Middle Chattahoochee Reservoirs Harmful algae, Invasive plants, Nutrients, and Turbidity

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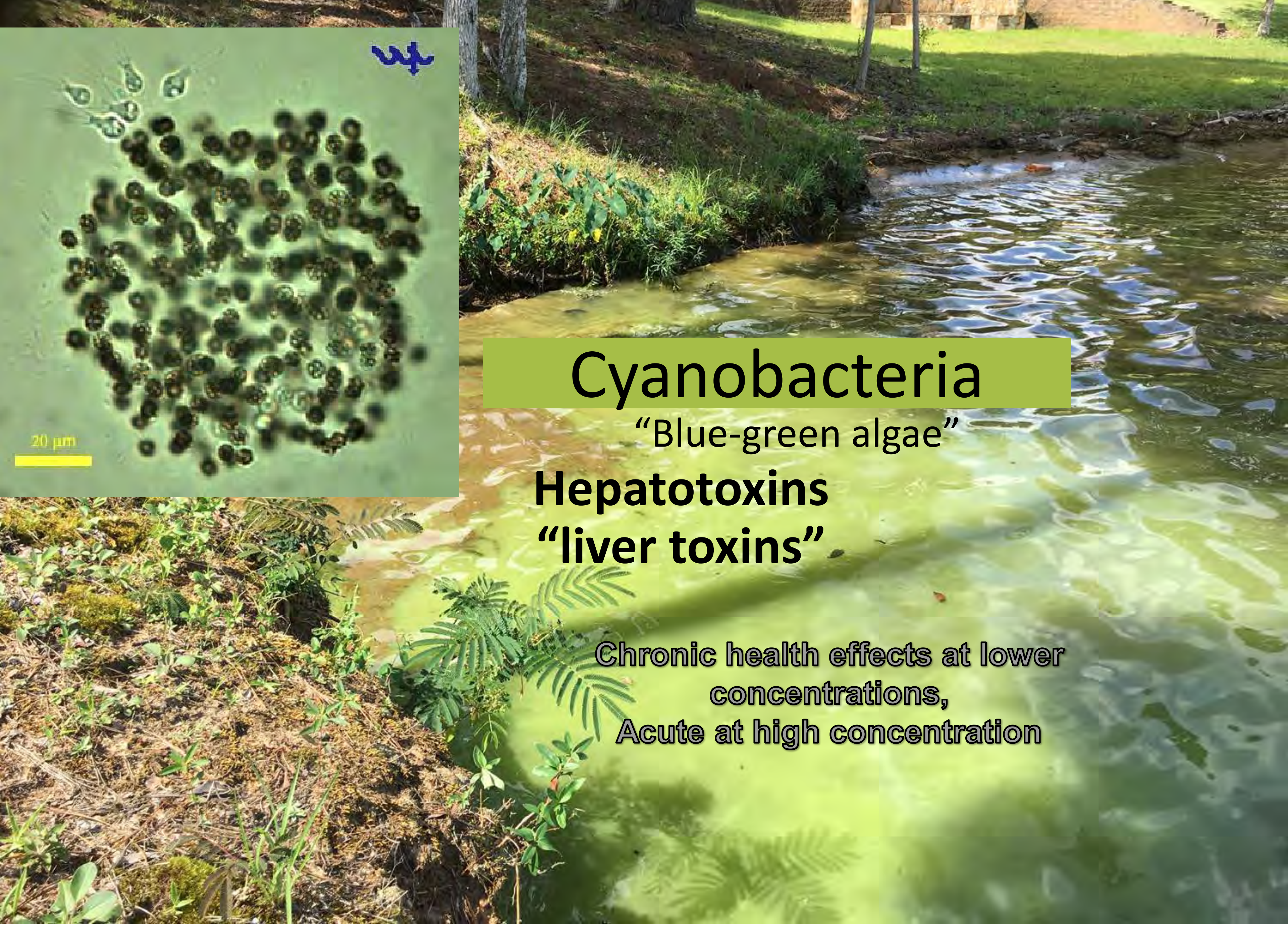
Project Objectives

- Investigate interactions between nutrient loading, sediment transport, and planktonic harmful algal blooms
- Monitor for toxic epiphytic cyanobacteria *Aetokthonos hydrillicola* on dense submerged aquatic vegetation, especially *Hydrilla verticillata*



Cyanobacteria

"Blue-green algae"

Hepatotoxins
"liver toxins"

Chronic health effects at lower concentrations,
Acute at high concentration

Cyanobacteria Impacts

Economic Losses

Adverse Health Effects

Loss of Biodiversity

Cyanobacteria Link (2005)

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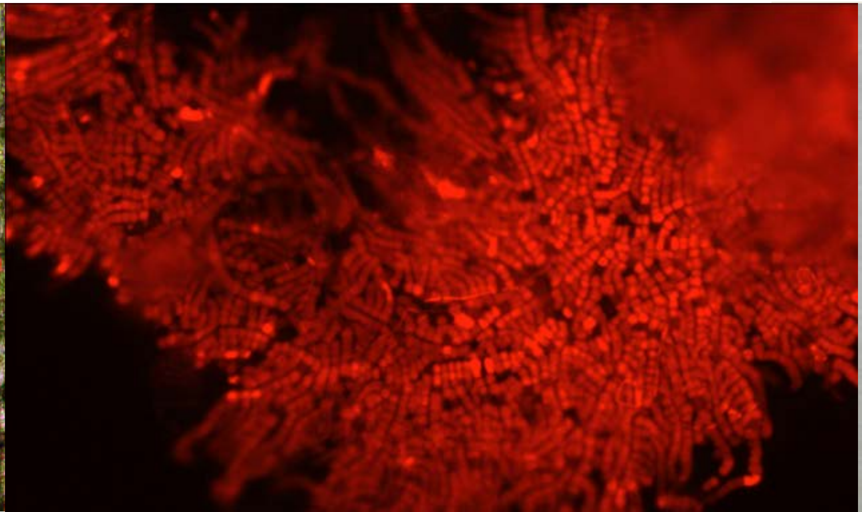
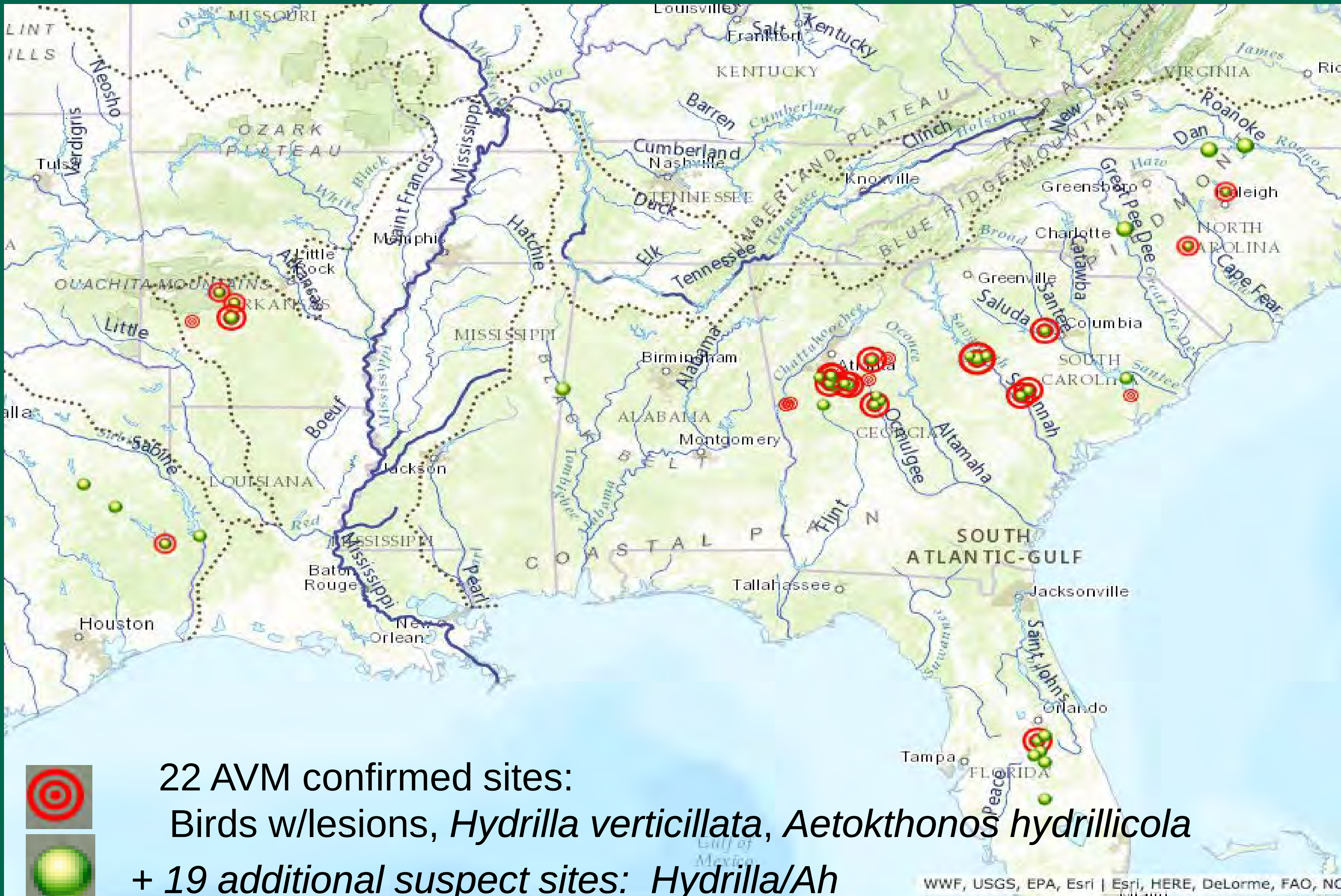
- **Cyanobacteria** (or blue-green algae) are photosynthetic bacterial species that can produce liver and **nerve toxins**
- Previously undescribed cyanobacterial species
  - (*Wilde et al. 2005, 2014*)
  - ***Aetokthonos hydrillicola***
- Grows as an epiphyte on hydrilla and other aquatic plants in all AVM sites




