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Microcystis Blooms (HAB)

Microcystis aeruginosa is a type of cyanobacteria, or blue-green algae. Blooms occur when several colonies start combining rapidly when conditions such as nutrient concentrations, salinity and temperature are optimal. Blooms can be toxic and lead to low dissolved oxygen levels.

Indicator Details 2015

Microcystis Blooms (HAB)

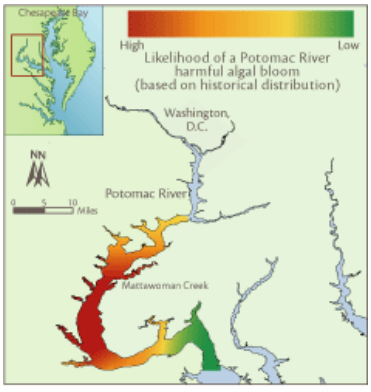
Forecast

Low to moderate severity *Microcystis* blooms are forecast to occur in the tidal Potomac River this summer; 9% ± 2% of samples collected over the summer are predicted to have levels that are considered to be "bloom" concentrations (>10,000 cells·mL^{-1}). Typical sample collection during summer for the affected region is 72 samples. If this prediction holds true, this summer would be ranked as the 8th best (or 11th worst) among the last 18 years of monitoring.

Categories of bloom severity are based on the percent of maximum bloom conditions used in the regression (Between 1989 and 2006, maximum was 25% of samples in 1994). Low severity = 0-33% of maximum (0 to 8% of summer samples), moderate = 33-66% (9 to 17% of summer samples), high = 66-100% of maximum (18-25% of summer samples).

Microcystis forecast provided by Peter Tango (USGS)

Maps



General location of harmful algal blooms in Potomac River. (Based on historical distribution.)

Microcystis blooms tend to occur in the mid to upper reaches of the Potomac River where conditions such as salinity and nutrient levels are optimal for bloom growth. Historical data shows that the highest likelihood of a bloom is in the vicinity of Mattawoman Creek, which is also where blooms usually start. Salinity levels in the lower reaches of the Potomac are too high for *Microcystis* survival, leading to a low likelihood of occurrence.

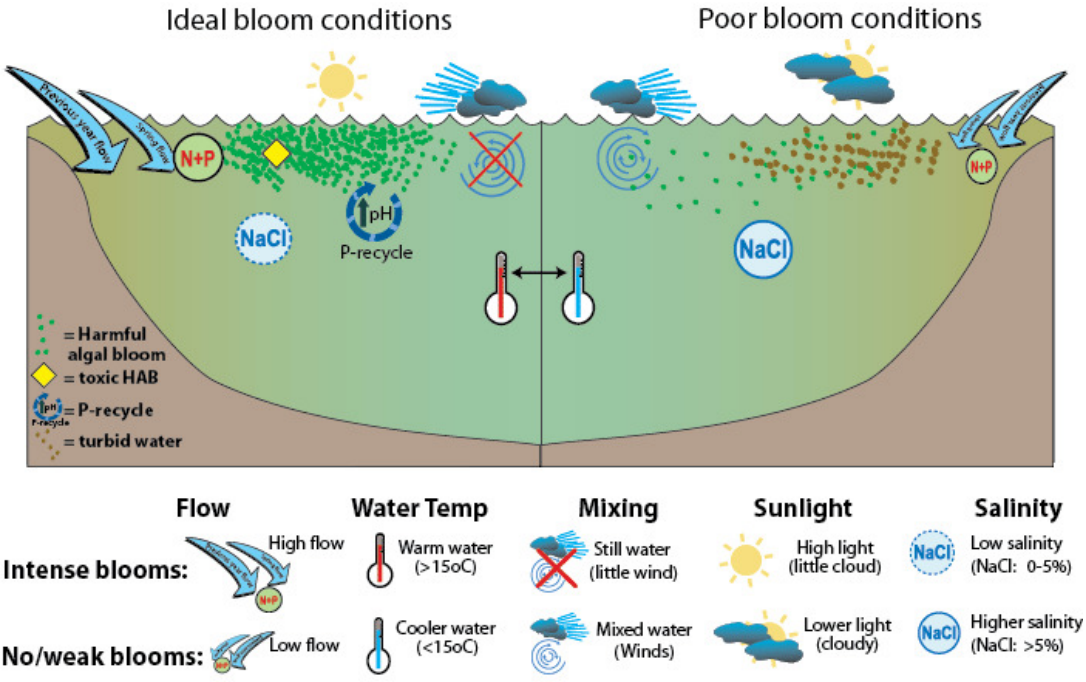
Data

*Note: While no blooms were detected by routine Department of Natural Resources (DNR) surveys in 2007, bloom conditions with cell counts up to 50,000 cells·mL^{-1} were recorded by scientists from Morgan State University in mid June.

