Monitoring of Cyanobacteria in Surface Drinking Water Sources

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Points to be covered:

- Objectives of a cyanobacteria monitoring program
- Problems monitoring cyanobacteria in source-water lakes
- Importance of methods of detection
- The "Bloom" concept: a love/hate relationship
- Examples of monitoring cyanobacteria

Why monitor? Monitoring and Detection

Why monitor cyanobacteria?

1. **Identify problems and problem areas in a lake**
2. **Provide data base for lake/watershed management plans**
3. **Track long-term trends**
4. **Predict future changes**

Does Language Shape What We Think?

Joshua Hartshome
Scientific American (2009)

BLOOM, HAB, CHAB

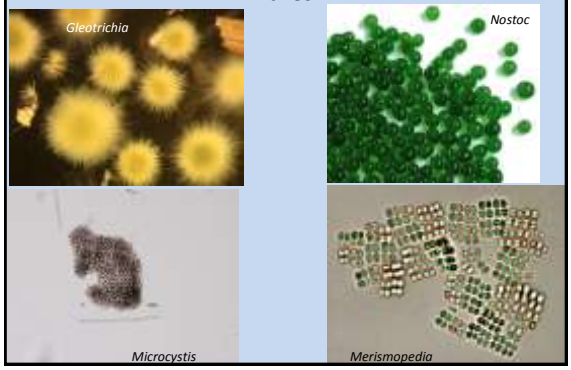
Source-water Lakes

- Eutrophic lakes
  - Serious, but consistent problem
- Meso-oligotrophic lakes
  - Typical drinking water source lakes, especially in the Northeast
  - Cyanobacteria problems tend to be episodic & difficult to predict

Cyanobacteria problems are not limited to eutrophic lakes

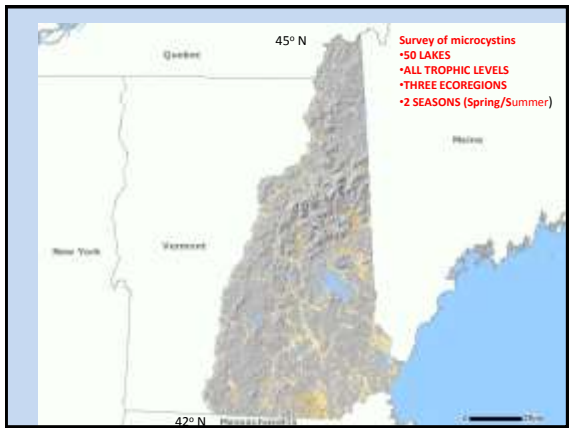
- E.g. New Hampshire: frequent cyanobacteria bloom warnings at beaches and reports of suspected toxicosis in dogs

Examples of cyanobacteria in Meso-Oligotrophic Lakes

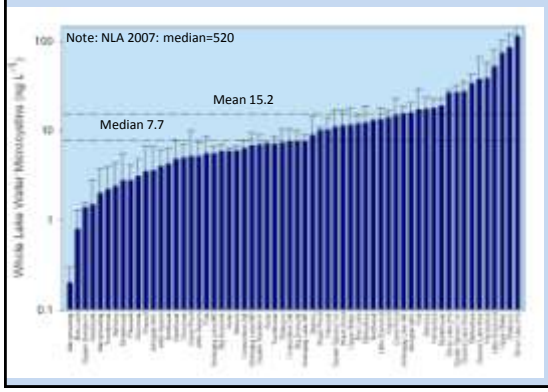


Cyanotoxins: Monitoring Considerations

- Be sure **limit of detectability** is appropriate for lake system
- Not all test procedures are suited to monitoring, especially in low-nutrient lakes
- Example: 50-lakes microcystin survey of NH lakes (Haney & Sasner 2000)



NH 50-Lakes Microcystin Survey - 2000



ELISA measurement of MCs in the Northeast USA: Center for Freshwater Biology

- 3-5x Extension of the ELISA standard curves to 25-50 pg MC mL^{-1} (cf 160 pg MC mL^{-1})
- 10-50x concentration of water sample (lyopholization)

Result: 30-250-fold increase in sensitivity, i.e. min lake detection=0.5-5 ng MC L^{-1}

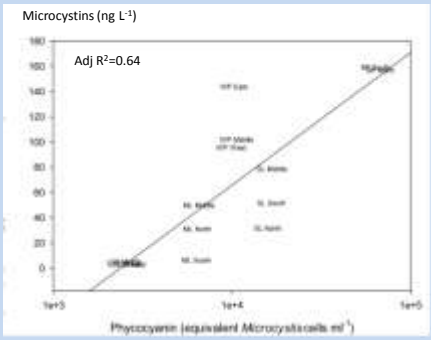
Common Cyano-Monitoring Parameters

- **Cell Counts** (**+ quantitative**; - only net-cyanobacteria)
- **Phycocyanin Fluorescence** (**+ rapid, all cyano**; - proxy, not 100% effective)
- **Cyanotoxins, e.g. Microcystins, Anatoxin a** (**+ direct**; - not all cyanotoxins)

How useful is Phycocyanin fluorescence?

