A Presentation on Blue-Green Algae and Harmful Algal Blooms in New Jersey Lakes

Lake Hopatcong Commission

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Objectives of Talk

- ✓ **What are blue-green algae (also called cyanobacteria), harmful algal blooms and what caused the June 2019 bloom?**
- ✓ **What are cyanotoxins?**
- ✓ **How to manage, control and prevent these blooms?**

Adaptations of Blue-Green Algae

- ✓ Can photosynthesize in a variety of light intensities
- ✓ Have resting spores called akinetes
- ✓ Some can fix gaseous nitrogen (heterocysts)
- ✓ Use enzymes to “cleave” phosphorus off organic compounds
- ✓ Some can regulate their position in the water column through gas vacuoles
- ✓ Generate colonies and cyanotoxins that make them unpalatable

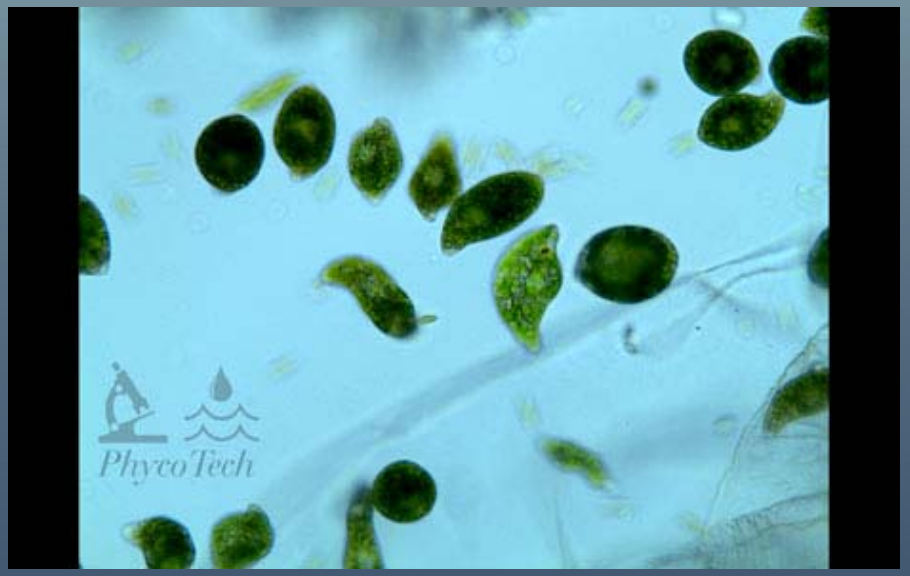
Does the bloom have the potential to produce cyanotoxins?

***Dolichospermum*, formally known as *Anabaena* (blue-green algae) Bloom**

***Euglena* Bloom**

Microscopic Confirmation

Dolichospermum*, formally known as *Anabaena



***Euglena* Bloom**

Blue-Green Algae Identified in Lake Hopatcong by NJDEP

Dolichospermum

***Woronichinia* (formally has been identified as *Coelosphaerium*)**

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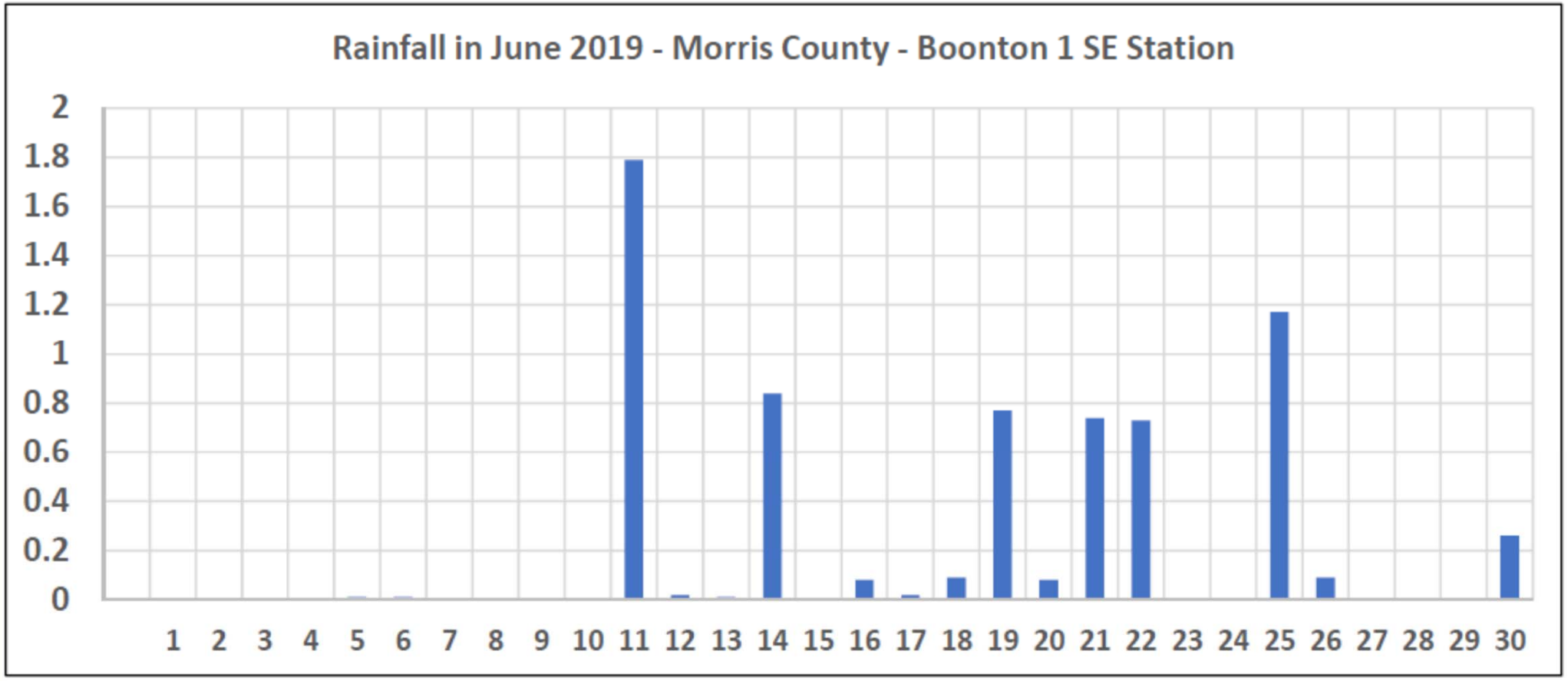
Blue-Green Algae Identified in Lake Hopatcong by Princeton Hydro

