Background on a proposed HAB-supported basis for Chlorophyll a criteria in Chesapeake Bay

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Outline

• Overview on how the HAB based criteria recommendations developed to focus on cyanobacteria and their toxins.

• Address concerns about data relationships worthy of supporting criteria

Widespread and Diverse Algal Bloom Activity in Maryland's Bays

Karlodinium bloom
Photo by C. Luckett

"Black Tide"
Photos by ANSERC

Macroalgae proliferation
Frog Mortar Creek
Photo by P. Tango

Local impacts on fish, shellfish and the fishing industry can be extensive

30,000-50,000 fish killed
Corsica River, MD

Macroalgae fouling crab traps, Susquehanna Flats

Crab jubilee with algal bloom, Potomac River

Bird kill, Poplar Island, Chesapeake Bay, 2001

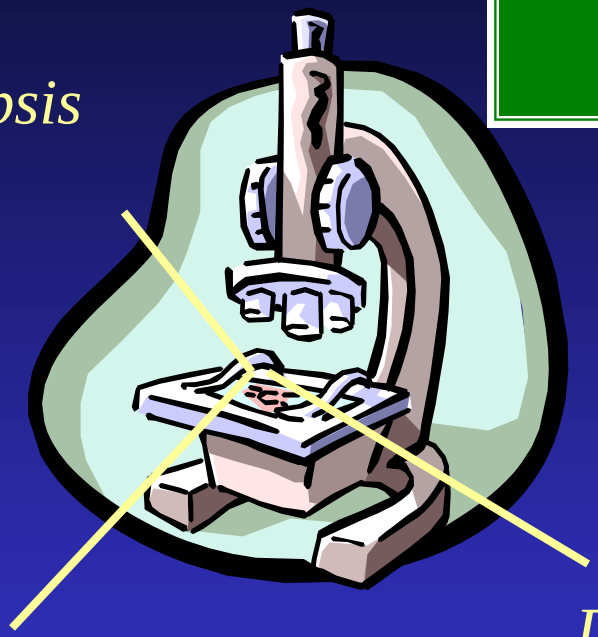
Bird kills and inducement of disease conditions have been related to cyanotoxins, the most common algal toxins detected in the Bay, These same toxins are linked with human health risks

Steatitic condition (left) in Great blue heron, Chesapeake Bay. Note extensive fat layer as compared to non-steatitic bird (right)

Photo's by Peter McGowan and Cindy Driscoll

>30 species of toxigenic phytoplankton recognized in the Chesapeake Bay tidal waters

Cylindrospermopsis raciborskii



Dinophysis acuminata

Pseudo-nitzschia spp.

