

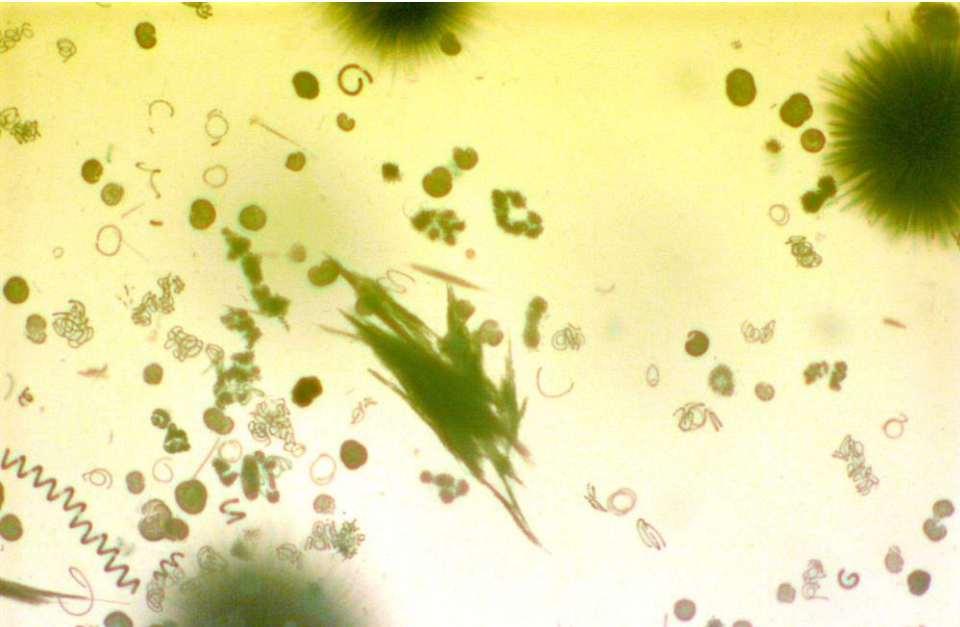
Algae 101: An Introduction to Harmful Algal Blooms

Greg Boyer

**State University of New York
College of Environmental Science
and Forestry, Syracuse, NY**



What are blue-green algae?

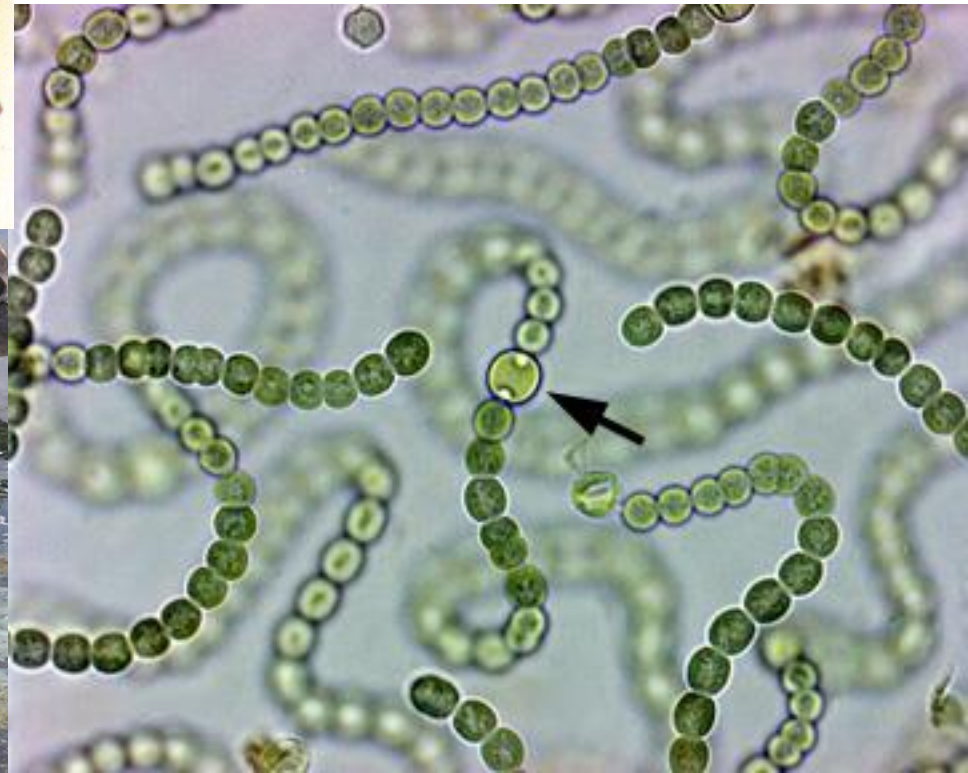


Specialized plant-like bacterium called Cyanobacteria

8000 species

3 billion years of evolution

not all are bad....





Blooms often concentrate at the shoreline or along docks.

Not every bloom or every scum is cyanobacteria. .



**Green (and Slimy)
Algae**

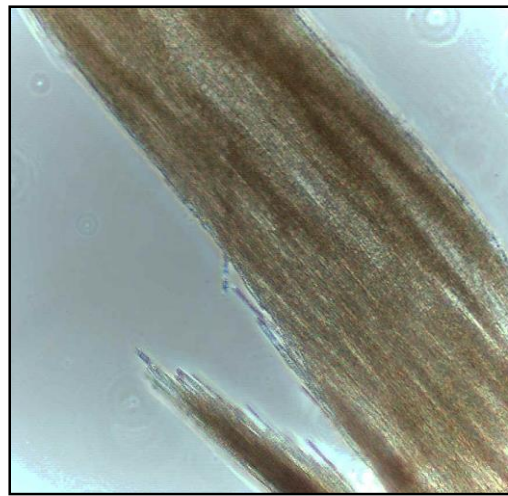


Spirogyra and
Mougeotia

Pretty easy to tell under a microscope...



