

# Canandaigua Lake – the 15 questions in 30 min everything you wanted to know about toxic algae but were afraid to ask talk.

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**SAFETY NOTICE**  
UNTREATED LAKE WATER MAY CONTAIN  
BLUE-GREEN ALGAE WHICH COULD CONTAIN  
BACTERIA AND TOXINS WHICH CAN  
CAUSE ILLNESS IF CONSUMED  
PEOPLE AND PETS SHOULD AVOID CONTACT WITH WATER  
THAT IS DISCOLORED OR HAS SCUMS ON THE SURFACE.  
IN THE EVENT OF SKIN, EYE OR THROAT IRRITATION,  
ALLERGIC REACTIONS OR BREATHING DIFFICULTIES,  
STOP CONTACT WITH THE WATER  
AND SEEK MEDICAL ATTENTION  
NEVER DRINK LAKE WATER  
REPORT ANY CONCERNS TO THE CAMPGROUND OFFICES  
OR THE OSWEGO CO. HEALTH DEPT. 349 3564

**NO SWIMMING**

**KEEP PETS OUT OF WATER**

REPORT DEAD WILDLIFE TO ANIMAL CONTROL  
598-4504



# Q1. Who am I?

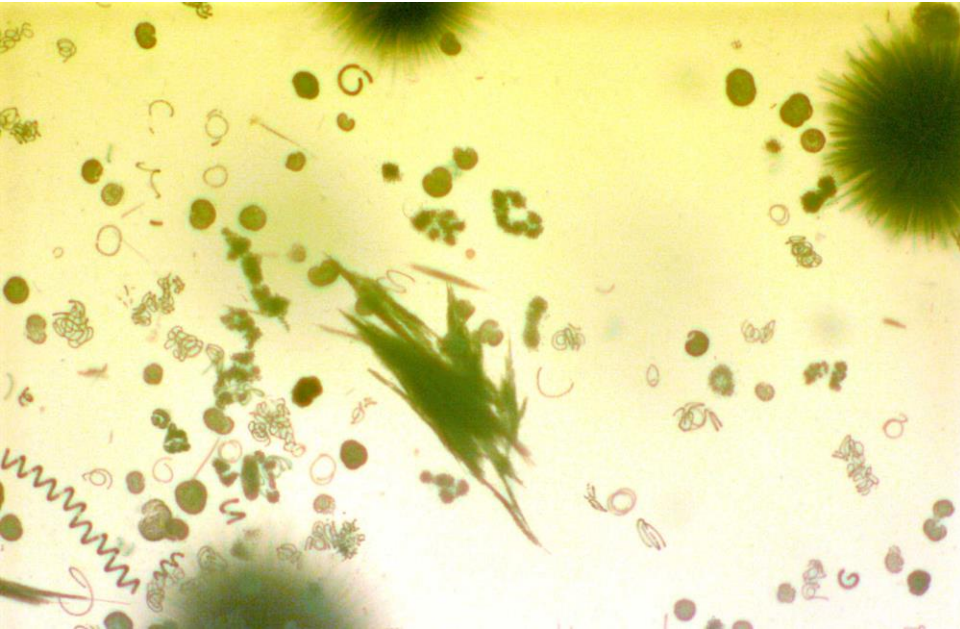


- Professor in Chemistry Department at SUNY-College of Environmental Science and Forestry (Syracuse)
  - Member water quality group
- Director of the Great Lakes Research Consortium (18 Universities)
- Research Scientist on Algal Toxins
  - 40 years experience (worldwide)
  - Analytical Chemist for CSLAP
  - NOAA Rapid Response Lab
  - Environment Canada toxins team
  - NYSDOH, WDOH, CDC, etc.

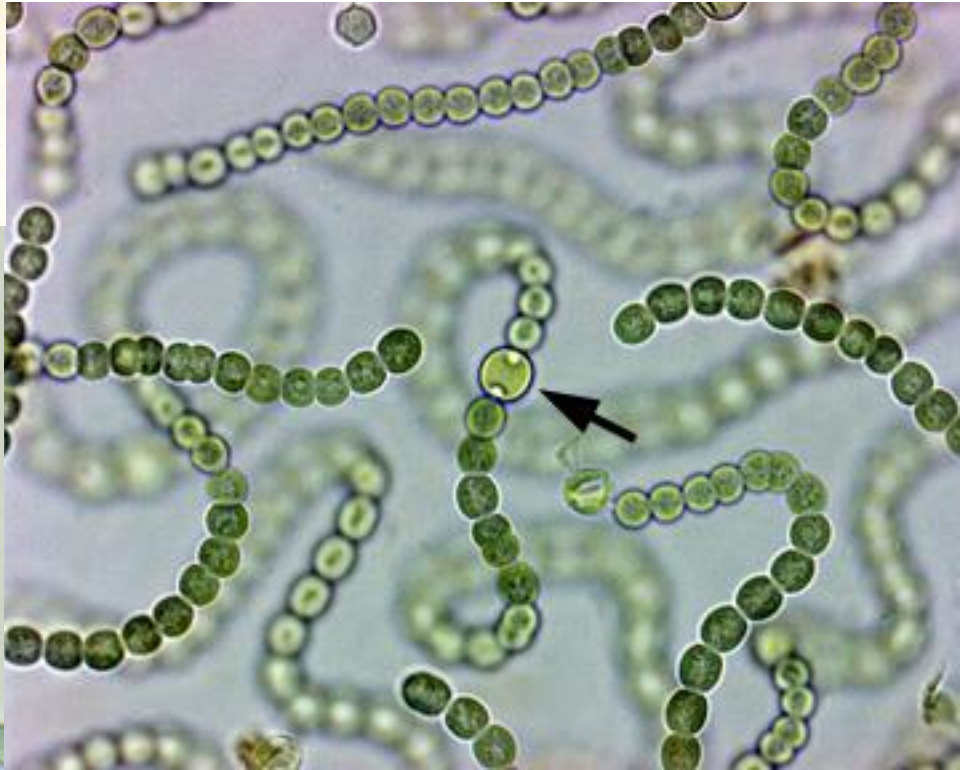
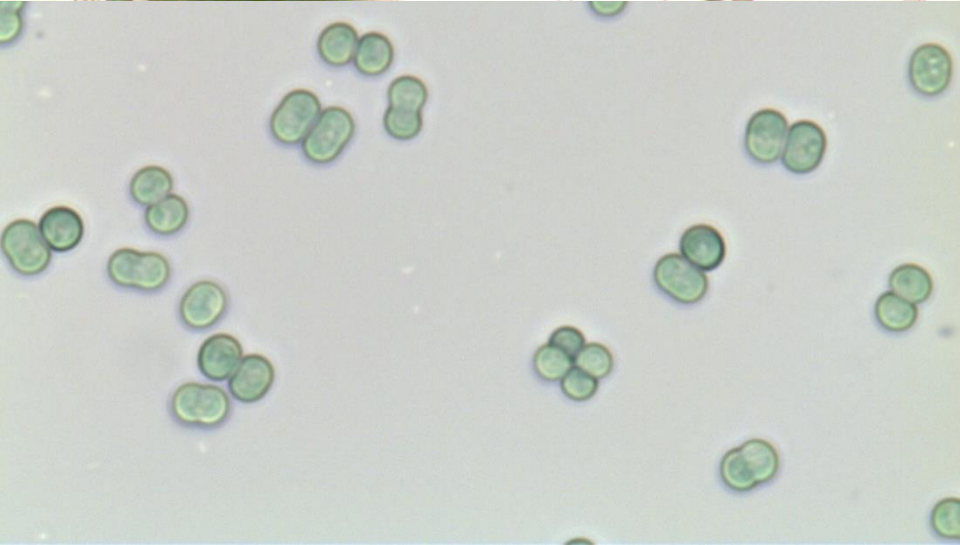


