Harmful Algal Blooms in New York State Lakes: Findings from a Statewide Citizen Science Monitoring Program

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Upstate Freshwater Institute

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Upstate Freshwater Institute (UFI)

Mission

- provide the scientific basis for protection of the freshwater resources of New York State
- advance freshwater research and education

Upstate Freshwater Institute

Background

- established in 1981
- not-for-profit [501(c)(3)]
- independent, but close professional ties to Syracuse University and SUNY-ESF
- overseen by a board of directors
- conducts fundamental and applied interdisciplinary research

There is a scientific consensus that HABs are increasing in frequency and intensity.

What are the factors that cause HABs? Can these factors be used to predict and/or control blooms?

Are Adirondack lakes susceptible to HABs?

Optimal Conditions for Cyanobacteria

- Elevated nutrient concentrations (phosphorus and nitrogen)
- Low N:P ratio
- Warmer water temperatures
- Calm conditions
- Presence of dreissenid mussel species (zebra, quagga)
  - Selective feeding
  - Nutrient cycling

Citizens Statewide Lake Assessment Program (CSLAP)

- Established in 1985 by NYSDEC and NYSFOLA
  - Trained volunteers collect data from representative lakes throughout NYS
- HAB monitoring began in 2011/2012
  - SUNY-ESF, SUNY-SB
- 170+ lakes in 2019
- Unique dataset!

Credit: NYSDEC
dec.ny.gov/chemical/81576.html

Sample Collection and Lab Analyses

- Sample collection
  - Open water (1.5 m) 8x, June-September; temperature, Secchi depth
  - nearshore (skim) samples when blooms observed; often localized
- Laboratory analyses (UFI, SUNY-ESF, SUNY-SB)
  - Water chemistry parameters (total phosphorus, total nitrogen, nitrate, ammonia, chlorophyll-a, conductivity, pH, calcium, color)
  - Cyanobacterial abundance estimated using a bbe Moldaenke FluoroProbe
  - Dominant phytoplankton taxa determined using an inverted microscope
  - Cyanotoxin (Microcystin) concentration
    - Protein phosphatase inhibition assay (PPIA), LC-MS, Enzyme-Linked ImmunoSorbent Assay (ELISA)
- Land use and lake area/depth data from NYSDEC

Definition of a HAB

Suspected HAB

"Confirmed blooms"

- Blue-green chlorophyll-a > 25 µg/L; or
- Microscopy confirms cyanobacteria as dominant taxa

"Confirmed blooms with high toxins"

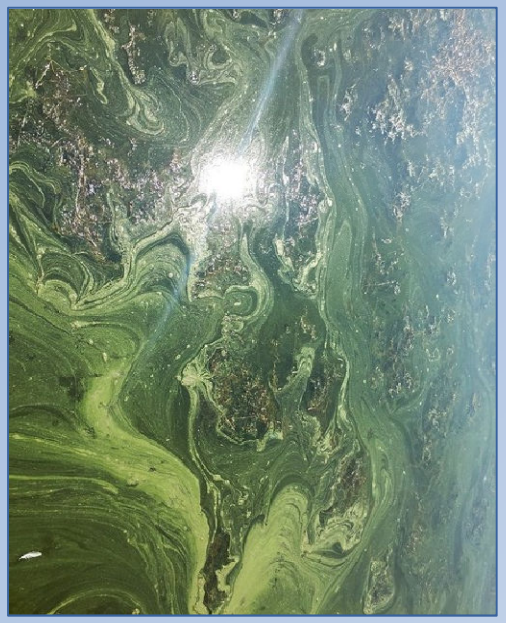
- Microcystin > 10 µg/L (open water), > 20 µg/L (shoreline)

What factors are associated with HABs and high levels of cyanotoxins?

HAB occurrence

Water quality

- Nutrients
- Temperature
- Phytoplankton biomass



Credit: Glenn Coin, Lake Neatahwanta

https://www.newyorkupstate.com/weather/2018/09/90_new_york_water_bodies_have_harmful_algae_blooms_most_this_year_so_far.html

Lake attributes and watershed characteristics

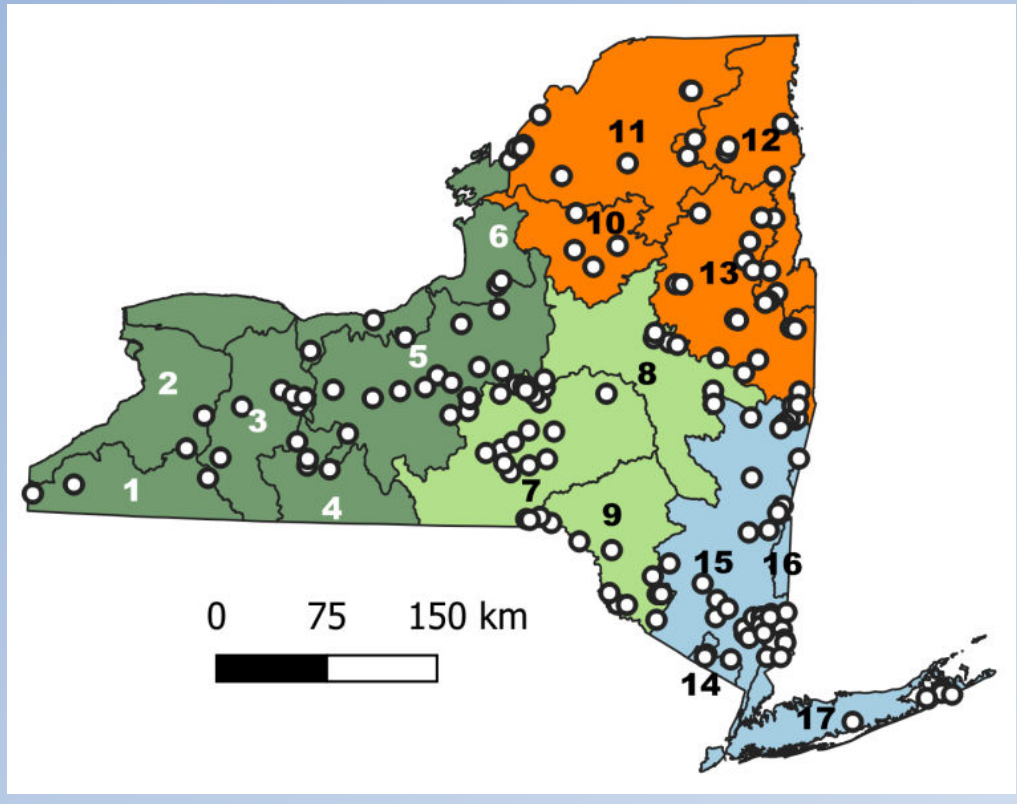
- Mean depth
- Land use
- Dreissenid mussels

