Cyanotoxin Water Pollution Sensor Priorities

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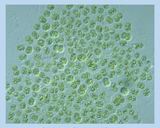
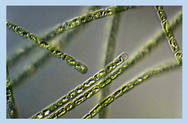
What are Cyanobacteria and toxins?

Photosynthetic bacteria capable of blooming to high abundance and producing harmful toxic compounds



Microcystis aeruginosa
protist.i.hosei.ac.jp



Aphanizomenon flos-aquae
cfb.unh.edu

Anabaena sp.
cfb.unh.edu

Planktothrix sp.
algaebase.org

Why is it important?

- **Human health and animal effects**
  - 500,000 residents without tap water in Toledo, August 2014
  - 52 human deaths in Brazilian dialysis center (Carmichael et al. 2001)
  - 368 confirmed canine poisoning cases since 1920's (Backer et al. 2013)
  - Many cases of livestock poisoning (Stewart et al. 2008)
- **Significant costs associated with treatment**
  - $3-4 million/year in Toledo

Current Approach – Cyanotoxin Monitoring

- **Well-developed laboratory methods for measuring toxins**
  - Biological assays:
    - Enzyme-Linked Immunosorbent Assays (ELISA)
    - Protein Phosphatase Inhibition Assays (PPIA)
    - Neurochemical assays (e.g. acetylcholinesterase-based)
  - Chromatographic Methods:
    - Gas Chromatography/Flame Ionization Detection (GC/FID), Mass Spectrometry (GC/MS)
    - Thin Layer Chromatography (TLC)
    - Liquid chromatography
- **Field methods for estimating cyanobacterial biomass**

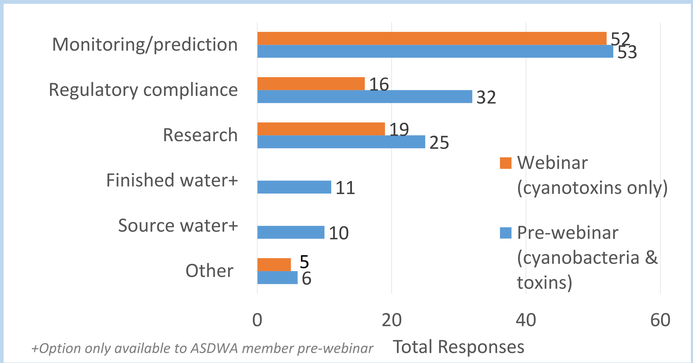
Drawbacks to Current Approaches

- **Only applicable in lab settings**
- **No single method for measuring multiple/all cyanotoxins**
- **Expensive and time consuming analyses**
- **Lack of standard reference materials**

Key for All Figures

Feedback received from federal employees & partner orgs
Feedback received during arsenic sensor needs webinar (cyanotoxins only)
**Combined responses from federal employees & partners*
***Option only available to webinar attendees*
Note: there may be overlap between the feds & partners and webinar groups

