BENTHIC HABS WORKGROUP WEBINAR

May 27, 2020 - 1:00 PM to 2:15 PM Pacific Daylight Time

Web Meeting Address: https://usace.webex.com/meet/jade.l.young
Meeting Number: 968 579 710
Phone Number: 1-888-363-4735
Access Code: 970 309 8
Security Code: 5272

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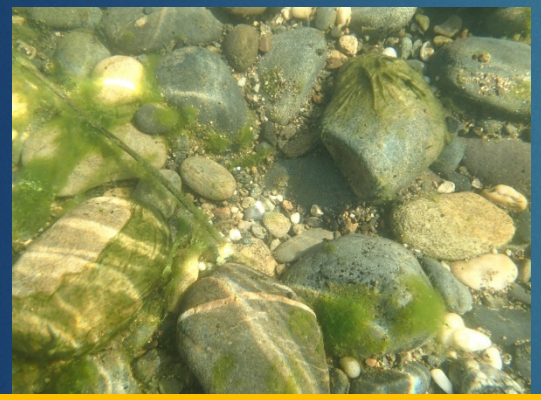


GUEST SPEAKER: KURT CARPENTER

BENTHIC SOURCES OF CYANOTOXINS IN THREE OREGON RIVERS USED FOR MUNICIPAL DRINKING WATER SUPPLY

AGENDA

I Welcome, Introductions & Agenda Overview
Margaret Spoo-Chupka

II Presentation: Benthic Sources of Cyanotoxins in Three Oregon Rivers Used for Municipal Drinking Water Supply
Guest Speaker – Kurt Carpenter

III Membership Networking Groups: Follow up to Membership Survey – Setting up networking groups
Jade Young

IV Announcements and Meeting Close
CCHAB Network: Benthic HAB Signage – Keith Bouma-Gregson

Where to Find Us: https://www.epa.gov/cyanohabs/epa-newsletter-and-collaboration-and-outreach-habs#benthic

ITEM II
Presentation: Benthic Sources of Cyanotoxins in Three Oregon Rivers Used for Municipal Drinking Water Supply

Kurt Carpenter
USGS, Oregon Water Science Center

Benthic Sources of Cyanotoxins in Three Oregon Rivers Used for Municipal Drinking-Water Supply

Kurt Carpenter
Research Hydrologist
U.S. Geological Survey
Oregon Water Science Center
Portland, Oregon

Presentation for Benthic Cyanobacteria Working Group
May 29, 2020

U.S. Department of the Interior
U.S. Geological Survey

Photo: Barry Rosen/USGS Emeritus/FGFU

HABs May Involve..

Phytoplankton AND Benthic "Periphyton"

Timothy Lake

North Fork Reservoir

Clackamas River Basin

USGS

Benthic Cyanobacteria in the Clackamas River Basin

Algal Genera	Reservoirs (n=2)	Mainstem (n=8)	Tributaries (n=15)
Schizothrix	2	8	14
Oscillatoria	0	8	13
Nostoc	0	8	5
Lyngbya	0	6	7
Tolypothrix	0	3	2
Dolichospermum[1]	2	0	0
Microcystis	1	0	0

[1] Formerly *Anabaena*

USGS Water Resources Investigations Report 02-4189 (Carpenter 2003)

USGS



2016-18 Study of Drinking Water Sources






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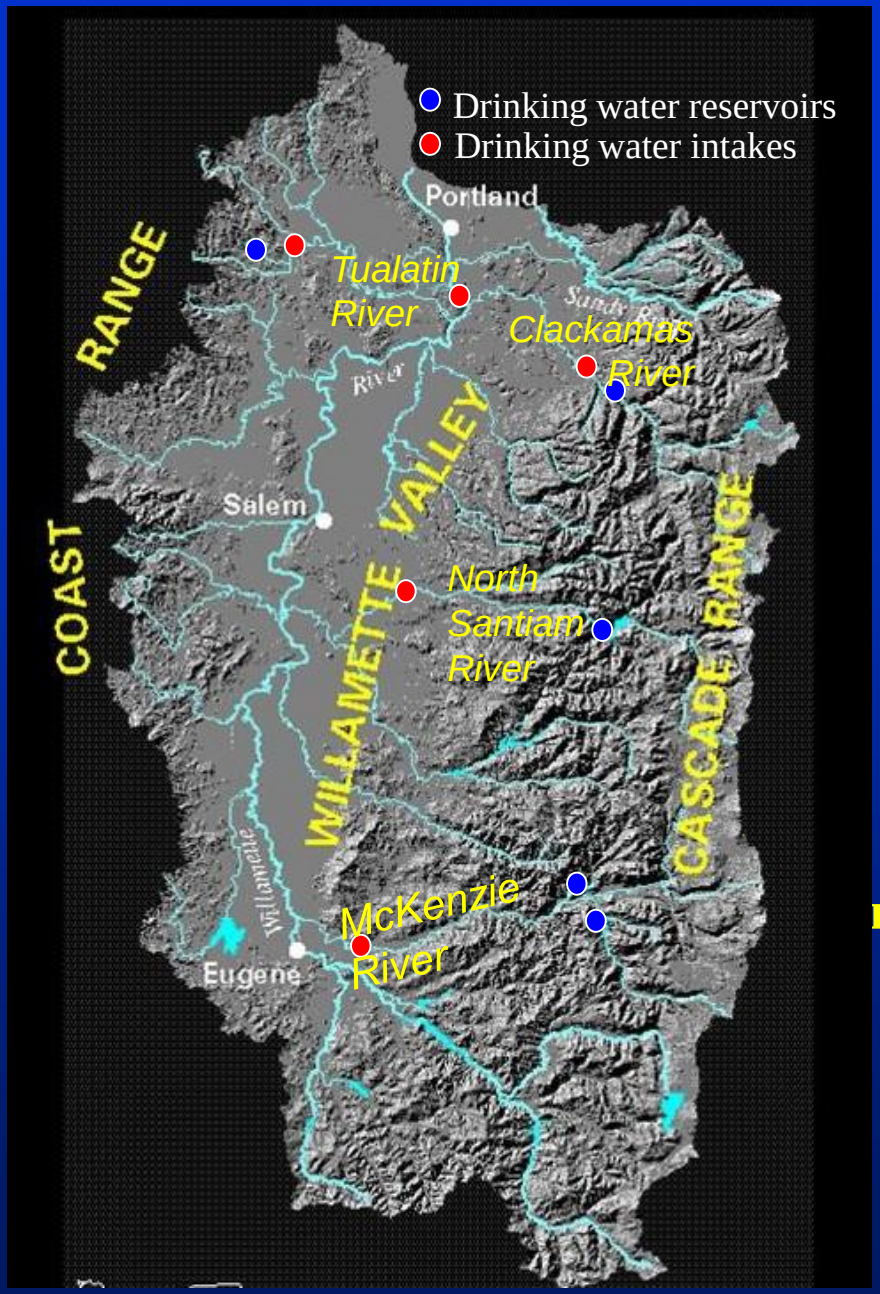
Study Areas

- Clackamas River/ Tributaries
- North Santiam River / intake
- McKenzie River / intake



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"Multiple Lines of Evidence" Sampling Approach





- ***Cyanobacteria colonies and mats*** **(n=78) hand-picked during visual surveys**
- ***Plankton net tows*** **(n=84) from reservoirs and riverine sites to identify cyanobacteria and cyanotoxins in transport to downstream DWTP intakes**
- ***SPATTs*** **(n=122) Deployment of solid-phase adsorbent toxin trackers in drinking-water intakes, tributaries, main-stem sites, and a few reservoirs**

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Cyanotoxin Analyses

- Cyanobacteria - 3 freeze-thaw cycles to release toxins
- SPATTs extracted with MeOH, concentrated
- Filtered - 1.2 µm glass fiber filters
- Analyze with Enzyme-Linked Immunosorbent Assays (ELISA) for 4 cyanotoxins

- Positive detection when extract concentration exceeded the lowest standard (0.15 µg/L for MC and ANX, 0.05 µg/L for CYL, and 0.02 µg/L for SAX)

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Results

- **Seven benthic samples of cyanobacteria—all from the Clackamas Basin—contained detectable levels of all 4 measured cyanotoxins. These included two samples of *Nostoc parmeloides* (ears) and five samples of *Microcoleus***

Nostoc parmeloides ("Ears")

Tested Positive:

Cylindrospermopsins
Microcystins
Anatoxins
Saxitoxins

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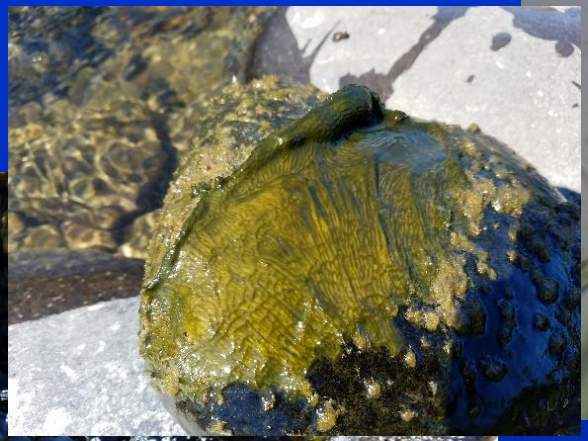
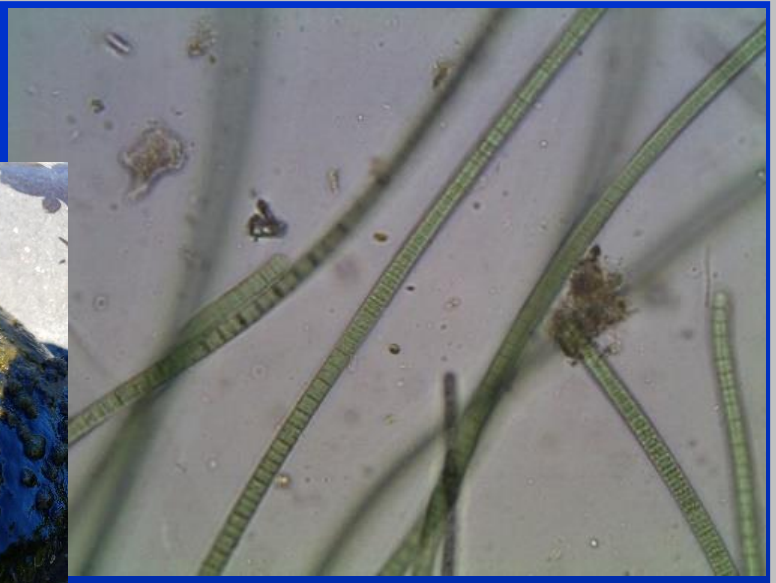
Microcoleus ("Mats")