Aetokthonos hydrillicola
“eagle killer living on hydrilla”
500 µm

"Avian" Vacuolar Myelinopathy 2019



22 AVM confirmed sites:

Birds w/lesions, *Hydrilla verticillata*, *Aetokthonos hydrillicola*

+ 19 additional suspect sites: Hydrilla/Ah

Neurological impairment

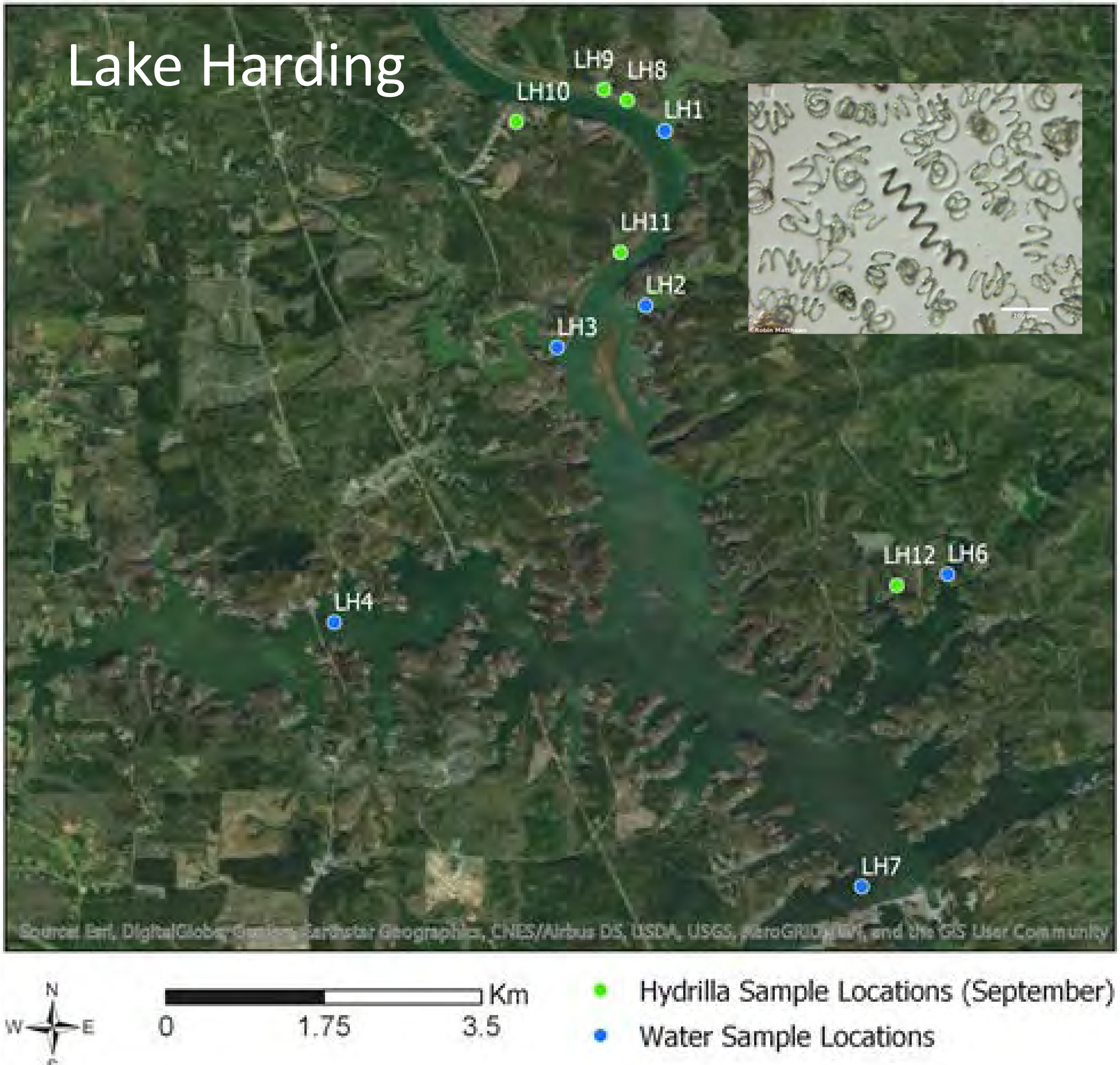
- Eagle with drooping wings

- Unresponsive coot

- Waterfowl and eagles wobble in flight
- Birds observed stumbling on land
- Coots may dive and then not right themselves
- Eagles may overshoot perches or fly into objects

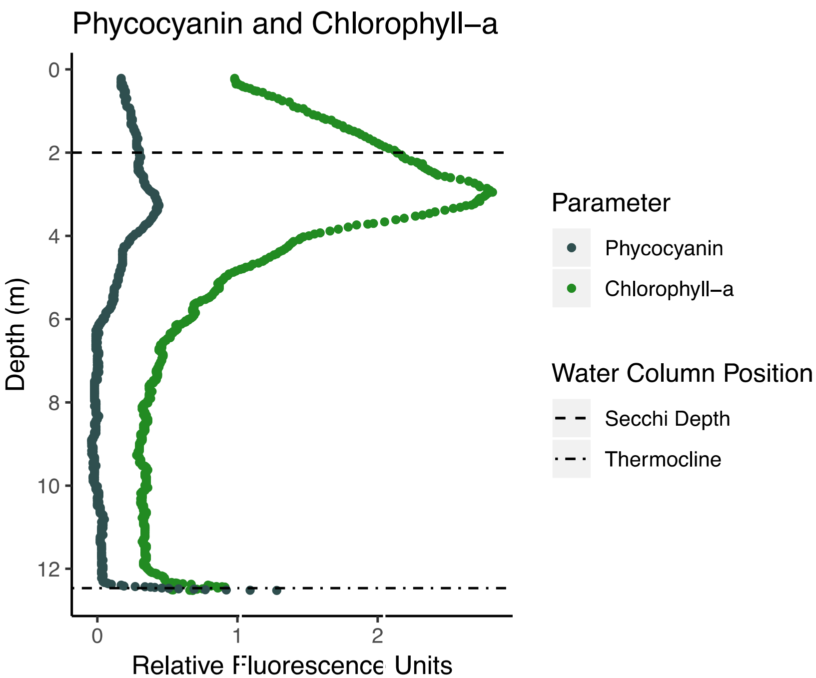
SAV Sampling 2018

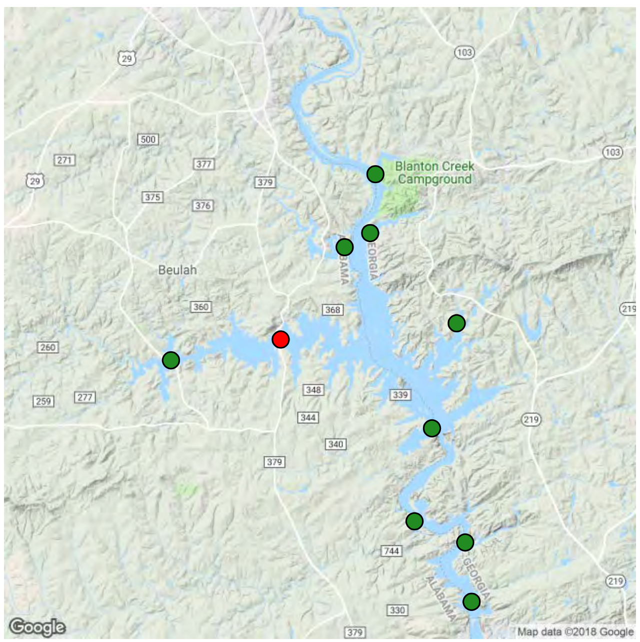
- Hydrilla infestations (5 locations) Harding
- No Hydrilla detected in Oliver and Goat Rock
- *Aetokthonos hydrillicola* was not detected on any of the samples

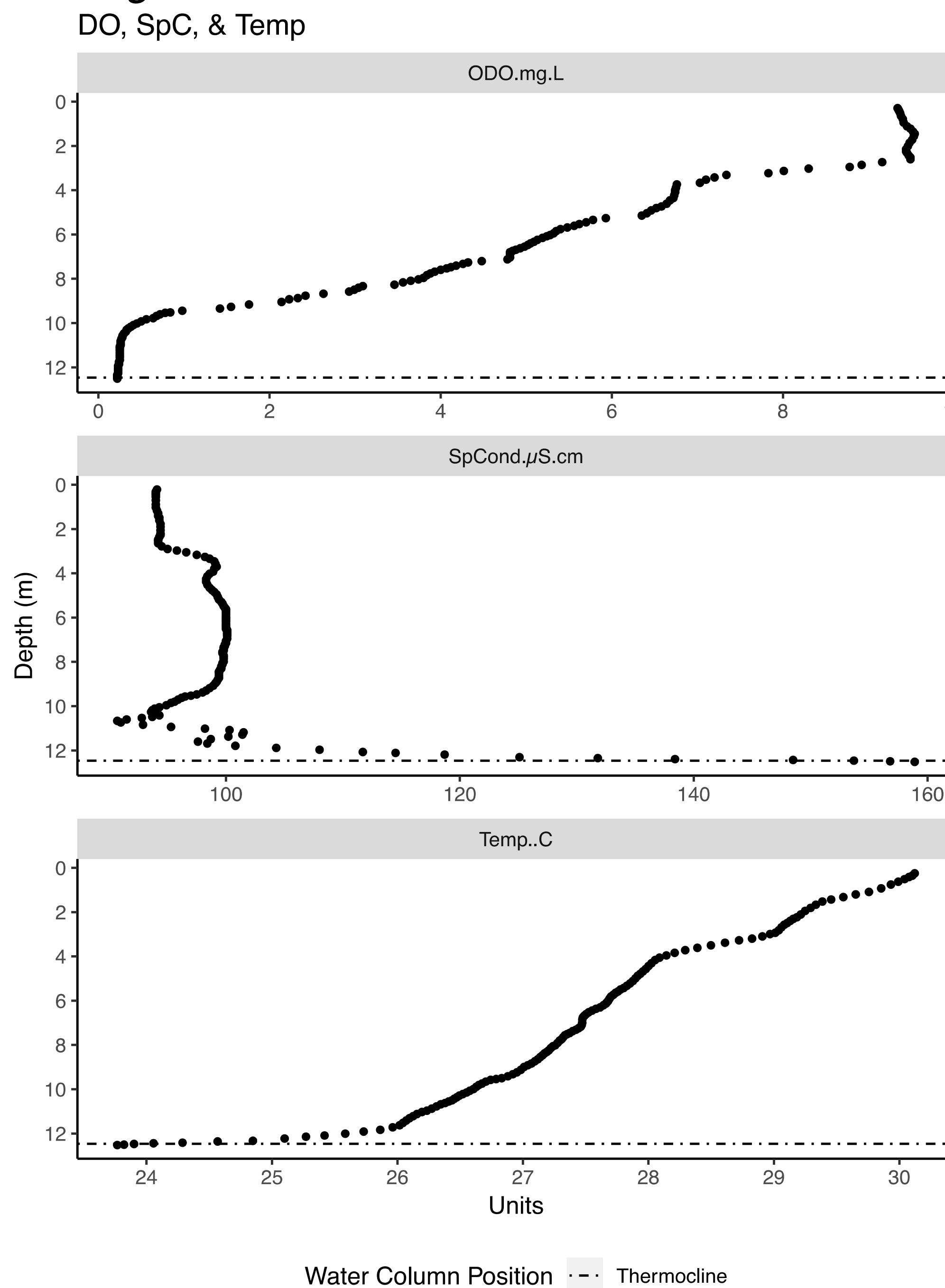


Lake Harding
LH9
LH8
LH10
LH1
LH11
LH2
LH3
LH12
LH6
LH4
LH7
N
W
E
S
0
1.75
3.5
Km
Hydrilla Sample Locations (September)
Water Sample Locations