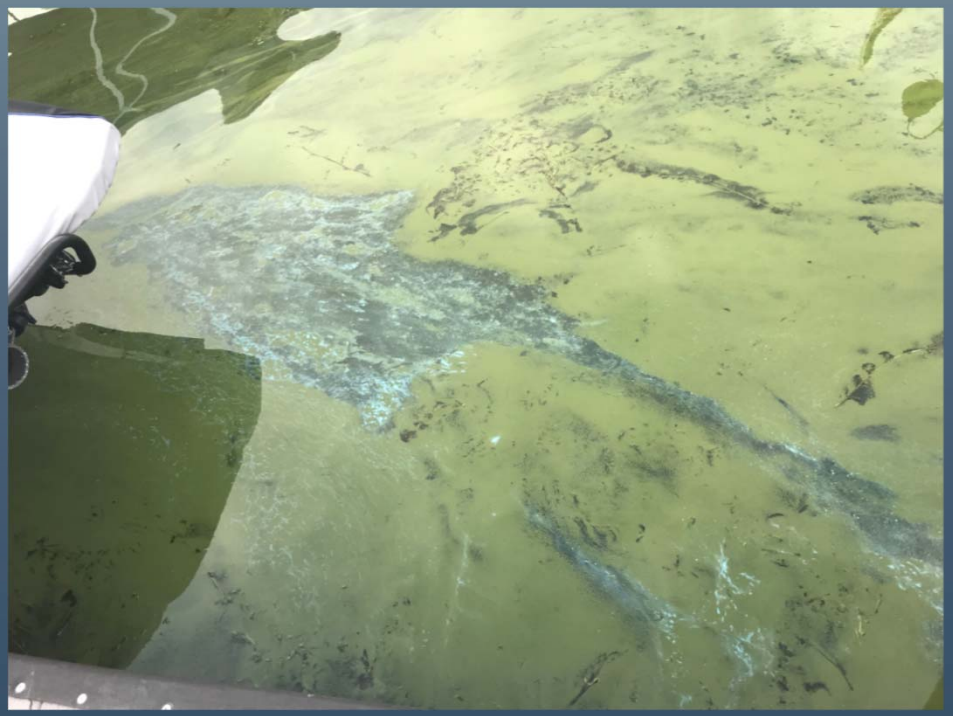
- ✓ Found *Dolichospermum* and *Woronichinia*; two of most frequently identified genera in the 8 nearshore sampling sites
- ✓ Princeton Hydro also identified the following but in general lower numbers and frequencies: *Aphanizomenon*, *Microcystis*, *Pseudanabaena*, and *Aphanocapsa*.
- ✓ Concentrations exceeded the 20,000 cells / mLs in two of Princeton Hydro's eight nearshore sampling sites.