Interested in why algae produce toxins.

## Q2. What are blue-green algae?



Specialized photosynthetic prokaryote (bacteria) called “Cyanobacteria”



# Q3. What is a Harmful Algal Bloom (HAB) and can I recognize it?

Blue and white crust forming on bloom that is decaying



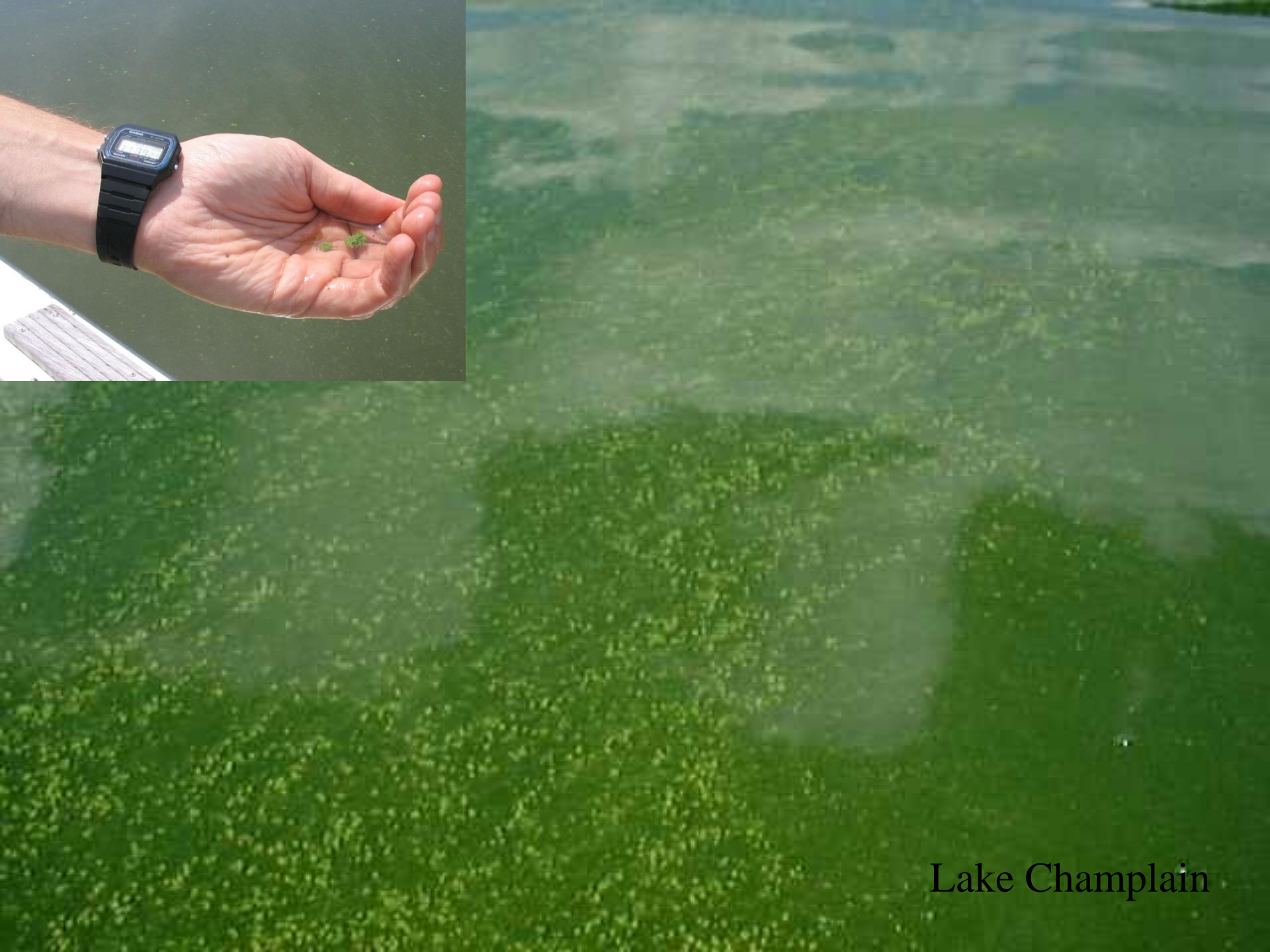


Blooms often concentrate at the shoreline or along docks.



