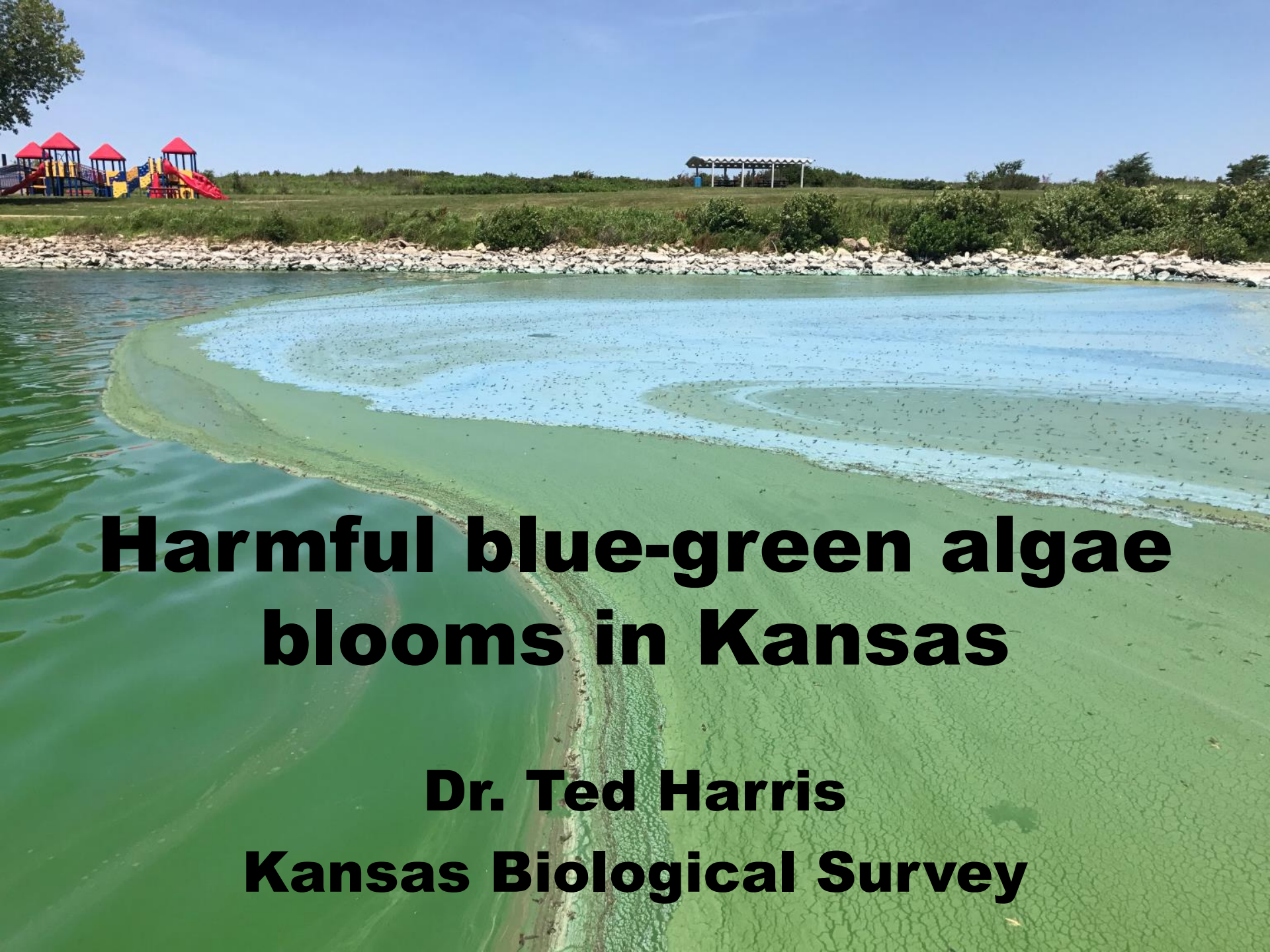


Harmful blue-green algae blooms in Kansas

Dr. Ted Harris

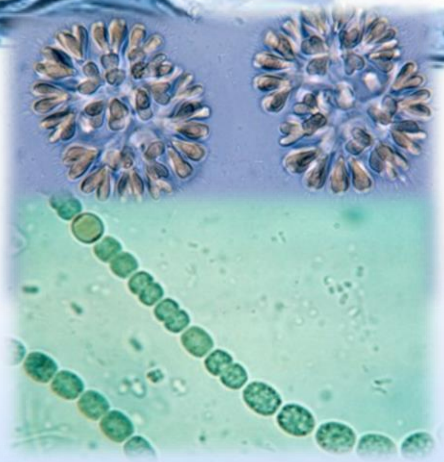
Kansas Biological Survey

Outline

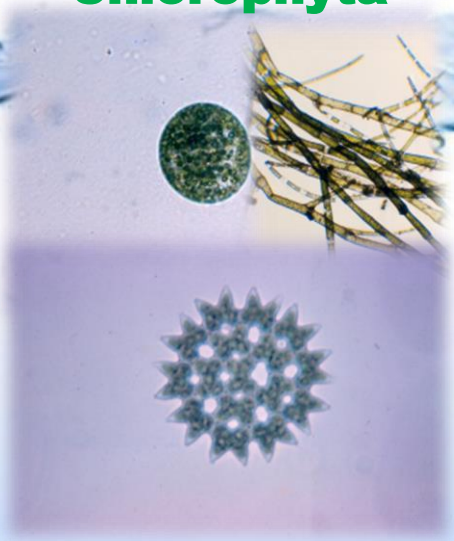
- What are Harmful BG Algal Blooms (HABs)?
- Consequences of HABs
- Causes of HABs
- How long have HABs occurred?
  - Preliminary data from KBS sediment cores
- Summary

Algal Diversity

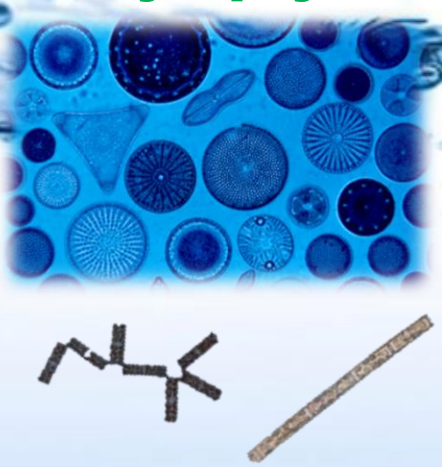
Cyanophyta



Chlorophyta

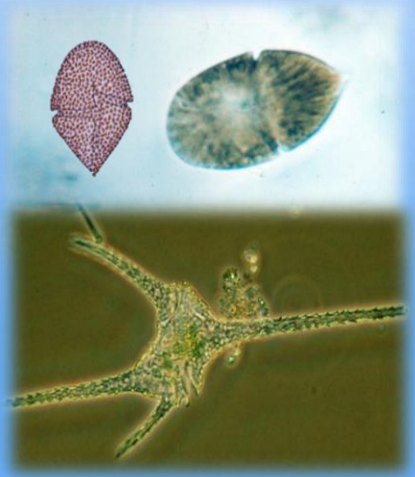


Chrysophyta

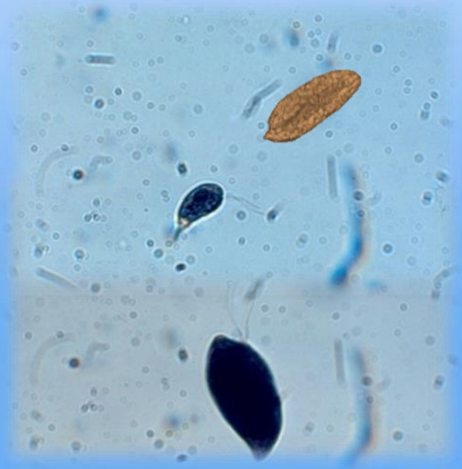


Freshwater groups of “tiny plants”