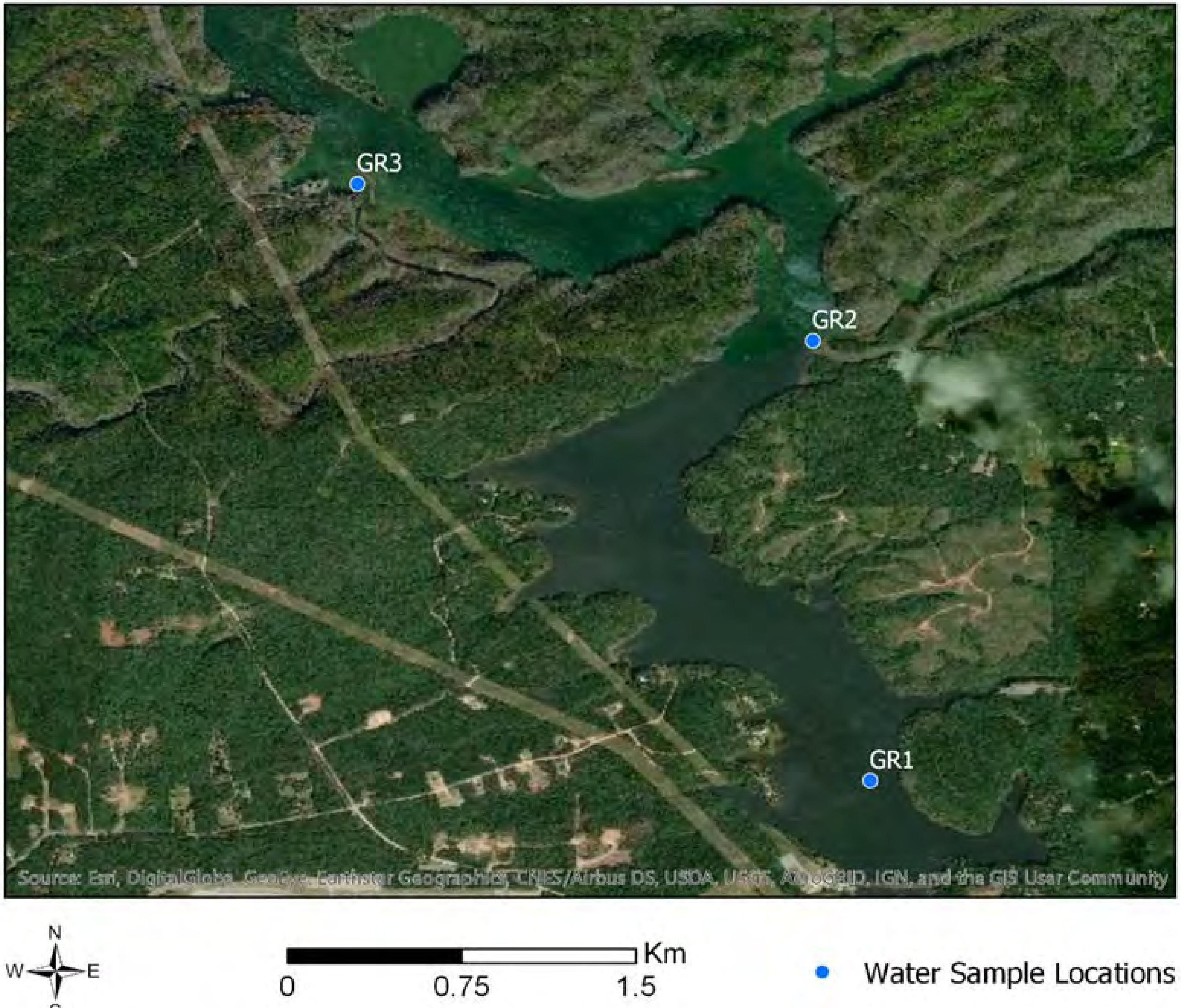
Lake Harding Site 4



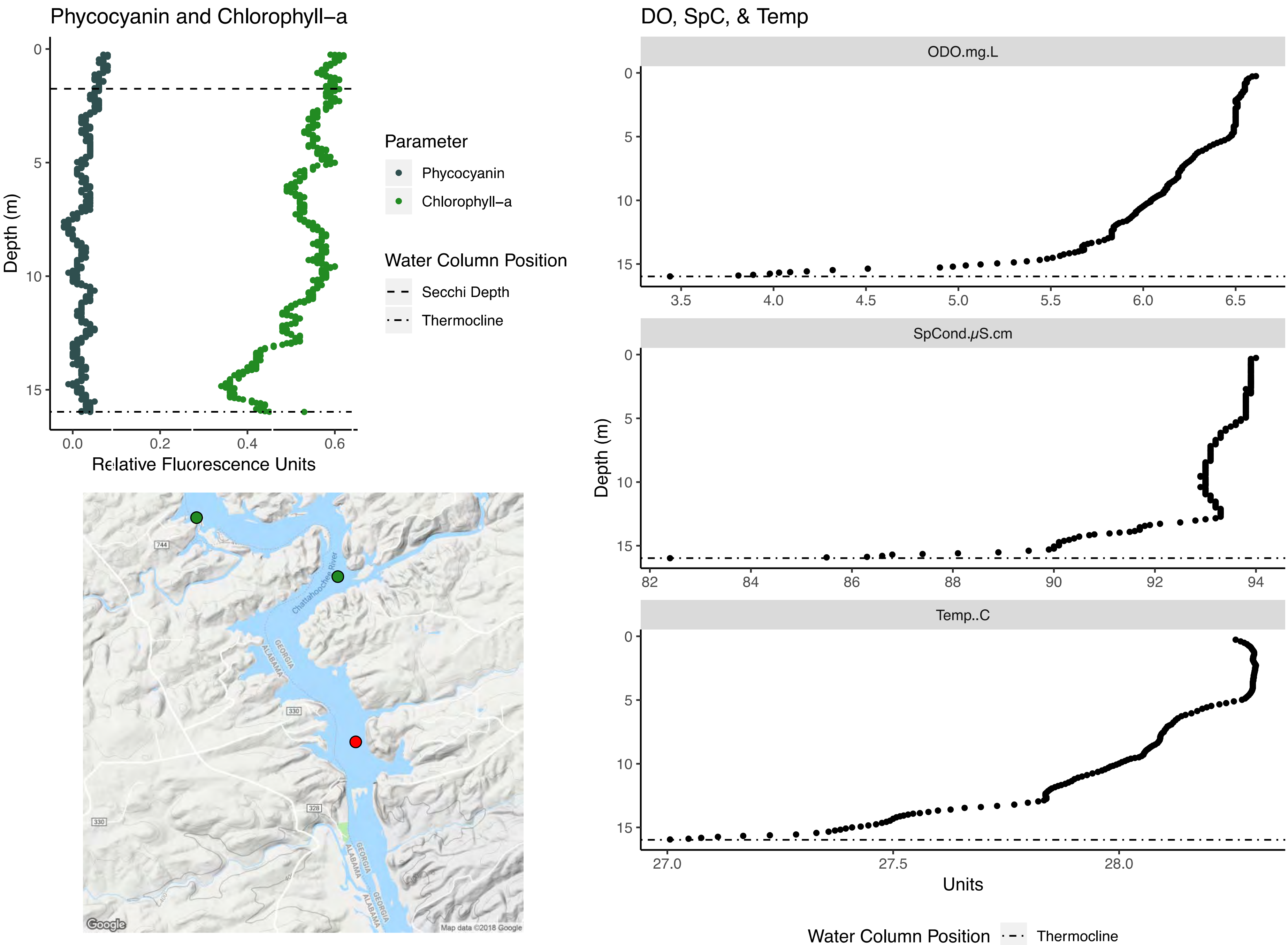




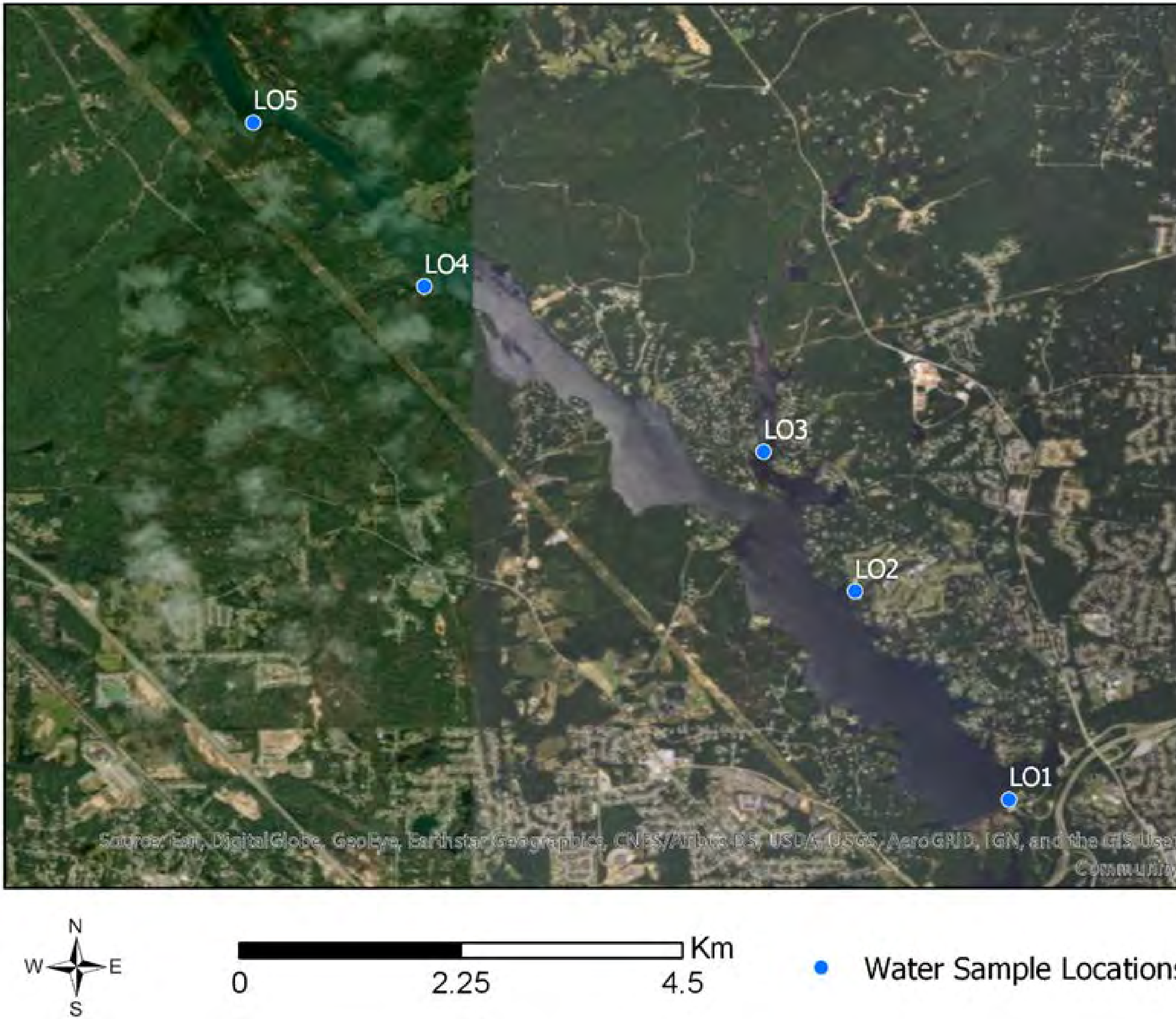
Lake Goat Rock



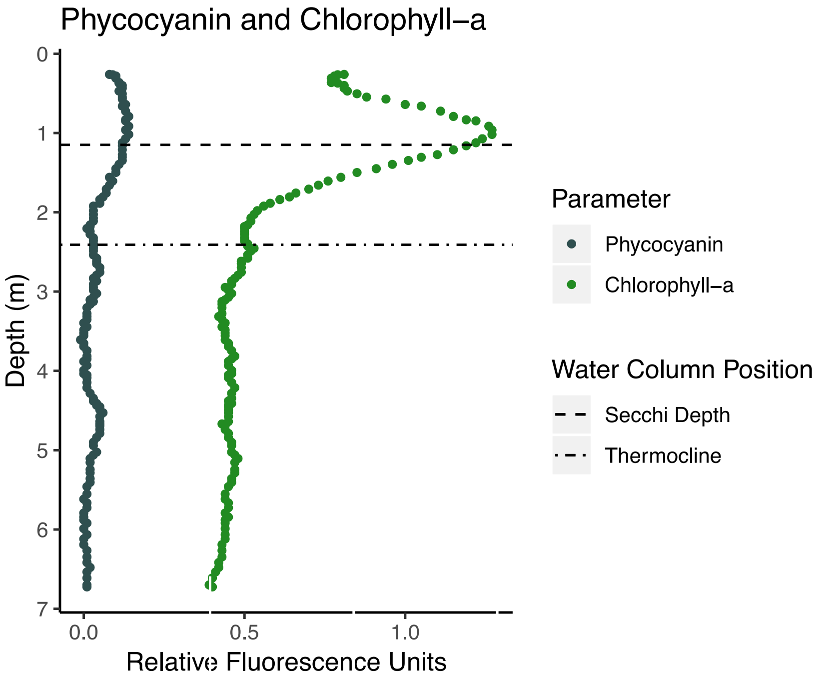
Lake Goat Rock Site 1