Records of cyanobacteria toxin history in the region

Sassafras River August 2005
Photo by John Vail

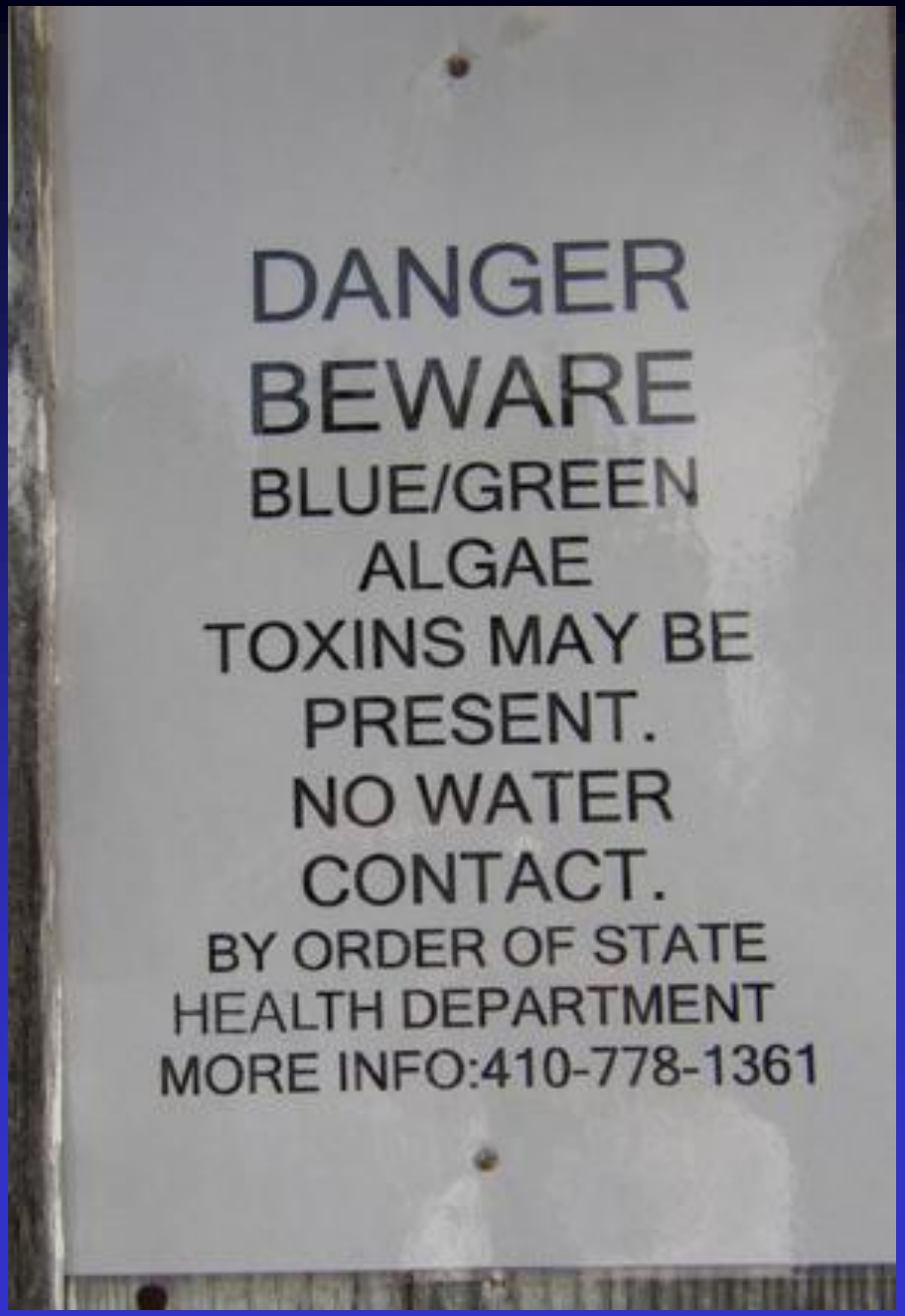
• **Tisdale (1931a,b) and Veldee (1931) *Am. J. Public Health*:** describe a regional epidemic of water-borne gastroenteritis in 1930-31, related to 'a chemical irritant' in the water, and associated with algae blooms including the Potomac River drainage near Washington, DC; Tisdale (1931a): algae referred to blue-greens.

