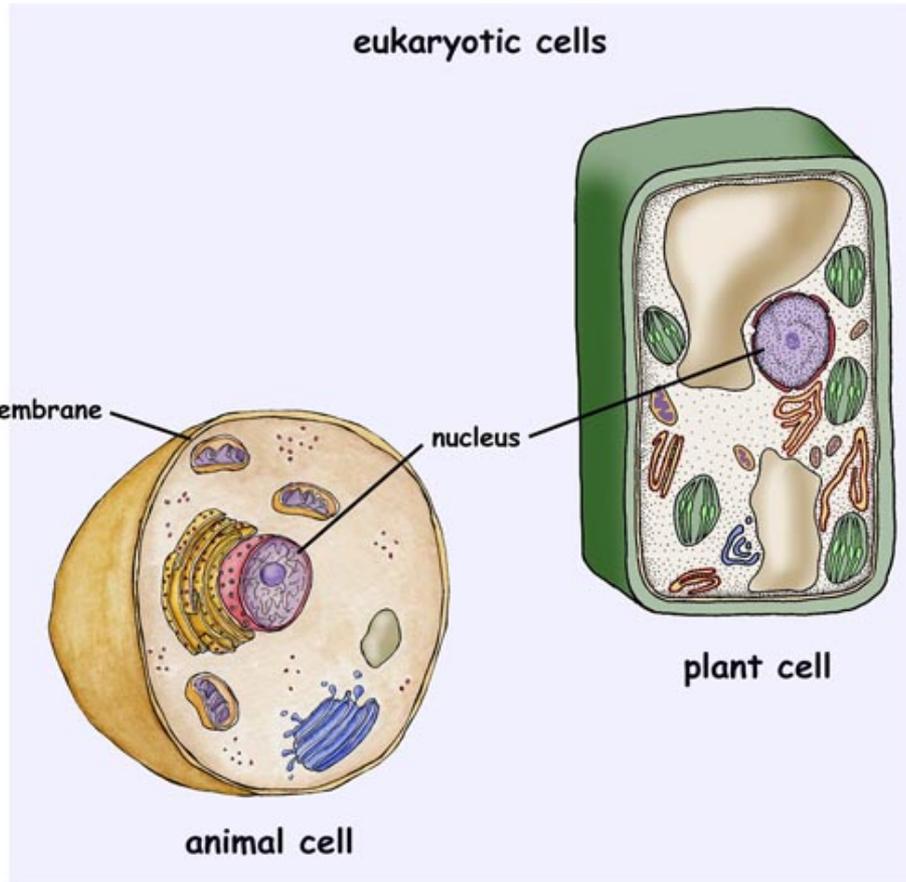
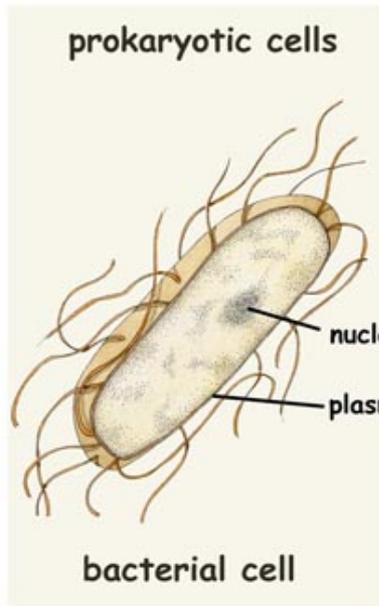


Harmful Algal Blooms and Cyanotoxins in New Jersey



Fred S. Lubnow, Ph.D.
Princeton Hydro, LLC
With offices in New Jersey,
Pennsylvania, Connecticut and
Maryland
flubnow@princetonhydro.com

