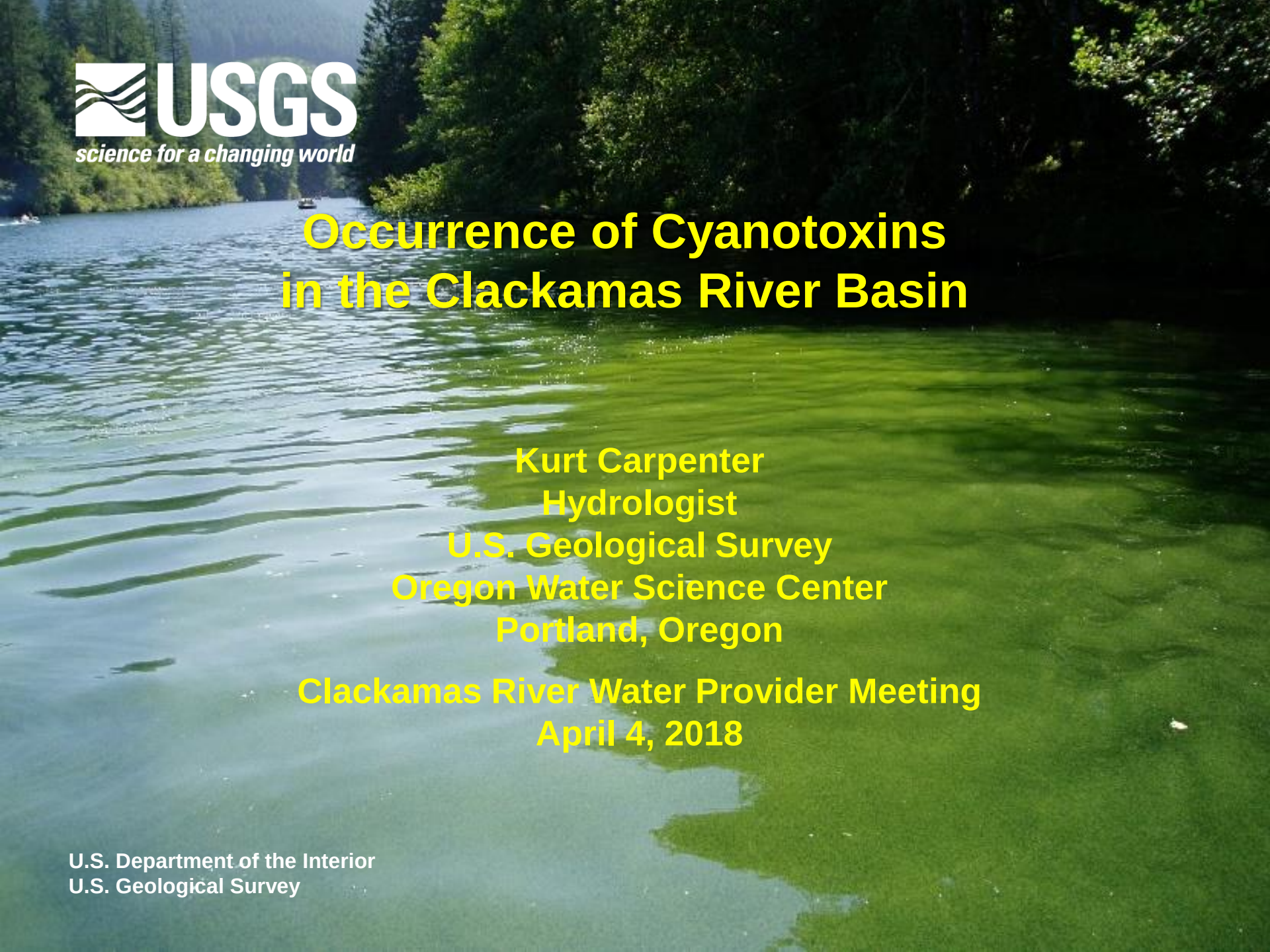

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science for a changing world

Occurrence of Cyanotoxins in the Clackamas River Basin

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Clackamas River Water Provider Meeting
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U.S. Department of the Interior
U.S. Geological Survey

Cyanobacterial Blooms Include..

