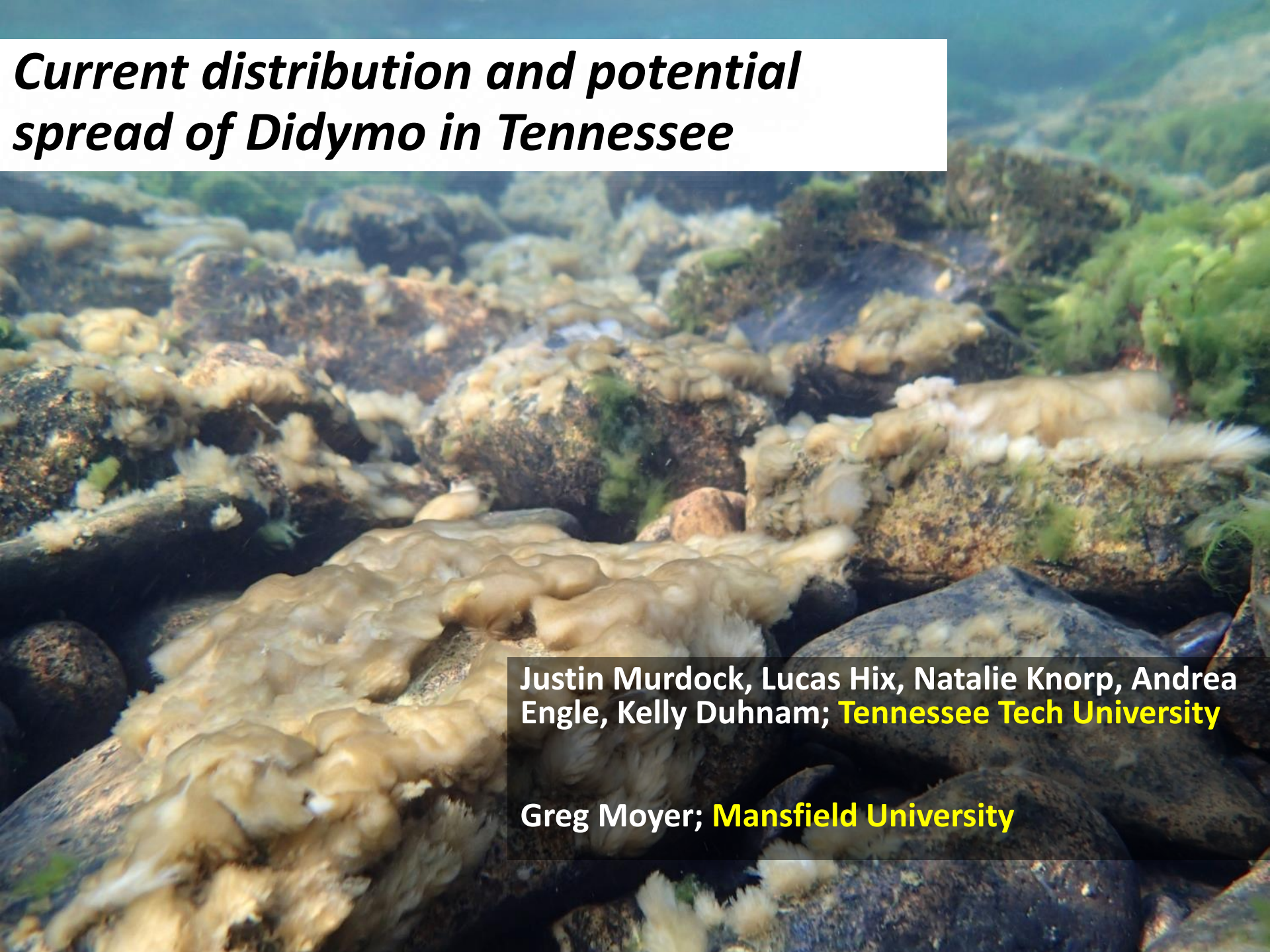
Current distribution and potential spread of Didymo in Tennessee



Justin Murdock, Lucas Hix, Natalie Knorp, Andrea Engle, Kelly Duhnam; Tennessee Tech University

Greg Moyer; Mansfield University

Acknowledgements

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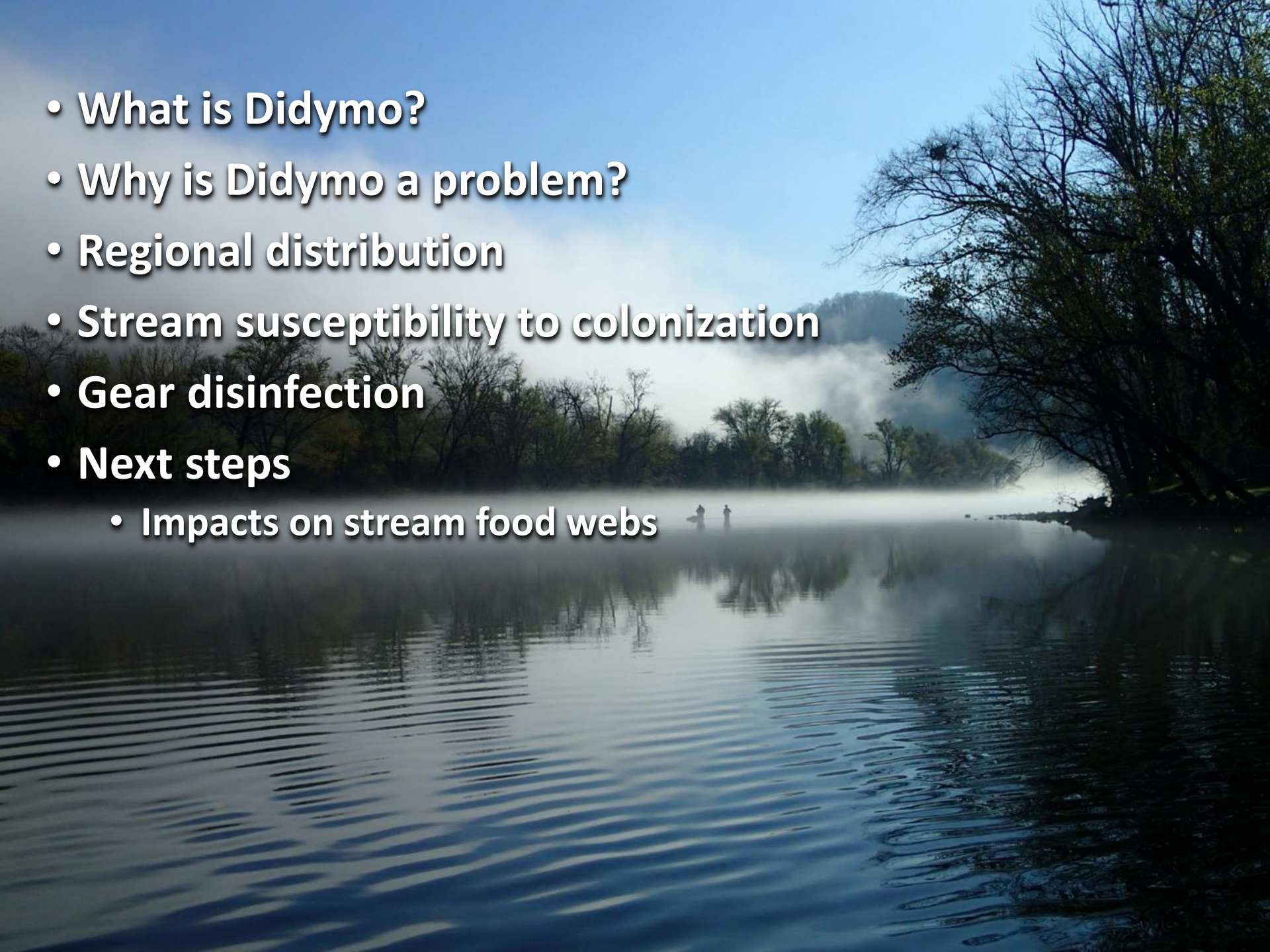
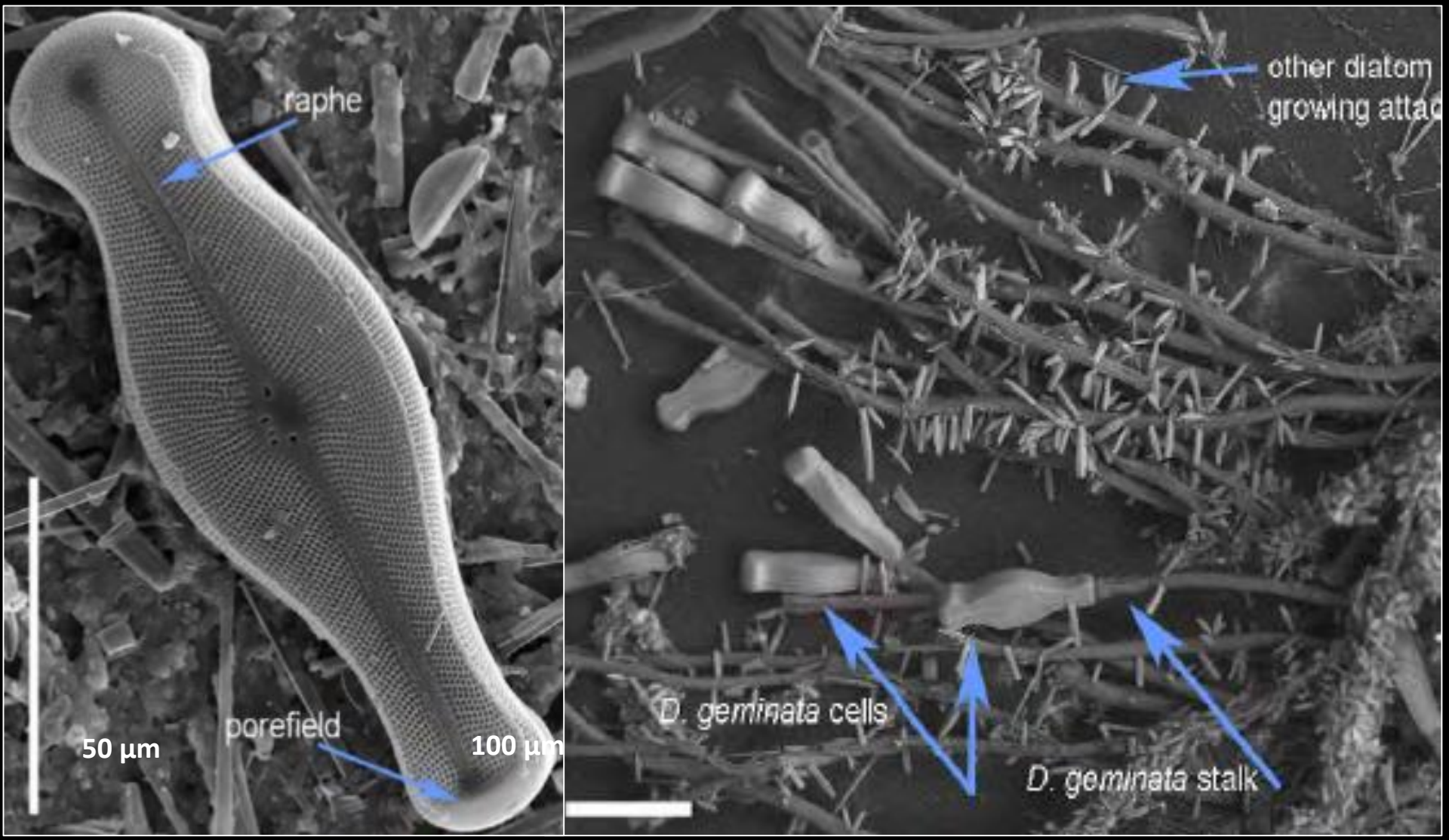
  - US Fish and Wildlife
  - The Tallassee Fund
  - Tennessee Tech University
  - Tennessee Tech Water Center