Comparing Cells



Eukaryotes



Prokaryotes



Anabaena (blue-green alga) Bloom



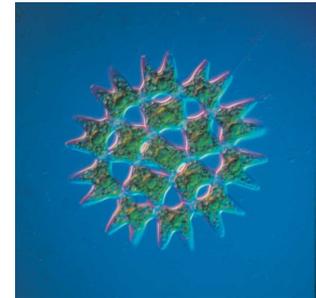
Euglena Bloom

The term “Algae”

- More of an ecological term than a taxonomic one since algae include both eukaryotes and prokaryotes (blue-green algae, also known as cyanobacteria)
- Most algae provide valuable ecosystem services
- Base of the food web; primary productivity
- Contribute toward oxygenating the water
- Sequester carbon
- May be a source of biofuel and have some pharmacological values
- However, some algae can be problematic

Freshwater Algae

- Phytoplankton (free floating algae)
- Filamentous Mat Algae (benthic algae)
- Macro-algae (stoneworts)



Source: Roberta Hill, VLMP © 2007

Harmful Algae Blooms (HABs)

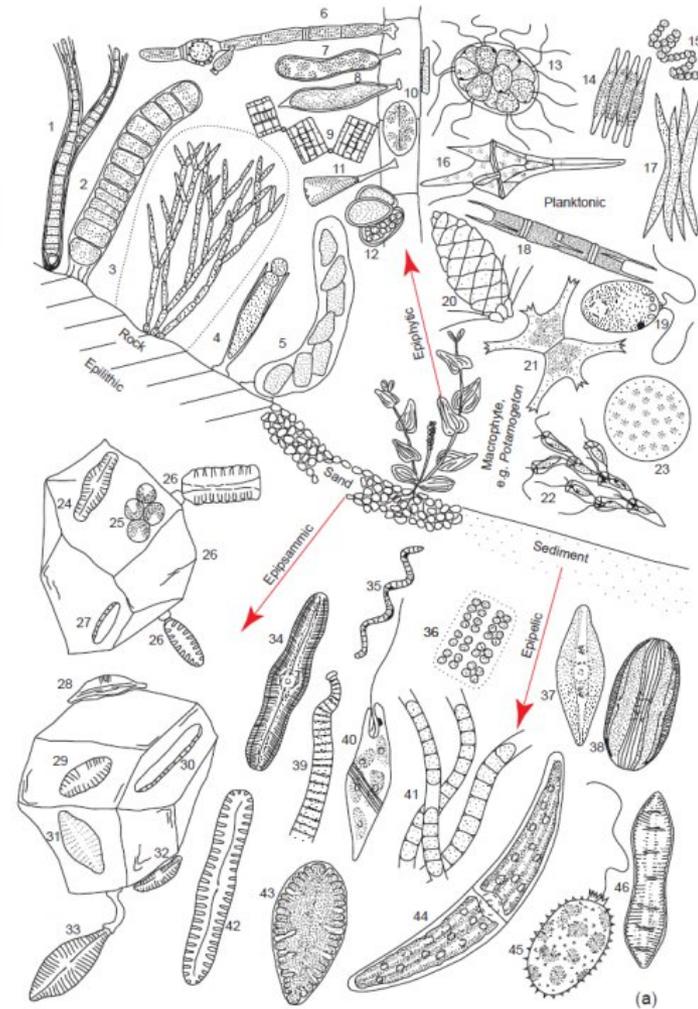
Notice

An algae bloom has made this area potentially unsafe for water contact. Avoid direct contact with visible surface scum.