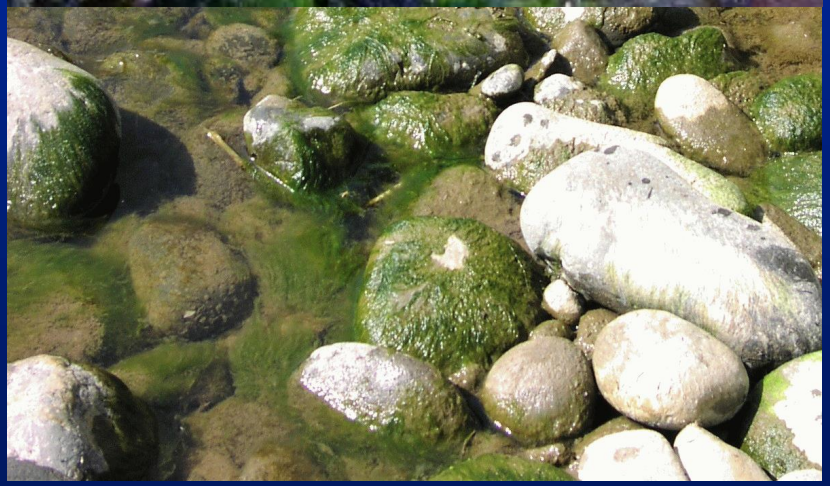
Floating Phytoplankton


Timothy Lake


North Fork Reservoir

and Benthic "Periphyton"


Lower Clackamas River



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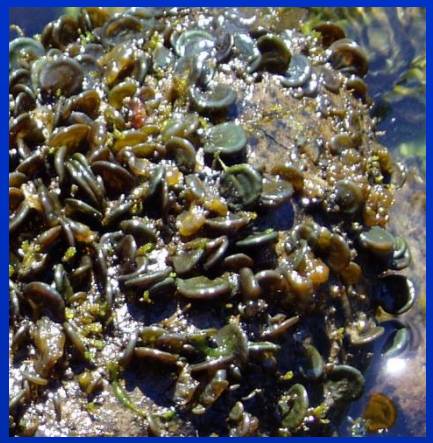
Toxin Producing Benthic Cyanobacteria


Nostoc




Oscillatoria

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Cyanotoxins

- Potent Liver, Kidney, and Neurologic Toxins
- UCMR4 (2018-2021): Includes Microcystins, Anatoxin-*a*, Cylindrospermopsin, Nodularians, and additional HAAs
- EPA's Cyanotoxins Toxicity Assessment and Proposed Drinking Water and Recreational Criteria

Toxin	10-day Health 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

- Microcystins Found in 30% of Lakes during National Lakes Assessment
- Similar Detection Rate in Pacific Northwest Streams during 2015

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2016-17 Pilot Study of Drinking Water Sources






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2016-17 Pilot Study of Drinking Water Sources

Clackamas River / tributaries
North Santiam River (2016 only)
McKenzie River/ tributaries
Upper Willamette River
Coast Fork Willamette River

Approach

- **Cyanobacteria colonies (n=75) collected and analyzed for 4 cyanotoxins: cylindrospermopsin, microcystin, saxitoxin, and anatoxin-*a* using ELISA**
- **Deployment of solid-phase algal toxin trackers (SPATTs) at 7 drinking water intakes, and various points in the watershed**
- **Plankton net tows to gage transport (2017 only)**
- **Samples collected mid-summer and early fall**