Blue tint within algae bloom

Small cells spread throughout the water column



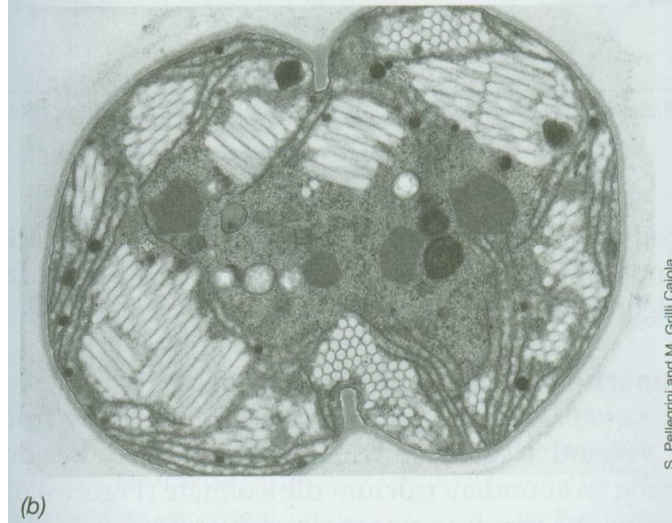
Lake Champlain

# Blooms form surface accumulations



A. E. Walsby

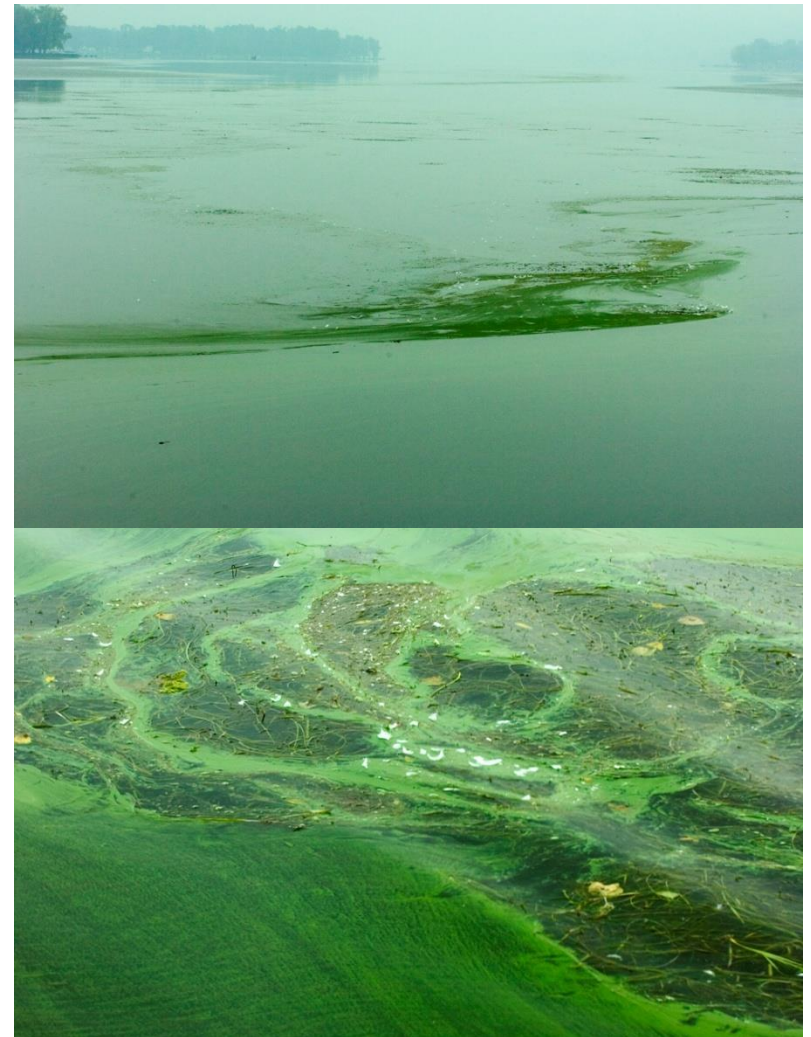
(a)



S. Pellegrini and M. Grilli Calola

(b)

## Conesus Lake



## Gas vesicles in *Anabaena* and *Aphanizomenon*

**Not every bloom or every scum is cyanobacteria. .**



**Green (and Slimy)  
Algae**



*Spirogyra* and  
*Mougeotia*

# Duckweed (higher plant)



# Pollen (higher plants)



A. Shambaugh 2005



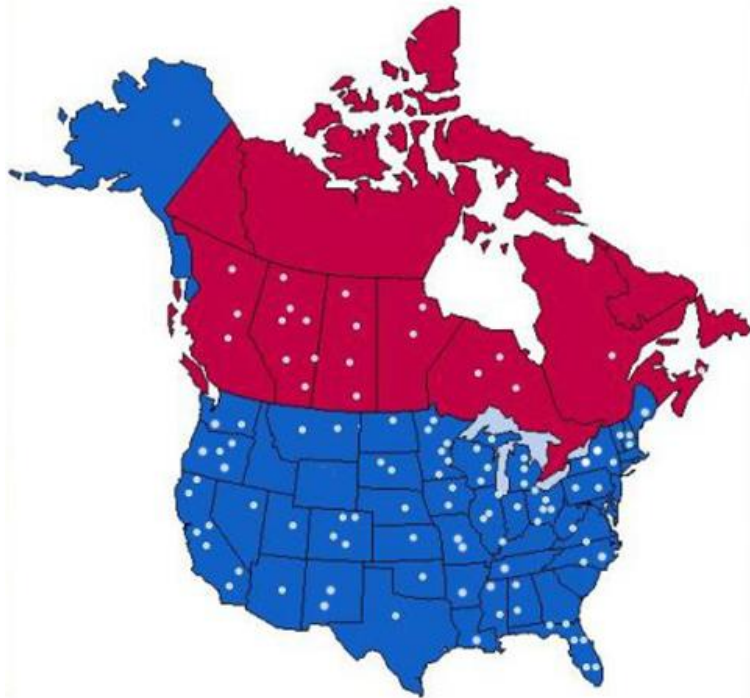
# Probably not cyanobacteria if...