- Field and Lab Help
  - Kate Henderson
  - Cole Harty
  - Matthew Padgett
  - James Barlow
  - Cody Wilson

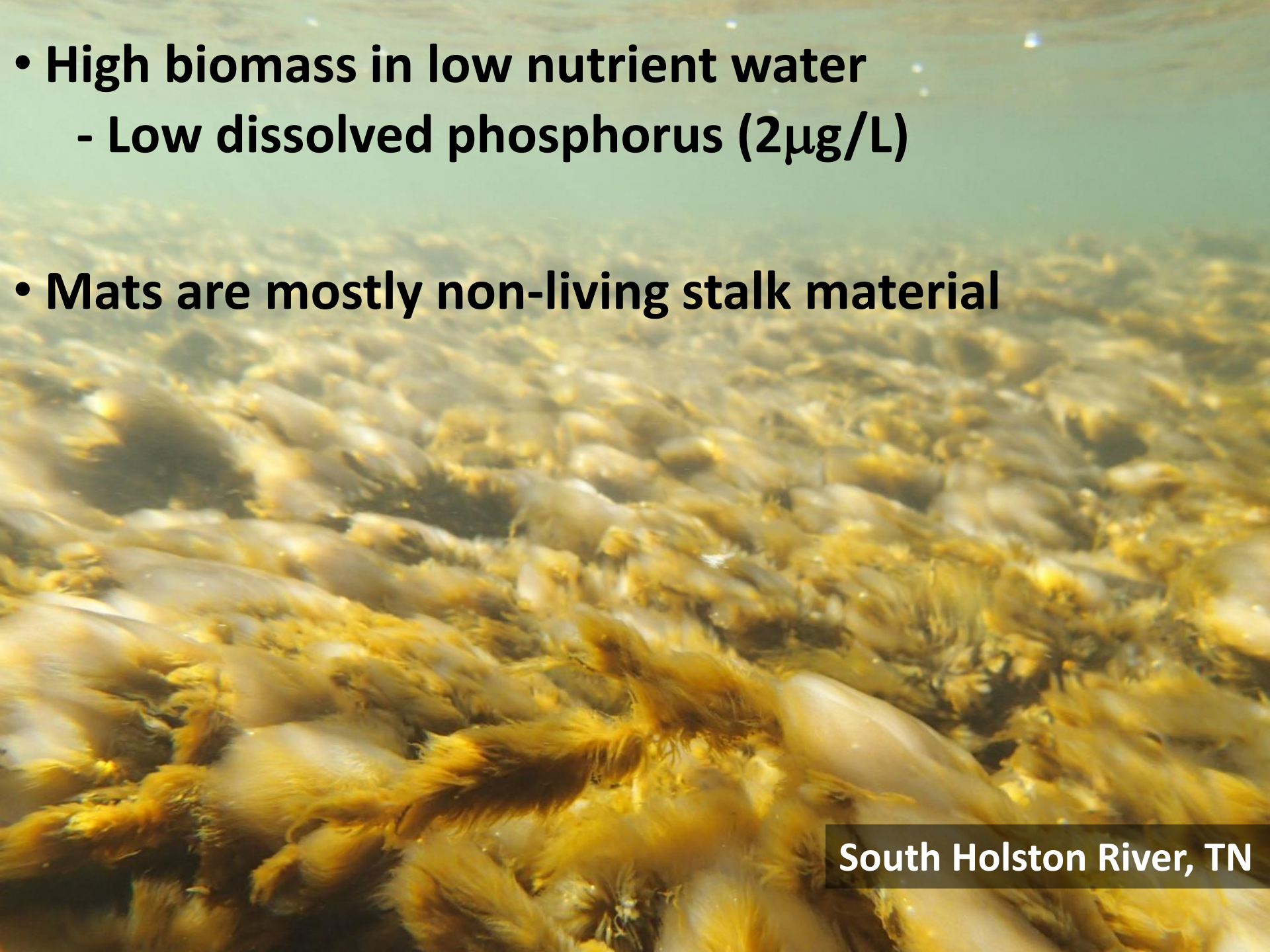


- What is Didymo?
- Why is Didymo a problem?
- Regional distribution
- Stream susceptibility to colonization
- Gear disinfection
- Next steps
  - Impacts on stream food webs

What is *Didymosphenia geminata* (Didymo)?



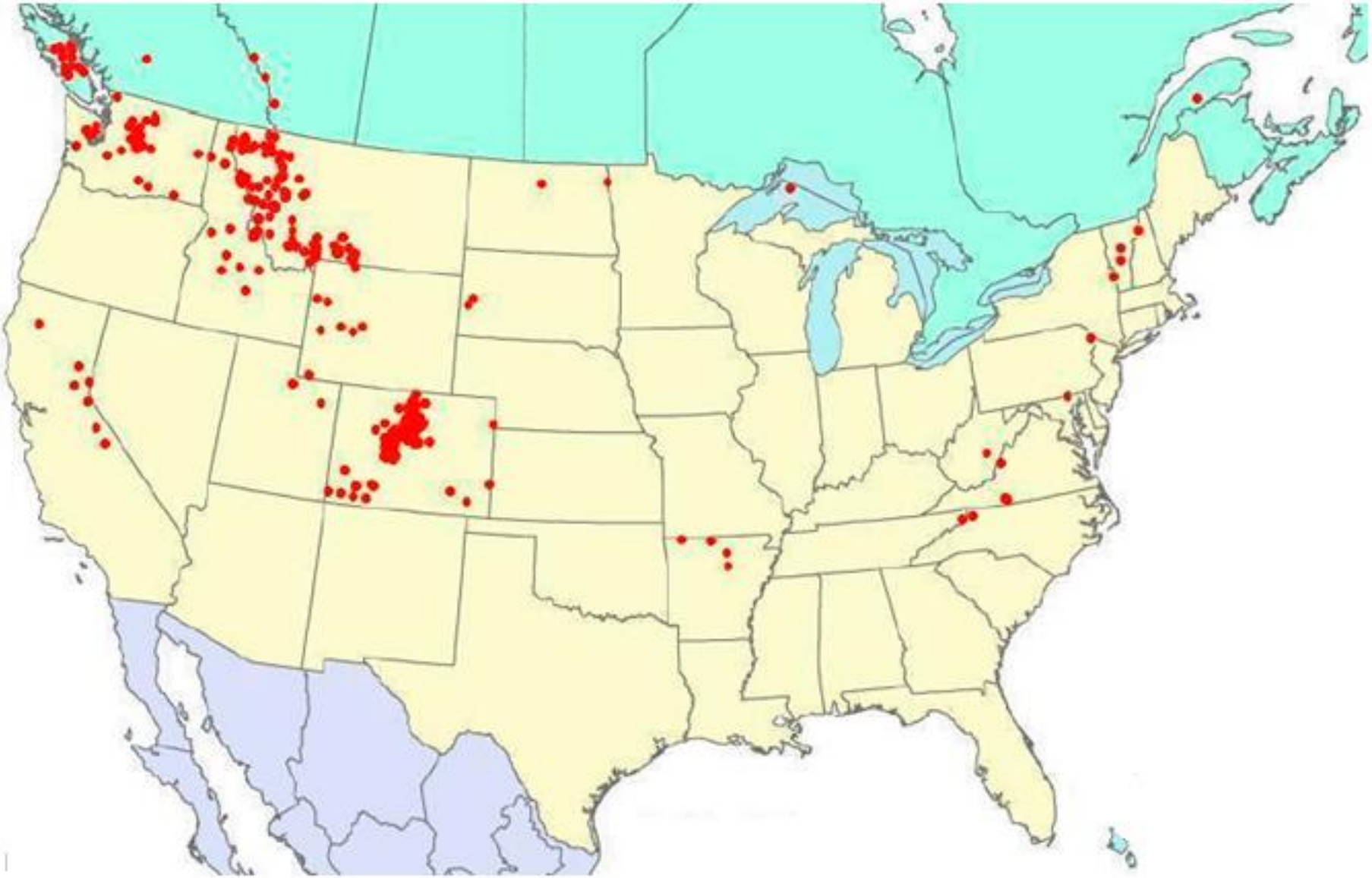
Spaulding and Elwell 2007


• High biomass in low nutrient water
- Low dissolved phosphorus (2μg/L)
• Mats are mostly non-living stalk material
South Holston River, TN

Why is Didymo a problem?

