Harmful algal toxins - monitoring and response for drinking and recreational water

October 26, 2016

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COLORADO
Department of Public Health & Environment

Geography quiz

- What are we looking at?

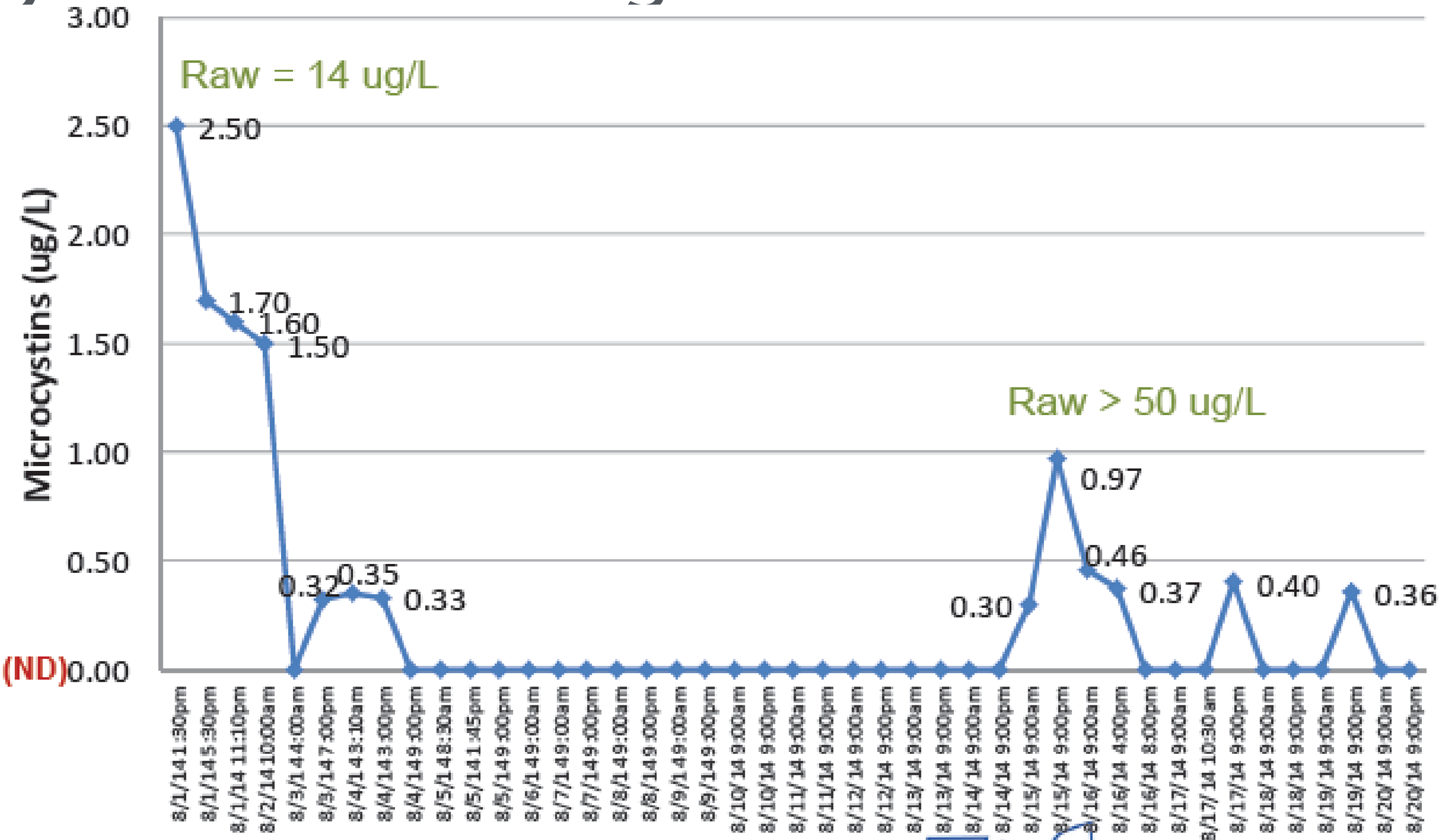
Geography quiz

- What are we looking at?

