Widespread anatoxin detected from attached cyanobacteria in the Klamath River and tributaries

Oregon Lakes Association

Cyanobacterial Harmful Algal Bloom Stakeholder Meeting
Friday, March 17, 2023

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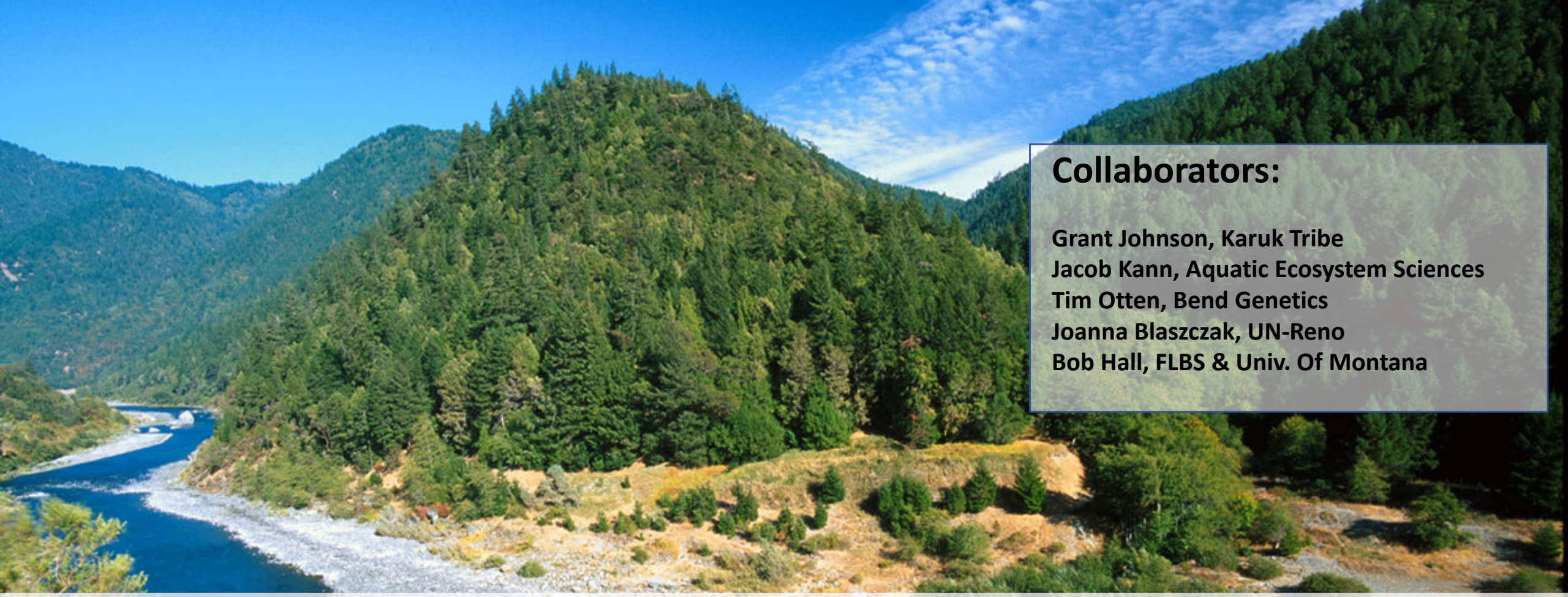

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Jacob Kann, Aquatic Ecosystem Sciences
Tim Otten, Bend Genetics
Joanna Blaszczak, UN-Reno
Bob Hall, FLBS & Univ. Of Montana

FLATHEAD LAKE BIO STATION
UNIVERSITY OF MONTANA

CALIFORNIA WATER BOARDS
North Coast - R1

UM BRIDGES
Bridging the Food-Energy-Water Nexus

NORTHWEST
Climate Adaptation
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Karuk Tribe