Blooms of the harmful algae *Microcystis aeruginosa* (a cyanobacterium) have occurred in the Potomac River for most summers since the 1960s. These blooms have had numerous ecological, economic, and human health implications and have been an impetus for major nutrient reduction programs. Consequences of these blooms depend largely on their scale (extent and duration) and intensity (cell density). Historic data shows that the scale and intensity of Potomac River HABs are variable from year to year. In some years (e.g. 2004) the scale of the bloom may be moderate but the intensity is high, while in other years (e.g. 1994) the scale may be high, but the intensity moderate.

Methodology

The main factors that determine HAB occurrence and characteristics in the Potomac River are nutrient availability (primarily phosphorus), salinity, water temperature, and light availability. For blooms to occur, the water temperatures have to be above 15 °C (59 °F) and salinity below 5 ppt. More intense blooms are also likely to occur if conditions are still (little wind mixing) and cloud free (higher sunlight). An overriding influence on bloom occurrences is river flow rates, most likely due to its effect on nutrient availability. As a result, monitoring has shown HAB variability associated with annual and seasonal weather patterns affecting nutrient delivery to the estuary.



Conceptual diagram detailing the main factors that determine HAB occurrence and characteristics in the Potomac River

Forecast approach: This year's forecast is based on a linear relationship between total Potomac River flow and the percent of water quality samples containing bloom levels of *Microcystis*. Note that these methods are slightly different than those previously used.

The algal community samples for assessing cyanobacteria levels are collected from the region of the Potomac between the Washington DC/Maryland border down to the Route 301 bridge. MD DNR typically collects 8 sets of 9 samples from June to September for a total 72 samples each year. An algal sample in this case is considered at bloom levels if it contains greater than 10,000 cells per milliliter of the cyanobacteria *Microcystis*.

River flow data are collected at the Point of Rocks location on the Potomac River. The 2008 portion of the data set is final flow data while January through May 2009 data are provisional.

Data used to develop the relationship are from 1989-2006, however, they exclude 1997 and 2004. The bloom conditions in those two years are much lower than expected by the trajectory of the model and may be a function of conditions related to conditions associated with extremely wet conditions (2003) to flood level flow events (January 1996) impacting the region. When cumulative flow over the Point of Rocks on the Potomac River is greater than 5.9 x 10^{11} cubic feet over the 17 months preceding the summer as is the case with these two years, our linear model fails. Further model developments are needed to better capture the conditions involving such high flow years to more accurately model the bloom patterns.

Data are available for the earlier period 1985-1988. These data are not included in this cyanobacteria forecast model, however, as phosphate bans were going into effect among the partner States and Washington DC in the Potomac River basin over multiple years. The post-1989 P-ban implementation era represents the time beyond this important and significant nutrient control period. The forecast could benefit from the flow model being expanded to include nutrient loads or a similar nutrient index.

The worst year in our 1989-2006 time series was 1994 and it showed 25% of all summer samples containing bloom levels of *Microcystis*. Since that time we have experienced widespread blooms (2004) but that bloom expanded in July and died out in August limiting its duration. Recently, bloom conditions have been less than levels forecast with our basic river flow model. In 2007 MD DNR samples showed no bloom detections and in 2008, the model predicted 9% of samples would detect bloom conditions when only 1.3% of samples detected blooms. Once again this year based on the flow conditions leading up to this summer we predict 9% of samples will show *Microcystis* bloom conditions for summer 2009, a moderately severe cyanobacterial bloom year for the Potomac River.