Conditions that Result in an Blue-Green Algal Bloom

- ✓ High seasonal temperatures
- ✓ Still water conditions / thermal stratification
- ✓ Total Phosphorus concentrations as low as 0.03 mg/L can generate nuisance blooms / scums


Rainfall in June 2019 - Morris County - Boonton 1 SE Station
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Blooms at Lake Hopatcong (June 2019)



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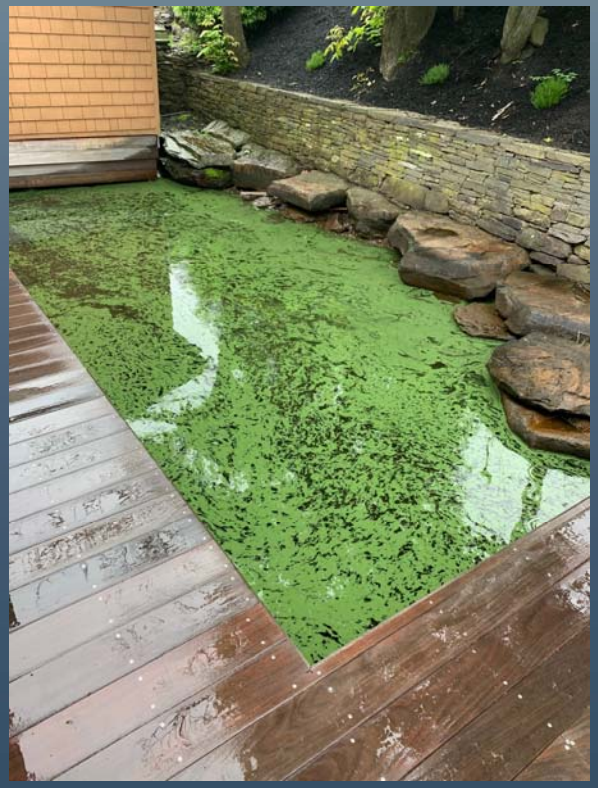
Blooms at Lake Hopatcong (18 October 2017)

Harveys Lake, Luzerne County, PA (June 2019)