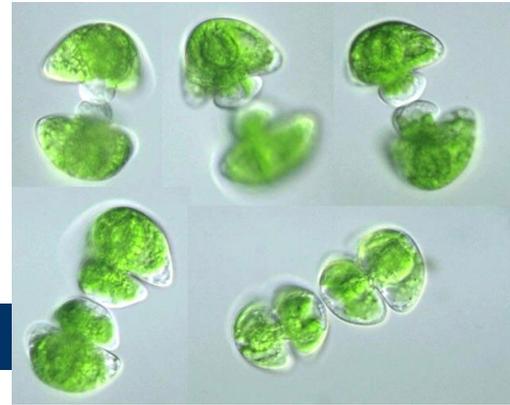


Algal groups

- Green algae
- Chrysophytes
- Diatoms
- Dinoflagellates
- Euglenoids
- Blue-green algae
- Others

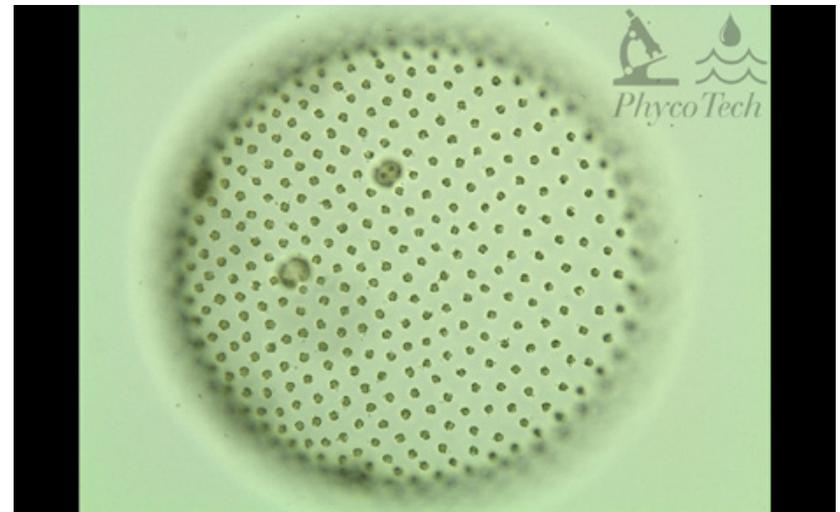
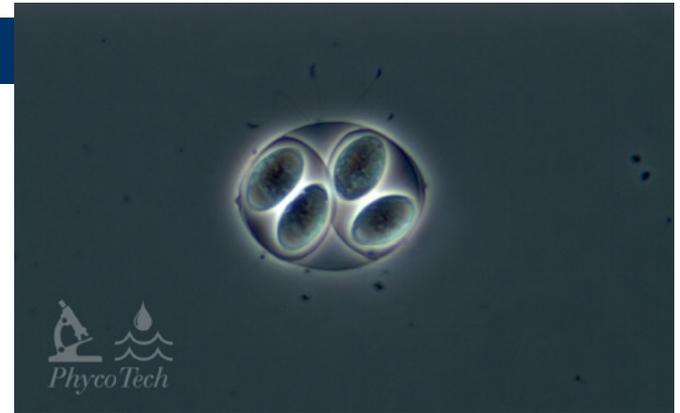
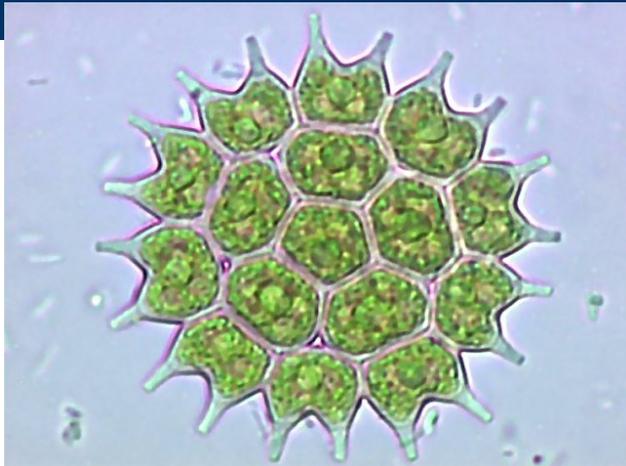