Yurok Tribe

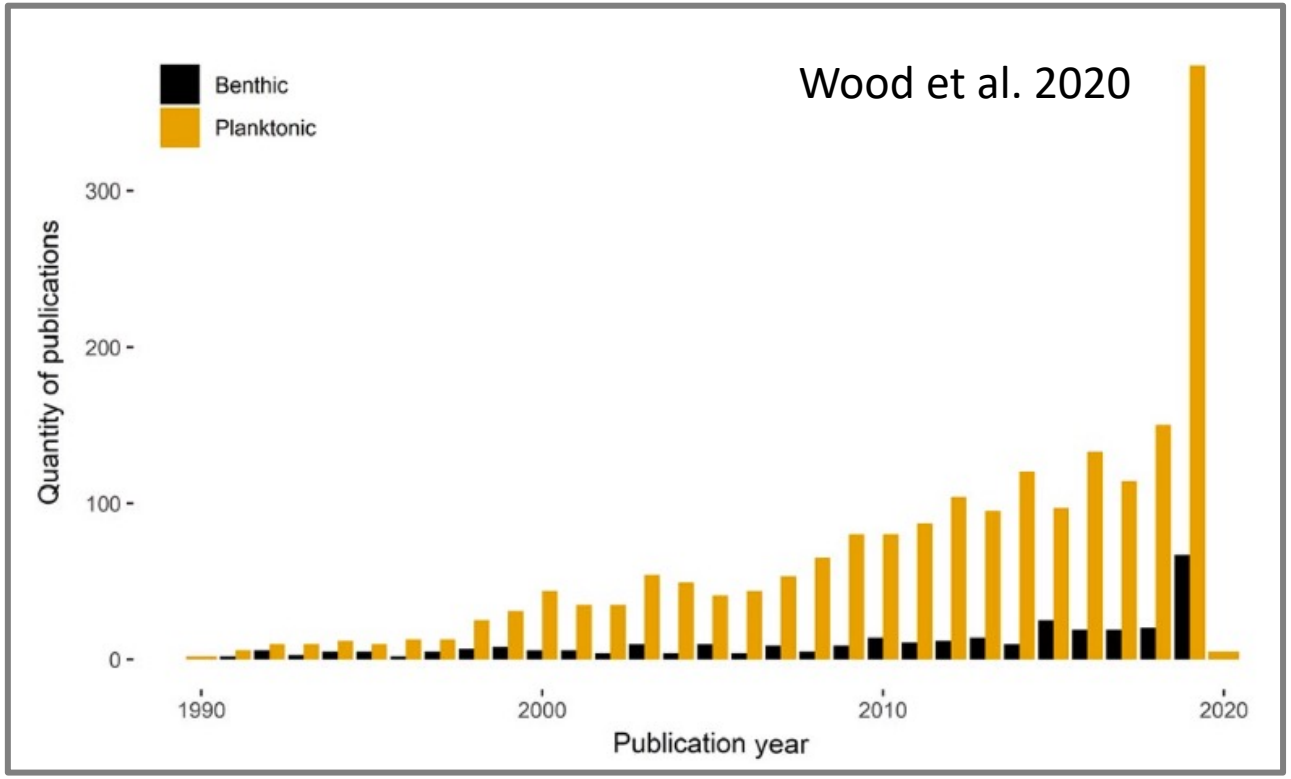
Hoopa Valley Tribe

Quartz Valley Indian Reservation

Resighini Rancheria

Benthic cyanobacteria are widespread and can produce toxins

Research is focused on planktonic cyanobacteria and toxins



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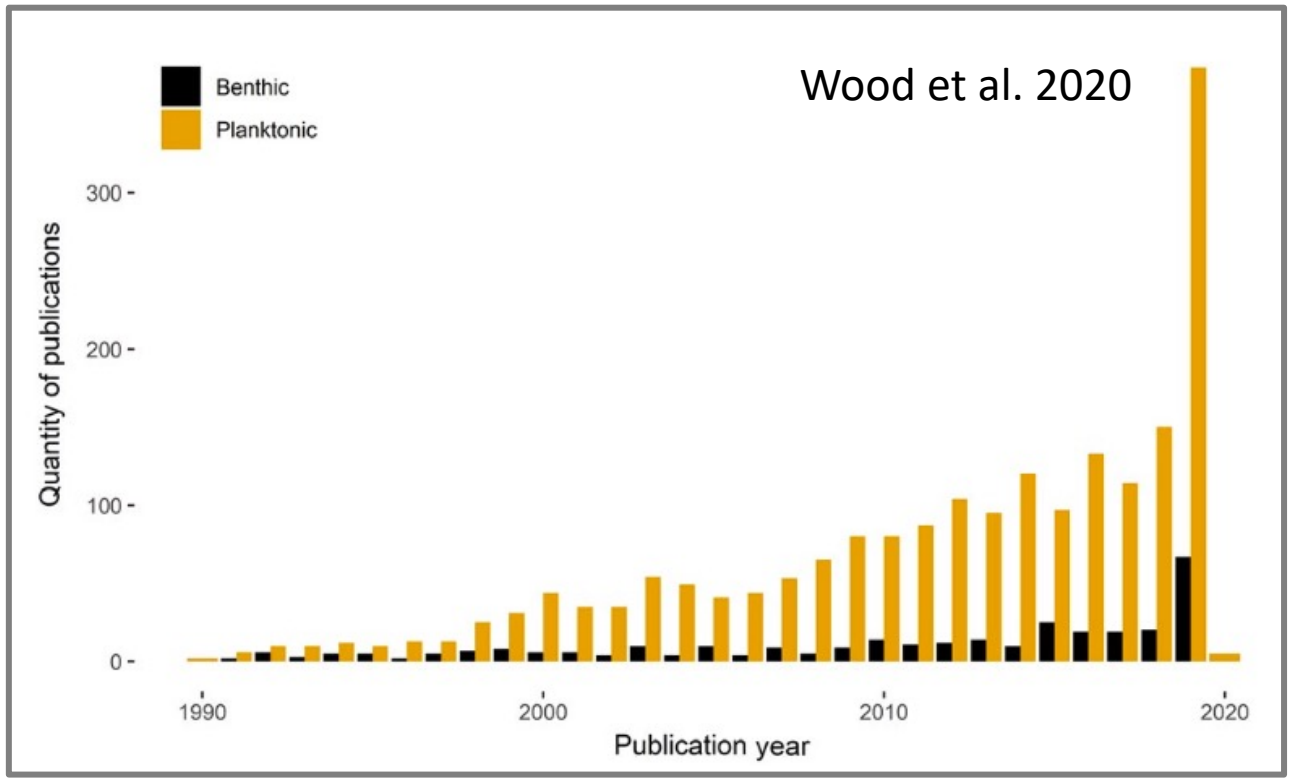

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Distribution and drivers of benthic cyanobacteria and toxins are poorly understood

Anatoxin is a potent neurotoxin, often associated with dog illness and death

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By Anna King (NW News Network)
Sept. 17, 2021 9:02 a.m.

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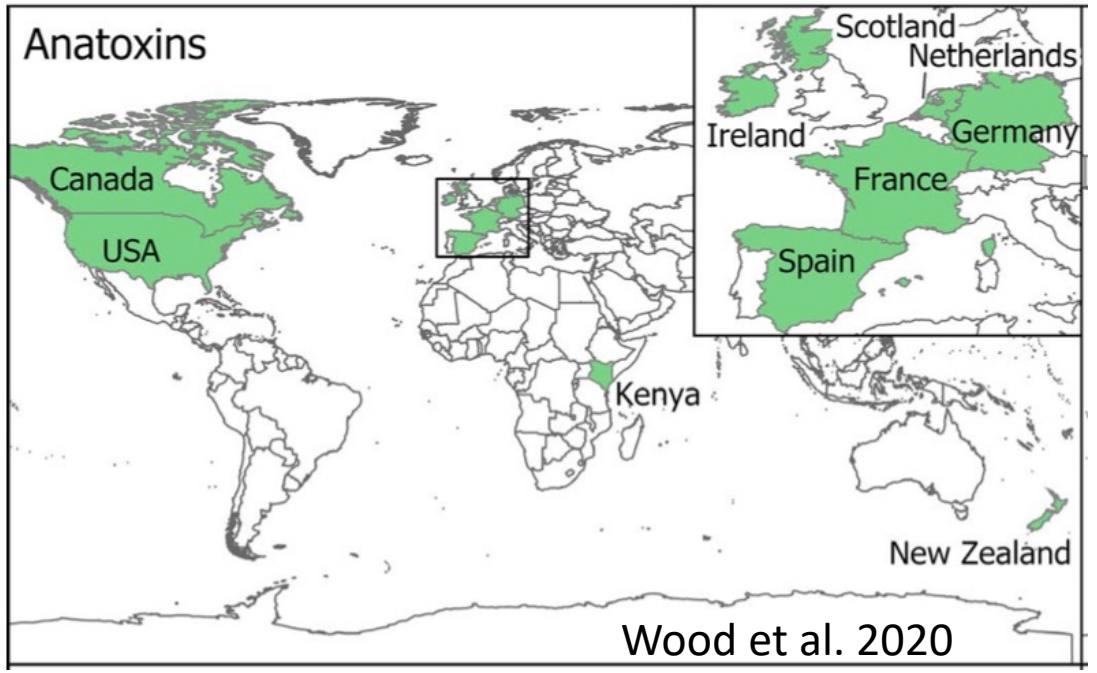
- Degrades quickly in the environment
- Can occur in planktonic and benthic cyanobacteria
- Benthic sources are poorly documented



The Klamath River has high productivity that leads to water quality impairment

- Well-documented planktonic blooms of *Microcystis* in reservoirs that transfer to river
- Sporadic sampling for anatoxin via water grab samples result in low percentage of detections (> 9%)
- Observations of benthic mats in 2019 lead to hypothesis of benthic anatoxin production

What is the extent and anatoxin dynamics associated with attached cyanobacteria in the Klamath River?

- How does anatoxin vary among mediums, sites, and through time?

