

Cyanobacteria in Surface Drinking Waters: An Ecologist's View

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Cyanobacteria Management: New role for the water engineer

- Need knowledge of the “enemy”
- Defeat (or survive) the enemy by knowing its strategies, i.e. understand its ecology

Problem lakes

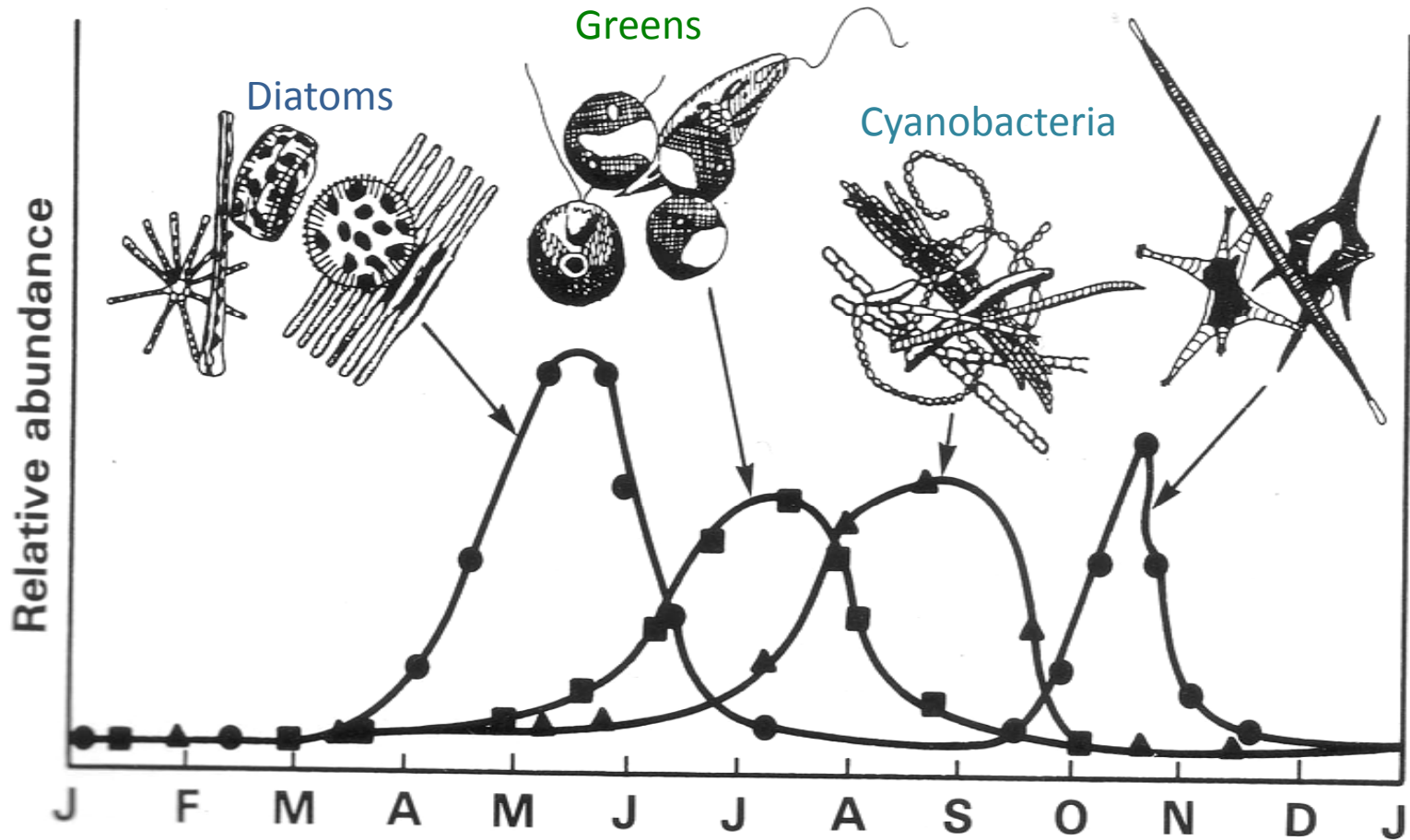
- Eutrophic lakes
 - Serious, but consistent problem

- Meso-oligotrophic lakes
 - Spatial and temporal heterogeneity
 - Typical problem lakes in the Northeast

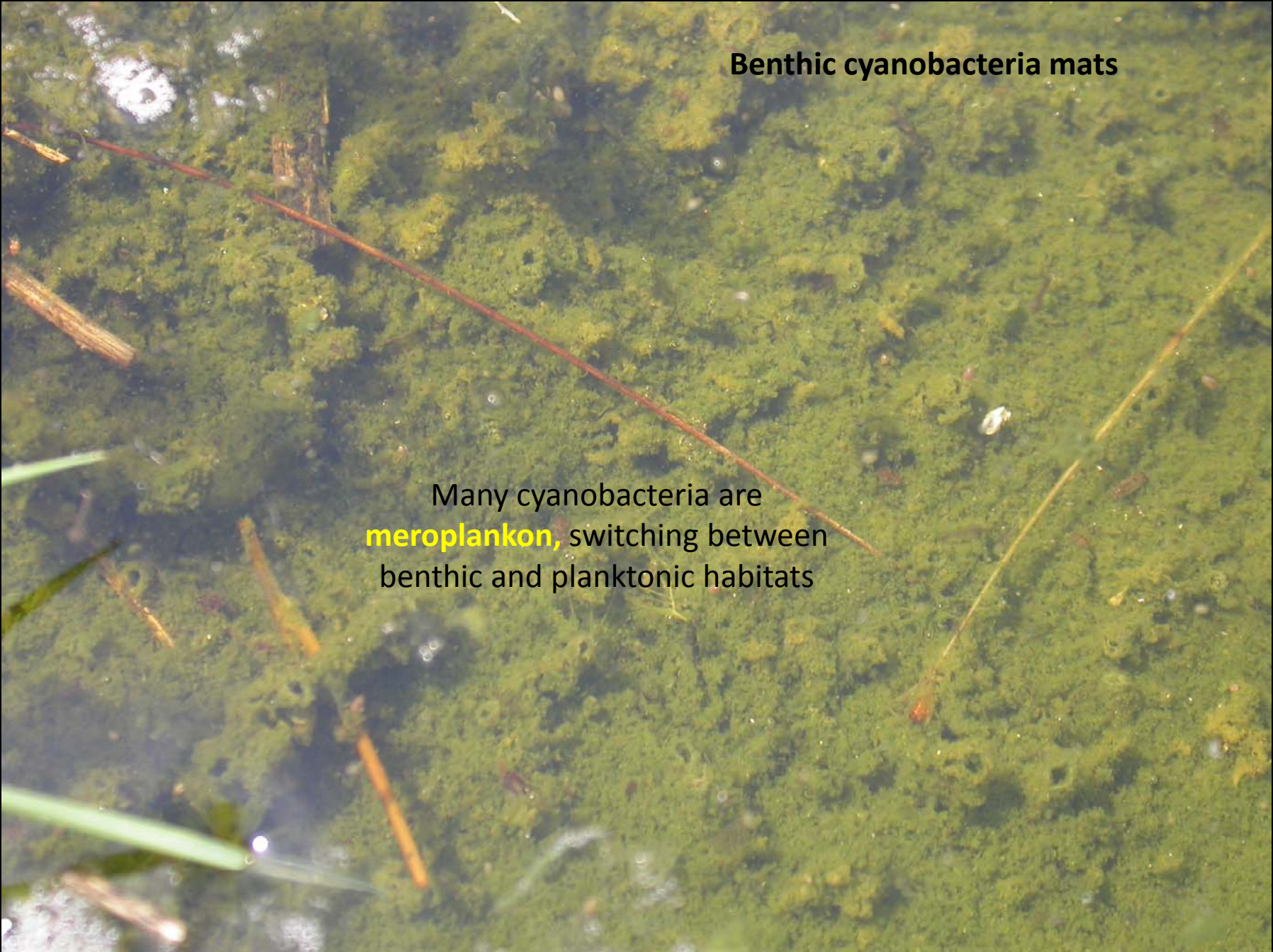
Cyanobacteria

When and where are they?