- **Decreases recreational appeal of stream**
- **Changes physical habitat**
  - **Homogenizes habitat**
  - **Changes flow**
- **Change food resources for invertebrates, fishes?**
  - **Reduce selection?**
  - **Increases organic matter**
  - **Epiphytes**

C.A. Gillis, Matapedia River, Quebec



Spaulding and Elwell 2007

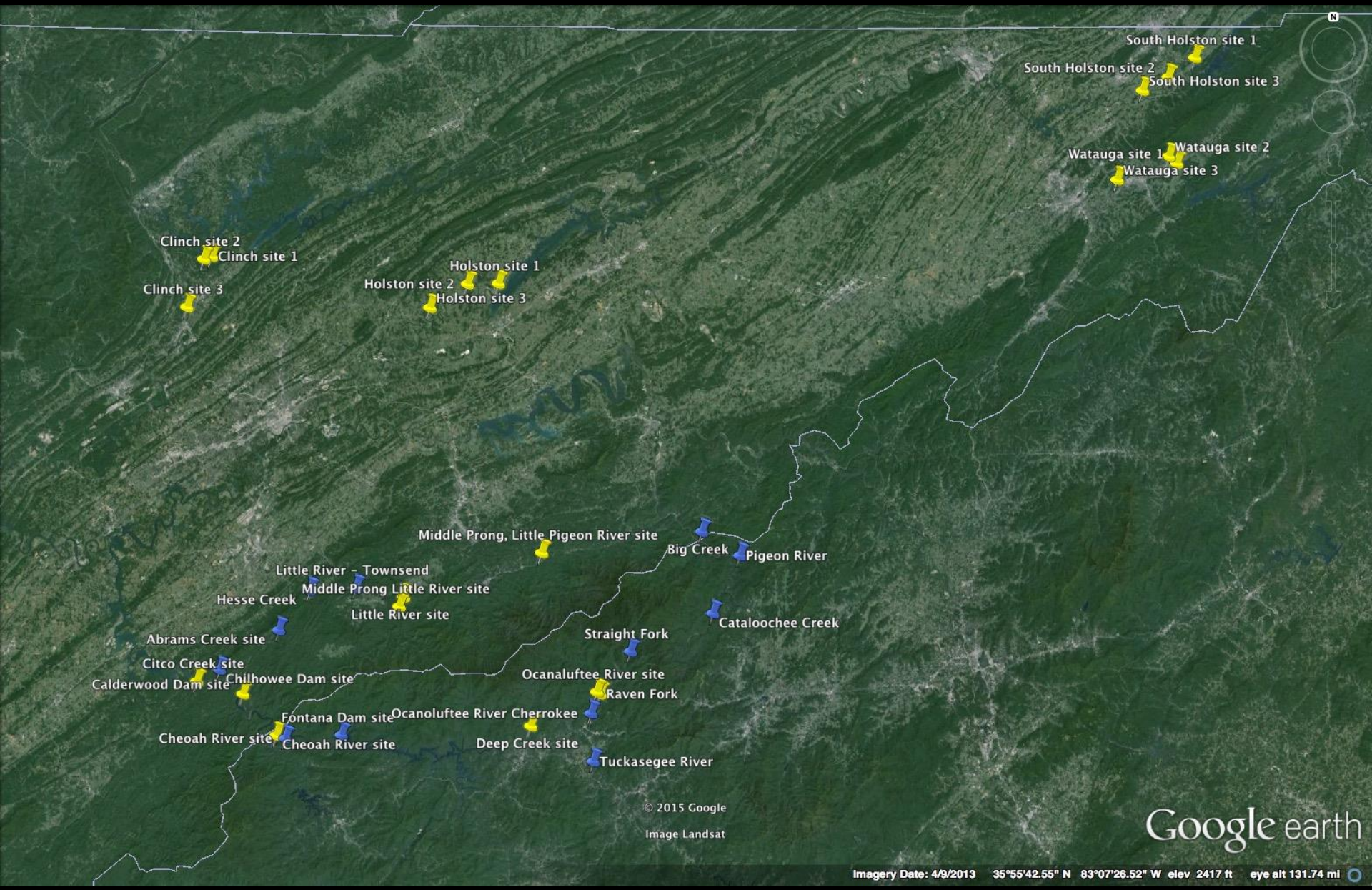
Study Objectives

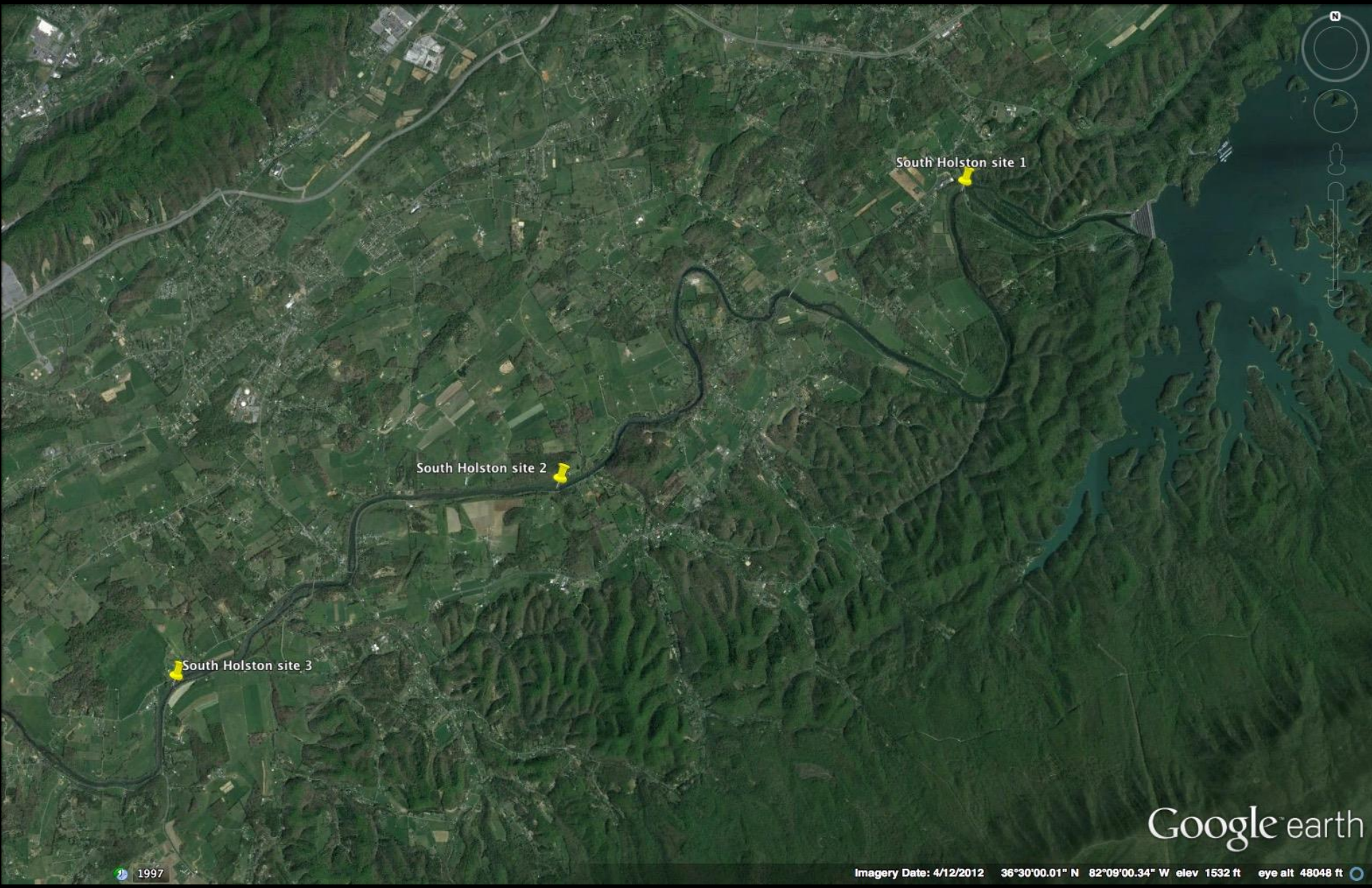
1. Distribution (Tailwaters and GSMP)
    - Presence vs. Absence
    - Cells only vs. mats
    - Related environmental factors

