



Photo: Civil Air Patrol

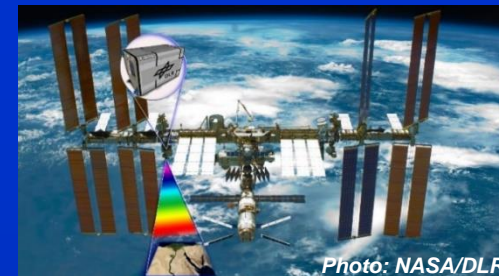


Photo: NASA/DLR

# USGS Oregon Water Science Center HAB Monitoring Programs

Kurt Carpenter  
Research Hydrologist

OLA-OSU Annual HABs Meeting,  
Corvallis, OR  
March 17, 2023



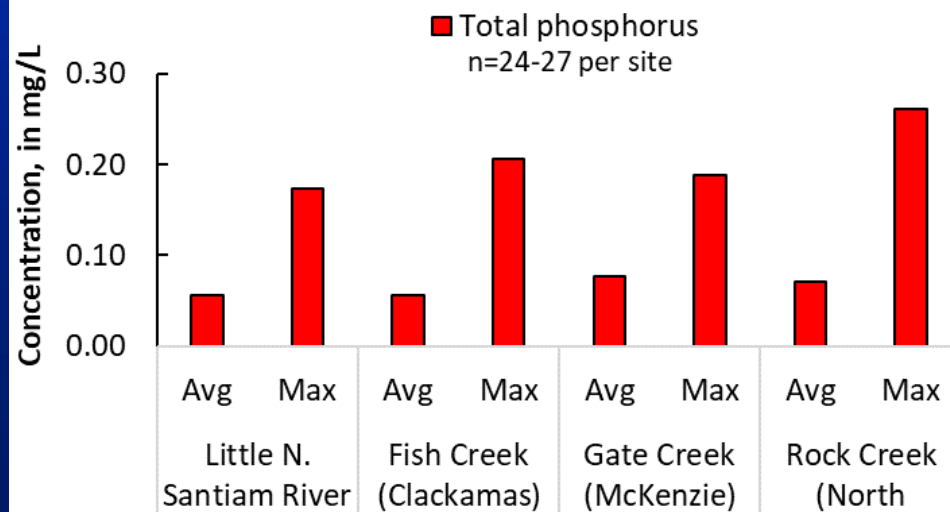
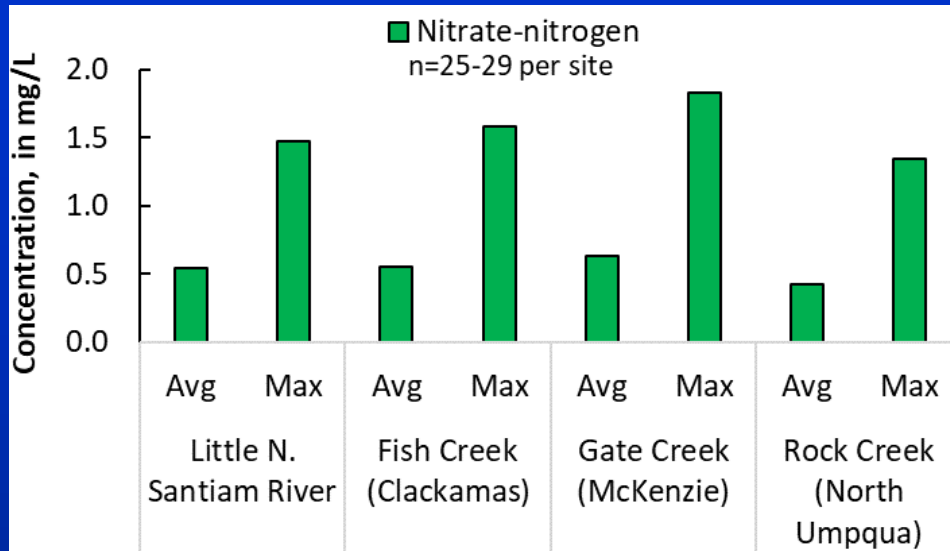
# Post-Fire Nutrient Enrichment

## Nitrate Concentrations

- Max concentrations of 1.8 mg/L in fire affected tributaries following storms
- ~ 0.25-0.5 mg/L in mainstems

Nitrogen + geologic phosphorus =  
algae growth

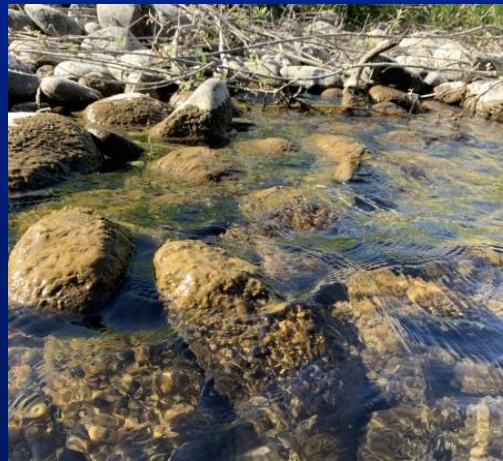
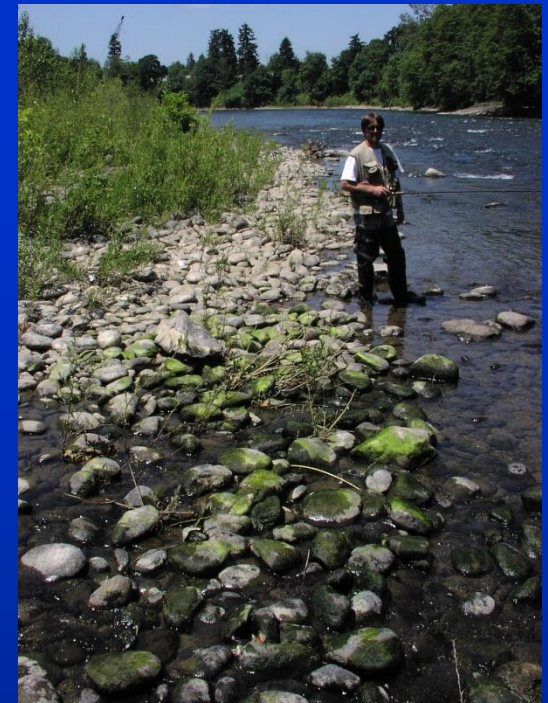
Harmful Algal Blooms (HABs) & nuisance growths of “periphyton”