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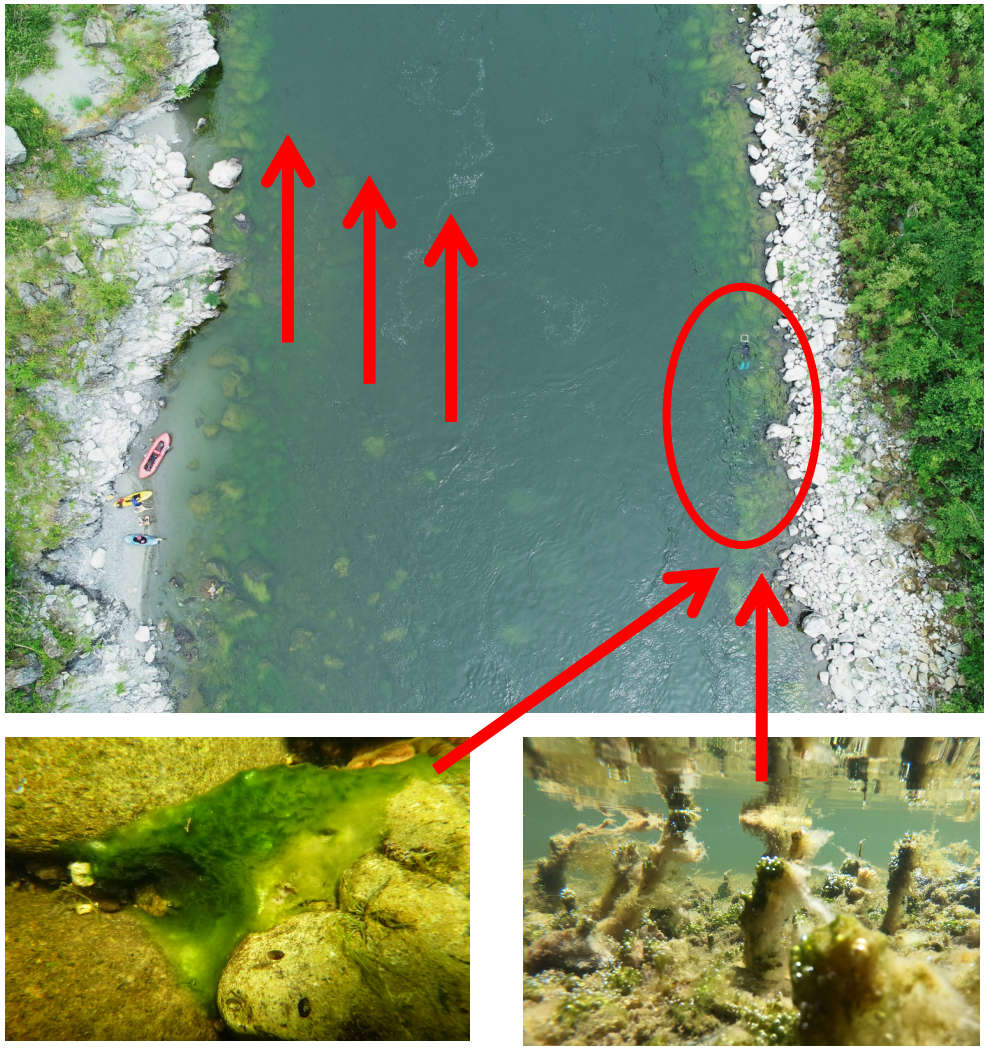

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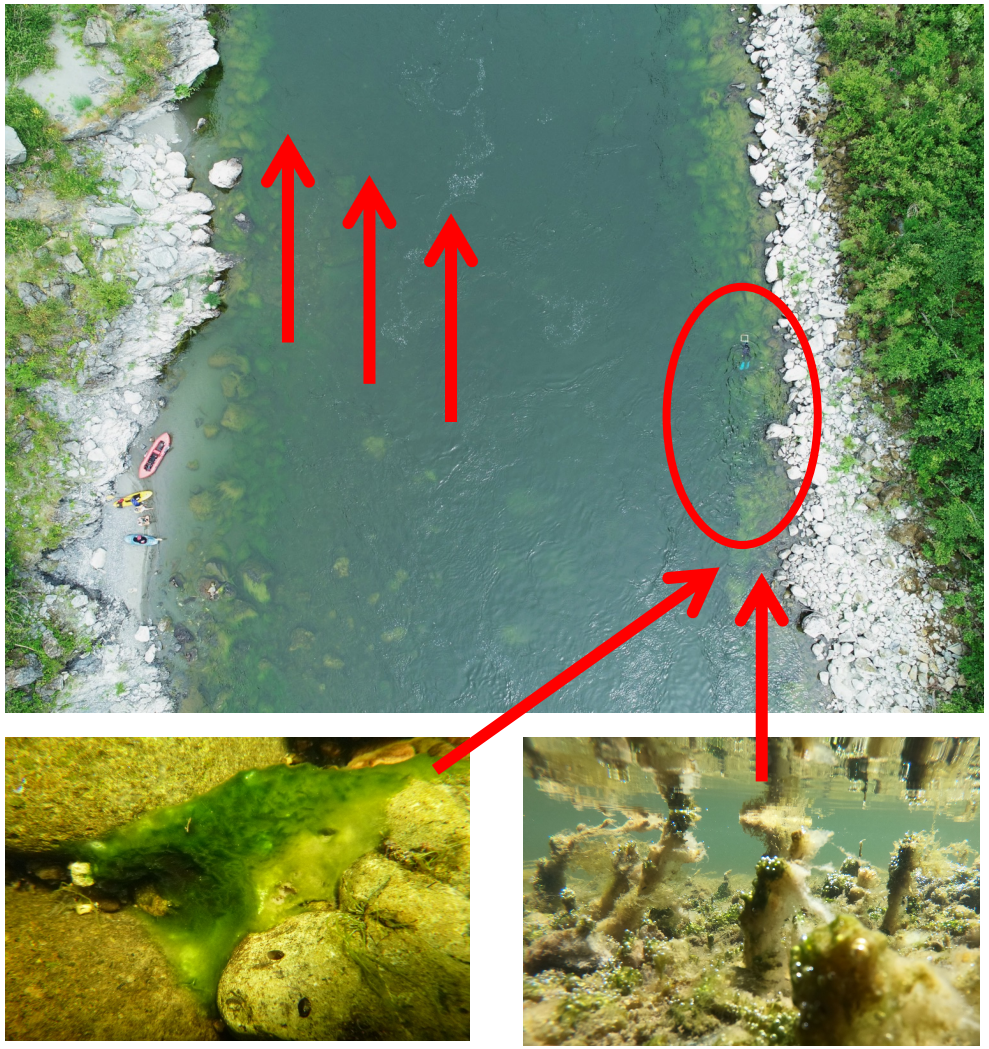
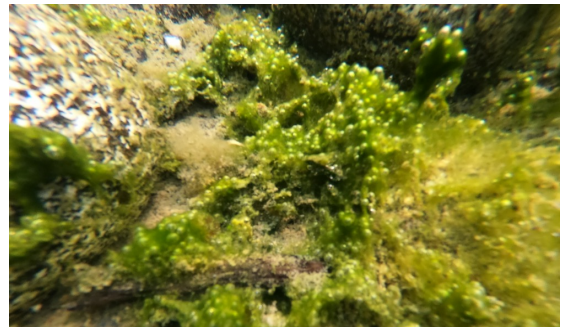
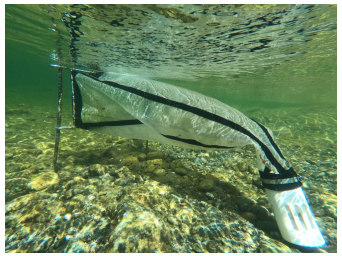