Data Analysis

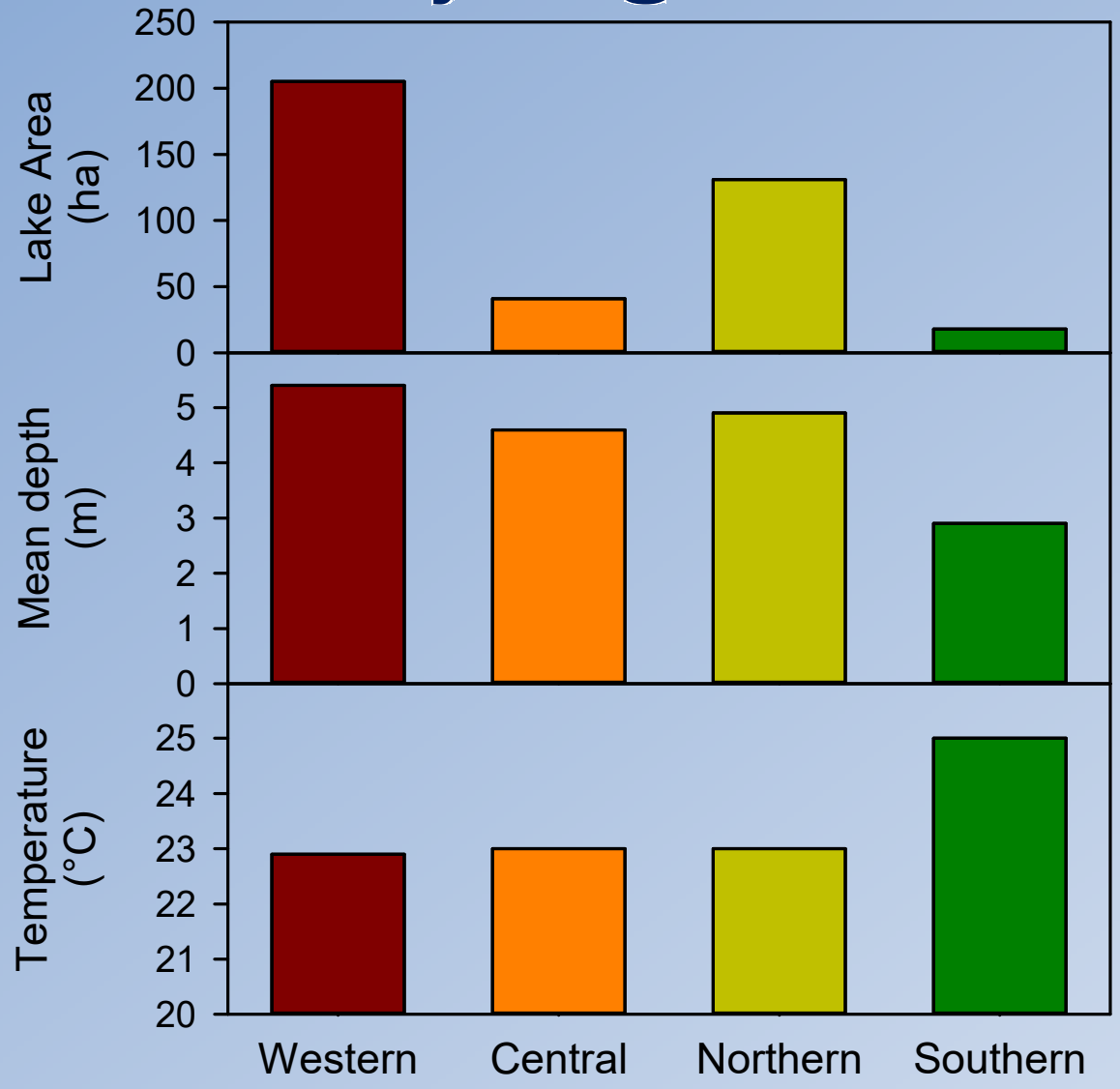
- CSLAP data from 2012-2017
- Average values used for water chemistry parameters (1 to 6 years of data)
- A binary approach used to characterize HABs and HABs with high toxins
- Simple descriptive analyses
- Multivariate analyses conducted on log-transformed data
  - Principal component analysis (PCA)
  - Classification analysis

