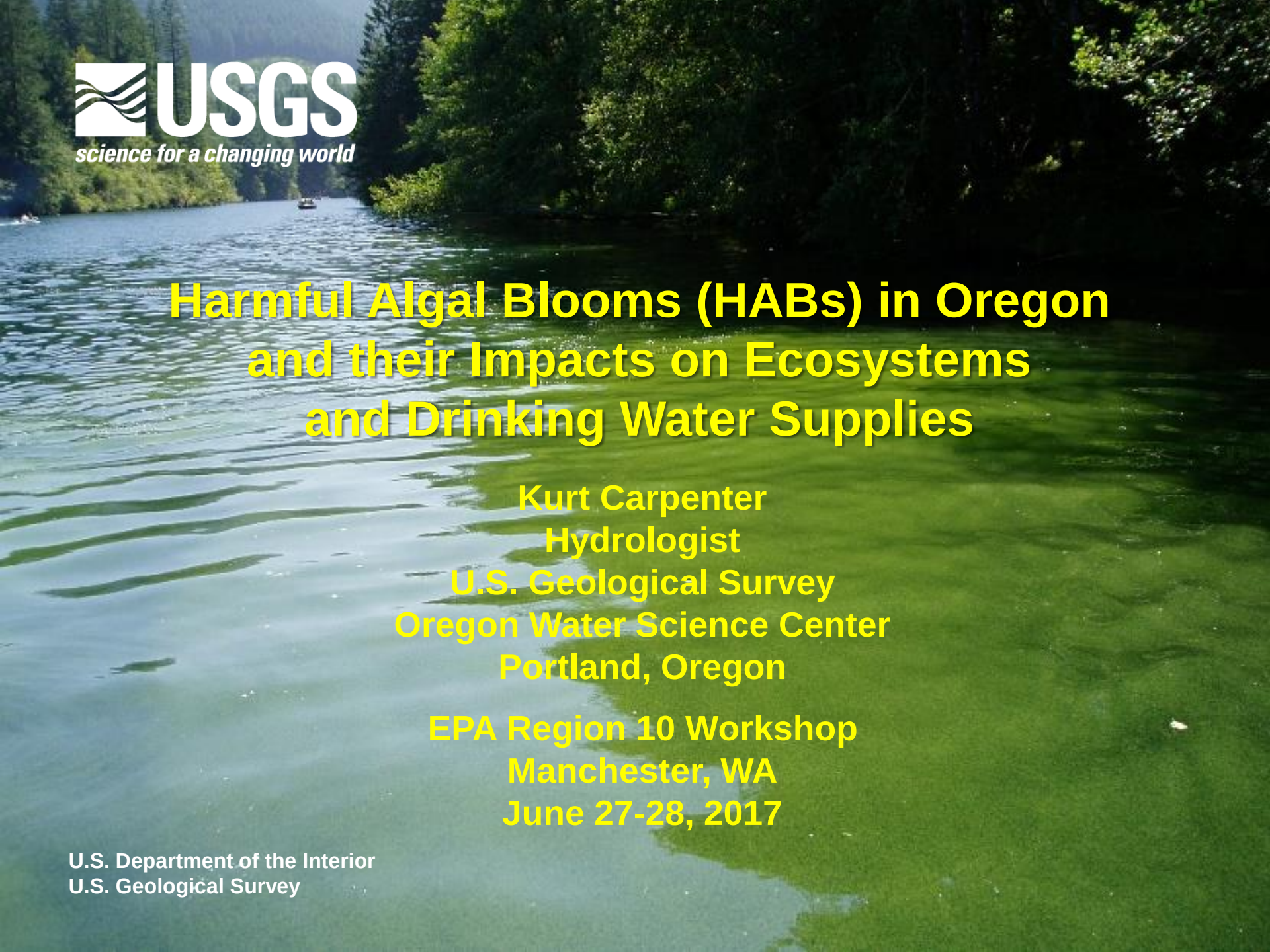

Harmful Algal Blooms (HABs) in Oregon and their Impacts on Ecosystems and Drinking Water Supplies

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EPA Region 10 Workshop
Manchester, WA
June 27-28, 2017

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

Harmful Algal Blooms in Oregon and their Impacts on Ecosystems and Drinking Water

- Widespread and *growing* issue
- Over 50 water bodies affected
- Large Cascade COE reservoirs
- Willamette River in downtown Portland
- Urban - Laurelhurst Park Pond, Blue Lake
- Agricultural - Willow Creek Reservoir, irrigation ponds, canals
- Coastal Lakes (10-mile and Cullaby Lakes)
- Lawson Bar, South Umpqua R. – permanent advisory