- Material is bright green in color
- Consists of long cohesive strands
- Is attached to rocks, debris or the sediment surface rather than free-floating
- Has leaves or other “structures”

**Point – Can not be sure it is cyanobacteria without looking under a microscopic.**

# Q4. Are harmful algal blooms (HAB) unique to our area?

Documented HAB Outbreaks  
in North America



**No!**

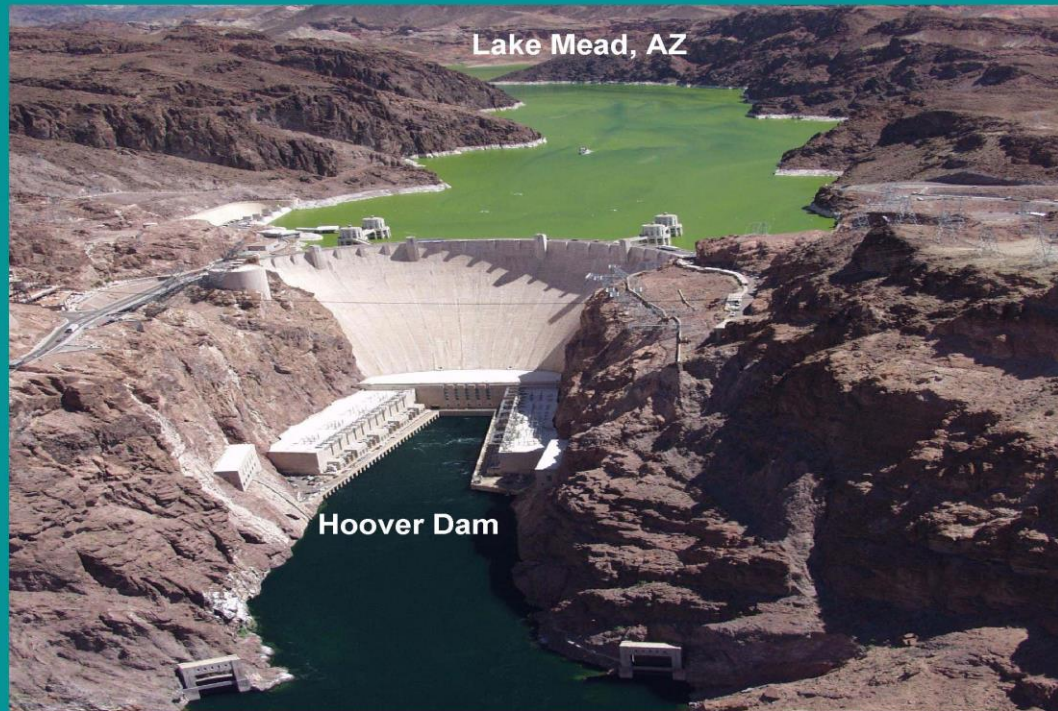
*“And all the waters that were in the river turned to blood. And the fish that were in the rivers died; and the river stank, and the Egyptians could not drink the water of the river, . . .”*

***Exodus 7:20-21***

Hamilton Reservoir, Platte River Power Authority, Fort Collins, CO



Tai Hu, China



# Q5. Why do algae grow?



LIGHT

NUTRIENTS

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



WARM TEMPERATURE

Water > 60 C



CALM WINDS



Seed Population

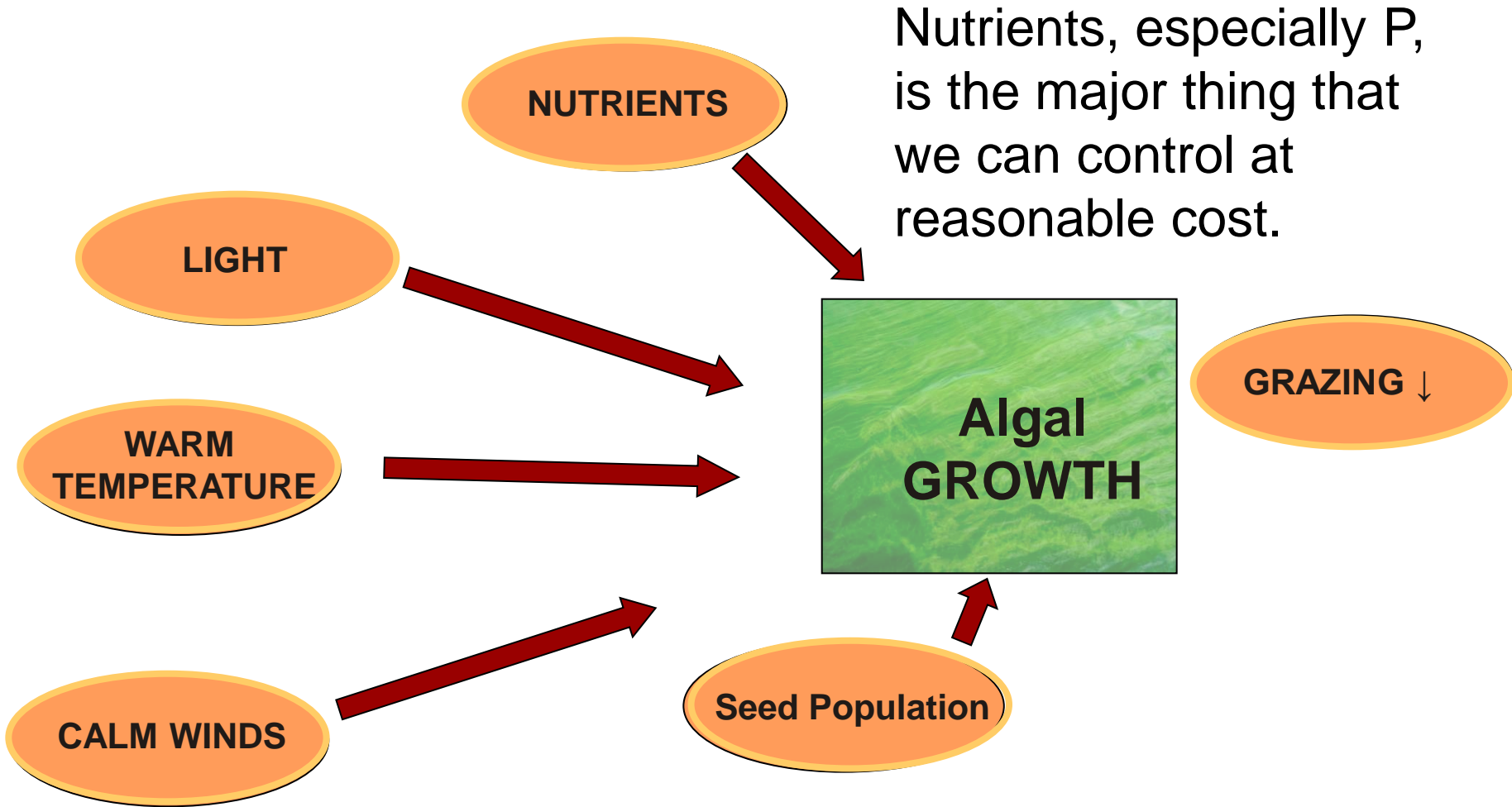


Algal GROWTH

GRAZING ↑↓

Many of these factors will increase in current climate change models.