Green algae



- Very diverse, freshwater group
- Can thrive in low nutrient waters
- Can bloom anytime during the growing season, depending on the species
- Blooms can be a bright green color or filamentous mats
- During blooms can produce unpleasant tastes
- Many are easily grazed on by zooplankton

Planktonic green algae



Desmids – a group of green algae

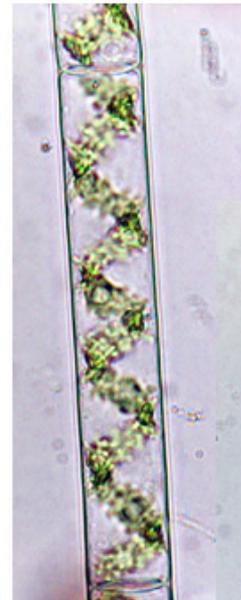
- Generally indicative of “cleaner” waters; low nutrients
- Prefers acidic waters



Filamentous mat algae



Spirogyra



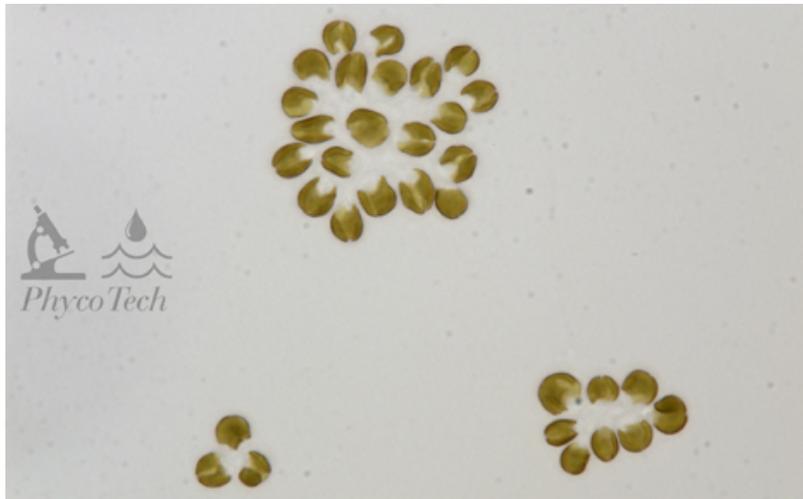
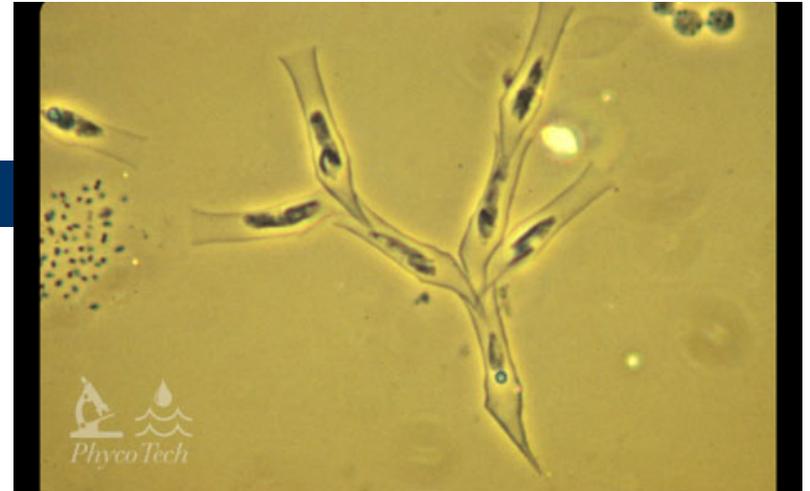
Spirogyra



Chrysophytes – golden algae

- Generally prefer colder waters and lower pH values
- Can also thrive in low nutrient waters and in low light intensities
- Can bloom in the spring and give the water a brown color
- Can produce taste and odor problems for drinking water supplies

