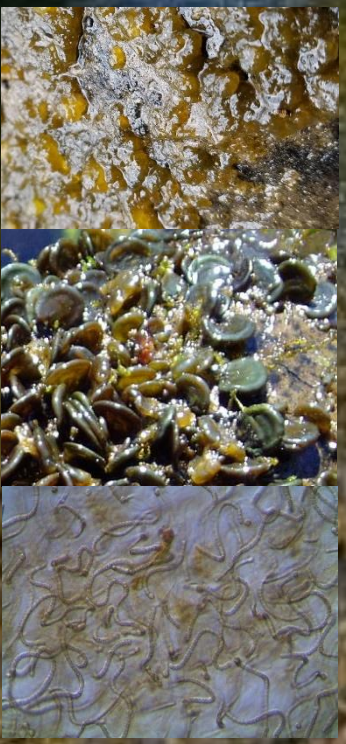
Benthic Periphyton as a Source of Cyanotoxins in Three Oregon Rivers Used for Municipal Drinking-Water Supply



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Protecting Drinking Water Sources from Cyano-HAB Impacts in the Willamette Basin
Willamette Basin Partners' Workshop
April 28, 2021

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

Photo: Barry Rosen/USGS Emeritus/FGFU

HABs Can Involve..

Phytoplankton AND Benthic "Periphyton"

Timothy Lake

Clackamas River Basin

North Fork Reservoir

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2016-18 Study of Drinking Water Sources






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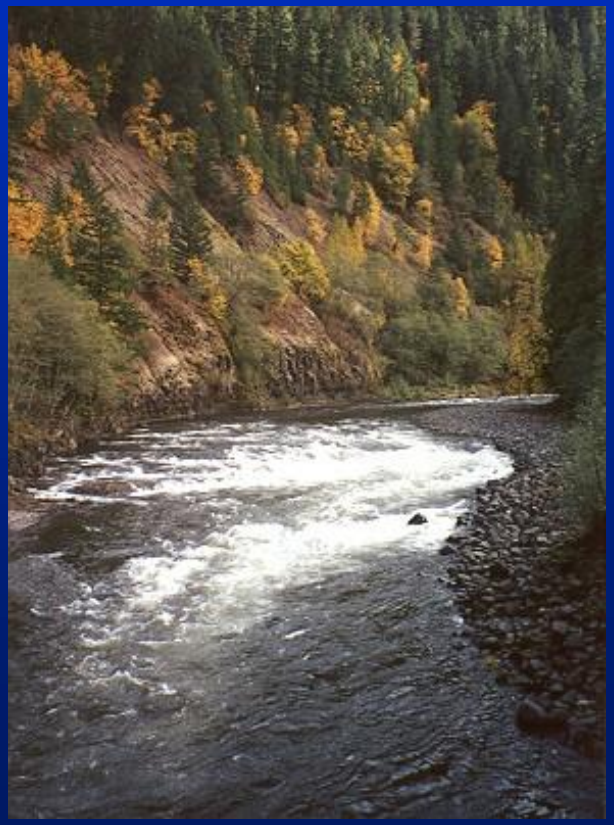
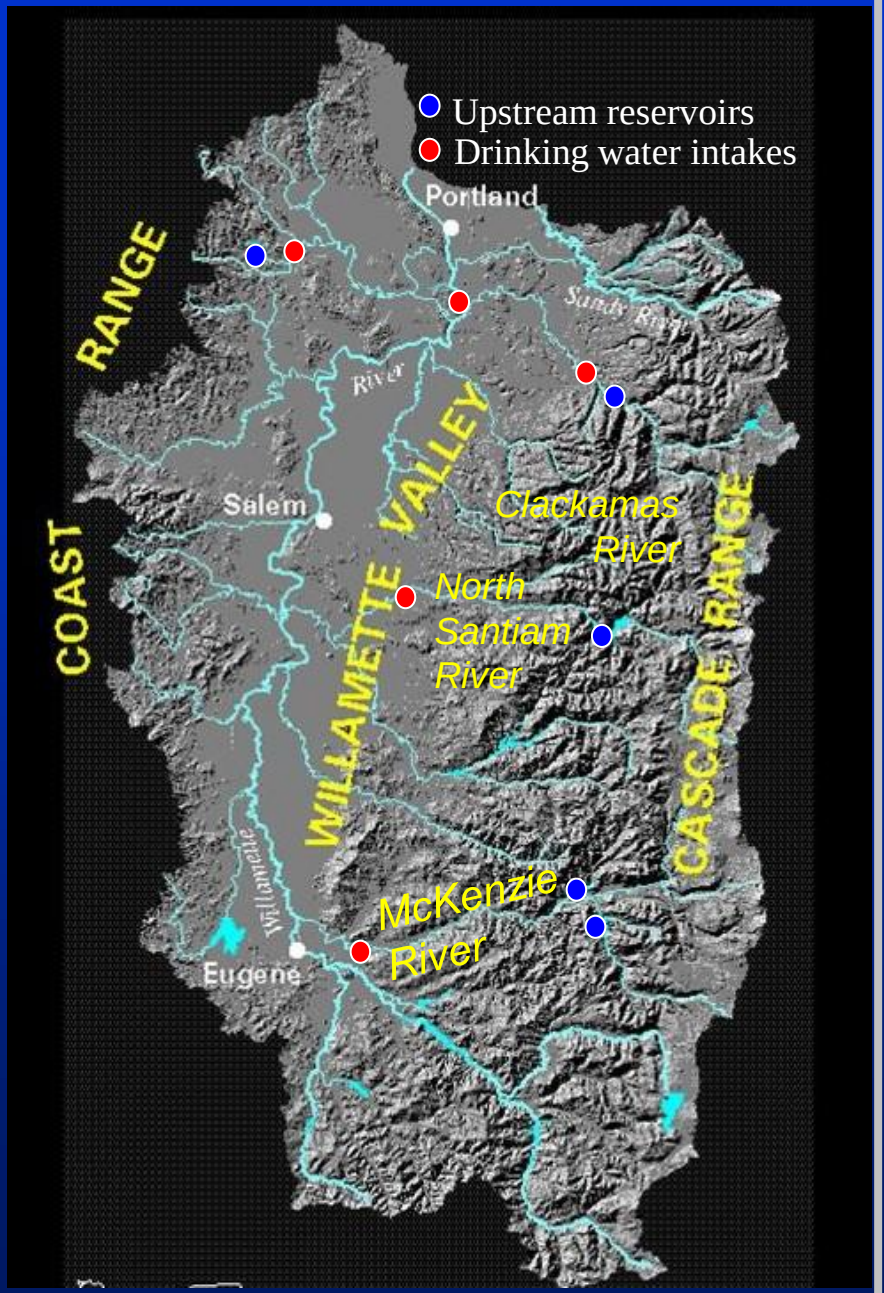
64 Sampling Sites

