Influence of zebra mussel invasion, phosphorus and other environmental factors on microcystin concentrations in lakes

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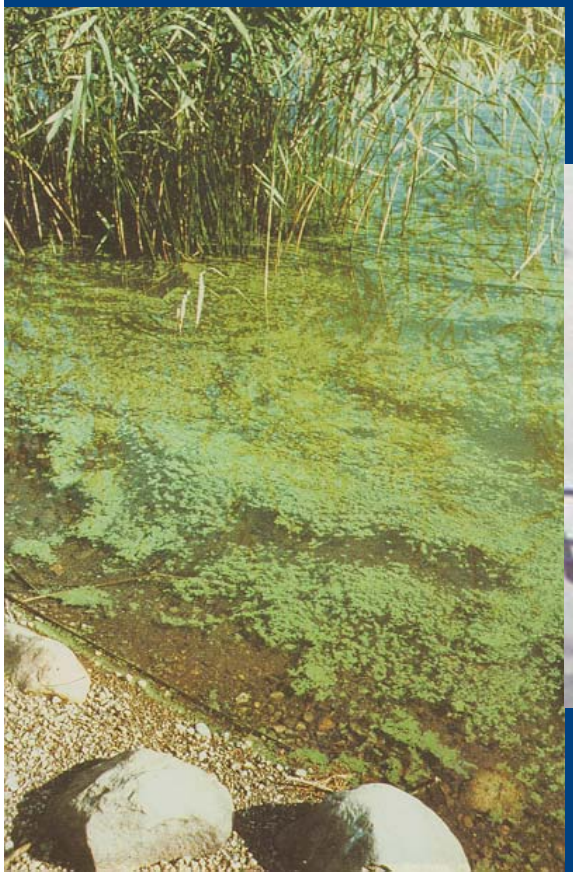

zebra mussel *(Dreissena)*

Collaborators

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Stephen Hamilton
Alan Wilson
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Toxins produced by freshwater planktonic cyanobacteria

Toxin type	Primary organ affected	Produced by
microcystins	**liver**	***Microcystis*** ***Anabaena*** ***Oscillatoria***
anatoxins	nervous system	*Anabaena* *Aphanizomenon* *Oscillatoria*
saxitoxins	nervous system	*Anabaena* *Aphanizomenon* *Cylindrospermopsis*
cylindrospermopsins	liver	*Cylindrospermopsis* *Aphanizomenon*
LPS	skin irritant	all of the above