Preliminary samples results available on NWIS web  
<https://nwis.waterdata.usgs.gov/usa/nwis/qwdata>

# Attached Benthic Algae “Periphyton”

- Filamentous “nuisance” green algae
- Stalked diatoms
- Cyanobacteria
- Impacts on  
Drinking water (tastes and odors,  
disinfection by-products, cyanotoxins)  
Aquatic life (habitat, food webs, high pH)



# Cascade River Periphyton Includes Toxin-Producing Cyanobacteria

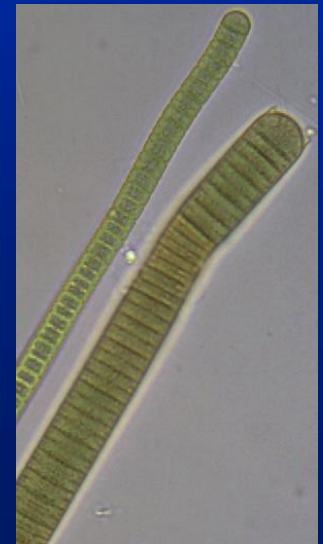
*Nostoc*



*Microcoleus*



*Oscillatoria*



# Coming Soon: USGS Data Release on Cyanotoxin Occurrence in Three Cascade Range Rivers

*--Preliminary Information-Subject to Revision. Not for Citation or Distribution--*

Sample type	Number of samples	Number of detections			
		Microcystins/ ADDA	Cylindro- spermopsins	Anatoxins	Saxitoxins
<b>ALL</b>	<b>322</b>	<b>234</b>	<b>108</b>	<b>182</b>	<b>154</b>
Colonies/mats	87	67	37	40	32
Plankton net tows	89	70	25	24	66
SPATTs	146	97	46	118	56

Sample type	Number of samples	Percent detection			
		Microcystins/ ADDA	Cylindro- spermopsins	Anatoxins	Saxitoxins
<b>ALL</b>	<b>322</b>	<b>73%</b>	<b>34%</b>	<b>57%</b>	<b>48%</b>
Colonies/mats	87	77%	43%	46%	37%
Plankton net tows	89	79%	28%	27%	74%
SPATTs	146	66%	32%	81%	38%

SPATT Methods: Kudela, R., 2011, Harmful Algae, v. 11, p. 117–125; Lane and others, 2010, Limnology and Oceanography—  
Methods, vol. 8, p. 645–660  
ELISA Method: EPA Method 546