- Should be verified against microscope IDs
  - Some non-cyanobacteria have PC fluorescence
- Best if calibrated against standard (chemical or standardized culture)
- It can be used (*with care*) a surrogate for microcystins

PC predict toxins: must know the cyanobacteria composition



From: Murby 2009

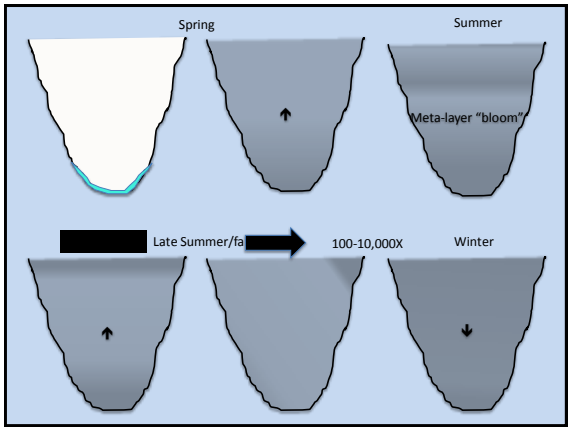
HABs/CHABs Definition? Subjective?

Might be helpful to identify sources of cyanobacteria & cyanotoxins

1. Surface blooms are transient
2. Sub-surface "blooms" , i.e. metalimnetic layers
3. Benthic sediments
4. Benthic Mats

Surface CHABs

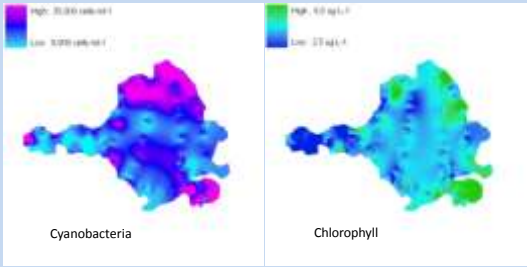
How they arise in meso-oligotrophic lakes