Locations of 168 Study Lakes

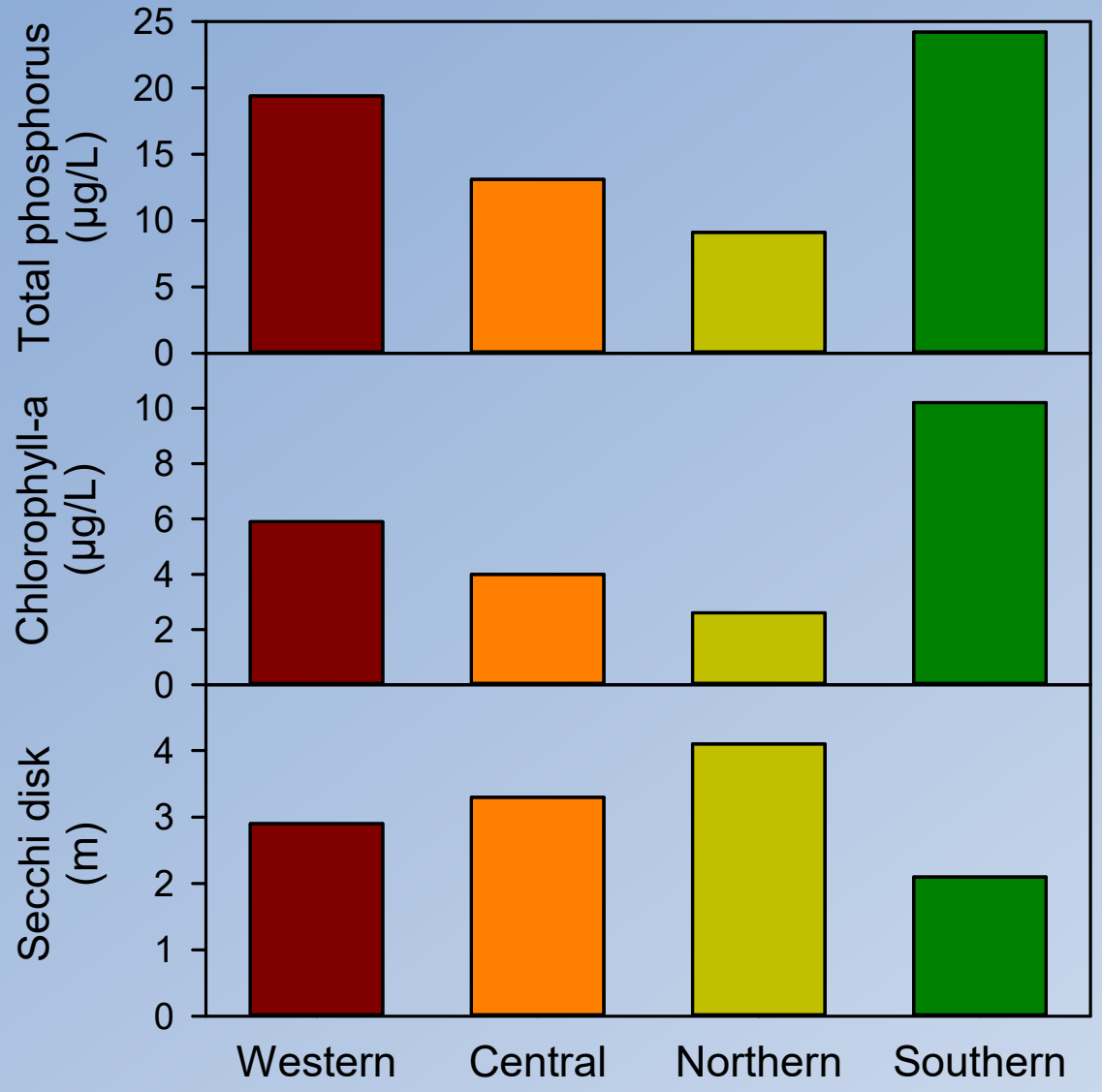
Drainage Basin No.	Drainage Basin Name	Region
1	Allegheny River	Western
2	Lake Erie-Niagara River	Western
3	Genesee River	Western
4	Chemung River	Western
5	Seneca-Oneida-Oswego River	Western
6	Lake Ontario	Western
7	Susquehanna River	Central
8	Mohawk River	Central
9	Delaware River	Central
10	Black River	Northern
11	St. Lawrence River	Northern
12	Lake Champlain	Northern
13	Upper Hudson River	Northern
14	Ramapo River	Southern
15	Lower Hudson River	Southern
16	Housatonic River	Southern
17	Atlantic Ocean	Southern