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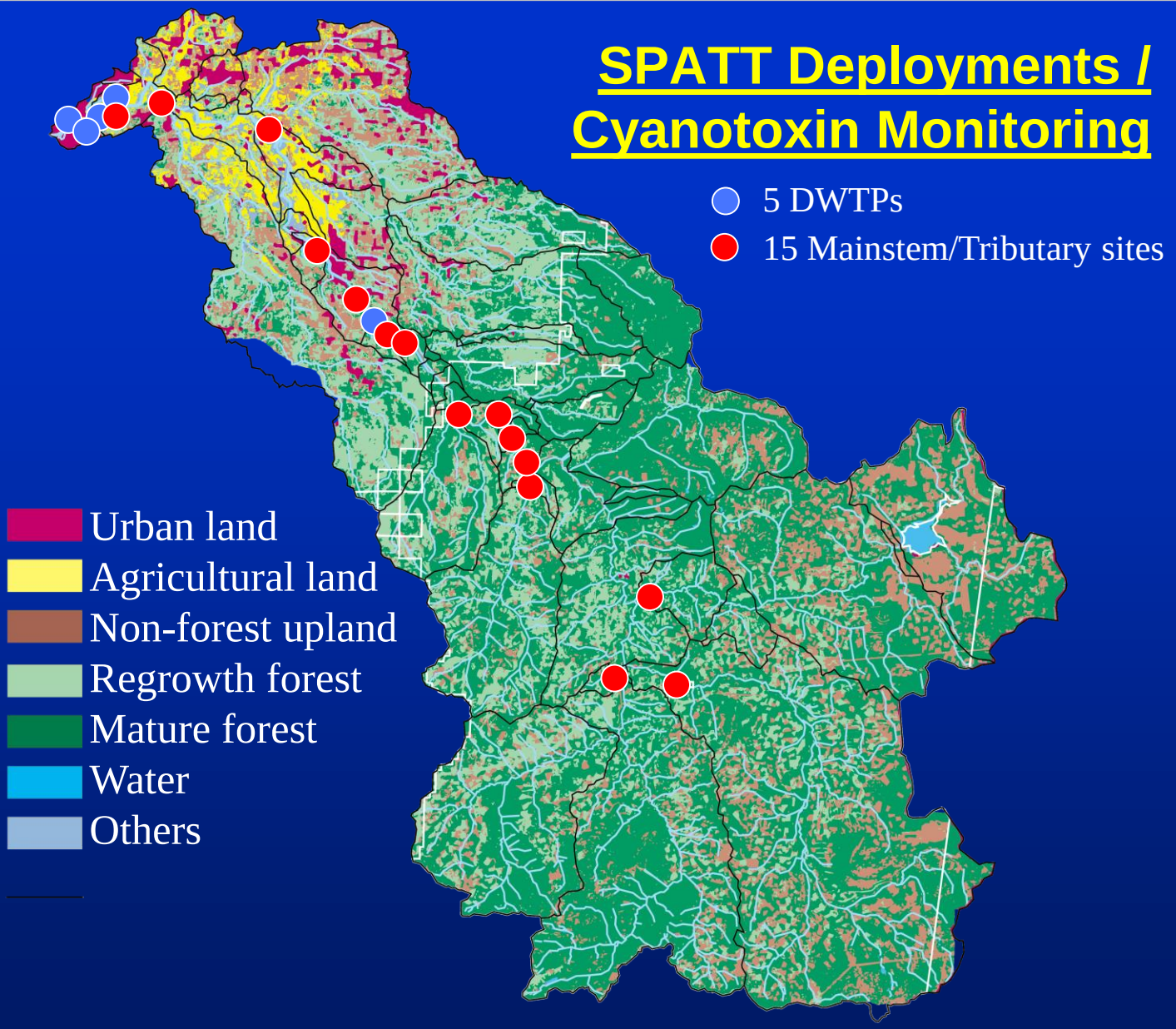
SPATT Deployments / Cyanotoxin Monitoring



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SPATTs - Solid Phase Algal Toxin Trackers

- HP20 "Dianon" microbead resins sorb cyanotoxins over time
- Qualitative results, good screening tool
- Embroidery hoops contain 3 grams (dry wt) of resin inside 2 layers of 100 µm nitex mesh
- Precondition 24 hrs in 100% methanol
- Post deployment: Freeze, then elute with 50% methanol
- Blow off methanol in fume hood
- Analyze with ELISA

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Cyanotoxin Testing Method

- Add hand-picked cyanobacteria (~2-10 mL of sample) to ~5 mL stream water in a 20 mL vial
- 3 freeze-thaw cycles to release toxins
- Filter samples through 0.7 µm GF/F filters
- Perform Enzyme-Linked Immunosorbent Assays (ELISA) for 4 cyanotoxins

- Positive detection when filtrate concentration exceeded the lowest standard
- Given the nature of these samples, results are qualitative, yet informative