Pyrrophyta



Cryptophyta



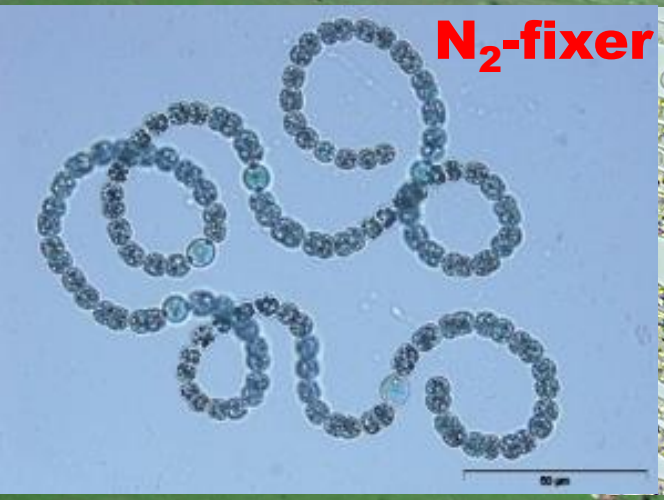
Euglenophyta

Harmful Algal Blooms in KS

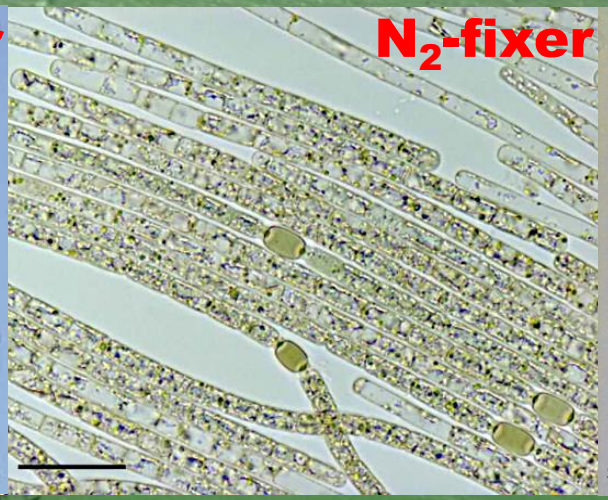
- Made of "blue-green" algae (Cyanobacteria)
- *Can* produce potent toxins (more potent than cobra!)
- *Can* produce taste-and-odor compounds
- But not always (we don't know why)
- Can increase 10^4 in a few hours in one spot
- Different from "red tide" algae

Cyanobacteria diversity

- 2000 - 8000 cyanobacteria species
- Each species has 100s/1000s of strains
- Only some <u>strains</u> capable of toxin/ T&O
- Strain must have gene(s) to produce toxin



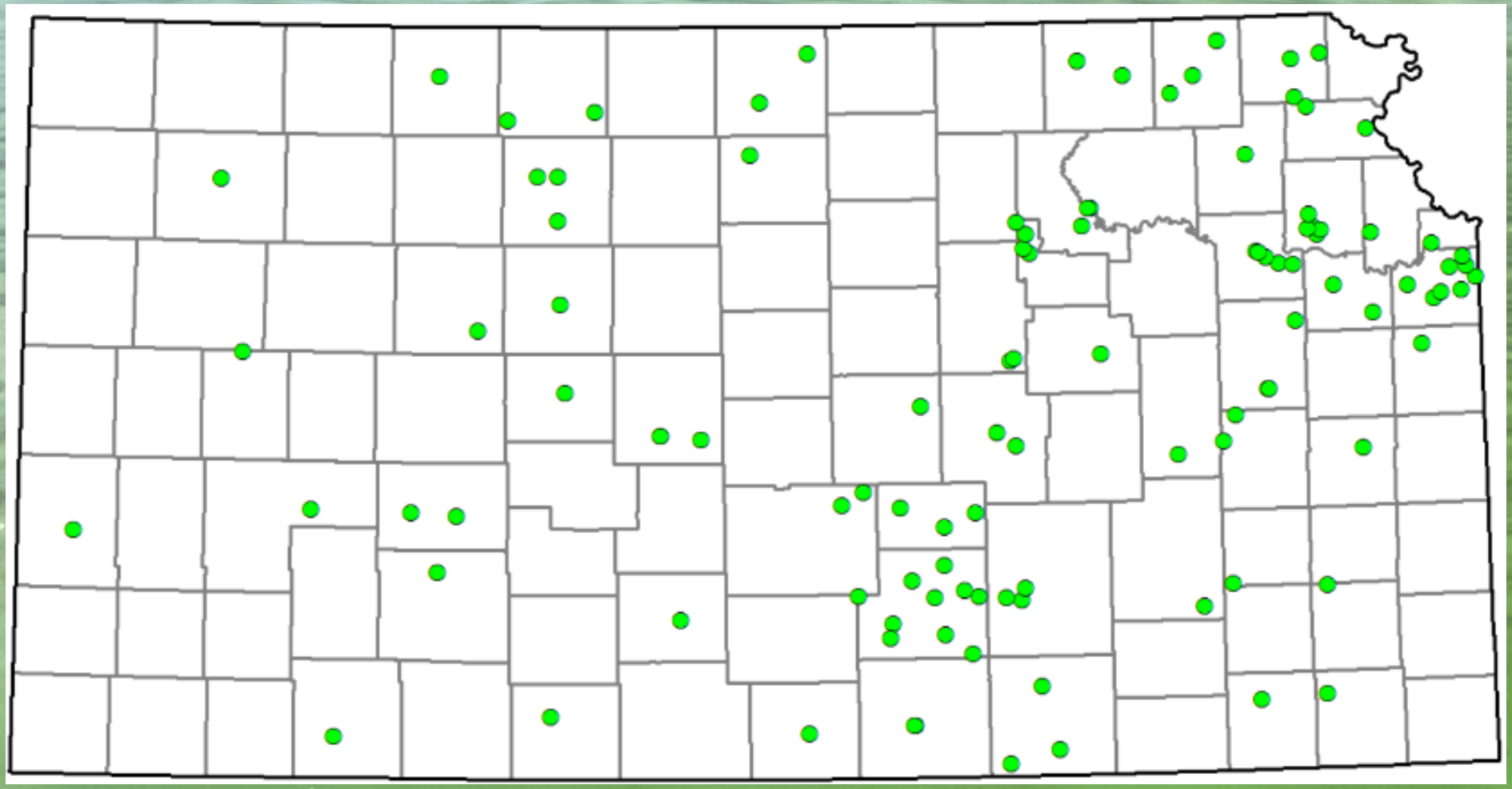
Anabaena
<u>Marion</u>
(now *Dolichospermum*)