Anabaena



Aphanizomenon



Microcystis

*Known to a generation of scientists as Anni, Fanni and Mike
(3 most common bloom-forming species)
NOT the three most common toxic species!*

Why do the algae grow?



LIGHT

NUTRIENTS

Nutrients (N,P) usually come from the land as run-off.



WARM TEMPERATURE

Water > 60 F



CALM WINDS



Seed Population



Algal GROWTH

GRAZING ↑ ↓



How do we prevent blooms?

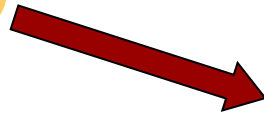
- We know the seed population is there
- Zebra mussels may promote blooms or “harvest blooms”, best bet is to keep them out of the system.



How do we prevent blooms?



LIGHT

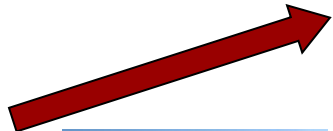


WARM
TEMPERATURE



Water > 60 F

CALM WINDS



Not much we can do about light, temperature and winds

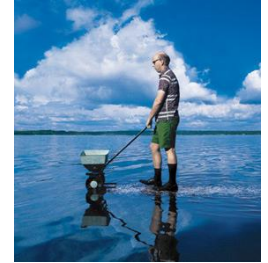


If anything – climate changes predicts we will have more calm days and warm falls (aka a longer growing season)

How do we prevent blooms?

NUTRIENTS

Nutrients (N,P) usually come from the land as run-off.



That brings us to nutrients.....

It is not the only thing important, it is the only thing we can control.

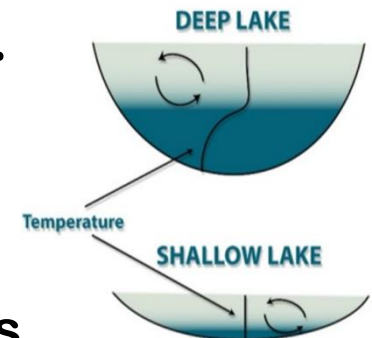
Algal GROWTH

Blue-green algae don't care what is the source of nutrients.
control both episodic and continual inputs

Why are they called Harmful?

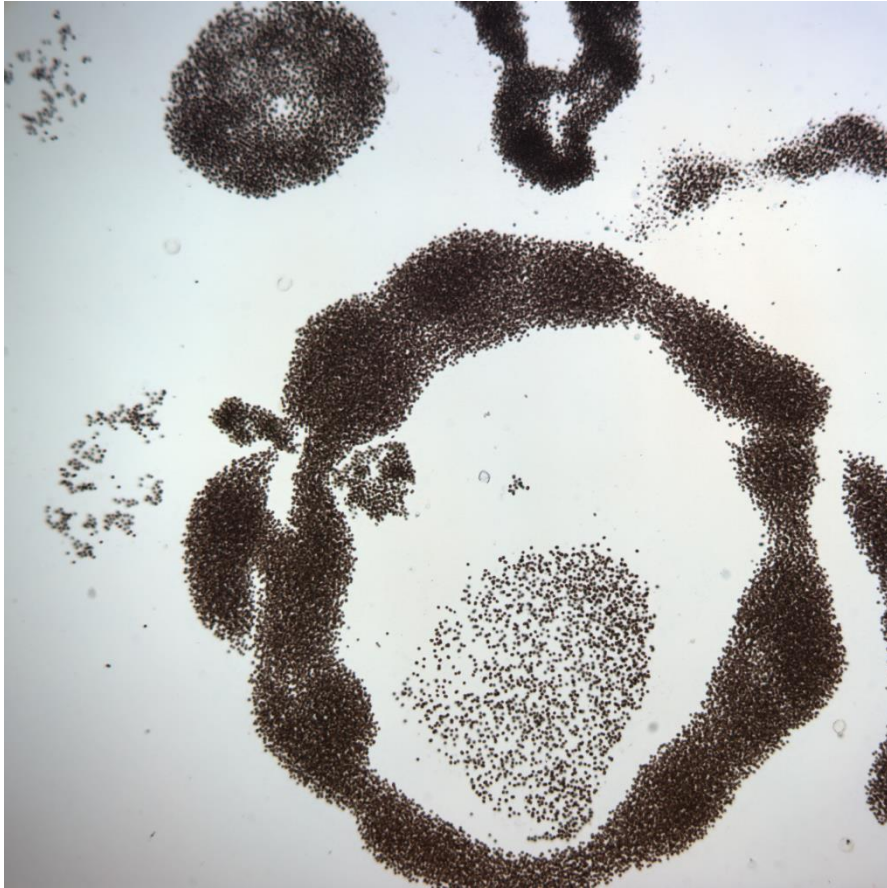


- Cyanobacteria are a common member of the aquatic flora!
- Some (not all) produce:
 - liver toxins (hepatotoxin).
 - Neurotoxins
 - Other nasty compounds
 - Swimmers itch
 - Alzheimer's-like agents.
- When they die – it uses up oxygen.