Clackamas River at McIver Park



Cymbelloid stalked diatoms



Tested Positive:

Cylindrospermopsins
Microcystins
Saxitoxins
Anatoxins

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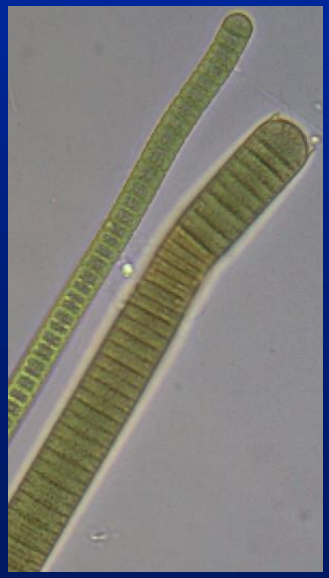
USGS Unpublished Data Subject to Revision

Oscillatoria (“Mats”)

Common in many habitats and rivers, streams, and wetlands



Tested Positive:

Cylindrospermopsins
Microcystins
Anatoxins

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Wollea

Upper Clackamas River,
in mats of stalked diatoms
(*Cymbella janischii*)

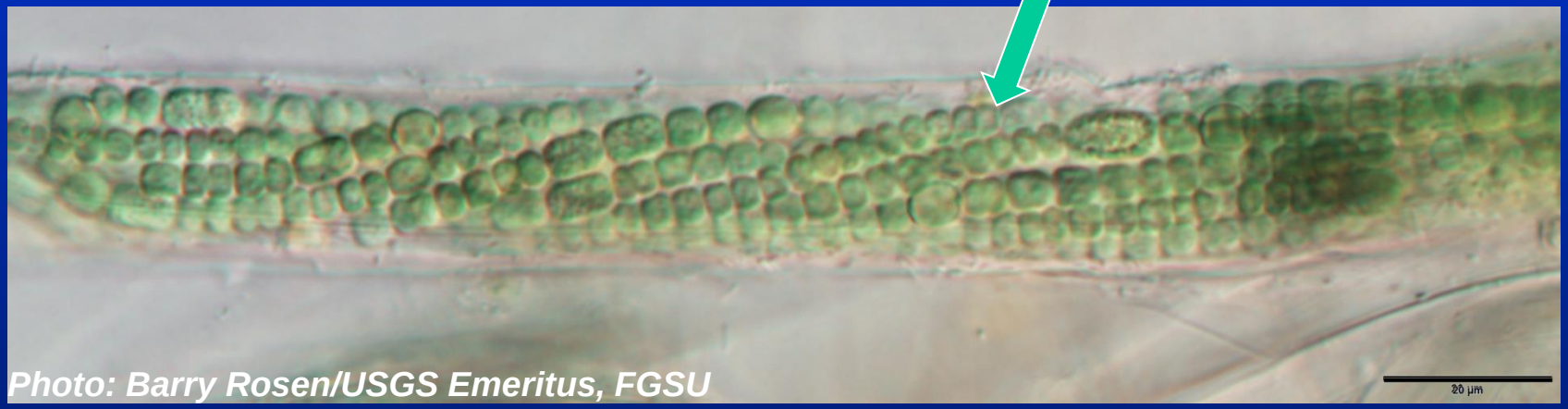

Photo: Barry Rosen/USGS Emeritus, FGSU

Tested Positive:

Cylindrospermopsins
Microcystins
Saxitoxins

USGS Unpublished Data Subject to Revision

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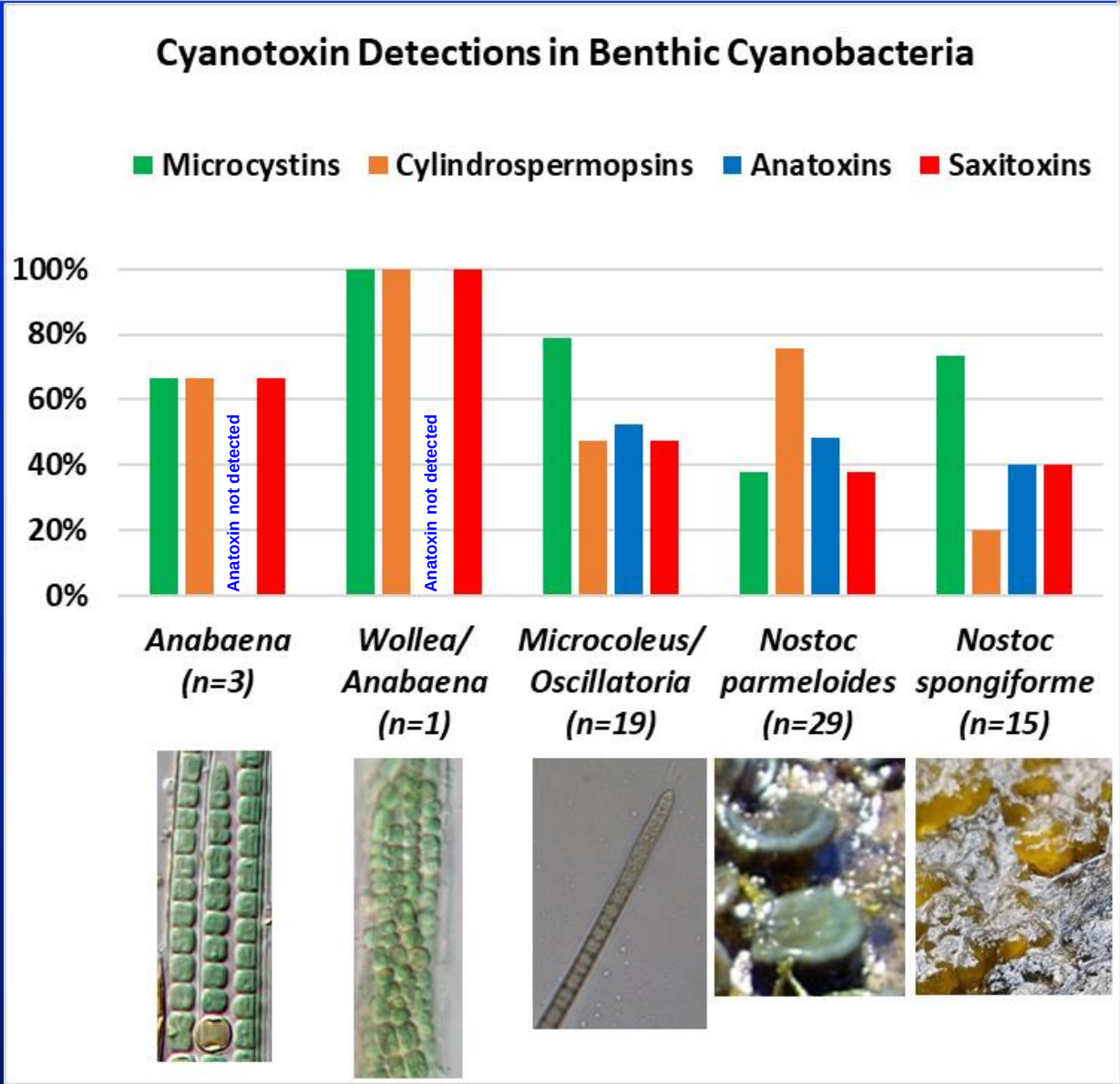
Results

- 94% of 67 samples tested positive for one or more cyanotoxins
- Only 4 samples tested negative for all 4 toxins
- *Microcoleus*, *Oscillatoria* and *Nostoc* were the most common toxic benthic taxa
- Genes often present along with toxins



USGS Unpublished Data Subject to Revision

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Cyanotoxin Genes - qPCR (n=12)

- 12 multiple-toxin specimens tested
- CYL and SAX genes and toxins - mostly agree
- One case of toxin gene detected, but no toxin found - not unexpected

	Sample extract cyanotoxin concentrations (ug/L)			
Cyanobacteria present	MC	CYL	SAX	ANX
Nostoc	0.48	**0.12** <		0.29
Microcoelus	0.33 <		**3.33**	0.17
Nostoc	1.15	**0.14**	**0.17**	0.23
Wollea saccata, Anabaena, Nostoc spongiforme, Tolypothrix	**8.54**	**0.65**	**0.53** <	
Dolichospermum, etc	0.23	**0.35** <		0.26
Dolichospermum, Nostoc, Tolypothrix	**4.89**	**2.67**	**0.18** <	
Dolichospermum, Oscillatoria, Tolypothrix	4.77	**3.40**	**0.20**	0.16
Dolichospermum, Oscillatoria, Tolypothrix	2.74	**2.67**	**0.16**	0.16
Dolichospermum, Oscillatoria, Tolypothrix, Rivularia	144 <		**0.06** <	
Dolichospermum spp., possibly other cyanos	**30.5**	**0.11** <		0.17
Dolichospermum, Nostoc	2.51	**0.07**	**0.08** <	
Oscillatoria, Tolypothrix, Rivularia	<	**0.07**	**3.67**	0.26
	Yellow highlight = Toxin Gene Present			

USGS ELISA/CRW Phytoxigene Data Unpublished - Subject to Revision

- MC genes sometimes not detected in lowest concentration samples
- Several labs are working on primers for anatoxins

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Toxin Occurrence by Sample Type