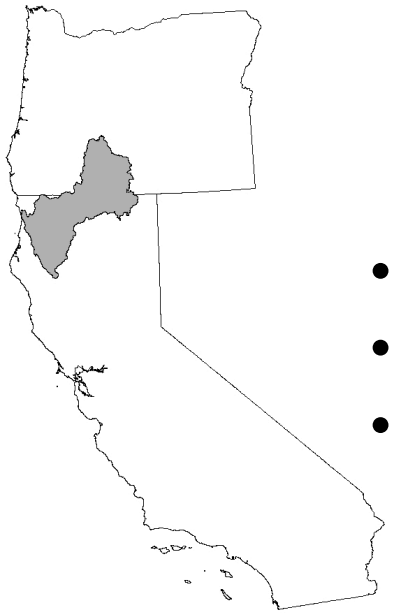
- How does anatoxin vary among mediums, sites, and through time?
- What taxa is producing anatoxin?
- What conditions promote anatoxin production?

Sampled Klamath River and tributaries 3x in summer 2021

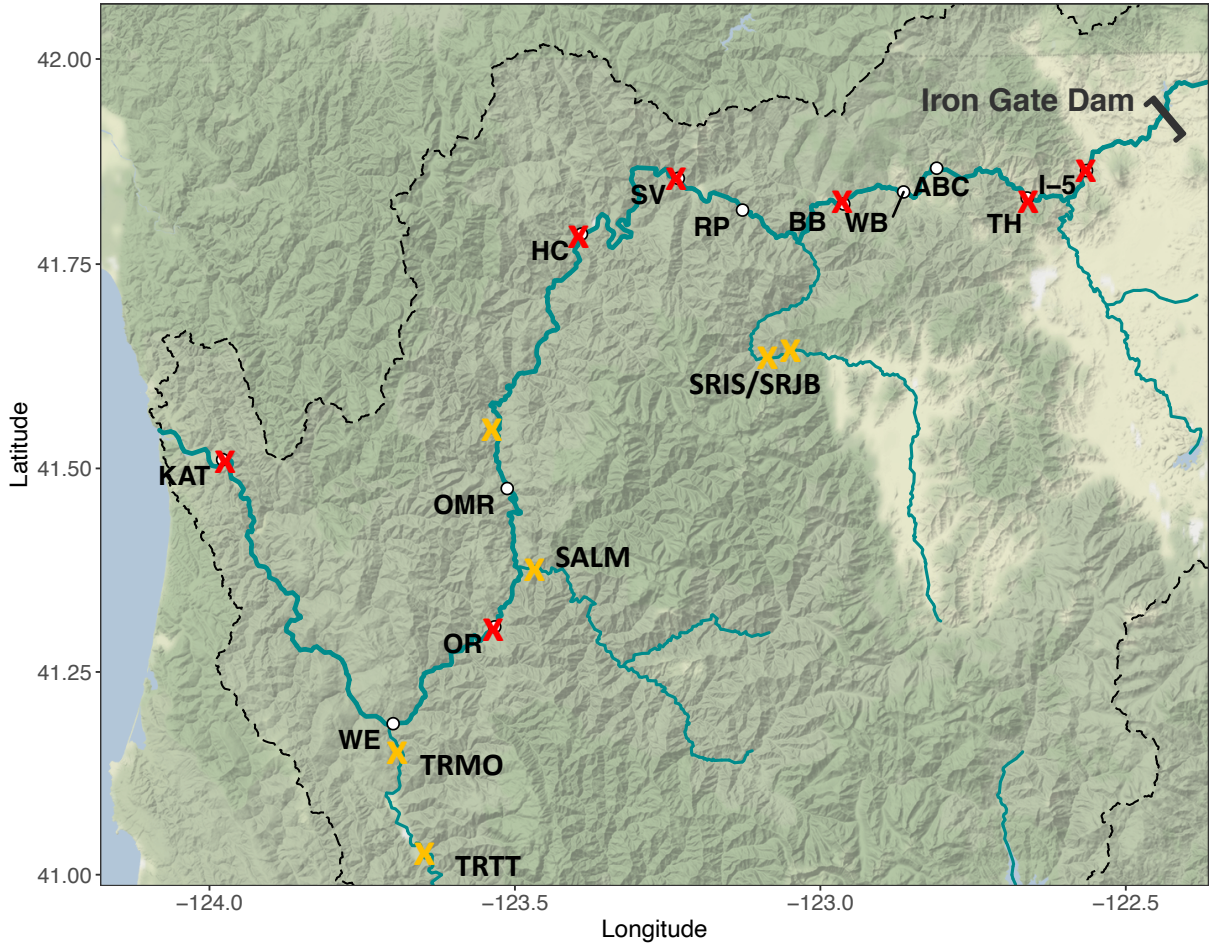




- Composite mat samples
- Water column grabs
- Net samples for transported CPOM



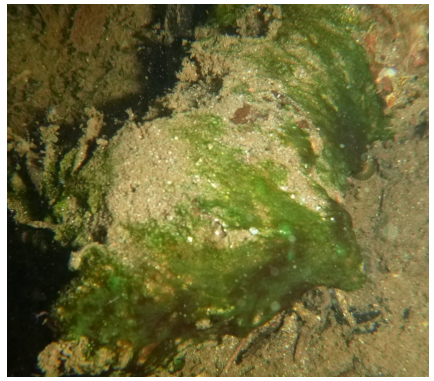
- Qualitative microscopy
- AnaC gene copies
- Anatoxin by ELISA