Especially important in stratified lakes

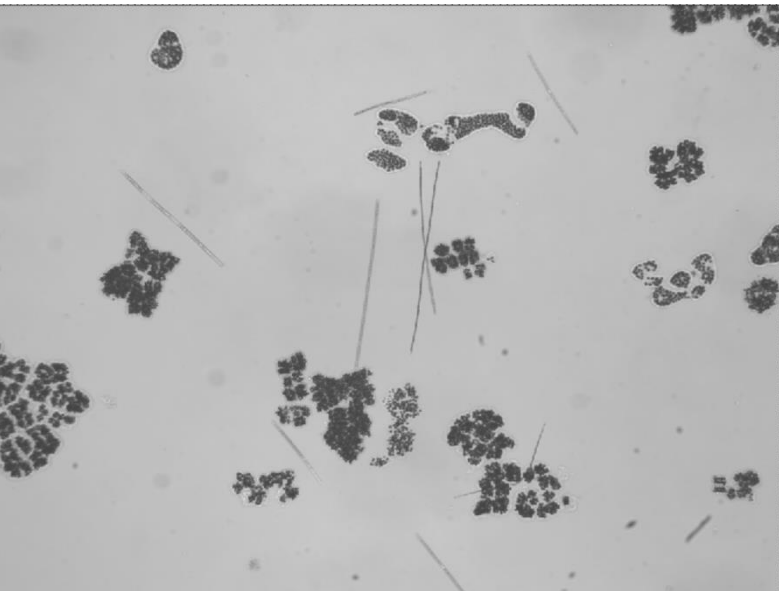
What is the difference between *Microcystis* and microcystins?



- *Microcystis aeruginosa*
 - non-N fixer.
 - Likes organic N
 - forms surface blooms
- Very common genera
 - Found in every water body
- Can exist in toxic, non-toxic and potentially toxic forms.
 - Liver toxin called microcystins
 - Cell wall may be allergenic to some.

Microcystins

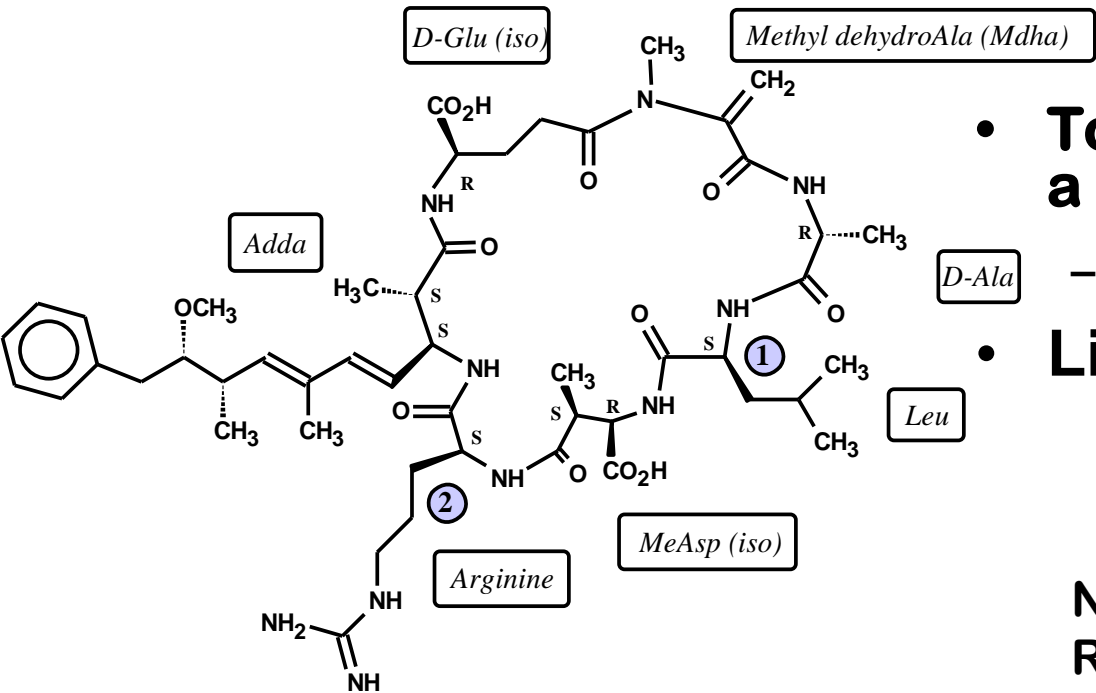
- Family of toxins made by
 - *Microcystis* species
 - *Anabaena* species
 - *Planktothrix* species.
 - *Nodularia* species (halophytes)