City of Toledo - chronology

- August 1, 2014:
  1. Sudden bloom spike overwhelmed plant before they could adjust treatment.
  2. Ohio EPA notified by City of microcystin sampling results above drinking water advisory threshold of 1.0 ug/L.
  3. 2nd set of samples taken and confirm levels above threshold.
- August 2, 2014:
  1. City issues “Do Not Drink Advisory” to 500,000 people.
  2. Governor declares state of emergency
- August 4, 2014:
  1. All sample results below threshold and advisory lifted.

Microcystin concentrations in Toledo's finished drinking water



Microcystins also detected at 31 distribution sites

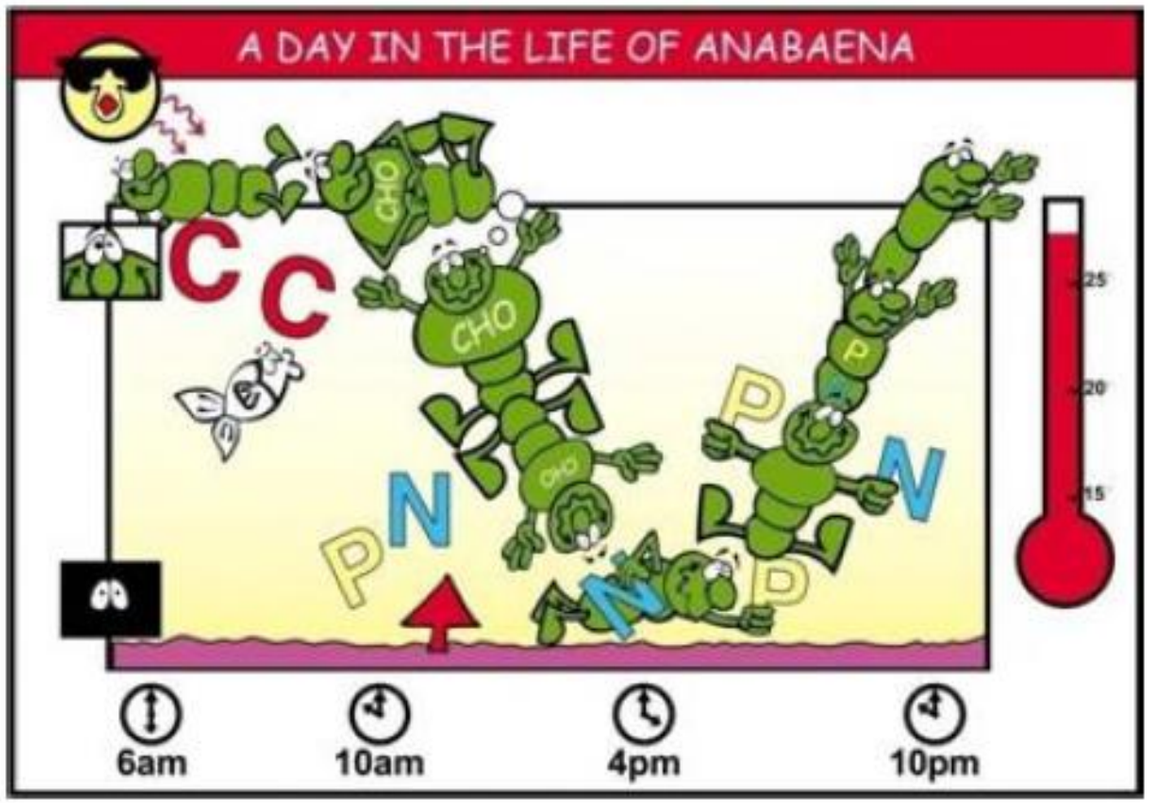
ND= Not Detected (Concentration <0.30)

OhioEPA

Data Source: Toledo PWS

Cyanobacteria (Blue-Green Algae)

- Like warm, stagnant, high-nutrient water
- Heterocysts – fix atmospheric nitrogen
- Aerotopes – gas vacuoles regulate buoyancy
- Some species capable of producing toxins and T&O
- Toxin production is unpredictable



Beyond Toledo – nationwide panic

- EPA national study finds around 1/3 of lakes have microcystin

Ohio River – Maysville intake

Beyond Toledo – nationwide panic

- Recreational and economic impacts

OREGONLIVE
The Oregonian

Future of blue-green algae in Willamette River still uncertain; users frustrated

Volunteers for the Oregon Health Authority have put up warning signs in Willamette, Sellwood, Waterfront, and East Bank Esplanade parks. These signs caution river users against drinking or cooking with the water due to blue-green algae bloom scum that can produce harmful toxins. *(Adrianna Rodriguez)*

Toxic algae forces cancellation of Portland regatta

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Algae Bloom In Willamette River Means No Swimming In Portland Triathlon

OPB | Sept. 19, 2014 12:51 p.m. | Updated: Sept. 19, 2014 3:43 p.m. | Portland

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CONTRIBUTED BY:

Lizzy Duffy

PART OF SERIES:

OPB News Blog

The Portland Triathlon has been forced to change its course due to the toxic scum floating around in the Willamette River.