- Clackamas, North Santiam, and McKenzie Rivers
- Main-stem, upper and lower basin tributaries, reservoirs, springs, and raw source water at DWTPs





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“Multiple Lines of Evidence” Sampling Approach





- ***Cyanobacteria colonies and mats*** **(n=81) 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

- Cyanotoxins extracted following 3 freeze-thaw cycles
- Microcystins, cylindrospermopsins, anatoxins, and saxitoxins analyzed
- Analyze with Enzyme-Linked Immunosorbent Assays (ELISA) for 4 cyanotoxins

- Positive detection when extract concentration exceeded the lowest standard.. so conservative

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Results

- **91% of 81 samples tested positive for one or more cyanotoxins**
- **Seven benthic samples from the Clackamas Basin contained all 4 cyanotoxins - two samples of *Nostoc* "ears" and five samples of *Microcoleus***

Nostoc parmeloides ("Ears")

Tested Positive:

Cylindrospermopsins
Microcystins
Anatoxins
Saxitoxins

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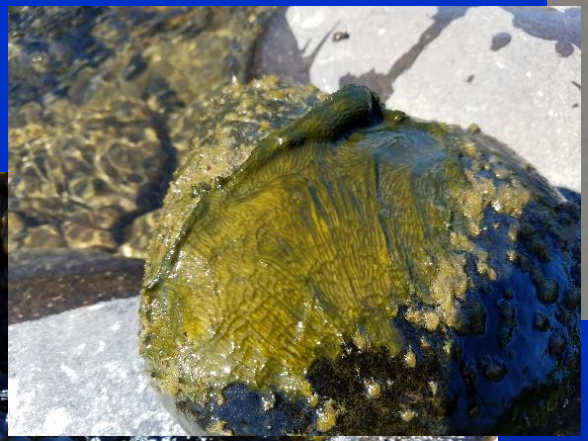
Microcoleus ("Mats")

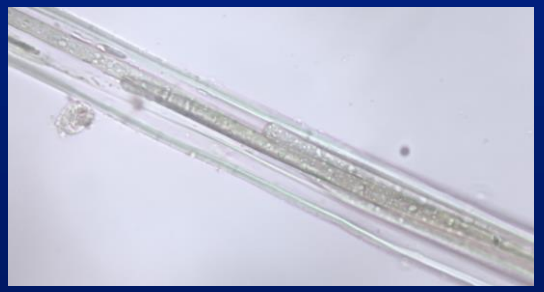
Clackamas River at McIver Park



Cymbelloid stalked diatoms

Tested Positive:

Cylindrospermopsins
Microcystins
Saxitoxins
Anatoxins



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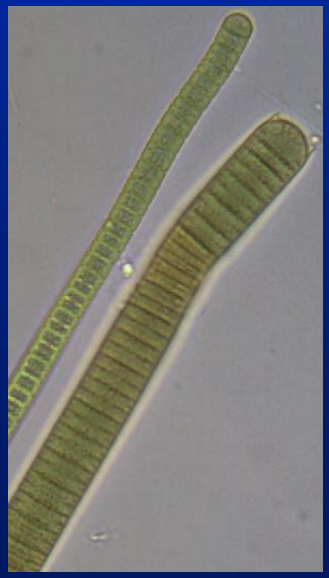
Oscillatoria (“Mats”)

Common in many habitats and rivers, streams, and wetlands



Tested Positive:

Cylindrospermopsins
Microcystins
Anatoxins

Wollea

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

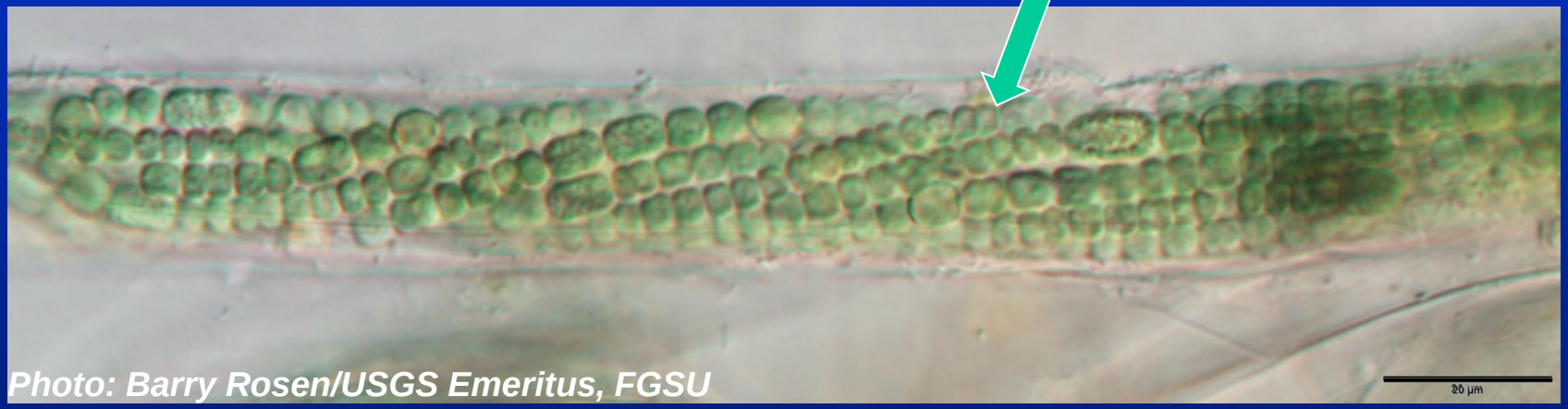


Photo: Barry Rosen/USGS Emeritus, FGSU

Tested Positive:

Cylindrospermopsins
Microcystins
Saxitoxins

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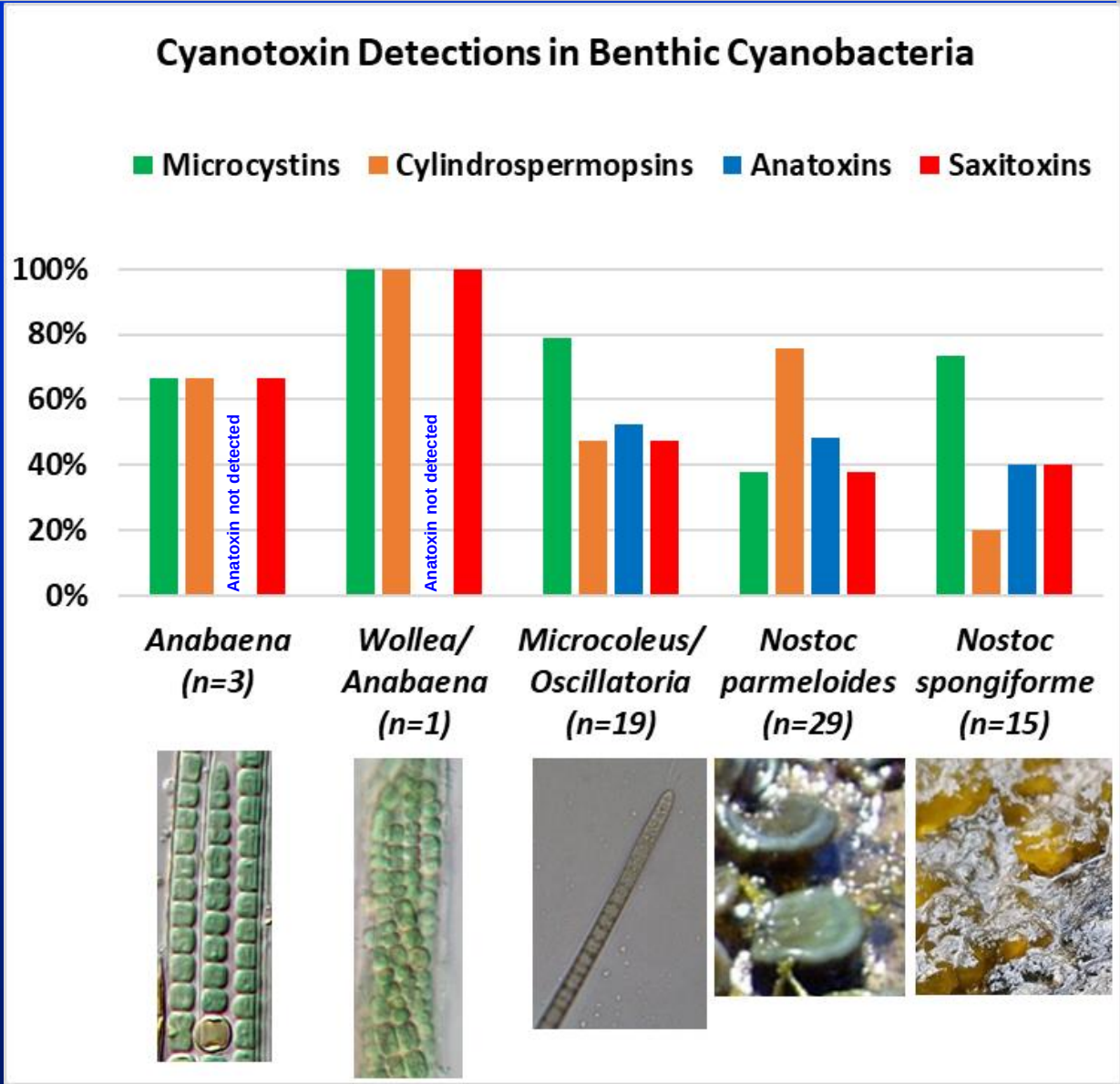
Results

- 91% of 81 samples tested positive for one or more cyanotoxins
- Only 7 samples tested negative for all 4 toxins
- *Microcoleus*, *Oscillatoria* and *Nostoc* were the most common toxic benthic taxa
- Genes often present along with toxins



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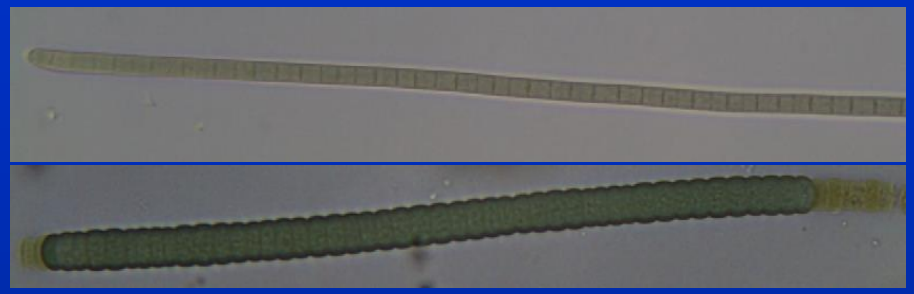
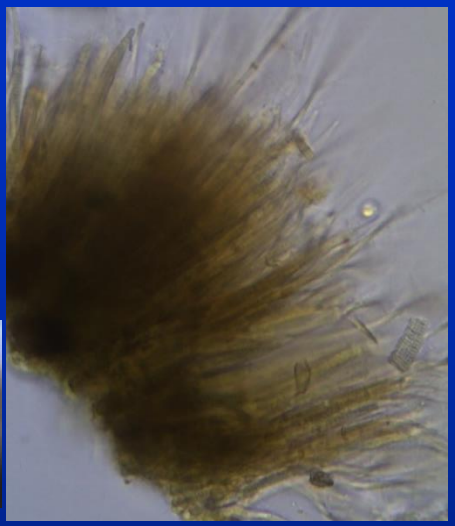
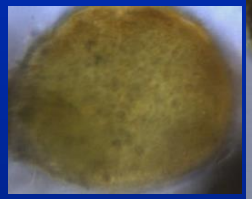
Benthic Cyanobacteria Commonly Found in Plankton Net Tows







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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 in water
- Toxins might associate with sediments or organic carbon and be transported downstream

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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)
Clackamas County Water Environment Services (Andrew Swanson)
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)
US Army Corp of Engineers (Holly Bellringer, Norman Buccola, Tina Lundell)
USGS (Barry Rosen, Terry Slonecker)

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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%

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