Timothy Lake, Clackamas R. Basin

Cougar Reservoir, McKenzie R. Basin
Photo credit: Chauncey Anderson USGS

North Fork Reservoir, Clackamas R. Basin

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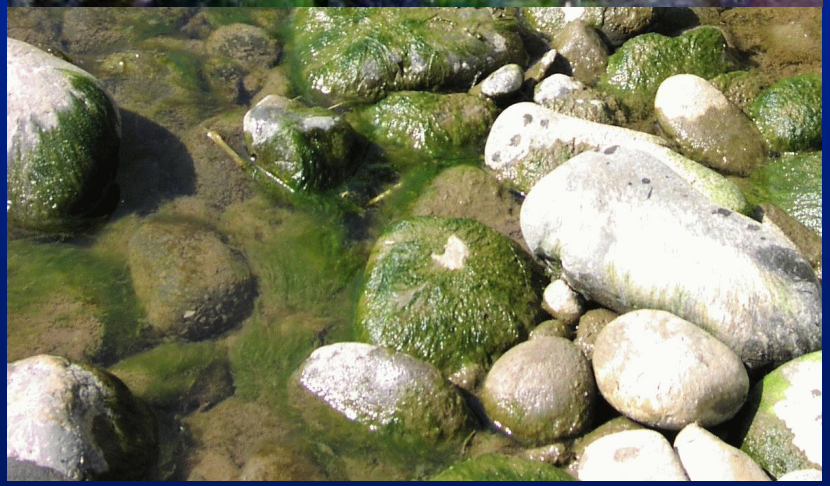
Algal Blooms Include..

Floating Phytoplankton

and Benthic “Periphyton”



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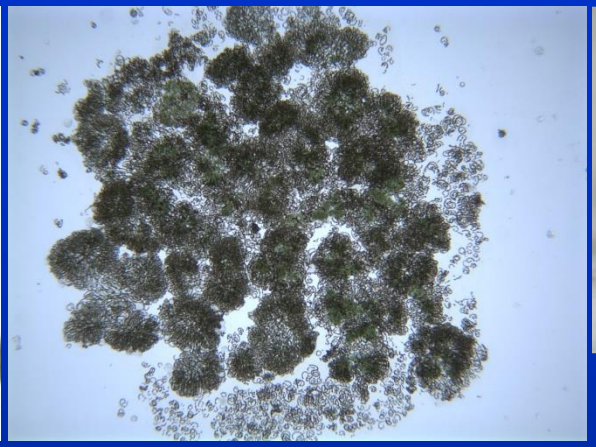
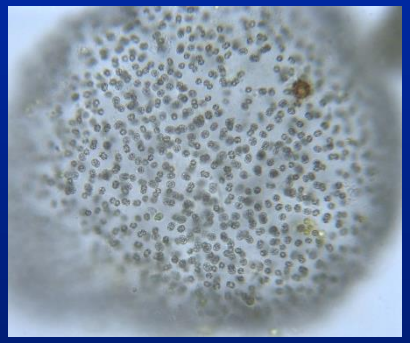
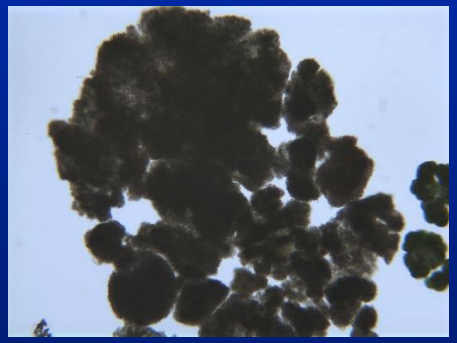
Potentially Toxic Cyanobacteria in Plankton



Dolichospermum [formerly *Anabaena*]