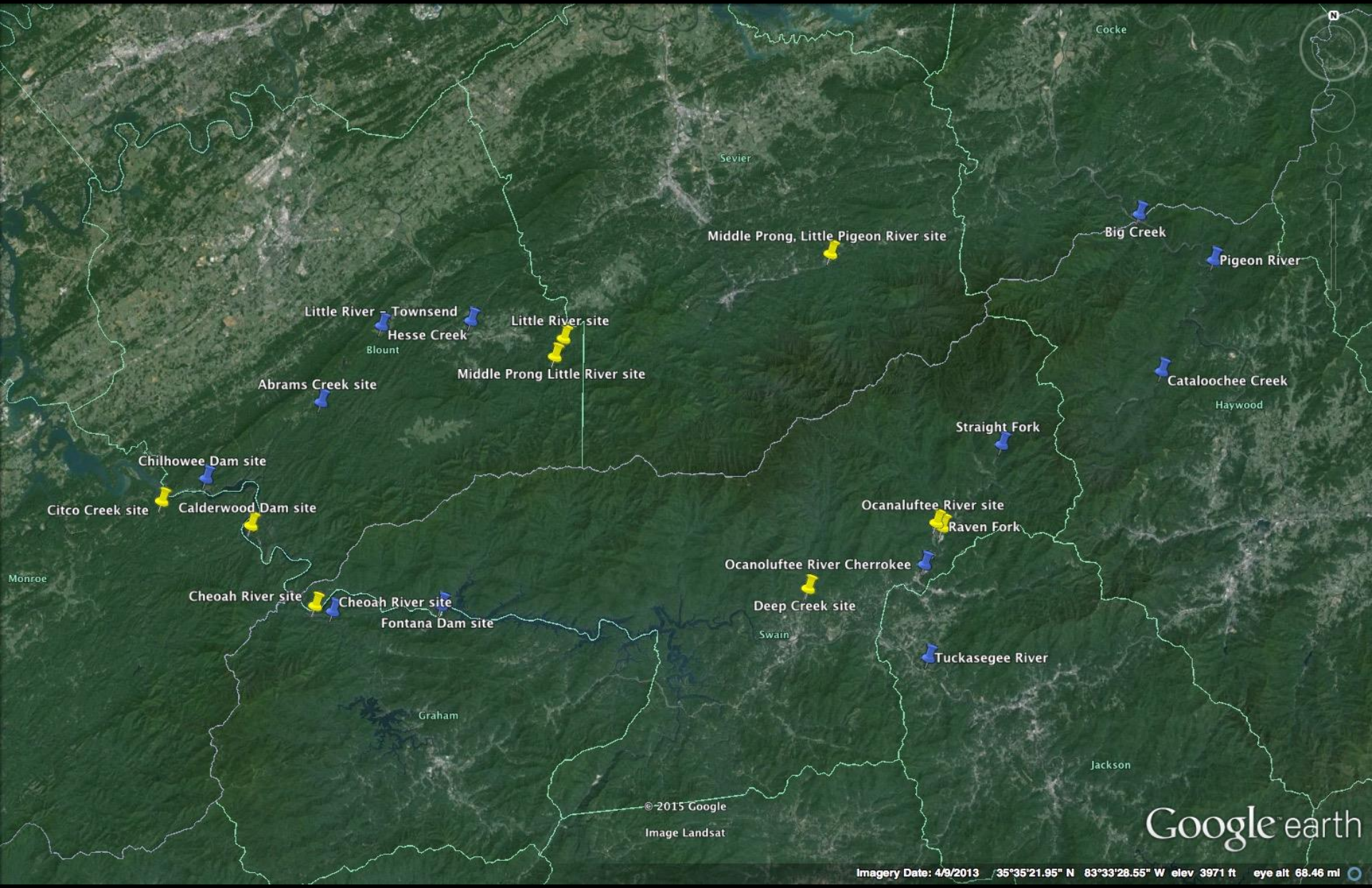
2. Abundance
    - Cell abundance
    - Mat coverage
    - Related environmental factors

    2 years (Spring, Summer, Fall of 2014 & 2015)

Study sites

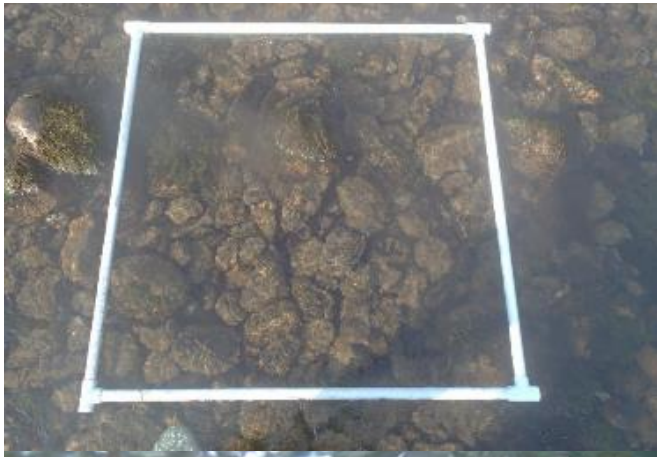

South Holston site 1
South Holston site 2
South Holston site 3
Watauga site 1
Watauga site 2
Watauga site 3
Clinch site 2
Clinch site 1
Clinch site 3
Holston site 1
Holston site 2
Holston site 3
Middle Prong, Little Pigeon River site
Big Creek
Pigeon River
Little River - Townsend
Middle Prong Little River site
Hesse Creek
Little River site
Cataloochee Creek
Straight Fork
Abrams Creek site
Citco Creek site
Calderwood Dam site
Chilhowee Dam site
Ocanaluftee River site
Raven Fork
Fontana Dam site
Ocanoluftee River Cherrokee
Cheoah River site
Cheoah River site
Deep Creek site
Tuckasegee River
© 2015 Google
Image Landsat
Google earth
Imagery Date: 4/9/2013 35°55'42.55" N 83°07'26.52" W elev 2417 ft eye alt 131.74 mi

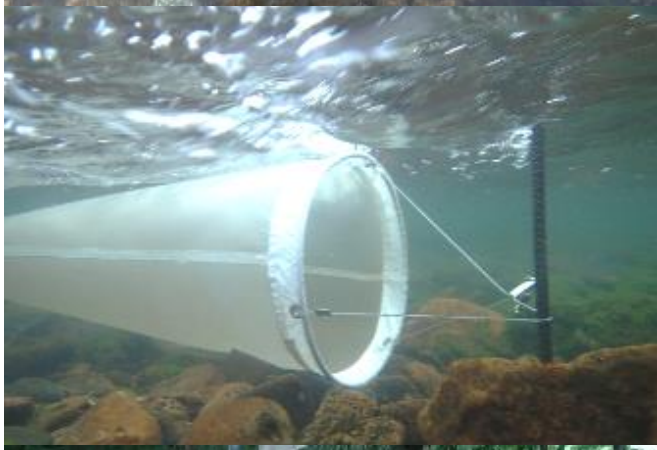

South Holston site 1
South Holston site 2
South Holston site 3
Google earth
1997
Imagery Date: 4/12/2012 36°30'00.01" N 82°09'00.34" W elev 1532 ft eye alt 48048 ft


Cocke
Sevier
Middle Prong, Little Pigeon River site
Big Creek
Pigeon River
Little River - Townsend
Hesse Creek
Blount
Little River site
Middle Prong Little River site
Abrams Creek site
Cataloochee Creek
Haywood
Straight Fork
Chilhowee Dam site
Citco Creek site
Calderwood Dam site
Ocanaluftee River site
Raven Fork
Ocanoluftee River Cherrokee
Monroe
Cheoah River site
Cheoah River site
Fontana Dam site
Deep Creek site
Swain
Tuckasegee River
Graham
Jackson
© 2015 Google
Image Landsat
Google earth
Imagery Date: 4/9/2013 35°35'21.95" N 83°33'28.55" W elev 3971 ft eye alt 68.46 mi

Detection Methods

- Visual inspection
- Mat coverage
  - % mat coverage
- Drift net
  - presence/absence
  - cell abundance
- Benthic sample (transects)
  - presence/absence
  - cell abundance