- Cyanobacteria colonies

vs

- Plankton net tows

vs

- SPATTs

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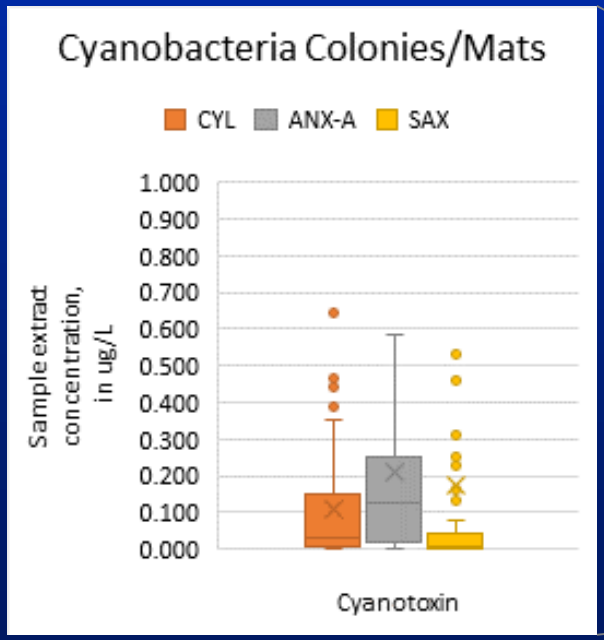
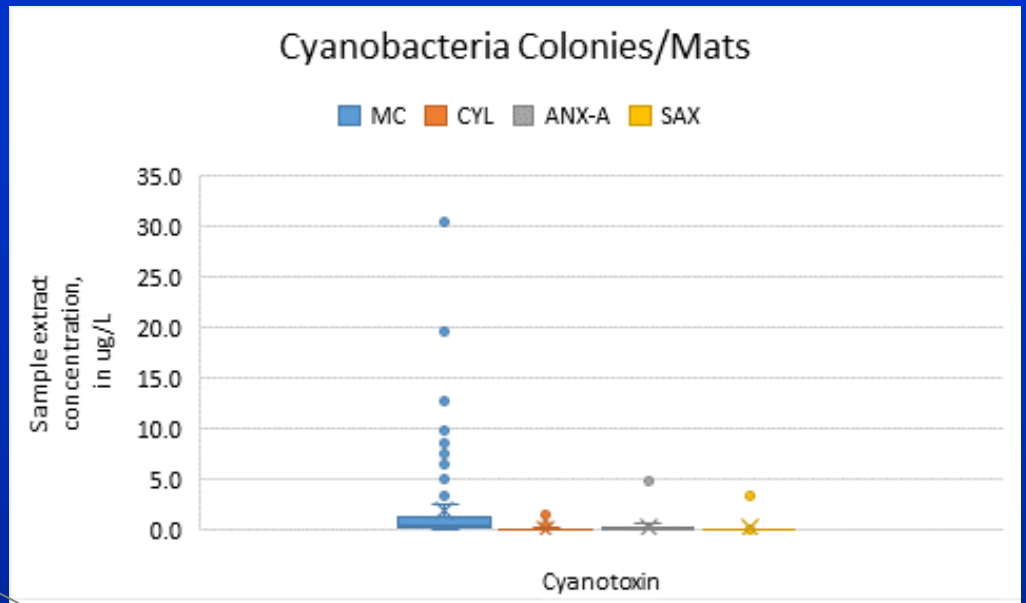
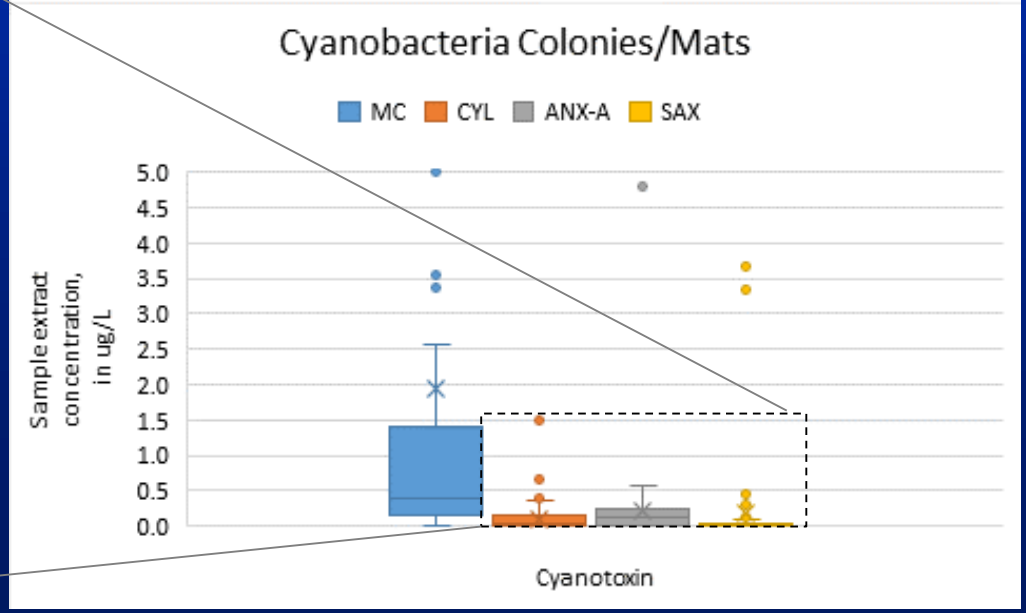
Toxin Occurrence by Sample Type

Cyanobacteria Colonies/Mats

- Microcystins > Anatoxins > Cylindrospermopsins and Saxitoxins







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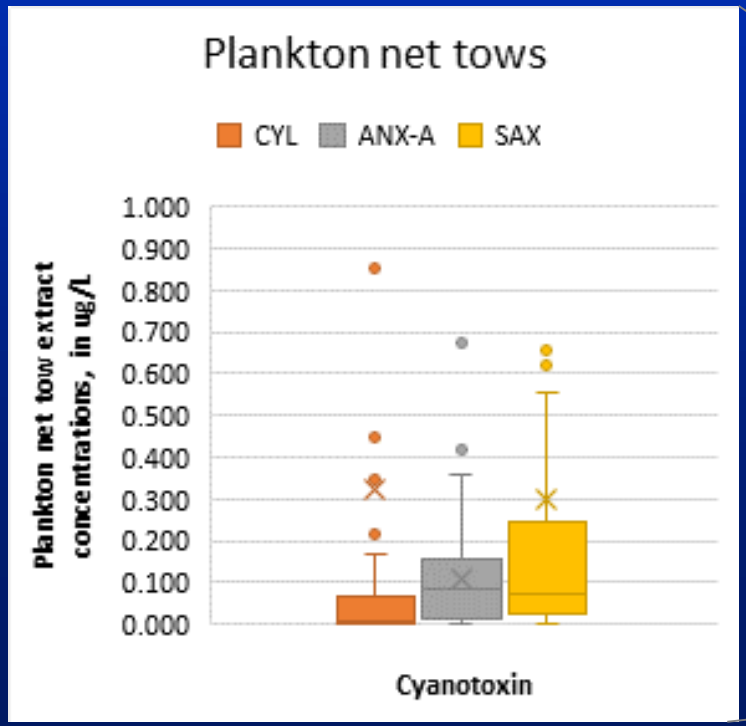
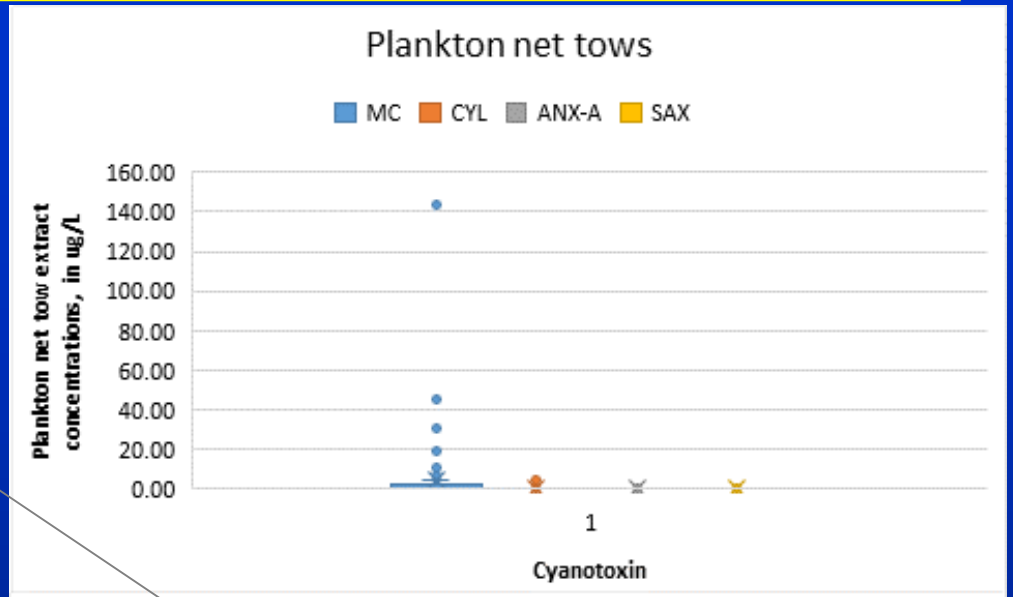
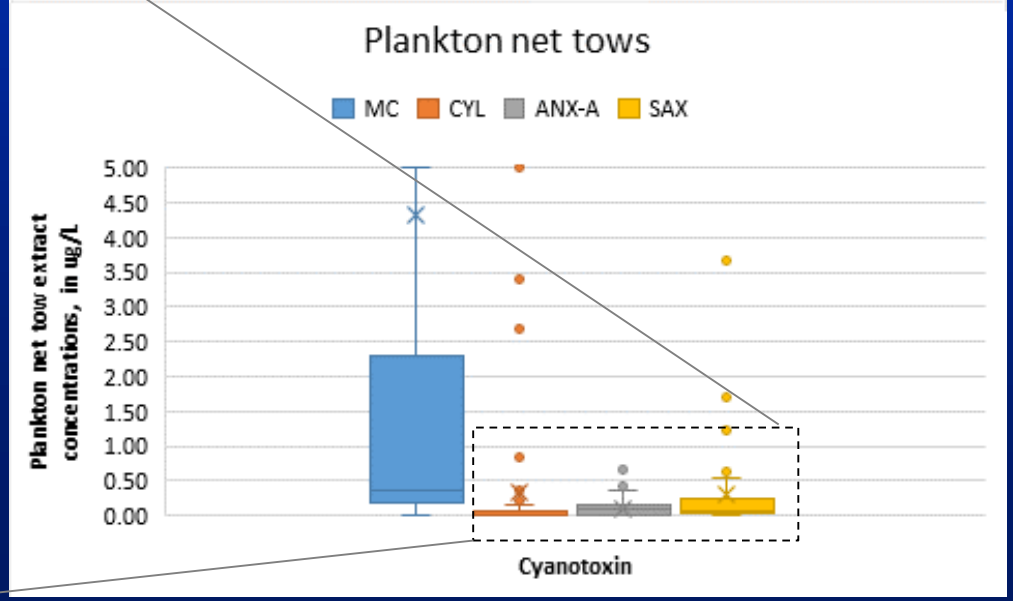
Toxin Occurrence by Sample Type