*Dolichospermum mendote**





Microcystis

*Gleotrichia**

*Cylindrospermopsis**

* Photos by Barry Rosen, USGS

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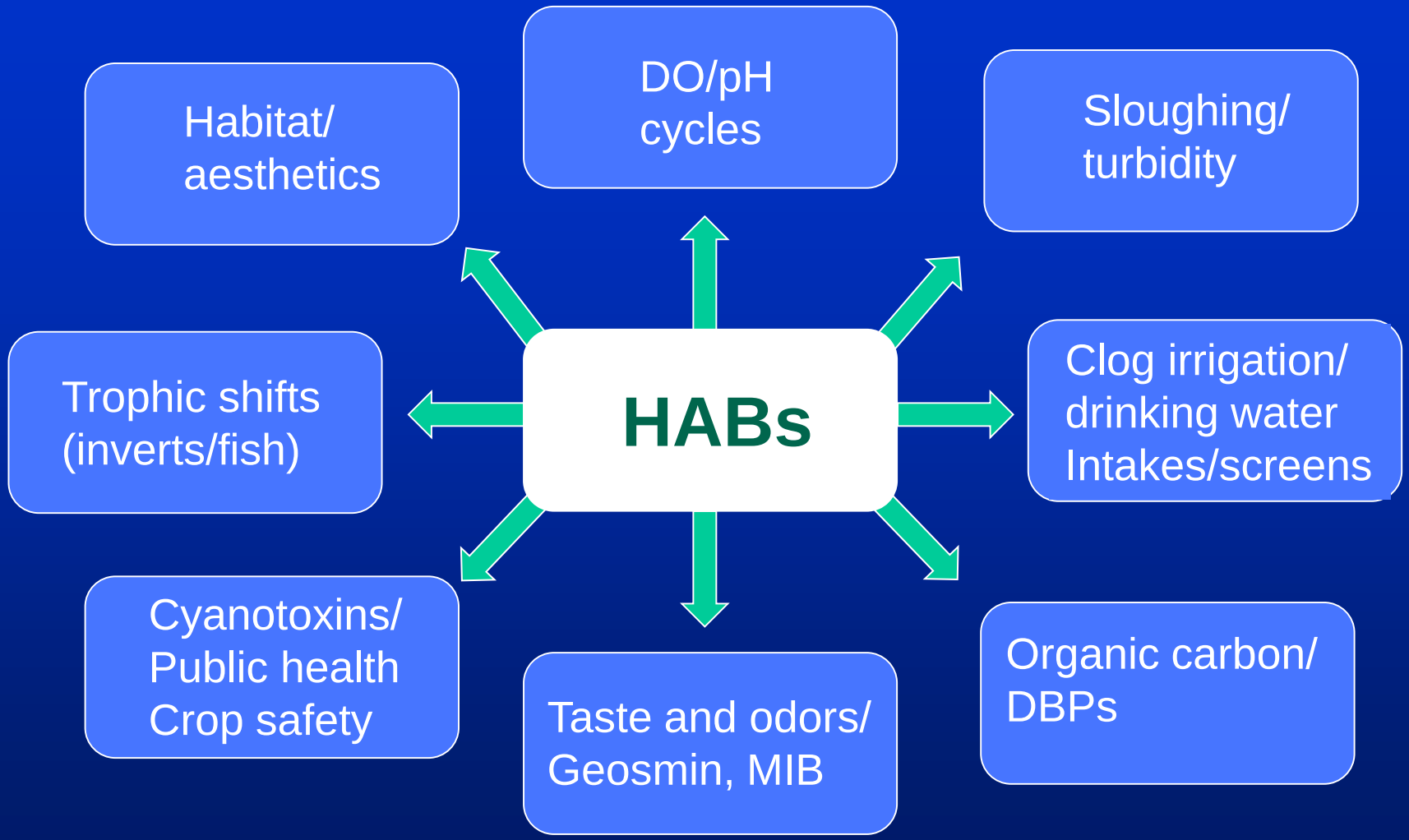
Potentially Toxic Benthic Cyanobacteria