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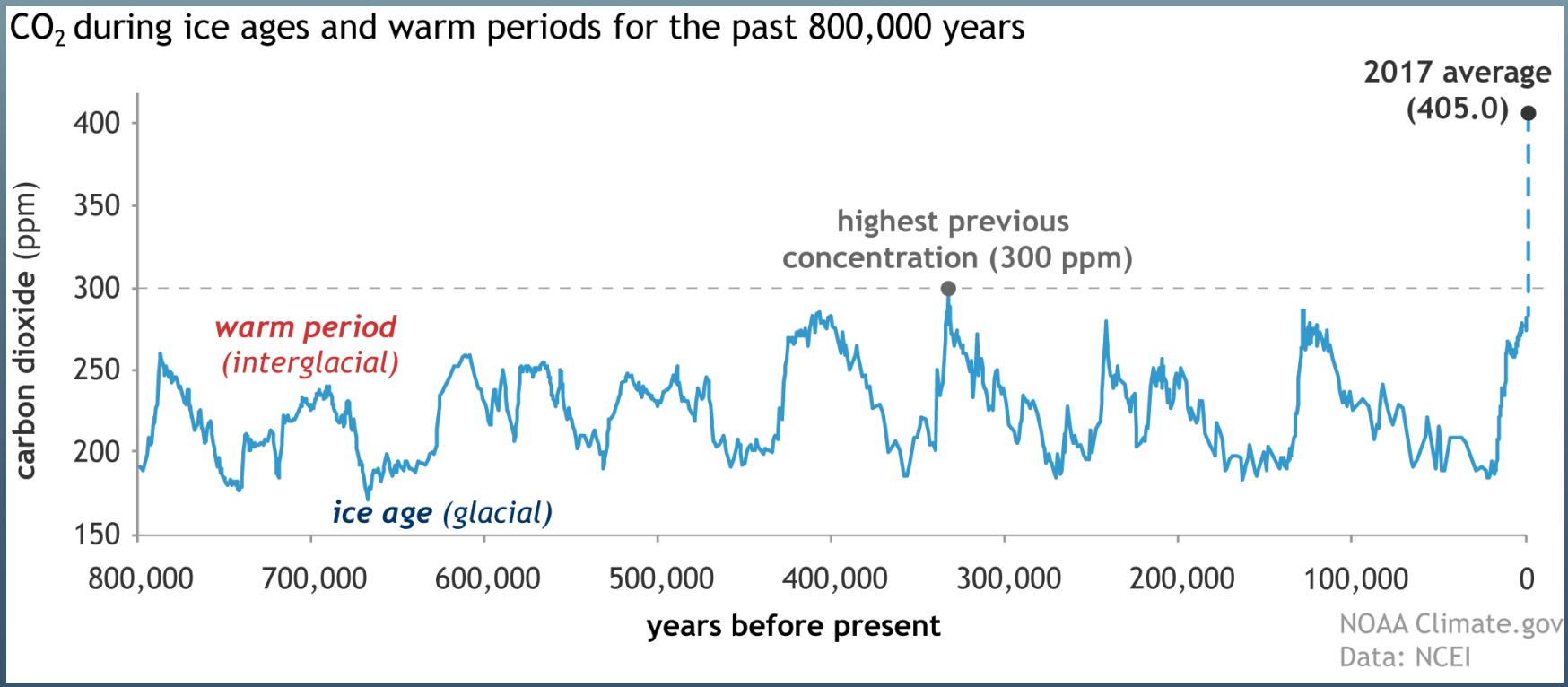
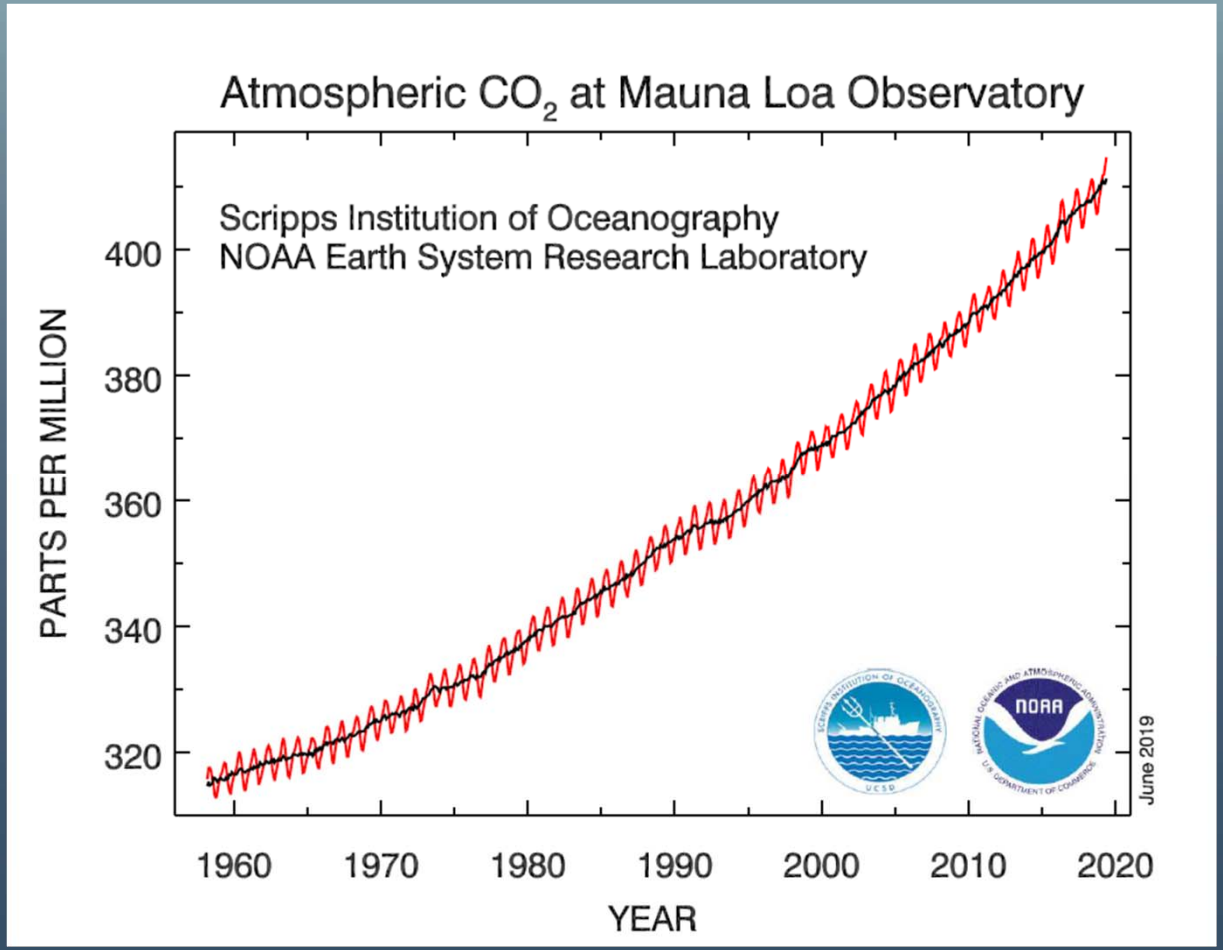
Blooms occurred at other lakes in the region

- ✓ Lake Mohawk, NJ
- ✓ Spruce Run Reservoir, NJ
- ✓ Swartswood Lake, NJ
- ✓ Harveys Lake, PA
- ✓ Waynewood Lake, PA
- ✓ Octoraro Reservoir, PA
- ✓ DeForest Lake, NY
- ✓ Conditions impacted larger lakes more so than smaller lakes