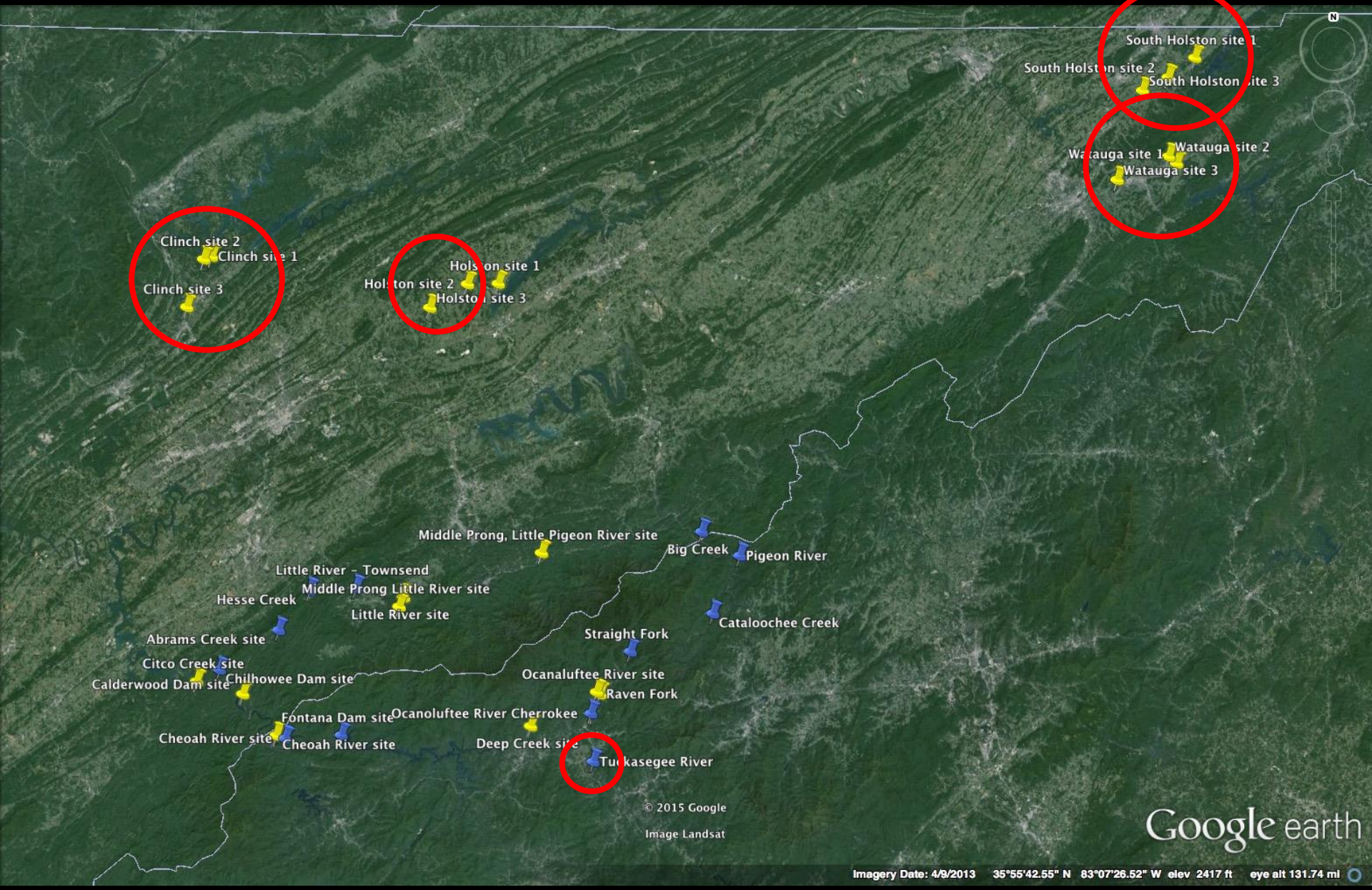




Habitat Measurements

- Water quality
  - Temperature, pH, conductivity & turbidity
  - Nutrients, metals & minerals
- Canopy coverage
- Channel morphology, discharge & depth
- Substrate type

Study sites and current distribution



Results: Distribution

Presence: Stream with

- Higher **pH**, magnesium, dissolved phosphorus
- Lower **total nitrogen**, temperature, depth, canopy cover

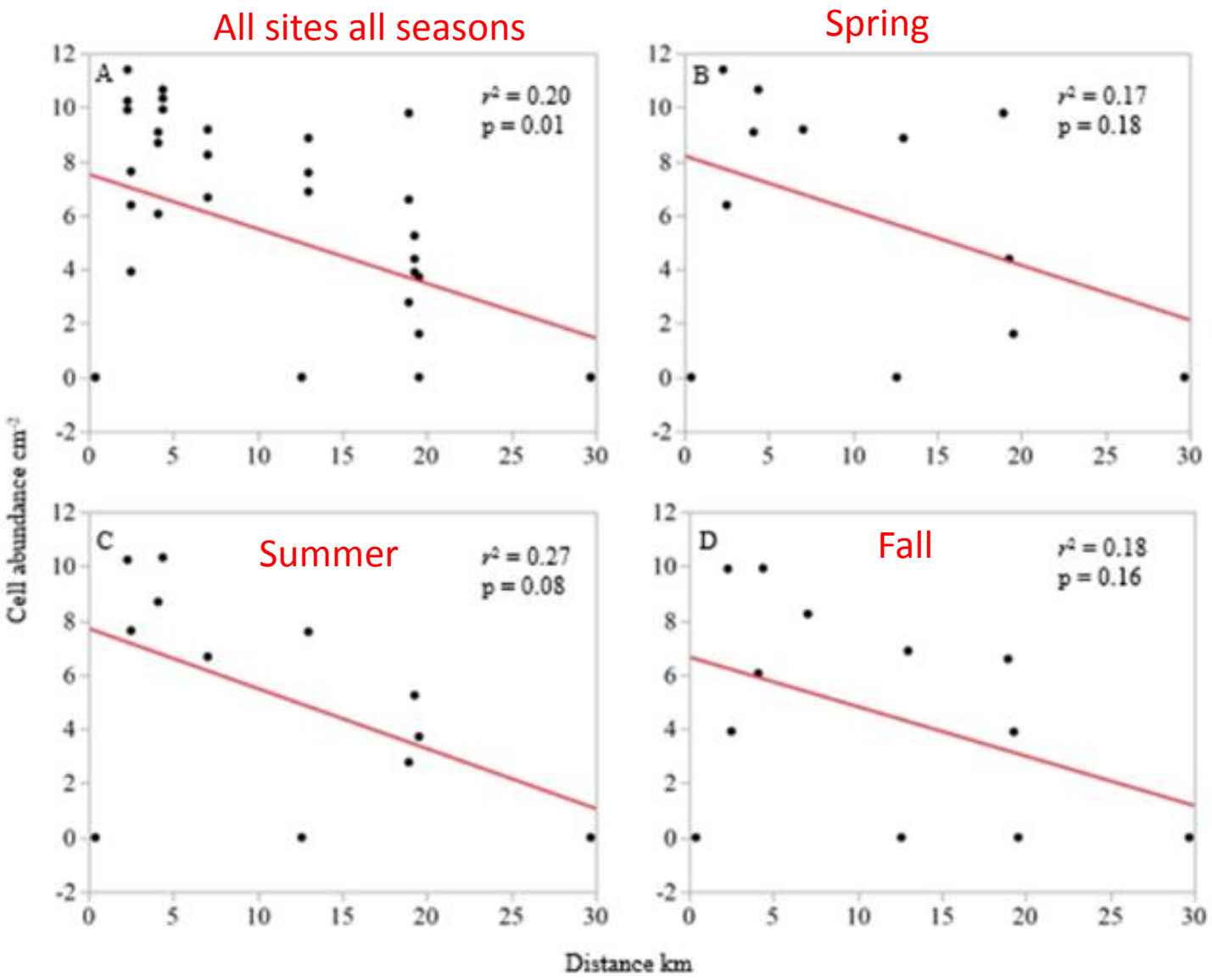
If cells present: Formed mats with

- Higher calcium and conductivity
- Lower **sulfate**

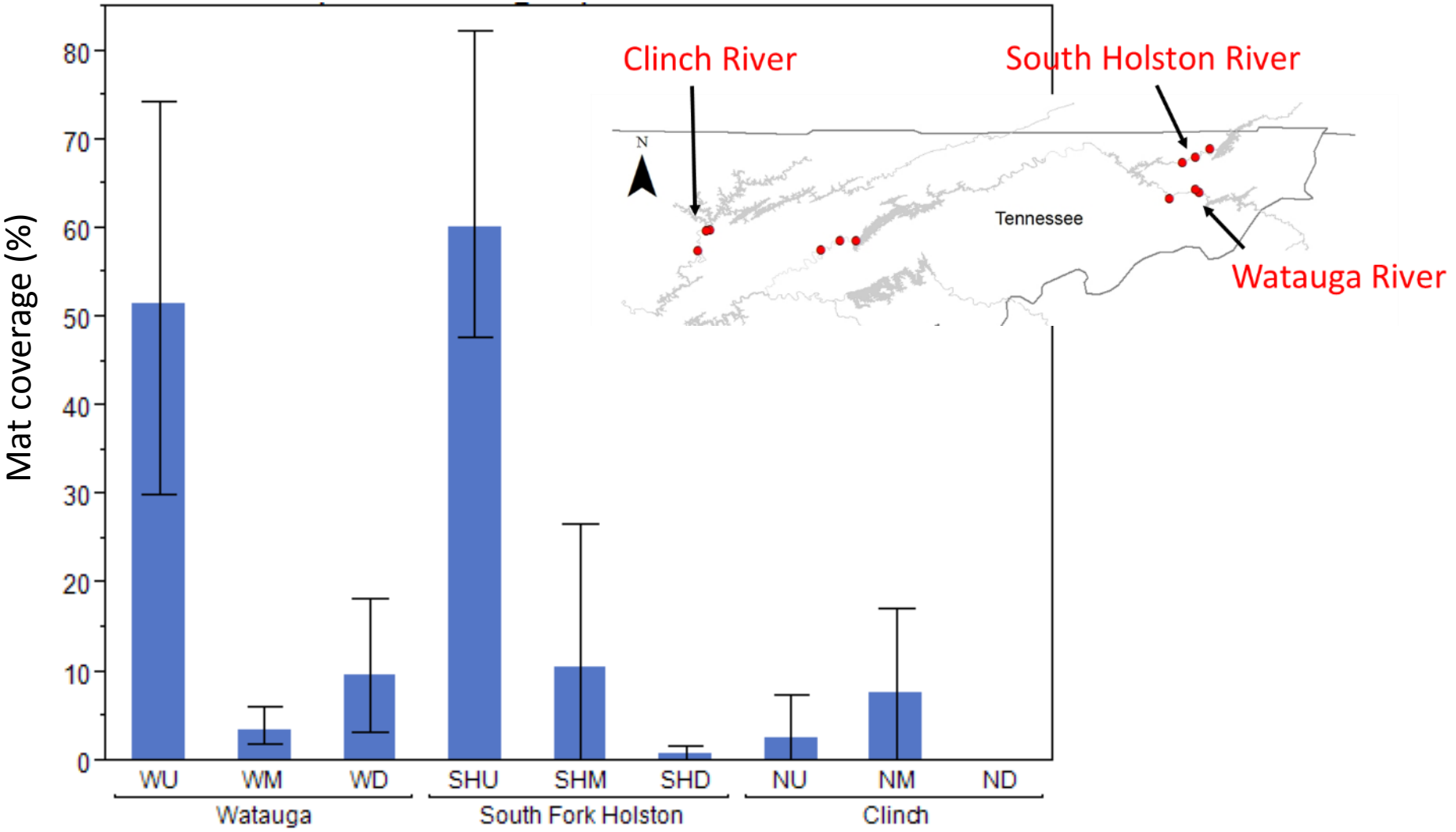
Phosphorus?