Nostoc

Oscillatoria

USGS

Some Impacts from HABs



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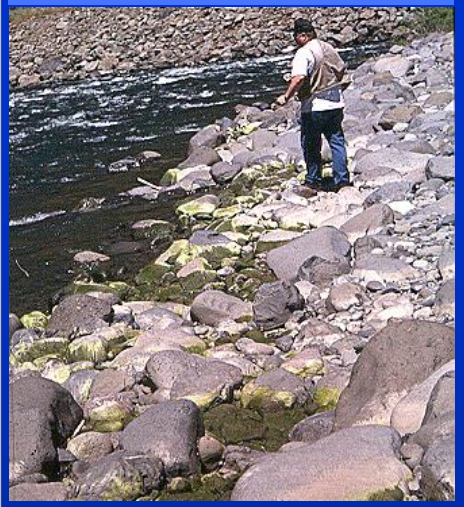
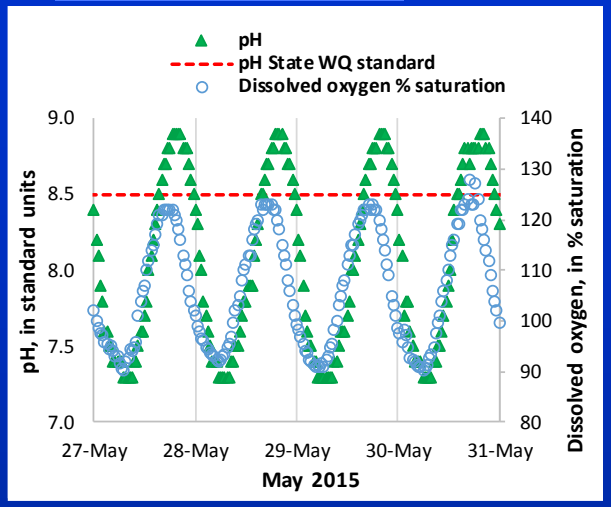
Habitat/aesthetics

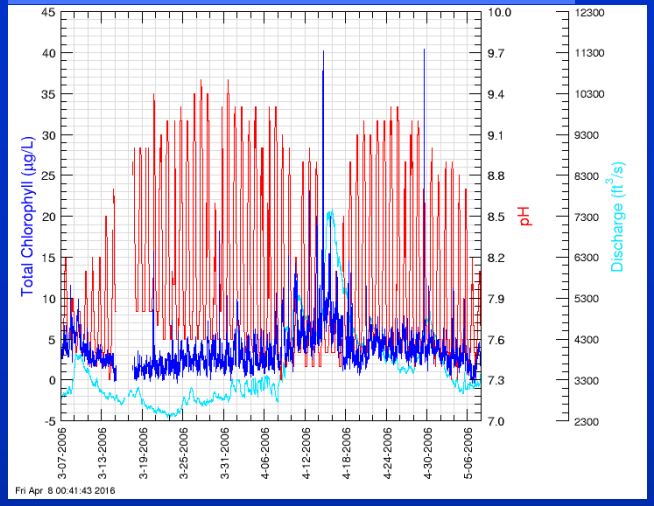


DO/pH cycles



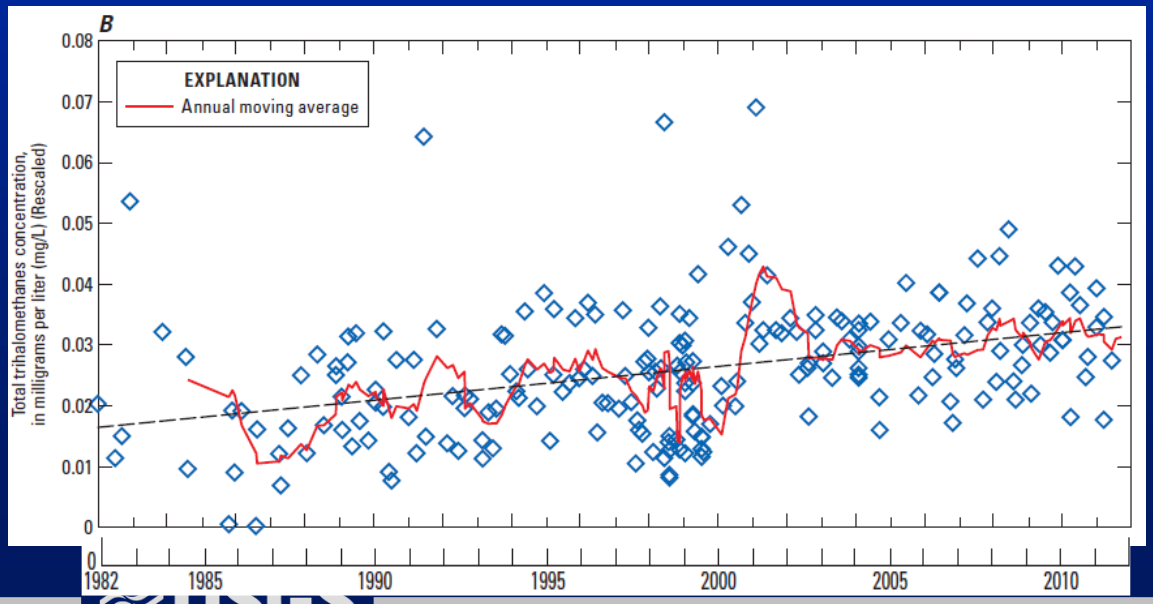
http://or.water.usgs.gov/clackamas/monitors/