Seasonal Succession General Pattern



Benthic Cyanobacteria



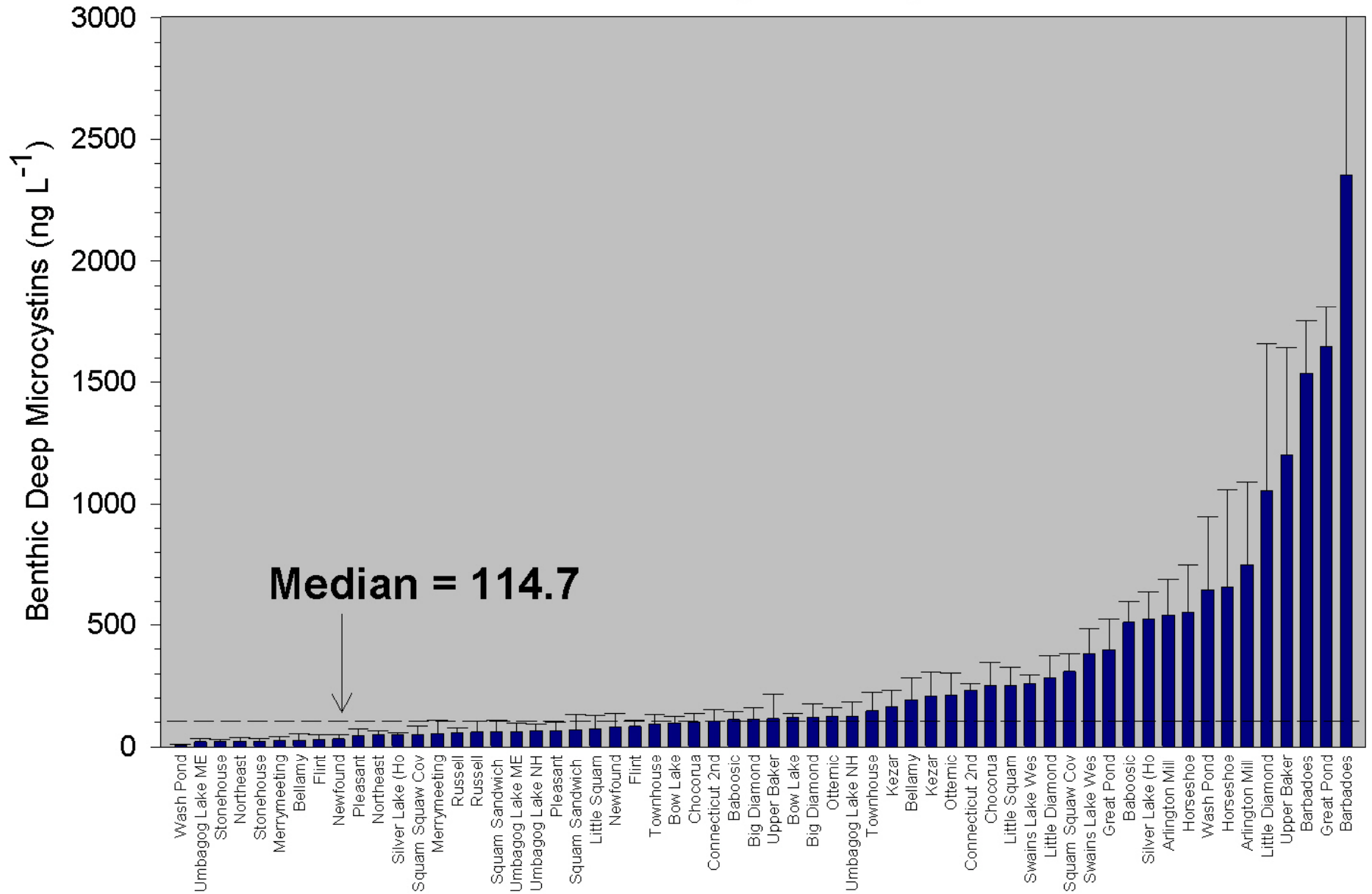
Benthic cyanobacteria mats

Many cyanobacteria are **meroplankton**, switching between benthic and planktonic habitats