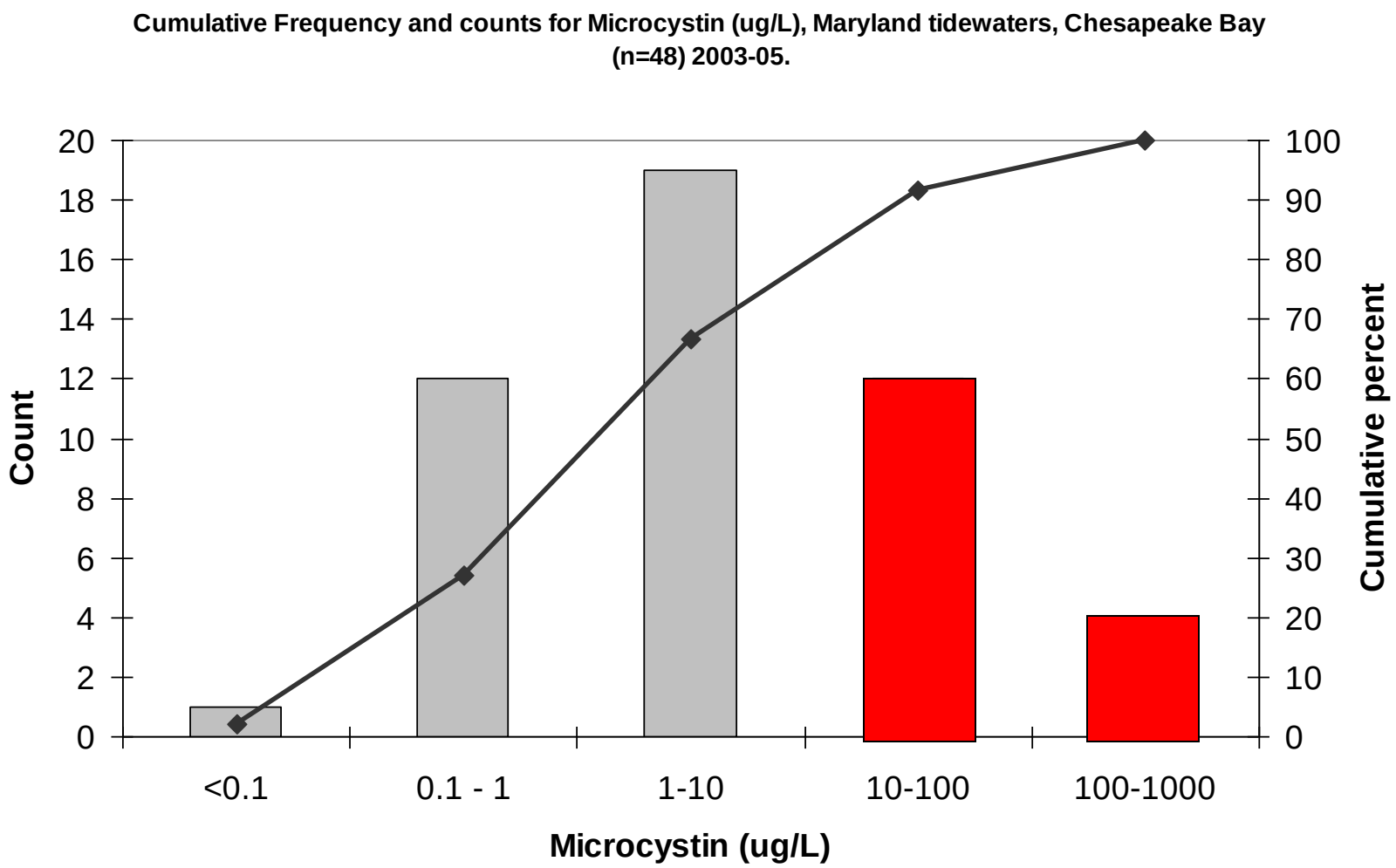
• In 1975, endotoxic shock of 23 dialysis patients in Washington, DC, was attributed to a cyanobacterial bloom in a drinking water reservoir **(World Health Organization 2003).**

Recent Bay Human Health Issues:

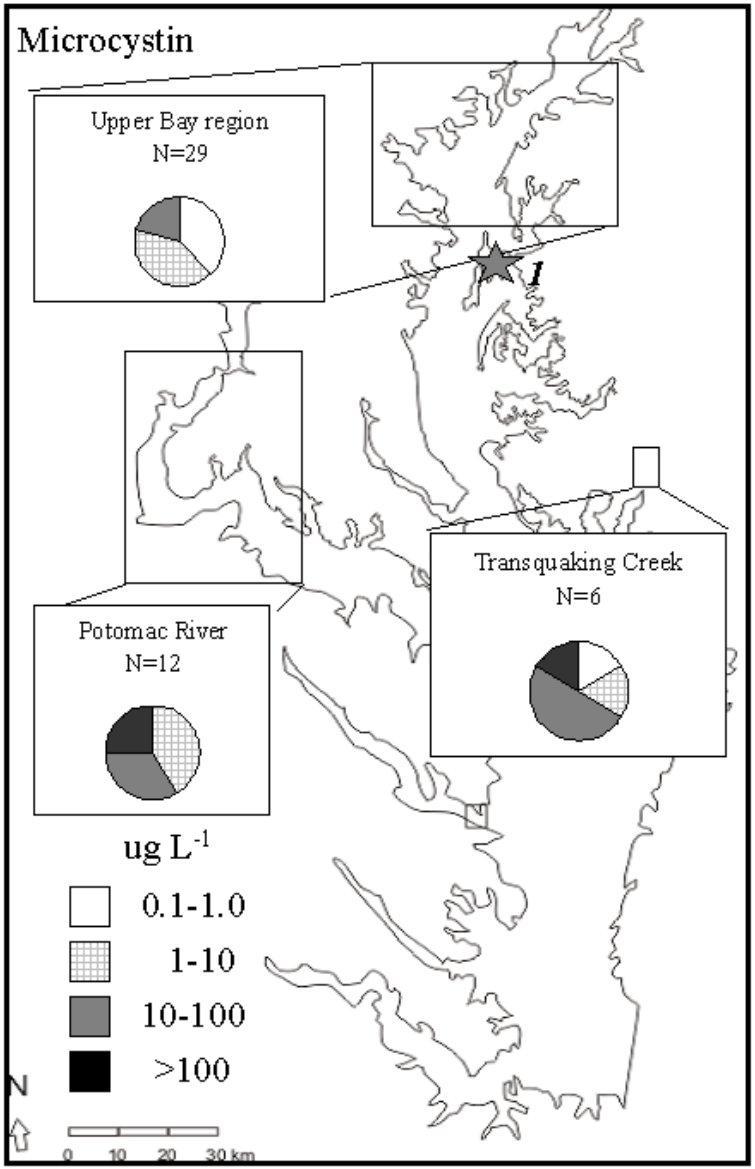
- Beach Closures on Sassafras River
  2000, 2003, 2004 and
  Colonial Beach, VA 2004
- Transquaking Creek 2005 –
  Caution to Recreationalists
- Potomac River 2006
  Health Advisory on 26
  miles of the River

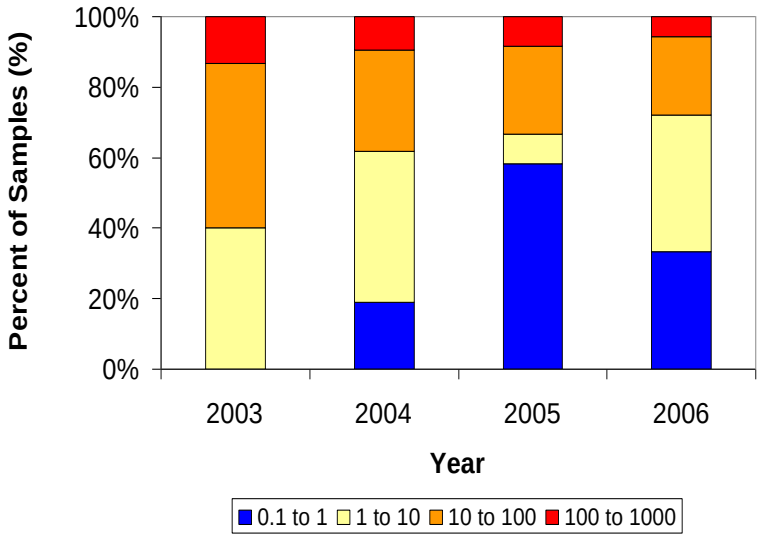
All issues here were linked with cyanobacteria blooms dominated by Microcystis and its associated toxins





33% of samples 2003-2005 exceed the suggested 10 ug/L recreational threshold protective of children