# Q6. What can we do about it?



# Q7. Are blue-green algae harmful?



**Yes!**

**Some (not all) can produce:**

- **liver toxins or heptotoxins.**
  - **Neurotoxins**
  - **Other very nasty compounds**
    - **Swimmers itch**
    - **Alzheimer's-like agents.**
- When they die – they use up oxygen.**

# Q7. Has anyone ever died from these toxins?

**Not in the US. Most affects are with animals:**

.....associated with the *Anabaena Flos-aquae* bloom were estimated deaths of 5000-7000 gulls, 560 ducks, 400 coots, 200 pheasants, 50 squirrels, 18 muskrats, 15 dogs, 4 cats, 2 hogs, 2 hawks, 1 skunk, 1 mink, plus numerous song birds.

Storm Lake, Iowa, 1952

# Q8. Has anyone ever gotten sick in the US from blue-green algae?

## Absolutely!



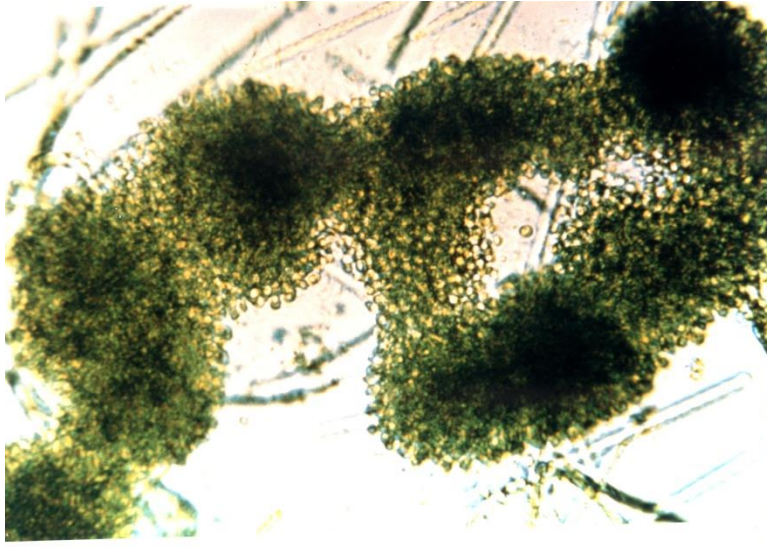
**Coroner Cites Algae in Teen's Death . . .**

**Experts are Uncertain About Toxin's Role**

*September 2003*, After a yearlong investigation, the Dane County, WI coroner has concluded that the....

- 1930: *Microcystis* bloom on Ohio and Potomac Rivers caused intestinal illness in 5,000-8,000 people.
- 1980: Several cases of illness in Pennsylvania following a bloom.
- 2004: Approximately 50 people reported illness following exposure to toxic cyanobacterial blooms in Nebraska lakes and reservoirs.
- 2010: Seven people ended up in the Toledo hospital following exposure to toxic cyanobacteria in Grant Lake St. Marys (Ohio).
- 2014: Toledo – hundreds of people called into the hospital due to BGA toxins even though the levels were well below any health effects

# Q9. Tell me more about the *Microcystis* and microcystins



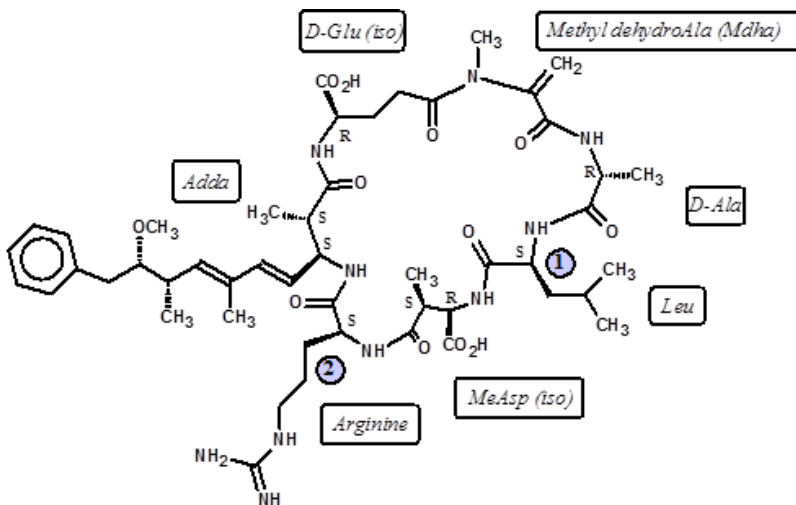
- *Microcystis aeruginosa*
  - non-N fixer.
  - Likes organic N
  - forms surface blooms

- Very common genera
  - Toxin also produced by a number of other species.

- Large variation in toxins
  - 100+ structural variants + 500 toxin-like peptides

- Microcystins are liver toxins (LD<sub>50</sub>: 25-60 μg kg<sup>-1</sup>)

- Toxin is very stable to boiling



# Q10. What is our Government doing to protect us?

> 1-2 ppb microcystin



20 ppb microcystin for recreational contact



US EPA uses 1.6 ppb (ug/L) as the advisory level in drinking water for adults



# Q11. How do we make up these numbers?

## Toxicology test:

## How is it get interpreted?

- Feed a known amount of toxin to a rat/mouse/pig.
- Determine the NOAEL (no observed adverse effect level)
- Multiply by 10 (species)
- Multiply by 10 (populations)
- Multiply by 2-10 (just because)
- Back calculate to safe level for consumption assuming:
  - 1.6 liters/day for 365 d/yr for life
  - 100 g (3.5 oz) contaminated fish/d for 365 days



Over 1 ppb!  
I am going to die!

# Another example



- $LD_{50}$  microcystin LR =  $50\mu\text{g}/\text{kg}$
- 40 lb lab (18kg)
- 1 ppb toxin in water
- =  $900\ \mu\text{g}$  (almost 1 mg)
- Dog must drink 900 liters of water to consume enough toxin for acute toxicity

**Take home message:**

**Dogs do not die from drinking the water**

# Q12. How does an animal die from cyanobacteria toxins?

## Possible reasons are:

- Only source of drinking water.
- Concentration is  $\gg 1$  ppb.
  - Wind borne accumulations
    - Worry about shoreline blooms
  - Animal itself concentrates the toxin
    - Foodweb and diet
    - Behaviors
- You have a more potent toxin.