Deep Benthic Core



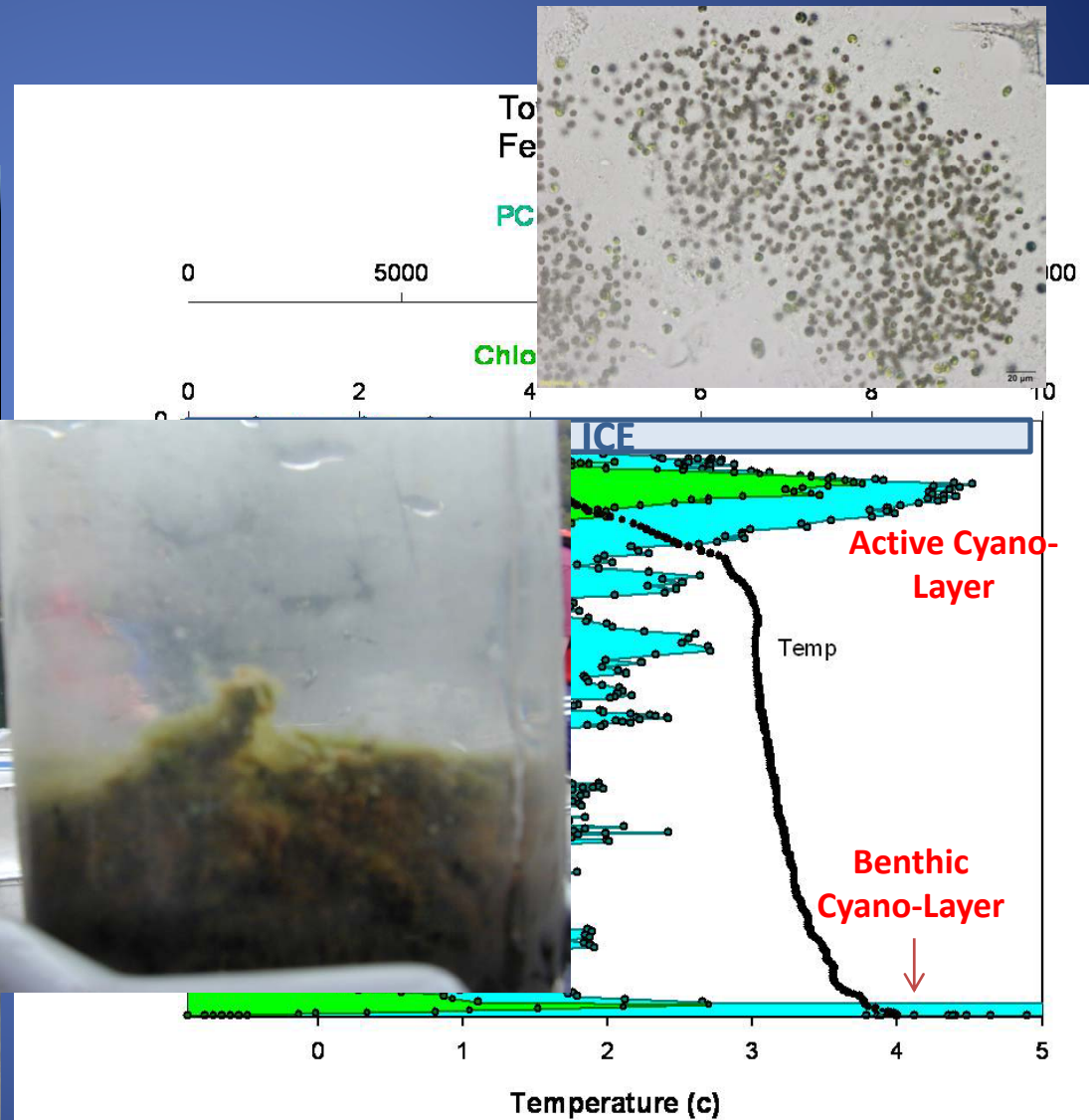
Benthic Deep Microcystins



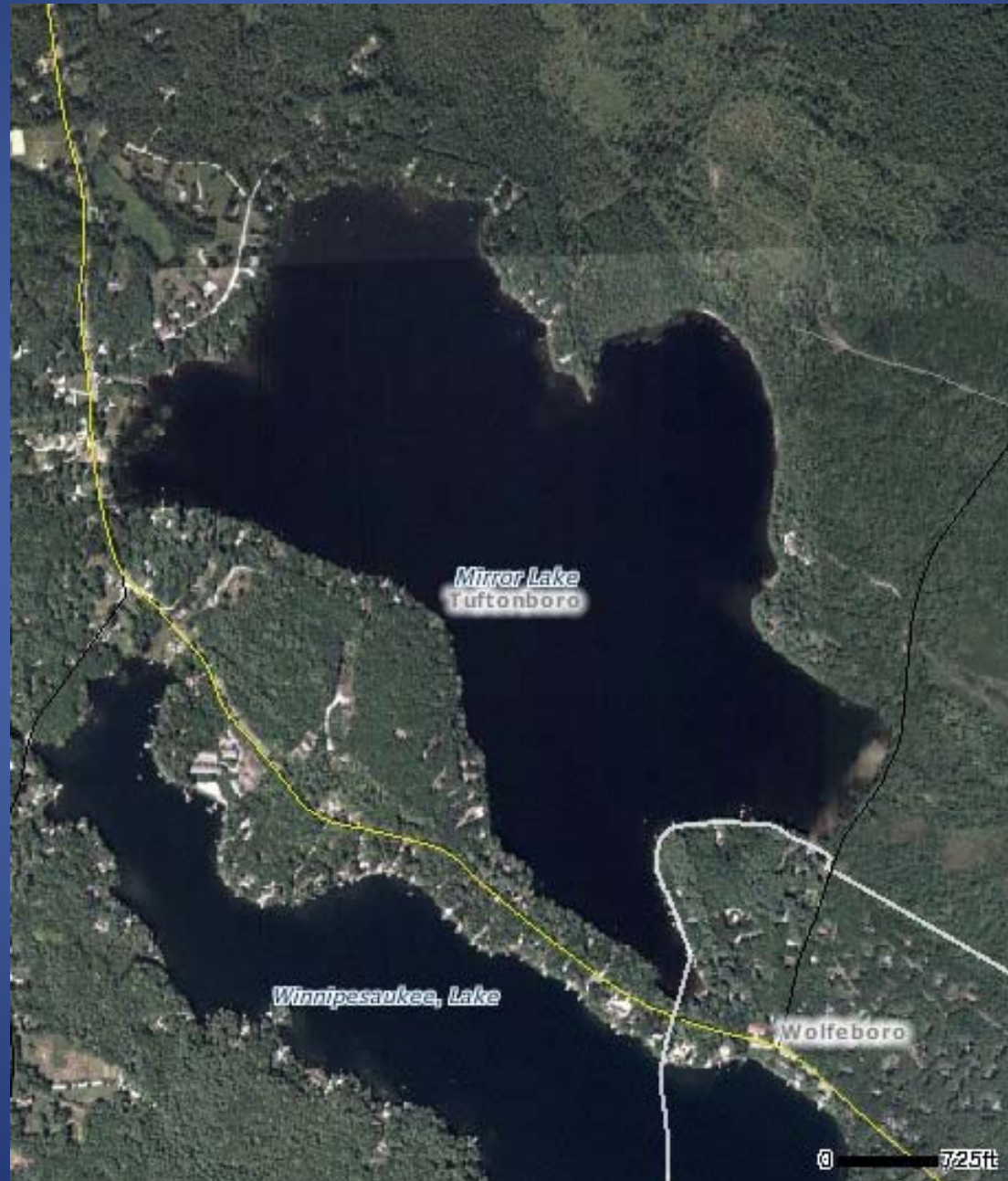
Vertical Distributions

Winter Strategies

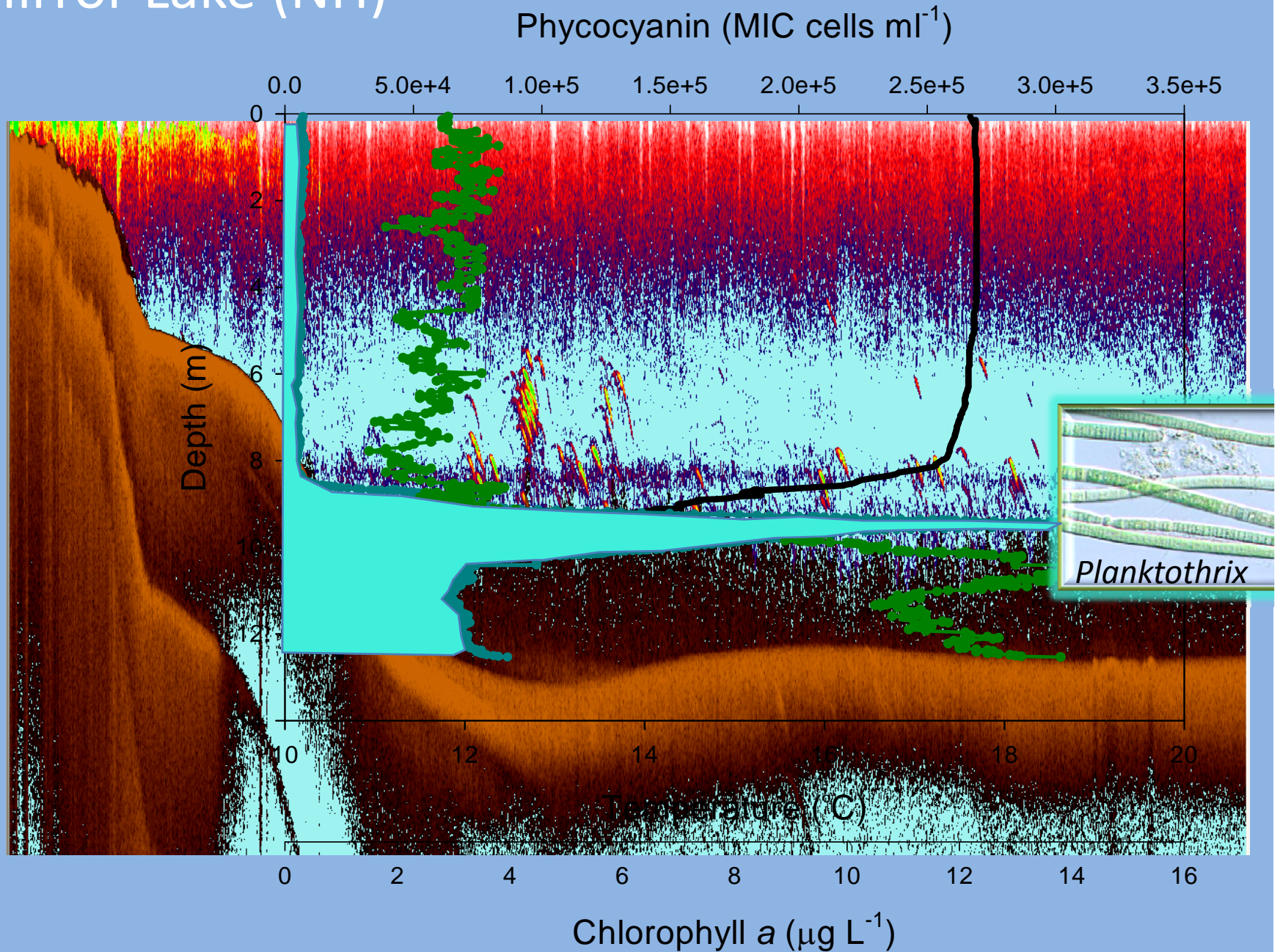
Milton 3-Ponds



Deep (metalimnetic) Layers: Mirror Lake, NH

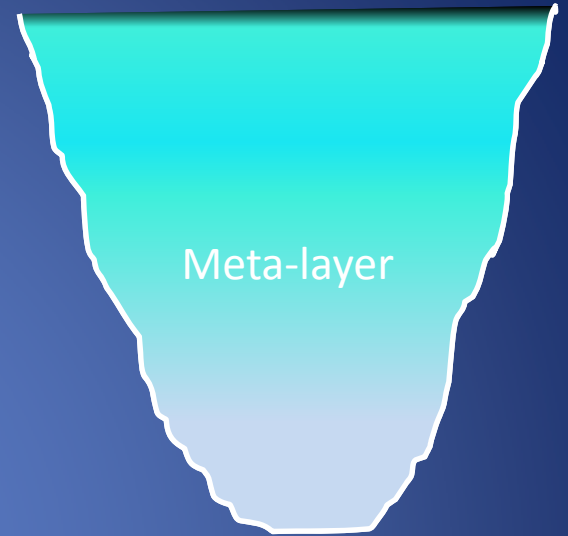


Mirror Lake (NH)



Spring

Summer