Chrysophytes

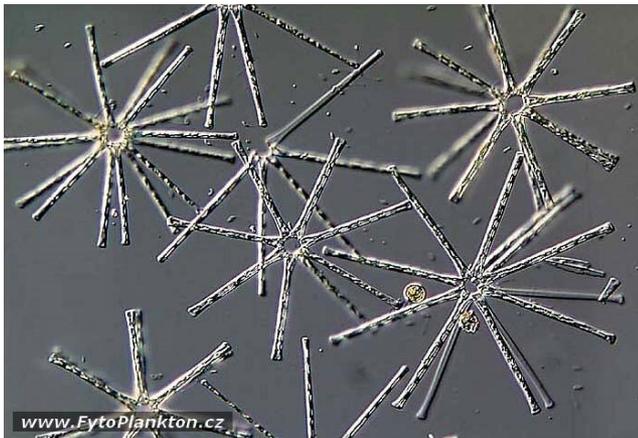
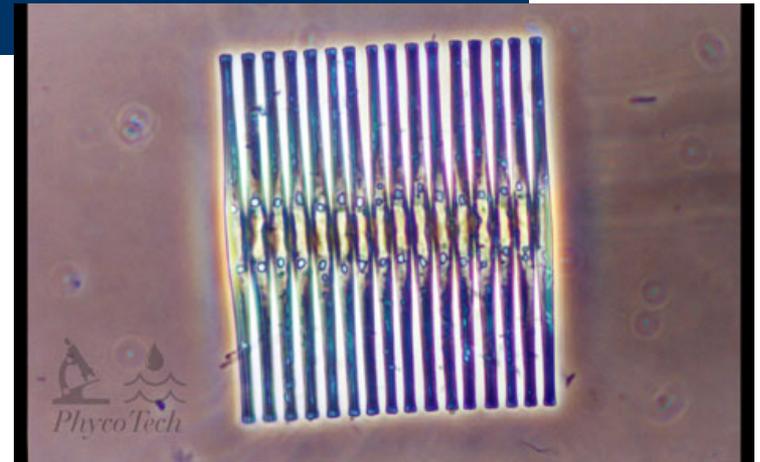


Diatoms –brown algae

- Cell walls made of silica (glass)
- Can bloom in the spring and cause “brown” blooms
- Some can be grazed by zooplankton

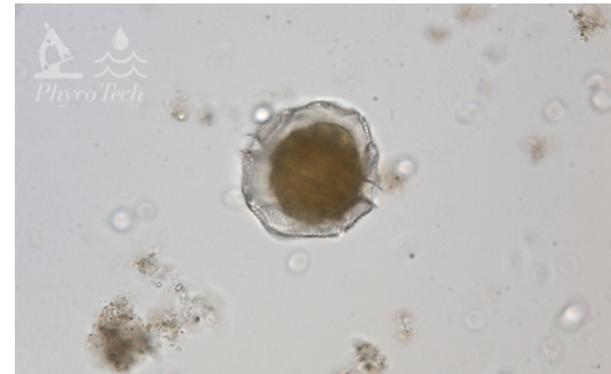


Diatoms



Dinoflagellates

- Can be a major problem in marine systems, producing red tide (harmful algal blooms; saxitoxins)
- However, this is not the case in freshwater systems
- Some can be grazed on by zooplankton



Euglenoids

- Small group but common in eutrophic (high nutrient) waters
- Can produce brown, green and even red blooms, typically in the spring



Cyanobacteria (blue-green algae)

- Photosynthetic bacteria
- Very old organisms so they are very well adapted to their environments
- The dominant nuisance group of algae in freshwater ecosystems
- Responsible for nuisance scums, negatively impact recreational usage, potable water supplies and ecological value
- Can produce cyanotoxins and taste / odor compounds.
- Many are not grazed by zooplankton

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

Zooplankton

- Micro-animals that live in the open waters
- Four freshwater groups: protozoa , rotifers, cladocerans, copepods
- Some are herbivorous and feed on algae
- Larger forms visible to naked eye