Does it matter? If people perceive that the water is tainted, the economic loss can be huge!



# Q13. How common is toxic *Microcystis* in New York?

(very!)

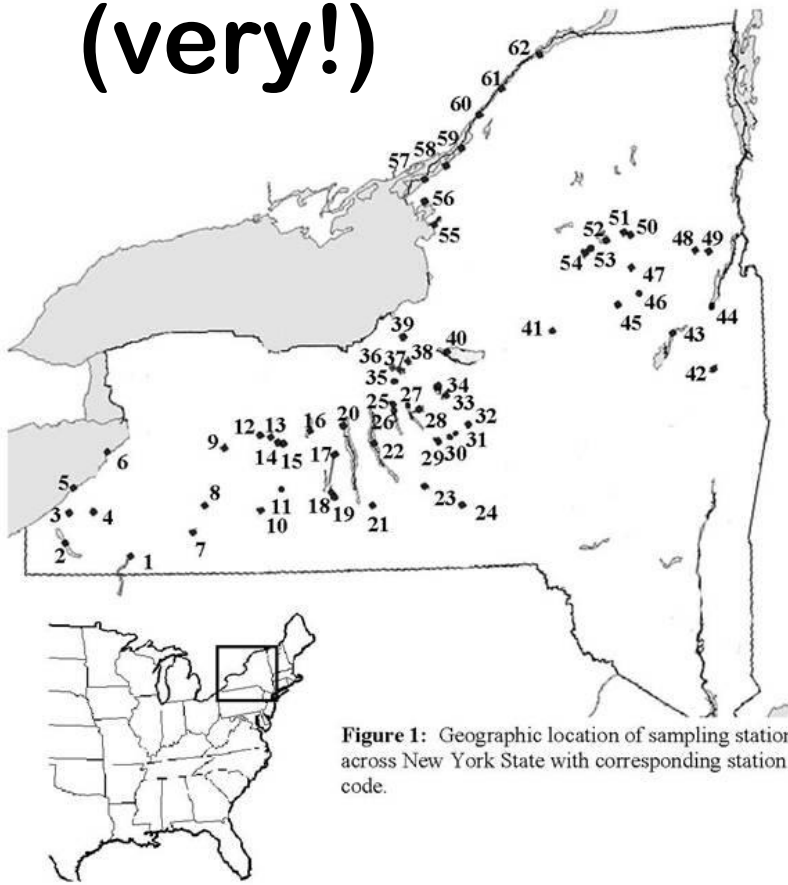


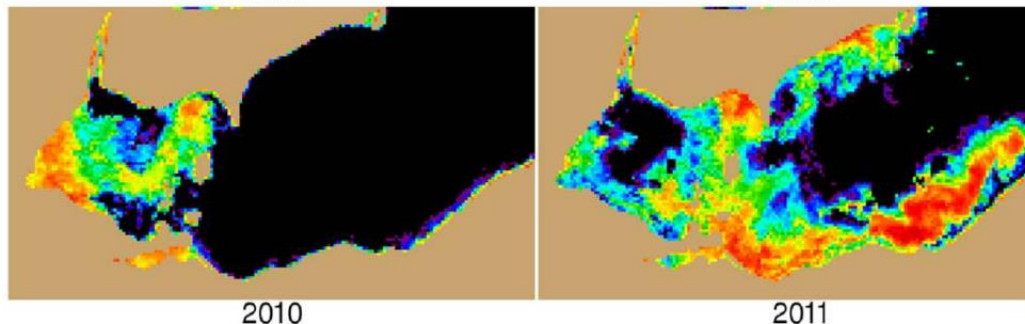
Figure 1: Geographic location of sampling stations across New York State with corresponding station code.

- Microcystins are very abundant in NYS.
  - Half of our samples tested have the potential to make toxins.
  - About half made toxin.
  - About **10-15%** of samples are at a level of concern.
- Neuro-toxins occur but are very rare (< 1-5%).
- Many species make toxins (not just *Microcystis*).
- potential ≠ production

# Q14. Can we predict when a bloom is going to occur?

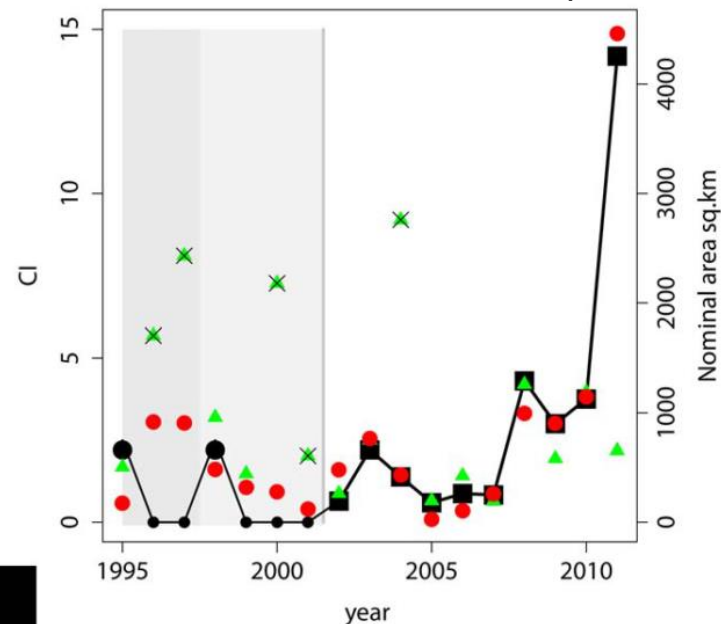
## Probabilistic models:

Statistical analysis tool that estimates, on the basis of past (historical) data, the probability of an event occurring again.