Aphanizomenon
<u>Sebelius</u>
(now *Chrysosporum*)

Microcystis
<u>Milford & Marion</u>

Locations of CyanoHAB events in KS reservoirs from 2010-2017



Blooms form under the right conditions

Consequences of Cyano blooms

unpleasing

roperty values

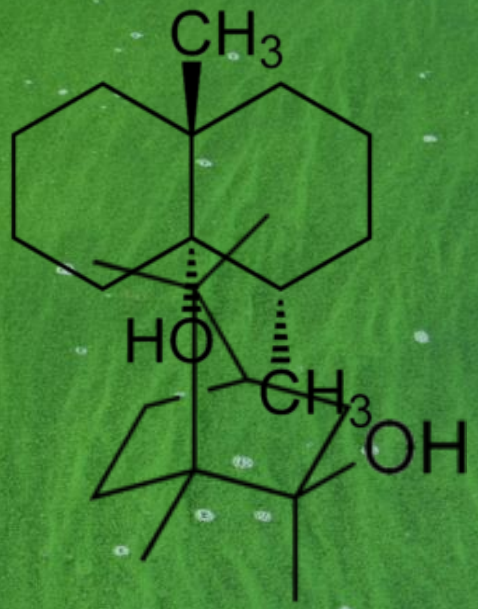
ste-and-odor compounds

Cyanobacterial toxins

- **Hepatotoxins, Neurological, Dermatoxins**
  - **Microcystin most common**
  - **>200 forms (congeners) range in toxicity**
- **Linked to illness/death of animals & humans**

Cyanobacterial Taste & Odor

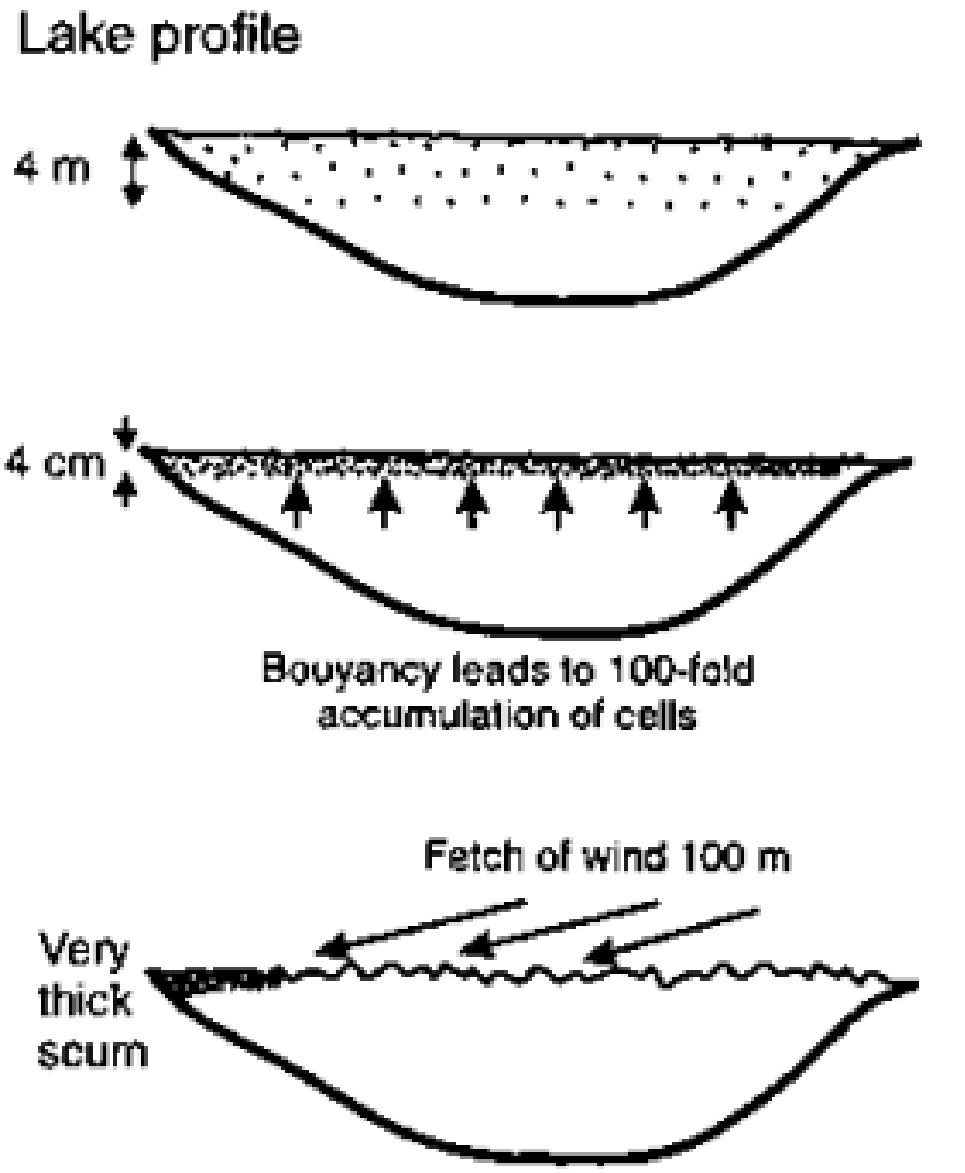
- Earthy, musty, fishy, swampy, or grassy T & O
  - Geosmin
  - 2-Methylisoborneol (MIB)