Event organizers decided Friday to err on the side of caution before Portland health officials announced Friday afternoon that the massive blue and green algae bloom between Ross Island and the Fremont Bridge is harmful.

"The city and state Willamette River managers were unable to give us definitive safe to swim information," the triathlon says on its website. "Because the information is incomplete, we have decided to lean on the side of safety for all our athletes."

As OPB's Kristian Foden-Vencil reported on Thursday, exposure to some types of algae can create a numb, tingling or dizzying feeling that could lead to difficulty breathing or heart problems.

Instead of swimming to running to bicycling, participants will start with

Dogs sickened by algae toxins in Willamette River

Beyond Toledo – nationwide panic

- Reports of dead cattle, fish, dogs

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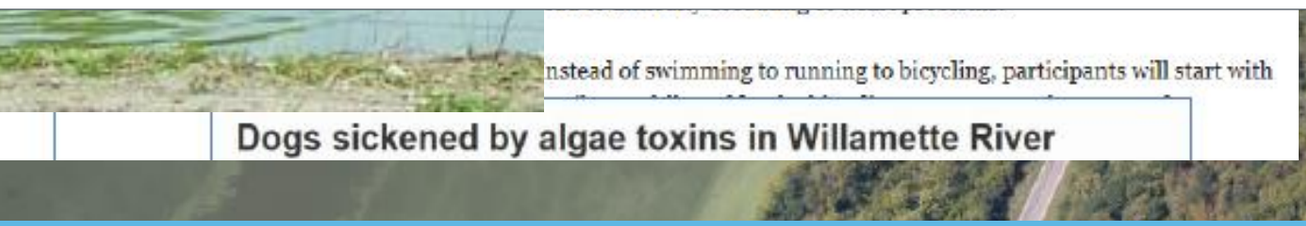
Dogs sickened by algae toxins in Willamette River

Beyond Toledo – nationwide panic

EPA do something!!

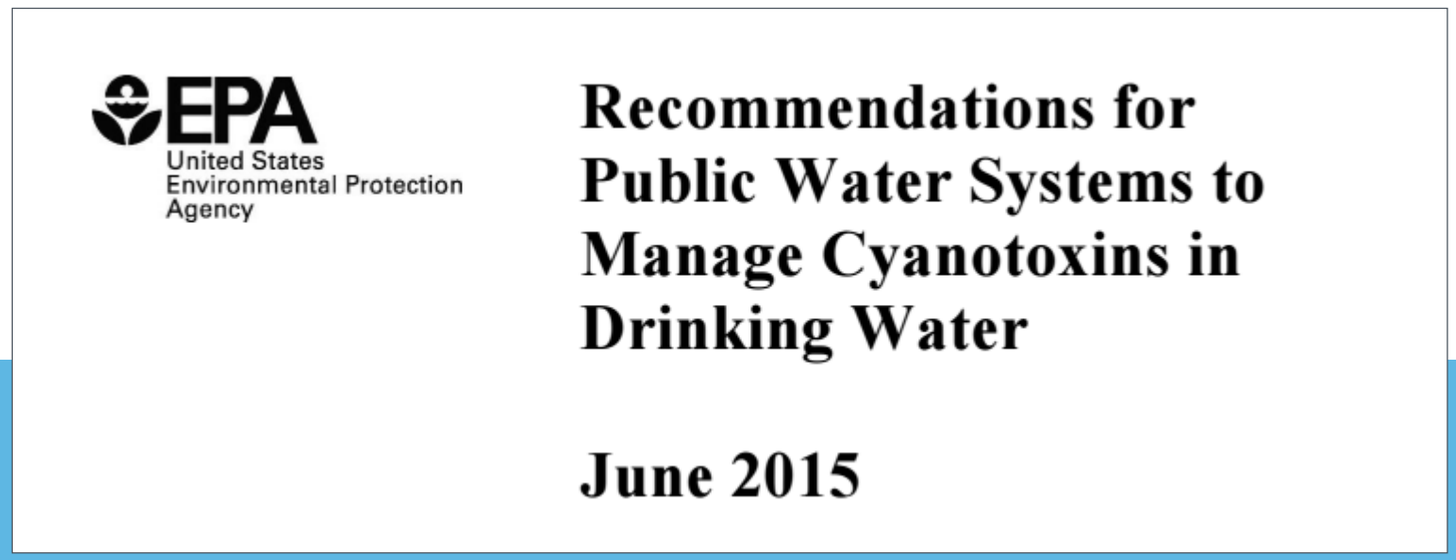
- Feb 2015 - Safe Drinking Water Act amended for algal toxins
  - EPA must submit to Congress a strategic plan for assessing and managing risks with algal toxins in drinking water