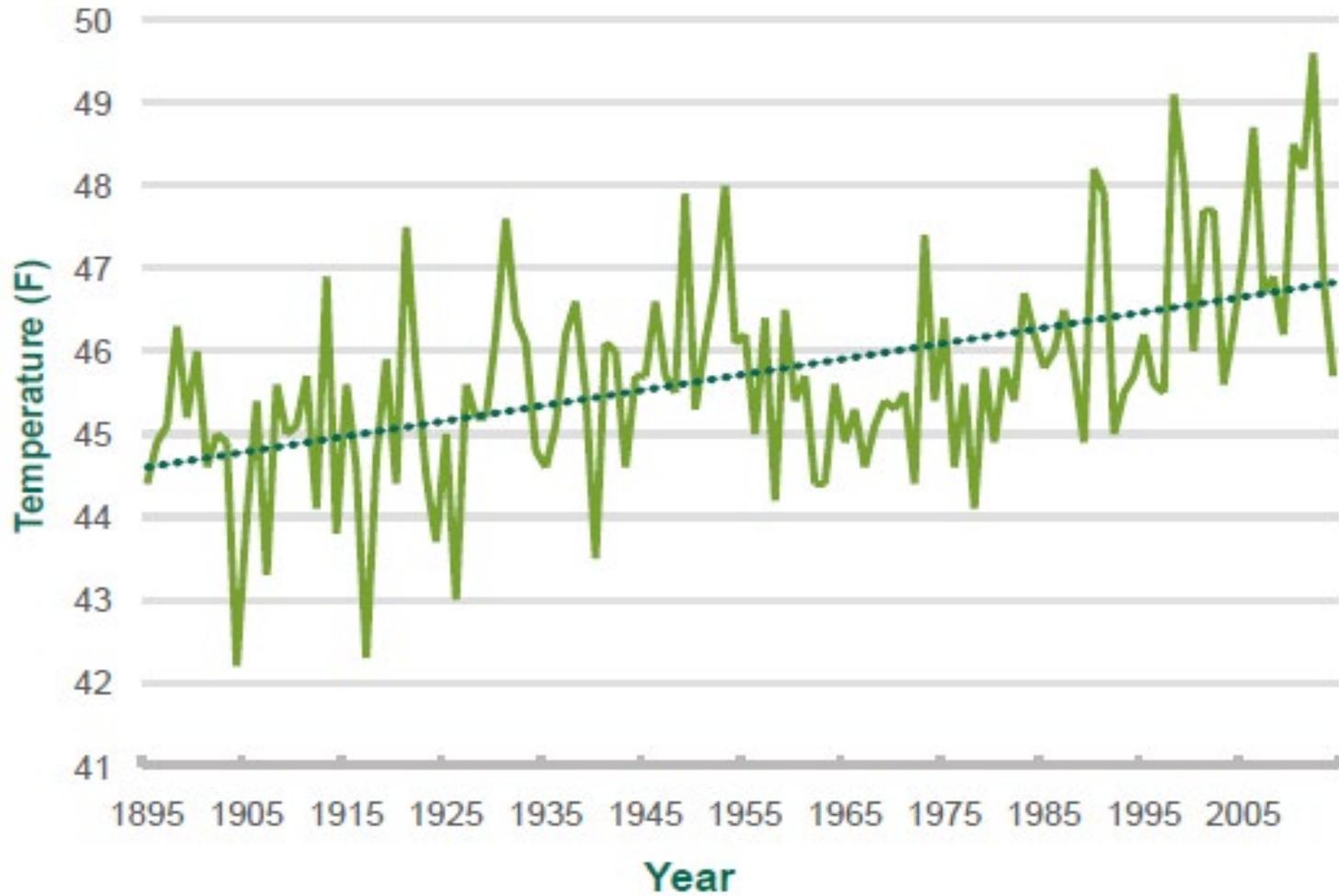


Conditions that Result in an Blue-Green Algal Bloom

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