Calm, Cloudy

Late Summer

Light Wind



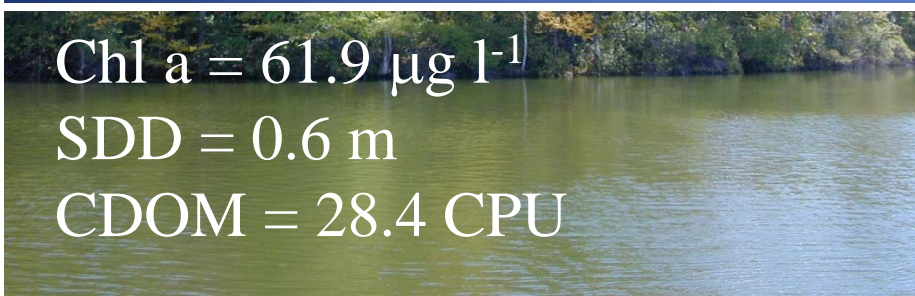
100-10,000X



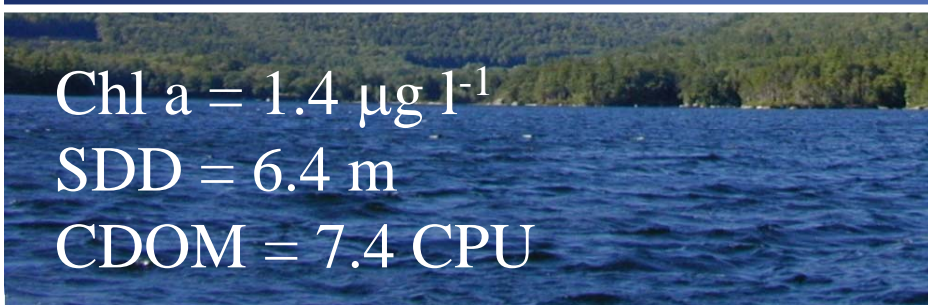


York Pond

Cyanobacteria are in all lakes



Chl a = $61.9 \mu\text{g l}^{-1}$
SDD = 0.6 m
CDOM = 28.4 CPU



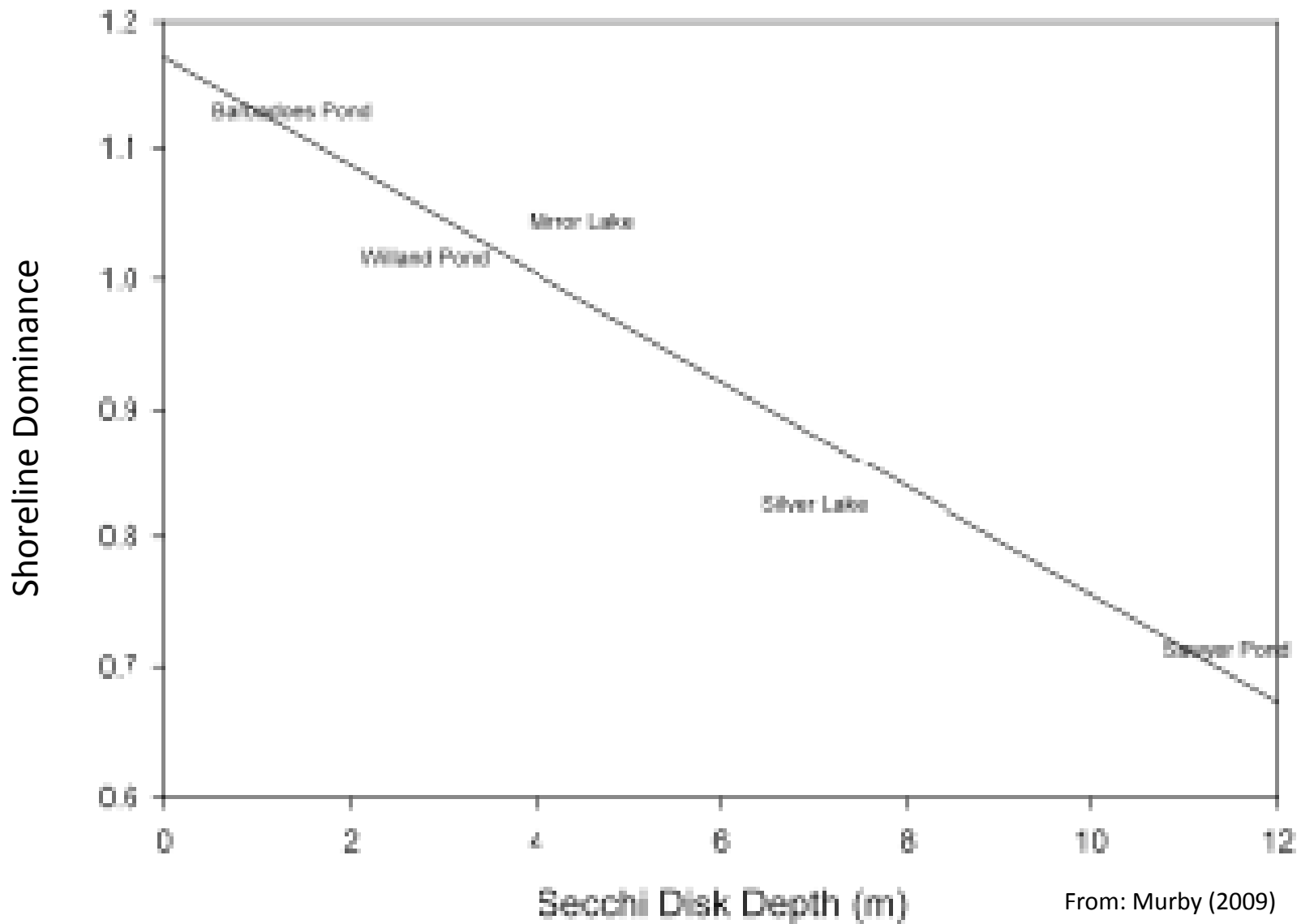
Chl a = $1.4 \mu\text{g l}^{-1}$
SDD = 6.4 m
CDOM = 7.4 CPU