Impacts of Climate Change



Impacts of Climate Change



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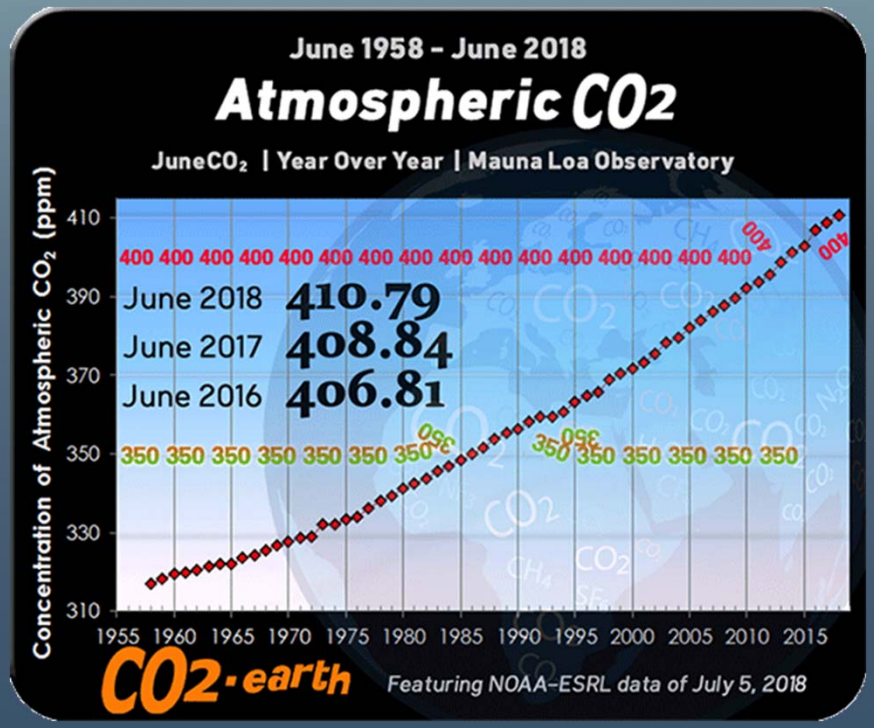
Impacts of Climate Change

- ✓ Mean monthly atmospheric CO_2 for May 2019 was 416.7 ppm
- ✓ Atmospheric CO_2 on 30th of June was 413.5 ppm



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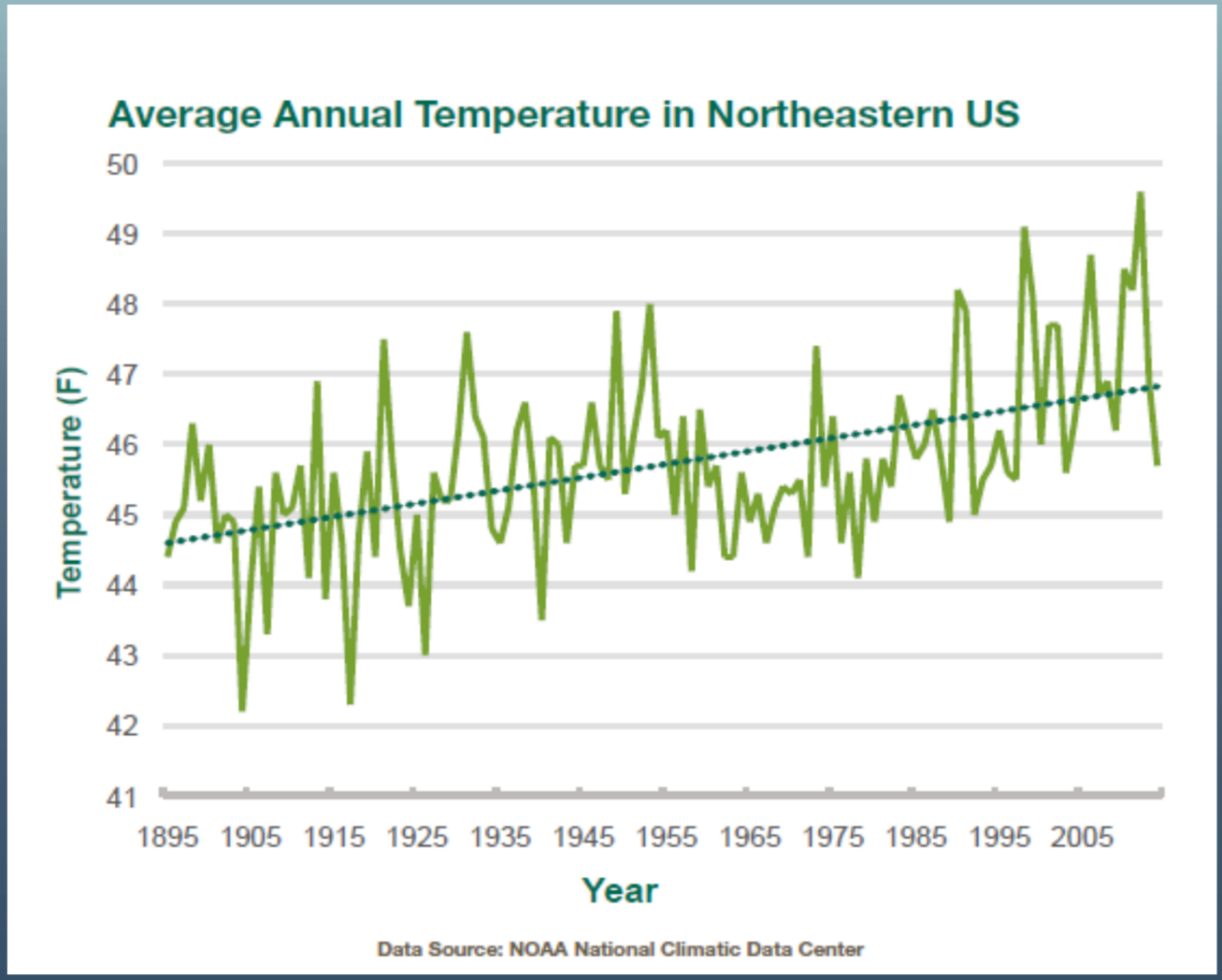