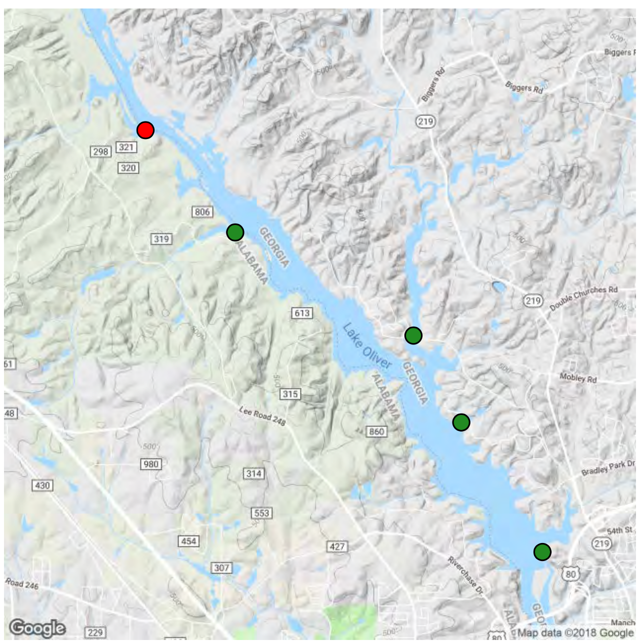


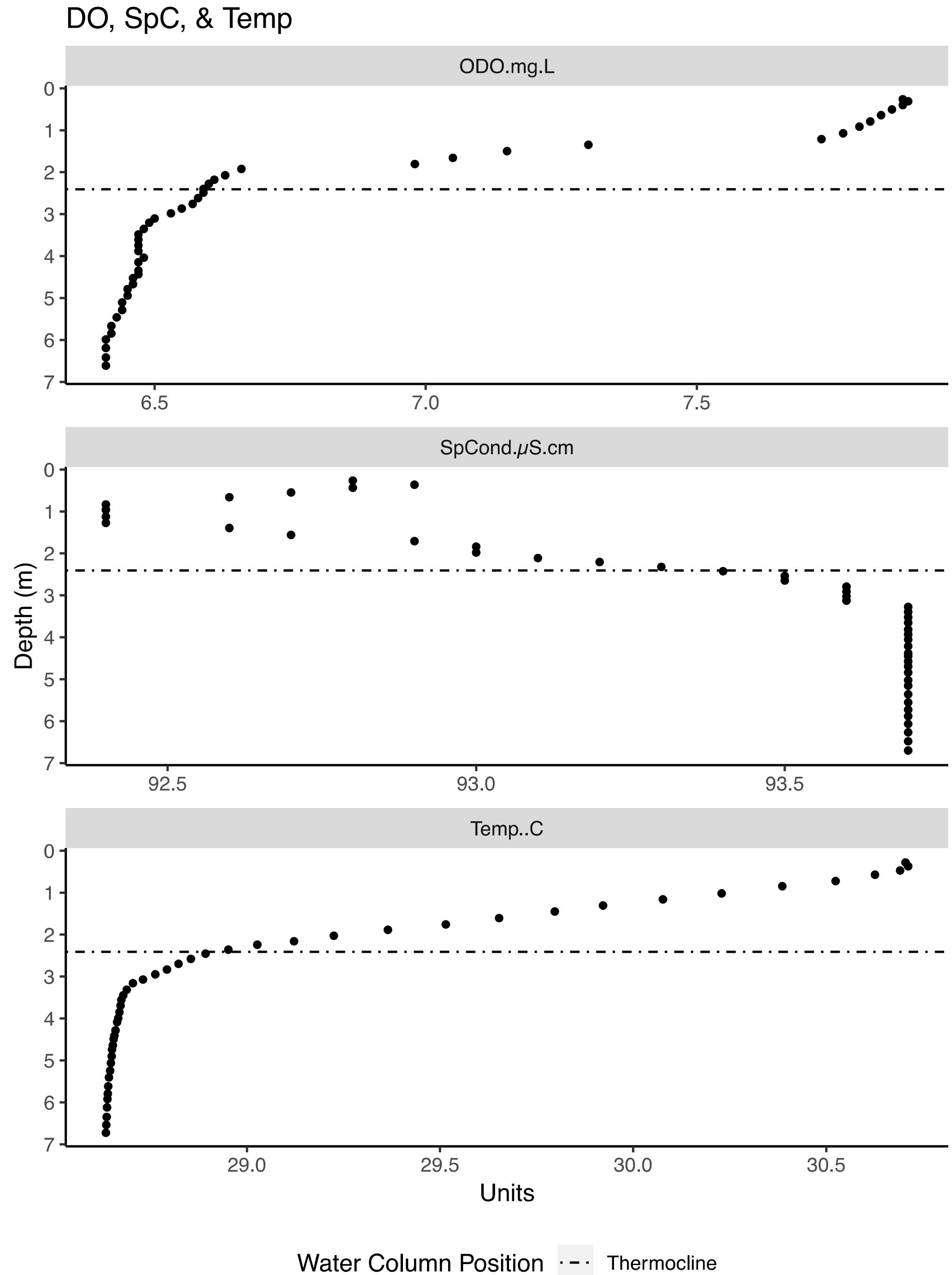
Lake Oliver



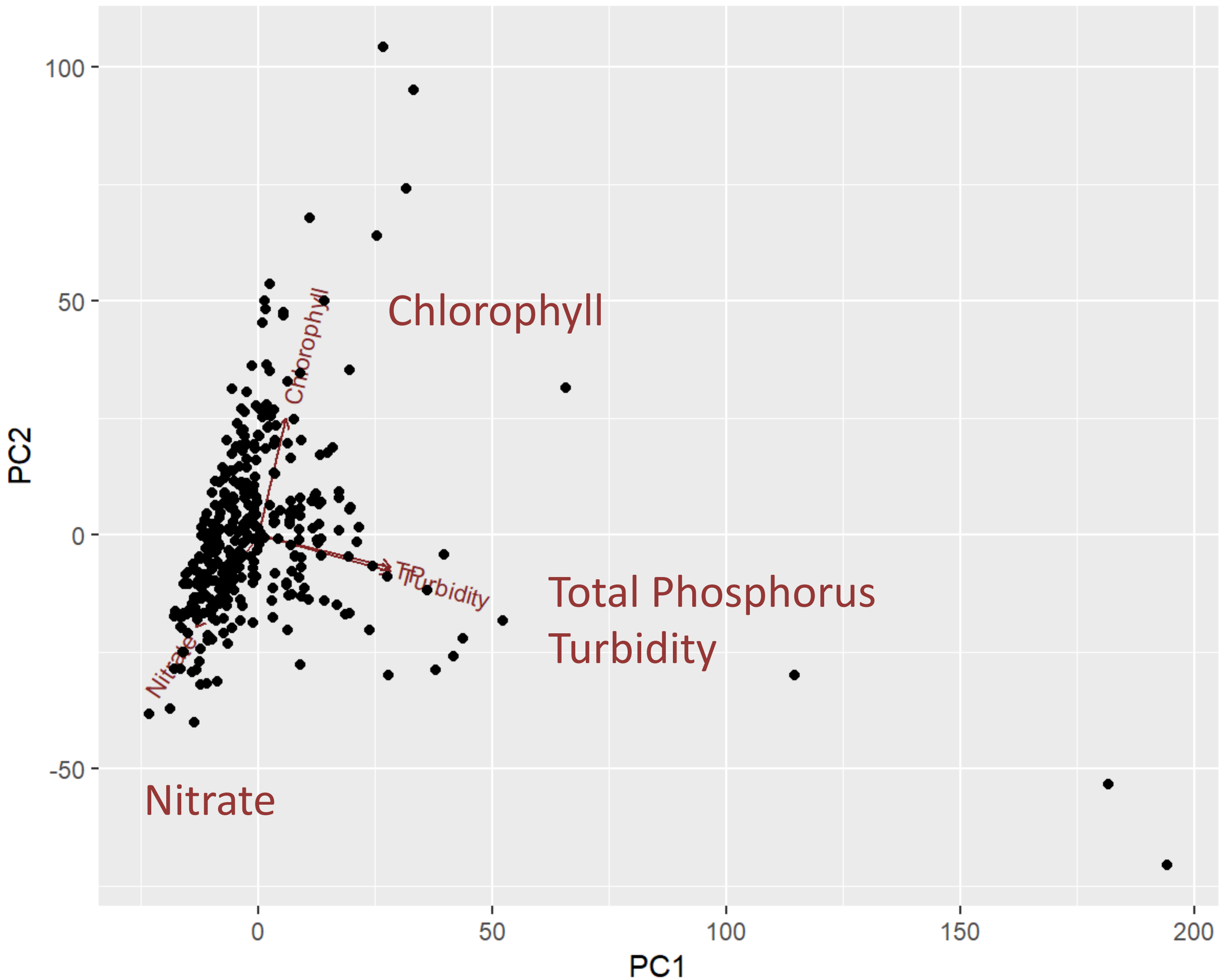
Lake Oliver Site 5







GA Power Ambient Water Quality Monitoring 2000-2017 (quarterly)