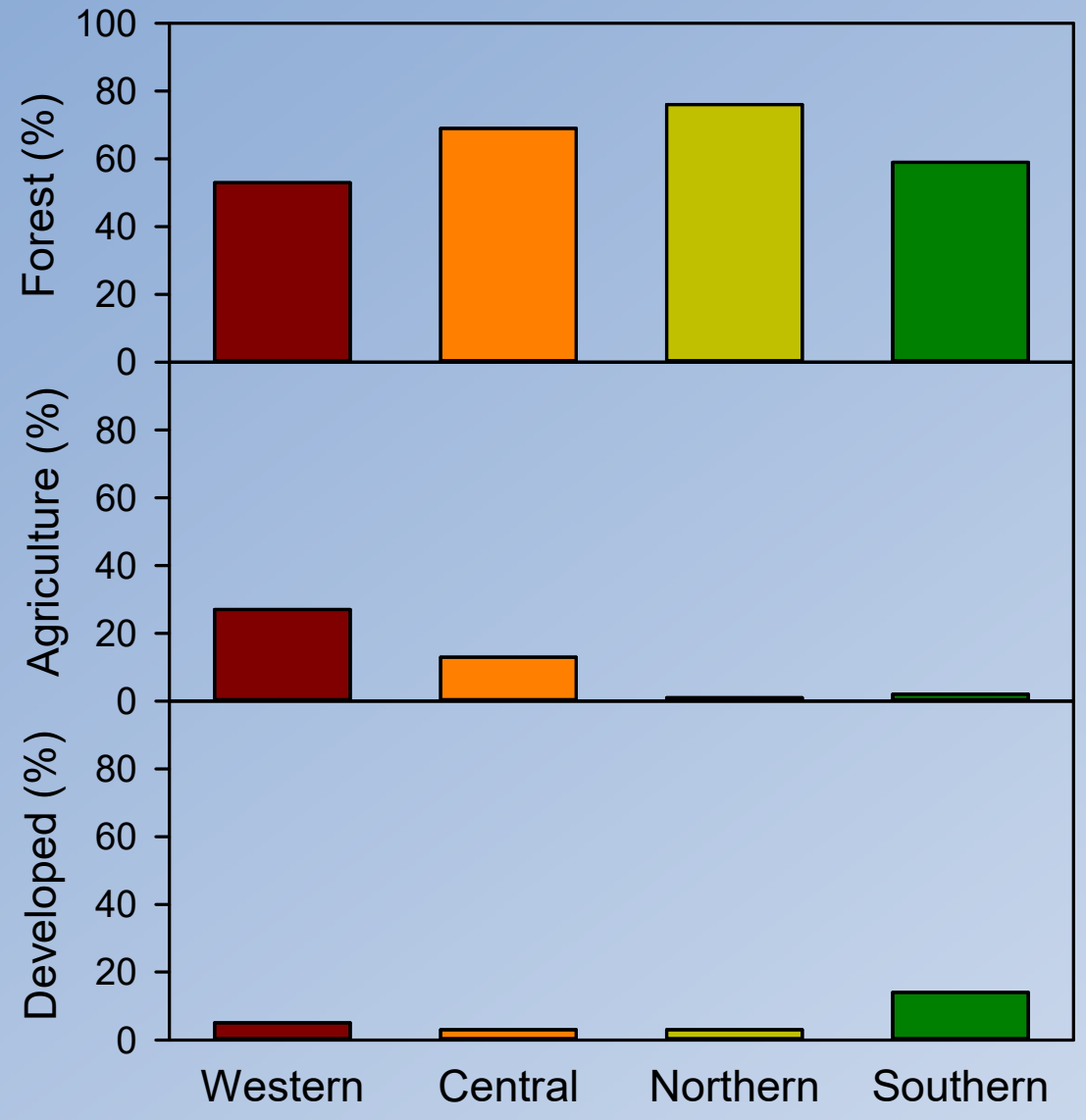
Physical Characteristics of CSLAP Lakes by Region