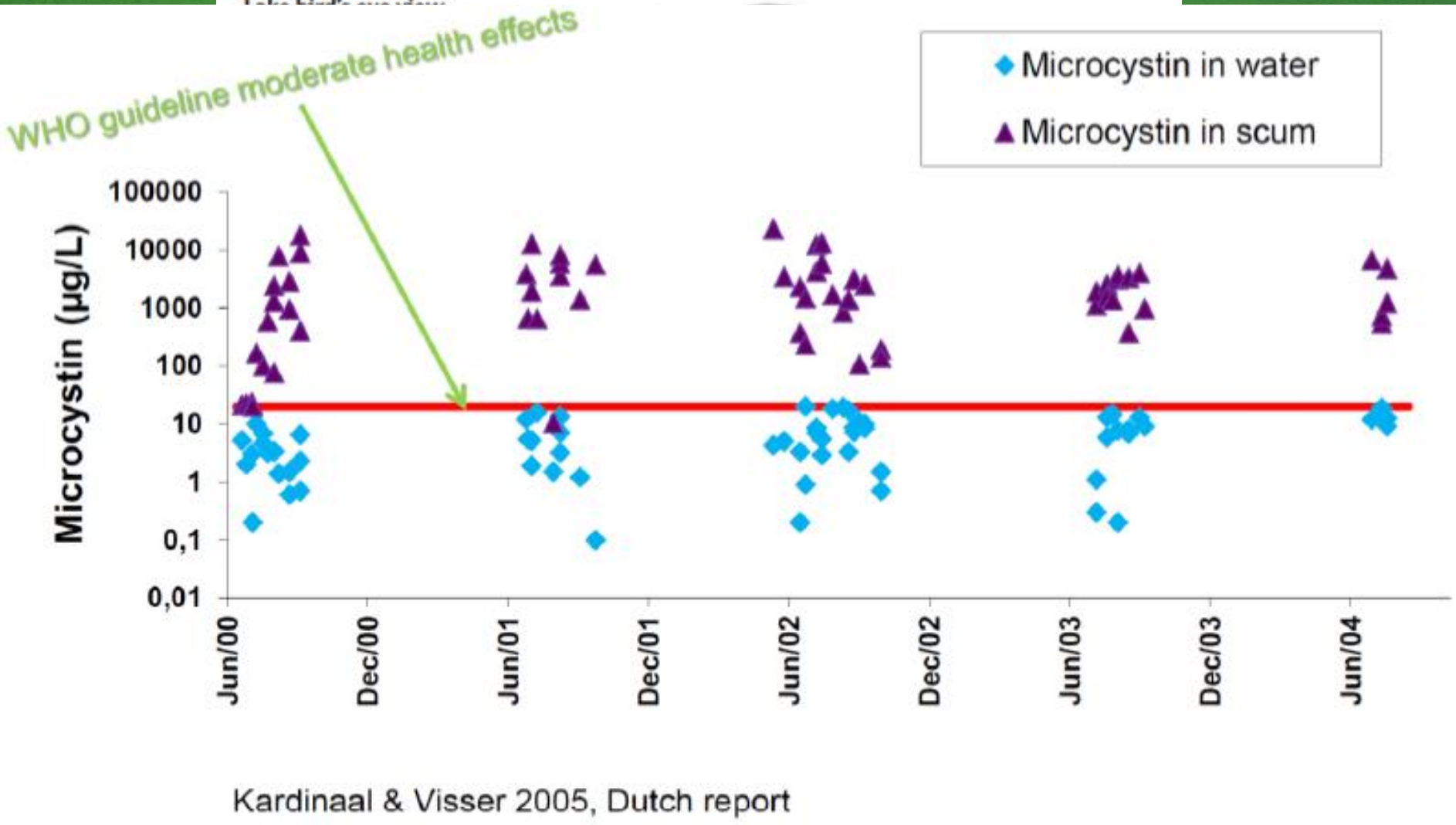
- Difficult to remove with conventional drinking water treatment technologies
- T & O episodes compromise public confidence in drinking water safety