CHALLENGES TO CYANO-MONITORING

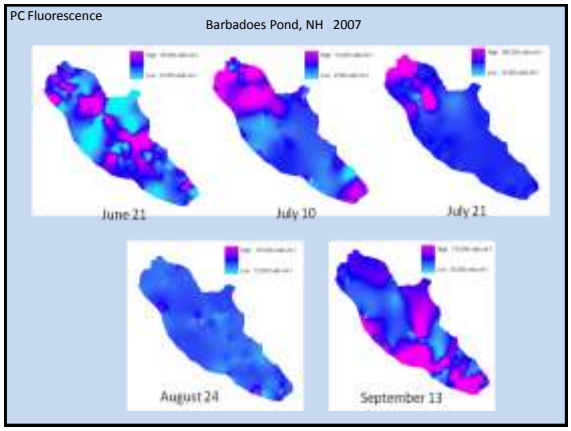
PATCHINESS IN SPACE

PATCHINESS IN SPACE

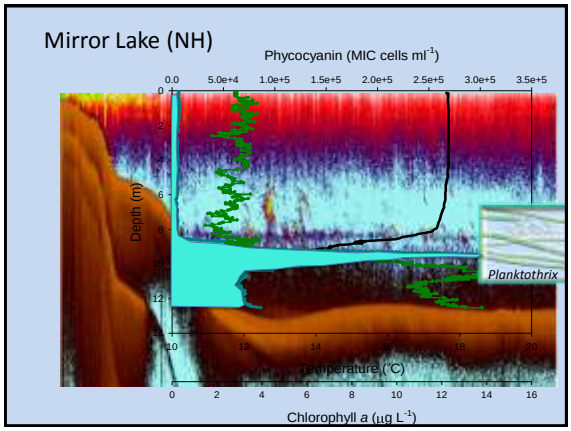


Willand Pond: Phycocyanin fluorescence and Chlorophyll horizontal distributions

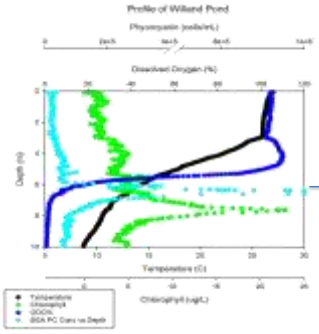
PATCHINESS IN SPACE & TIME



Deep (metalimnetic) Layers: Mirror Lake, NH



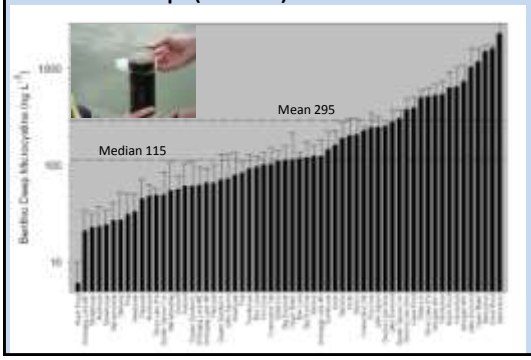
Deep (metalimnetic) Layers: Willand Pond, NH



Planktothrix & Woronichinia
>1x10^6 cells mL^{-1}

July 10, 2012

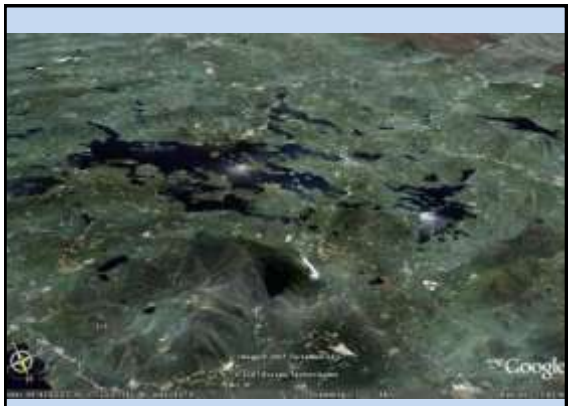
Deep (> 3 m) Benthic MC



Monitoring leads to Management

Setting phosphorus limits for cyanobacteria

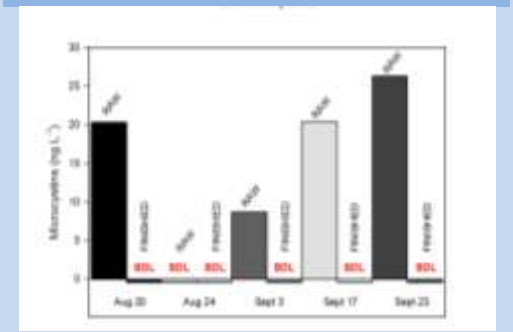
Example: Meredith Water Department

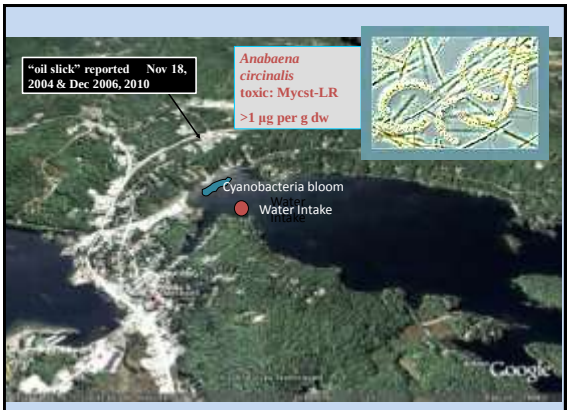


Meredith Water Quality

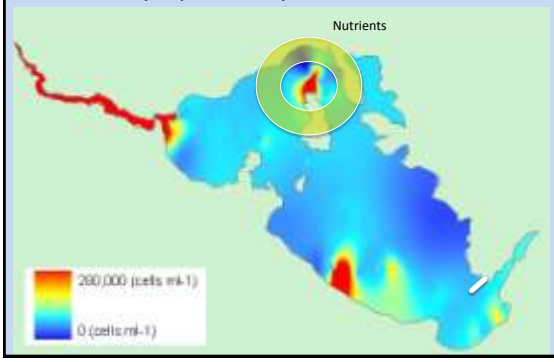
Lake Waukewan Water Treatment

Microcystins in raw and finish water





Lake Waukewan (Meredith, NH) Synoptic Survey with PC Probe



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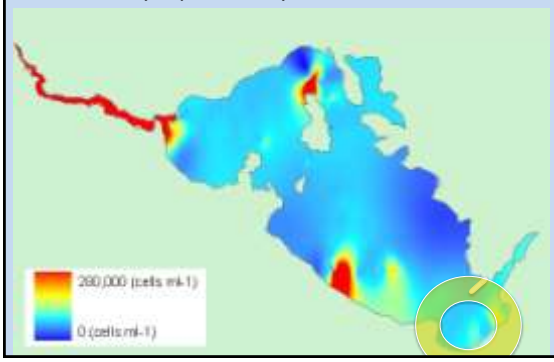