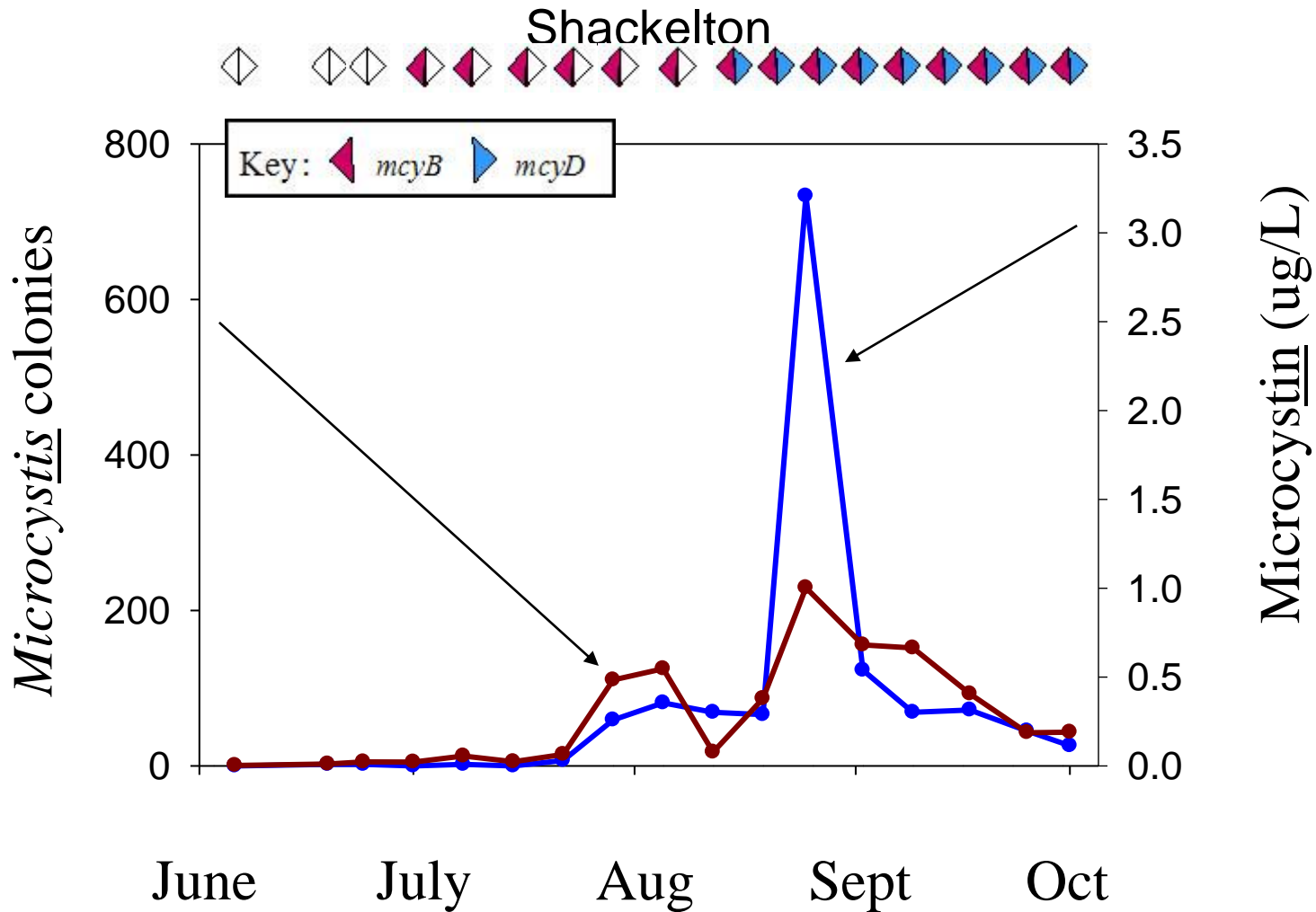
- **Toxic and non-toxic species a morphologically indistinct**
 - DNA tools can tell them apart.

- **Liver Toxin**
 - 0.3 -1.6 ug/L (ppb) in DW
 - 4 ug/L in recreational water

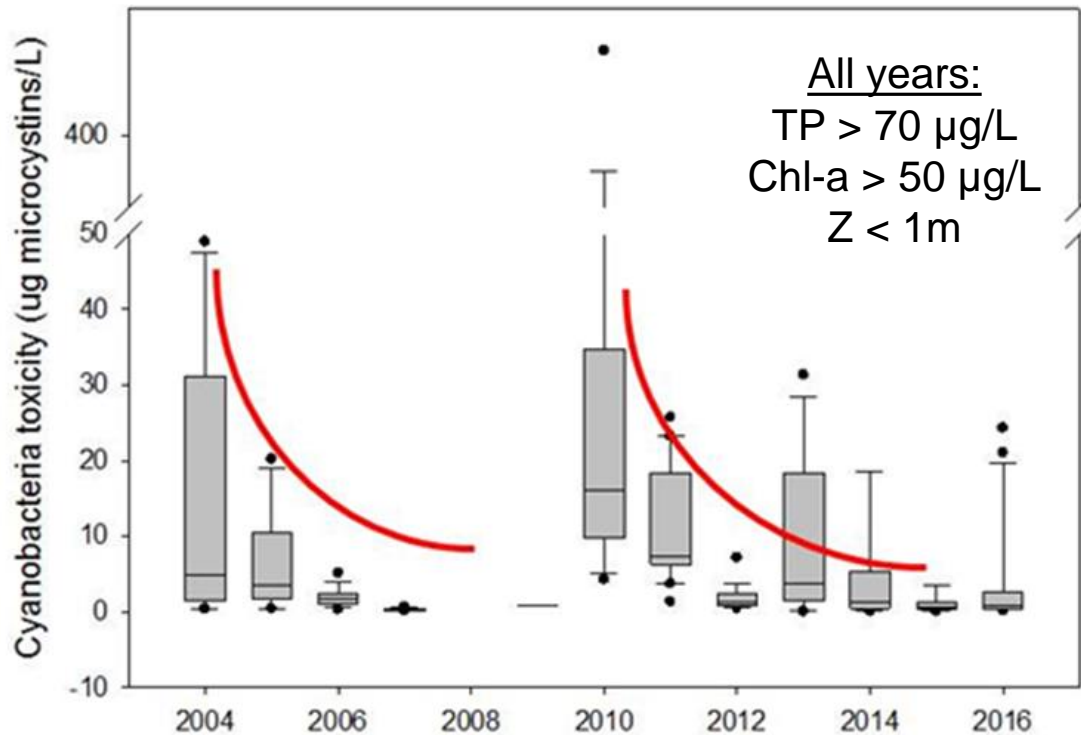
NOT Bio-accumulated
Rapidly metabolized



Toxin Production in Oneida Lake, 2003

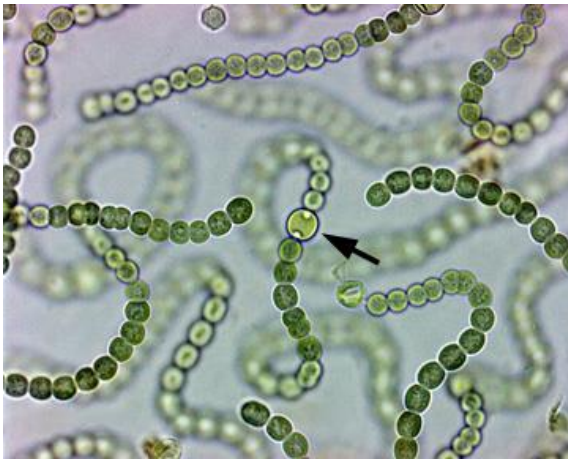


Phosphorus is important for algal biomass, but other factors are important for toxicity.