State	Calcium	Soluble reactive phosphorus	Sulfate	Total Nitrogen	Temperature	Conductivity	pH	Canopy Coverage	Depth
	mg·L	µg·L	mg·L	mg·L	°C	µS·cm		%	m
Absent	6	4	3.6	0.4	14	85	6	35.5	0.3
	(-9.7)	(4.9)	(6.2)	(0.6)	(4.7)	(125.9)	(0.7)	(24.5)	(0.16)
Cells	21.2	1.4	15.4	0.7	7	245	6.9	2.2	0.5
	(3.2)	(1.2)	(3.1)	(0.5)	(1.7)	(71.4)	(0.3)	(4.8)	(0.19)
Cells and mats	17.5	3	7.2	0.8	10.5	223	7.1	8	0.2
	(9.8)	(3.2)	(3.0)	(0.56)	(3.6)	(130.2)	(0.75)	(13.6)	(0.14)

Cell Abundance vs. Distance from dam



Results: Didymo patterns (2014)



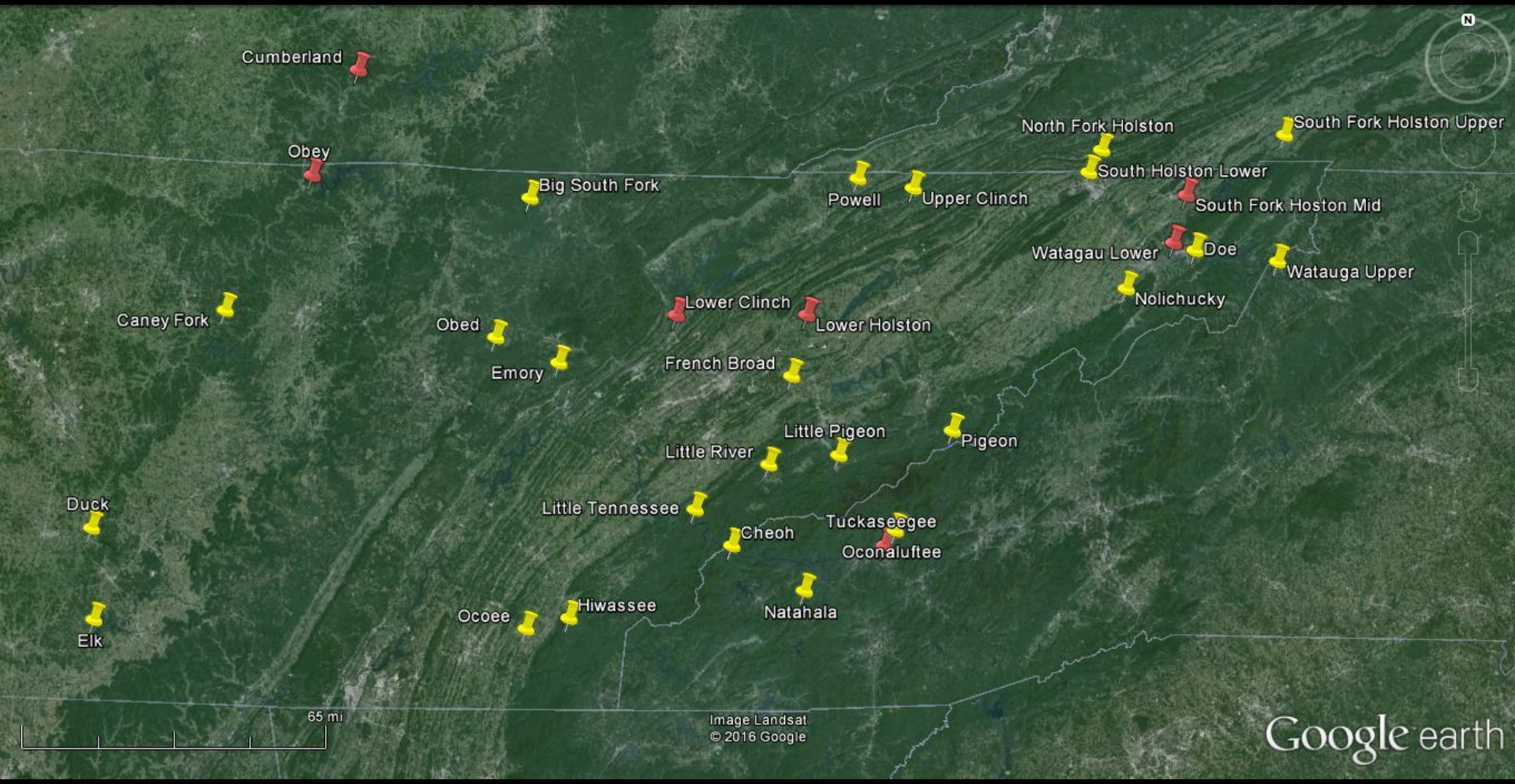
Distribution Conclusions

- Regionally, Didymo cells are present in streams with higher pH, light availability, and phosphorus

- When Didymo is present, mat coverage is correlated with low sulfate, and higher pH and conductivity

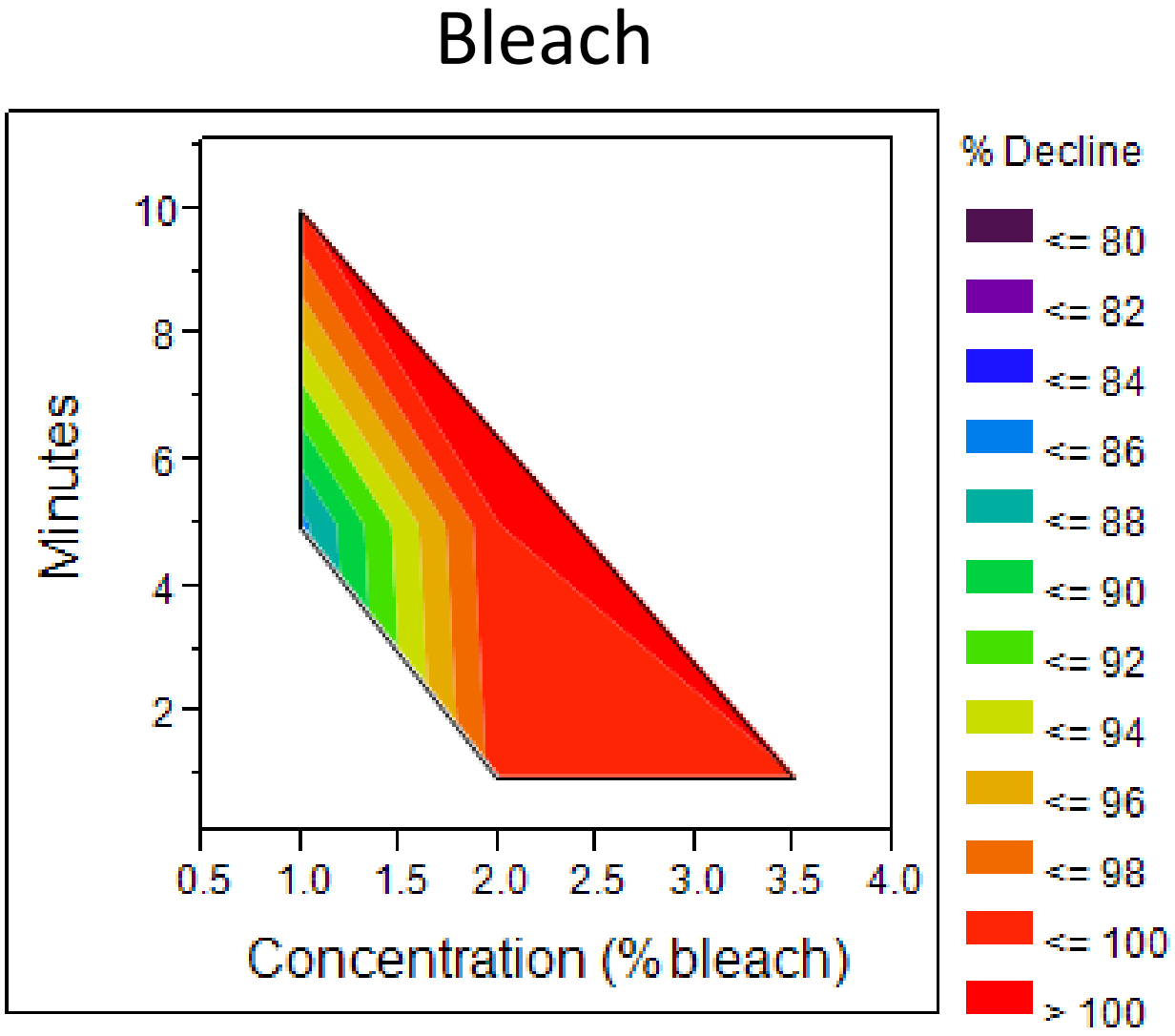
- In Tennessee, Didymo is **limited to tailwaters** with decreasing biomass downstream.