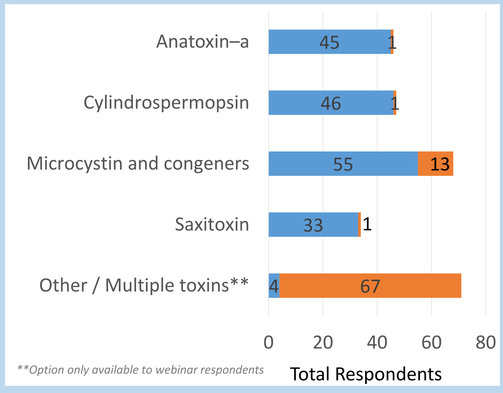
Reasons for Monitoring

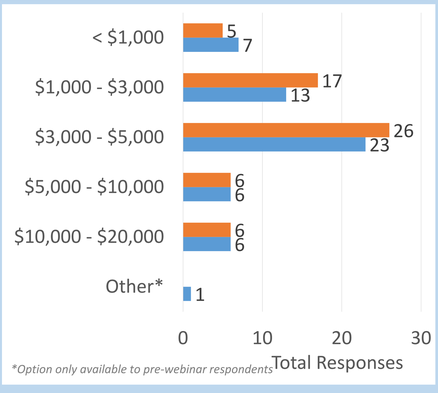


Summary of Cyanotoxin Feedback

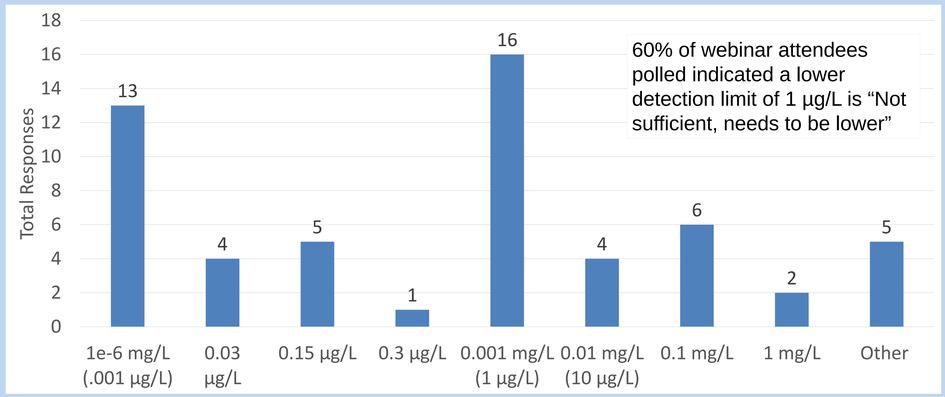
Characteristic	Need
Toxin of interest	Multiple / Microcystin and congeners
Limit of Detection* *Limits of Detection will be toxin-specific	Lower: < 1 µg/L, Upper: 5,000 mg/L
Sampling Frequency	Daily
Deployment Length	1 month / 3 months
Data Logging	Integrated into an external system
Data Transmission	Cellular, WiFi
Price	$3,000 - $5,000

Toxin of Interest, Desired Price

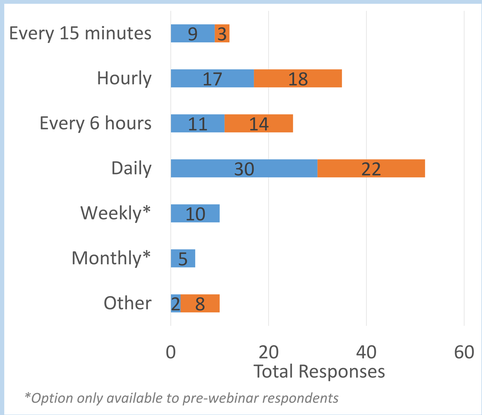


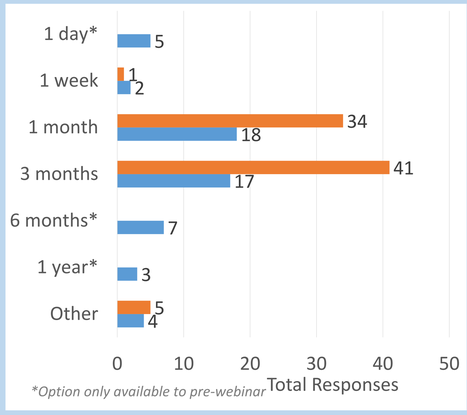


Limits of Detection

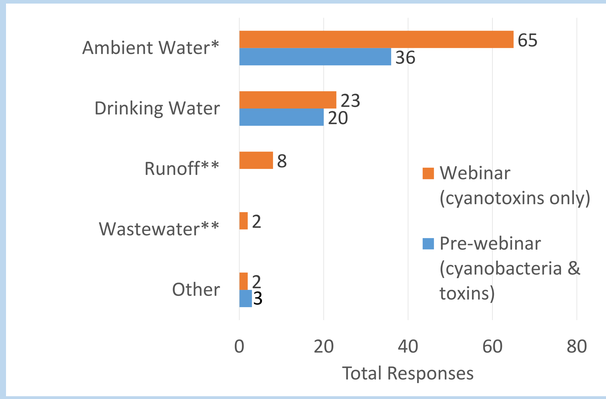


Sampling Frequency, Deployment Length

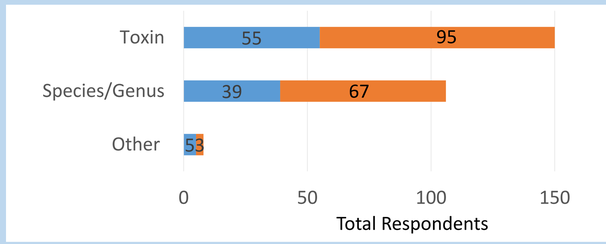




Sampling Environment



Measurement Capability



Potential Benefits of Advanced Sensors for Cyanobacteria/toxins

- **"Real-time" data**
- **Continuous monitoring**
- **Field-deployable**
- **Portable**
- **Affordable**
- **Easy to operate**

Next Steps

- **Alliance for Coastal Technologies (ACT)**
  - Third-party testbed for technology evaluation
  - Capacity- and consensus building forum
  - Information clearinghouse for environmental technologies
- **ACT and HABs**
  - Two past technology workshops (2002, 2007)
  - Upcoming technology workshop , including cyanotoxins (Late 2016/Early 2017)

ACKNOWLEDGEMENTS

Alliance for Coastal Technologies
Association of Clean Water Administrators
Association of State Drinking Water Administrators
National Water Quality Monitoring Council
U.S. Agency for International Development
U.S. Bureau of Reclamation
U.S. Department of Agriculture
U.S. Environmental Protection Agency
U.S. Geological Survey
U.S. Park Service
Water Environment Federation

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