YSI Sonde Chlorophyll

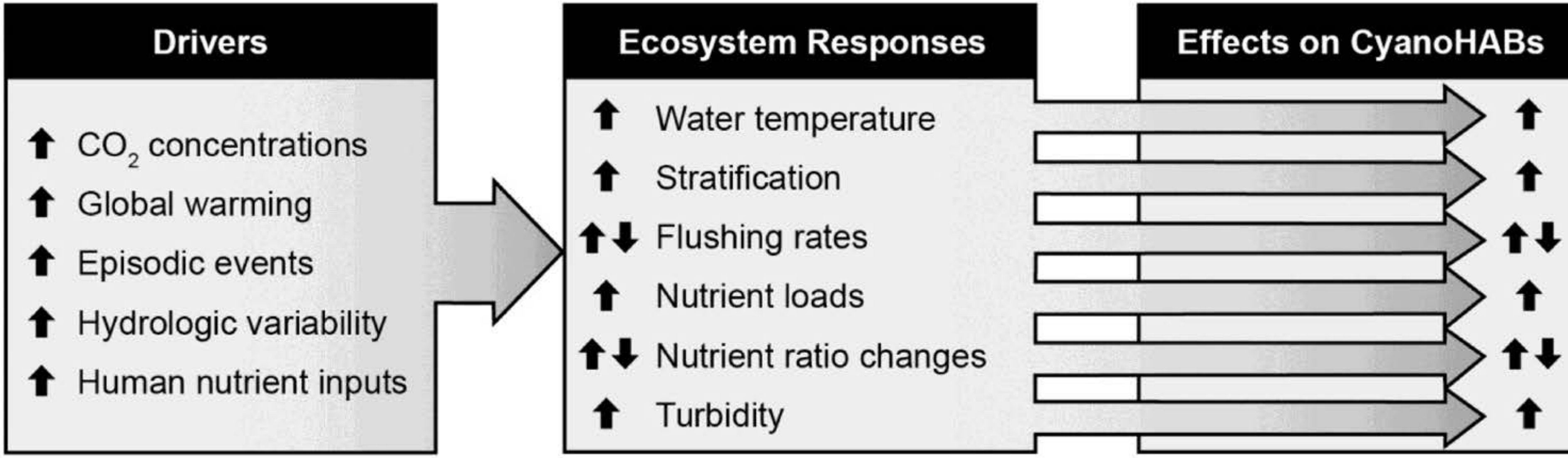
Surface Chlorophyll readings can be confounded by sunlight

Sensor measures fluorescence of algae

Non photochemical quenching

Algae fluoresce less under bright sunlight

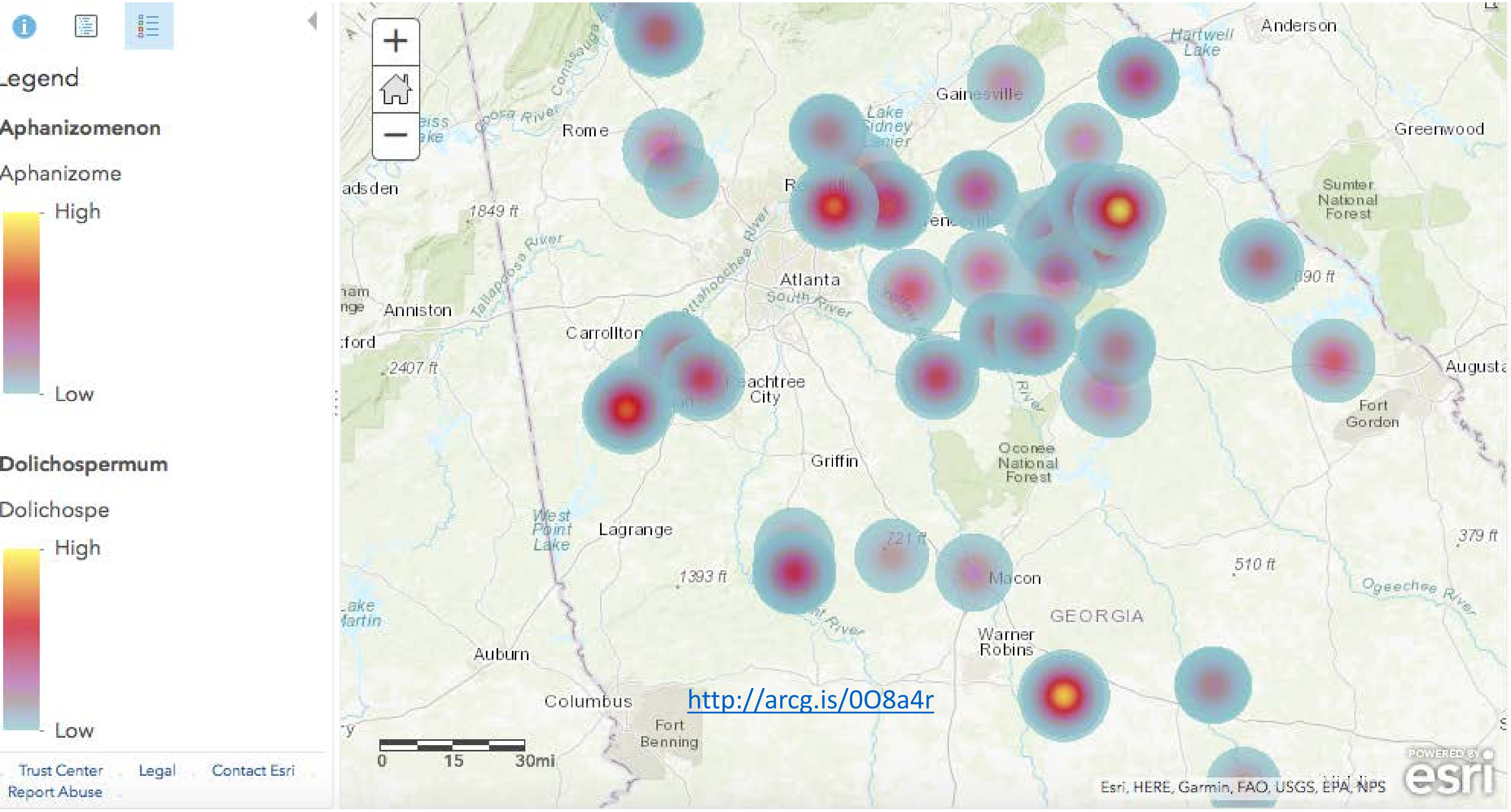
Linkage of major anthropogenic and climatic environmental drivers of ecosystem change to their impacts on CyanoHAB potentials.



"Higher temperatures coupled with elevated P concentrations frequently yielded growth rates of toxic Microcystis cells which exceeded all other treatments and populations."

Davis, et al. 2009. The effects of temperature and nutrients on the growth and dynamics of toxic and non-toxic strains of Microcystis during cyanobacteria blooms. Harmful Algae 8:715–725.

UGA Extension Soil & Water La Nutrient & Harmful Algal Bloom Screening; Farm ponds, Urban detention ponds, Recreational Lakes



http://arcg.is/0O8a4r

Hydrilla infestations can support filamentous algal mats, provide nutrients for benthic algae upon decay

Common benthic, endophytic & epiphytic cyanobacteria genera that can produce toxins:

- *Anabaena*
- *Lyngbya*
- *Nostoc*
- *Oscillatoria/ Planktothrix*
- *Phormidium*


Hydrilla can produce
clear water phase

Hydrilla grows well even….

In Southeastern man-made lakes with

Fluctuating water depth
Shoreline exposed during drought
High erosion during storm events

Turbidity?
Can prevent hydrilla growth if early spring inflows are intense
But.. Can grow under low light intensity
“Sticky” leaves attract phosphorus laden clay particles
Clear water column but providing TP source to epiphytic cyanobacteria.

Factors Affecting Surface Runoff

- Land Use
- Proximity to Streams
- Proximity to Ponds/Wetlands
- Soil Permeability
- Soil Erodability
- Slope
- Floodplain