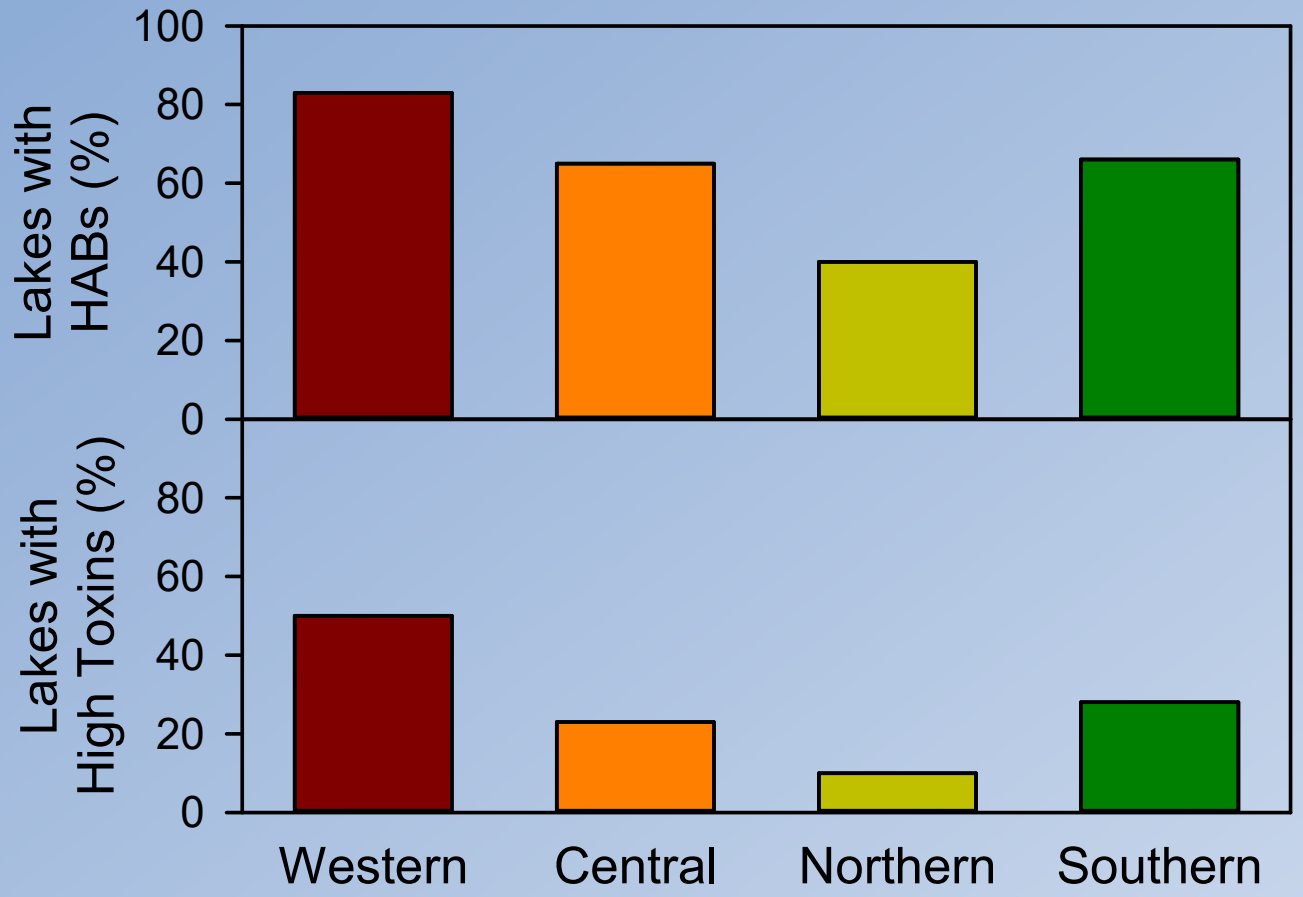
Trophic Status of CSLAP Lakes by Region



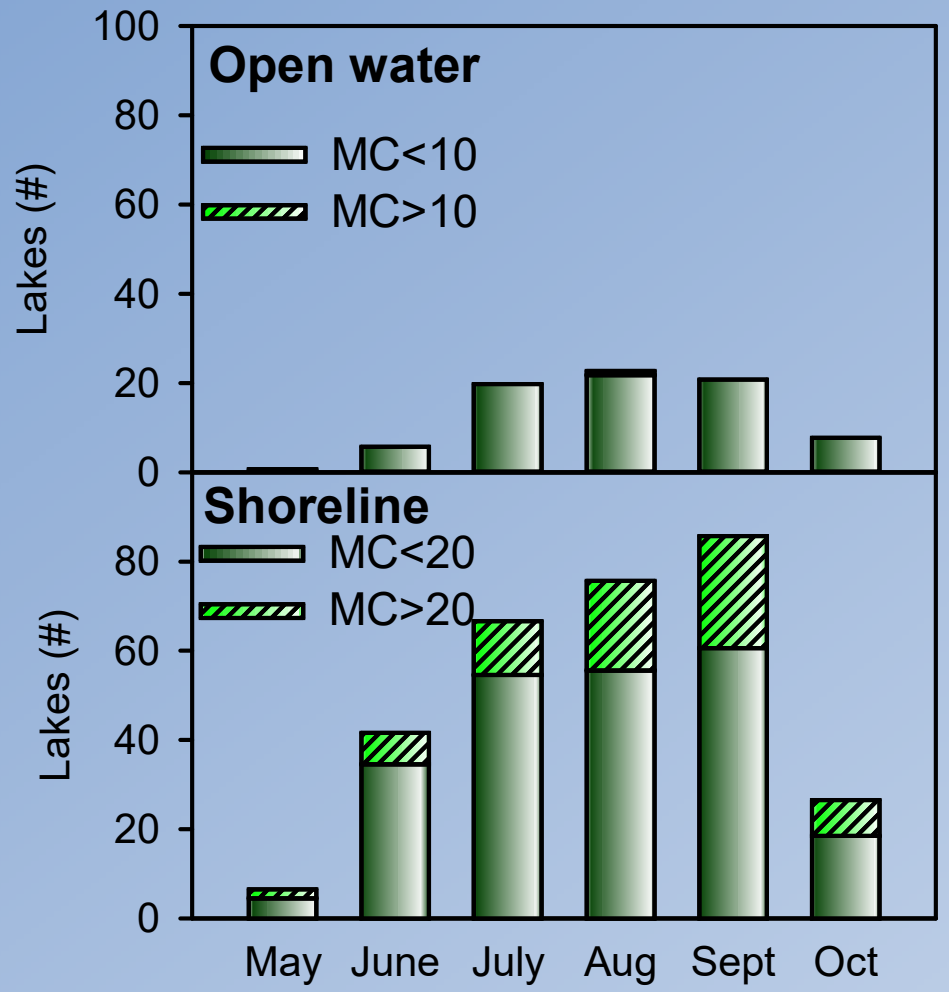
Regional Land Use Patterns



Occurrence of HABs in CSLAP Lakes



Seasonal Distribution of HABs, 2012-17

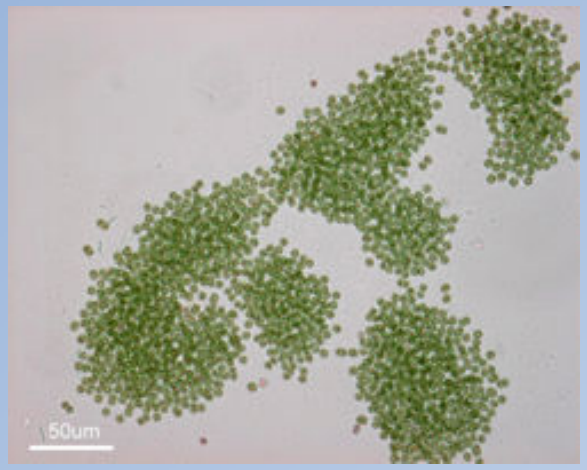


- HABs are most common during July-September
- Open water blooms are relatively uncommon and rarely toxic
- 80% of confirmed HABs were shoreline blooms; 24% had high toxins