Surface scums – Cyano. specialty

Chorus & Bartram 1999



Surface scums – Cyano. specialty



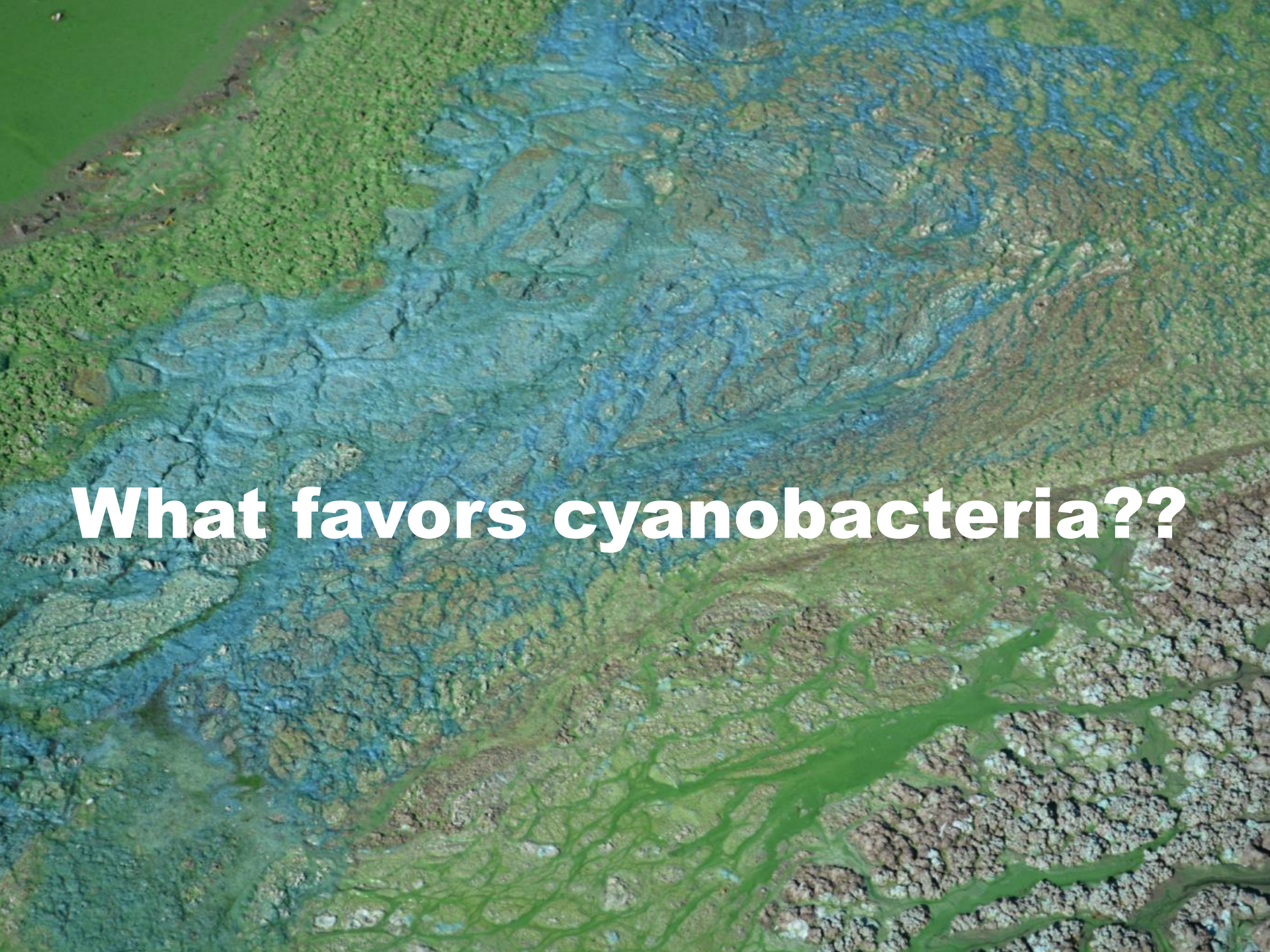
Kardinaal & Visser 2005, Dutch report

Scums are major health hazard

Why? Algal bloom causes

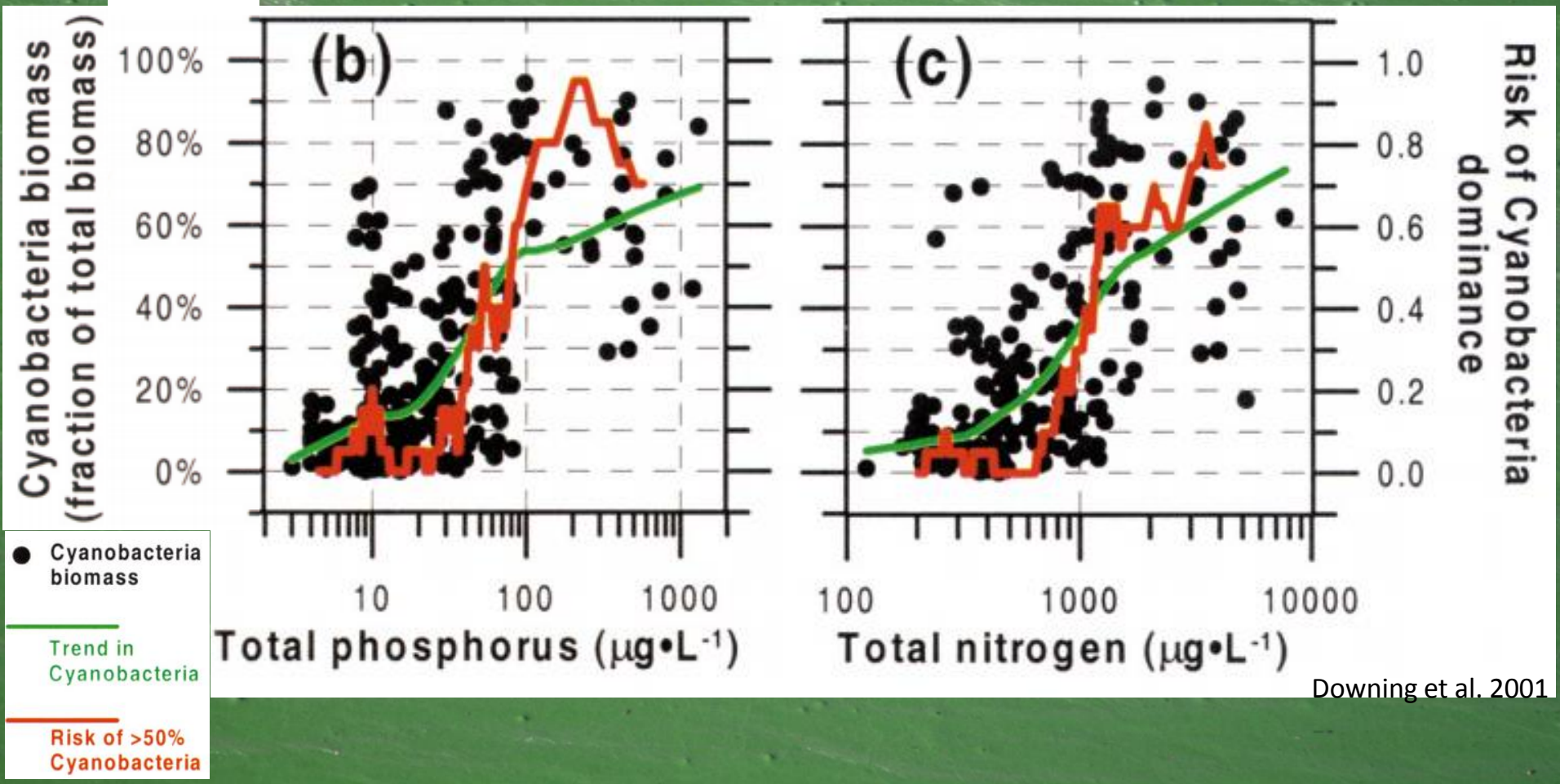
- Remember → algae are tiny plants
- Plants need:
  - Light
  - Nutrients
  - Water

- Each group of algae has different adaptations


What favors cyanobacteria??