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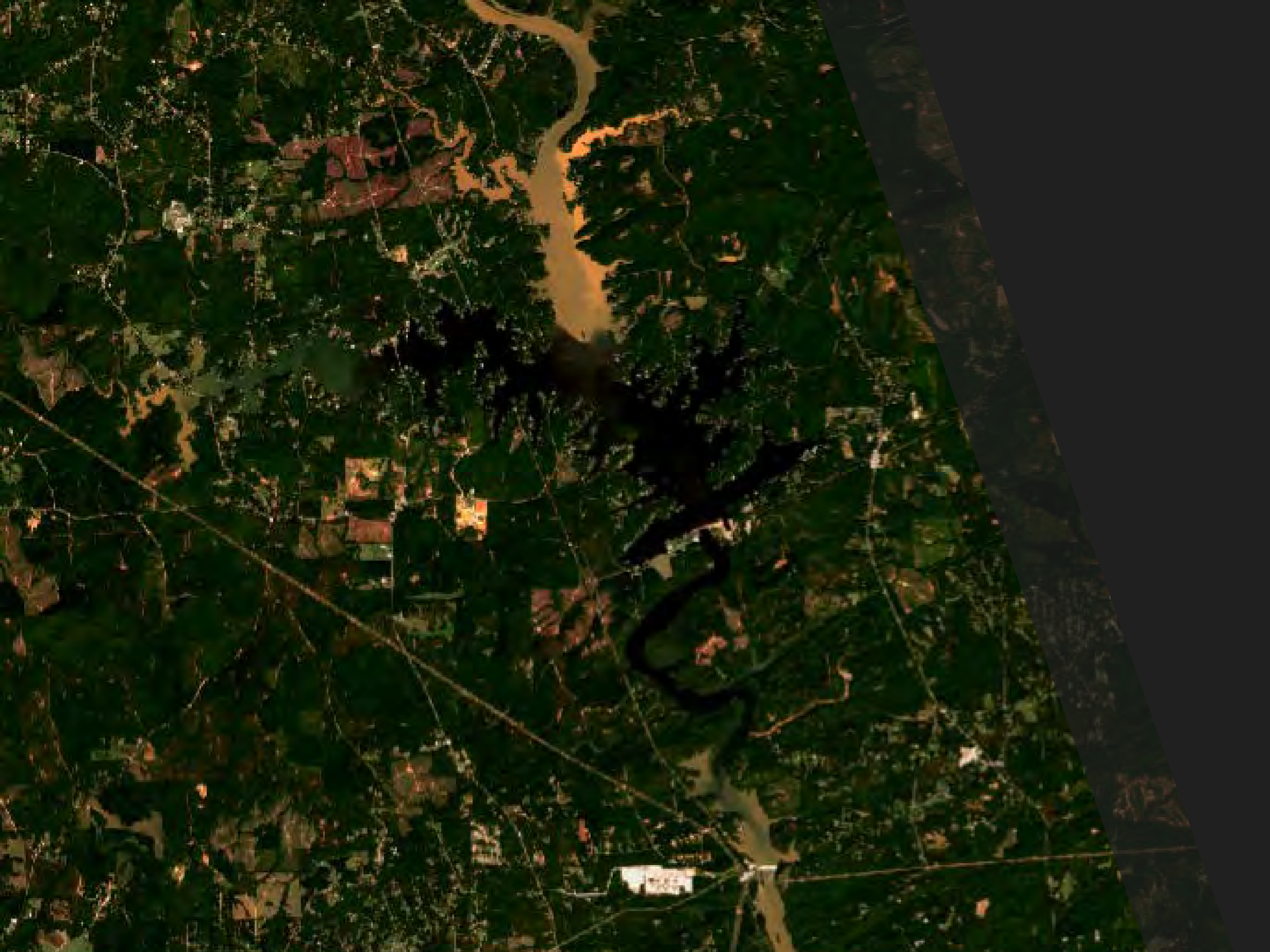
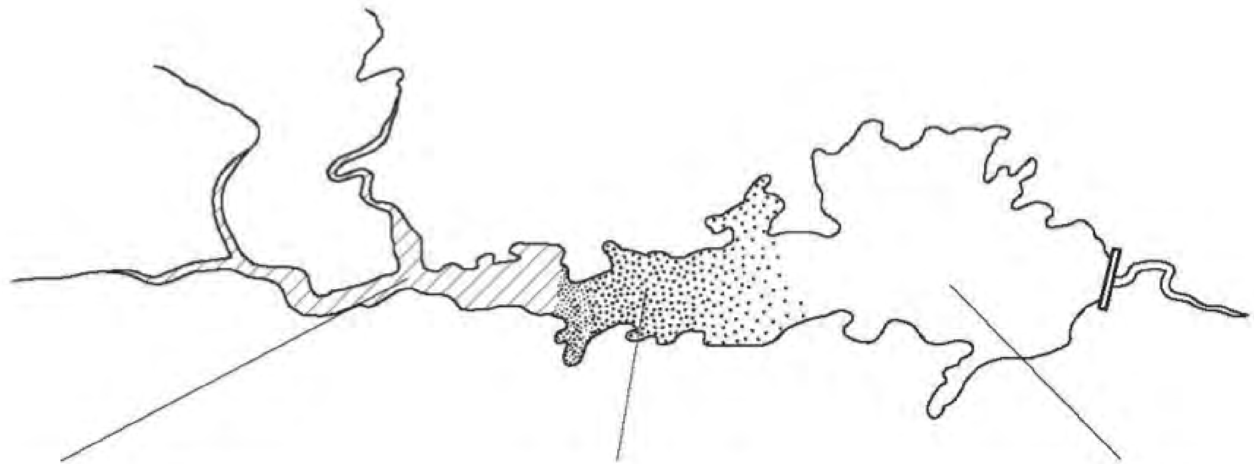
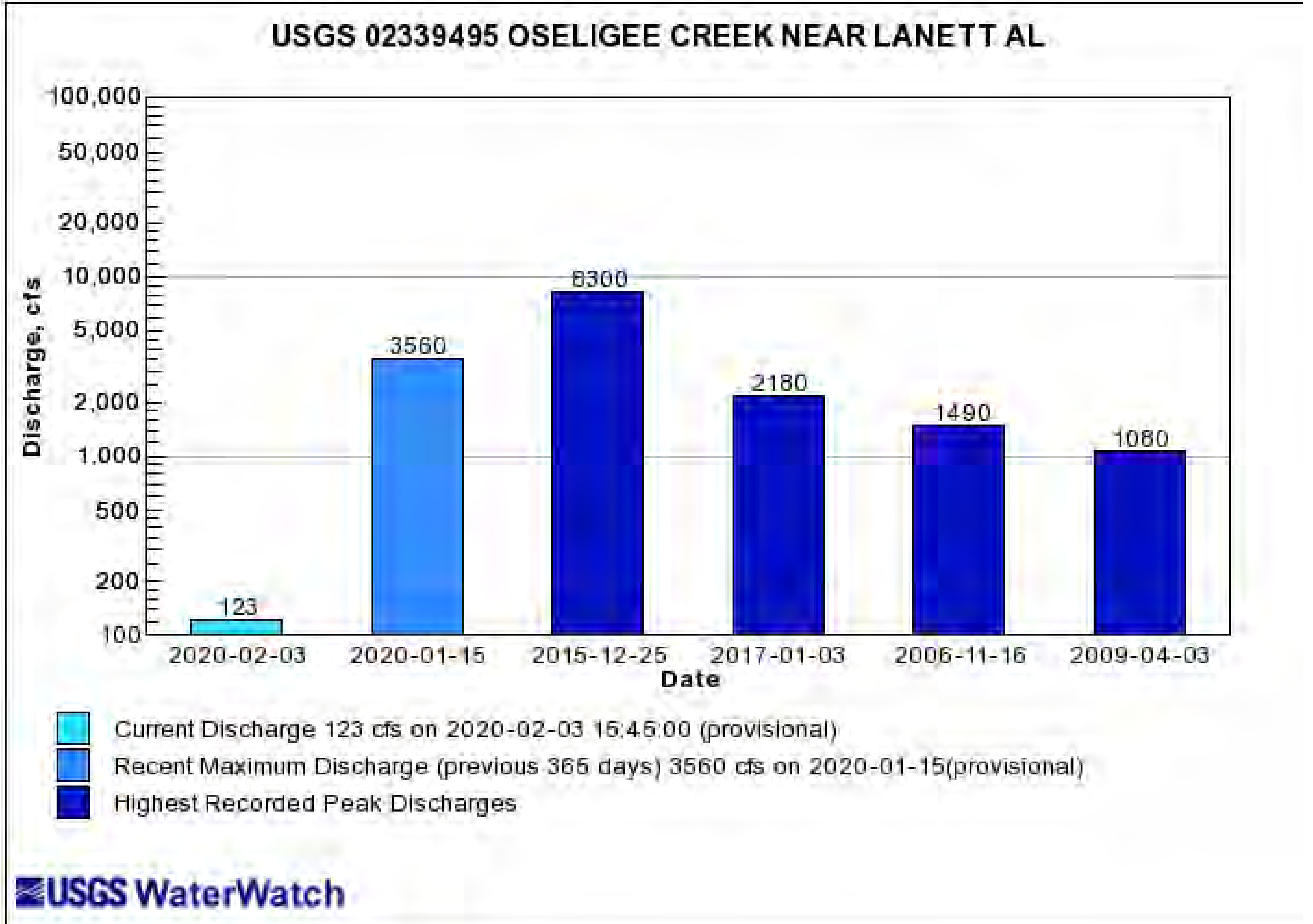
7 Factors, 3 points each