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Important Caveats

- Samples were not unialgal (or axenic) cultures, so it is possible that multiple cyanobacterial strains are present

-Toxins may accumulate in sediments, particularly in the filamentous forms (*Oscillatoria, Phormidium, Lyngbya*)

- Possible interferences can be evaluated with spikes of natural samples

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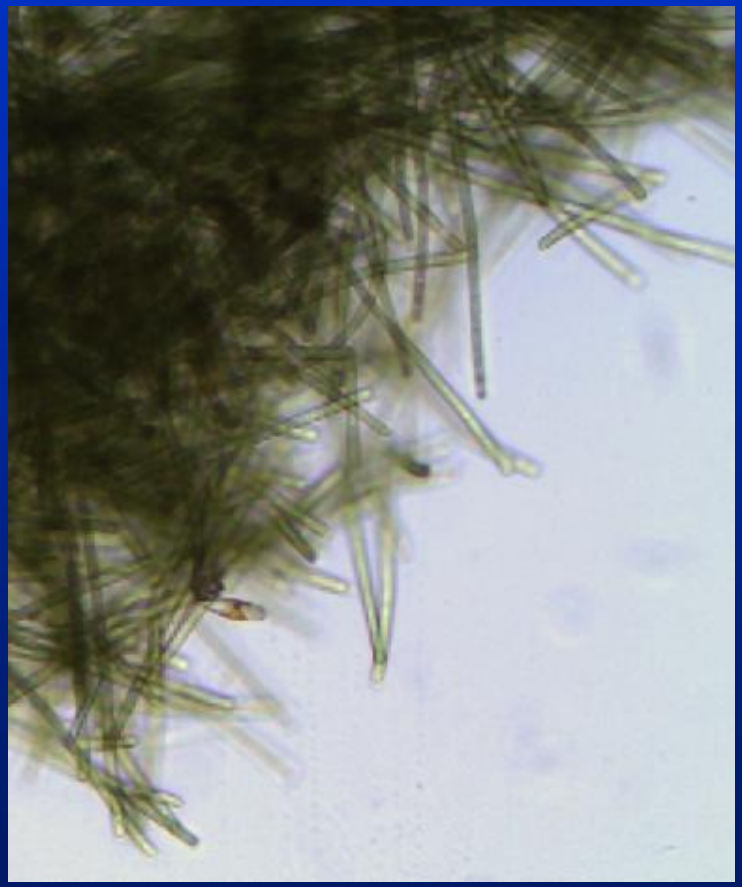
Phormidium

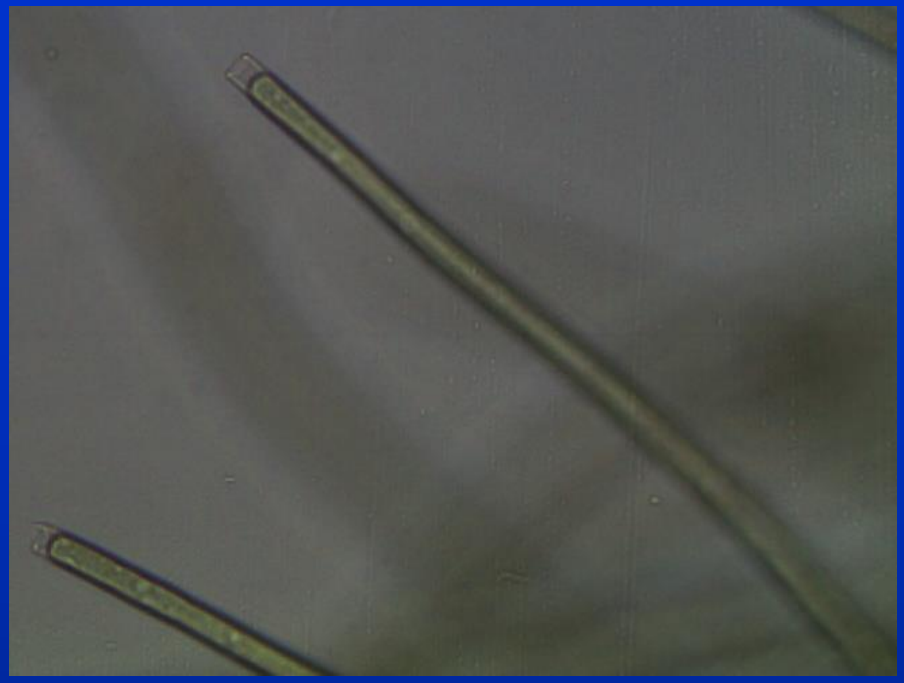
Fish Creek, Clackamas Basin

USGS

Phormidium

Fish Creek, Clackamas Basin





Tested Positive:

Cylindrospermopsin

Microcystin

Anatoxin-*a*

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Wollea

Upper Clackamas River, associated with or within mats of large stalked diatoms (C*ymbella janischii*)

Photographs by Barry Rosen, USGS

<u>Tested Positive</u>:

Cylindrospermopsin
Microcystin
Saxitoxin

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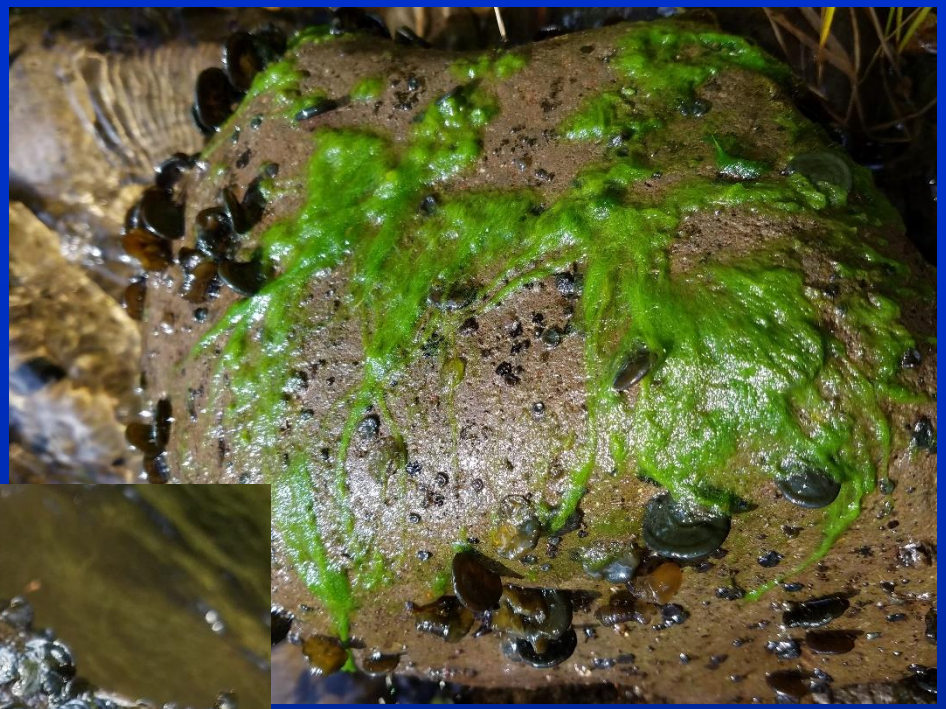
Nostoc parmeloides

Oak Grove Fork Clackamas River



Tested Positive:

Cylindrospermopsin

Microcystin

Anatoxin-*a*

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2016 SUMMARY

- **35 of 39 periphyton samples (~90%) tested positive for one or more cyanotoxins**

Cyanotoxin	# Detections	Percent
Cylindrospermopsin	33	85%
Microcystins/Nodularins	28	72%
Anatoxin-*a*	17	44%
Saxitoxin	16	41%

USGS Unpublished Data Subject to Revision

- **86% detection in cyano colonies for Clackamas Basin**
- **No cyanotoxins were detected in the quality assurance equipment blank**
- **Standard curves: good r^2 values (0.99-1.0)**

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2017 SUMMARY

- Similar percentage of detections (85%) in cyanobacteria colonies
- Fewer Cylindrospermopsin detections in 2017 than in 2016
- Saxitoxin, Microcystin, and Anatoxin-*a* most frequently detected
- More Microcystin detections in SPATTs in 2017 than in 2016