Why? 2 primary factors

Nutrients = Nitrogen & Phosphorus



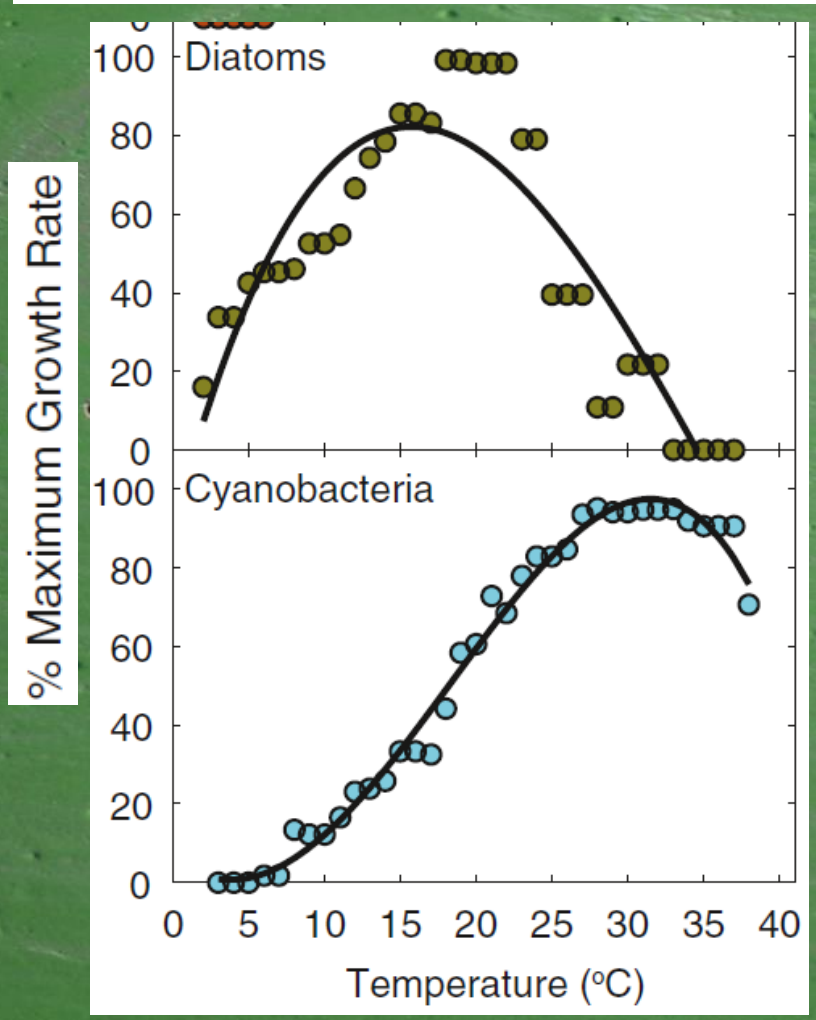
Downing et al. 2001

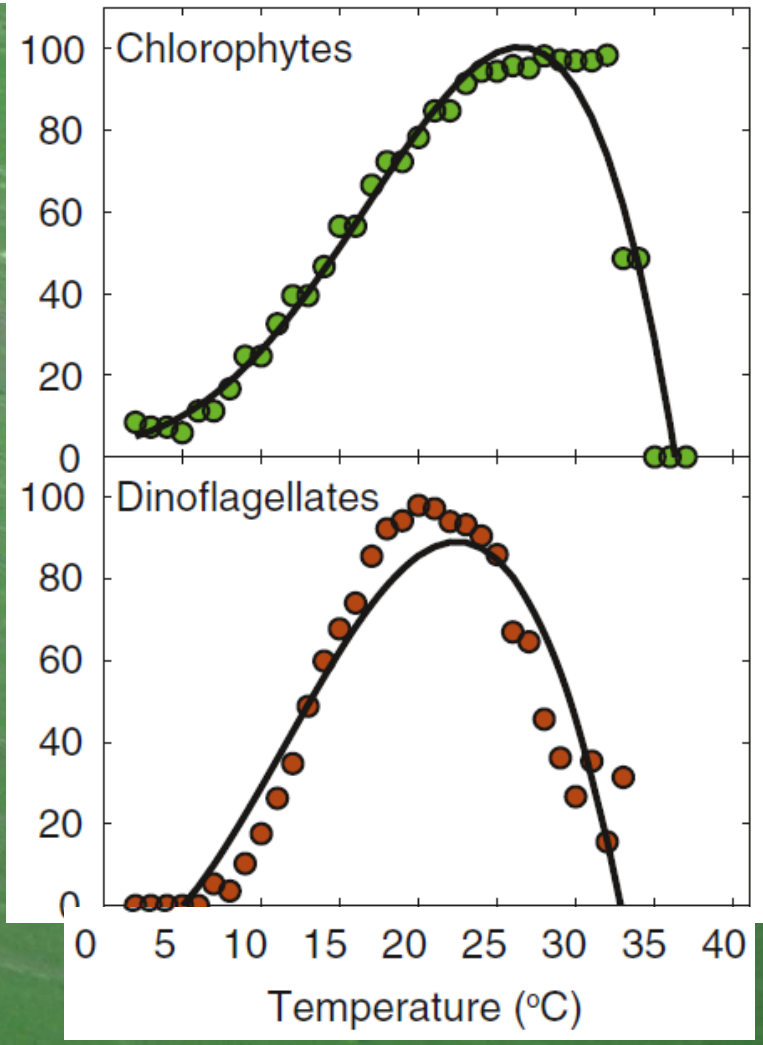
CLIMATE

Blooms Like It Hot

A link exists between global warming and the worldwide proliferation of harmful cyanobacterial blooms.

Hans W. Paerl[1] and Jef Huisman[2]





Other factors

Low Nitrogen to Phosphorus Ratios Favor Dominance by Blue-Green Algae in Lake Phytoplankton

Val H. Smith

Science, New Series, Vol. 221, No. 4611 (Aug. 12, 1983), 669-671.

N:P

Combined effects of nitrogen to phosphorus and nitrate to ammonia ratios on cyanobacterial metabolite concentrations in eutrophic Midwestern USA reservoirs

Ted D. Harris,[1,2]* Val H. Smith,[1] Jennifer L. Graham,[2] Dedmer B. Van de Waal,[3] Lenore P. Tedesco,[4] Nicolas Clercin[5]

N form

The selective advantage of buoyancy provided by gas vesicles for planktonic cyanobacteria in the Baltic Sea

ANTHONY E. WALSBY ✉, PAUL K. HAYES, ROLF BOJE, LUCAS J. STAL

Float

A novel model for cyanobacteria bloom formation: the critical role of anoxia and ferrous iron

L. A. Molot ✉, S. B. Watson, I. F. Creed, C. G. Trick, S. K. McCabe, M. J. Verschoor, R. J. Sorichetti, C. Powe, J. J. Venkiteswaran, S. L. Schiff

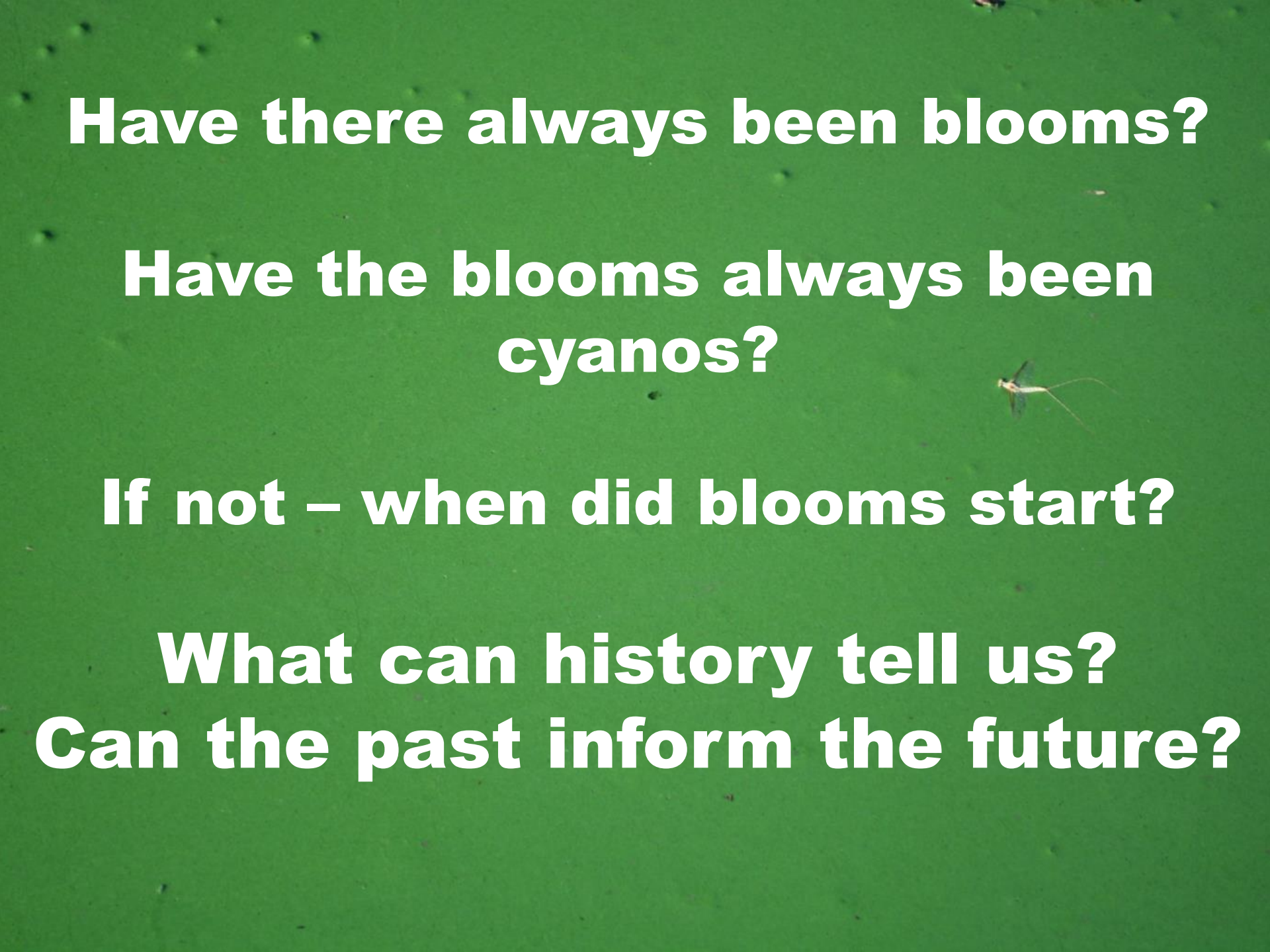
Iron?

Others: luxury uptake/ N & P storage, pesticides/herbicides, adapt to hi/lo light…

Most Kansas waterbodies:
Have plenty of nutrients
Although nutrient reduction helps!
Get hot in summer

The numbers

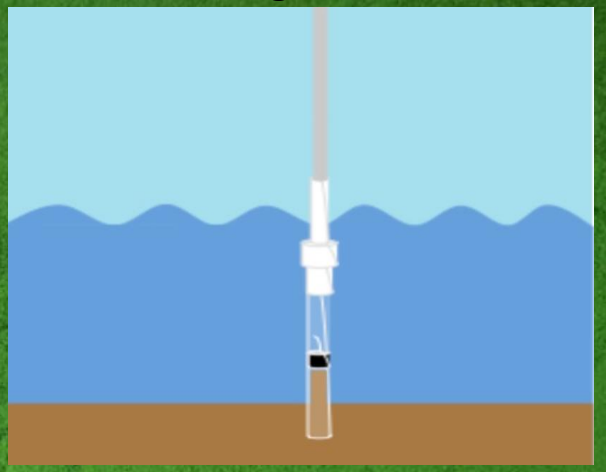
- KS has 200,000 impoundments
- Between 20-30 bloom in summer
- Round up to approx. 30 get blooms/year
- Estimate 0.015% of lakes have blooms
- Small number, but blooms can be very toxic
  - KS has had one of the most toxic blooms ever recorded! → Milford 2011
  - Raw lake water had 7,500 times the current World Health Organizational Guidance Value for recreation


Have there always been blooms?
Have the blooms always been cyanos?
If not – when did blooms start?
What can history tell us?
Can the past inform the future?