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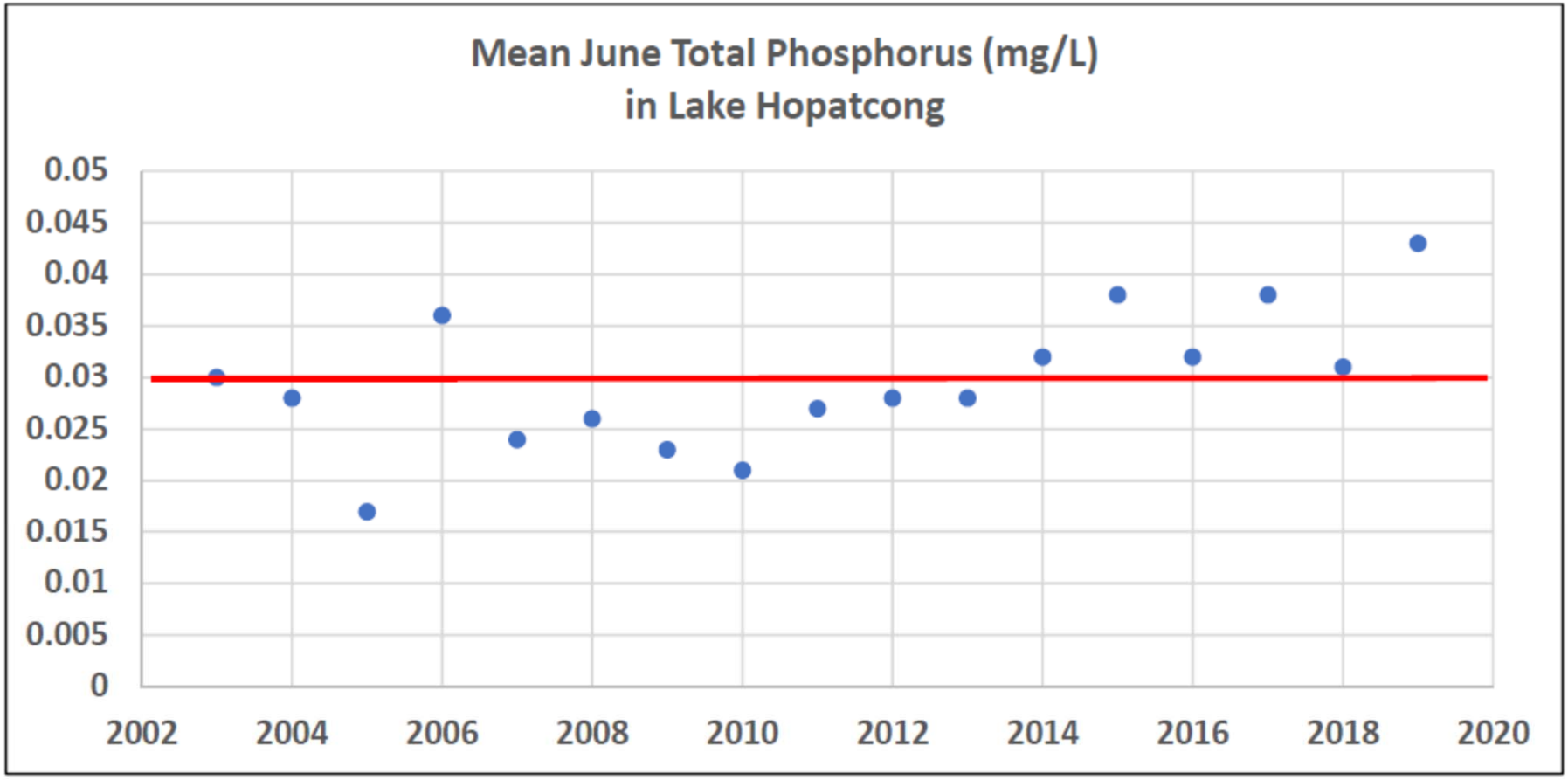
Impacts on Mid-Atlantic Region and the Lake Hopatcong Watershed