Cyanobacteria and eutrophication

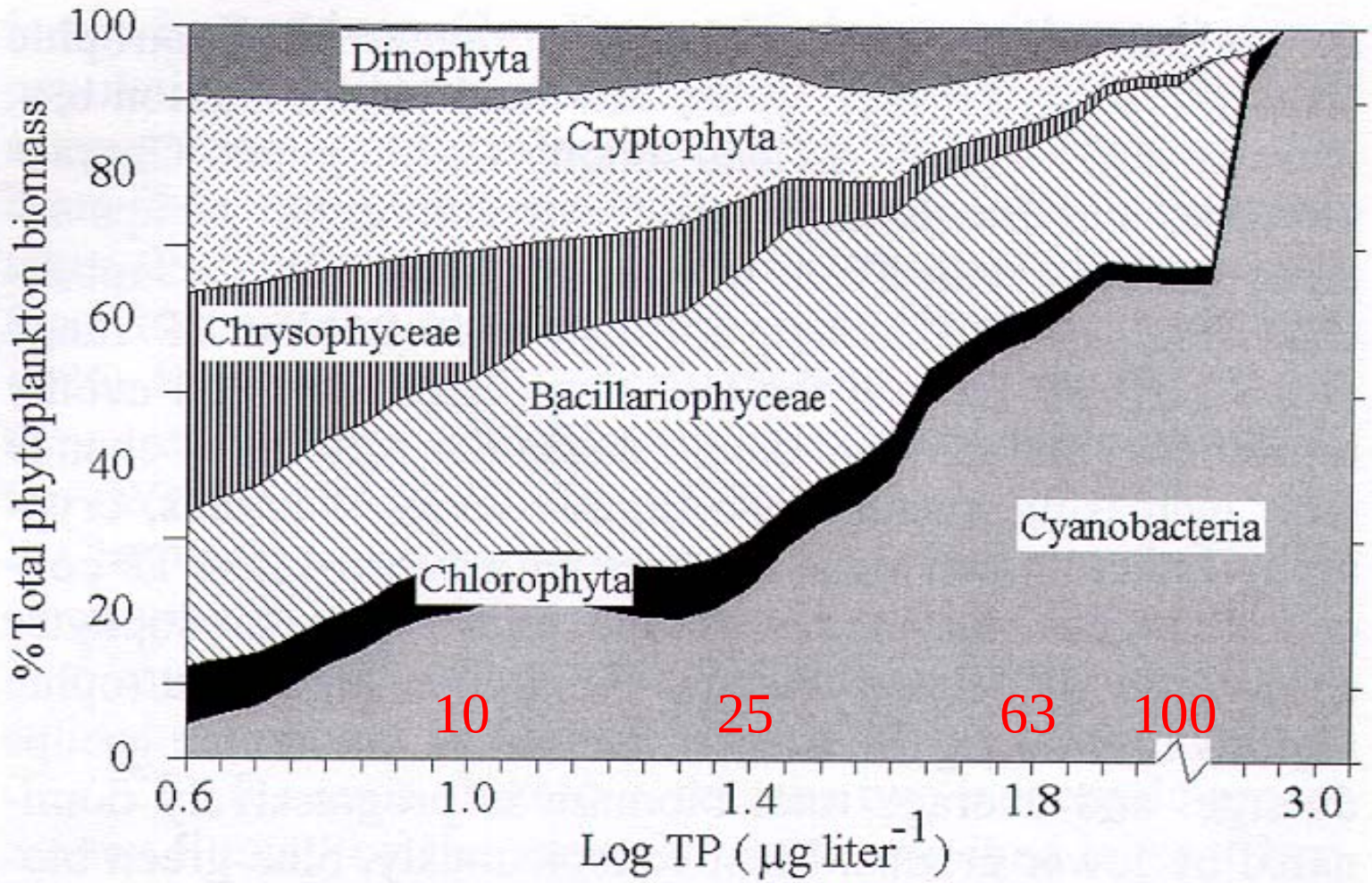


Fig. 4. Area plot of average contribution (%) of individual taxonomic groups to total summer biomass; data fitted with LOWESS smoothing technique.

Watson et al. (1997)