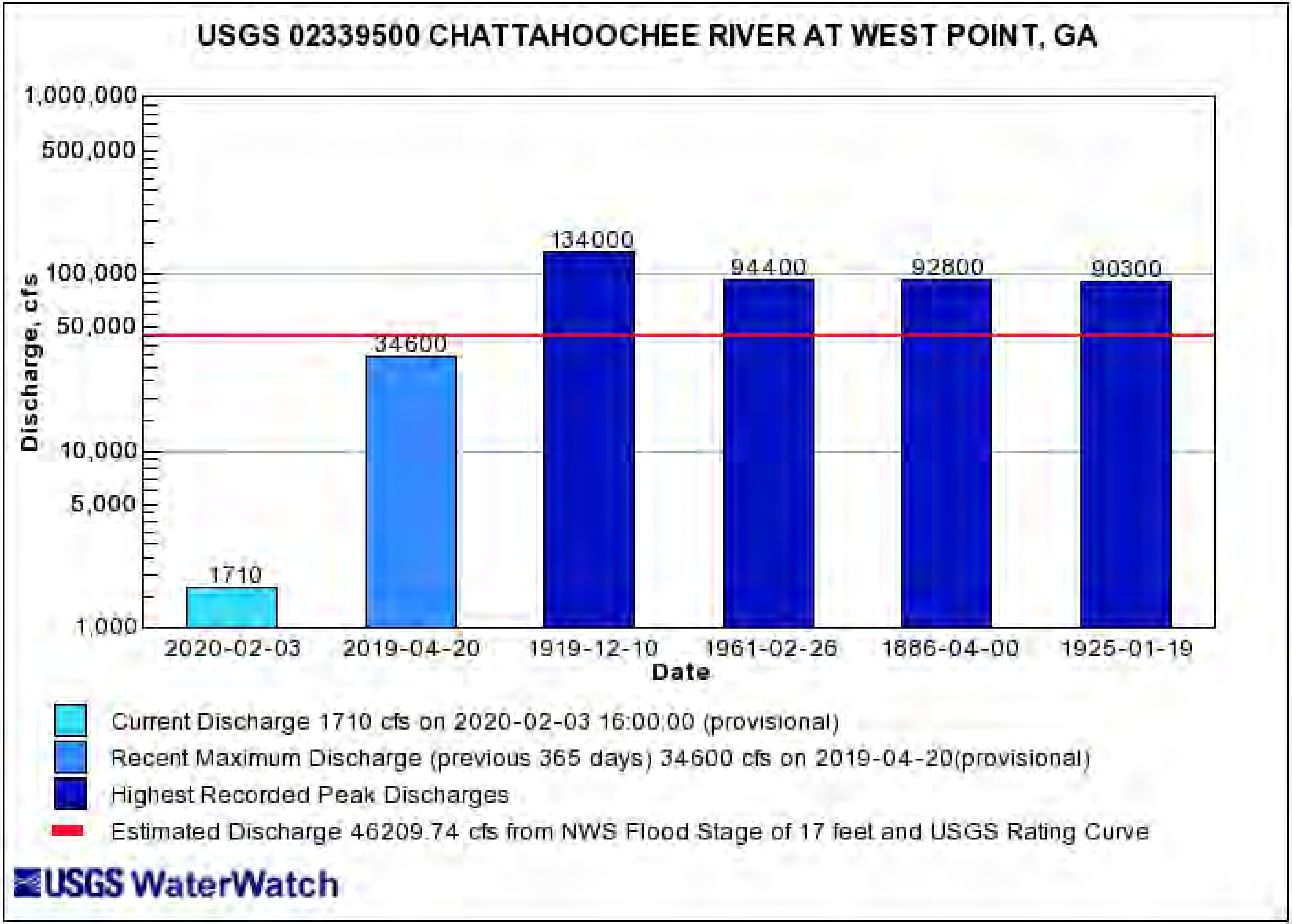


Riverine Zone	Transitional Zone	Lacustrine Zone
• Narrow, channelized basin	• Broader, deeper basin	• Broad, deep, lake-like basin
• Relatively high flow velocities	• Reduced flow velocities	• Little flow velocities
• High suspended solids, turbidity, low light availability, photic zone less than mixing zone	• Reduced suspended solids, less turbidity, light availability increased	• Relatively clear, light more available at depth, photic zone greater than mixing zone
• Nutrient supply by advection, relatively high nutrients	• Adjective nutrient supply reduced	• Nutrient supply by internal recycling, relatively low nutrients
• Light-limited primary production	• Primary production relatively high	• Nutrient-limited primary production
• Cell losses primarily by sedimentation	• Cell losses by sedimentation and grazing	• Cell losses primarily by grazing
• Organic matter supply primarily allochthonous	• Intermediate between allochthonous and **autochthonous** organic matter sources	• Organic matter supply primarily autochthonous
• More eutrophic	• Intermediate	• More oligotrophic

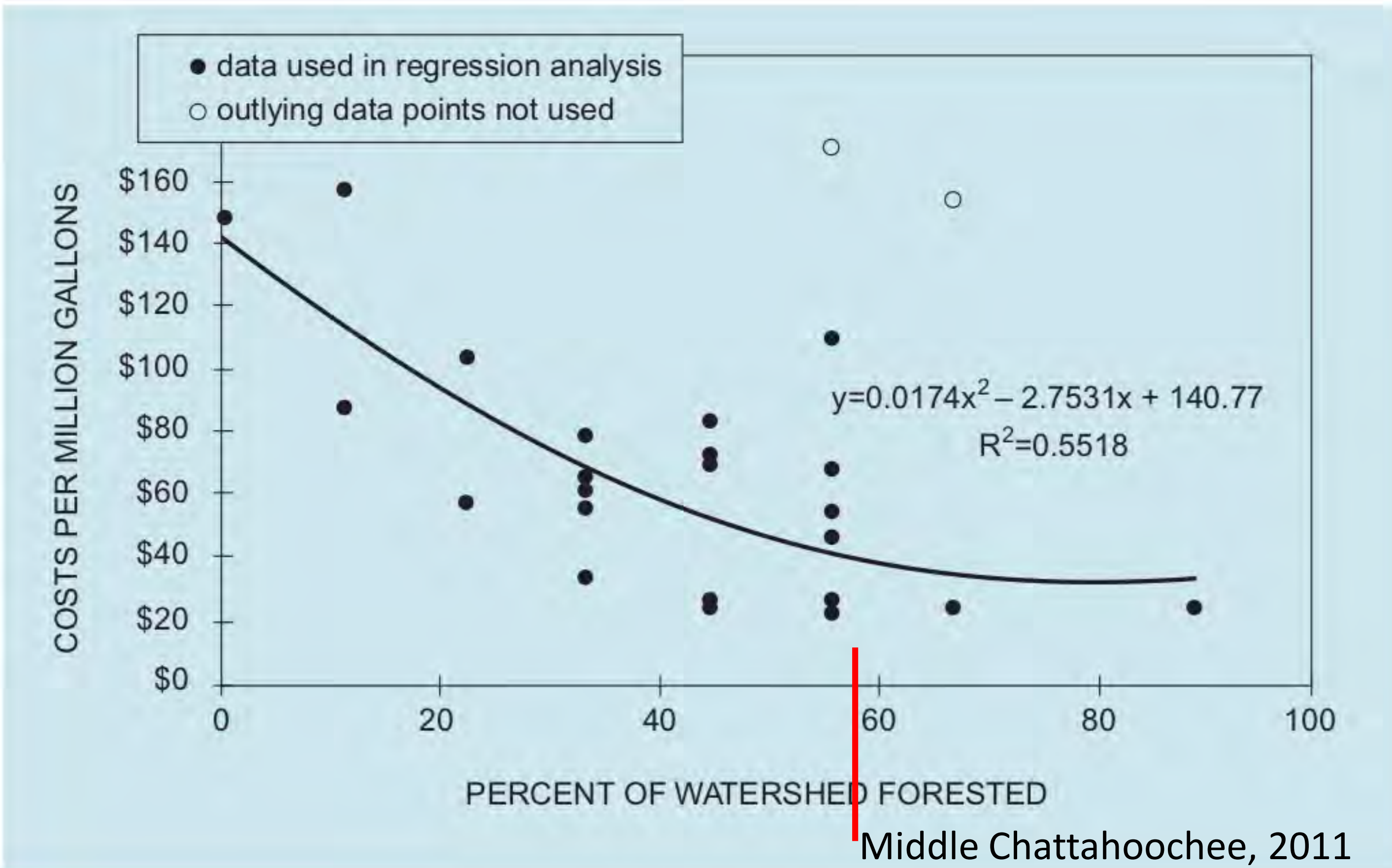
Figure 10–1. Diagram of an idealized reservoir showing longitudinal zonation and environmental factors controlling light and nutrient availability for phytoplankton production, algal productivity and standing crop, organic matter supply, and trophic status in an idealized reservoir (modified from Kimmel and others, 1990, figure 6.1).



USGS 02339495 OSELIGEE CREEK NEAR LANETT AL
Discharge, cfs
100,000
50,000
20,000
10,000
5,000
2,000
1,000
500
200
100
123
3560
8300
2180
1490
1080
2020-02-03
2020-01-15
2015-12-25
2017-01-03
2006-11-16
2009-04-03
Date
Current Discharge 123 cfs on 2020-02-03 15:45:00 (provisional)
Recent Maximum Discharge (previous 365 days) 3560 cfs on 2020-01-15(provisional)
Highest Recorded Peak Discharges
USGS WaterWatch


USGS 02339500 CHATTAHOOCHEE RIVER AT WEST POINT, GA
Discharge, cfs
1,000,000
500,000
100,000
50,000
10,000
5,000
1,000
1710
34600
134000
94400
92800
90300
2020-02-03
2019-04-20
1919-12-10
1961-02-26
1886-04-00
1925-01-19
Date
Current Discharge 1710 cfs on 2020-02-03 16:00:00 (provisional)
Recent Maximum Discharge (previous 365 days) 34600 cfs on 2019-04-20(provisional)
Highest Recorded Peak Discharges
Estimated Discharge 46209.74 cfs from NWS Flood Stage of 17 feet and USGS Rating Curve
USGS WaterWatch

Upstream Forests Predict Treatment Costs



(Ernst, et al, 2004)

Loss of Forest & Wetland Acres 2001-2011

Class in 2011

Class in 2001	Developed, High Intensity	Developed, Med. Intensity	Developed, Low Intensity	Developed, Open Space	Cultivated Crops	Pasture/ Hay	Grassland/ Herb.	Grand Total
Evergreen Forest	632	2,122	5,110	6,754	185	770	50,846	66,418
Mixed Forest	53	186	442	669	53	61	5,920	7,384
Deciduous Forest	716	2,401	5,815	8,543	119	425	11,852	29,870
Woody Wetlands	4	54	133	290	24	6	371	882
Em. Herb. Wetlands	0	4	8	15	4	1	25	57
Grand Total	1,405	4,767	11,508	16,271	386	1,262	69,013	104,612

~34,000 Acres Developed

Conservation vs Restoration

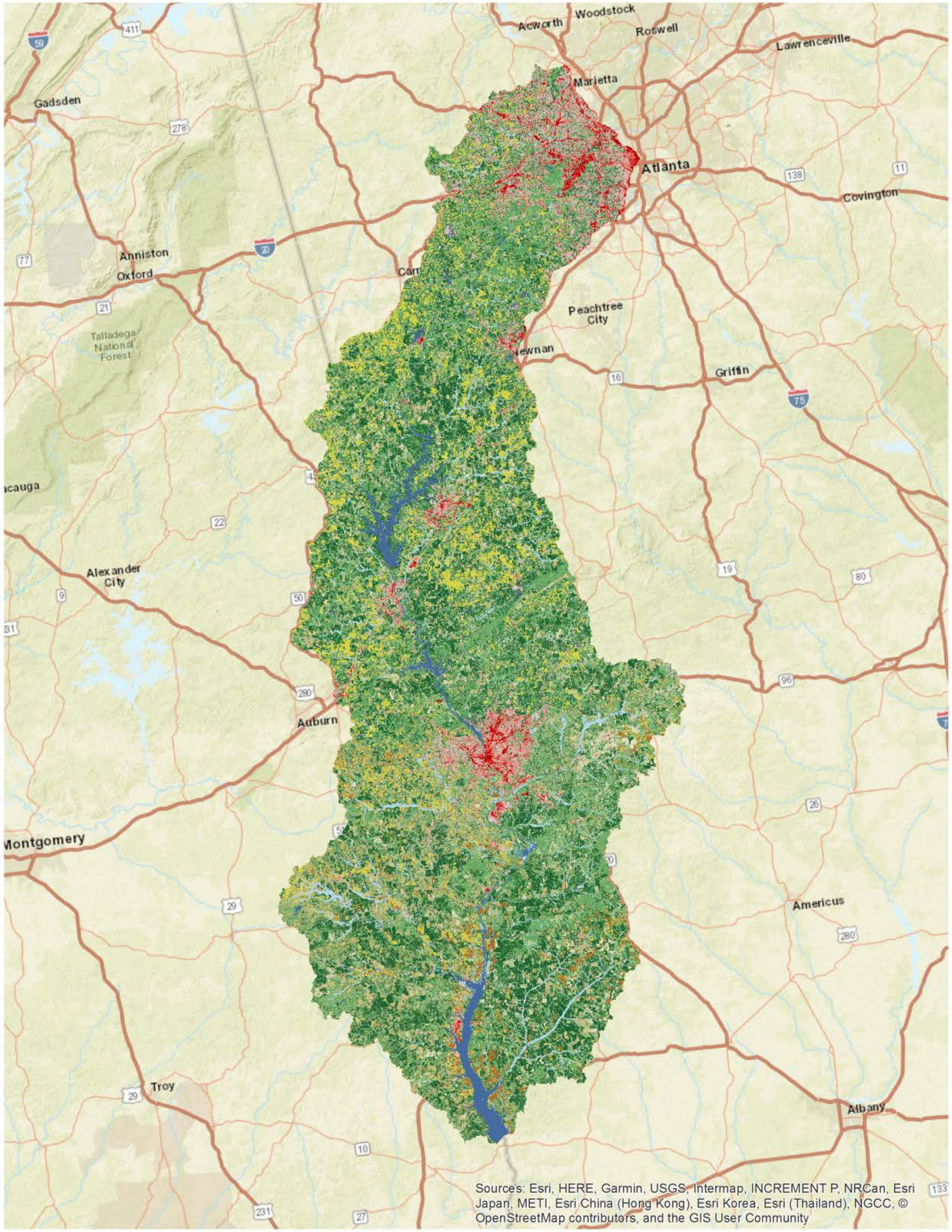
Conservation Priority Index (CPI)