2017 Clackamas Data	Saxitoxin	Cylindrospermopsin	Microcystins and Nodularins	Anatoxin-*a*
All samples (n=48)	42%	4%	58%	31%
Net tows (n=15)	67%	0%	53%	0%
Cyano Colonies (N=16)	44%	6%	69%	38%
SPATT (N=17)	18%	6%	53%	53%

USGS Unpublished Data Subject to Revision

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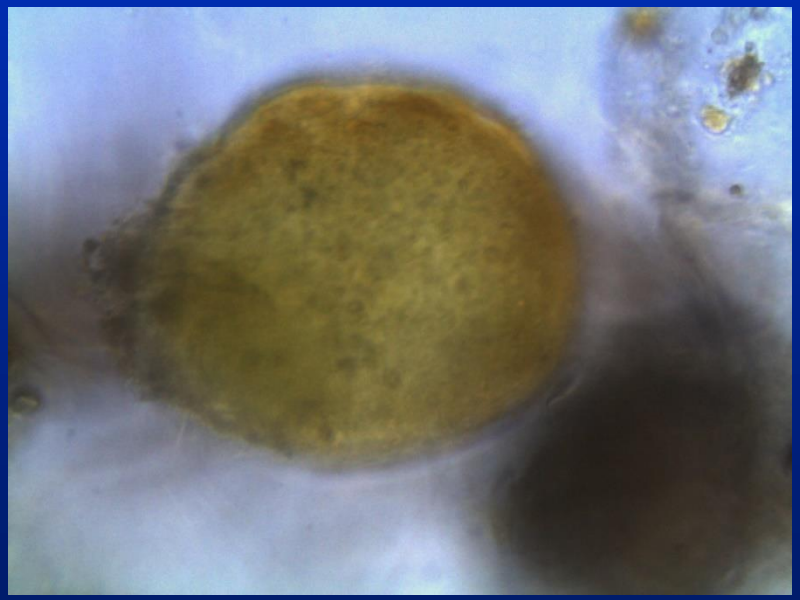
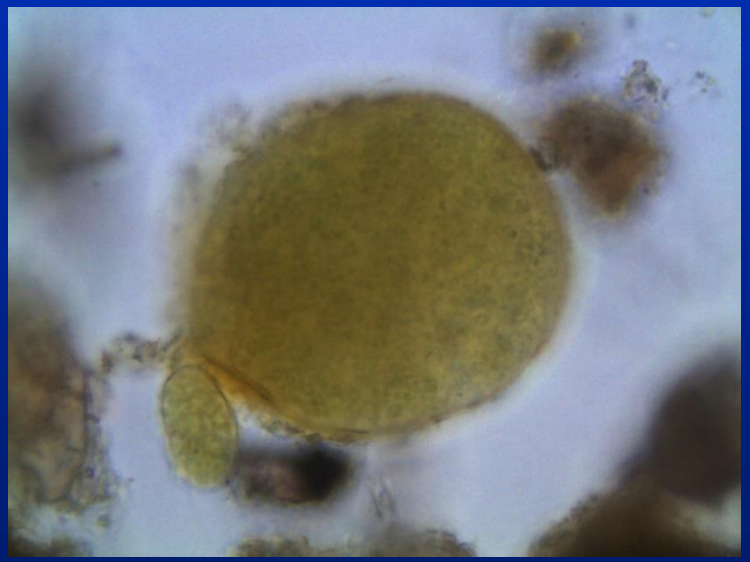
Primary Conclusions

- High percentage of cyanotoxins in benthic colonies
- Frequent detection of cyanobacteria and cyanotoxins in plankton net tows (in transport)
- SPATTs worked well to screen for the presence of cyanotoxins





Small Nostoc colonies from net tows in the Upper Clackamas River upstream of the Collawash River and at Big cliff

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2018 Plan

- Continue testing benthic cyanobacteria, plankton net tows, and SPATTs
- Integrate USGS sampling with UCMR4 sampling to overlap with each of the CRWPs
- Sample fewer locations but sample more frequently (increase SPATTs from 2x per season to 4-6 x per season) at selected DWTPs

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Acknowledgements

Clackamas River Water Providers (Kim Swan)
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