EPA responds

- Studies find liver, kidney, and reproductive toxicity
- Health Advisories are informal technical guidance, **non-regulatory** concentrations estimated for specific exposure durations where health effects aren't anticipated to occur

Chemical	10-day advisory	
	Bottle-fed infants and pre-school children	School age children and adults
microcystins	0.3 µg/L	1.6 µg/L
cylindrospermopsin	0.7 µg/L	3 µg/L



The challenges

- Need to educate and raise awareness among surface water systems that could be impacted
  - New acute health advisory with potentially devastating PN
  - FEMA's valuation of lost water is $103 per person per day
  - 1,000 people with a week long advisory ~ $1M
- No database of toxin data in Colorado but we know many systems with blue-green algae and taste and odor issues
- No Colorado lab capacity
  - High analytical costs, 3-4 day turnaround time
  - Debate among analytical methods

The solution - Colorado Harmful Algal Bloom Workgroup

- Colorado convened group of utilities and experts
- Guidance by systems for systems
- Resources to help systems large and small
  - Guidance, trainings, troubleshooting, lab support, data sharing, TTX
- Meetings to share successes and challenges, Google Group to communicate quickly, and a library to share information

AWWA Rocky Mountain Section
Colorado New Mexico Wyoming

CLRMA

Colorado Parks Wildlife

Colorado State University

CoWARN Colorado's Water/Wastewater Agency Response Network

CDPHE CO

COLORADO
Department of Public Health & Environment

The team created best practices on monitoring and a blueprint for responding – www.rmsawwa.org

April 2016

Harmful Algal Bloom Monitoring Guidance

For Colorado drinking water providers with surface water sources
From the Colorado Harmful Algal Bloom Workgroup

Step 1: Observe and prepare	Visually inspect source waters for algae blooms at least weekly during bloom season (typically late summer through early fall). Taste and odor events, shorter filter runs, and changes in source water quality may indicate the presence of a bloom. Before bloom season starts, be prepared and order cyanotoxin (microcystins and cylindrospermopsin) field tests, evaluate source and treatment options, and develop a monitoring, response, and communication plan. **If bloom observed continue to step 2*
Step 2: Field screen for blue-green algae	Immediately after observing bloom use microscopic examination or phycocyanin analyzers if available or use *jar and stick tests*[1] and field identification guide[2] for presence of blue-green algae which could produce cyanotoxins. Continue examinations at least weekly during presence of bloom. **If blue-green algae are present continue to step 3*

Colorado's drinking water guidance

5 Steps

1. Do you have a bloom?
2. Is it cyanobacteria?
3. Is it producing toxins in your raw water?
4. Do you have toxins in your finished water?
5. Are they above the health advisory limit?

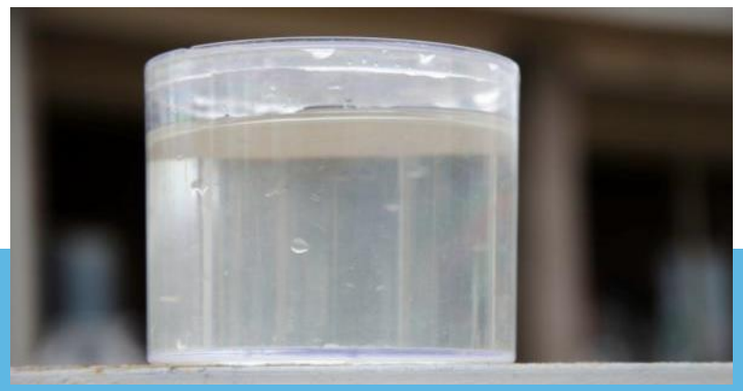
Step 1: Observe and prepare

- Inspect source weekly during bloom season
- Look for other treatment indicators
- Order field tests and develop response plan if prone to blooms