Plankton Net Tows

- Microcystin concentrations highest
- Saxitoxins > Anatoxins > Cylindrospermopsins







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Cyanobacteria in Plankton Net Tows

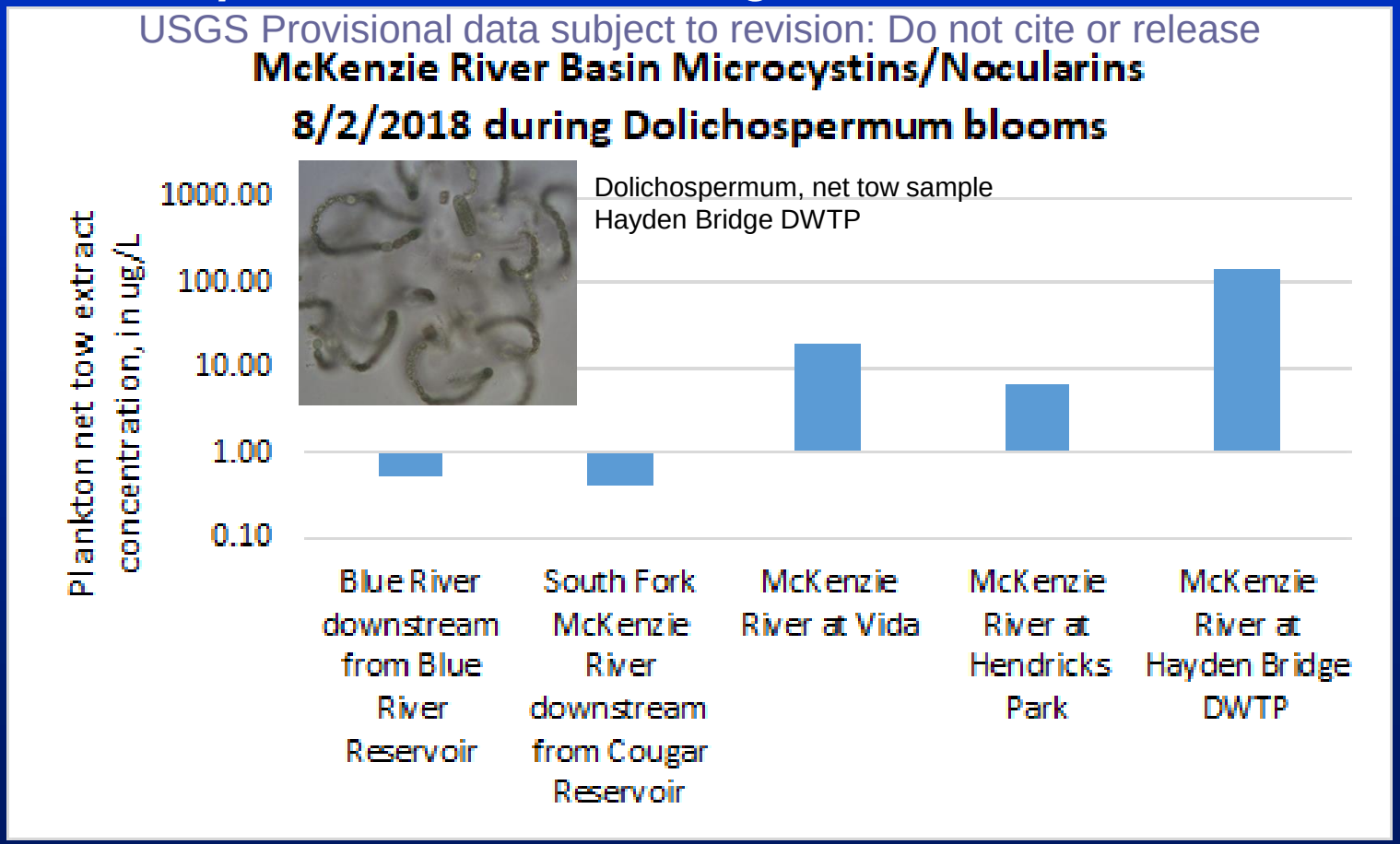
- 84 plankton net tow samples resulted in 176 cyanotoxin detections, or 2.1 per sample, on average

USGS

Plankton Net Tow Extract Concentrations Increased Downstream

- **Highest microcystin concentration (144 ug/L) from McKenzie River at Hayden Bridge DWTP on 8/2/2018 during *Dolichospermum* bloom in Cougar Reservoir**

USGS Provisional data subject to revision: Do not cite or release



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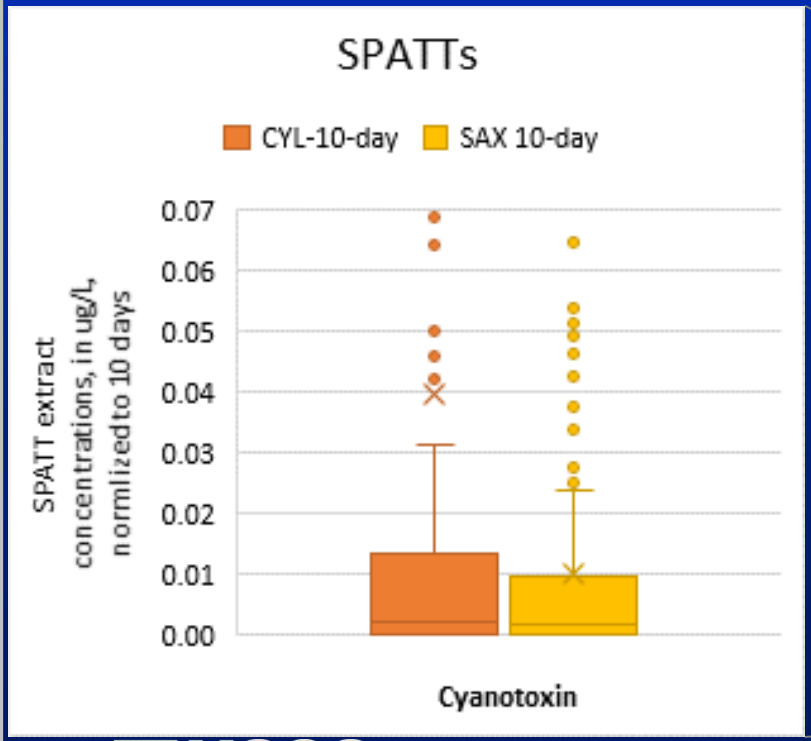
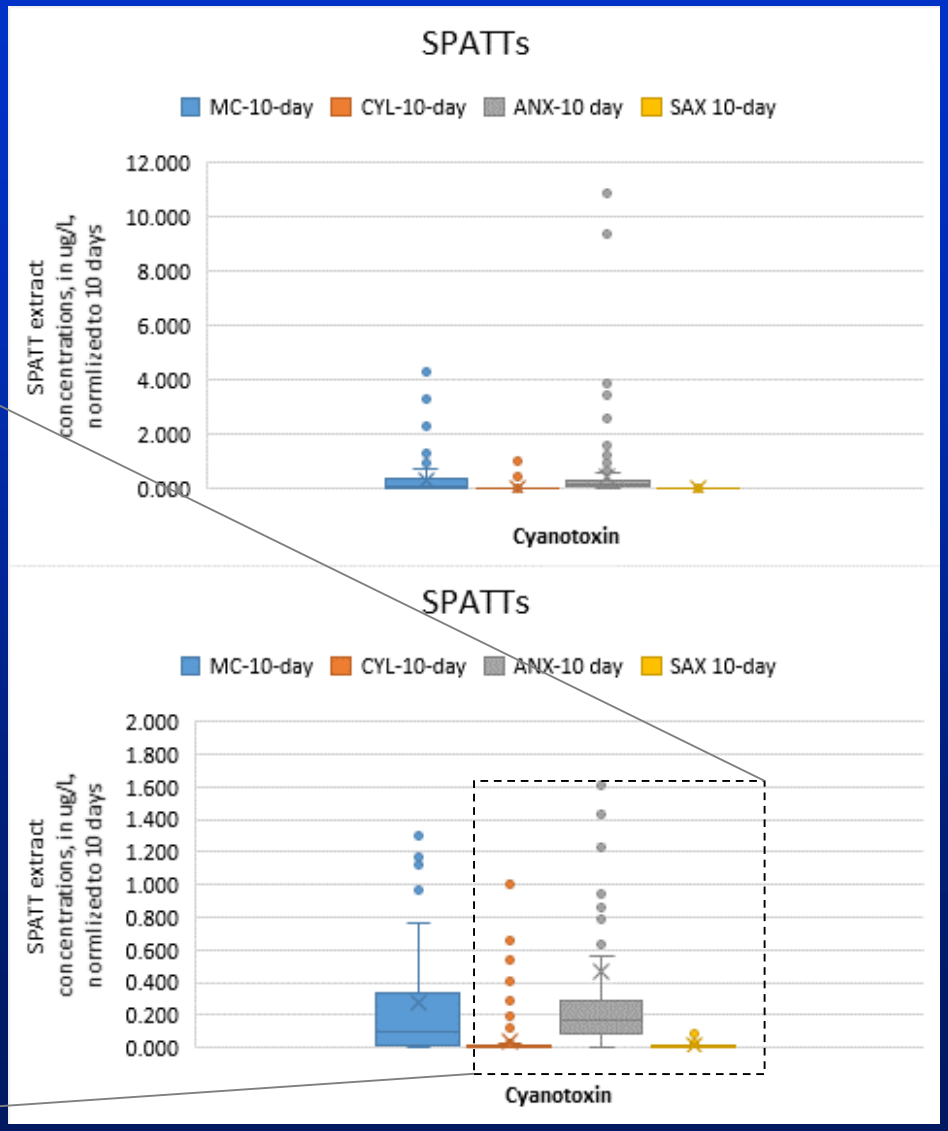
Toxin Occurrence by Sample Type