Important Cyanobacteria Taxa

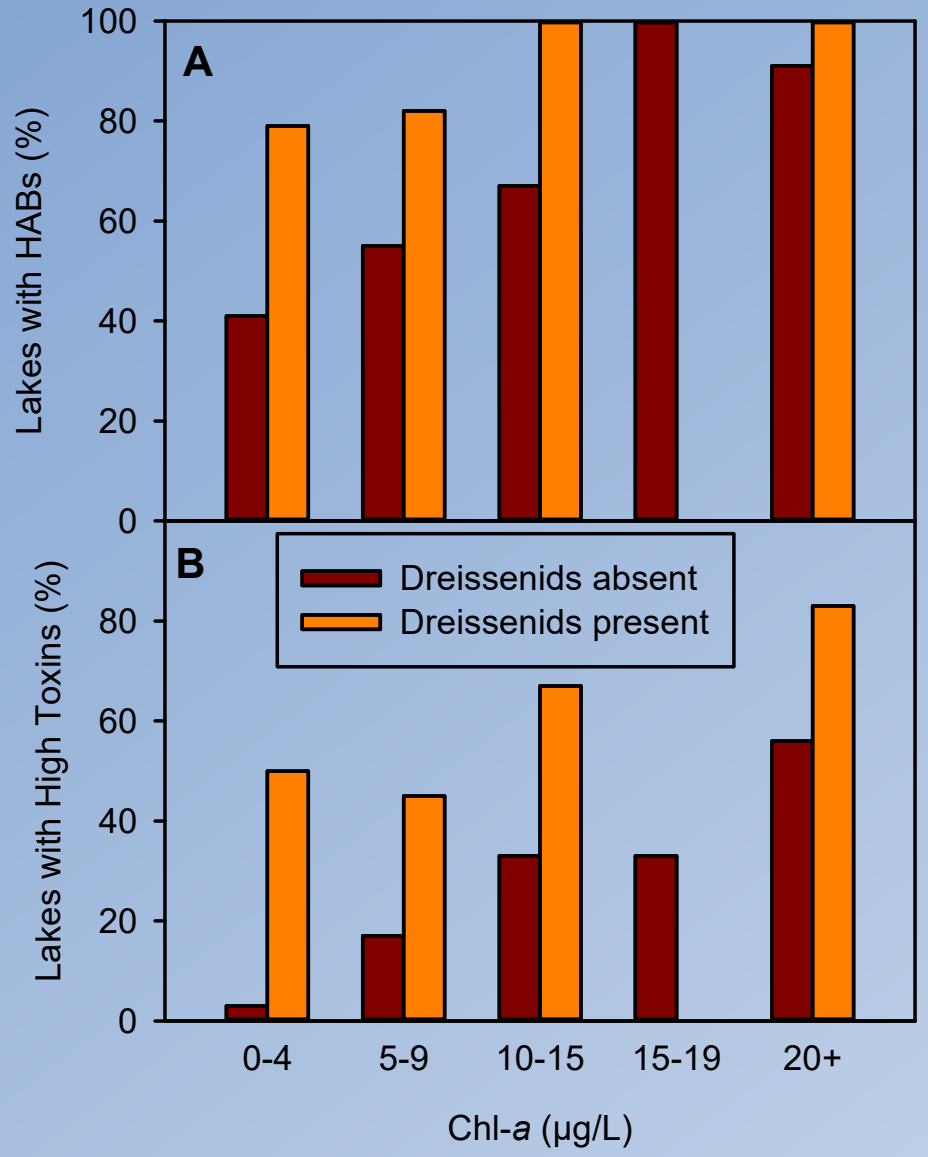
- High toxin blooms were dominated by *Microcystis* (94%) and *Dolichospermum* (57%)
- Other taxa identified in high toxin blooms:
  - *Woronichinia* (37%)
  - *Aphanizomenon* (17%)
  - *Lyngbya* (16%)

Microcystis



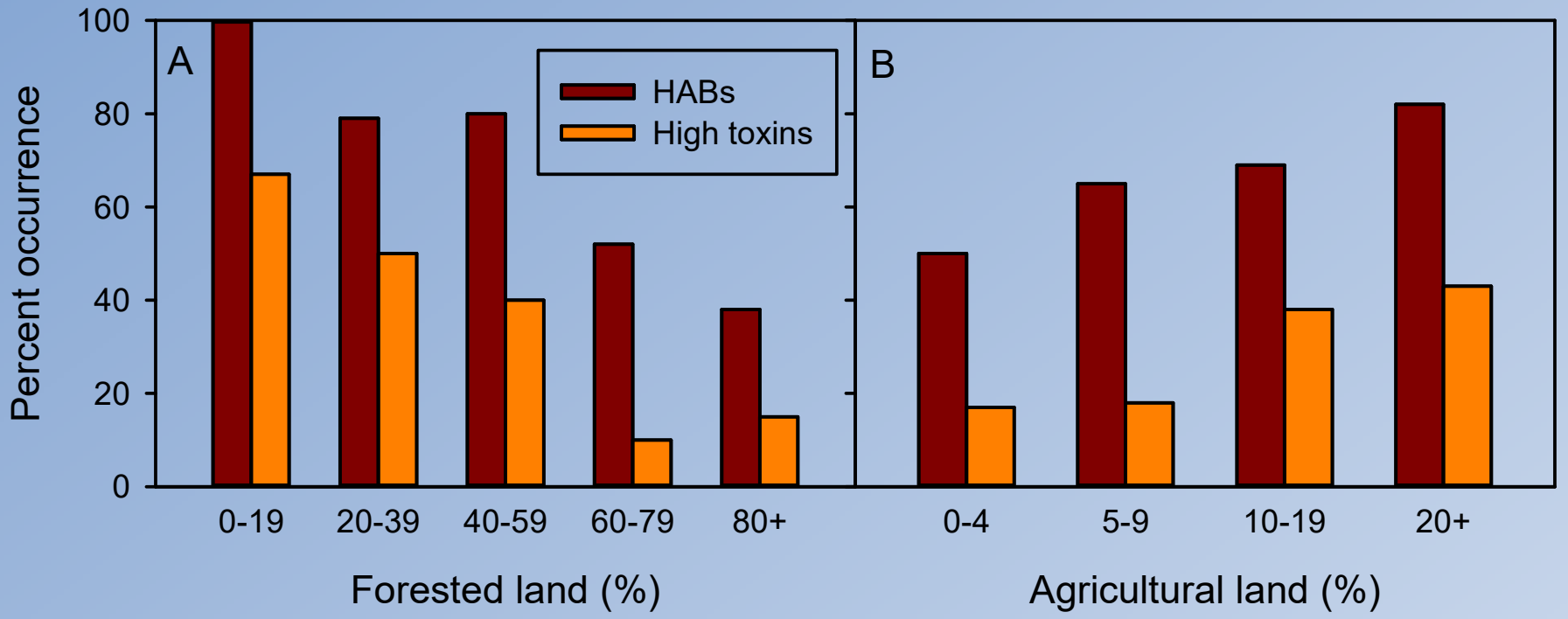
Dolichospermum

Effects of Productivity and Dreissenid Mussels on Bloom Status



- The occurrence of blooms and blooms with high toxins increases with increased productivity (Chl-a)
- The presence of dreissenid mussels increases the likelihood of blooms and blooms with high toxins
  - larger effect in lower productivity lakes