## NOAA's Lake Erie Model

Stumpf et al 2012



Black: Observations  
Red: March-May TP  
Green: June TP

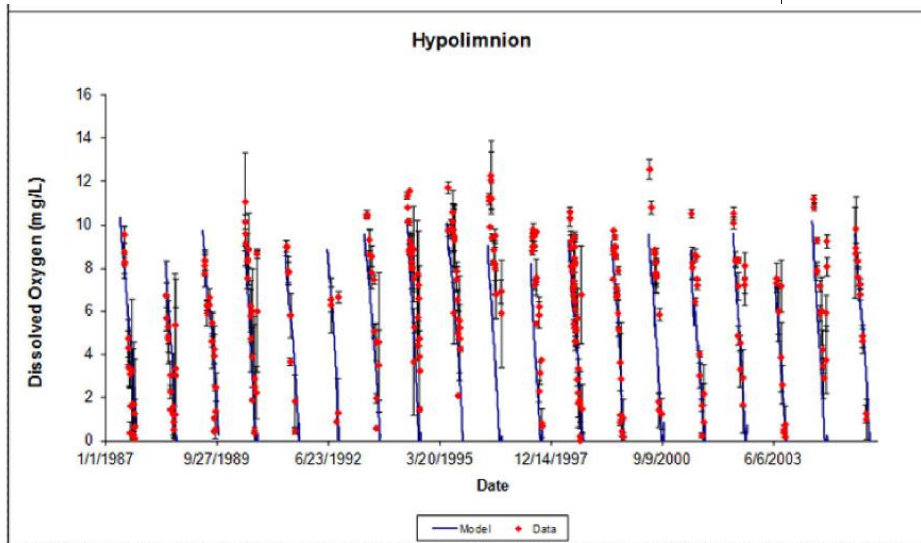
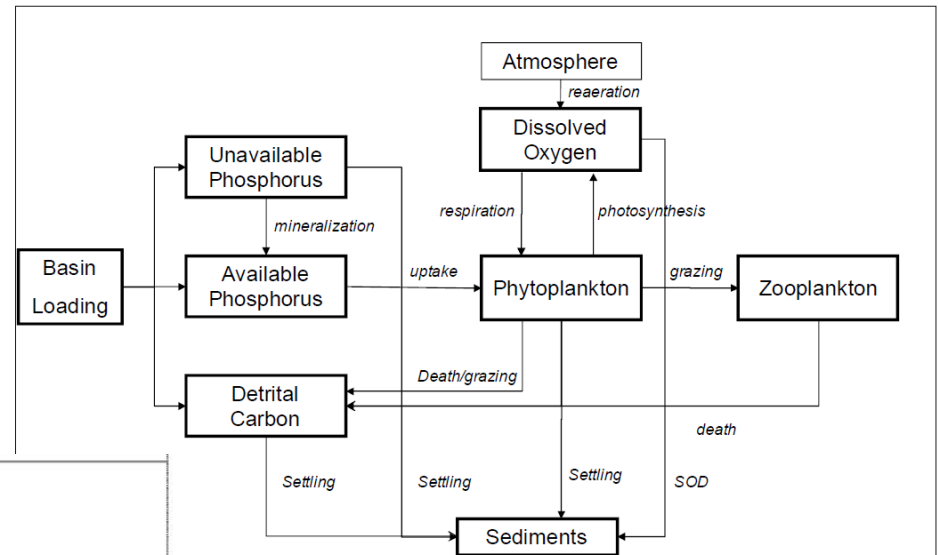
*Take Home message: Western Lake Erie HABs follow spring TP*

# Q14. Can we predict when a bloom is going to occur?

## Deterministic models:

The outcome of the model is determined by the parameter values (rates) and the initial conditions.