Dreissena invasion

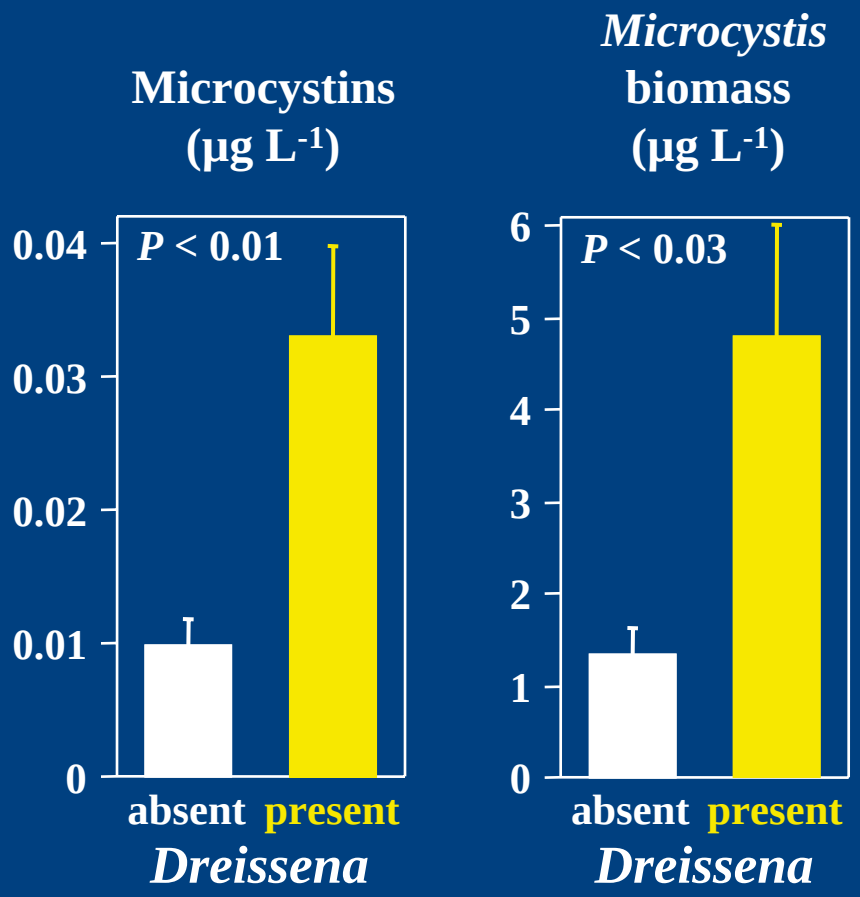
What we have found so far

Michigan lakes (2002-2003)

- 39 thermally-stratified lakes (max depth > 9m)
- TP range: 5 - 19 µg L^{-1}
- single-visit sampling, 2 August - 4 September (euphotic zone)
- chlorophyll *a*, phytoplankton species composition, particulate microcystin
- microcystin measured via ELISA

What we have found so far

Michigan lakes (2002-2003)



Knoll et al. (2008)

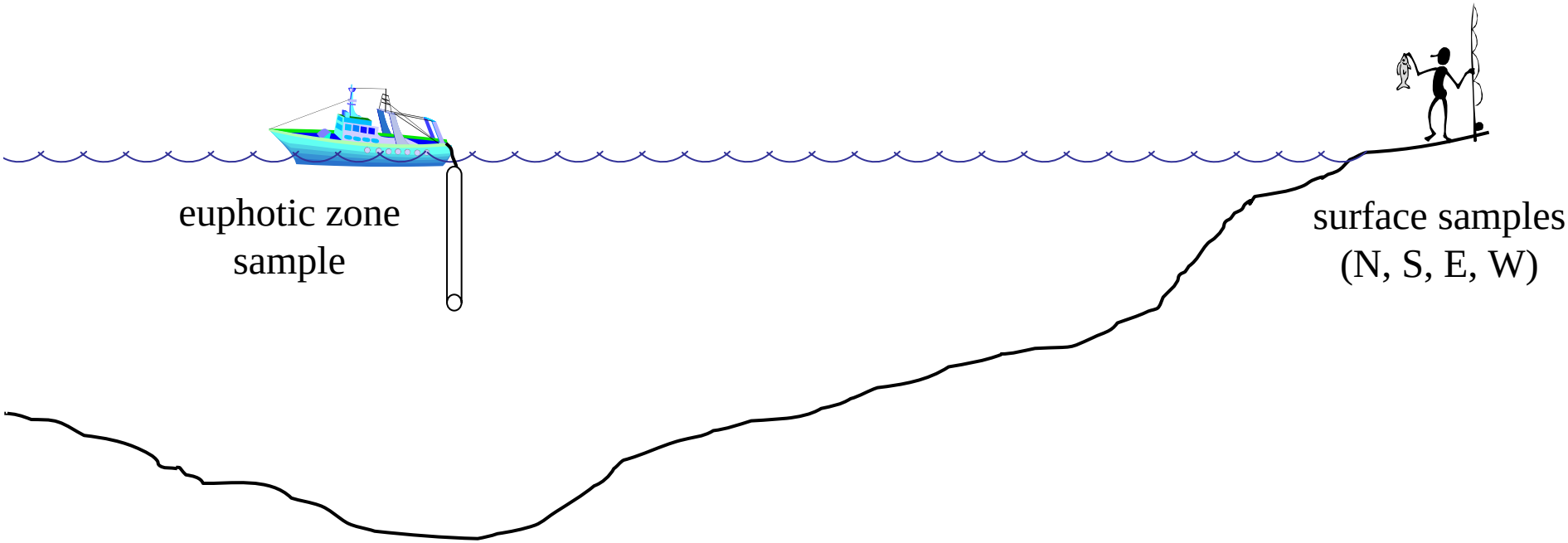
Citizens Monitoring Program (CLMP)