Christine Lake

Horizontal Distributions

Shoreline Cyano-Dominance: Ratio of Shore:Deep PC vs Water Clarity



Meredith Water Department



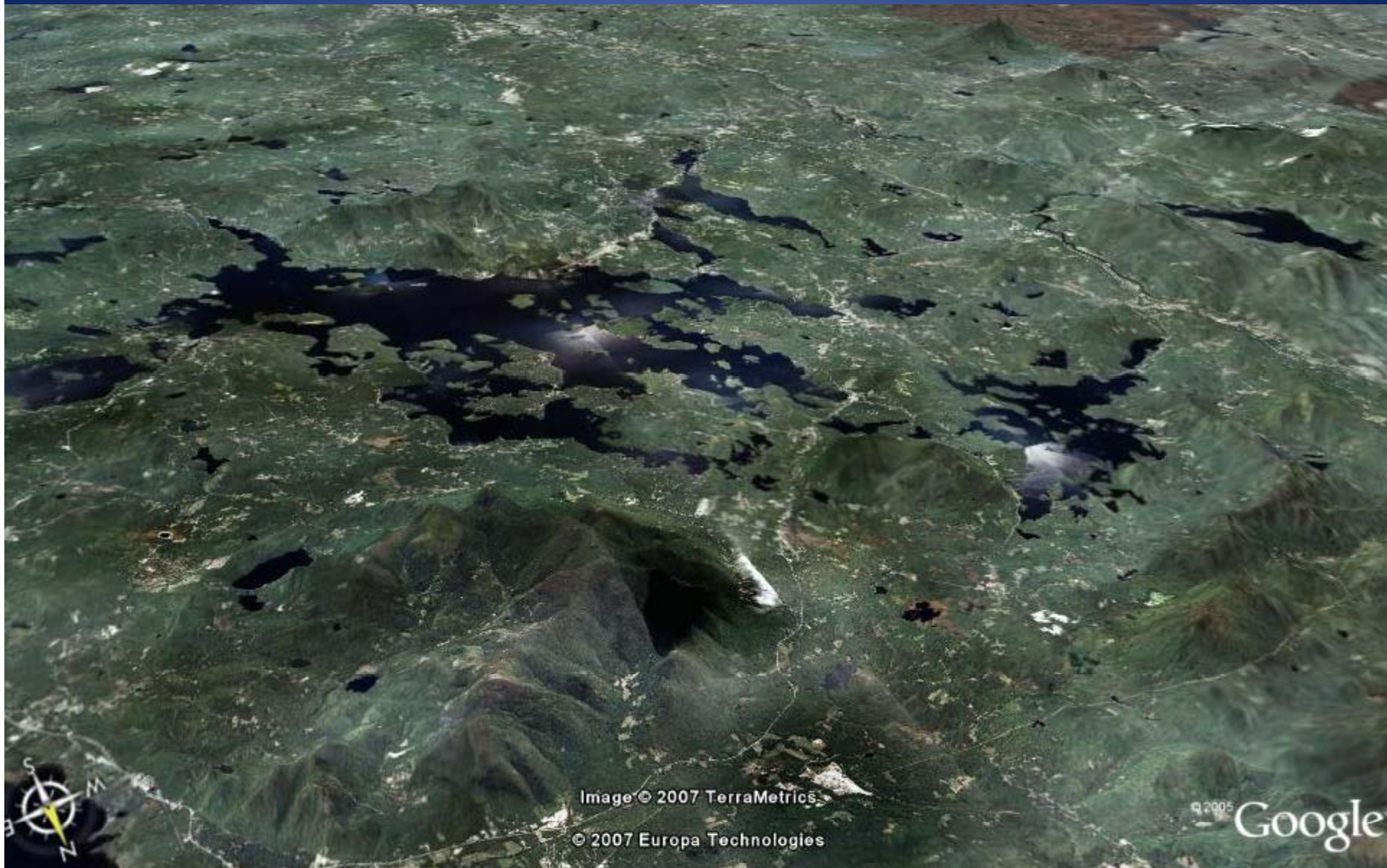


Image © 2007 TerraMetrics

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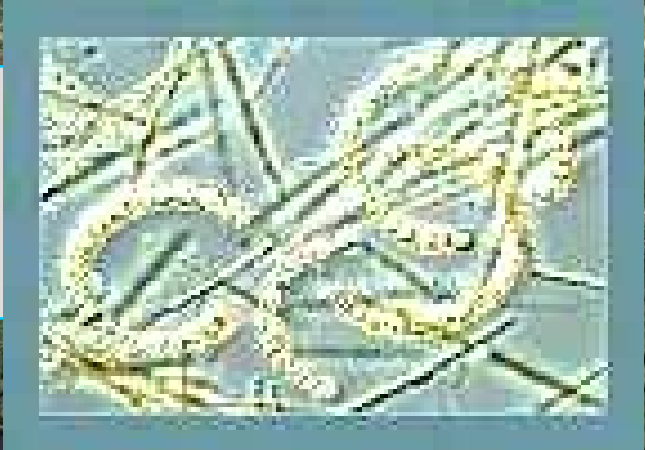
Point 43°43'03.07" N 71°23'01.15" W elev 537 ft

Streaming ||||. 58%

Eye alt 13.62 mi

“oil slick” reported Nov 18, 2004 & Dec 2006

Anabaena circinalis
toxic:
microcystins!



Water Intake

Meredith



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r 43°39'09.15" N 71°30'42.60" W elev 541 ft