Factors that affect toxicity include:

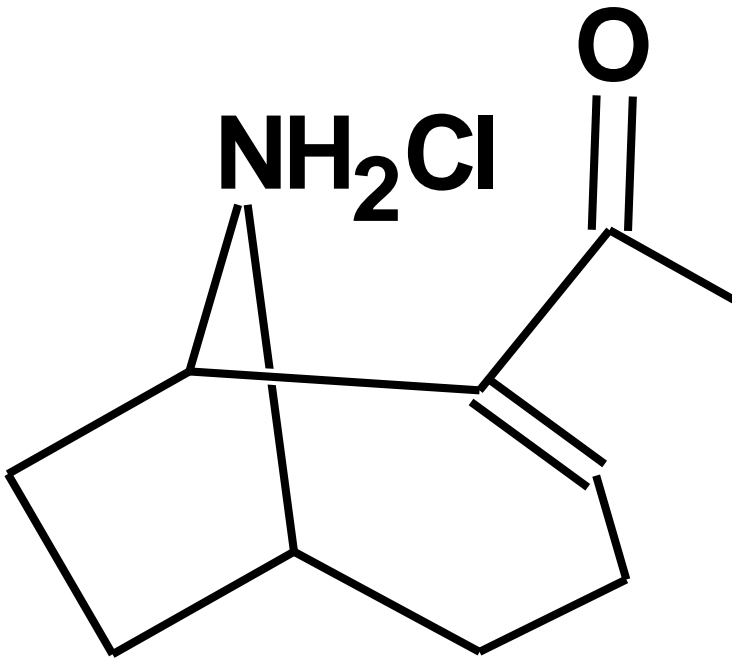
- Algal species
- Nitrogen, Iron
- Light
- Competition
- Bacteria



Anatoxin-a

- **Potent Neurotoxin.**
 - LD-50: 200 $\mu\text{g kg}^{-1}$ (less toxic?)
 - Smaller molecule, fewer types
 - Much less stable
 - Harder to collect and test
 - Responsible for a number of animal fatalities.

- **Causative organisms (?) include:**
 - *Anabaena species (many)*
 - *Dolichospermum*
 - *Oscillatoria sp.*
 - *Planktothrix / Aphanizomenon*
 - *Benthic sources (Phormidium?)*
 - *Different nutrient requirements*

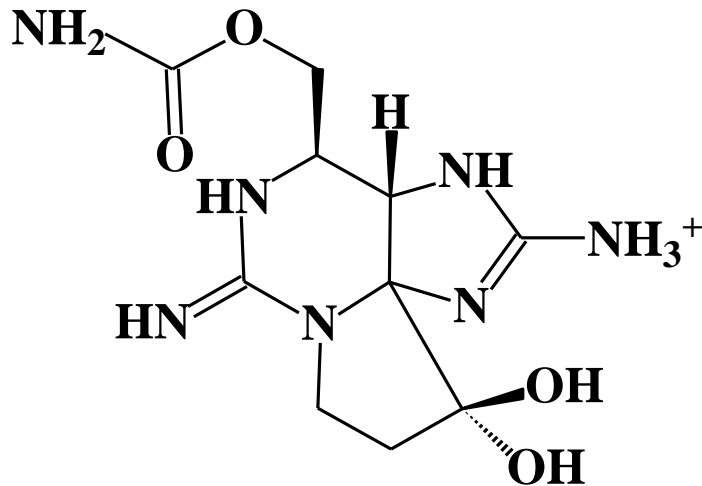




Paralytic Shellfish toxins



- Another Potent Neurotoxin.
 - LD-50: $10 \mu\text{g kg}^{-1}$ (more toxic)
 - Smaller molecule, many types
 - Responsible for a number of animal and human fatalities.
- Causative organisms (?) include:
 - *Anabaena species (many)*
 - *Dolichospermum*
 - *Oscillatoria sp.*
 - *Planktothrix / Aphanizomenon*
 - *Benthic sources (Phormidium?)*
 - *Different nutrient requirements*



Other toxins rare in CNY (but common on the internet!)

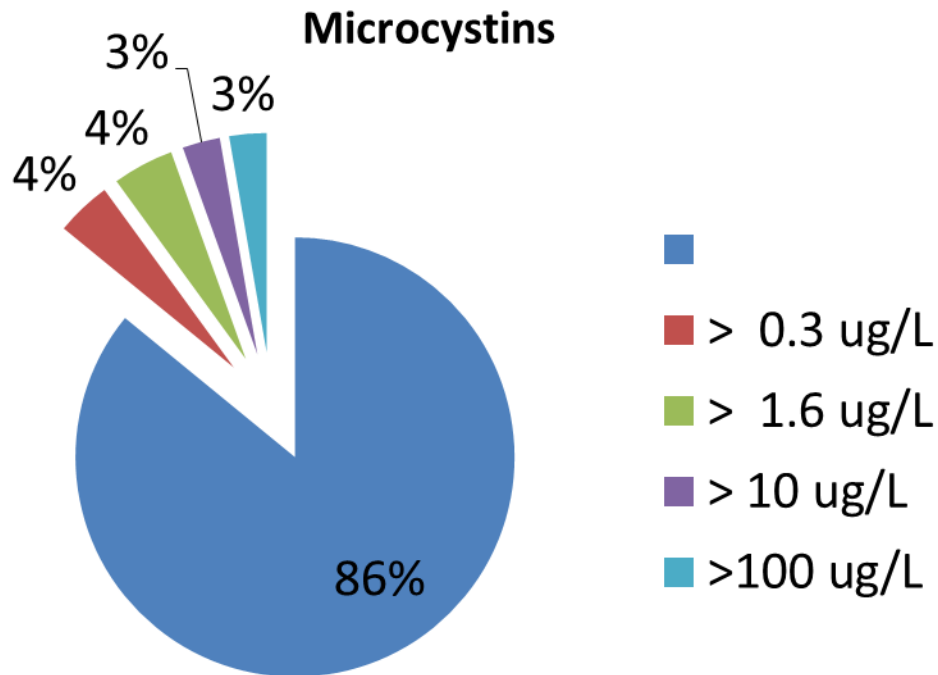
- Cylindrospermopsins
(Florida)
- β Methyl amino alanine
(ALS-like symptoms)
- Dermatotoxins
 - Allergic response to cells
 - Real dermatotoxin