Michigan lakes (2006)

- 75 lakes
- TP range: 1 - 103 µg L^{-1}
- latitude range: 41.8°N - 46.5 °N
- depth range: 2.4 - 87 m
- single-visit sampling
- multiple sites sampled
- citizens shipped frozen samples to MSU (Express Mail)
- chlorophyll *a*, whole-water microcystin
- microcystin measured via ELISA

Citizens Monitoring Program

Sampling

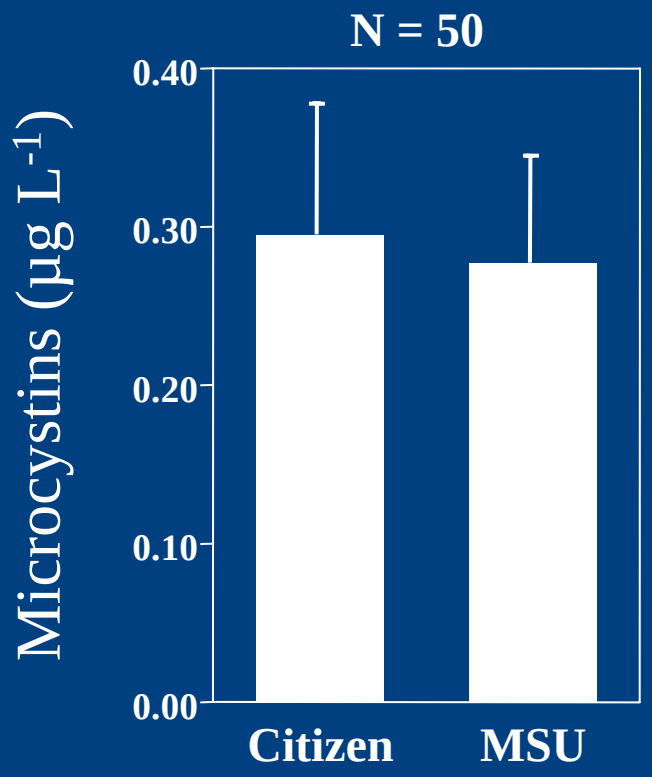


euphotic zone sample: TP, chlorophyll, microcystin

shoreline samples: chlorophyll, microcystin

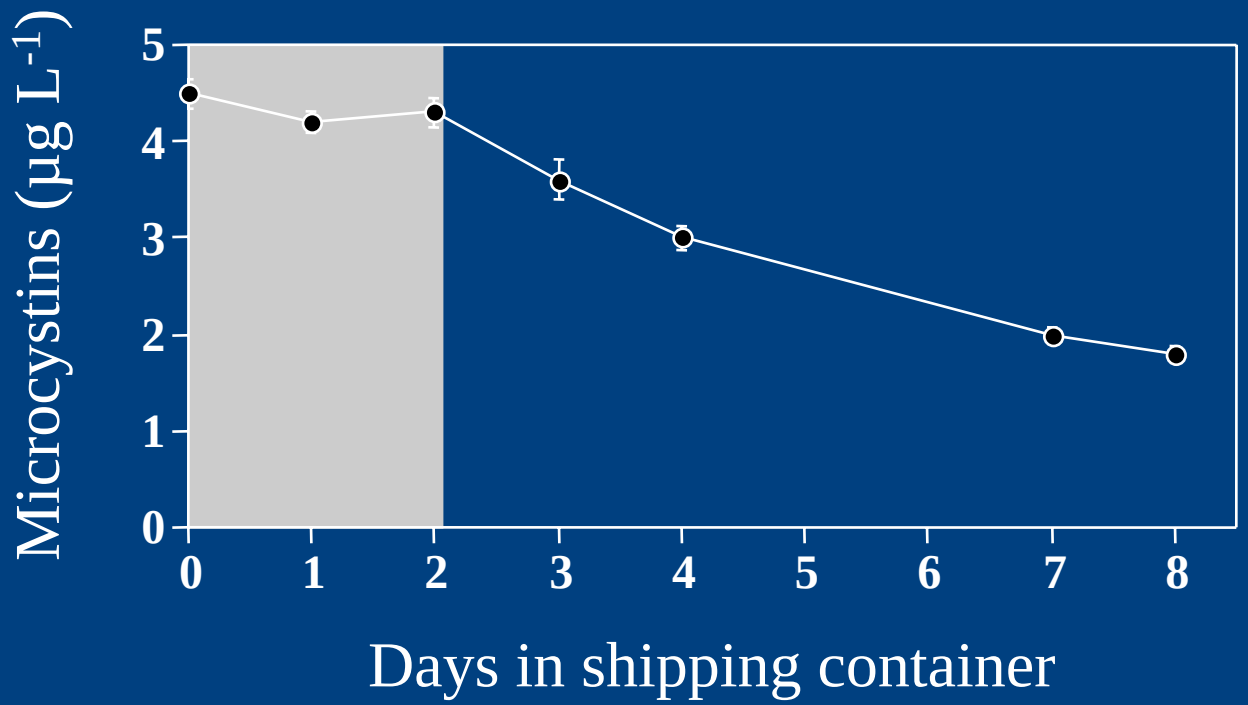
Citizens Monitoring Program

QA/QC



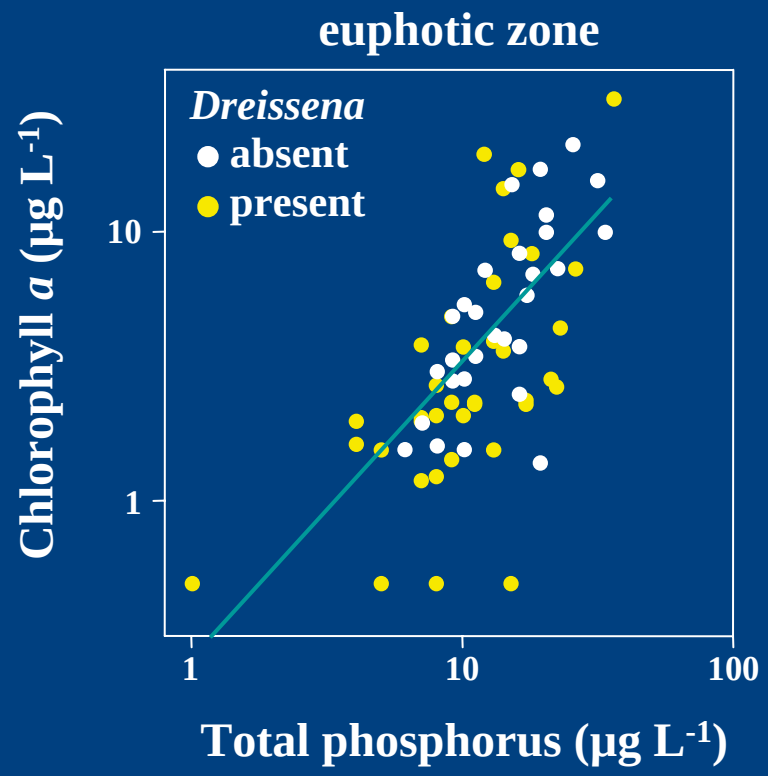
Citizens Monitoring Program

QA/QC



Citizens Monitoring Program

Survey Results



for all lakes:

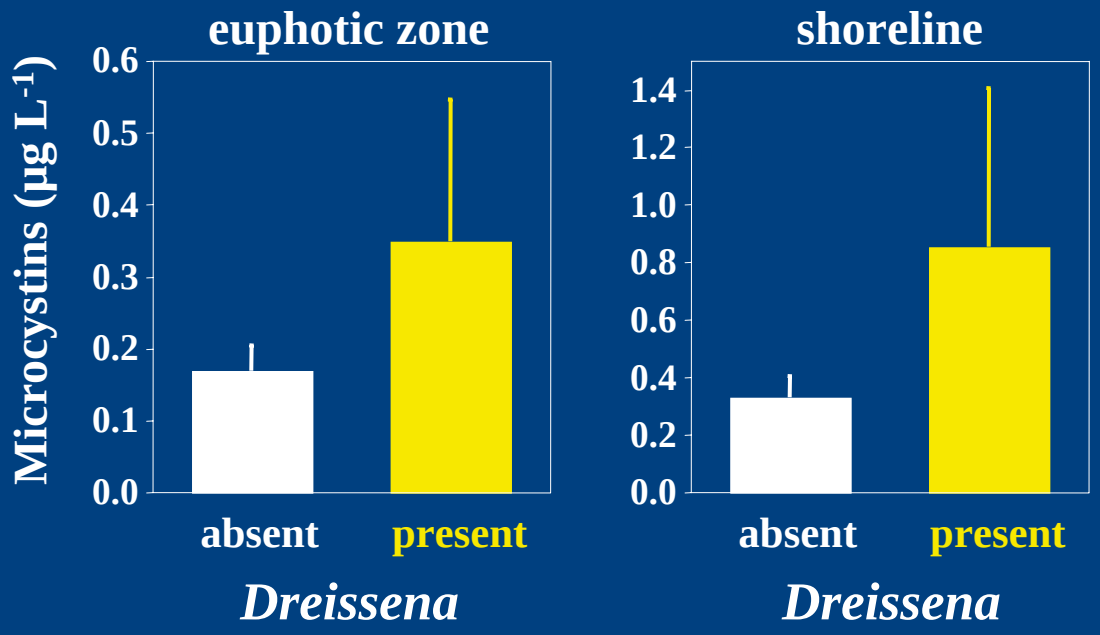
$y = -0.58 + 1.07x$

$R^2 = 0.43$

$P < 0.0001$

Citizens Monitoring Program

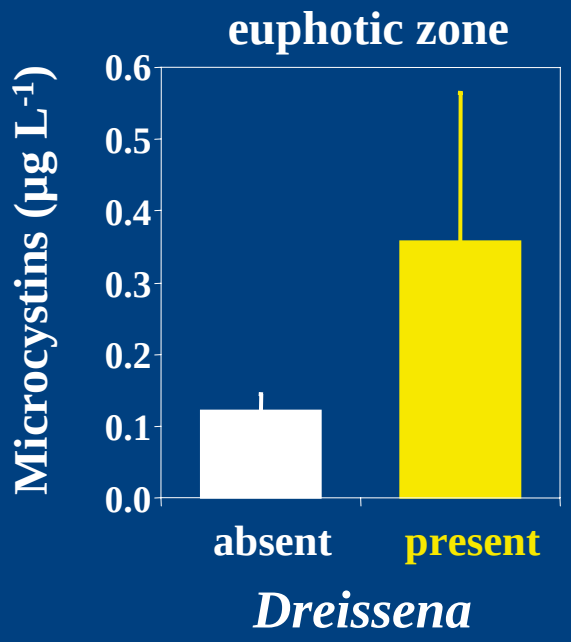
Survey Results

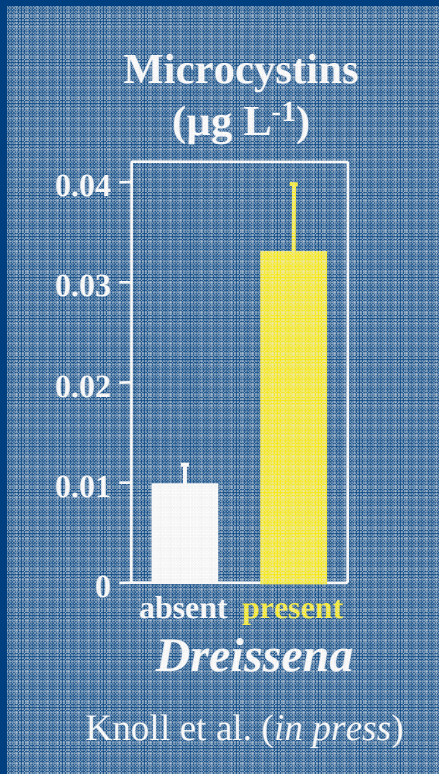


Citizens Monitoring Program

Survey Results

TP < 25 µg L^{-1}

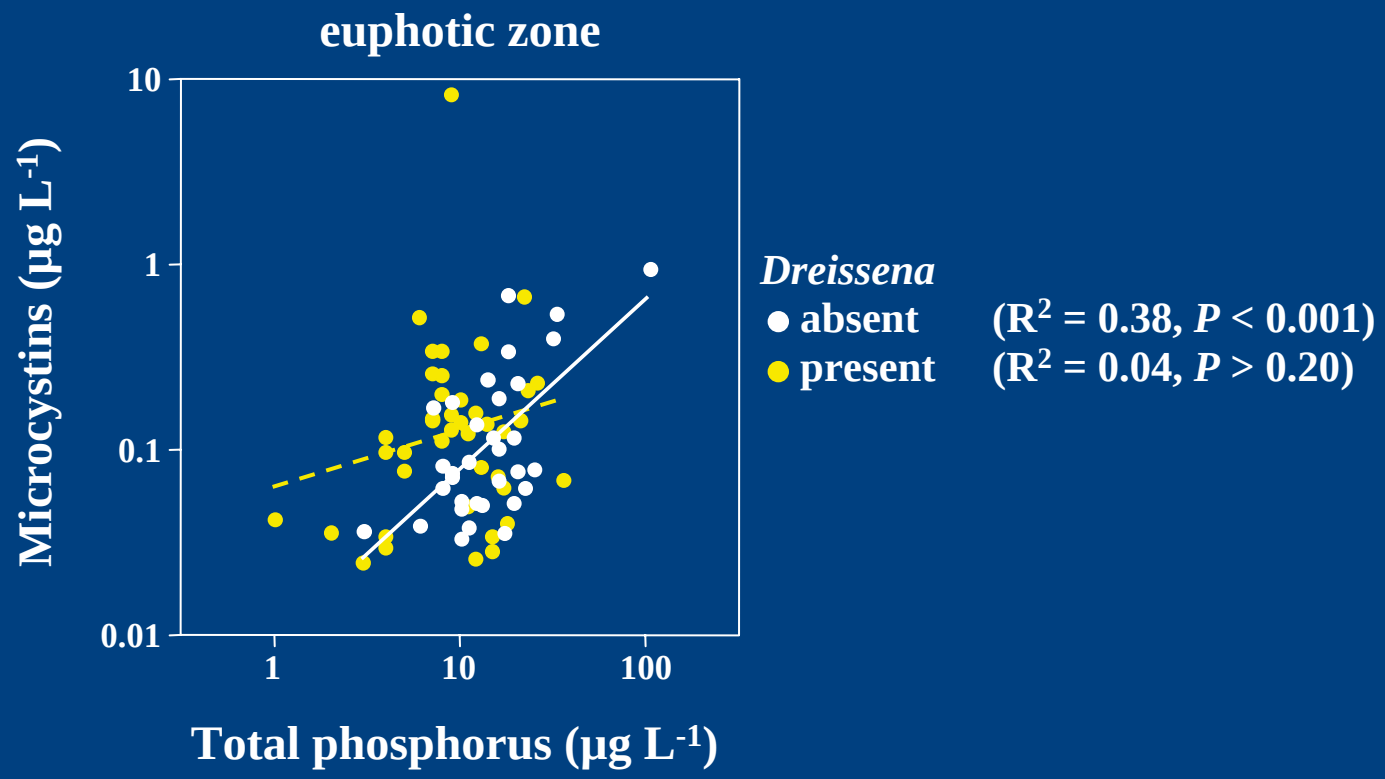




Knoll et al. (*in press*)

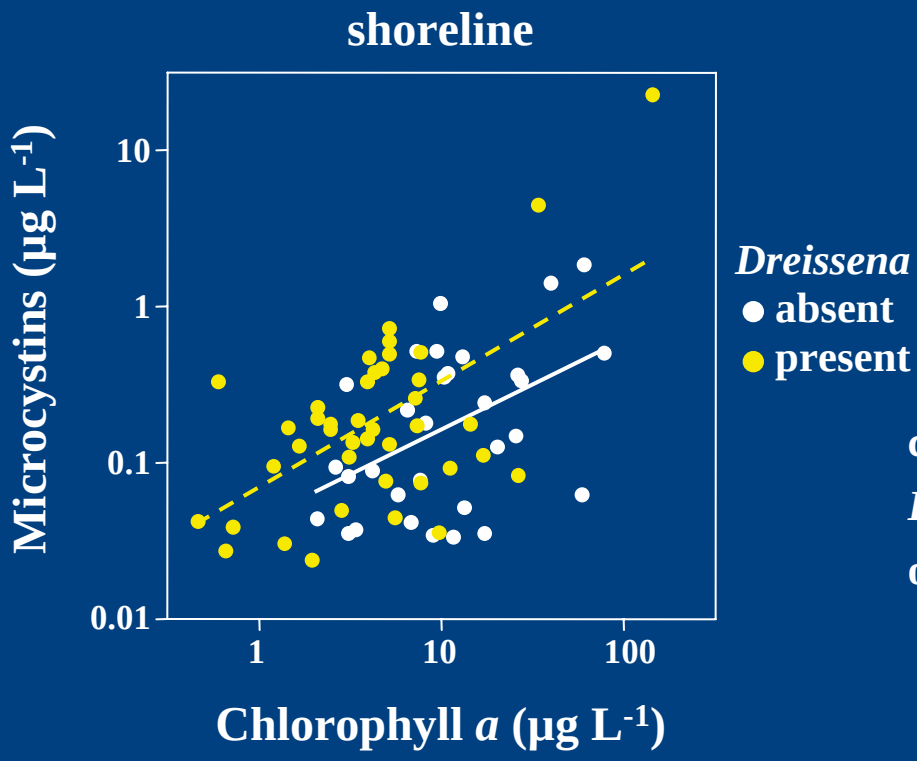
Citizens Monitoring Program

Survey Results



Citizens Monitoring Program

Survey Results



chlorophyll, $P < 0.0001$

Dreissena, $P < 0.02$

overall $R^2 = 0.29$

Conclusions

- citizen monitoring provides reliable data (TP, chl, microcystins)
- microcystins are ~3 times higher in invaded (*Dreissena*) than uninvaded lakes with low-moderate nutrients (TP < 25 µg L^{-1})
- microcystin levels are highly variable across invaded lakes (very few instances of levels above “safe” limits)
- no influence of other environmental variables (depth, area, latitude) on toxin levels were found
- microcystins increase with TP, but only in uninvaded lakes (need more data)
- shoreline chlorophyll levels might serve as an "early-warning" monitoring tool for microcystins (other cyanotoxins?) in the context of recreational risk