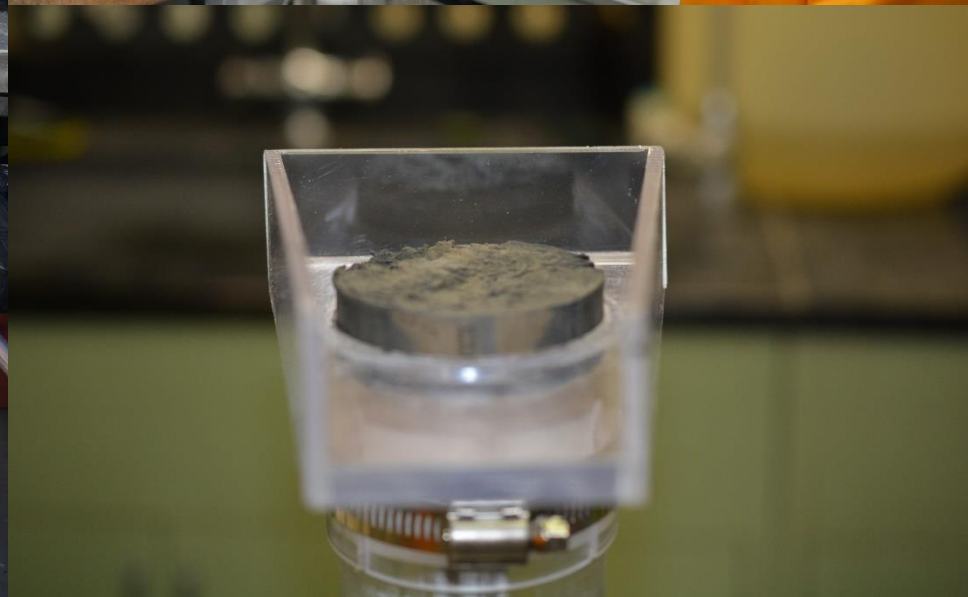
Sediment coring

- Cores – like tree rings
- HAB historical record
  - Uses algal pigments
  - Different algae → Different pigments
- Shows algal groups through time