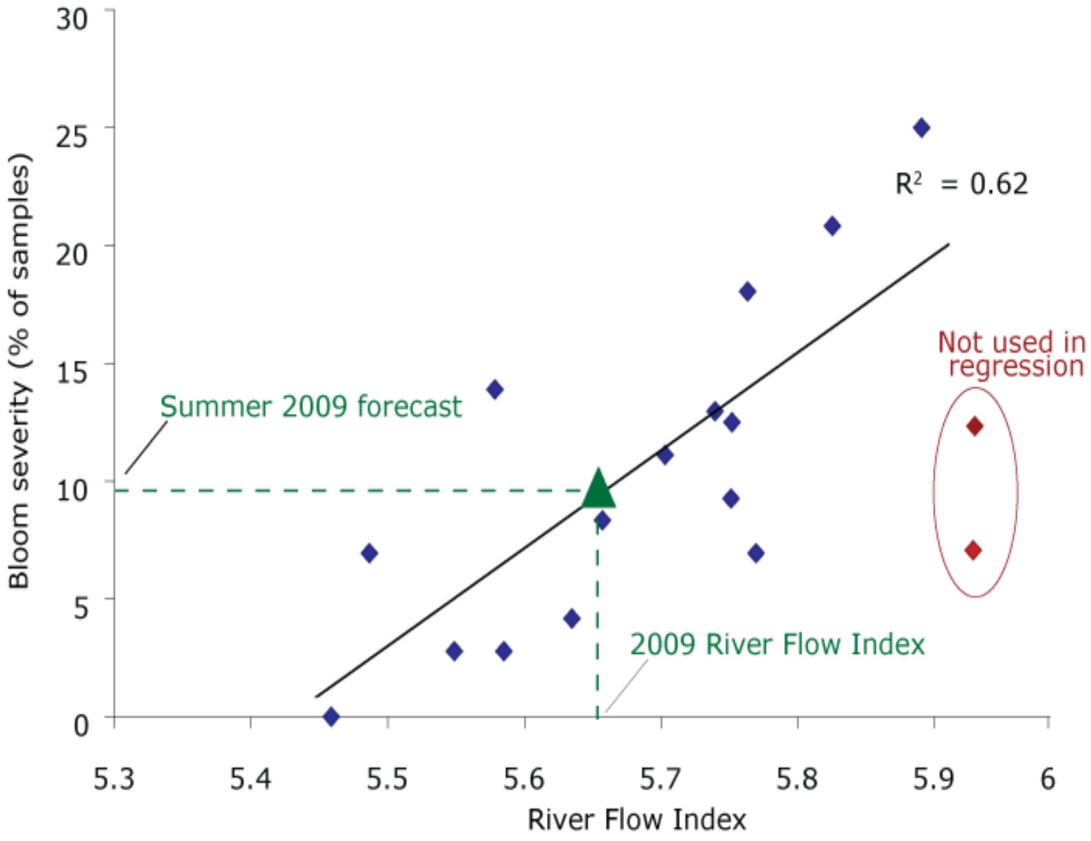


Figure 1. Regression relationship between river flow index at Point of Rocks, Potomac River, MD and Bloom Severity Index as % of samples in a summer season where bloom levels of *Microcystis* were detected. 2008 Summer Forecast is shown here.

X-axis: River Flow Index = Log_{10}(Cumulative 17 month flow in cubic feet/(1* 10^{-6}))
Y-axis: Bloom Severity Index = % Summer Potomac samples at bloom level

Categories of bloom severity are based on the percent of maximum bloom conditions used in the regression (Between 1989 and 2006, maximum was 25% of samples in 1994). Low severity = 0-33% of maximum (0 to 8% of summer samples), moderate = 33-66% (9 to 17% of summer samples), high = 66-100% of maximum (18-25% of summer samples).

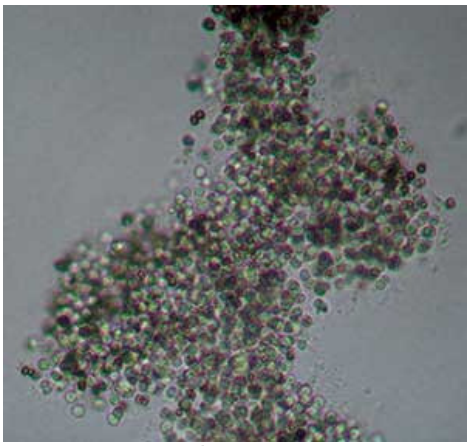
Background

What are harmful algal blooms (HABs)?

A harmful algal bloom (HAB) is defined as the proliferation of algae, causing negative impacts to other organisms. Harmful algal blooms may be composed of microscopic cyanobacteria or phytoplankton that, when the conditions are right, multiply and build up into bloom levels, often creating thick mats and or surface water scum. These blooms may become harmful to other organisms, leading to fish kills or human health problems, due to the natural toxins they may contain, and/or reduction in dissolved oxygen levels during their decay.

Surface bloom of the cyanobacterium Microcystis aeroginosa *in the Potomac River in August 2004. (Source: Morgan State University Estuarine Research Center)*

What is *Microcystis aeruginosa* ?
Microcystis aeruginosa is a type of cyanobacteria, or blue-green algae. Cyanobacteria are not algae–they are actually closely related to bacteria and are photosynthetic. *Microcystis* are colonial, which means that they group together in colonies. Blooms occur when several colonies start combining rapidly. *Microcystis* blooms tend to have a green color and are very thick. Blooms can also be toxic and can cause health problems in animals. Humans can have health problems such as gastrointestinal problems if they drink the affected water. Humans can also get a skin irritation if they come in contact with it. Blooms occur annually in late summer in the Bay and occur in tidal freshwater.



Microscopic view of Microcystis aeruginosa*. Cells 3-4.5 µm diameter. (Source: Department of Biological Sciences. Old Dominion University.)*

What factors encourage harmful algal blooms?
The major factors needed for an algal bloom to occur include water temperature, salinity, and the amount of nutrients in the water. Excess nutrients such as those contributed by human activities can increase the intensity of the bloom (see Methodology tab).

What are some local areas that are prone to *Microcystis aeruginosa* blooms?
Potomac River, Upper Bay, Sassafras River, Bush River, Magothy River

Additional Information

Relevant Web Sites

MD DNR - Eyes on the Bay
Virginia DEQ - Chesapeake Bay Monitoring Programs
Maryland DNR - Harmful Algal Blooms
Maryland DNR - *Microcystis* FAQ