's bloom was forecasted to start in early summer, extend for up to 20 miles, and last for 1–2 months (see table). The actual bloom occurred later in the summer and extended farther down the river. The remnants from Hurricane Ernesto prematurely ended the bloom in late August, leading to a duration that was close to the forecast.

M. aeruginosa can produce a toxin that is harmful to the liver if ingested. A recreational health advisory was issued on August 31 for affected waters (Figure 8). HABs also occurred in other regions of the Bay this summer. For more information, visit www.dnr.state.md.us/bay/hab and www.eyesonthebay.net.

Bloom condition	2006 Forecast	2006 Observed
Bloom onset	Early summer	Late summer
Bloom duration	Moderate (1 to 2 months)	Moderate (1.5 months)
Bloom extent	Small to medium (<20 miles)	Medium (26 miles)

Comparison of harmful algal bloom forecast to observed conditions.

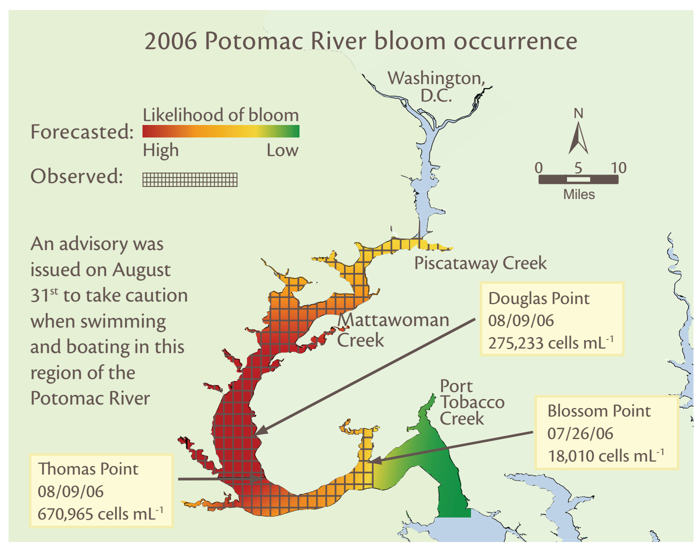


Figure 8: 2006 harmful algal bloom occurrence with forecasted likelihood.

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