- ✓ **Warmer and wetter** throughout the 21st century
- ✓ Temperature could increase between 3 and 7ºF
- ✓ More extreme heat days over summer season
- ✓ An increase in the frequency of Extreme Weather Events
- ✓ **Growing season could increase by 15 to 30 days**
- ✓ **Number of frost days could decrease by 20 to 40 days**

Controlling TP Concentrations

- ✓ State's Surface Water Quality Standard (SWQS, N.J.A.C. 7:9B – 1.14(c) 5) for TP in the surface waters of a freshwater lake or impoundment is 0.05 mg/L
- ✓ Based on the TMDL / Watershed Implementation Plan (2006) Lake Hopatcong's target to have mean in-lake TP concentrations at or below 0.03 mg/L
- ✓ Currently updating the WIP with funds through the NJ Highlands Council


Mean June Total Phosphorus (mg/L)
in Lake Hopatcong
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020

What are cyanotoxins?

- ✓ Cyanotoxins are diverse group of mostly low-molecular weight molecules produced by cyanobacteria that can have a negative impact on the health of a variety of organisms including pet, livestock and humans.
- ✓ Various “strains” within a species of blue-green algae have the potential to produce cyanotoxins and they are produced when the population is under some type of “stress”
- ✓ There are three main types of cyanotoxins: heptatoxins, neurotoxins and dermatoxins

Cyanotoxins are NOT Taste and Odor Compounds

- ✓ Cyanotoxins are colorless, tasteless and odorless compounds
- ✓ Taste and odor compounds such as Geosmin and MIB can be produced by cyanobacteria (blue-green algae) and some actinobacteria
- ✓ Blue-green algae can produce T&O compounds and not produce cyanotoxins
- ✓ They can also produce cyanotoxins and no T&O compounds

Some of the more common cyanotoxins

- ✓ **Microcystins** – a group of 100 toxin variants. We have found this to be the most identified cyanotoxin and most are hepatotoxins. US EPA and NJDEP draft thresholds of concern.
- ✓ **Cylindrospermopsin** – most are hepatotoxins. US EPA and NJDEP draft thresholds of concern.
- ✓ **Anatoxin-a** – primarily a neurotoxin. NJDEP draft thresholds of concern only.

Lake Erie and Toledo, Ohio

- ✓ Early August of 2014 massive cyanobacterial algal bloom in the western end of Lake Erie.
- ✓ The cyanotoxin microcystin was found in dangerous levels in the finished municipal water.
- ✓ Half a million people were warned not to drink the water.

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US EPA's Concern Over Cyanotoxins

- ✓ In May of 2015 US EPA developed Health Advisories for two cyanotoxins in drinking water supplies
- ✓ In November 2016 EPA released Draft Human Health Recreational Ambient Water Quality criteria and/or Swimming Advisories for freshwater recreational waterbodies; these were revised in May 2019
- ✓ Monitoring under EPA's Unregulated Contaminant Monitoring Rule (UCMR-4) will occur between 2018 and 2020.

NJDEP's Concern Over Cyanotoxins

- ✓ In August 2017, NJDEP developed the "NJ Cyanobacterial Harmful Algal Blooms (HABs) Freshwater Recreational Response Strategy and Guidance"
- ✓ NJDEP Division of Science, Research & Environmental Health developed Human Health Recreational Thresholds
- ✓ Cells counts (blue-green algae) > 20,000 cells / mLs
- ✓ Or…