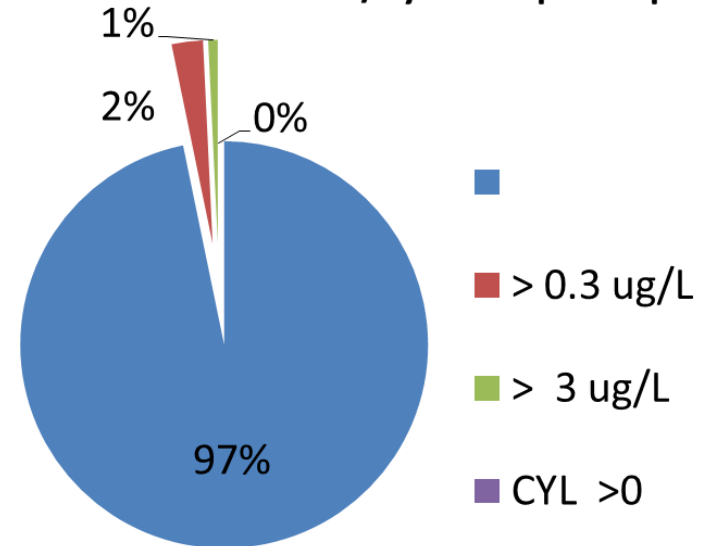
Lyngbya rash/blisters
- glboyer@esf.edu

Big Picture Overview of New York Lakes

Microcystins in about 14% of our samples



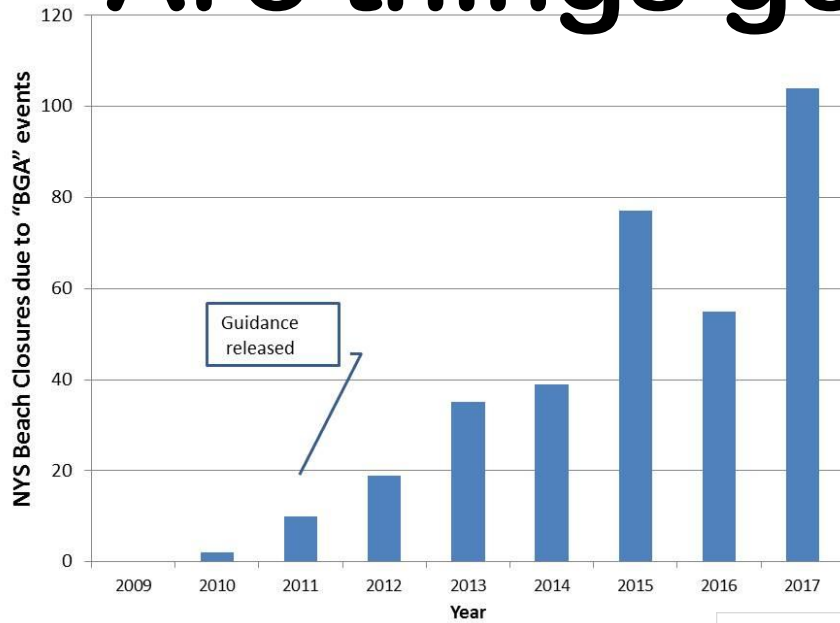
Anatoxins/Cylindrospermopsins



Anatoxin-a in about 3-4% of our samples

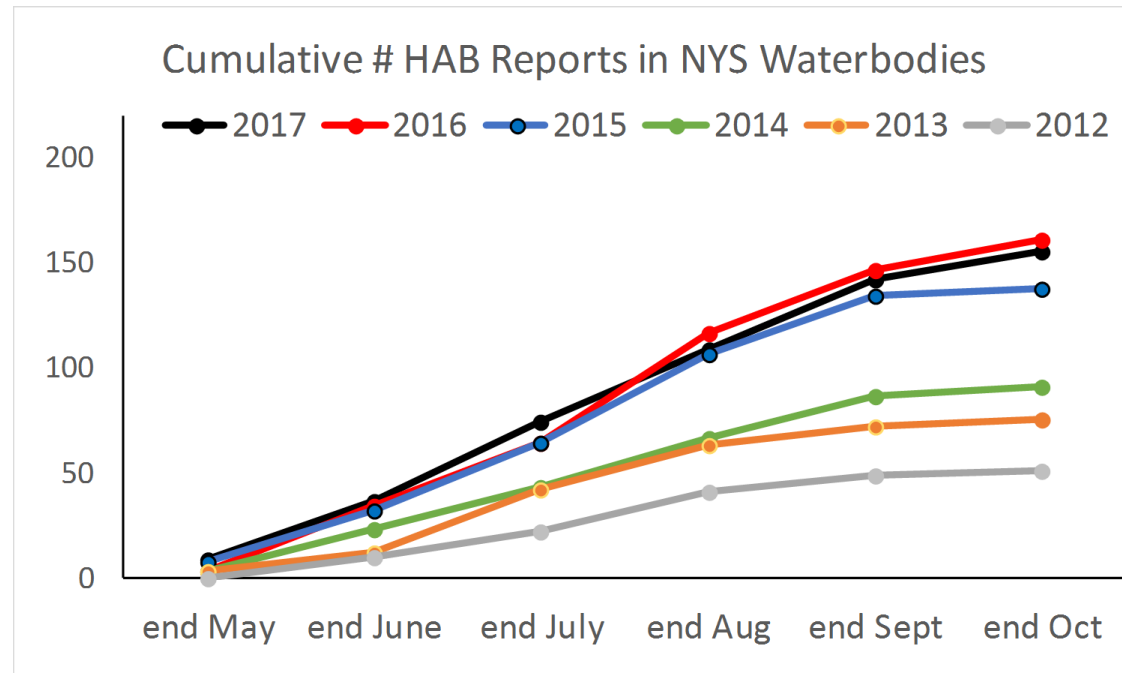