Average Annual Temperature in Northeastern US



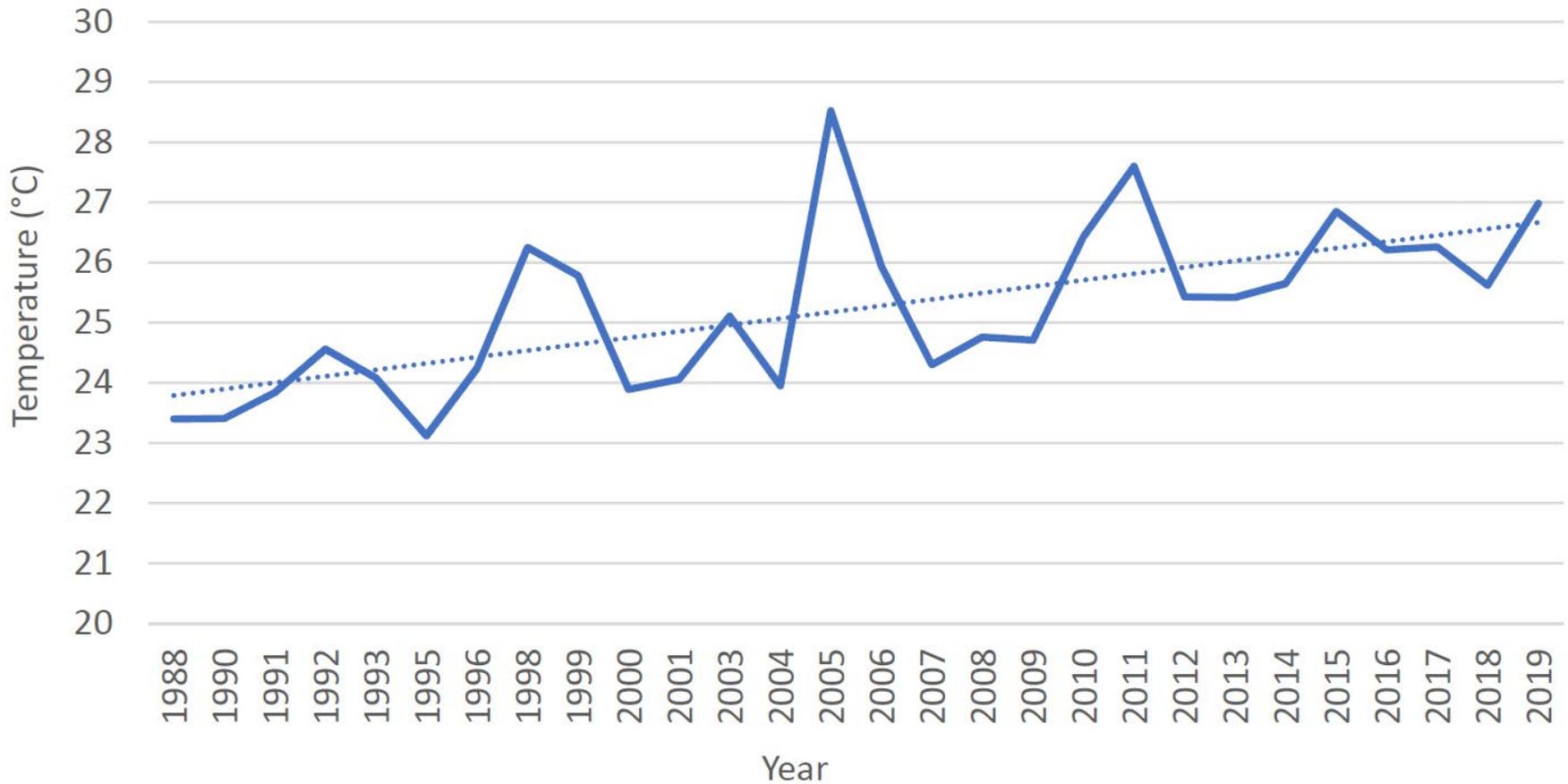
Data Source: NOAA National Climatic Data Center