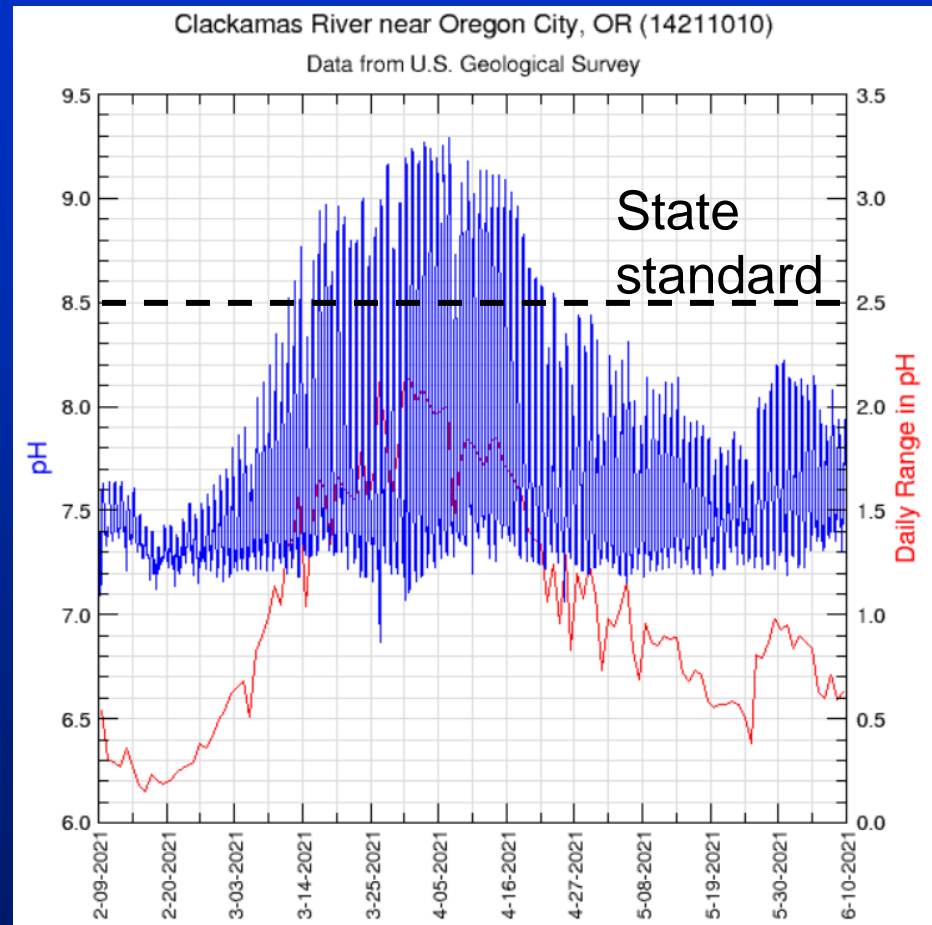


# Periphyton-Photosynthesis-Induced Diel Swings in pH

- pH up to 9.3 units
- Diel swings up to 2.0 units



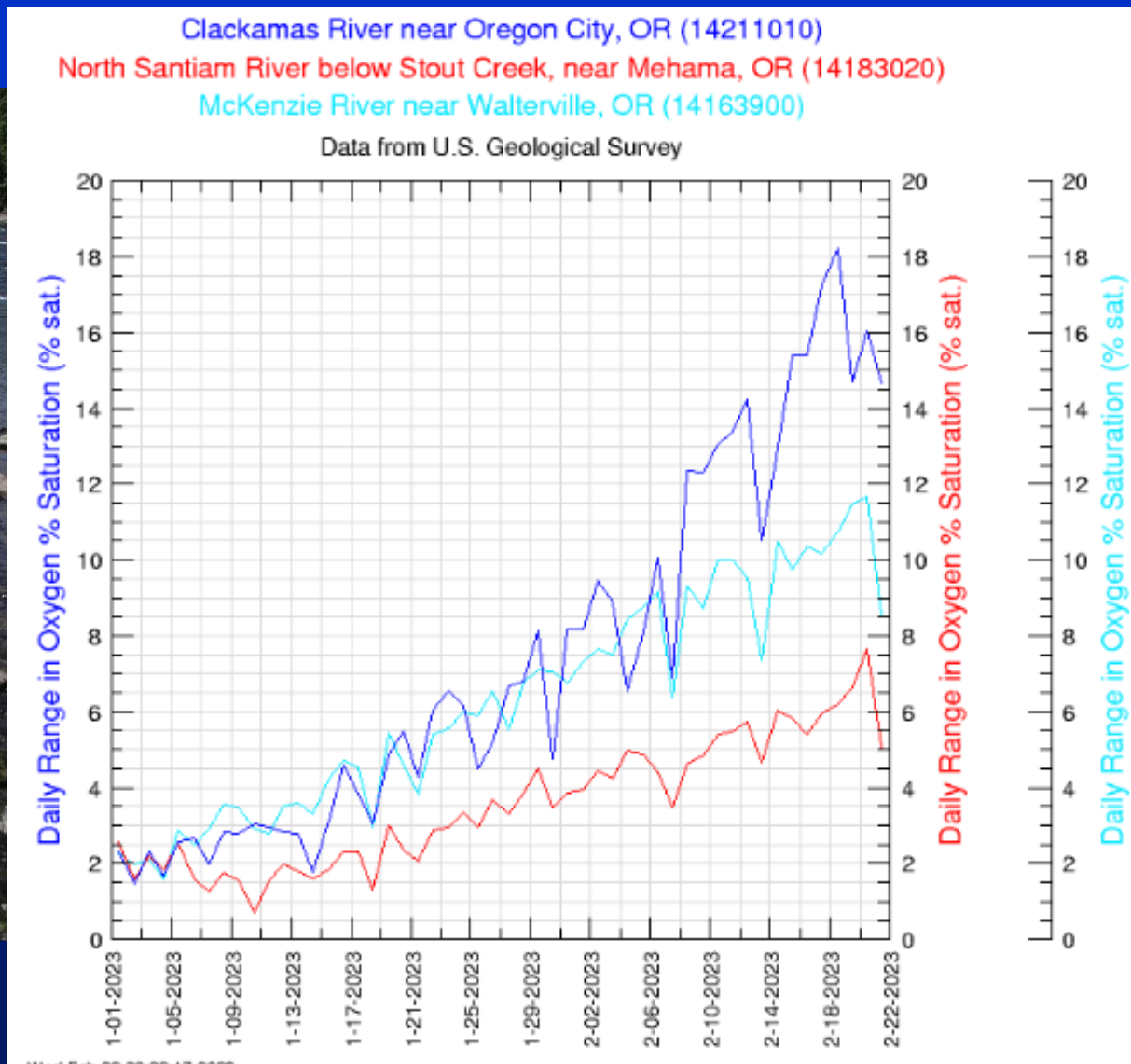
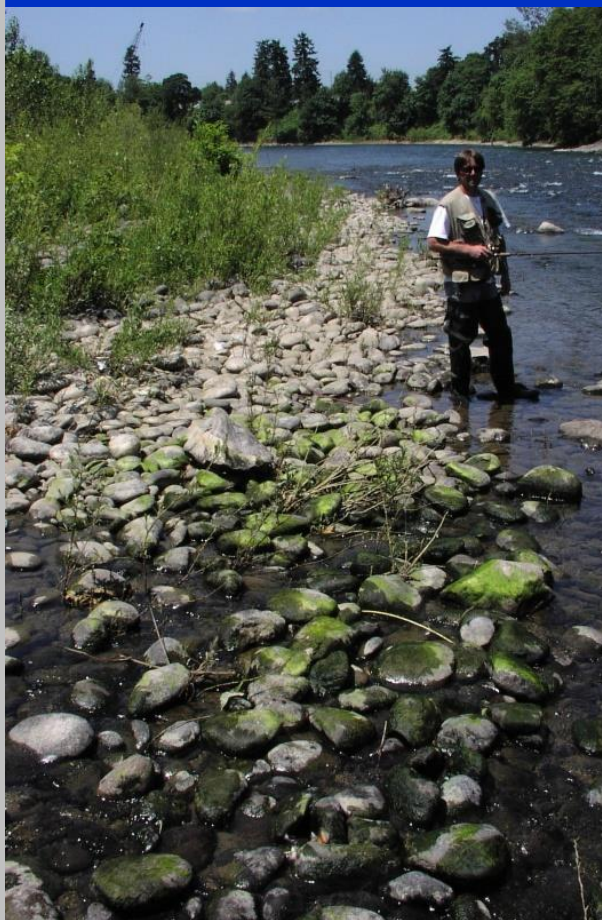
Photo courtesy of Stuart Dyer, Oregon DEQ