## ECOFORE Lake Erie Hypoxia



Deterministic models can predict chemical parameters pretty well

# Deterministic Model for Sodus Bay, Total Chlorophyll

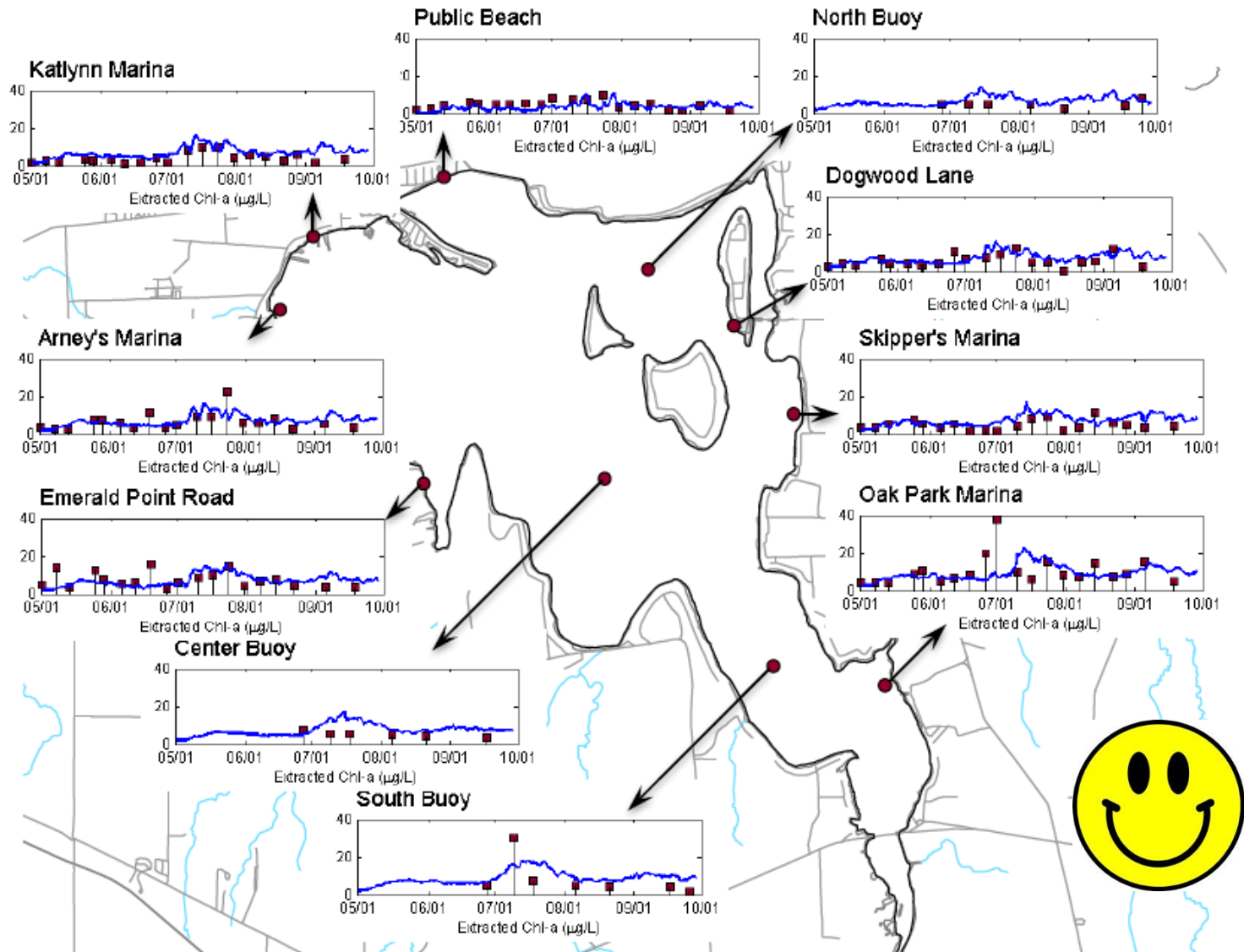
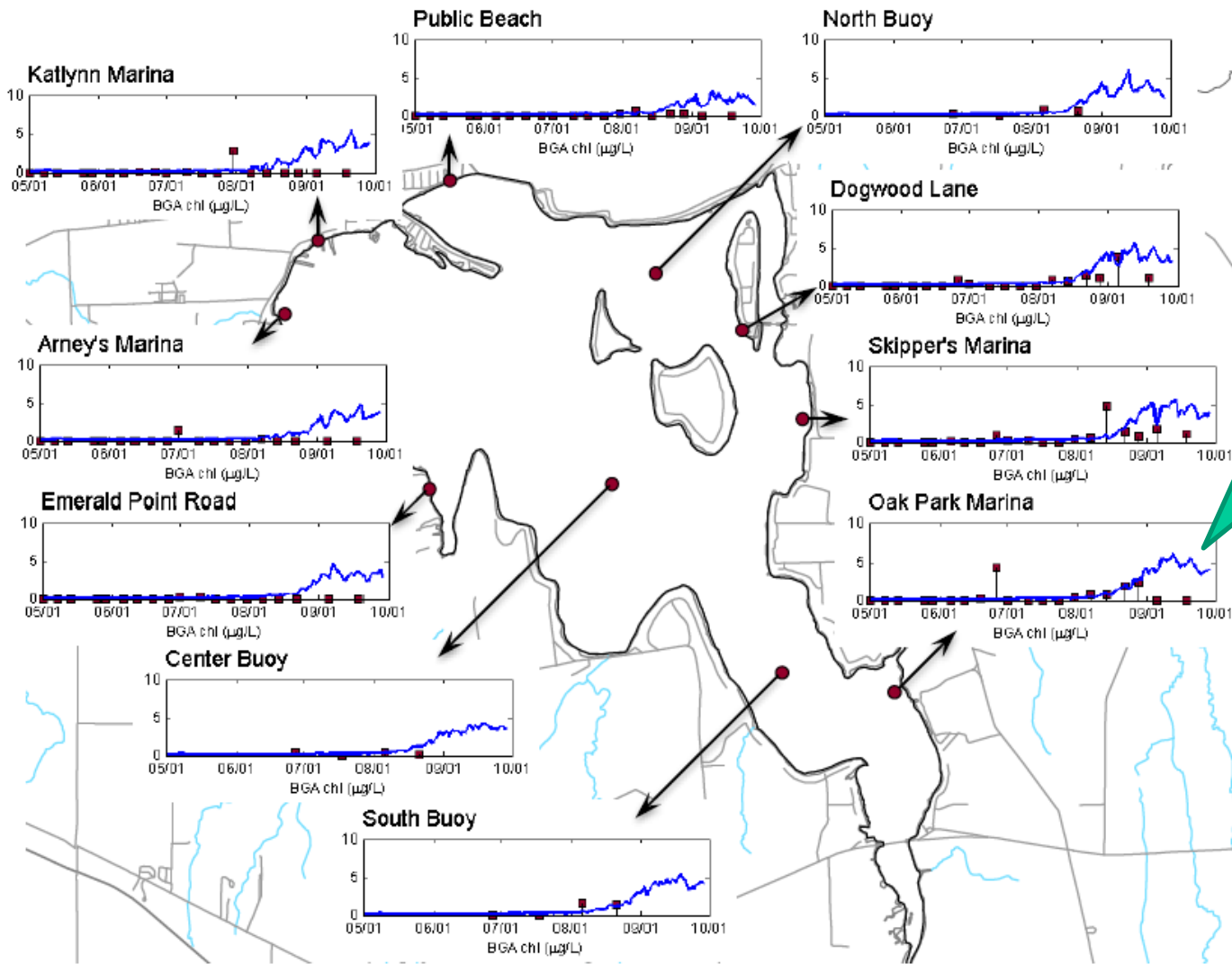


Figure 24. Measured (red stems) and modeled (blue lines) chl in  $\mu\text{g/L}$  over time in 2013.

# Deterministic Model for Sodus Bay Cyanobacteria



Current models do not capture End-of-summer BGA blooms

FYI – this takes a lot of time and data:  
4 buoys  
900 samples



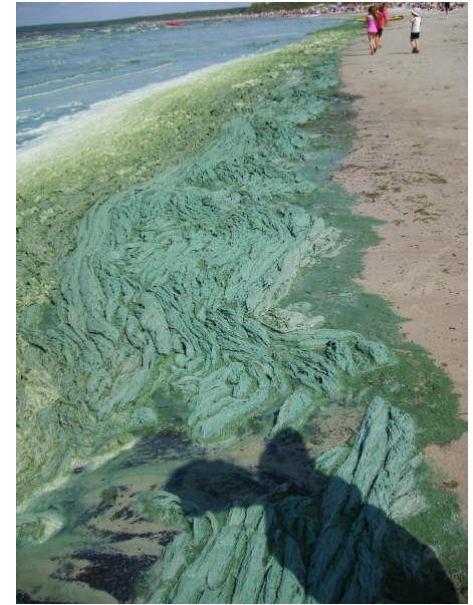
Figure 25. Measured (red stems) and modeled (blue lines) BGA chl in  $\mu\text{g/L}$  over time in 2013.

# Q15. What do I do if I see a bloom?

1. Remember not all blooms are toxic.
2. If it is a bloom, don't drink the water. Avoid contact with scums.
3. Be very careful of surface accumulations where the algae may pile up on the beach.

Be careful that young children don't "eat" the seaweed.

4. If your pet gets into the water, wash them off with clean water from a hose.



# Q16. Do you have questions for me?

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