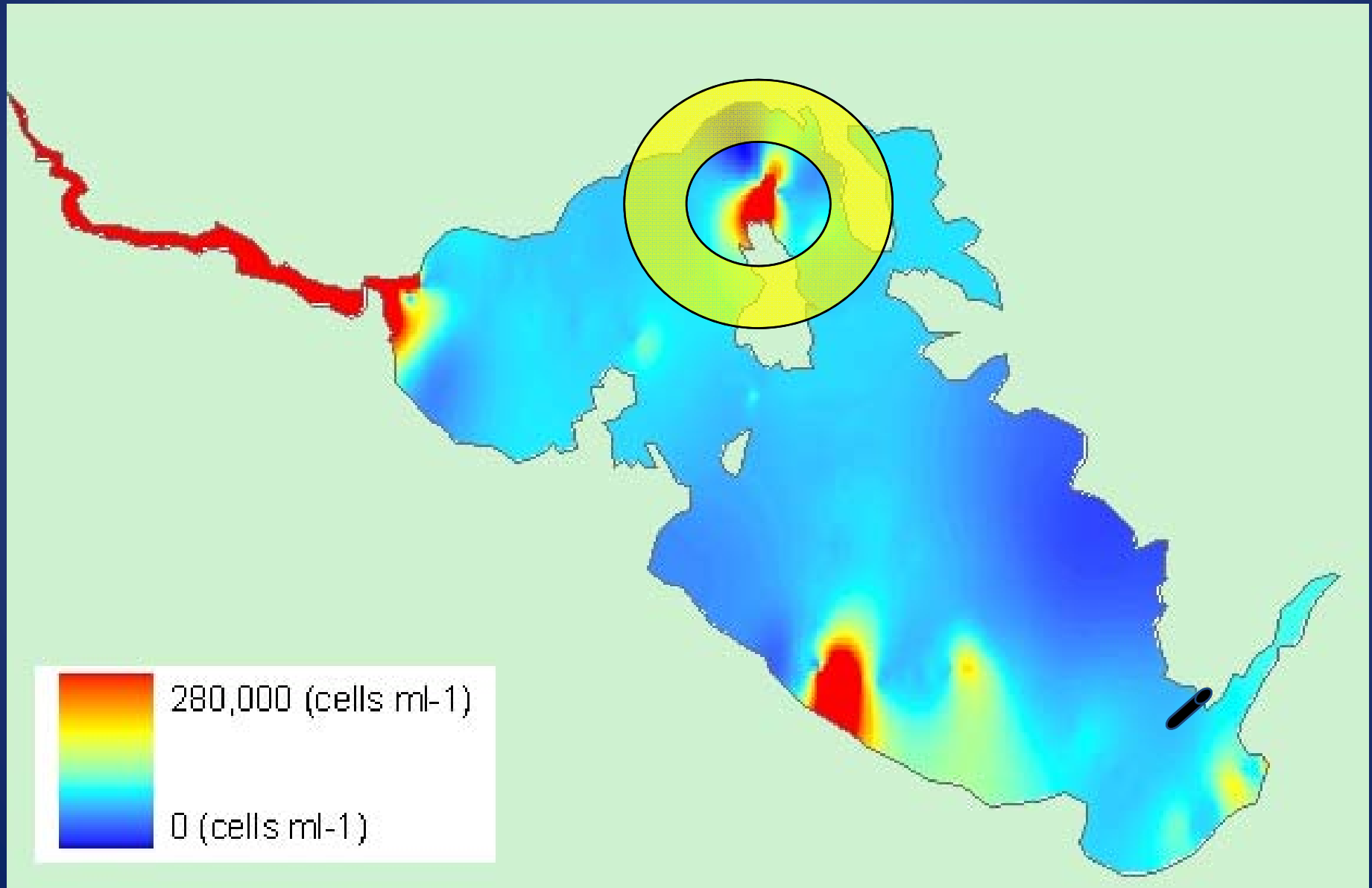
Streaming 1%

Eye alt 7969 ft

Lake Waukewan Grazers



Lake Waukewan (Meredith, NH) Synoptic Survey with PC Probe



Phosphorus sources?