2015-2017 data; $n \sim 4800$

Are things getting worse?



Beach closures at NYS parks reported to the DOH have steadily increased;

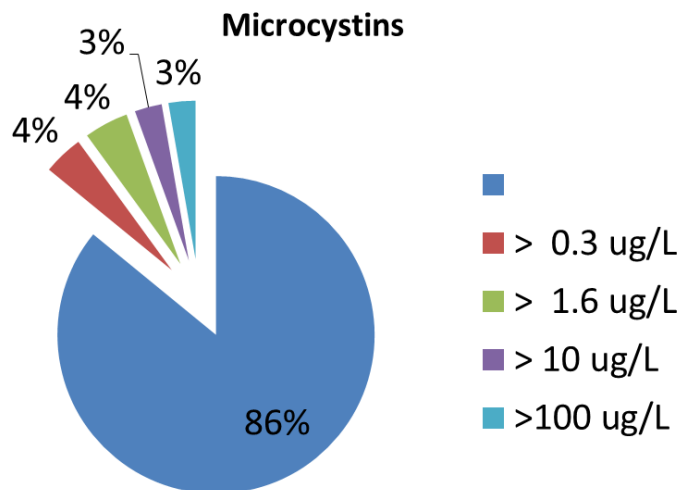
Over 160 water bodies were reported to the DEC HAB network last year;



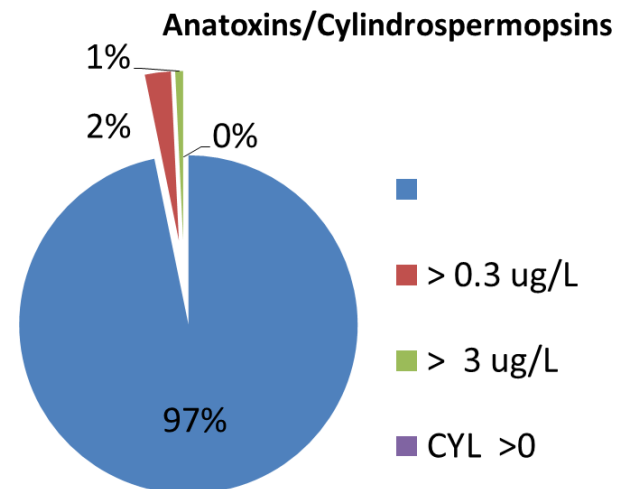
Lets talk a little about Indian River Lakes (Butterfield)