Regional eDNA study

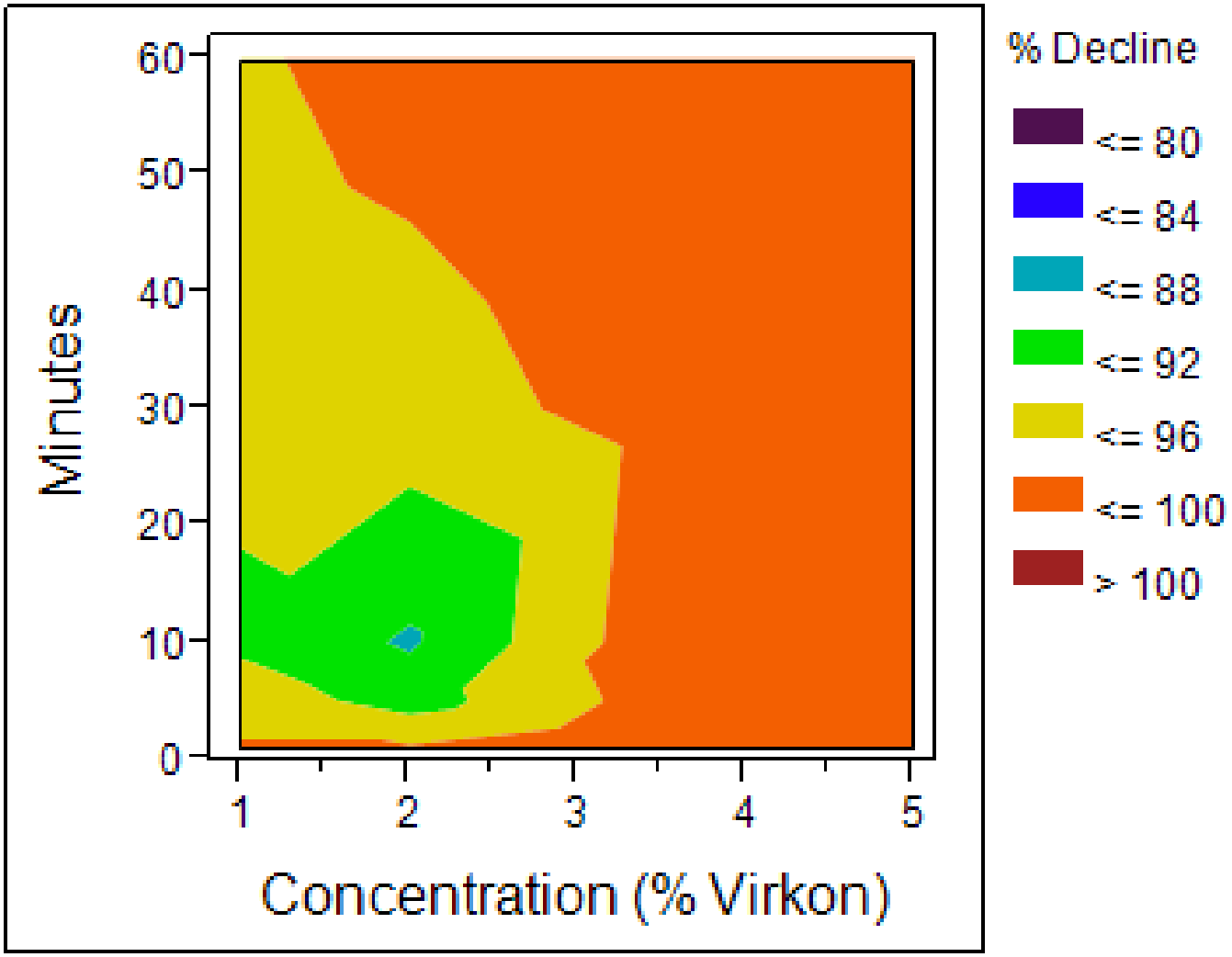


Disinfection study

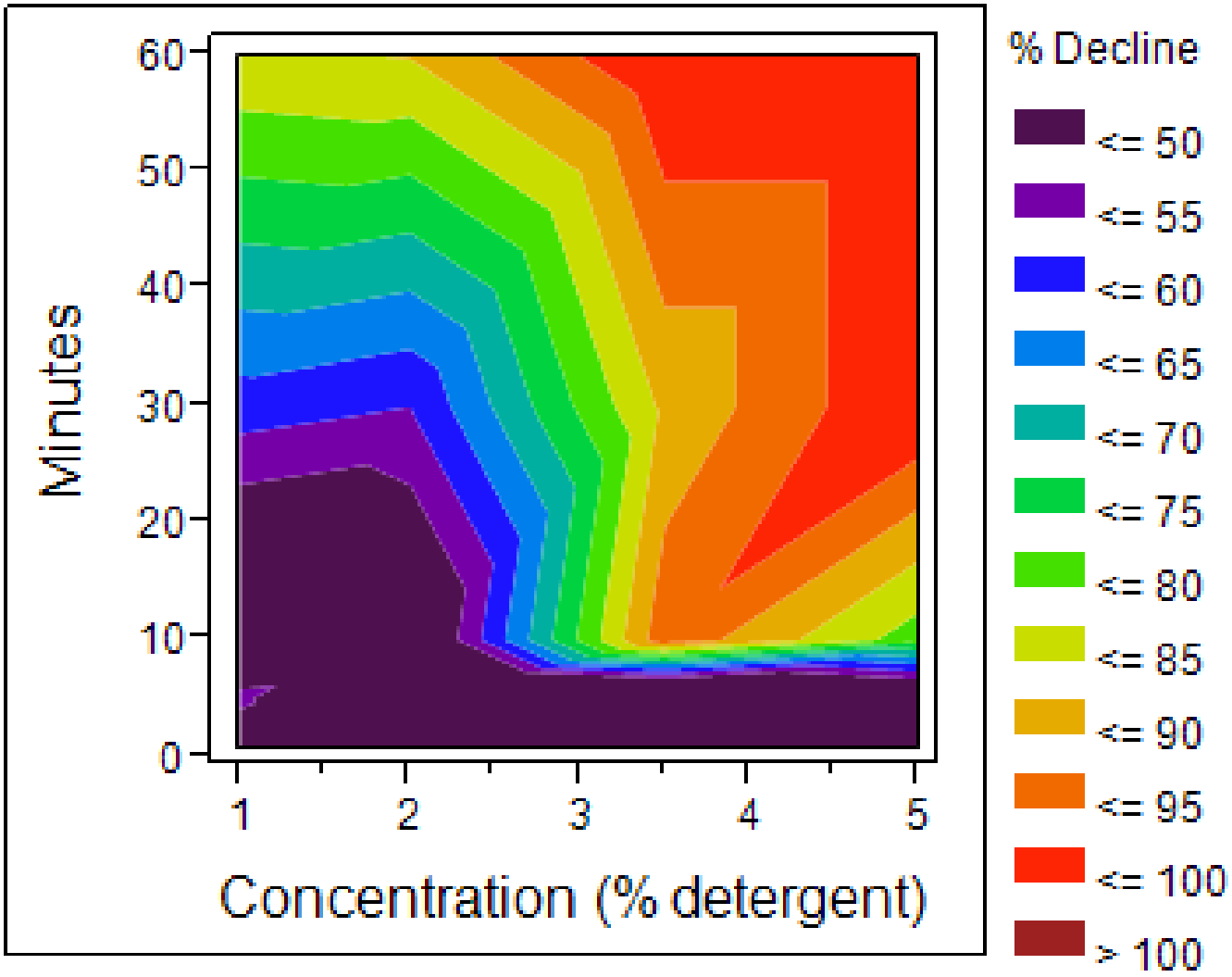
- Bleach
- Virkon
- Detergent
- Acidity
- Salinity



Virkon


Minutes
60
50
40
30
20
10
0
1
2
3
4
5
Concentration (% Virkon)
% Decline
<= 80
<= 84
<= 88
<= 92
<= 96
<= 100
> 100

Detergent

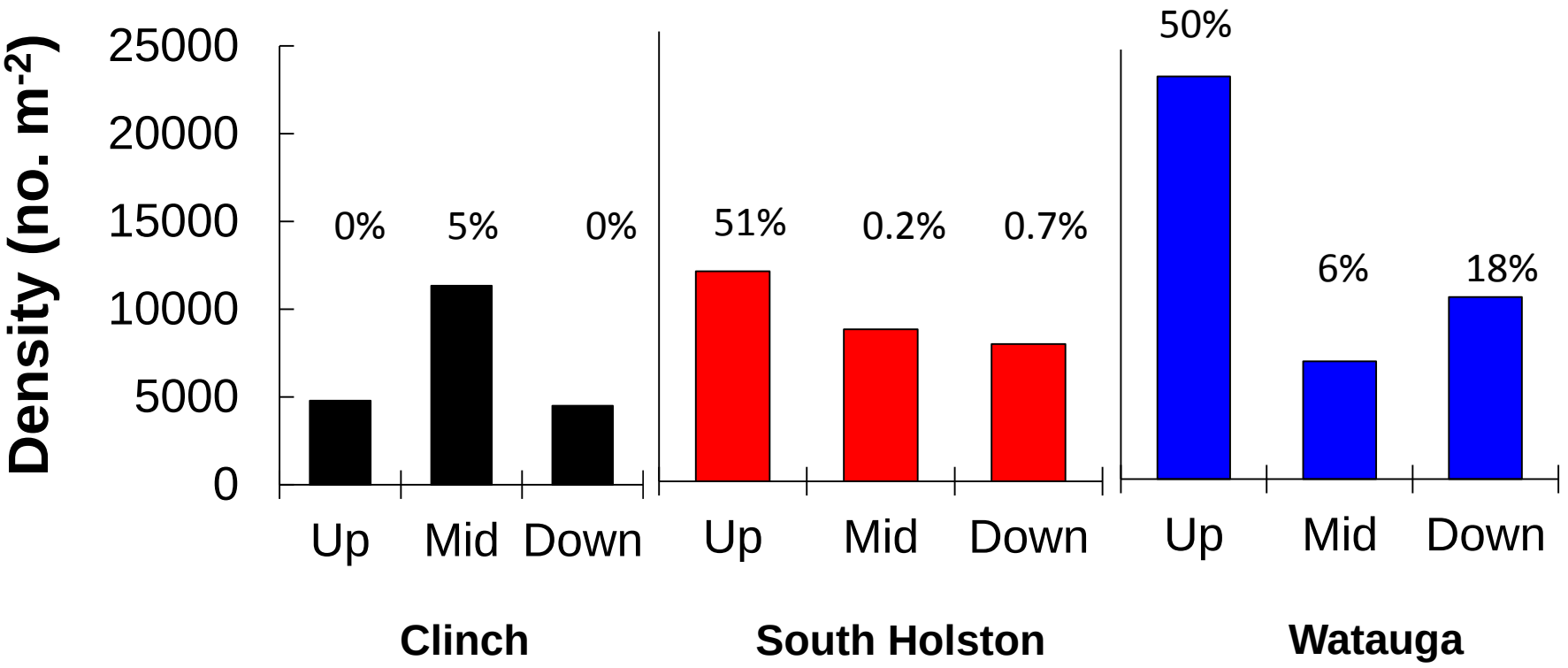

Minutes
60
50
40
30
20
10
0
1
2
3
4
5
Concentration (% detergent)
% Decline
<= 50
<= 55
<= 60
<= 65
<= 70
<= 75
<= 80
<= 85
<= 90
<= 95
<= 100
> 100