SPATTs

- Microcystins and Anatoxins > Cylindrospermopsins and Saxitoxins





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Summary

- 544 cyanotoxin detections in 289 samples from 59 sites
- Anatoxin-*a* and microcystins were detected in 63% and 60% of SPATTs
- All 4 cyanotoxins detected in 8% of samples (all sample types)

		Total (ADDA) Microcystins/ Nodularins	Cylindro-spermopsin	Anatoxin-*a*	Saxitoxin
All 289 samples	Detections	202	78	135	129
	% detection	70%	27%	47%	45%
84 net tows	Detections	66	21	23	66
	% detection	79%	25%	27%	79%
122 SPATTs	Detections	73	21	77	32
	% detection	60%	17%	63%	26%
78 Cyanobacteria colonies/mats	Detections	59	32	34	31
	% detection	76%	41%	44%	40%
5 Planktonic cyanobacteria		4	4	1	0
		80%	80%	20%	0%
	Color Legend:	> 50%	40-50%	15-30%	0%

USGS

USGS Provisional Data Subject to Revision

Conclusions

- **Presence of all 4 primary cyanotoxins confirmed in numerous samples of benthic cyanobacteria**
- **Plankton net tow samples contained cyanobacteria, including *Nostoc* (especially) in transport to drinking water intakes**
- **Since toxins are intracellular, risk is unknown but frequent detection in SPATTs indicates that some toxin is dissolved**
- **Toxins might also be transported downstream associated with sediments or organic carbon**

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Considerations and Next Steps

- Samples were natural collections, not unialgal cultures, so multiple strains may be present
- Culturing is ongoing to isolate and identify toxin production, spectral reflectance
- Focus this year on upstream reservoirs, with continuous profiling down to 75-85 meters in two large water storage reservoirs with recurring HABs, and the downstream reaches, where benthic cyanobacteria are abundant

On-going Collaborations:
Hyperspectral Fingerprinting From Satellites to Cells

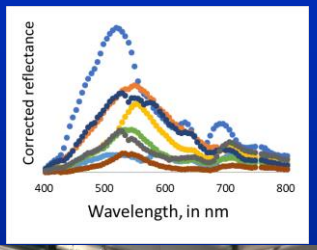

NASA / ISS

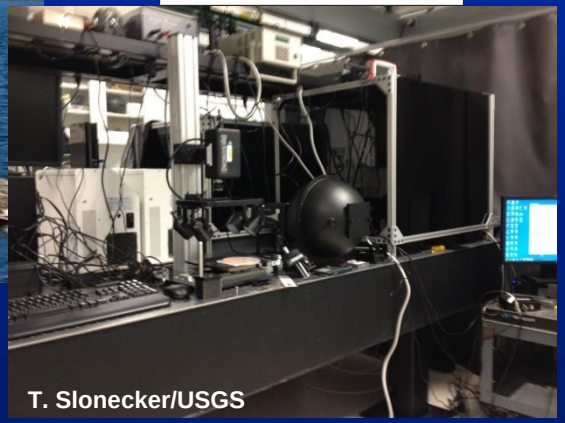
J. Graham/USGS

Other USGS Science Centers

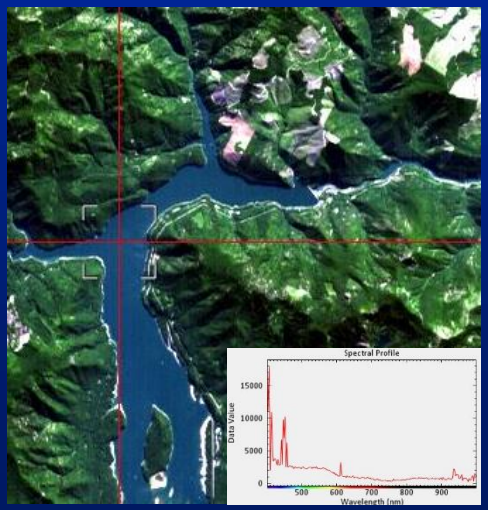
D. Weathers/USGS

City of Salem, EWEB, US ACE, OSU




T. Slonecker/USGS

USGS/NIST Sensor Science Division



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Thank You!

Acknowledgements

Clackamas River Water Providers (Kim Swan)
City of Estacada (Chris Lewis)
Clackamas River Water (Suzanne DeLorenzo and Tracy Triplett)
City of Lake Oswego (Kari Duncan)
North Clackamas County Water Commission
South Fork Water Board (John Collins)
Eugene Water and Electric Board (David Donahue and Karl Morgenstern)
City of Salem (Brandin Hilbrandt)
USGS (Barry Rosen)

Kurt Carpenter
kdcar@usgs.gov
503.251.3215

USGS

ITEM III
Membership Networking Groups: Follow up to membership survey results – Setting up networking groups

Jade Young

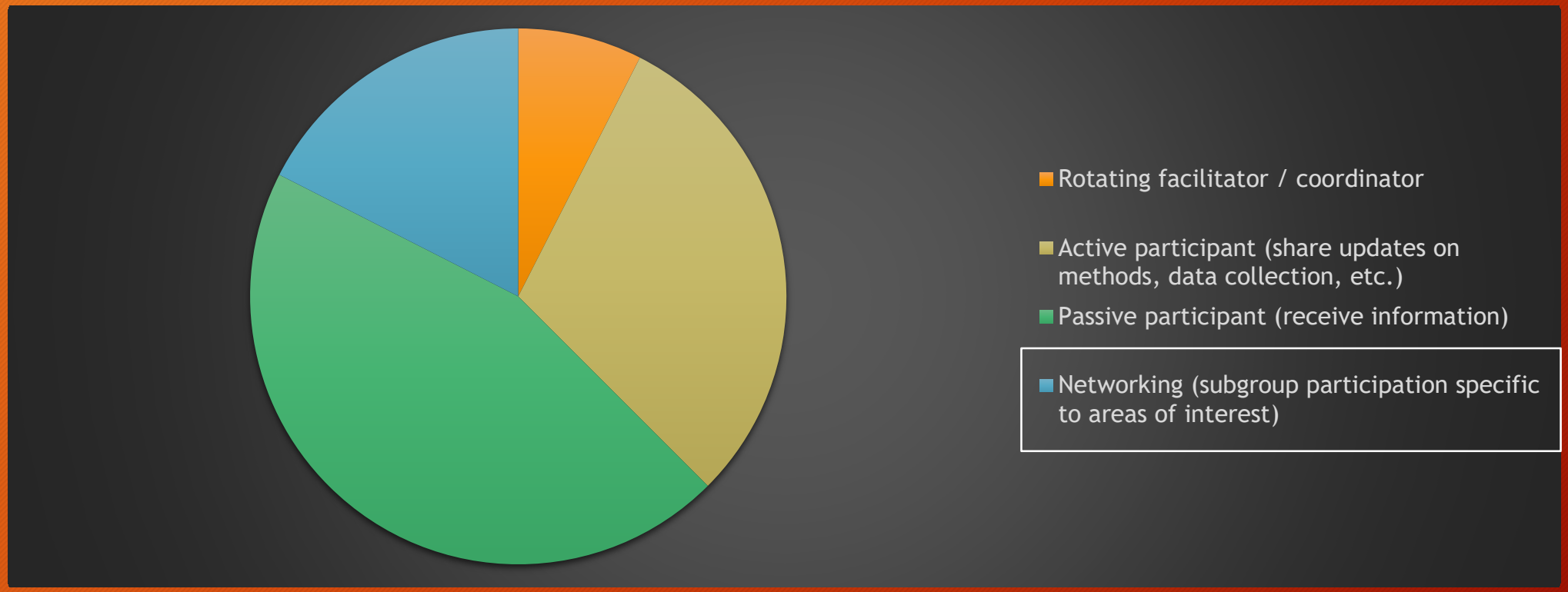
2019 Membership Re-survey

Summary of Responses

- 40 responses collected
- 17 new members
- New agencies represented

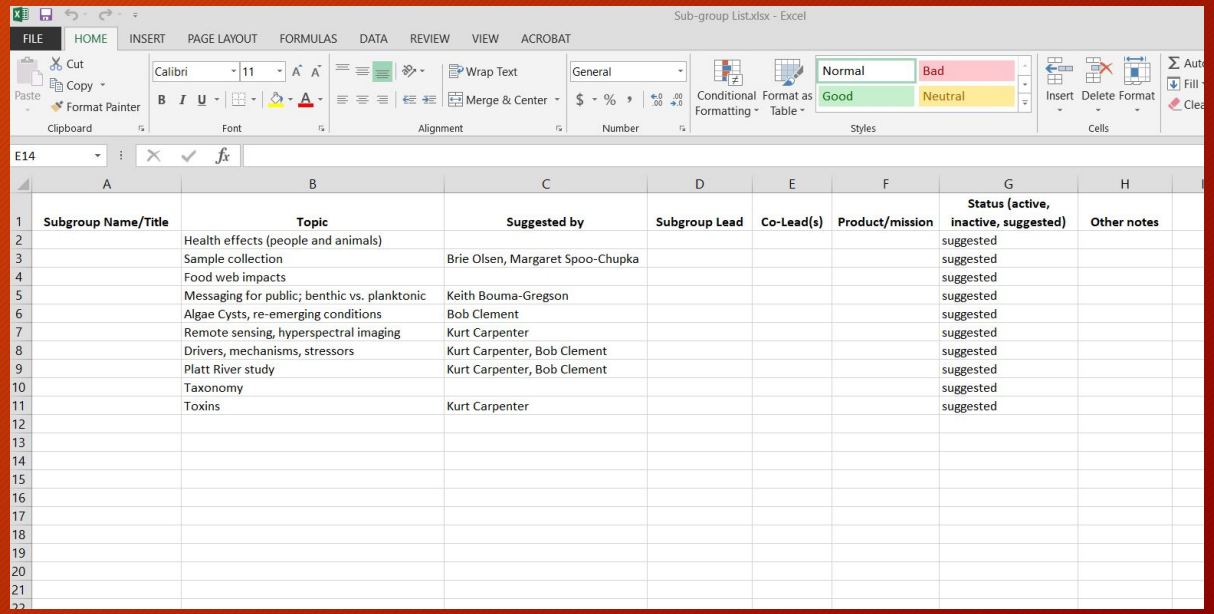
Anabaena sp. mat in the Russian River by Rich Fadness.