As a reminder

Microcystins in about 14% of our samples



Anatoxin-a in about 3-4% of our samples



2015-2017 data; n ~ 4800

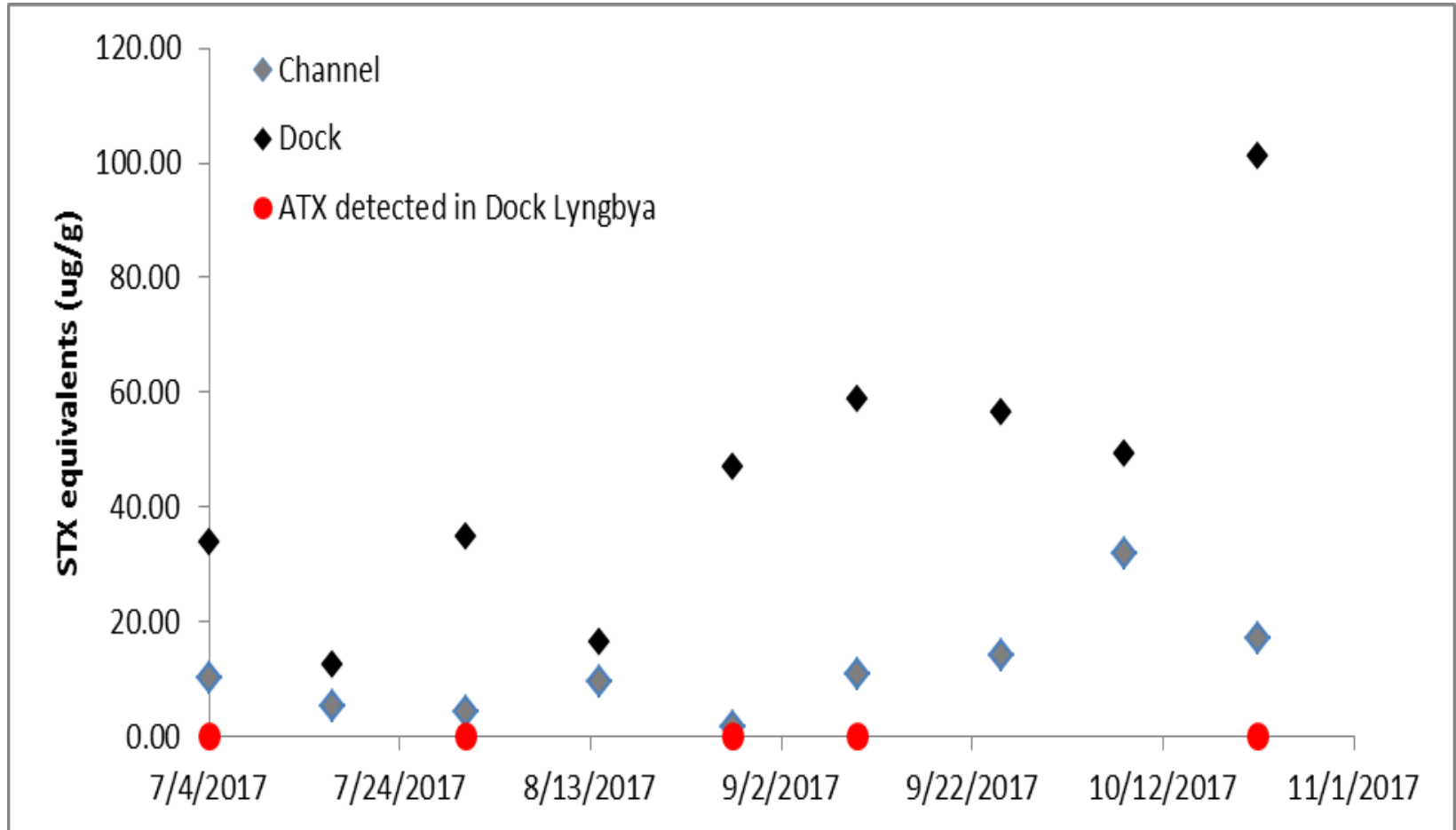
Microcystins in Butterfield Lake

liver toxins found in 50% of the lakes

Sample year	#	# positive	Range (ppb)	Median (ppb)	ATX?
2011	1	1	0.24	0.24	no
2012	8	4	0 - 0.5	0.45	no
2013 ϕ	13	5	0 - 6.0	1.5	no
2014	15	4	0 - 2.5	1.8	no
2015	8	0	<0.3	-	no
2016	8+8b	0	<0.3	-	2 (0.01)
2017	23	0	<0.3	-	3 (0.6)
2017ben	26	0	<0.2*	-	16 (0.2)*
2018	1	0	<0.3	-	no

** units in ug/gdw*

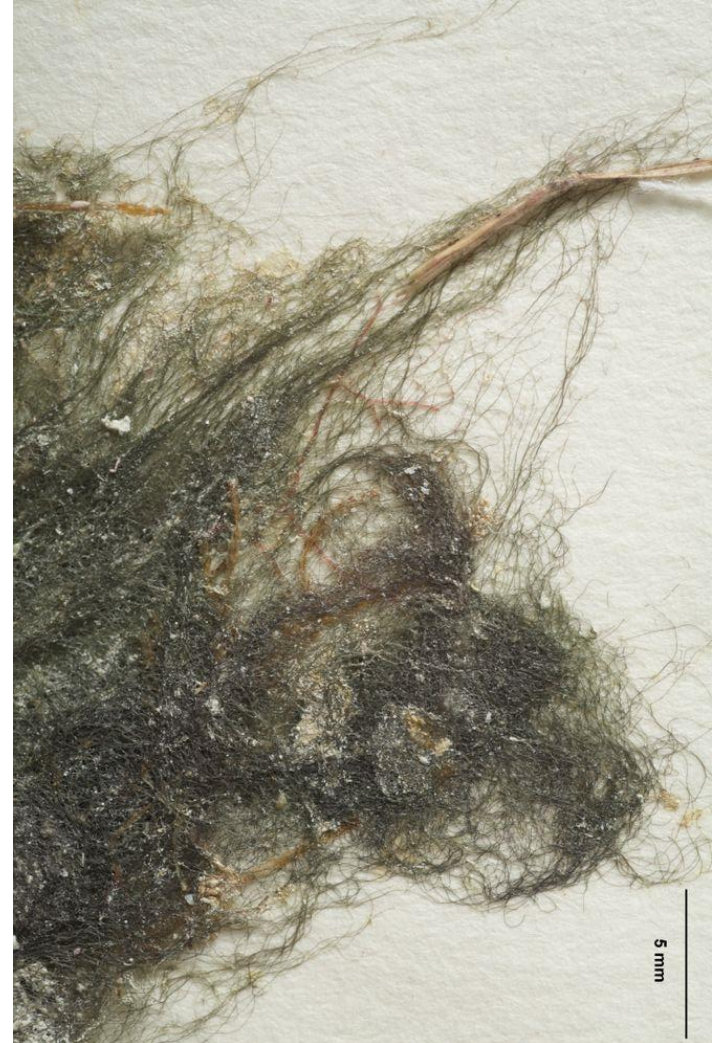
Benthic Algae in Butterfield



Summary

- Butterfield seems to be a unique lake or typical of an Adirondack lake
 - Minor pelagic cyanobacteria blooms
 - Little *Microcystis* or microcystins
- Concerned about localized benthic algae
 - Lead to rashes upon contact
 - Production of neurotoxins such as PST
- Very different management scenario
- Very poorly understood.

Typical Lyngbya pics



Lets keep things in perspective

“And all the waters that were in the river turned to blood. And the fish that were in the rivers died; and the river stank, and the Egyptians could not drink the water of the river, . . .”

Exodus 7:20-21

- Blooms are not new.
- Long term solution is by nutrient control.
- Avoid contact as you cannot separate good from bad blooms by looking.
- Careful of pets and small children.
- Enjoy your lake (outside of the bloom)

Glboyer@esf.edu