<https://waterdata.usgs.gov/monitoring-location/14211010>

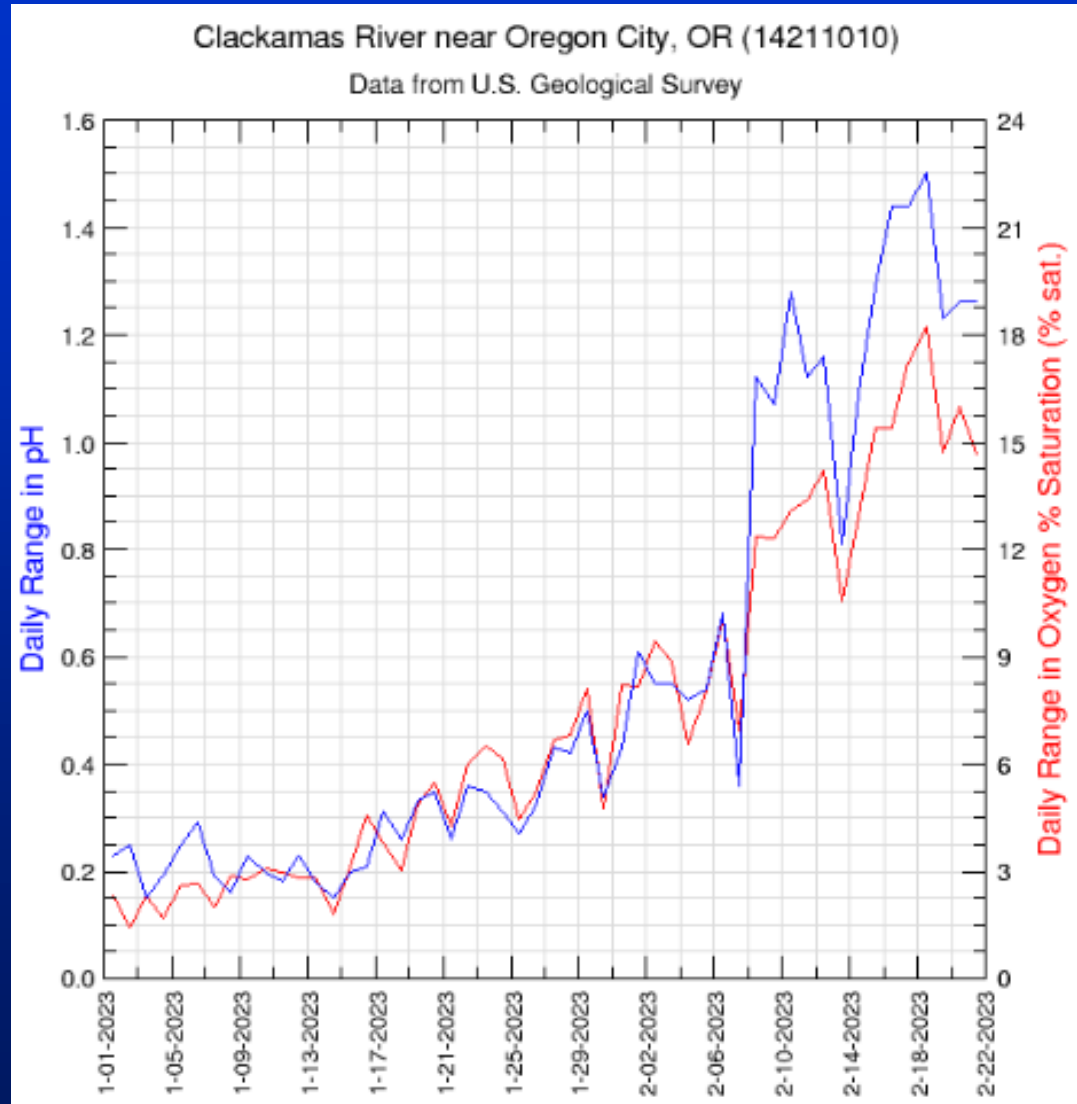
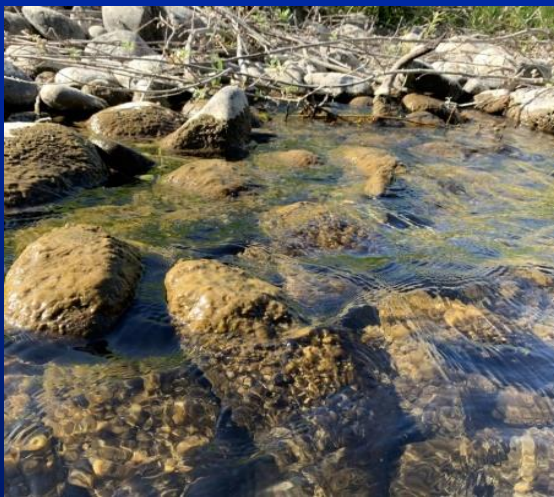
# Early Season Periphyton Bloom

- Diel swings in DO from photosynthesis are reliable indicators of periphyton



# Diel Swings in pH/DO - Reliable Indicators of Algal Activity

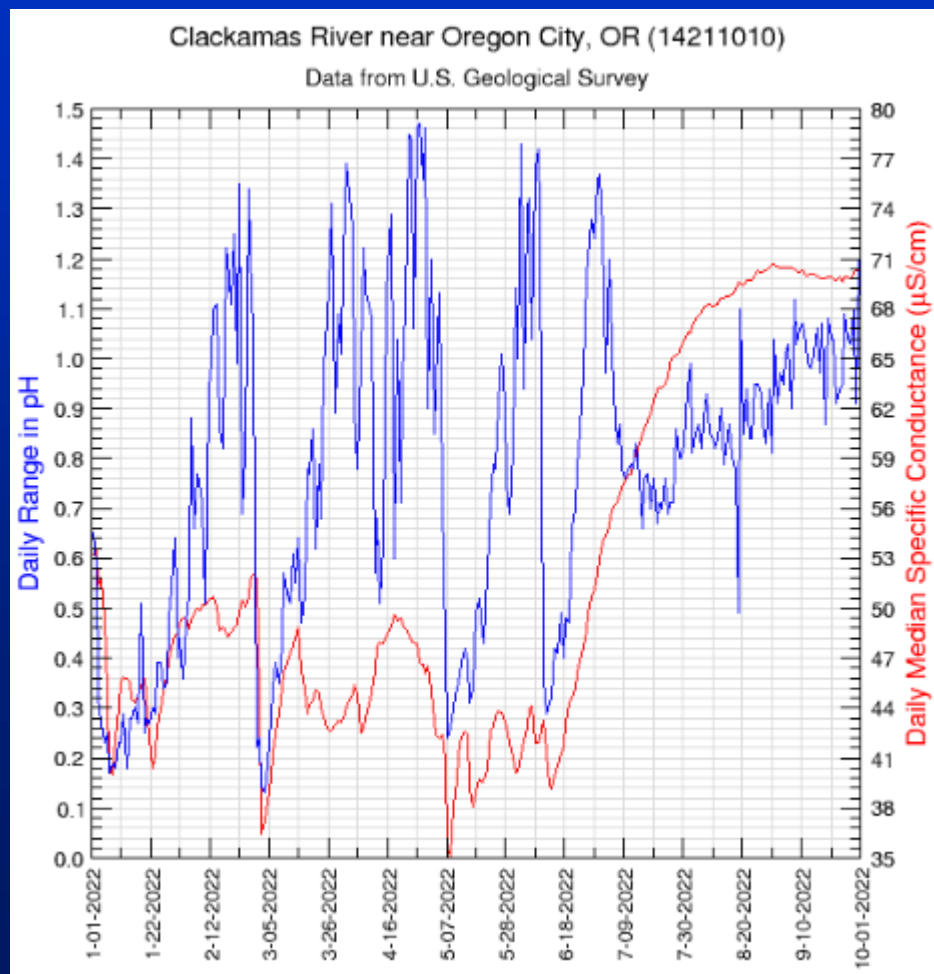
- Especially when pH and DO trend together