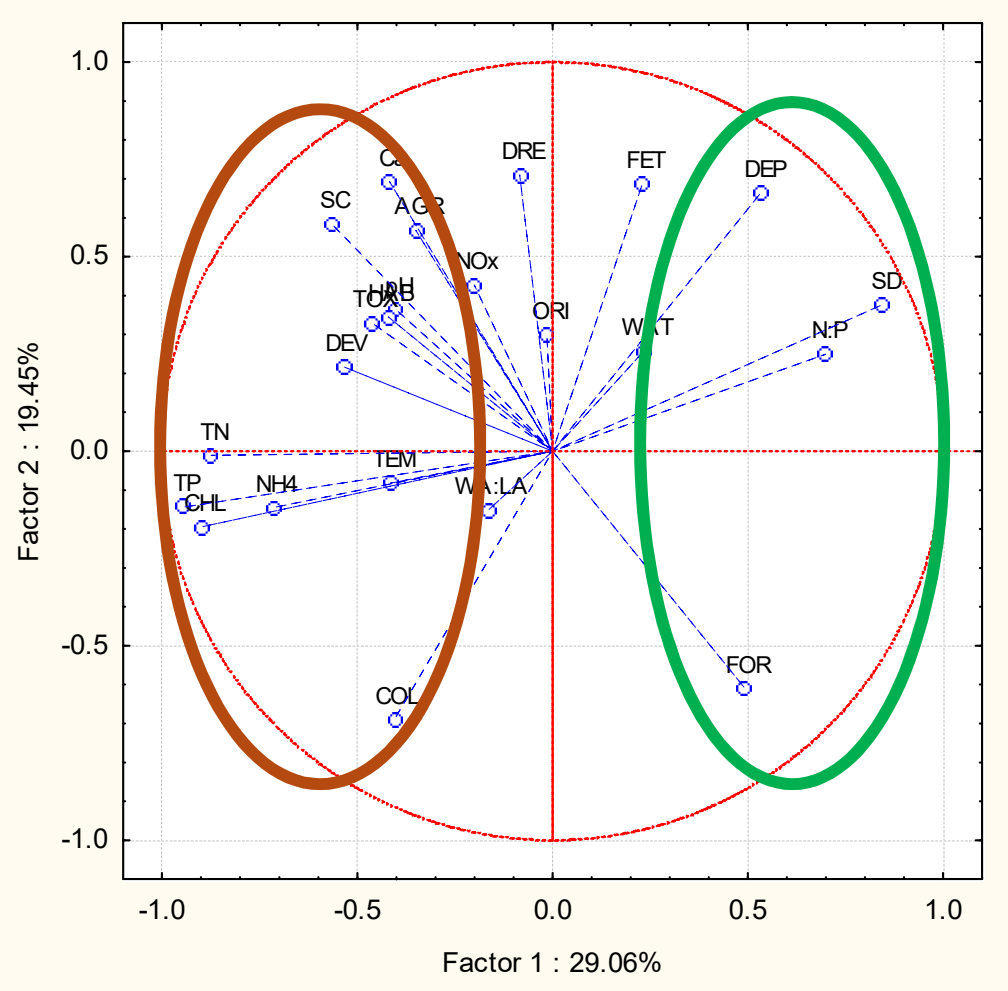
Bloom Status and Land Use



- The occurrence of blooms and blooms with high toxins decreased with increased forest cover and increased with increased agricultural land use

Principal Component Analysis

- Transforms a large number of correlated variables into a smaller number of uncorrelated variables