As a member of the Benthic HABs Discussion Group, which role is of most interest to you?



Subgroups component - suggestions

- Topic of interest
- Proposal/plan/mission/end product
- Lead, co-leads
- Membership



Sub-group List.xlsx - Excel

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E14

	A	B	C	D	E	F	G	H
1	Subgroup Name/Title	Topic	Suggested by	Subgroup Lead	Co-Lead(s)	Product/mission	Status (active, inactive, suggested)	Other notes
2		Health effects (people and animals)					suggested	
3		Sample collection	Brie Olsen, Margaret Spoo-Chupka				suggested	
4		Food web impacts					suggested	
5		Messaging for public; benthic vs. planktonic	Keith Bouma-Gregson				suggested	
6		Algae Cysts, re-emerging conditions	Bob Clement				suggested	
7		Remote sensing, hyperspectral imaging	Kurt Carpenter				suggested	
8		Drivers, mechanisms, stressors	Kurt Carpenter, Bob Clement				suggested	
9		Platt River study	Kurt Carpenter, Bob Clement				suggested	
10		Taxonomy					suggested	
11		Toxins	Kurt Carpenter				suggested	

Subgroup obligations

- Notify co-facilitators for tracking
- Periodically check-in / report to the larger group

Future directions

This is a member driven group.

Jade will be tracking subgroup information.

Will summarize and contact those interested soon.

ITEM IV

Open Discussion, Publications & Upcoming Meetings

ITEM IV
CCHAB NETWORK: BENTHIC HAB SIGNAGE

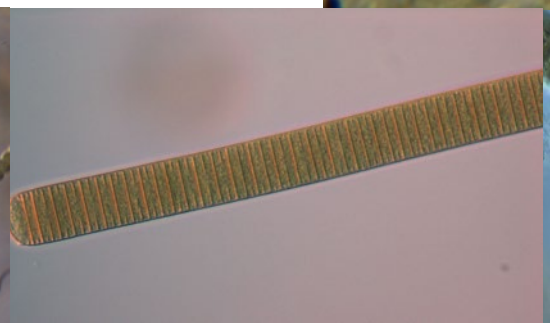
KEITH BOUMA-GREGSON

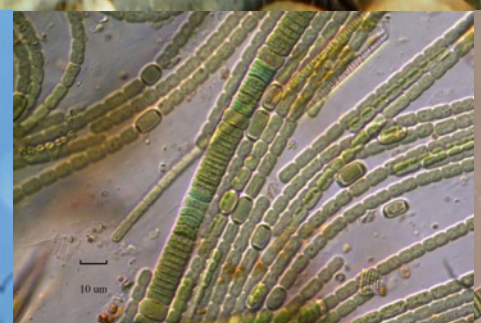
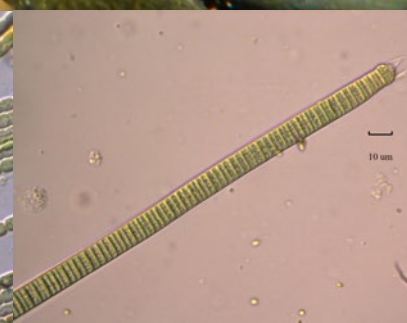
Benthic Cyanobacteria Signage and Messaging

Keith Bouma-Gregson, Ph.D.
California State Water Resources Control Board

Benthic Workgroup
May 27, 2019





The need

CA has no signage and minimal messaging for incidents where benthic cyanobacteria are present or suspected.

CAUTION

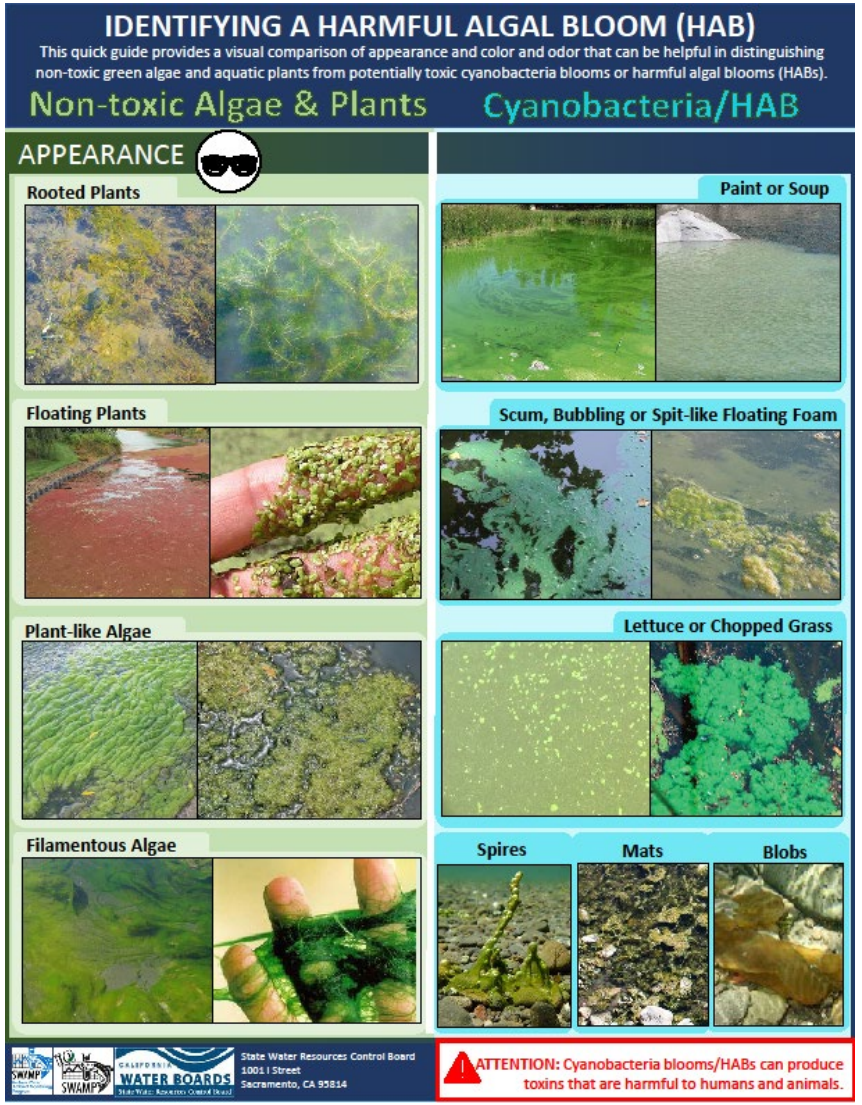
Harmful algae may be present in this water.
For your family's safety:

- You can swim in this water, but **stay away from algae and scum** in the water.
- **Do not** let pets and other animals go into or drink the water, or eat scum on the shore.
- **Keep children away** from algae in the water or on the shore.
- **Do not** drink this water or use it for cooking.
- For fish caught here, **throw away guts and clean fillets** with tap water or bottled water before cooking.
- **Do not** eat shellfish from this water.

Call your doctor or veterinarian if you or your pet get sick after going in the water.

For more information on harmful algae, go to **https://mywaterquality.ca.gov/habs/index.html**

For local information, contact: Enter your contact information in this text box



Objectives

CA CyanoHAB network subcommittee formed

Goal

For cyanobacterial incidents that involve benthic cyanobacterial mats, create a sign and posting criteria that fits into the CCHAB decision tree.

- Some considerations:
  - How to incorporate into CCHAB decision tree?
  - General posting or related to trigger levels?
  - What trigger level should the benthic sign equate to?

Medium risk sign – Greater Wellington Regional Council

The signs

Process

- Reviewed other entities HABs signage to reference if and how other groups have approached benthic HABs
  - All states in USA and Australia, Canadian provinces, and New Zealand Regional Councils

Design decisions:

- Number of signs
- Layout
- Colors
- Language
- Advisories
- Images

Two signs

General Awareness and Trigger Level

Sign objectives

1. inform people that benthic algal mats may be or are present
2. provide them with information for how to identify algal mats and
3. advise people on preventative practices to reduce the risk of exposure to algal mats (advisories).