May 28, 2015

June 1, 2015

Cherry Creek Reservoir



Step 2: Field screen for cyanobacteria weekly during bloom presence

- Jar Test - Cyanobacteria float to the surface or remain suspended in the water column

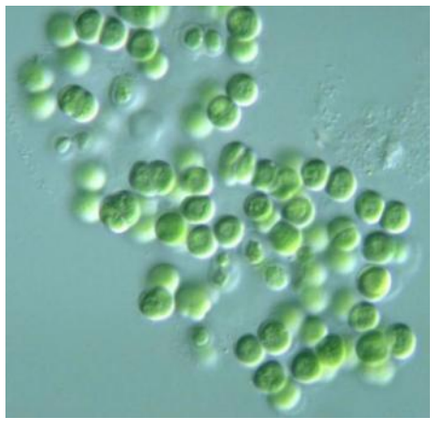
Step 2: Field screen for cyanobacteria weekly during bloom presence

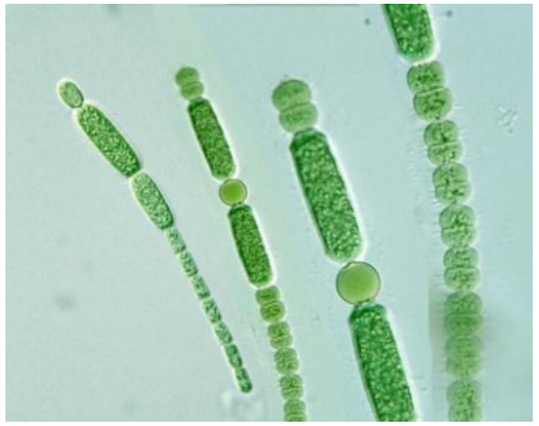
- Stick Test - Long strands are probably NOT cyanobacteria

Step 2: Field screen for cyanobacteria weekly during bloom presence

Step 2: Field screen for cyanobacteria weekly during bloom presence

Cyanobacteria Taxa	Microcystin	Anatoxin	Cylindro-spermopsin	Saxitoxin
Anabaena circinalis	x	x		x
Anabaena flos-aquae	x	x		
Anabaena planctonica		x		
Anabaena spiroides		x		x
Aphanizomenon flos-aquae		x	x	x
Cyanobium sp.	x			
Microcystis aeruginosa	x			
Planktothrix agardhii	x		x	