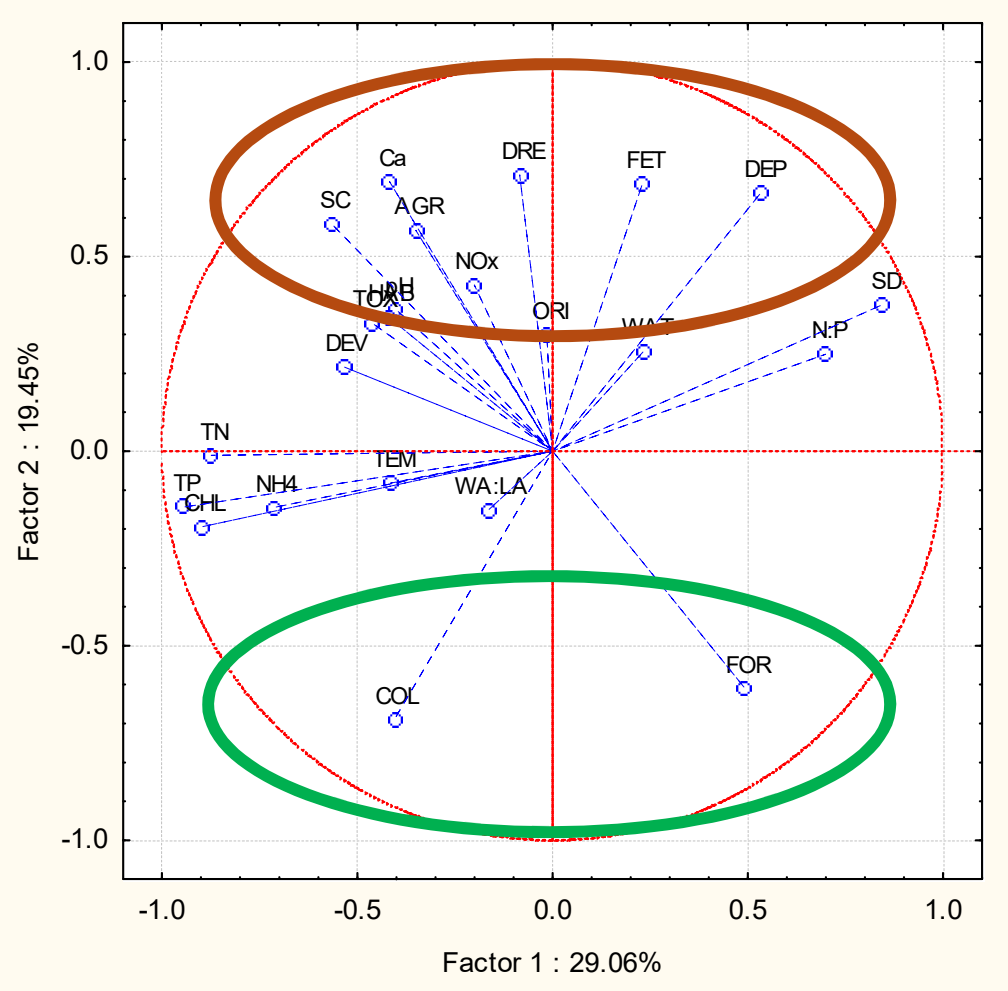


- Elevated nutrients and phytoplankton biomass
- Developed and agricultural land use
- HABs

- Deep lakes with high transparency
- High N:P
- Forested watersheds

Principal Component Analysis

- Transforms a large number of correlated variables into a smaller number of uncorrelated variables

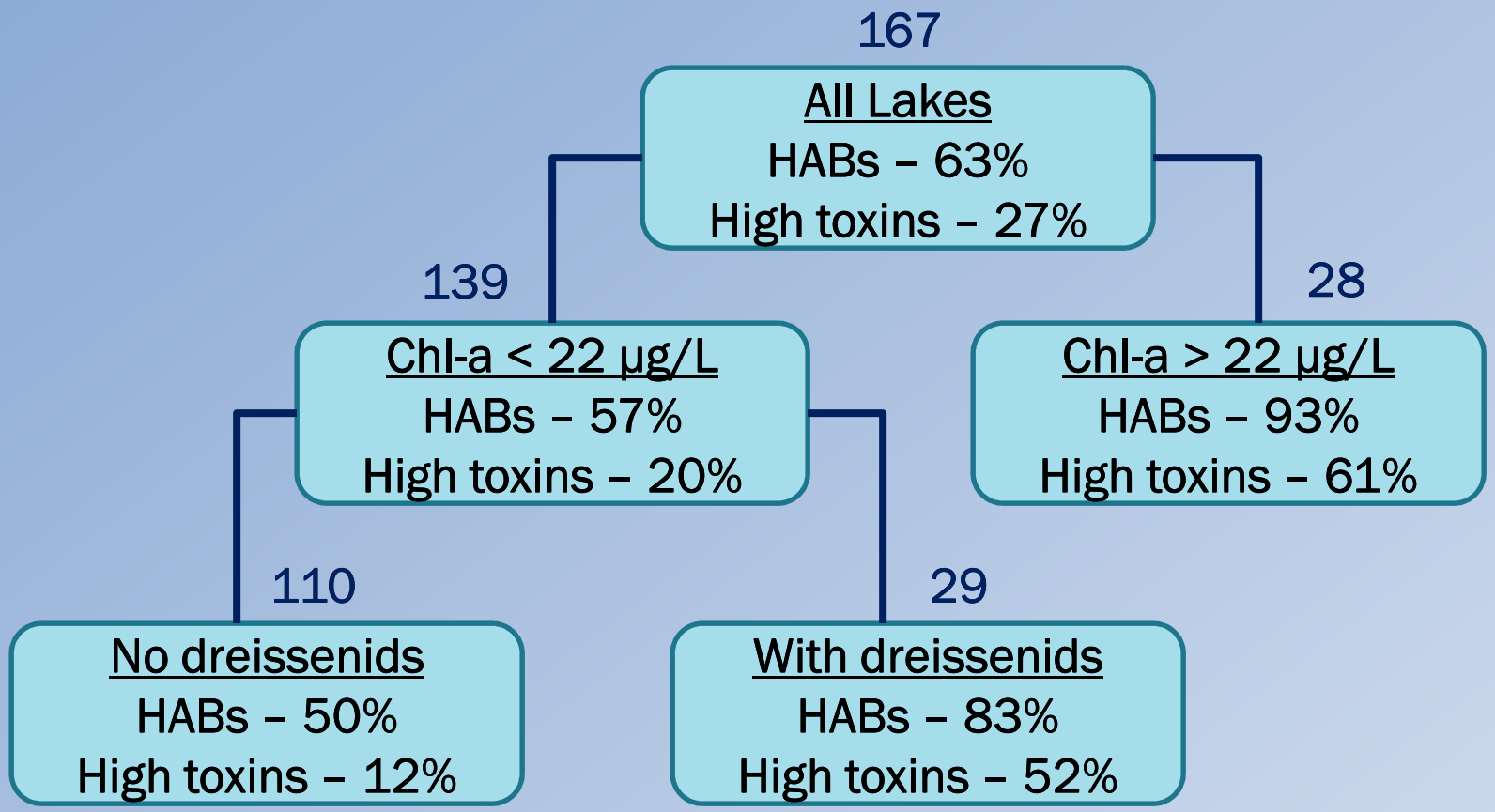


- Hard water lakes with dreissenid mussels
- Deep lakes with long fetches
- Agricultural land use
- HABs

- Highly colored lakes
- Forested watersheds

Classification Analysis

- Assigned lakes into classes based on our large group of potential predictor variables



Conclusions

- Most blooms occur along the shoreline during July-September
- Microcystis common in blooms with high toxins
- Blooms are more prevalent in productive lakes and lakes with dreissenid mussels
- Land use matters
- Adirondack lakes have relatively low susceptibility to HABs

Important factors

- Nutrients, trophic status
- Presence of dreissenid mussels
- Land use


Questions?
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