Spatial and temporal distribution of microcystin toxin results 2003-2006

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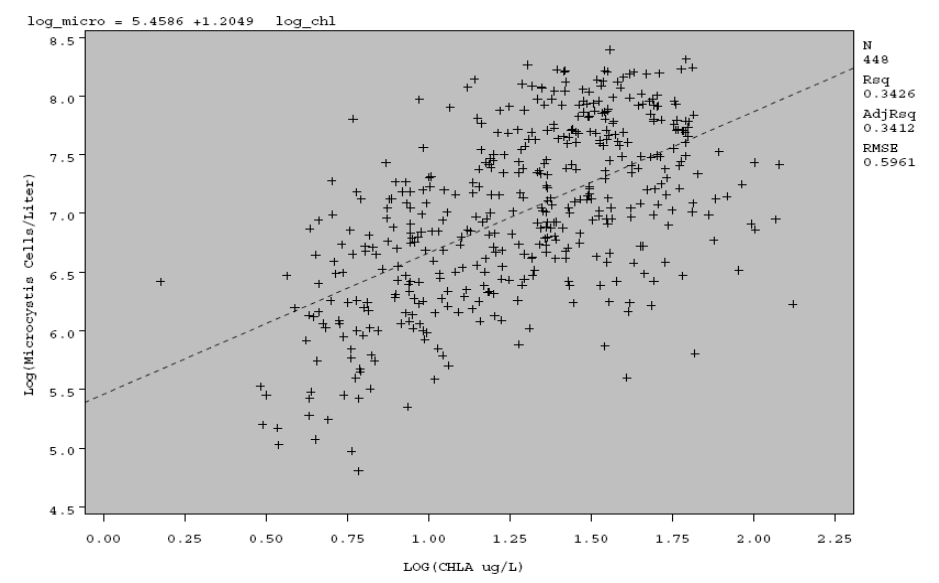
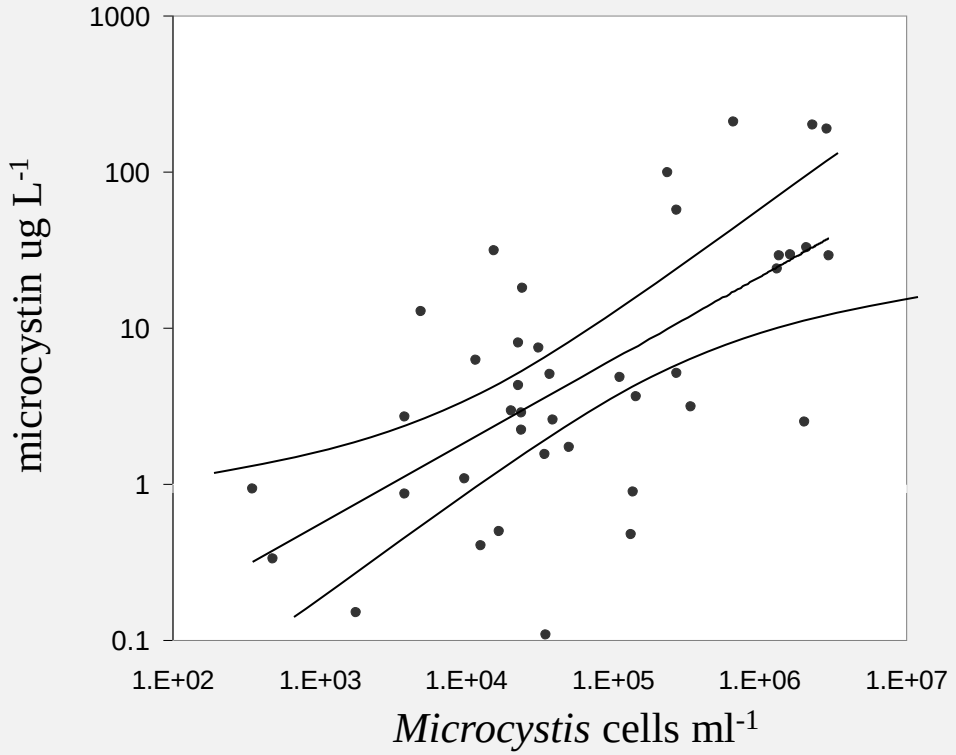
Algal and cyanotoxins, toxic bioassays in Maryland and Virginia

Significant Baywide and regional regressions exist for CHLA versus *Microcystis* counts.