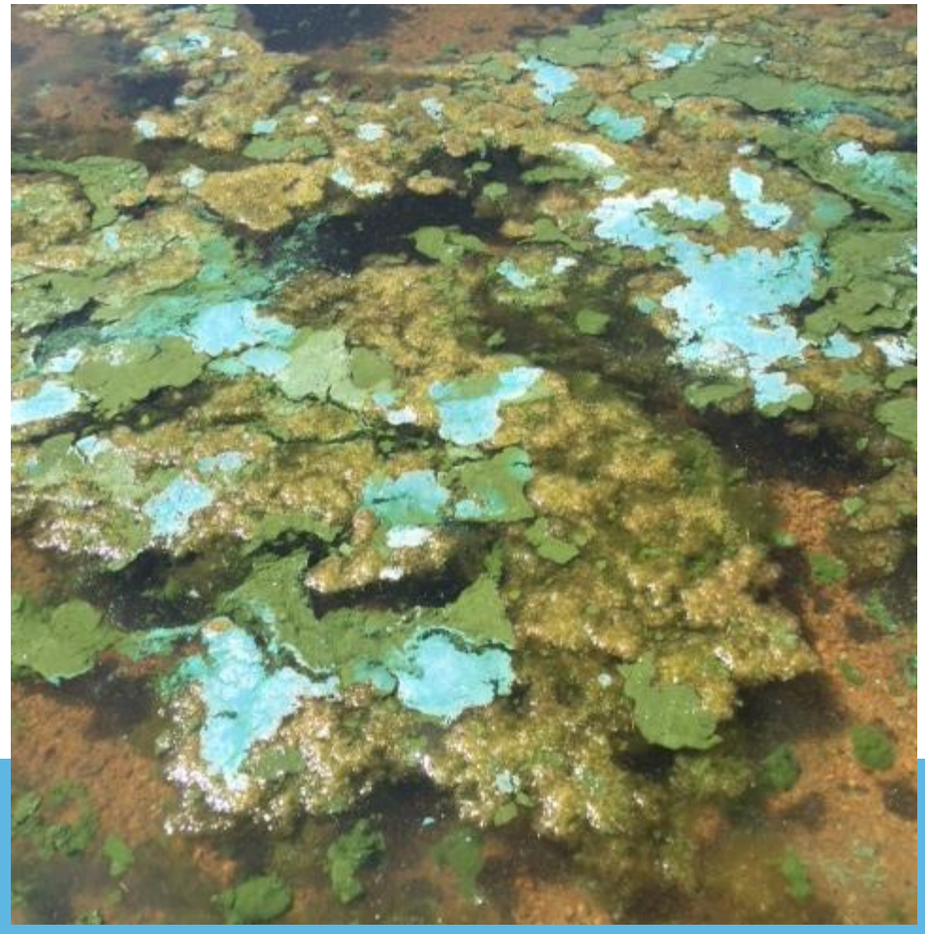




Step 2: Field screen for cyanobacteria weekly during bloom presence

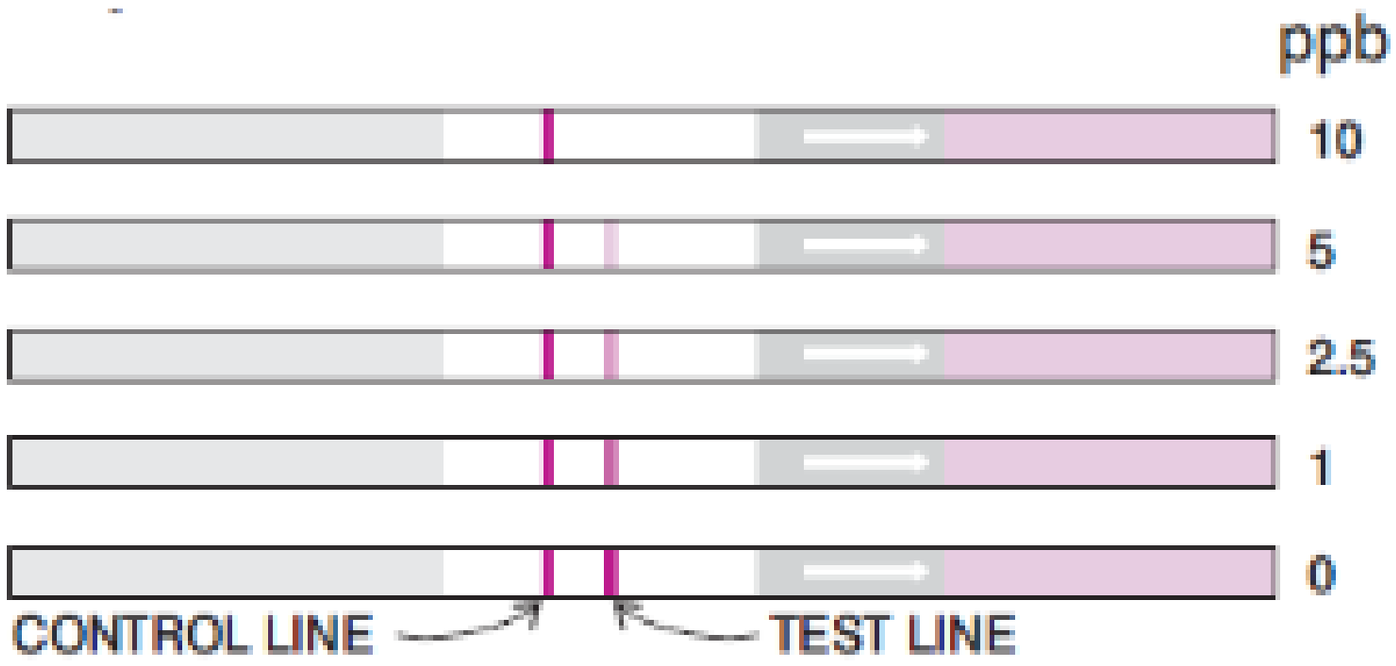
DeWeese Reservoir Aug/Sep 2015

- Widespread algae bloom reported by EPA
- Distressed fish reported by locals
- Looks terrible but NO toxins – Not cyanobacteria