Periphyton Sloughing



http://or.water.usgs.gov/clackamas/monitors/

Drinking Water Impacts (Disinfection by-products, T&Os, Cyanotoxins)



Carpenter and others 2013
(USGS SIR 2013-5001)

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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Monitoring HABs

- **Sampling considerations - patchy abundance in vertical and horizontal dimensions (wind affected)**
- **Algal cells (fluorescence by Chl-*a*, phycocyanin, flow cam, qualitative/quantitative counts, genetics)**
- **Bacteria indicators/genetic markers**
- **Culturing and assessment of toxin production, genes for taxonomy, pigment characteristics to improve satellite detection**
- **Toxin testing – strips, ELISA, HPLC, LC/MS, and SPATT passive samplers**

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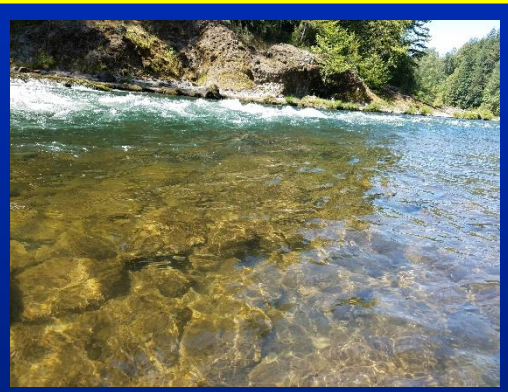
2016 Pilot Study of Drinking Water Sources



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2016 Survey of Drinking Water Sources

Clackamas River / tributaries
North Santiam River
McKenzie River
Upper Willamette River
Coast Fork Willamette River
Upper Tualatin River

Approach

- **50 samples of cyanobacteria collected and analyzed for 4 primary cyanotoxins: cylindrospermopsin, microcystin, saxitoxin, and anatoxin-*a* using ELISA**
- **Deployment of solid-phase algal toxin trackers (SPATTs) at 4 drinking water intakes, and other sites**

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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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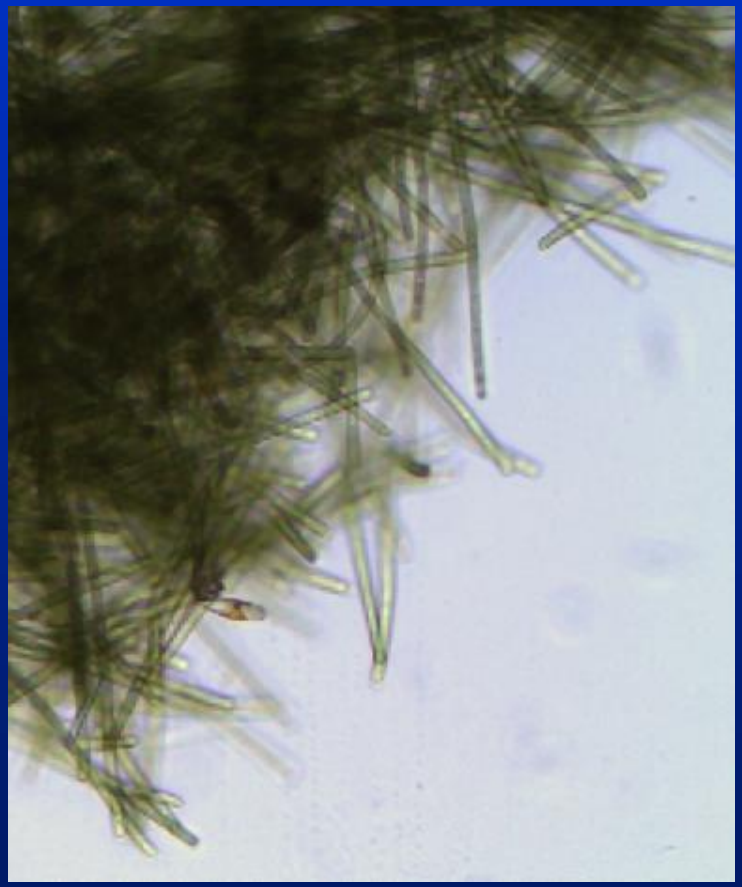
Phormidium