Toxin data relationships with *Microcystis* counts



Moving forward from Data to Criteria:

One train of thought: Protection against Potential Risk of blooms
If systems have experienced blooms in the past, this demonstrates a risk of future blooms. If CHLA levels occur above levels coincident with toxin issues for similar cyanobacteria blooms, then we set criteria levels accordingly.

A second train of thought: Measurable impairment.
The criteria are based on measured toxin conditions and must reflect the impairment, not the risk of impairment.

Moving forward from Data to Criteria:

Desired relationships to support HAB based CHLA criteria: Human health basis.

1) CHLA related to *Microcystis* in Bay waters
2) *Microcystis* related to microcystin toxins
3) Toxin levels achieve human health risk levels in the Bay

Designated Use Impairment:

Human Health Based: Levels of toxins (e.g. microcystin) associated with cyanobacteria abundances affecting ‘swimmable use’ by decreasing time and area for such recreational activities.

EPA Estuarine Chlorophyll Criteria document under development
Published criteria due out December 2006.

Gradient of CHLA and human health related thresholds towards developing estuarine CHLA criteria

- **0-2.5 ug/L**: no observable effects levels (NHMRC)
- **2.5-25 ug/L**: increasing levels of risk to living resources and human health (WHO, NHMRC), increase in toxin level detections (DNR, Kotak et al.). (Florida's Impaired waters rule for estuaries: average annual CHLA 11 ug/L).
- **25 ug/L**: unsuitable for human use with cyanobacteria, high risk conditions (NHMRC 2005, 2005 Cyano Conference Proceedings due out Oct 2006)
- (**33 ug/L**: EPA (2003), one suggestion of threshold limiting risks to living resources, Ches Bay data.)
- **50 ug/L**: WHO: moderate adult risk, significant risk to children, high likelihood of scum formation, risk of long term illness effects and short term adverse health effects

Associated with 10 ug/L microcystin

Supporting Data Analyses

- 50,000 cells/ml *Microcystis* statistically linked with CHLA levels of 29 ug/L in two analyses.
- Empirically, 25 ug/L CHLA ~ 50,000 cells/ml ~ 10 ug/L microcystin toxin.
- Empirical calculations match the Australian guidance.
- We offered to offset the Australian relationship with the average of it and the Chesapeake work for an indicator value = 27 ug CHLA/L.