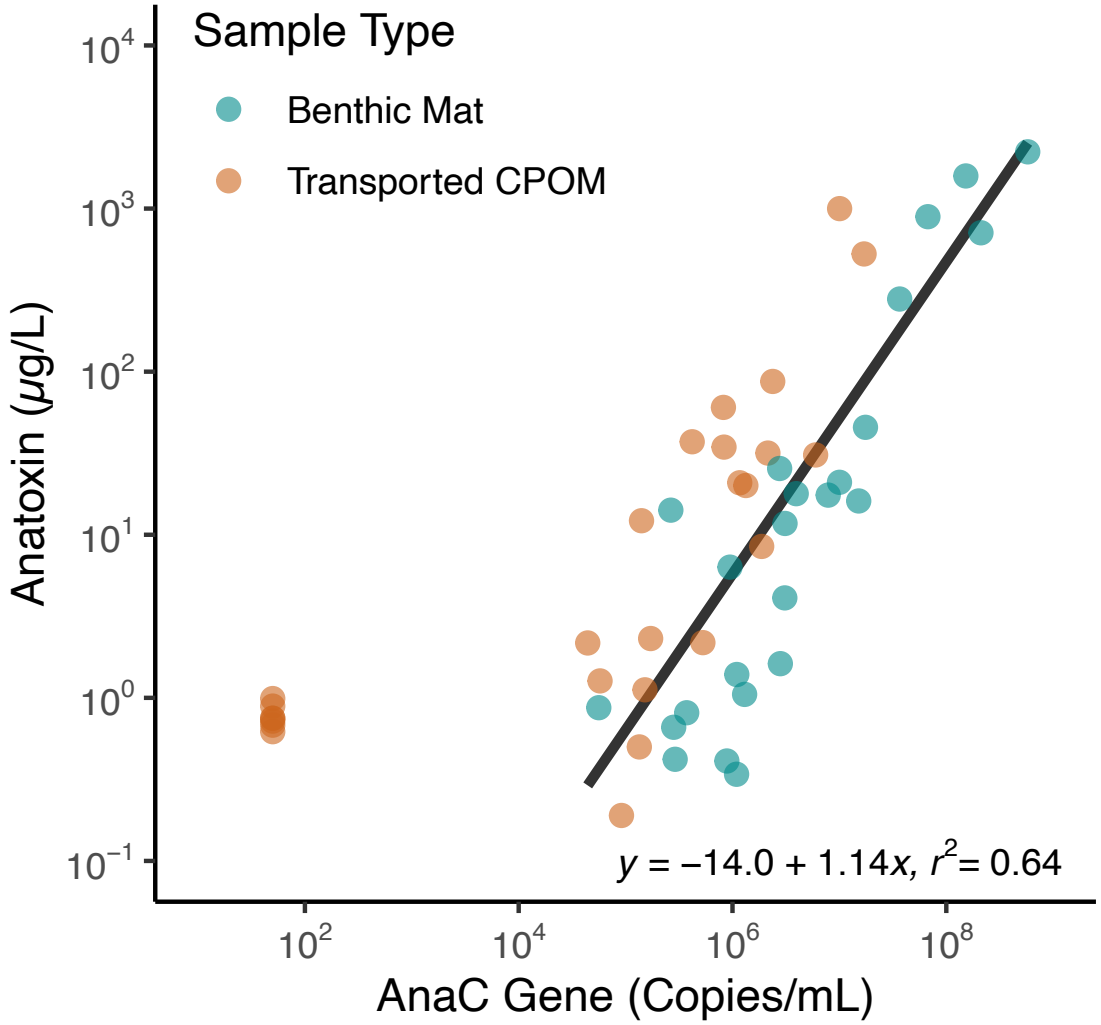
Benthic mat-forming cyanobacteria and associated anatoxins were nearly ubiquitous in summer 2021

Sample Type	Method	Total Samples	Positive Detections	% Detection
Water	qPCR	31	15	48%
CPOM	qPCR	27	20	74%
Mats	qPCR	36	31	86%
CPOM	ELISA	27	26	96%*
Mats	ELISA	26	26	100%*

*These were sample run without regardless of qPCR results, but did not include July samples, which were typically lower in toxins.