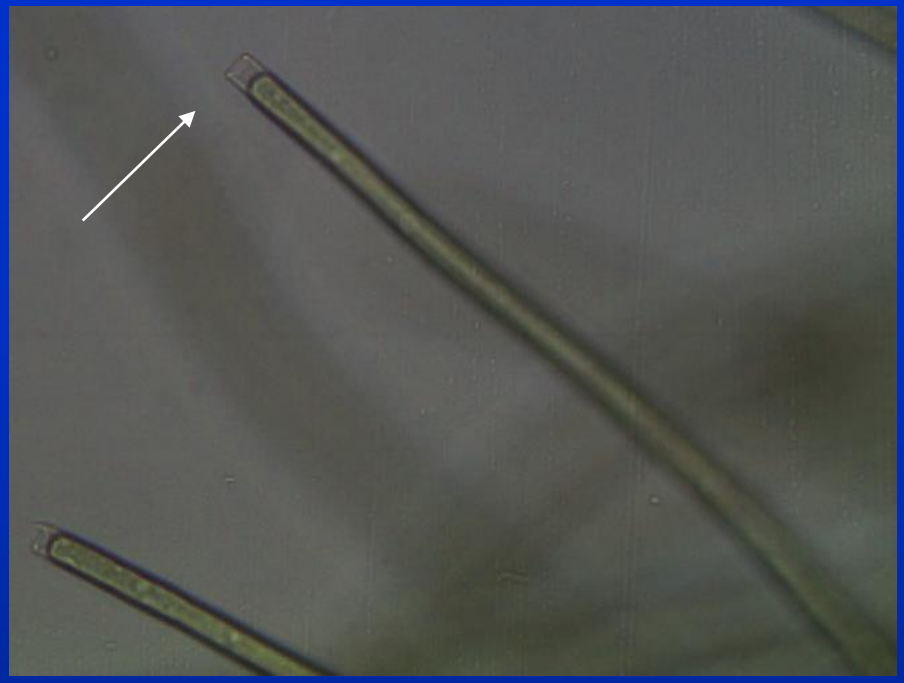
Fish Creek, Clackamas Basin

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*)