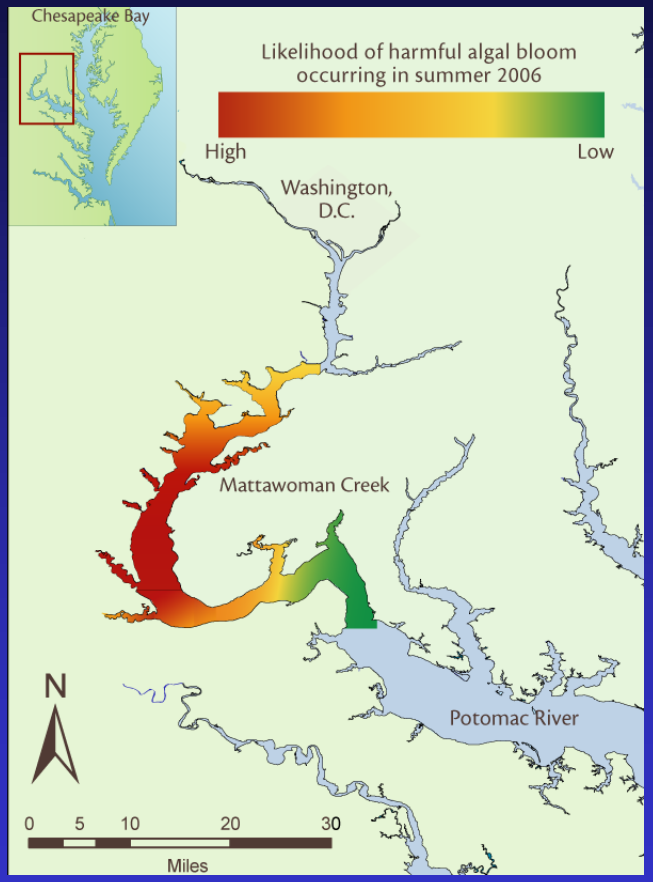
HAB-based Criteria Recommendations

- Criteria attainment will be based on actual microcystin toxin measures < 10 ug/L.

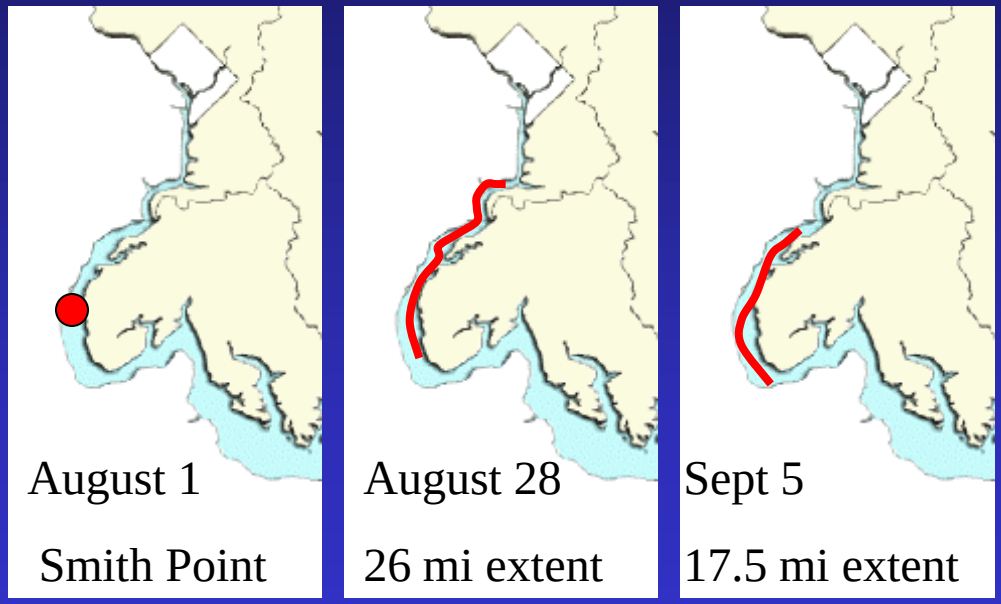
- Indicators for criteria assessment will rely on CHLA levels > 27.5 ug/L and *Microcystis* cell counts >50,000 cells/ml, levels associated with unacceptable human health risks in a recreational setting.

- Note: USEPA 2007 "The 27.5 ug/L concentration is applied as a 90^{th} percentile for log normal distribution of data coincident with a mean chla concentration of 14.7 ug/L for minimizing risk of Microcystis concentrations >50K cells/ml and microcystin concentrations exceeding 10 ug/L."

Time and Space considerations



2006: Regions of the Potomac River where *Microcystis* exceeded 10,000 cells per milliliter based on Chesapeake Bay Long-term Monitoring station results.



HAB-based Criteria Recommendations

USEPA 2007 proposed considerations

- Two or more samples in a cruise exceeding chla threshold
- Sequence of sampling events separated by 2 weeks (indicative of exposure risk as discussed in the literature)

In retrospect

- For CHLA: Consider dataflow data set to describe the data distribution in order to compare distribution results with a mean of 14.7 and 90th %-ile of 27.5 ug/L chla