Impervious surface:
runoff

5

1 Lawn: High Runoff
Fertilizer

2 Poor vegetation shoreline buffer
Erosion & runoff

3

Outboard motor: direct
input of phosphorus
Mixing of sediments

4

Impervious surface:
runoff



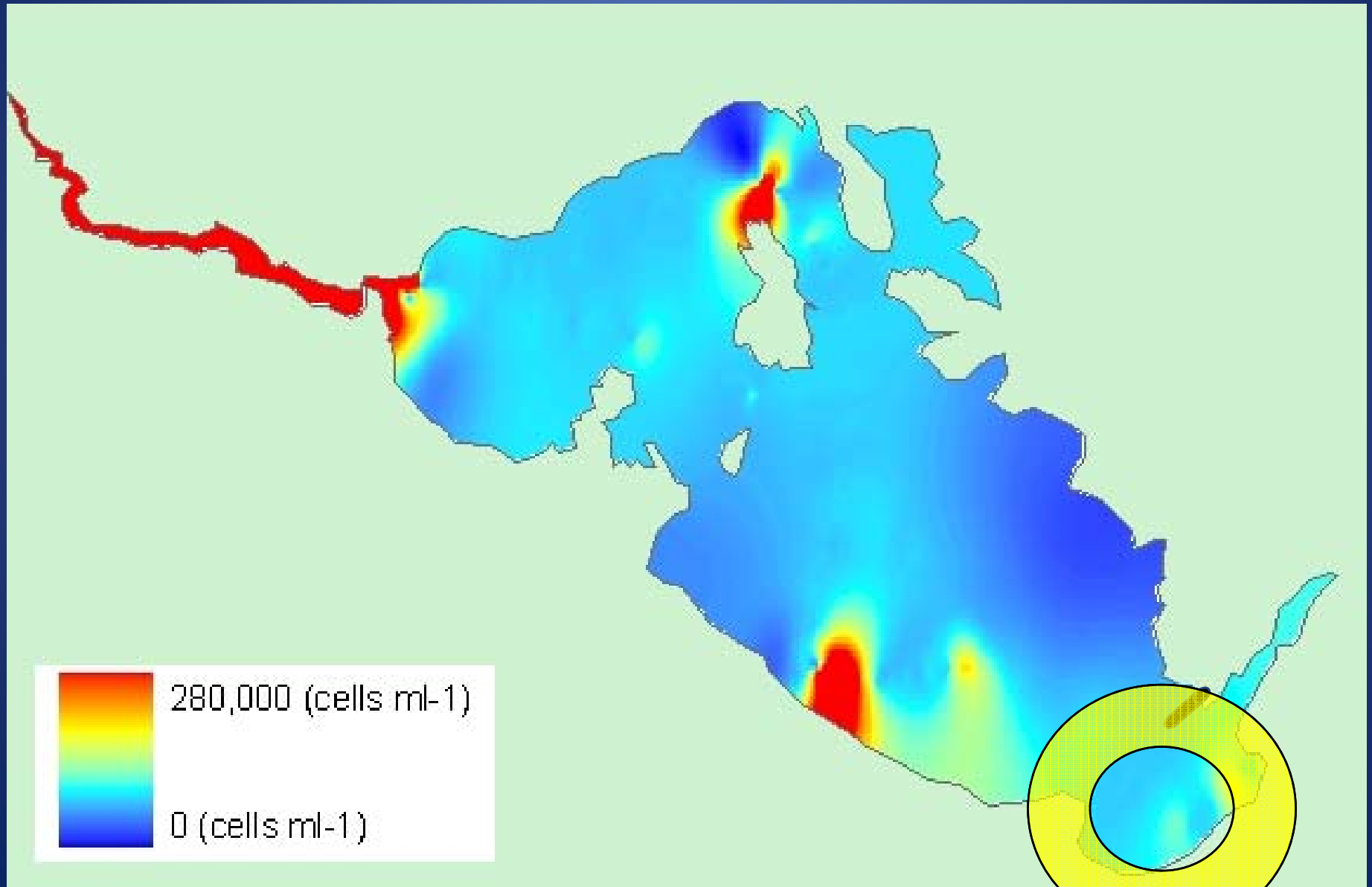
Setback



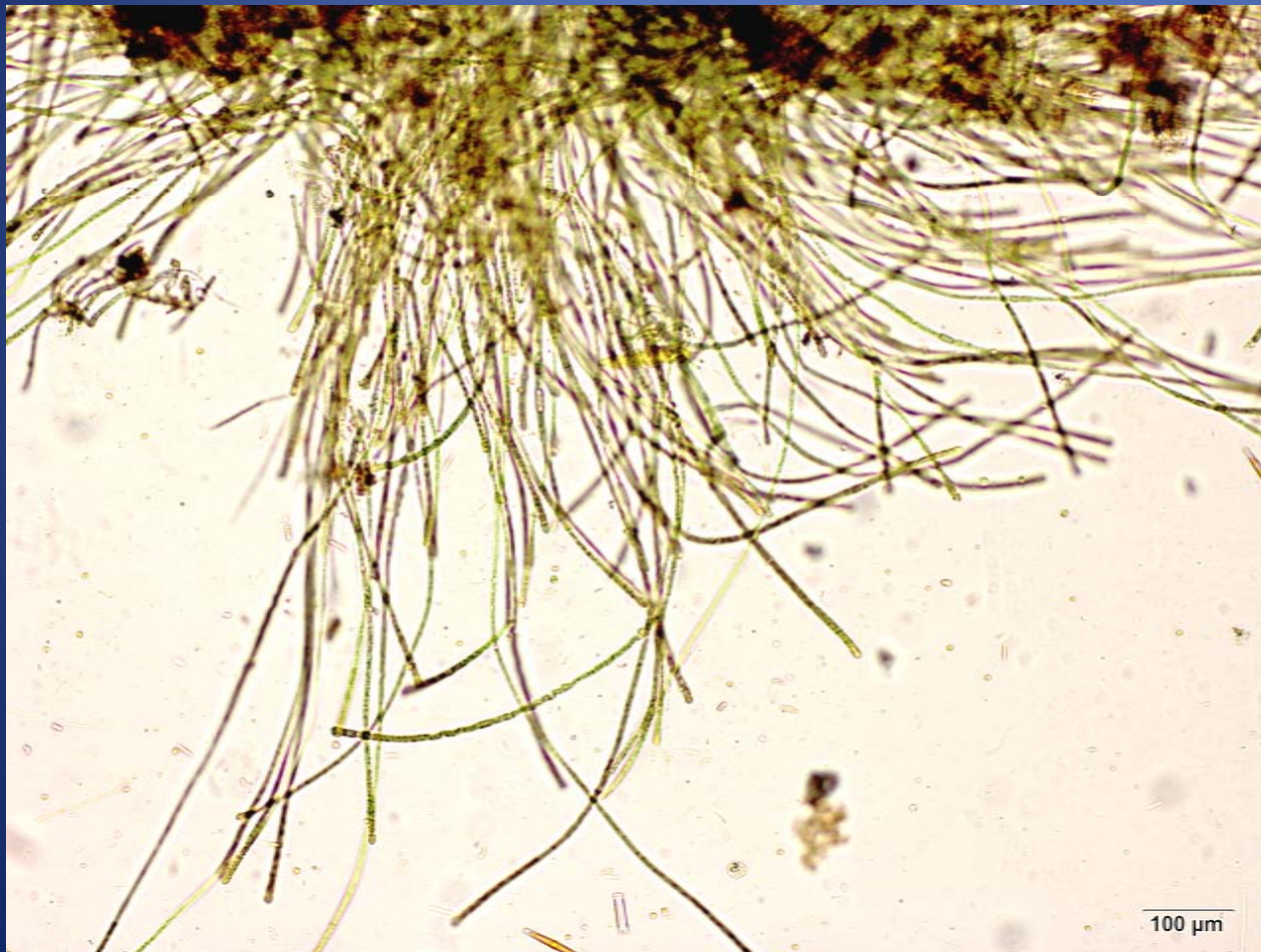
“Conversions”