Benthic Cyanobacteria Mat *Phormidium*

Lake Attitash, Amesbury/Merrimac MA Citizen Cyanobacteria Monitoring Program (CCMP) 2010 Report

- University of New Hampshire
- **Center for Freshwater Biology**
- CFB.UNH.EDU
- 603-862-2105
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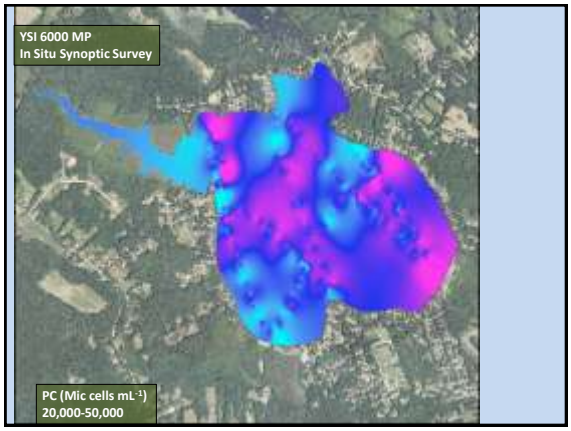
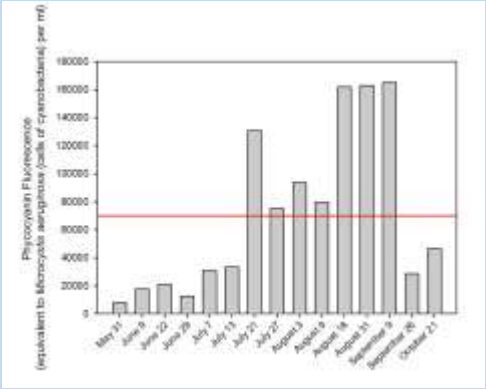
-
- **Summary**
-
- Lake Attitash of Amesbury and Merrimac, Massachusetts was sampled weekly between May 31st and August 31st of 2010 by the Lake Attitash Association (LAA) in order to monitor levels of cyanobacteria and microcystins (Fig.1). The lake was then sampled on September 9th and September 26th by the UNH field limnology class and again on October 21st when the cyanobacteria had accumulated blooms along the shoreline of the Northeast end of the lake. Epilimnetic water (0-3 meters) were routinely sampled from five separate sites by the Lake Attitash Association with a home-made, "mini-integrated- water-tube-sampler". Samples were analyzed for cyanobacteria and microcystins by the "Citizen Cyanobacteria Monitoring Program" or CC MP, a pilot program under the UNH Center for Freshwater Biology

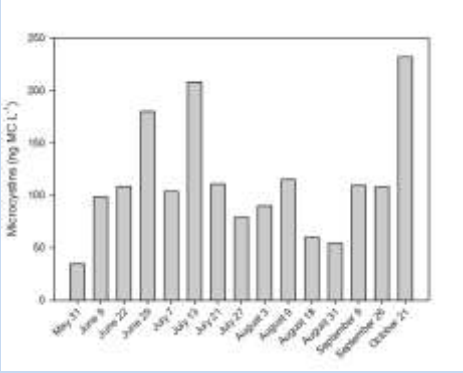


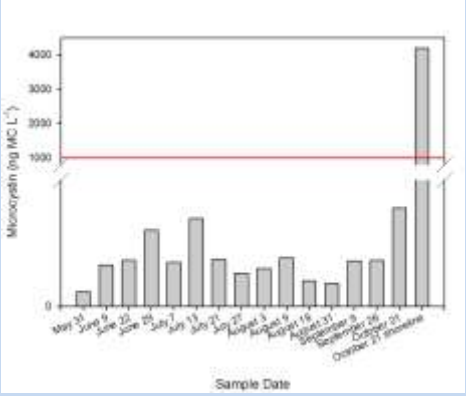
Heterogeneity

- How much data needed to determine change?
  - Cf within year variance: between year variance
  - Needed to reduce variability:

1. Multiple samples per season
2. Multiple sites per lake
3. Integrated epilimnetic samples







For Assistance/Advice in Setting up a Cyanobacteria Monitoring Program, Contact:

Thank You

- Questions?

- Special thanks to:
  - Amanda Murby (PhD Student, UNH)
  - Members of the UNH Center for Freshwater Biology
  - Daniel Leonard (Meredith Water Department)