# Early Season Periphyton Blooms

- Diel swings in pH moderate during the seasonal SC increase
- SC correlates with alkalinity, which increases as groundwater becomes relatively more abundant during summer



# Periphyton Surveys with Hyperspectral Sensors

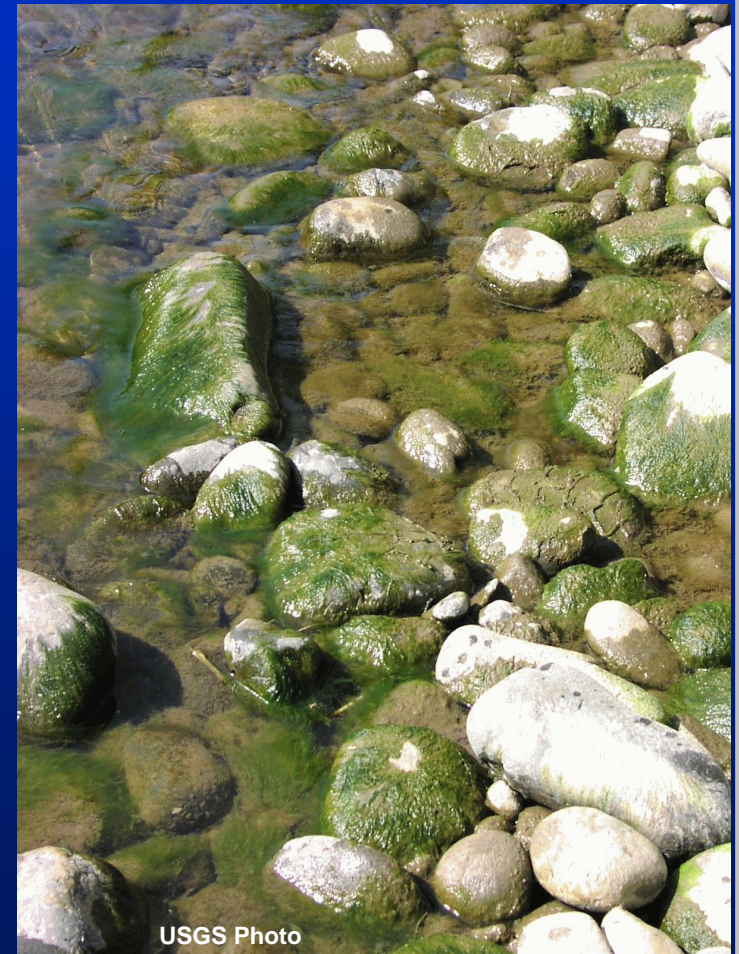
- Many rivers only partially wadable
- Most often riffle scale at best
- Difficult/expensive to sample
- Can we monitor with remote sensing?



Photo: Civil Air Patrol



J. Graham/USGS



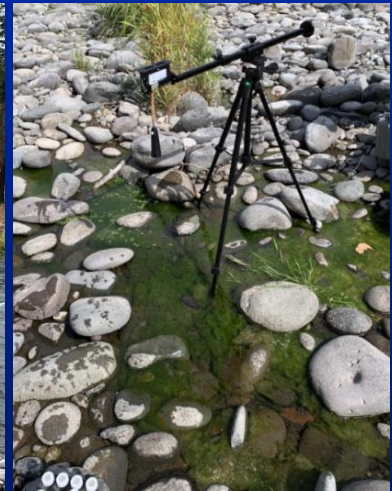
USGS Photo

# Riffle-Scale Surveys

- Hyperspectral data collection w/ drone
- Field spectra of periphyton on cobbles above & below the water surface
- Periphyton spectra collected from hyperspectral microscopic
- Coming soon: reach scale hyperspectral data from Civil Air Patrol aircraft