Postings

General awareness sign

- **Purpose:** to post at waterbodies where benthic mats may be an issue
- **Trigger level:** none
- Can be used seasonally or year round
- Can be placed with CCHAB planktonic signs

Trigger level sign

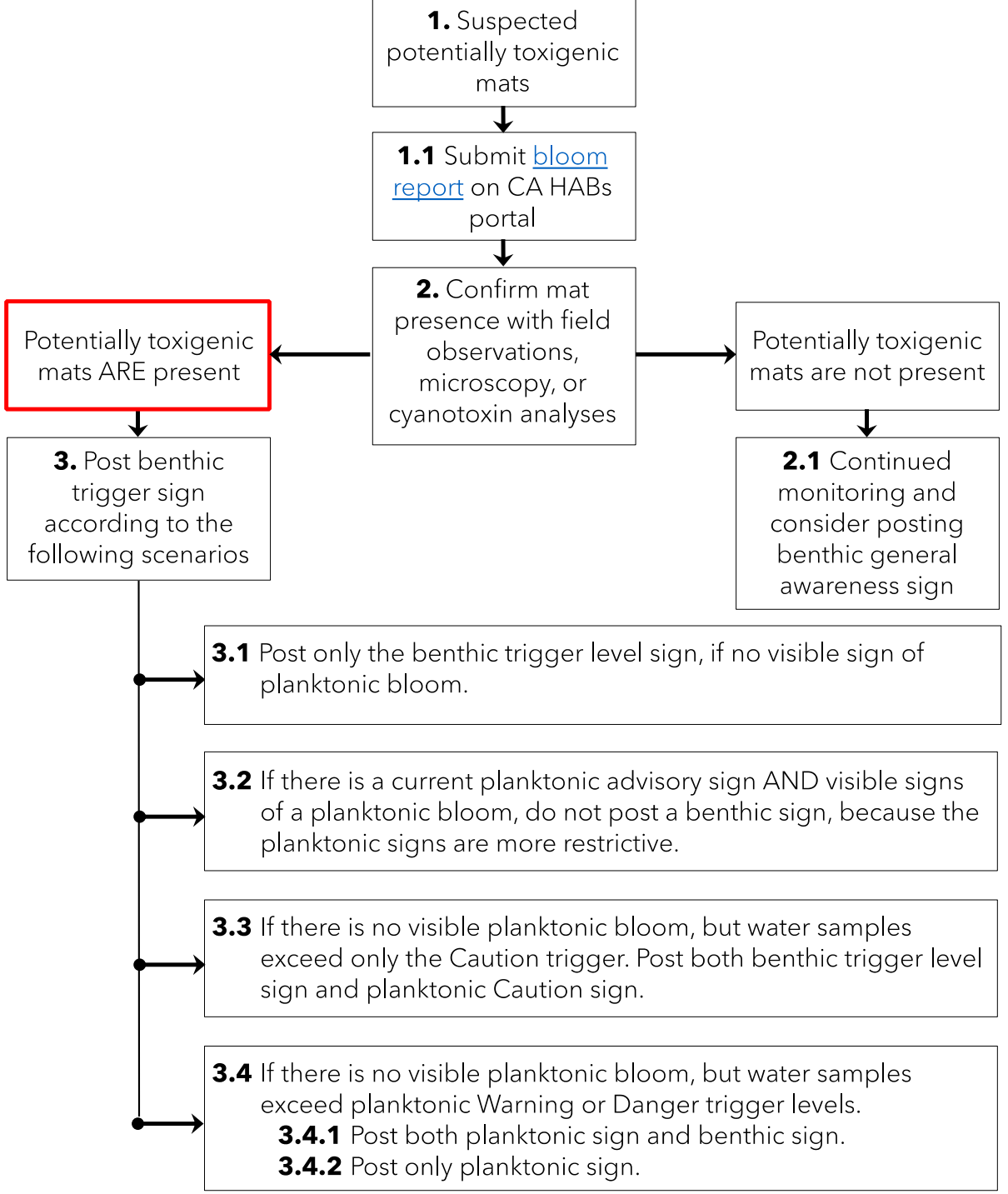
- **Purpose:** to post at waterbodies where benthic mats are confirmed
- **Trigger level:** visual confirmation of potentially toxigenic benthic mats OR detection of cyanotoxins within mat material (not overlying water).

De-posted when visual indicators are gone

Can be placed alongside General Awareness signs

Postings

Guidance document and flow-chart available on CA HABs Portal



Advisories

Considerations

- Children and dogs most at risk
- Focus on primary exposure route, ingestion of mat material
- Challenges of mixed assemblages and patchy distribution
- Little information about impacts of mat toxins on shellfish and fish
- Limited space on the signs

Do NOT let children or adults touch, eat, or swallow any algal mats.

Do NOT let dogs eat algal mats or drink from the water.

General Awareness Sign

Banner

- Statement about what to do.
- Color not associated with CCHAB planktonic signs

CHECK FOR ALGAE

Toxic algal mats may be present in this water

Mats can be attached to the bottom, detached and floating, or washed up on shore

If you see algal mats:

Do NOT let children or adults touch, eat, or swallow any algal mats.

Do NOT let dogs eat algal mats or drink from the water.

Call your doctor or veterinarian if you or your pet get sick after contacting or ingesting algae. For more information on toxic algae visit: **mywaterquality.ca.gov/habs**
For local information, contact:

Statement

- Descriptive statements about algal mats
- Language decisions:
  - Toxic
  - Algal
  - Mat
- Description about where mats may be

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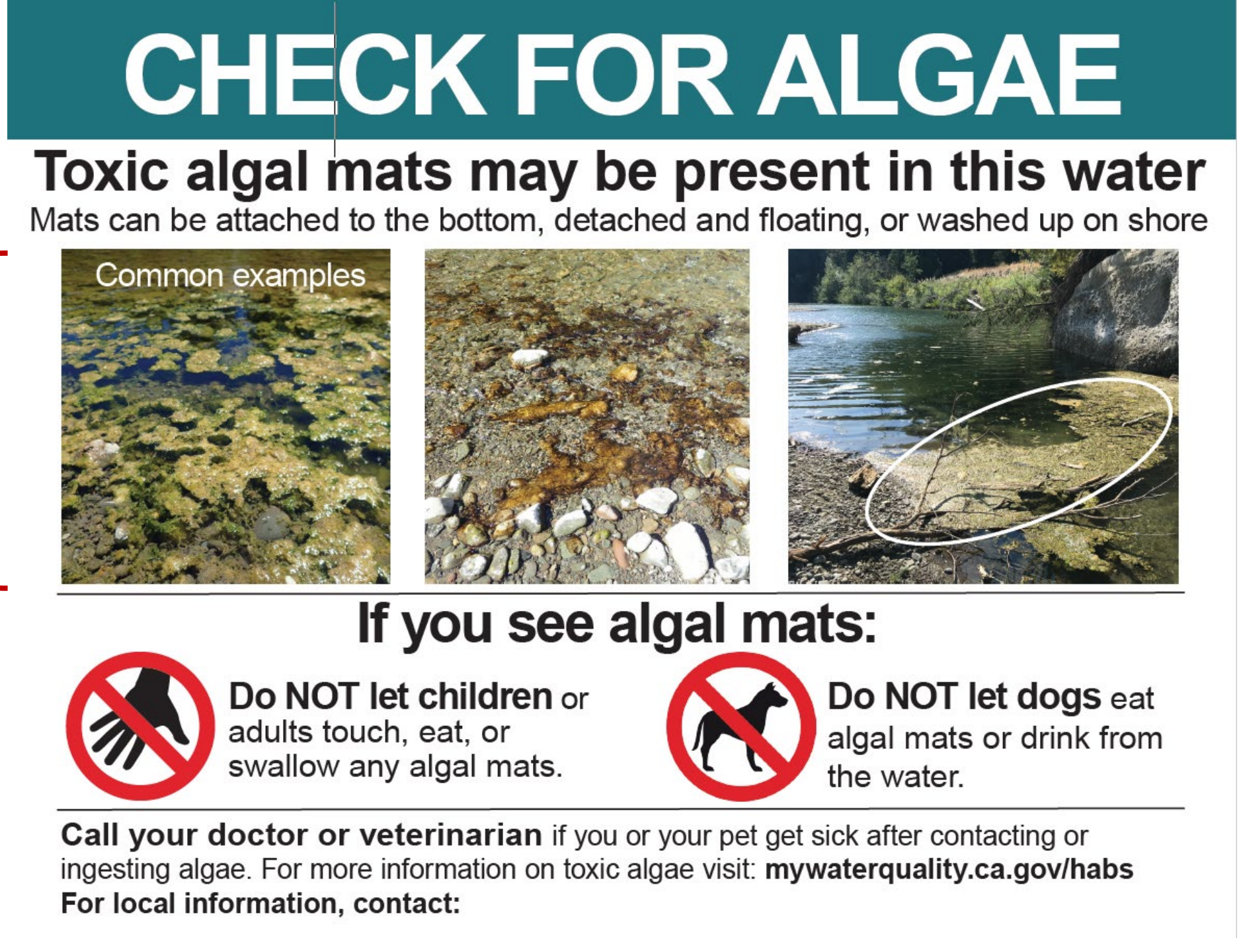
Images

- Examples of what benthic cyanobacteria can look like
- Image on right highlights detached floating clumps
- Chose not to put captions on each photo.



Advisories

- Children and dogs
- Allows for water contact and recreation
- Emphasis on contact and ingestion
- Emphasis on avoiding all algal material, not just cyanobacteria

CHECK FOR ALGAE

Toxic algal mats may be present in this water

Mats can be attached to the bottom, detached and floating, or washed up on shore

If you see algal mats:

Do NOT let children or adults touch, eat, or swallow any algal mats.

Do NOT let dogs eat algal mats or drink from the water.

Call your doctor or veterinarian if you or your pet get sick after contacting or ingesting algae. For more information on toxic algae visit: **mywaterquality.ca.gov/habs**
For local information, contact:

For more information

- Same information as on the CCHAB planktonic signs

CHECK FOR ALGAE

Toxic algal mats may be present in this water

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For local information, contact:

Trigger Level Sign

Banner

- Stronger wording
- Stronger color to communicate risk
- Same color as CCHAB caution sign, as advisories most closely match the Caution advisories

TOXIC ALGAE ALERT

Toxic algal mats ARE present in this water

Mats can be attached to the bottom, detached and floating, or washed up on shore

Do NOT let children or adults touch, eat, or swallow any algal mats.

Do NOT let dogs eat algal mats or drink from the water.

Call your doctor or veterinarian immediately if you or your pet get sick after contacting or ingesting algae. For more information on toxic algae visit: **mywaterquality.ca.gov/habs**

For local information, contact:

Date posted:

Statement

- Descriptive statements about algal mats
- Mats are in this water

TOXIC ALGAE ALERT

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Do NOT let dogs eat algal mats or drink from the water.

Call your doctor or veterinarian immediately if you or your pet get sick after contacting or ingesting algae. For more information on toxic algae visit: **mywaterquality.ca.gov/habs**

For local information, contact:

Date posted:

Advisories

- Placed above images to emphasize the advisory
- Children and dogs
- Allows for water contact and recreation
  - Alternate version when water contact not allowed

Images

- Same as for general awareness sign

TOXIC ALGAE ALERT

Toxic algal mats ARE present in this water

Mats can be attached to the bottom, detached and floating, or washed up on shore

Do NOT let children or adults touch, eat, or swallow any algal mats.