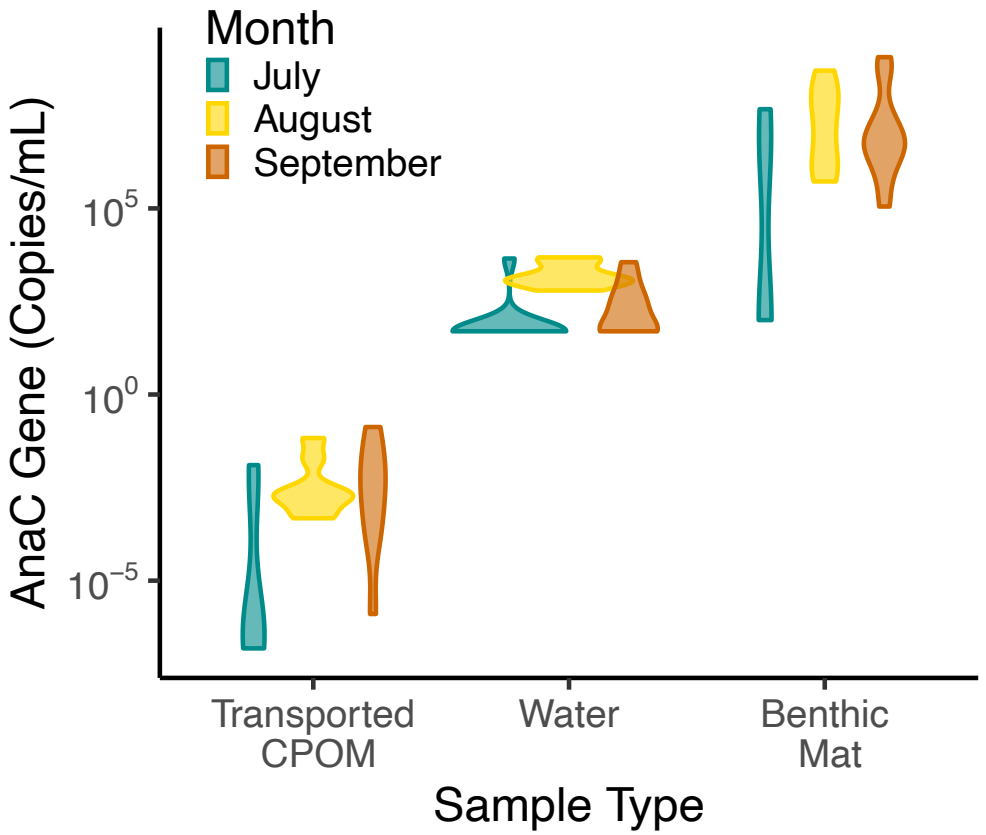


AnaC gene copies predicted Anatoxin concentration



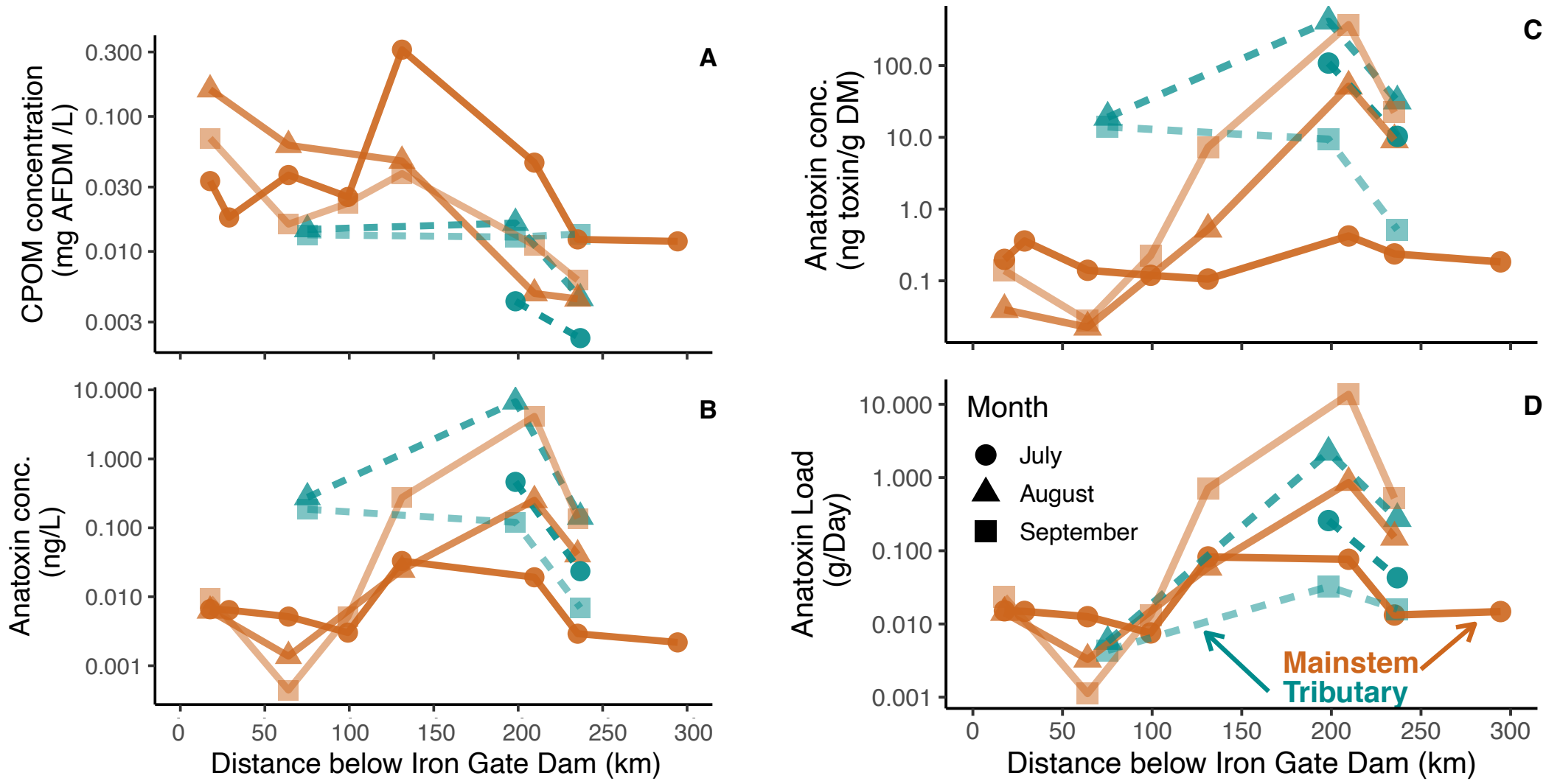
- ✓ AnaC gene copies are a good indicator of anatoxins

Anatoxins were highest in benthic mats

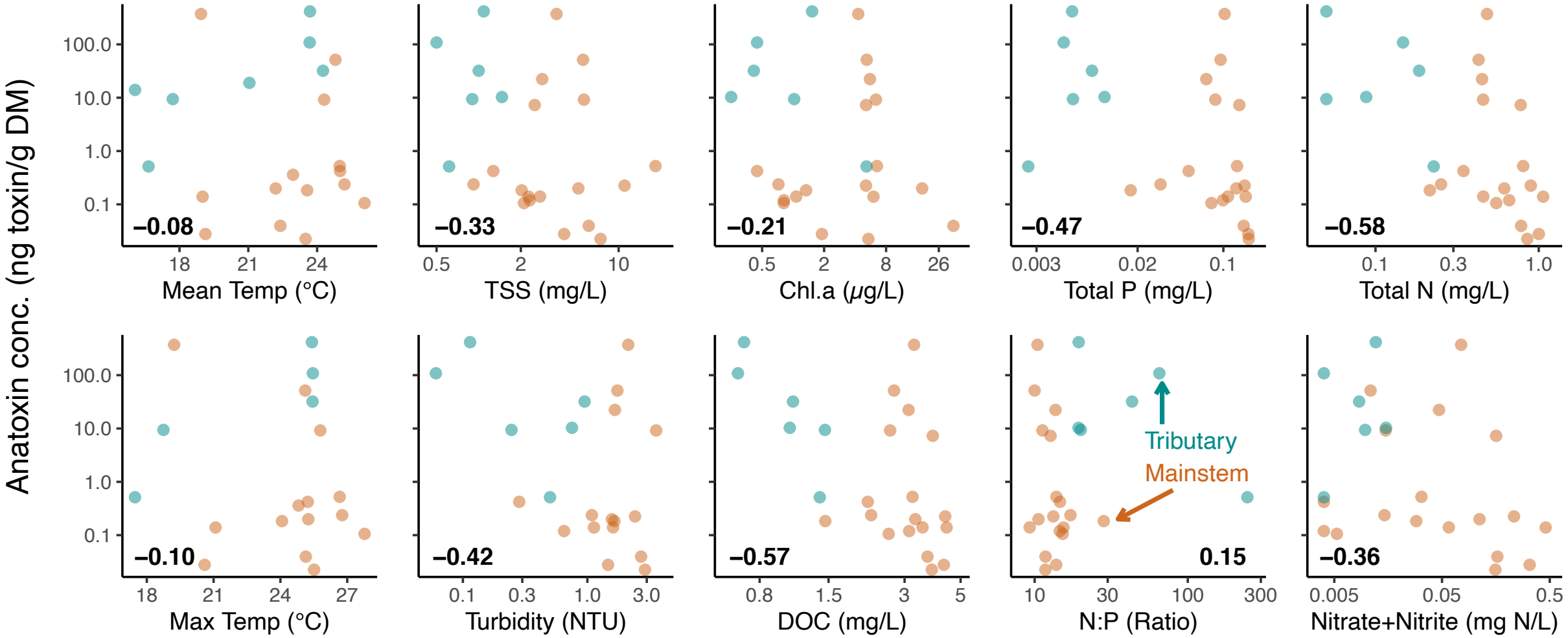


- ✓ Benthic mats were the primary source of anatoxins: risk is highest in attached mats
- ✓ Environmental concentrations were lowest in CPOM, but exposure is still possible in transported CPOM (i.e., “floating chunks”)

Environmental concentrations of anatoxin were highest in tributaries and in late summer



Tributary differences drove weak, negative correlations between anatoxin concentration and water quality