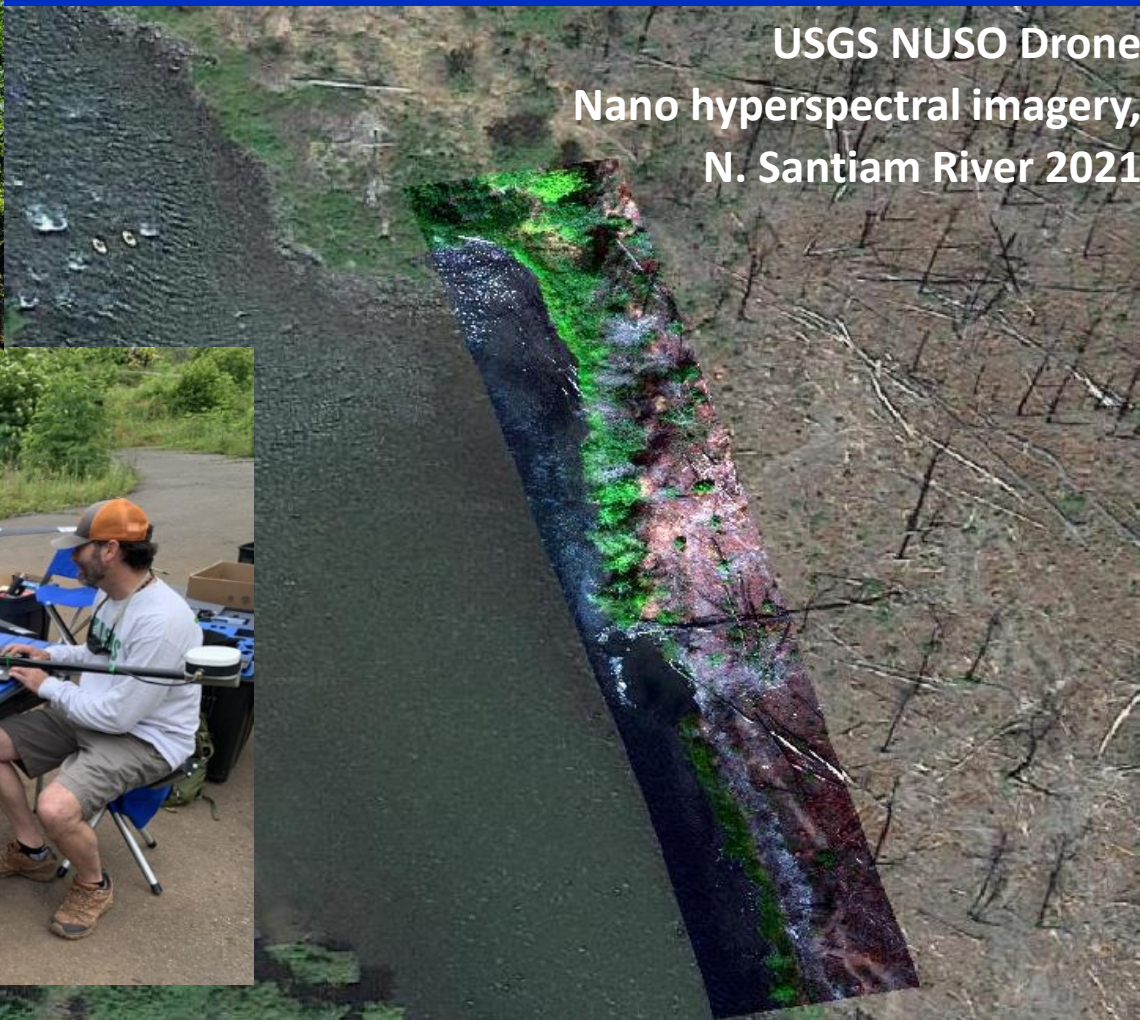
DJI M600 drone / Nano sensor



Collecting periphyton spectra, Clackamas & North Santiam Rivers

# Drones

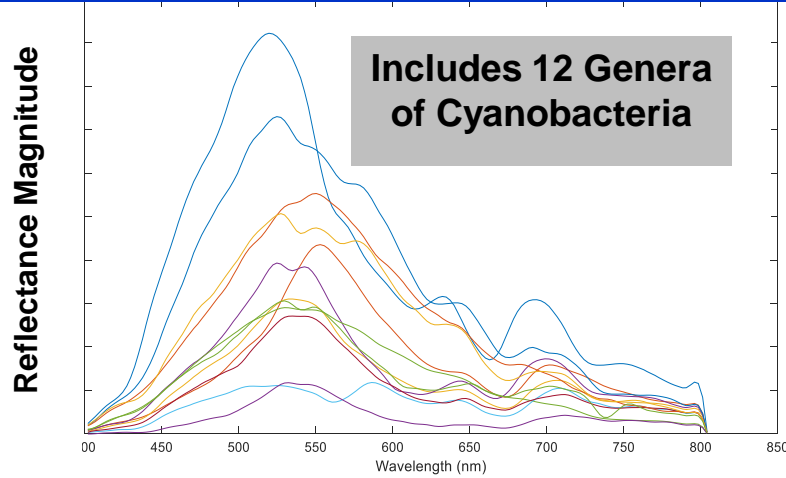
- Hyperspectral sensors
- RGB (high resolution)
- FLIR (Forward Looking InfraRed)