Ogdahl et al. 2014

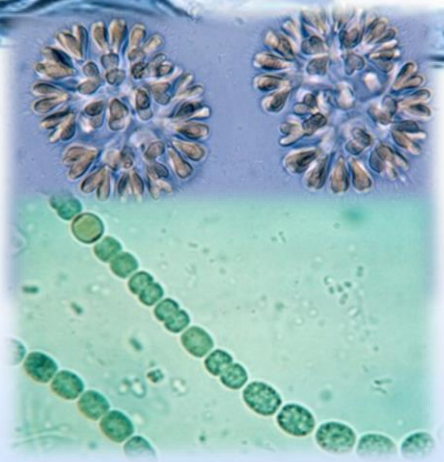


Milford sediment coring

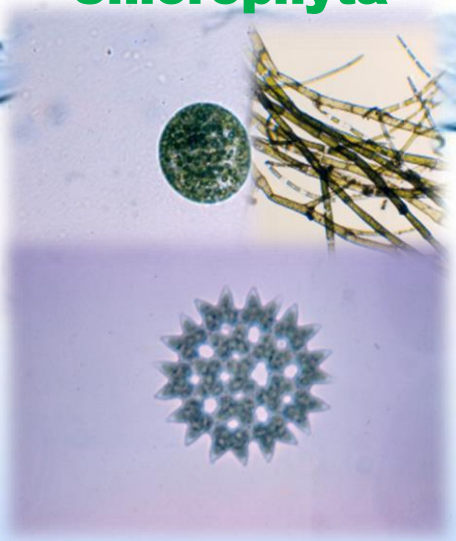


Total algae = all groups

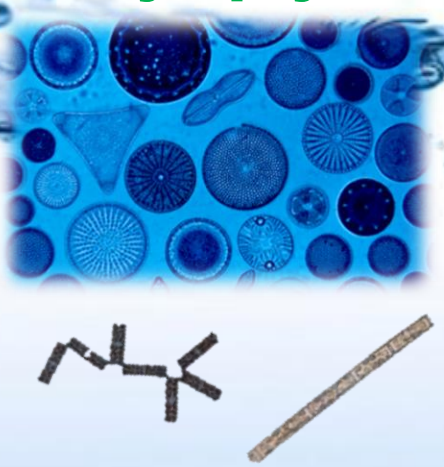
Cyanophyta



Chlorophyta

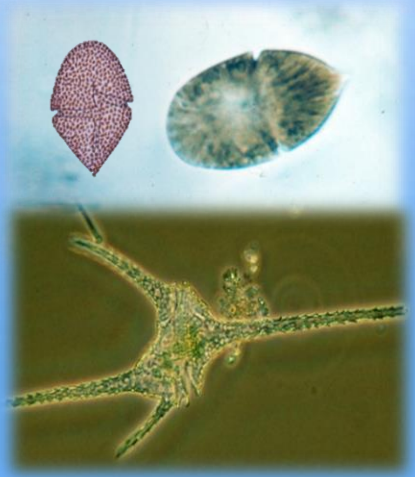


Chrysophyta



Each group has unique pigment

Pyrrophyta



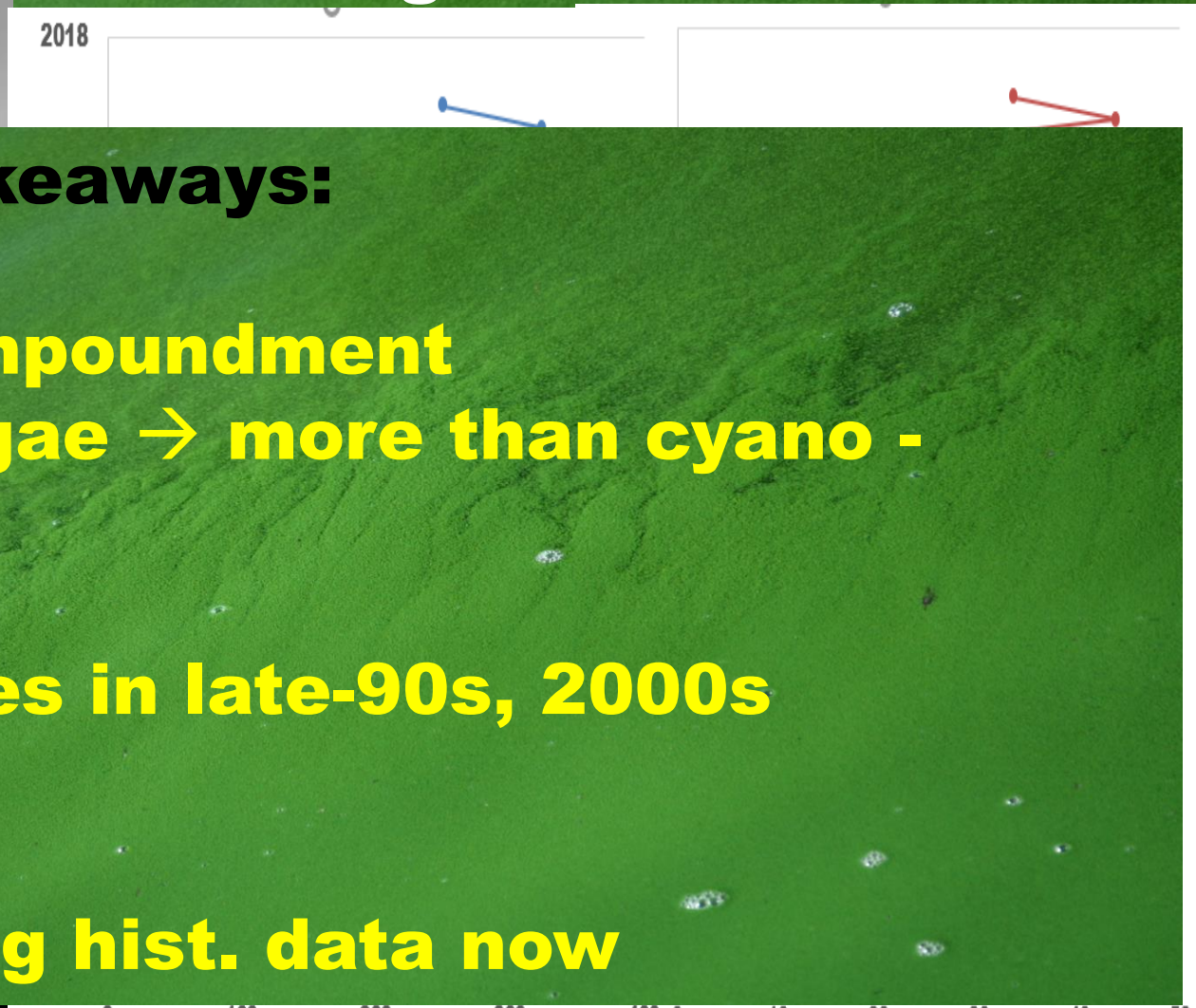
Cryptophyta

Euglenophyta

PRELIM Milford results

Total algae HABs

June 2018- Milford



Preliminary takeaways:

Blooms post impoundment
- mixture of algae → more than cyano -

Cyano increases in late-90s, 2000s

Why? Collecting hist. data now

Summary

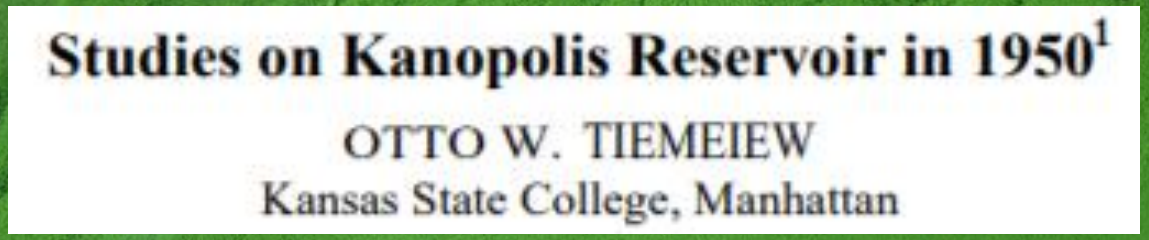
- Harmful Algal Blooms in KS are made of cyanobacteria (blue-green algae)
- Cyano can produce toxins/taste&odor
  - But not always (we don't know why)
- Cyanos buoyant – form scums
  - Change location rapidly
  - Scums are serious health hazard

Summary

- Cyanos like lots of nutrients & warm temperatures
- Most KS lakes have high probability of cyano blooms in summer
  - Can occur anytime
  - Risk of blooms highest in summer
- Milford did not always have HABs
  - What changed in mid/late 90s??
  - Finishing draft report now

Big Picture Summary

- **Milford and likely other lakes have increased in cyanos over time**
- **But some lakes showing the opposite**


Studies on Kanopolis Reservoir in 1950[1]

OTTO W. TIEMEIEW

Kansas State College, Manhattan

Documented large growth of cyanobacteria in 1950
Started in July and peaked in August
Bloom level within current KDHE public health warning

No HABs on Kannopolis since 2010 monitoring started…
What changed from 1950 until now?

Started unraveling Kanopolis history last month!

Big Picture Summary

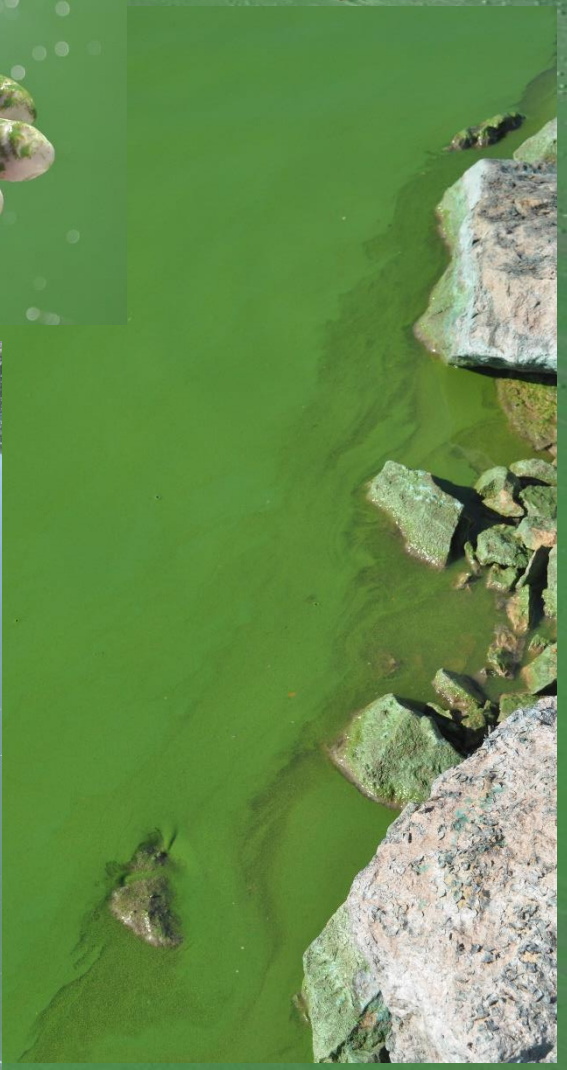
- **Why have some lakes increased in HABs while others decreased???**

- **Sediment coring can help gain insights into past & why/how HABs start & stop in a lake**
  - **Could be discouraging….**
  - **But can also bring hope**
    - **Decades w/ much less frequent HABs in Milford – can it return?**
- **More cored lakes, experiments, data collection/aggregation → better understand long- and short-term processes that help change risk of HABs**

Thank you!

Questions?

Email:
T992H577@KU.edu



Pictures from Milford 2017

Well this is gross...