Do NOT let dogs eat algal mats or drink from the water.

Common examples

Call your doctor or veterinarian immediately if you or your pet get sick after contacting or ingesting algae. For more information on toxic algae visit: **mywaterquality.ca.gov/habs**

For local information, contact:

Date posted:

For more information

- Added “immediately” to emphasize need for rapid medical attention.

TOXIC ALGAE ALERT

Toxic algal mats ARE present in this water

Mats can be attached to the bottom, detached and floating, or washed up on shore

Do NOT let children or adults touch, eat, or swallow any algal mats.

Do NOT let dogs eat algal mats or drink from the water.

Call your doctor or veterinarian immediately if you or your pet get sick after contacting or ingesting algae. For more information on toxic algae visit: **mywaterquality.ca.gov/habs**

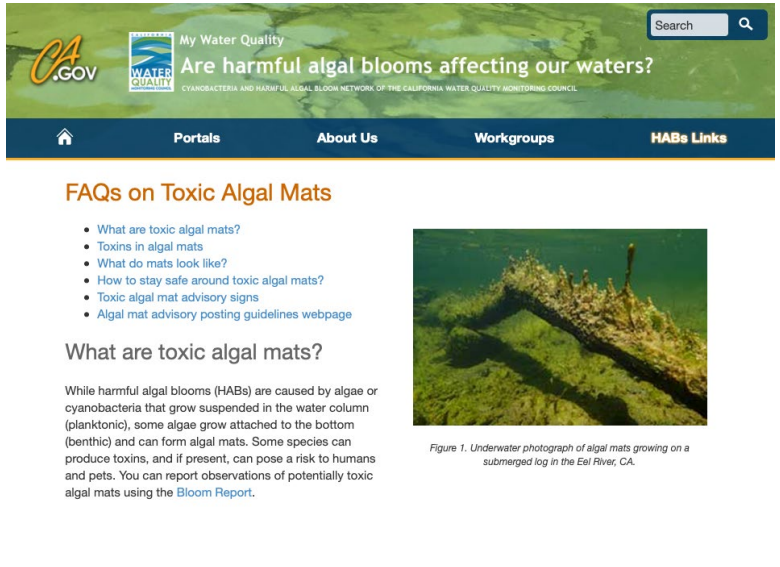
For local information, contact:

Date posted:

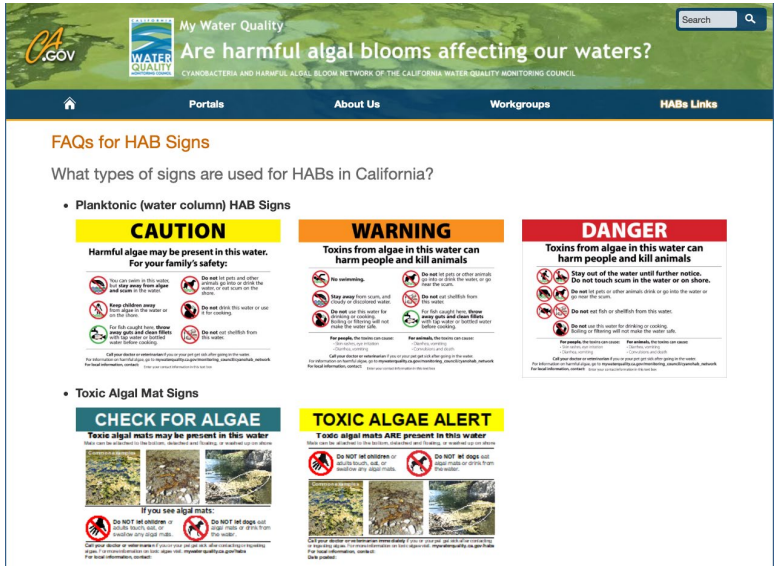
Webpages

CA HABs Portal: mywaterquality.ca.gov/habs

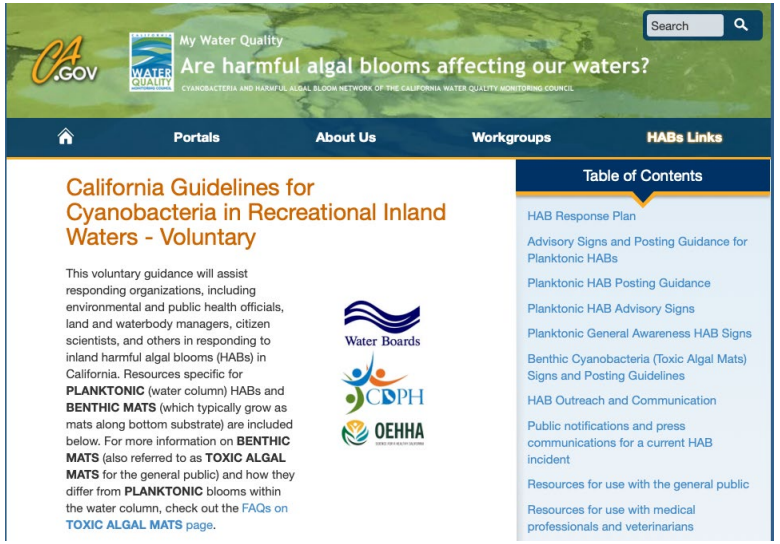
FAQs for algal mats



FAQs for HABs signs



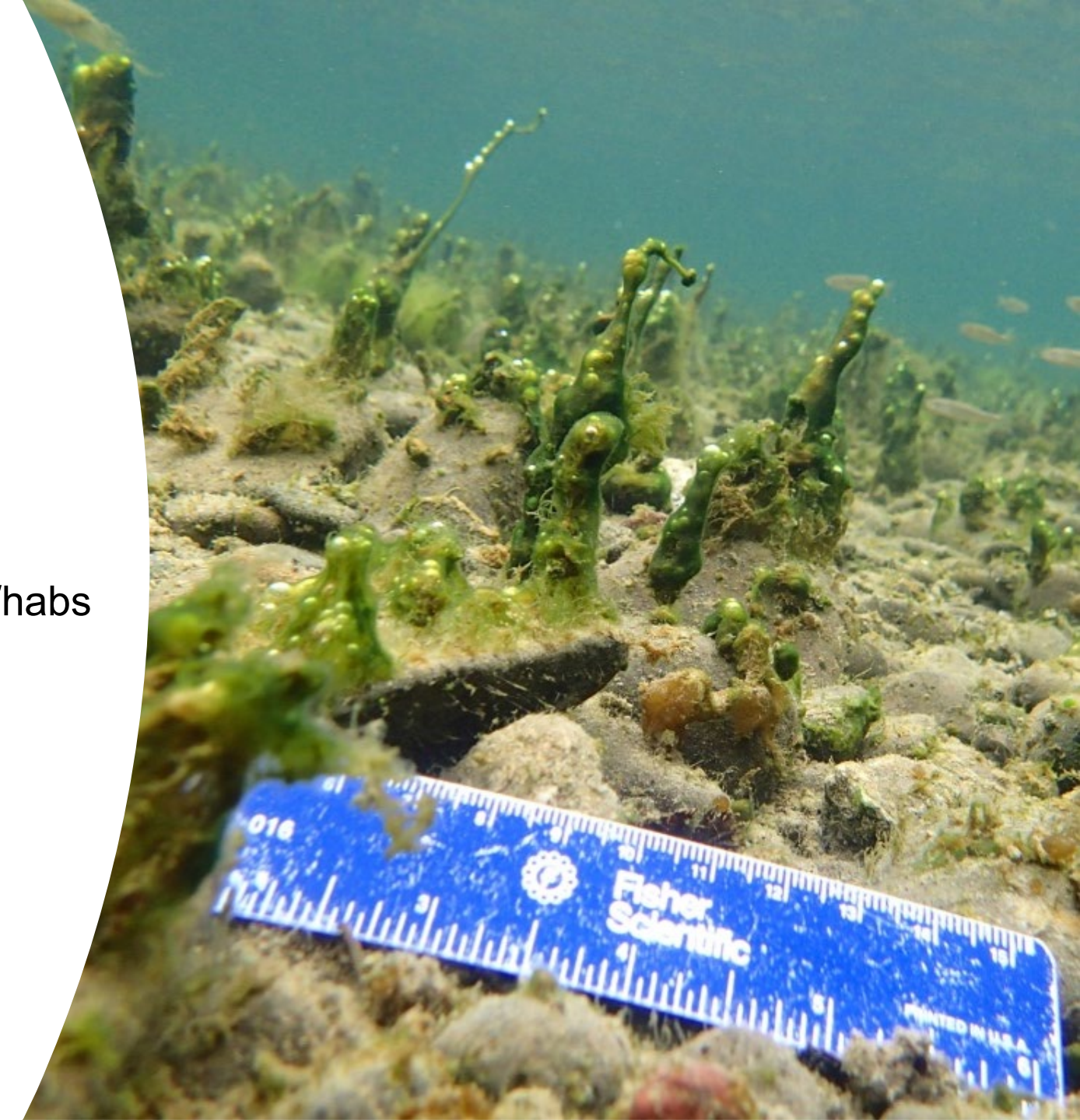
HABs response guidance



Questions

Keith Bouma-Gregson
keith.bouma-gregson@waterboards.ca.gov

CA HABs Portal: mywaterquality.ca.gov/habs



WRAP UP & NEXT STEPS

- Call for Benthic HAB Workgroup Co-facilitator
- Call for Guest Presenters - If you would like to provide a presentation or know someone contact the Benthic HAB facilitators.
- If you'd like to be added to the Benthic HAB Workgroup distribution list, send an email to the Benthic HAB facilitators.
- Benthic HAB Facilitators:

Margaret Spoo-Chupka Mspoo-Chupka@mwdh2o.com
Jade Young Jade.L.Young@usace.army.mil
Dr. Lesley D'Anglada Danglada.Lesley@epa.gov