Impacts on Mid-Atlantic Region and the Lake Hopatcong Watershed

- **Warmer and wetter** throughout the 21st century
- Temperature could increase between 3 and 7°F
- 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**

Lake Hopatcong (Mid-Lake Station) July Surface Water Temperature

$$y = 0.1065x + 23.684$$
$$R^2 = 0.4158$$



What are Cyanotoxins?

- Diverse group of chemical substances produced by blue-green algae which show specific toxic impacts on vertebrates.
- Some are **neurotoxins** (**anatoxin-a**, **anatoxin-a(s)**, **saxitoxins**)
- Some are **hepatotoxins** (**microcystins**, **nodularin** and **cylindrospermopsin**)
- Dermotoxins (**lyngbyatoxins** and **aplysiatoxins**)
- Documented impacts on humans, livestock and pets

Cyanotoxins are NOT Taste & Odor Compounds

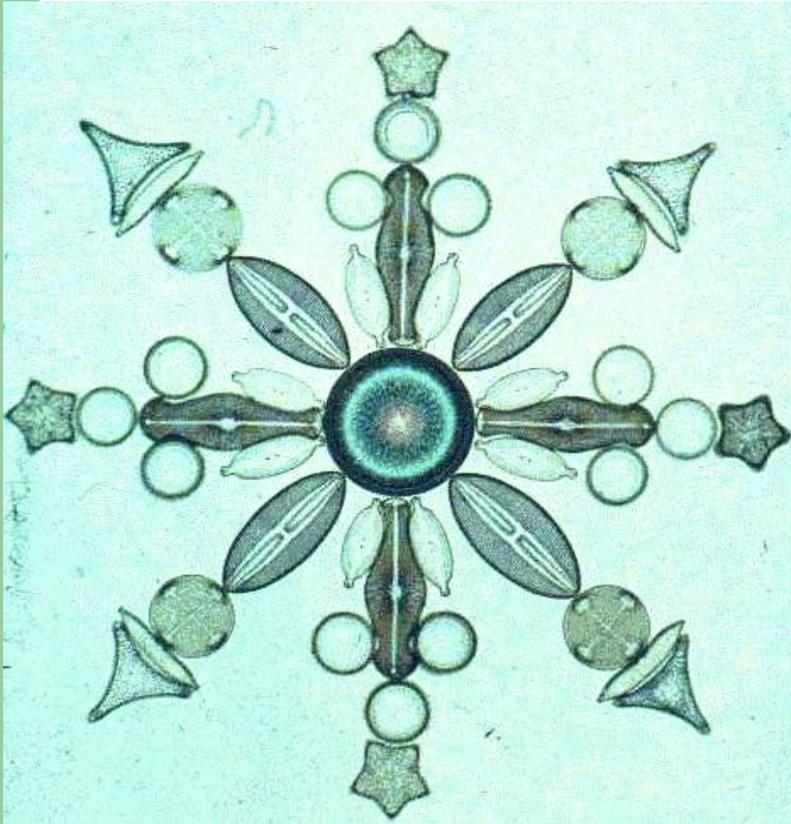
- Cyanotoxins are colorless, tasteless and odorless compounds
- Taste and odor compounds such as Geosmin and MIB can be produced by cyanobacteria (blue-green algae) and some actinobacteria
- Blue-green algae can produce T&O compounds and not produce cyanotoxins
- They can also produce cyanotoxins and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

Draft Thresholds for Cyanotoxins of Concern for Recreational Waterbodies

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

Prepared by Princeton Hydro, LLC

THANK YOU



Fred S. Lubnow, Ph.D.
Princeton Hydro, LLC