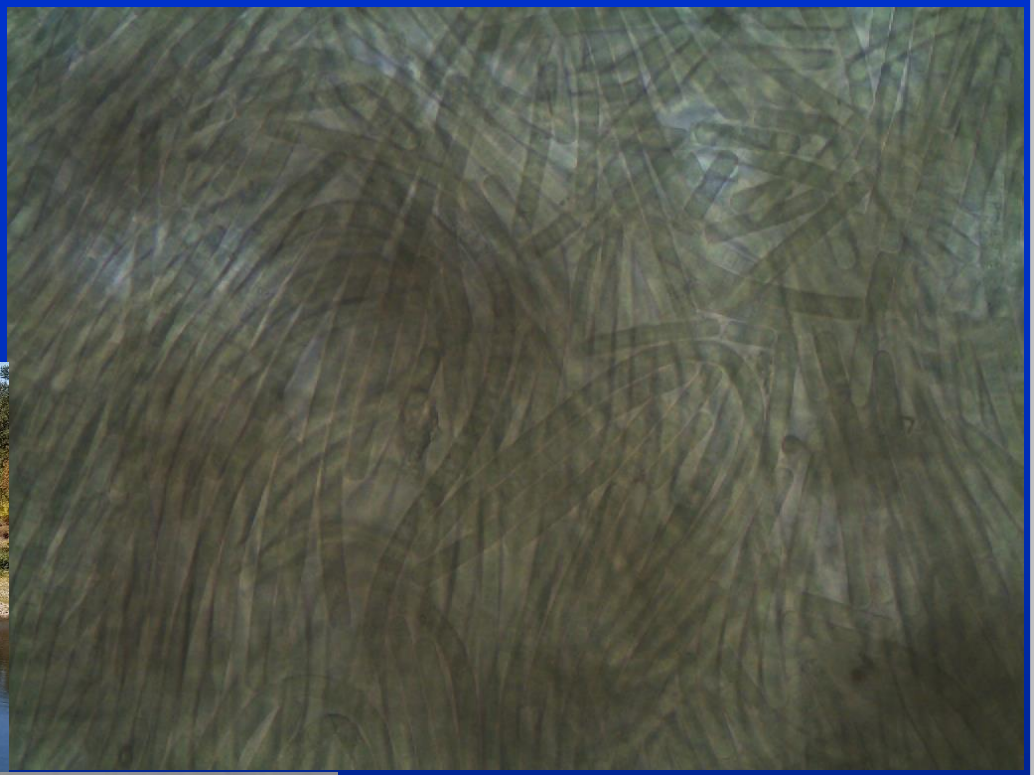
Photographs by Barry Rosen, USGS

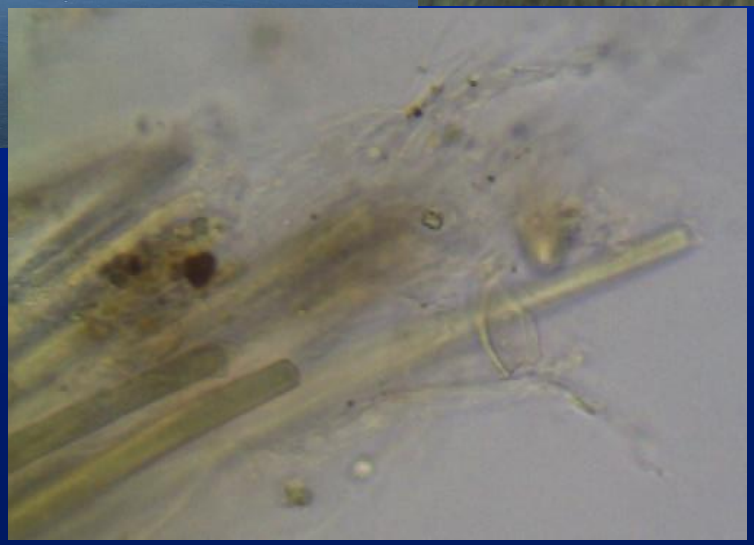
Tested Positive:

Cylindrospermopsin
Microcystin
Saxitoxin

USGS

Phormidium
Coast Fork Willamette River





Tested Positive:

Microcystin

Anatoxin-*a*

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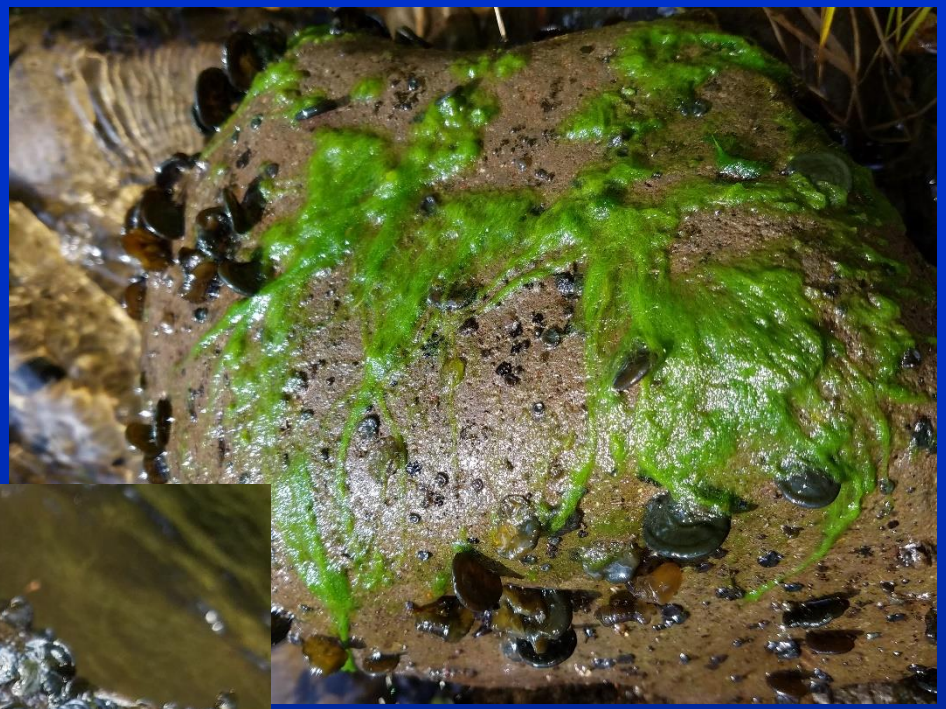
Nostoc parmeloides

Oak Grove Fork Clackamas River



Tested Positive:

Cylindrospermopsin

Microcystin

Anatoxin-*a*

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Nostoc parmeloides

Upper North Santiam River

Tested Positive:

Cylindrospermopsin

Microcystin

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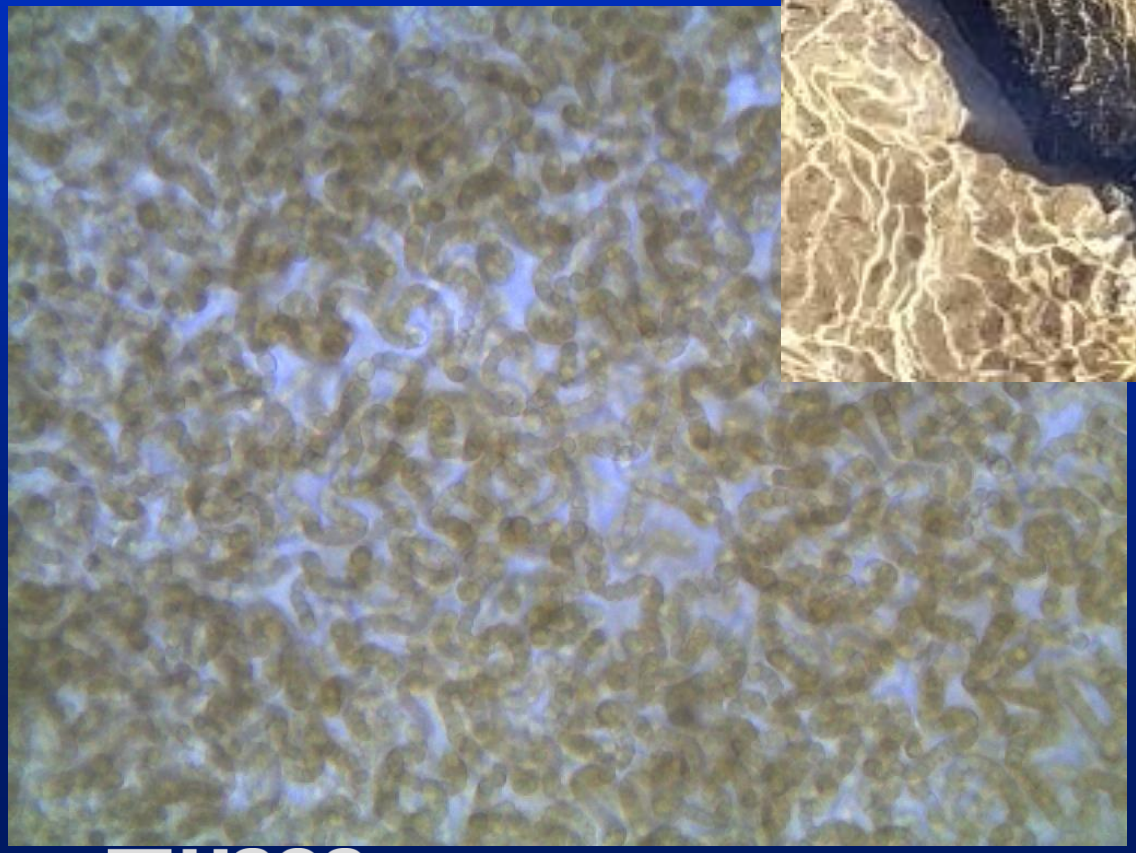
Nostoc spongiforme
McKenzie River



Tested Positive:

Microcystin
Saxitoxin
Anatoxin-*a*

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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

- **No Cyanotoxins were Detected in the Quality Assurance Equipment Blank**
- **Standard Curves: Good R^2 Values (0.99-1.0)**

USGS

SPATTs - Solid Phase Algal Toxin Trackers

- **26 Cyanotoxin Detections in 20 SPATTs**

Cyanotoxin	Total number of detections	Clackamas (n=8)	N. Santiam (n=3)	McKenzie (n=3)	Upper Willamette (n=1)	Coast Fork (n=1)	Middle Fork (n=1)	Tualatin (n=3)
Cylindrospermopsin	11	63%	100%	nd	nd	nd	nd	100%
Anatoxin-*a*	8	50%	67%	33%	nd	nd	nd	nd
Microcystins	5	0%	67%	33%	nd	nd	100%	33%
Saxitoxin	2	13%	33%	nd	nd	nd	nd	nd

USGS Unpublished Data Subject to Revision

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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 (HP20) placed inside 2 layers of 100 µm nitex mesh
- Precondition 24 h in 100% methanol before deployment
- Post deployment: Freeze, then elute with 50% methanol
- Blow off methanol in fume hood
- Analyze with ELISA etc
- DEMO

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