Paul readies the M600 drone,  
Clackamas River 2022

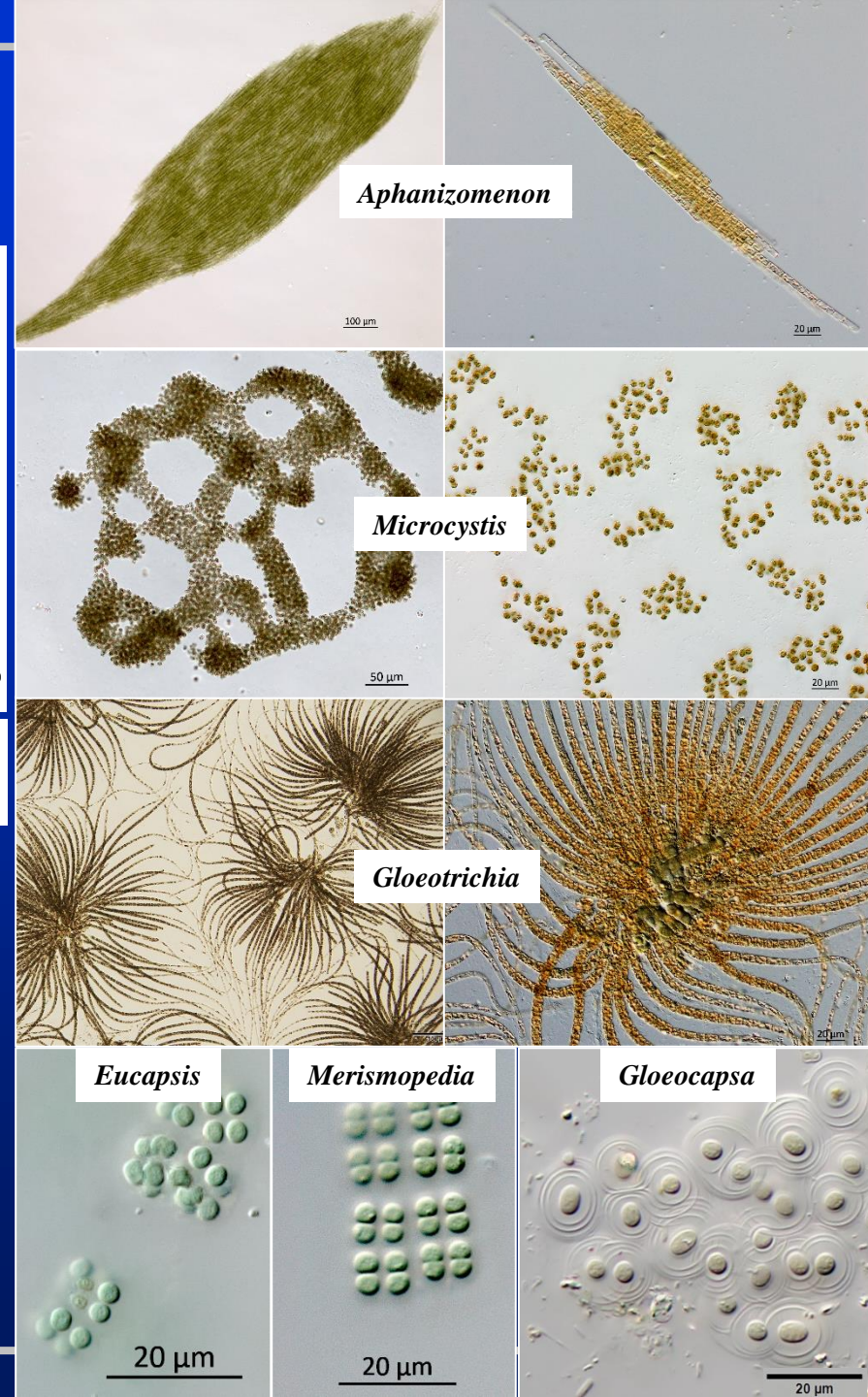


# Hyperspectral Microscope

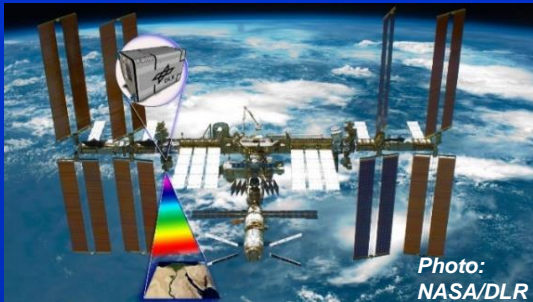


Legleiter et al., 2022  
(<https://doi.org/10.1016/j.rse.2022.113089>).

- We continue to expand this Reflectance Spectra Reference Dataset
- Future research can evaluate spectra consistency and identify factors influencing spectra magnitude and shape



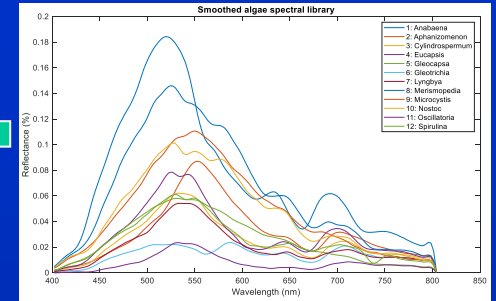
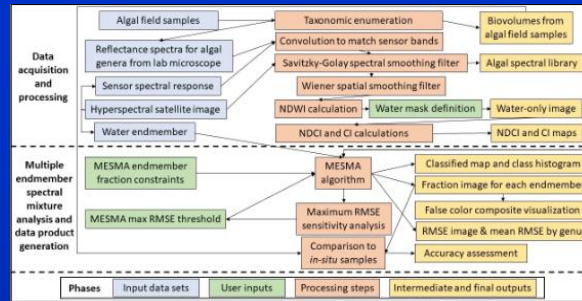
# Spectral Mixture Analysis for Surveillance of Harmful Algae



Satellite Data  
&  
In situ Algal  
Field Sample  
Data

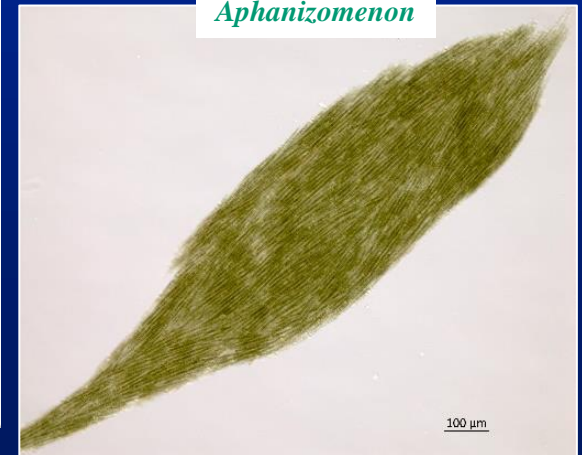
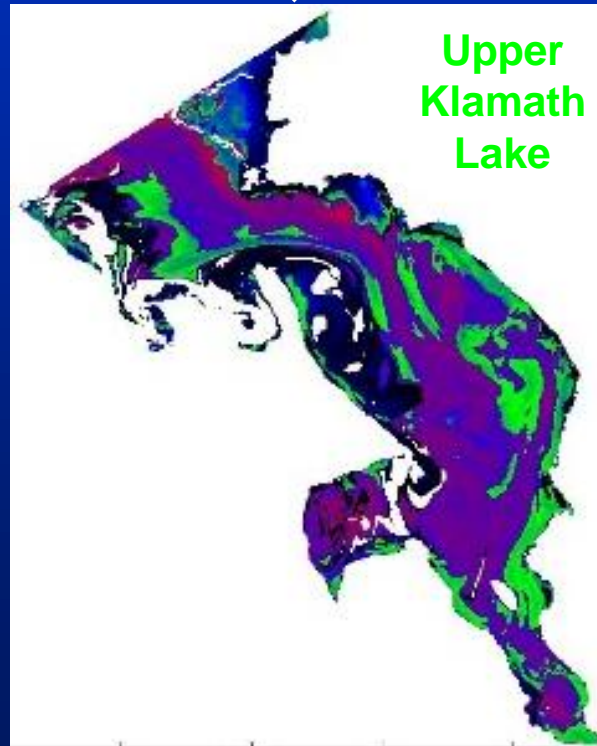