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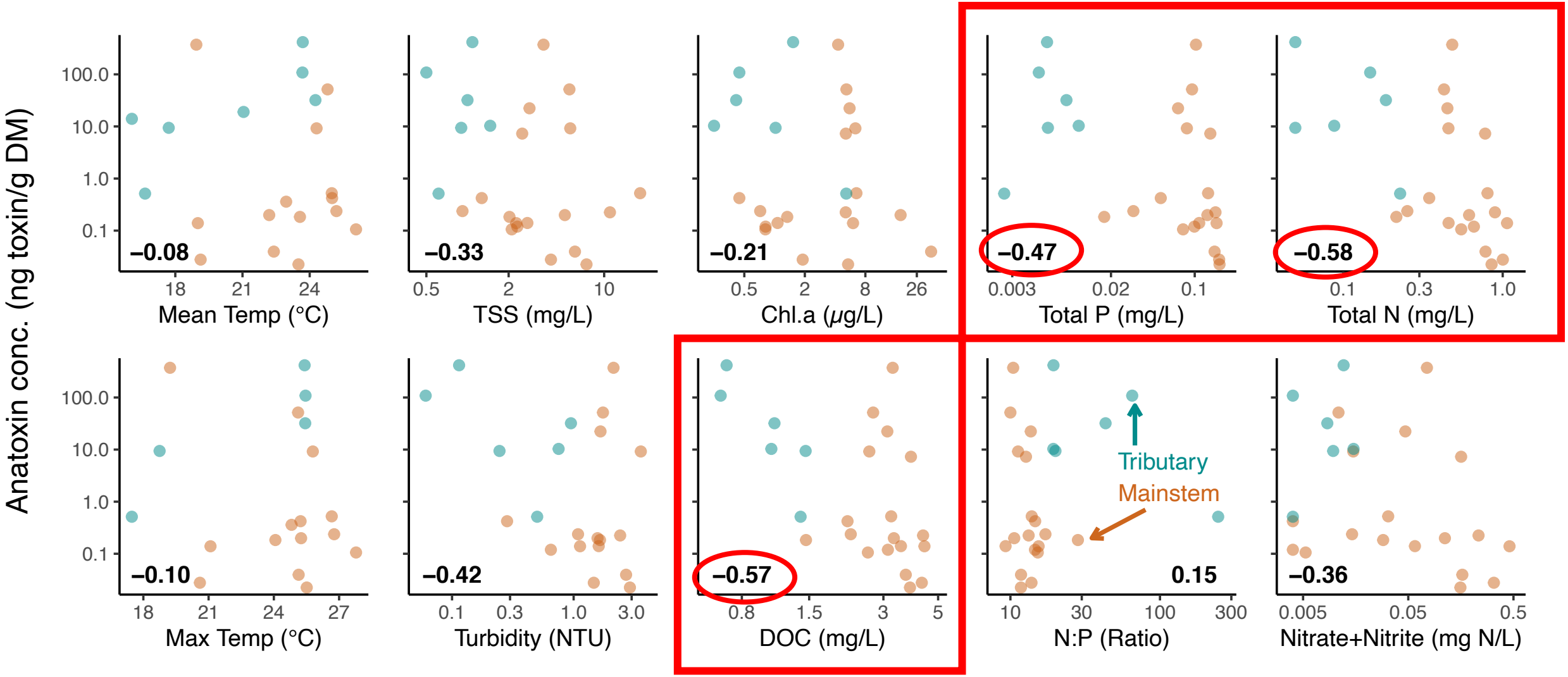
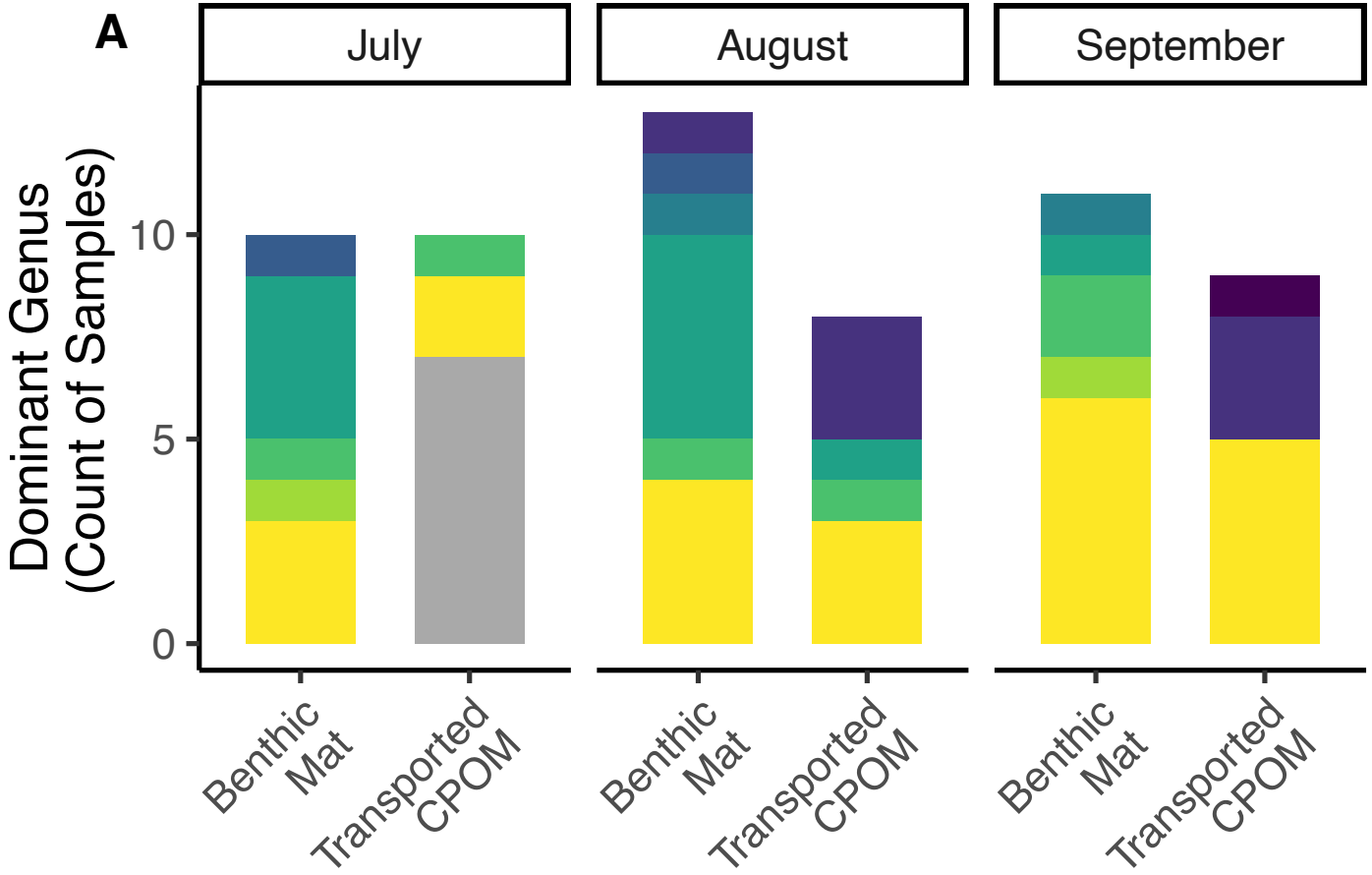
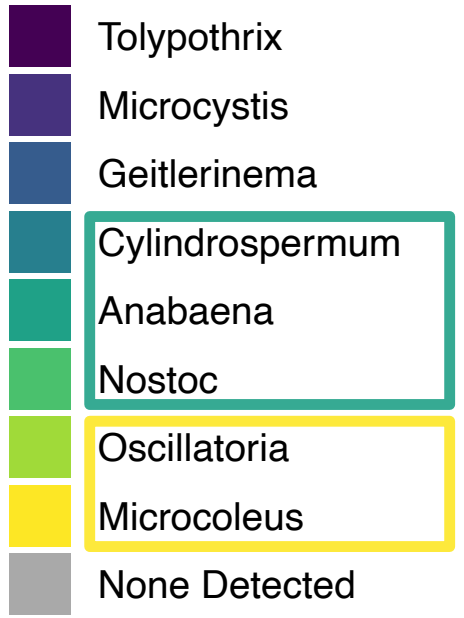
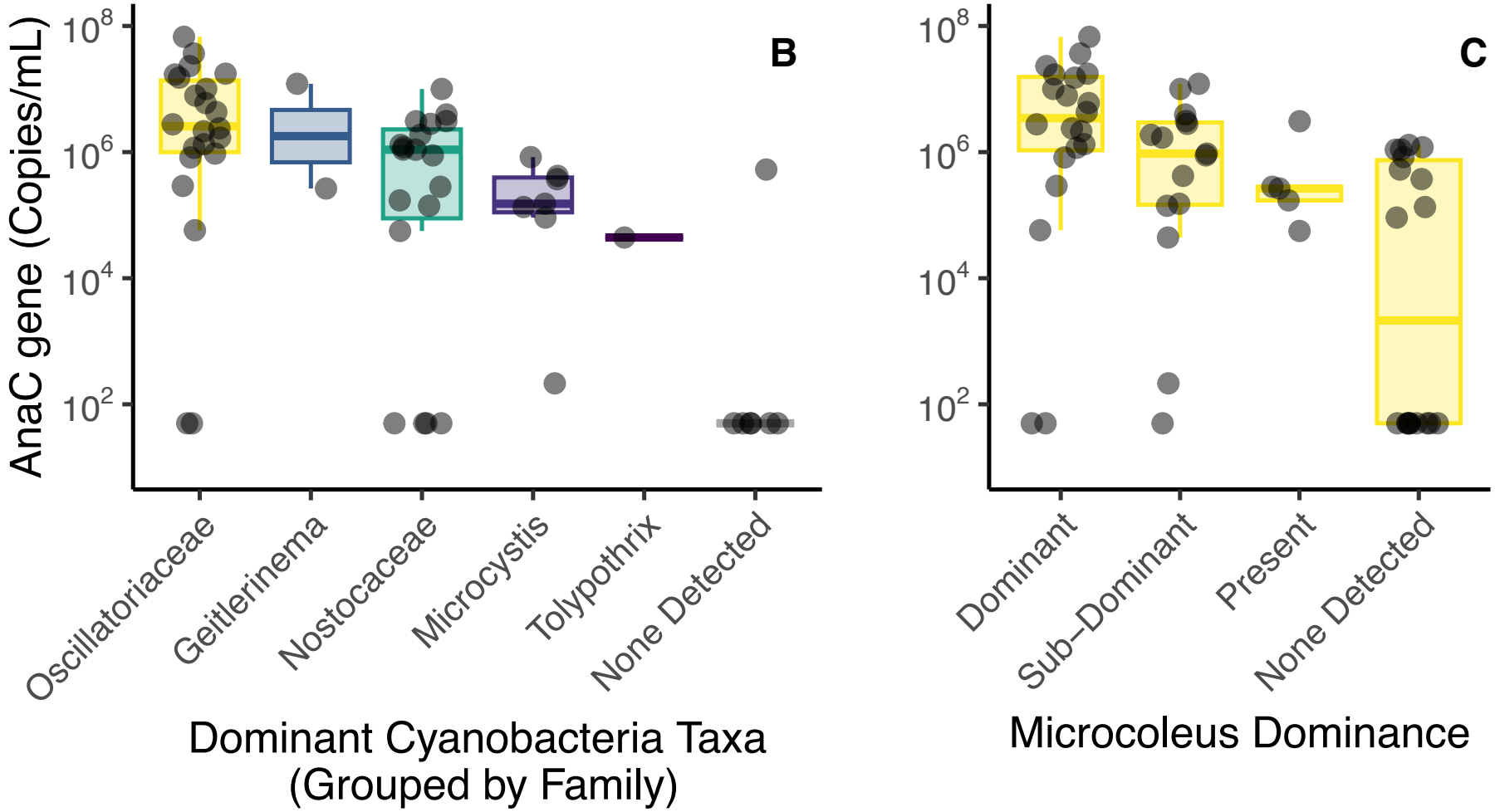