Study Objectives: Food webs

1. Assess the impact of Didymo mats on macroinvertebrate structure
    - Overall density
    - Species composition

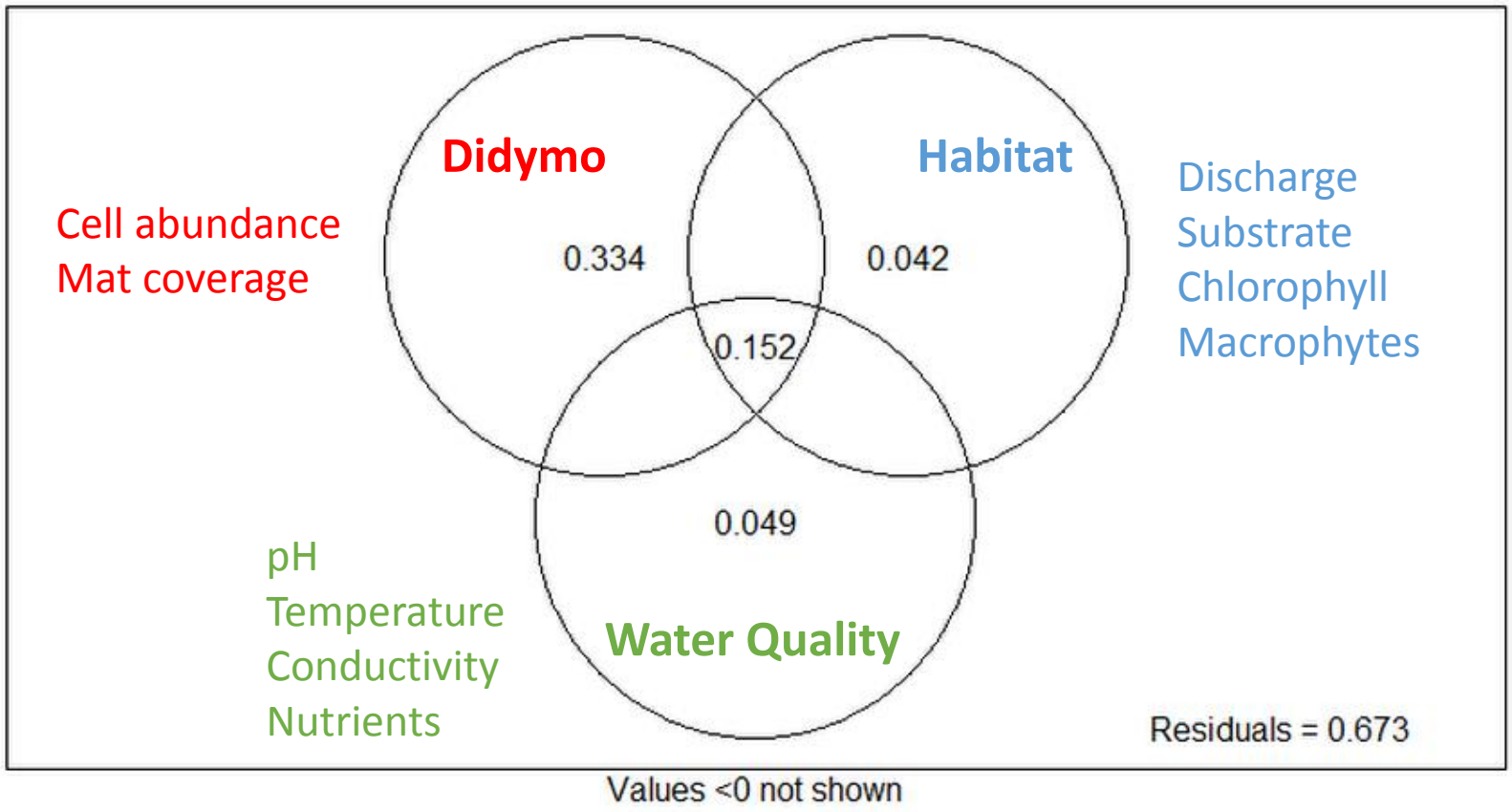
2. Determine whether Didymo mats change which food resources macroinvertebrates and trout are consuming
    - Stable isotopes (carbon and nitrogen)
    - Lipids
    - Gut contents

Results: Macroinvertebrate density



- Total densities were greatest where mat coverage was greatest.
- Consistent with other studies (Shelby 2006, Larned et al. 2007, Gillis and Chalifour 2010, Larned and Kilroy 2014)

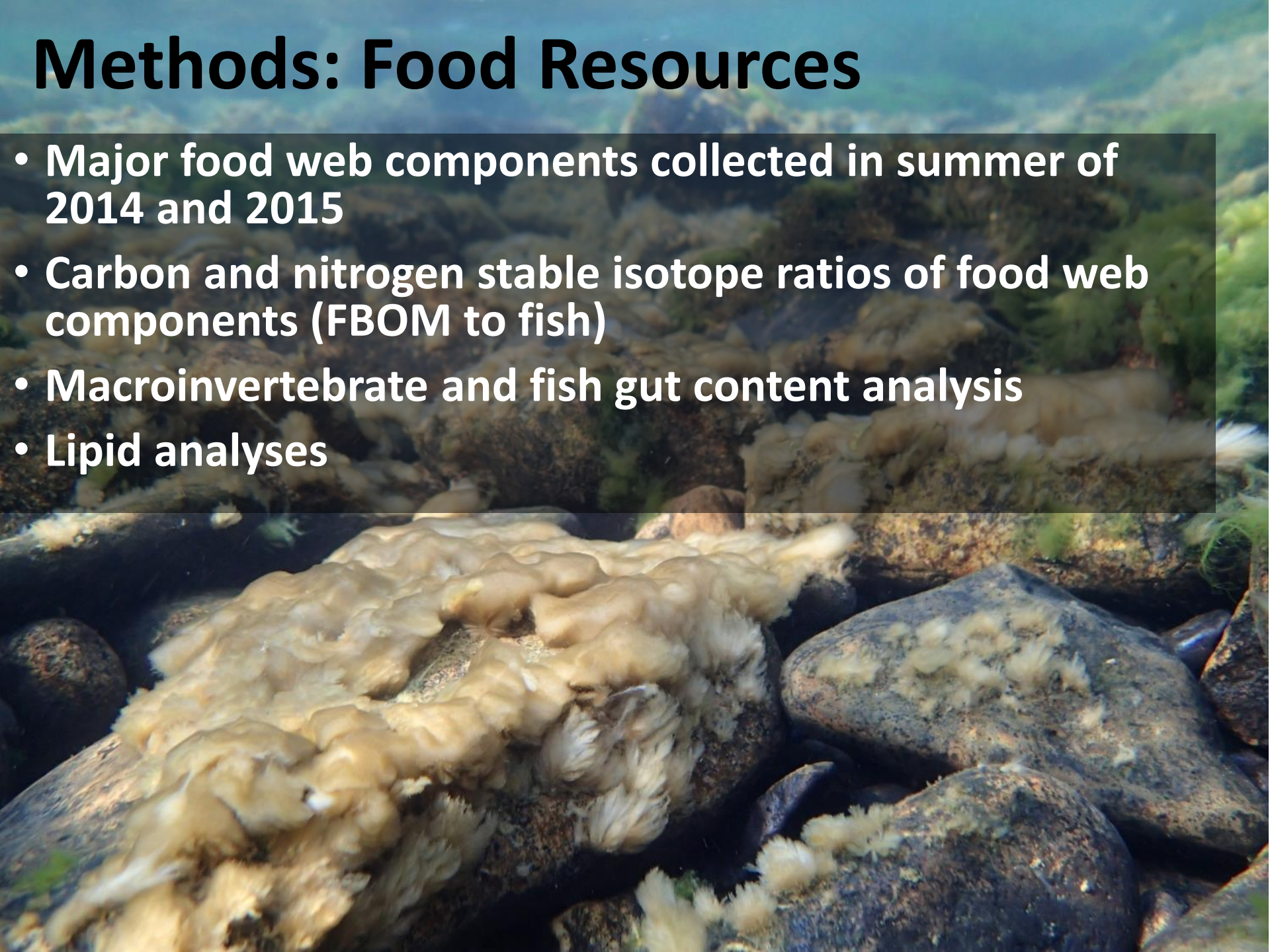
CCA variance partitioning of environmental factors on macroinvertebrate structure



- Didymo cell abundance and % coverage were strong drivers
- Measured environmental and habitat variables were not as important

Methods: Food Resources

- Major food web components collected in summer of 2014 and 2015
- Carbon and nitrogen stable isotope ratios of food web components (FBOM to fish)
- Macroinvertebrate and fish gut content analysis
- Lipid analyses



Results: Food Resources

- Stable isotope and lipid data suggest that mats changed macroinvertebrate food use

- Invertebrates at high Didymo sites tended to rely on more on macrophytes, whereas invertebrates at low Didymo sites tended to rely on rock biofilms

Preliminary Conclusions

- Didymo mats
  - increased macroinvertebrate abundance,
  - had strong influence on proportional abundance
- Mats may alter macroinvertebrates food resources
- Consequences for organisms in upper trophic levels like fish?

Questions?