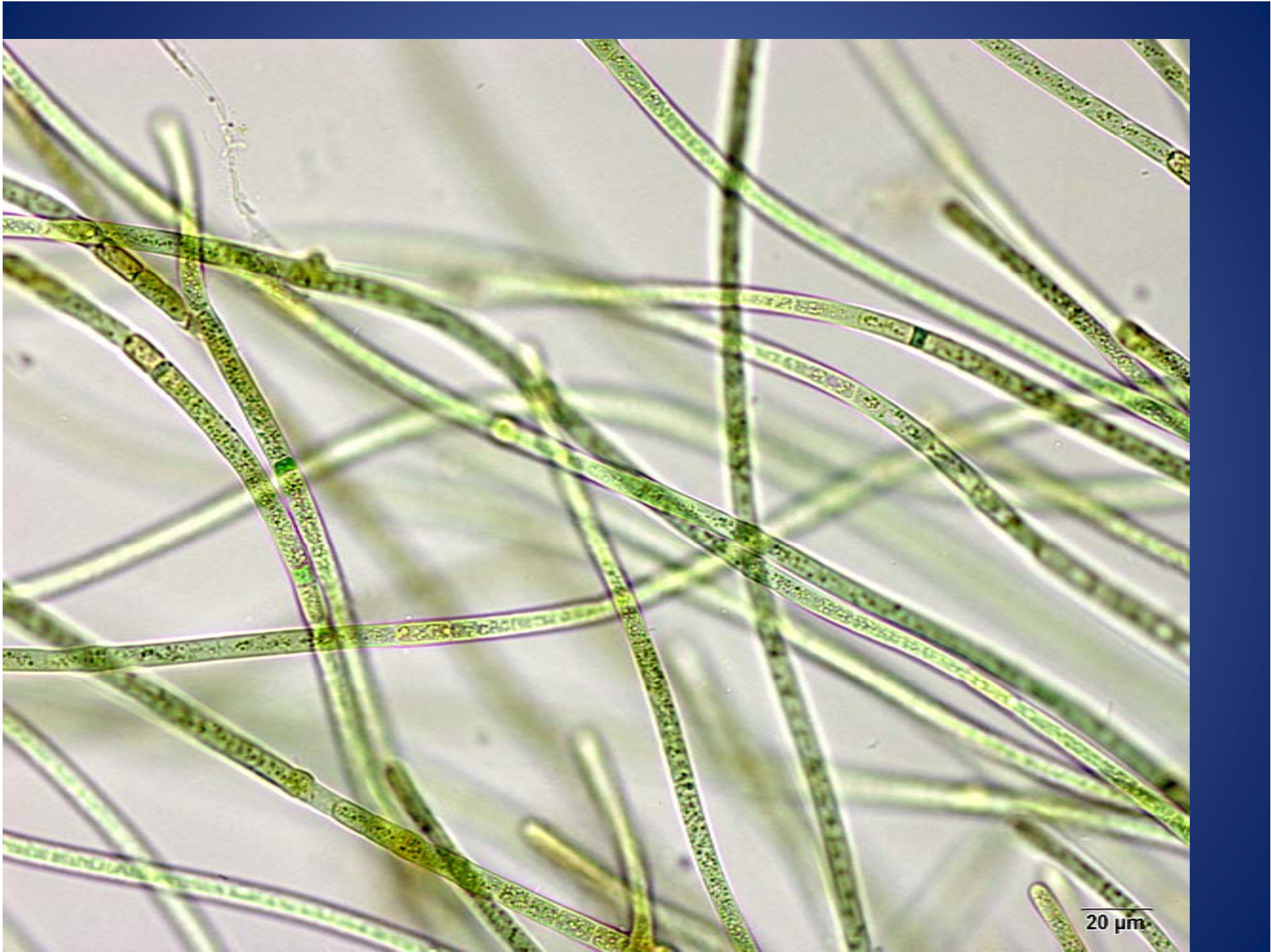


Lake Waukewan (Meredith, NH) Synoptic Survey with PC Probe



Benthic Cyanobacteria Mat



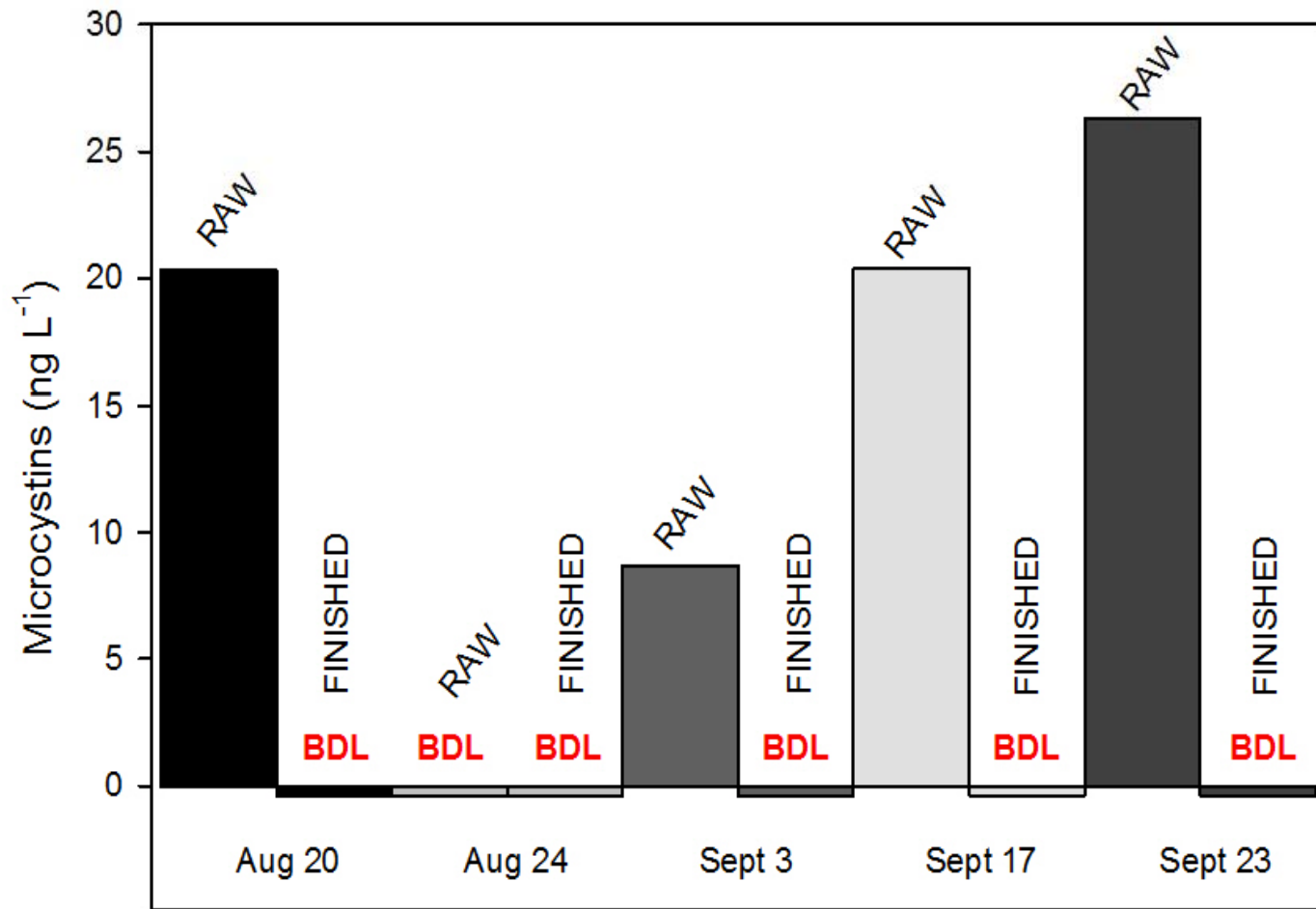




Meredith Water Quality

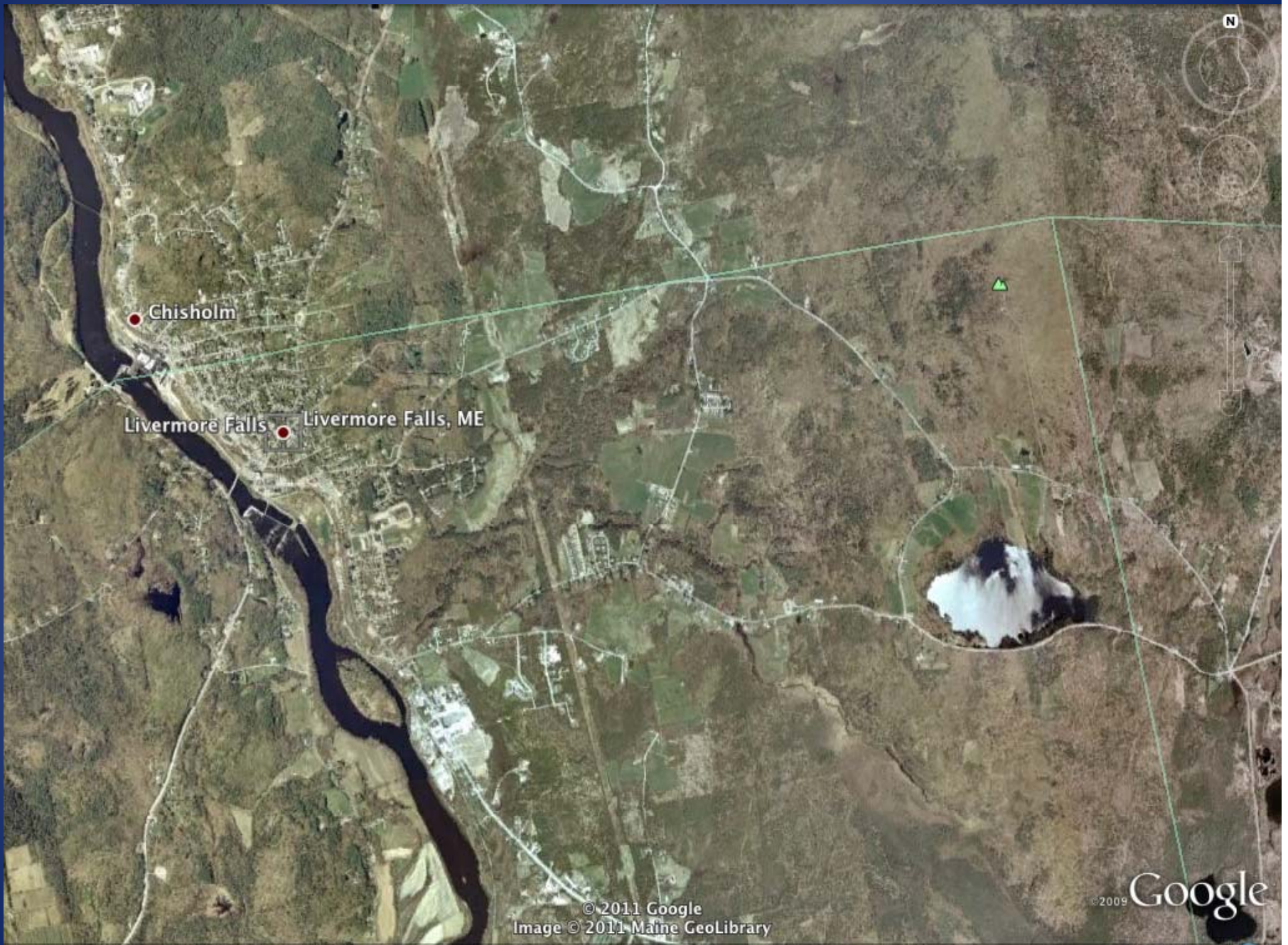
Lake Waukewan Water Treatment

Microcystin in raw and finish water



Livermore Falls, ME





Imagery Date: Dec 31, 2002

44°28'21.60" N 70°09'38.20" W elev 0 m

©2009 Google

Eye alt 6.74 km

Moose Hill Pond



Livermore Falls: Picocyanobacteria (<2 μm)

- Samples of water and sand filter from Moose Hill Pond
- No detectable microcystins
- No MC=No cyanotoxins?



Figure 2. Chains of cyanobacteria in Moose Pond, December 2010.



Figure 1. Picocyanobacteria in Moose Pond, December 2010.

Water Treatment

PC monitor of water intake



Positive



MC and Direct counts

Lake Assessment

Lake Sampling for cyanobacteria



WATER:
Profiles & Synoptic surveys



BENTHOS:
Shallow & Deep

Cyanobacteria Management Strategies

Lake Management

Watershed Management

Alternative Water Sources

Water Treatments

- Special thanks to:

Amanda Murby

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Daniel Leonard (Meredith Water Department)

Staff of the Livermore Falls Water Treatment Facility

Thank you

Questions?