Microcoleus was the most common dominant taxa in samples of benthic mats and transported CPOM



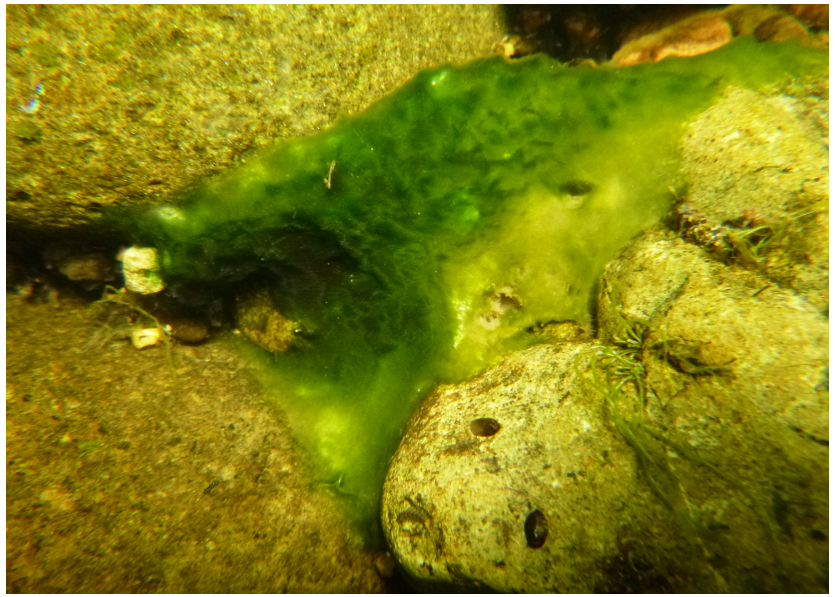


Microcoleus-dominant samples were associate with highest anatoxin indicators



Genetic results confirmed *Microcoleus* as the anatoxin producer in the Klamath River

- Cyanobacteria-specific 16S rDNA and anaC genes were sequenced
- Reference data bases were used to assign taxonomic ID
- Nearly all anaC sequences were most closely related to Phormidiaceae (*Microcoleus*)



Conclusions:

- Cyanobacterial mats and anatoxins were widespread in the Klamath River
- Anatoxin was highest in late summer, including in high water quality tributaries
- *Microcoleus* was the primarily anatoxin producer

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Implications for monitoring

- Include benthic taxa in monitoring in clear-waters
- Focus visual surveys on *Microcoleus* and related taxa
- Reserve sampling resources for late summer
- Use qPCR methods as a more affordable toxin indicator
- Drift nets are a useful monitoring method if field identification or access is riverbeds prohibit visual surveys

Thanks!

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