Step 3: Field screen for toxin presence in raw water

- Test strips – easy to use and $30 per test
- Microcystin and Cylindrospermopsin
- Freeze then thaw raw sample
- Evaluate source and treatment options



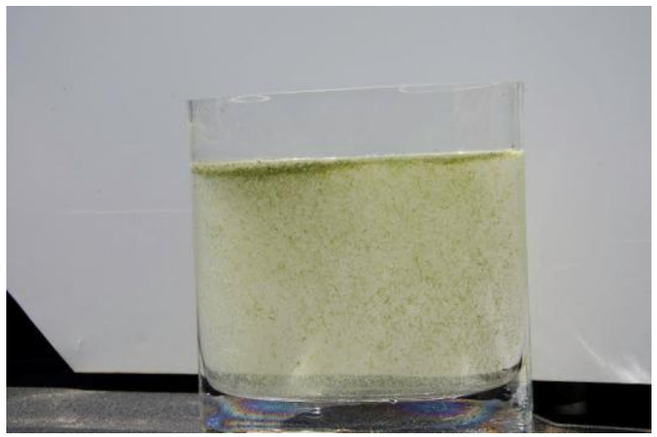
Step 3: Field screen for toxin presence in raw water

- Important to monitor raw water intake or swim area

Stagecoach Reservoir July 21, 2015

Swim beach/marina

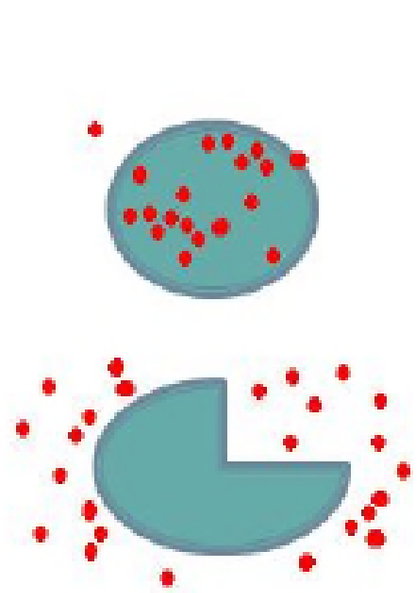
Dam



Cove

Step 4: Field screen for toxin presence in finished water

- Intercellular toxins and extracellular toxins require different treatment strategies
- Notify utility management of possible response actions



Source Control

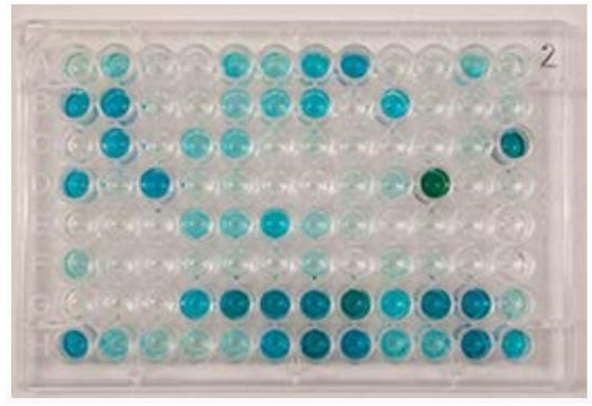
Conventional Treatment: Remove intact cells and avoid disruption

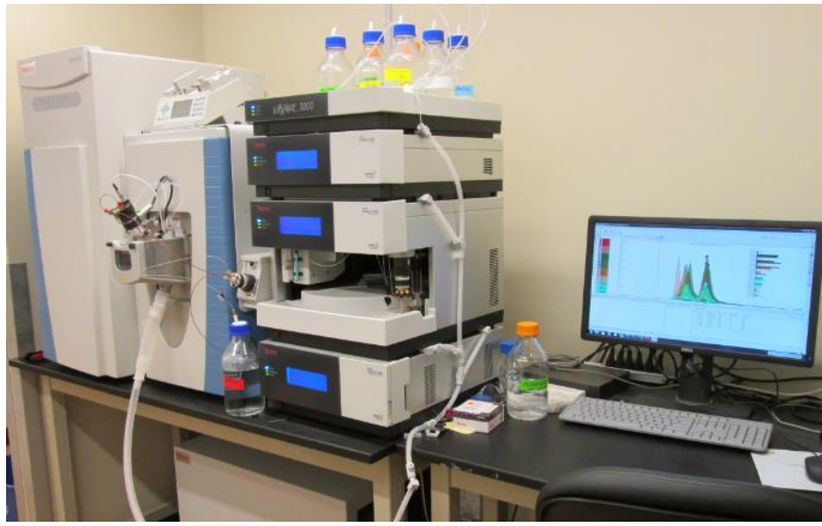
Oxidative Treatment: Destroy extracellular toxins