- 3 points for Forested Land Cover

Restoration Priority Index (RPI)

- 3 points for Agricultural Land
- 2 points for Grassland

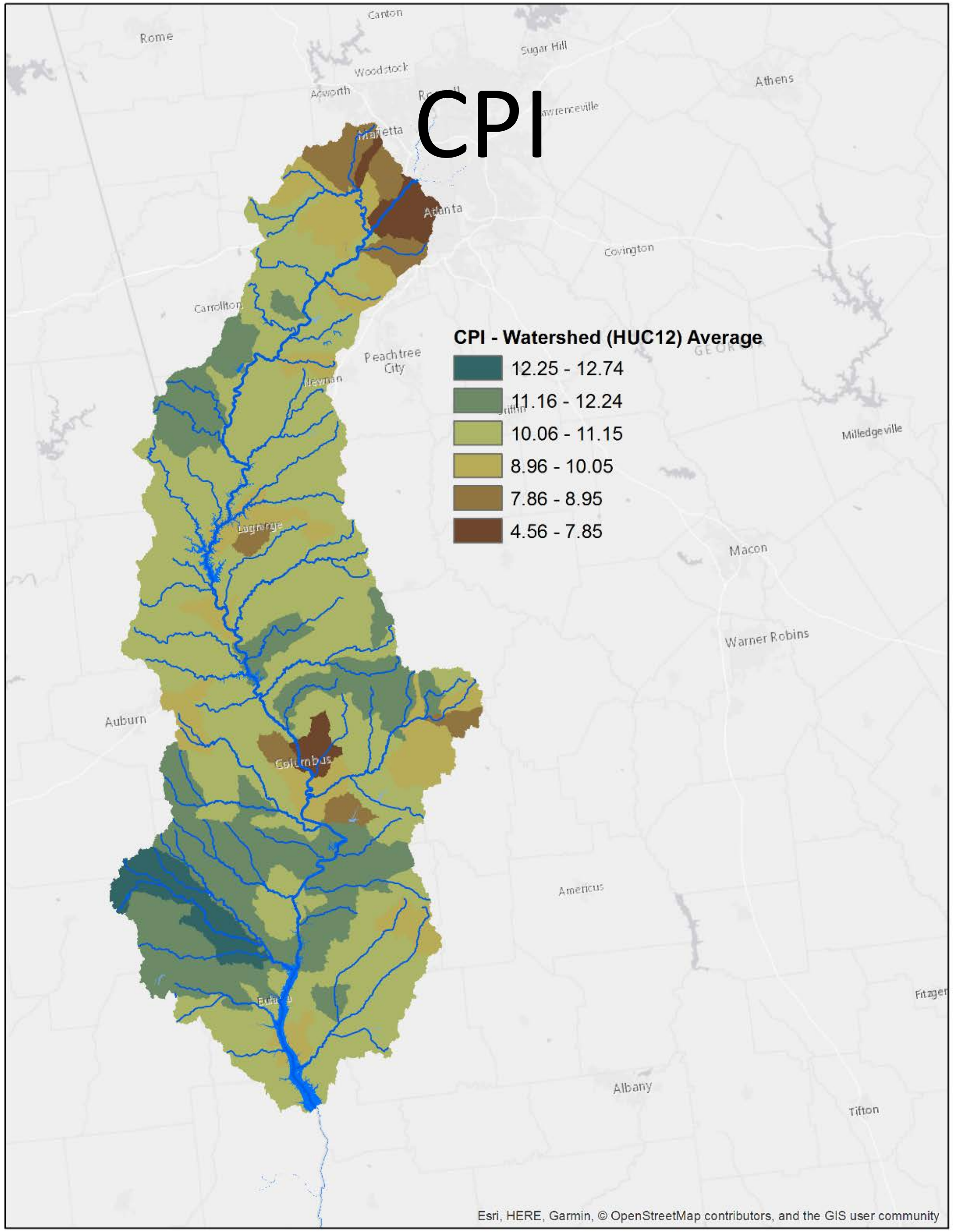
(Same Soil, Water, and Topographic Factors)



2011 Class	Percent
Open Water	2.7%
Developed, Open Space	6.2%
Developed, Low Intensity	3.6%
Developed, Medium Intensity	1.1%
Developed High Intensity	0.5%
Barren Land (Rock/Sand/Clay)	0.3%
Deciduous Forest	27.1%
Evergreen Forest	25.7%
Mixed Forest	3.9%
Shrub/Scrub	9.2%
Grassland/Herbaceous	5.5%
Pasture/Hay	7.9%
Cultivated Crops	1.9%
Woody Wetlands	4.1%
Emergent Herbaceous Wetlands	0.3%

Currently ~57% Forested
~78% “Natural”

CPI



CPI - Watershed (HUC12) Average
12.25 - 12.74
11.16 - 12.24
10.06 - 11.15
8.96 - 10.05
7.86 - 8.95
4.56 - 7.85
Canton
Rome
Sugar Hill
Woodstock
Acworth
Athens
Marietta
Atlanta
Covington
Carrollton
Peachtree City
Milledgeville
Macon
Warner Robins
Auburn
Columbus
Americus
Albany
Tifton
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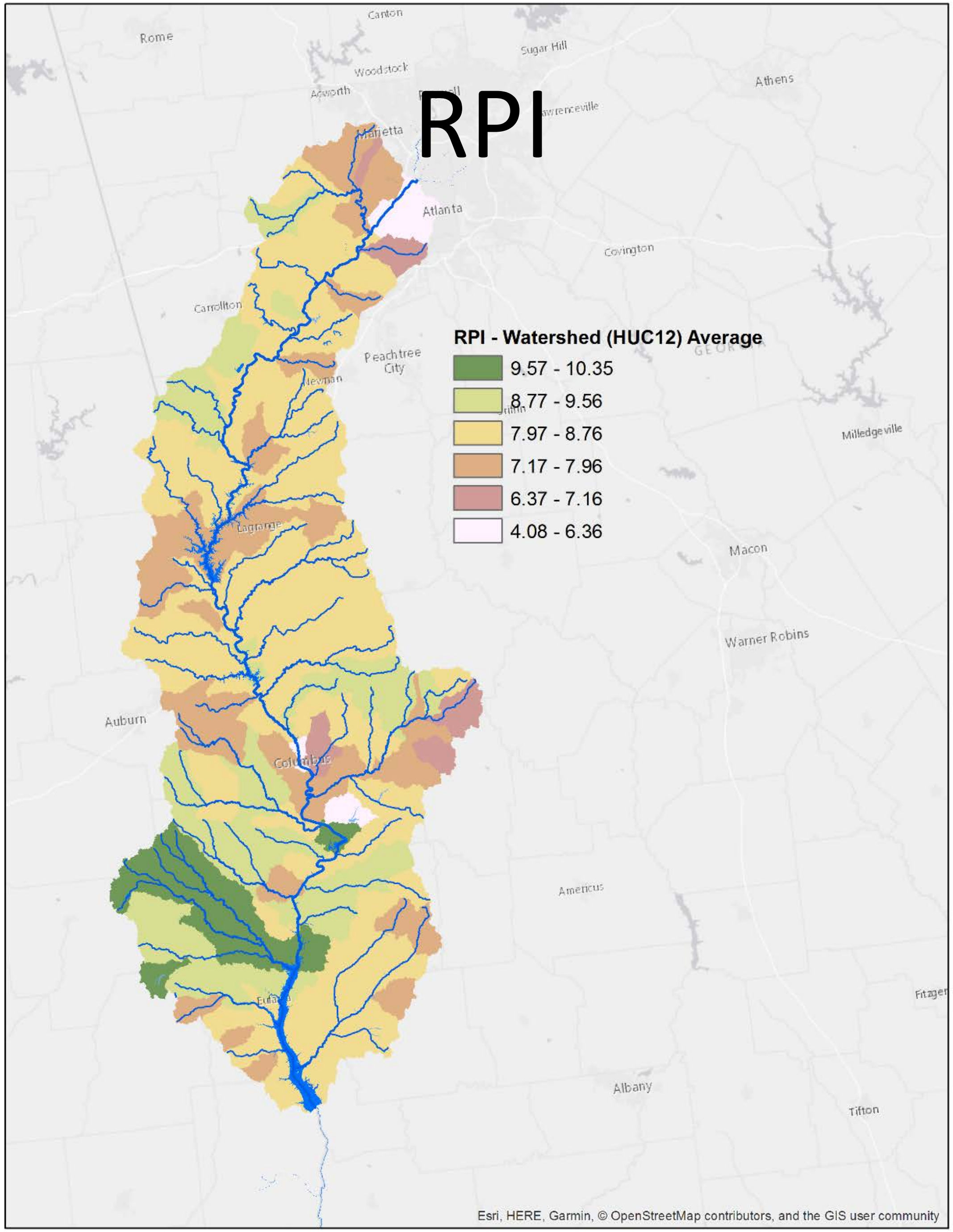
RPI


RPI - Watershed (HUC12) Average
9.57 - 10.35
8.77 - 9.56
7.97 - 8.76
7.17 - 7.96
6.37 - 7.16
4.08 - 6.36
Canton
Rome
Sugar Hill
Woodstock
Acworth
Athens
Marietta
Atlanta
Covington
Carrollton
Peachtree City
Milledgeville
Macon
Warner Robins
Auburn
Americus
Albany
Tifton
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Further Research Possibilities

- Would the model be valid at higher Chlorophyll-a concentrations (>5 μg/L)?
- Could we use sensor data as a surrogate for more expensive laboratory analysis?
- Investigate areas within each reservoir at risk for *Aetokthonos hydrillicola* growth
- Test water quality model with historical GA Power data
- Watershed HAB risk analysis using 2016 landcover data