Recreational Thresholds for Cyanotoxins

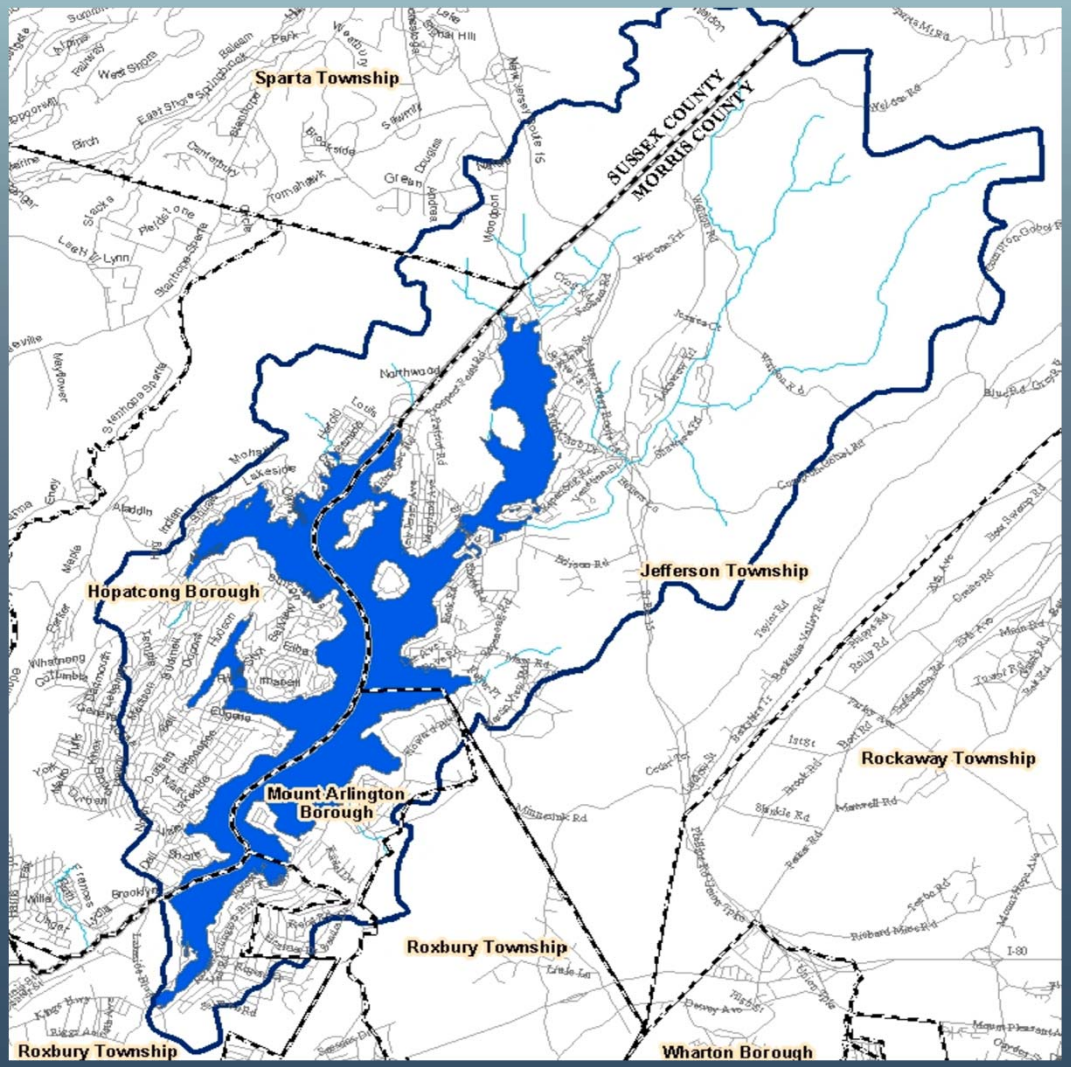
Cyanotoxin of Concern	NJDEP Threshold	US EPA Threshold
Microcystins	3 ppb	8 ppb
Cylindrospermopsin	8 ppb	15 ppb
Anatoxin-a	27 ppb	None at this time

Concern Over Cyanotoxins in Lake Hopatcong

- ✓ In response to a bloom on Lake Hopatcong in early August 2014, NJDEP did some cyanotoxin sample collection and analysis. Had some high hits along western shoreline but not along beach areas.
- ✓ Princeton Hydro did some follow up monitoring in 2015 during two summer events with no measurable concentrations of microcystins or cylindrospermopsin
- ✓ The Lake Hopatcong Commission asked Princeton Hydro to initiate a long-term cyanotoxin monitoring program, starting in 2018. No hits of cyanotoxins in July or August of 2018

What Can Be Done About Cyanotoxins? Three Tiered Approach

- ✓ Global issues associated with climate change
- ✓ Watershed Implementation Plan (WIP) to reduce phosphorus concentrations entering Lake Hopatcong (WIP was developed in 2006; about a third of the targeted TP reduced; currently updating the WIP)
- ✓ More localized bay / cove / beach restoration plans that address both in-lake and watershed issues



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Potential in-lake restoration measures for near-shore sections of the lake

- ✓ Aeration / circulation / bubblers
- ✓ Careful / judicial use of algicides
- ✓ Alternative products instead of copper-based algicides
- ✓ Floating Wetland Islands
- ✓ Ultrasonic devices
- ✓ Mechanical / physical removal of biomass (?)
- ✓ Phosphorus stripping from water column (?)

Potential drainage area restoration measures

- ✓ Existing septic systems? Alternative systems or at a minimum routine pump-outs
- ✓ Shoreline stabilization measures adjacent to beach / dock areas
- ✓ Goose control management
- ✓ Other source control management techniques (non-P fertilizers, pet waste removal, vegetative plantings, rain barrels, etc.)
- ✓ Green infrastructure / stormwater BMPs

Conclusions

- ✓ As a result of prevailing weather conditions and long-term climate trends, HABs will increase in frequency and severity in the Mid-Atlantic States
- ✓ The communities must be educated on the potential hazards of HABs and associated cyanotoxins
- ✓ The most cost effective and direct way of minimizing the impact of HABs and associated cyanotoxins is to reduce the amount of phosphorus available for algal growth.
- ✓ In Lake Hopatcong more than 80% of the annual phosphorus load originates from stormwater and septic systems

QUESTIONS?

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THANK YOU!

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