## “SMASH”

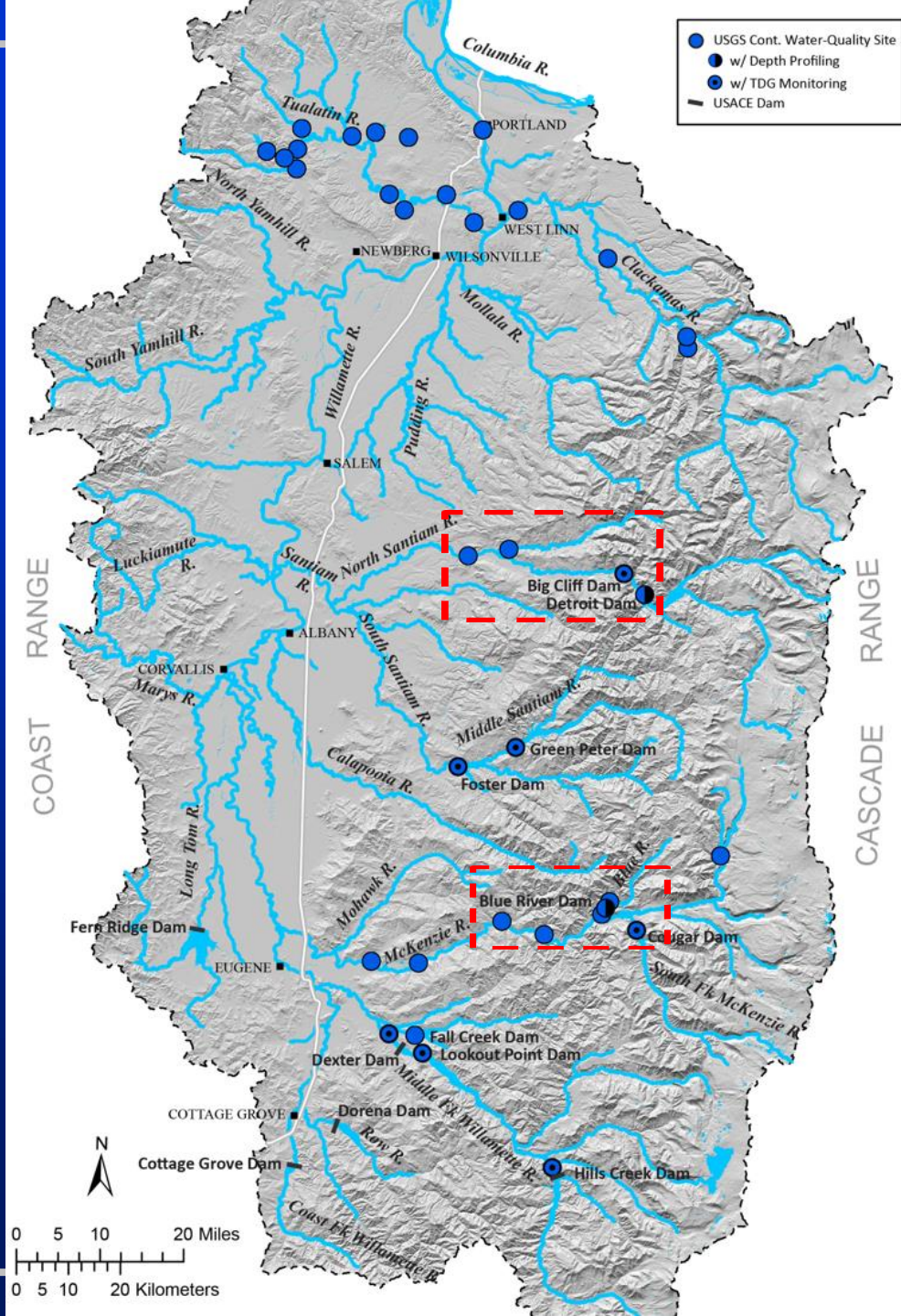


Spectral Data from  
Microscope

Multiple Lines of  
Evidence



# Continuous WQ Profilers Detroit and Blue River Lakes



## Other HAB Monitoring

- Targeted monitoring of HABs exiting the Ross Island Lagoon (water quality monitor at OMSI dock)
- Cyanobacteria surveys in the Molalla River, related to the occurrence of cyanotoxins and taste and odor issues in Canby's drinking water
- High-frequency mapping of water quality in the lower Willamette River and Cascade reservoirs, to ground truth SMASH

**Stay tuned – Please reach out if you have questions**



Oregon

# Hyperspectral-Periphyton Research Team

Virginia



Brandon



Thank You!



Kurt



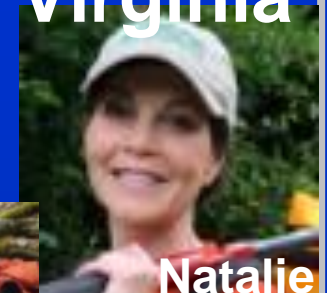
Paul



Tyler



Adam

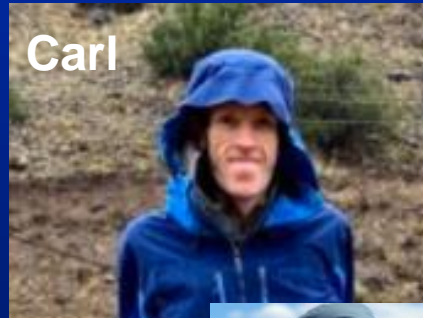


Natalie



Terry

## Colorado



Carl



Matt



Nancy



Wes

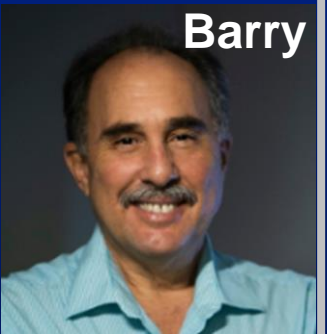


Will



Victoria

## Florida



Barry