Advanced Treatment: PAC, Membranes, etc. for additional toxin removal

Step 5: Quantitative lab analysis

- **Enzyme linked immunosorbent assay (ELISA):**
  - Total microcystins (not congener specific), cylindrospermopsin
  - Commercially available and cheaper than LC/MS/MS
- **LC/MS/MS analysis:**
  - Subset of microcystin congeners, cylindrospermopsin
  - EPA Method 544 available for microcystins
  - More expensive than ELISA





- **Response:**
  - Compare results to EPA health advisory values
  - Confirmation sample within 24 hours
  - Notify consumers
  - Check toxin levels throughout distribution system
  - Water is safe after 2 consecutive samples are below health advisory values

Cherry Creek Reservoir – June 2014

Microcystins = 24 ug/L ELISA

= 15 ug/L LC/MS/MS

C. Wolf

C. Wolf

Human Health Thresholds -Recreation

Action	Agency	Microcystins ug/L
advisory	California	0.8
reduce contact	Indiana	4
avoid contact	Kansas	4
advisory	Ohio	6
closure	Washington	6
closure	Australia	10
advisory	Oregon	10
low risk	WHO	<10
advisory	Massachusetts	14
advisory	Rhode Island	14
moderate risk	WHO	10-20
advisory	Broomfield, CO	20
caution	Iowa	20
contact restricted	Kansas	20
health alert	Nebraska	20
closure	Ohio	20
high risk	WHO	>20

What do we do?

- Is it safe for the public to swim?
- Is it safe to eat fish caught from the lake?
- Is it safe for dogs?
- How should we communicate with the public?

Partnership with CDPHE 2015

Algae Bloom Risk Management Toolkit for Recreational Waters

Recommended actions to protect public health

1. Visual monitoring for signs of toxic algae
   - Bottle and stick test, microscope
2. Test for toxins weekly if bloom (2x week if above Caution level)
   - Field test and lab test
3. Post signs and notify drinking water providers and county health if exceedance

Recommended provisional guidelines for toxic algae

Threshold (µg/L)	Microcystin*	Cylindrospermopsin	Anatoxin	Saxitoxin*
Caution	10	7	7	4
Warning / Avoid Contact	20	**	**	**

*Microcystin and saxitoxin guidelines are intended to be applied to total concentrations of all reported congeners of those toxins.

Caution Level

- Potentially toxic algae are visible
- Toxin levels above Caution values
- Remove after 2 tests are below Caution values or bloom subsides

CAUTION

Toxic Algae May be Present

- No pets in water!
- Do not drink lake water
- Avoid contact with floating algae mats

- **Fishing Permitted** - rinse fish well and discard guts
- **Boating Permitted** - avoid algae mats

Call your doctor or veterinarian if you or your animals have nausea, vomiting, diarrhea, rash, irritated eyes, seizures or breathing problems.

Poison Control Center 1-800-222-1222

Warning Level

- Microcystin levels above Warning value
- Human illness or pet death reported

WARNING

Toxic Algae Present

AREA IS CLOSED TO FULL-BODY CONTACT

- No Pets in Water!
- Do Not Drink Lake Water
- No Swimming or Body Contact
- No Water Skiing
- No Jet Skiing
- No Paddle Boarding

- **Boating Permitted** - avoid algae mats
- **Fishing Permitted** - rinse fish well and discard guts

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Poison Control Center 1-800-222-1222

Recreational waters next steps

- CDPHE Recreational Toolkit available at www.colorado.gov/cdphe
- EPA recreational health advisory levels for microcystin and cylindrospermopsin October 2016
- CPW is partnering with River Watch to seek volunteer groups to help monitor remote CPW-managed “high-risk” lakes

Questions?

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