Didymosphenia geminata effects on river food webs

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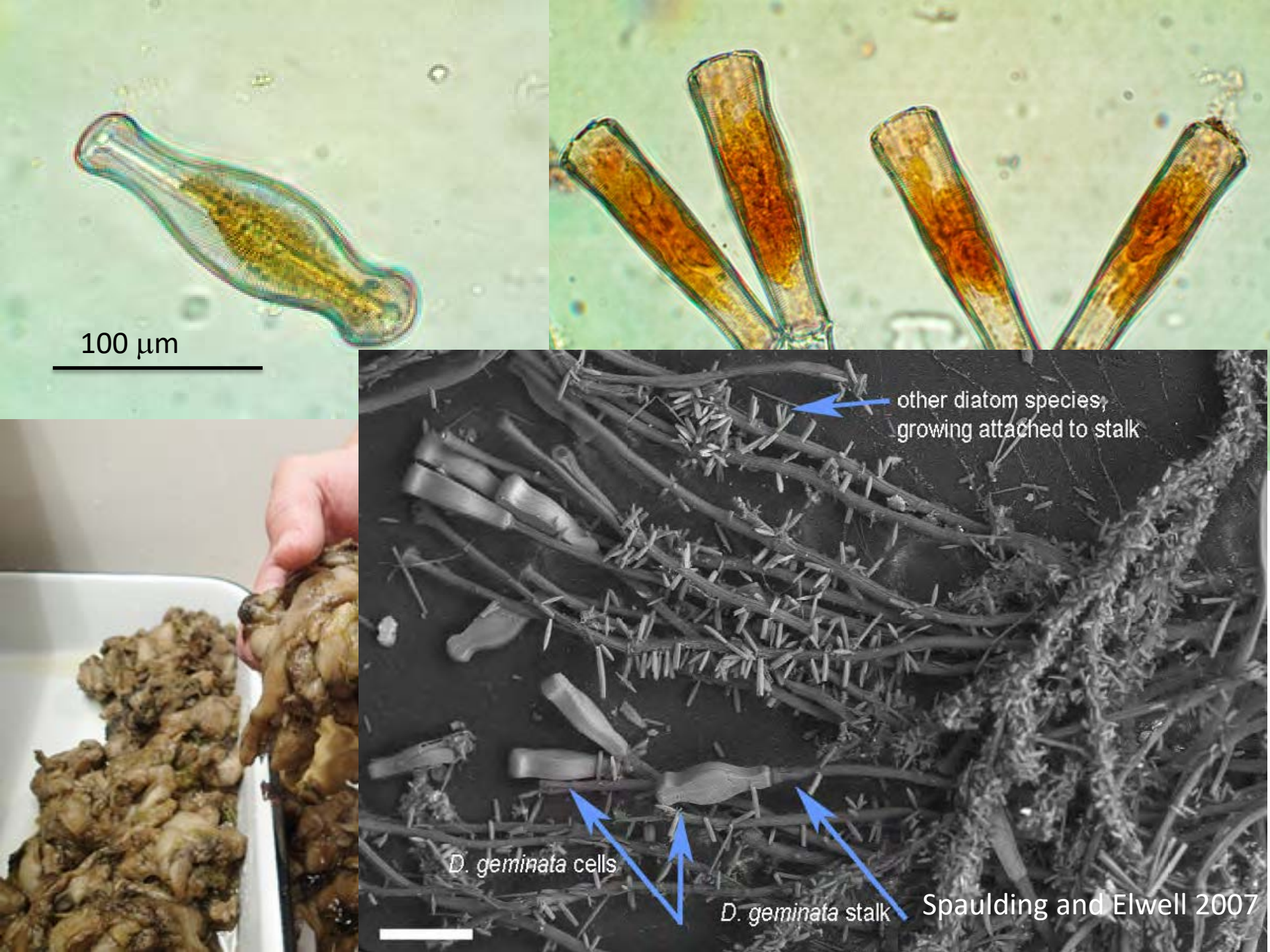
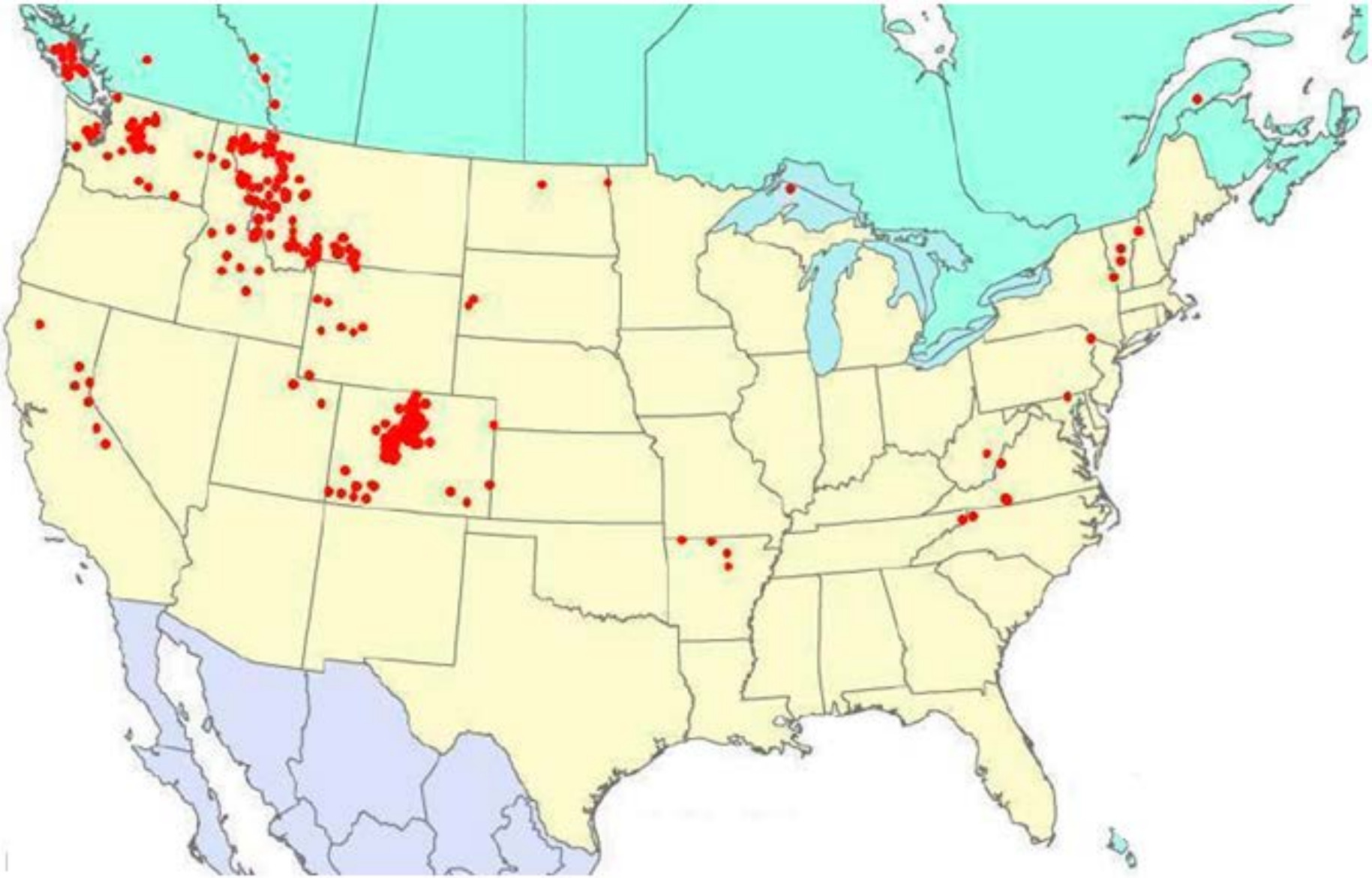
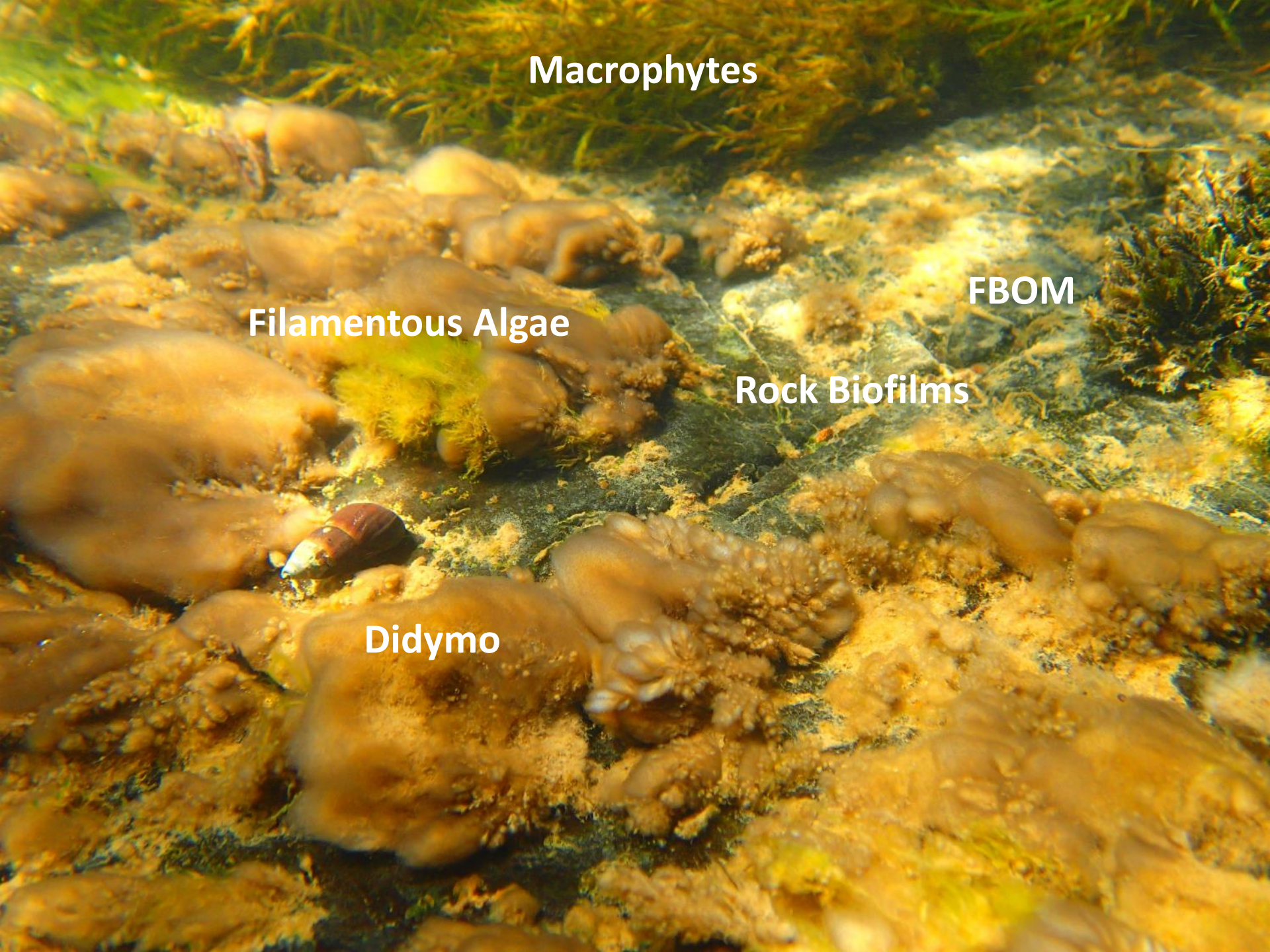

100 μm
other diatom species,
growing attached to stalk
D. geminata cells
D. geminata stalk
Spaulding and Elwell 2007



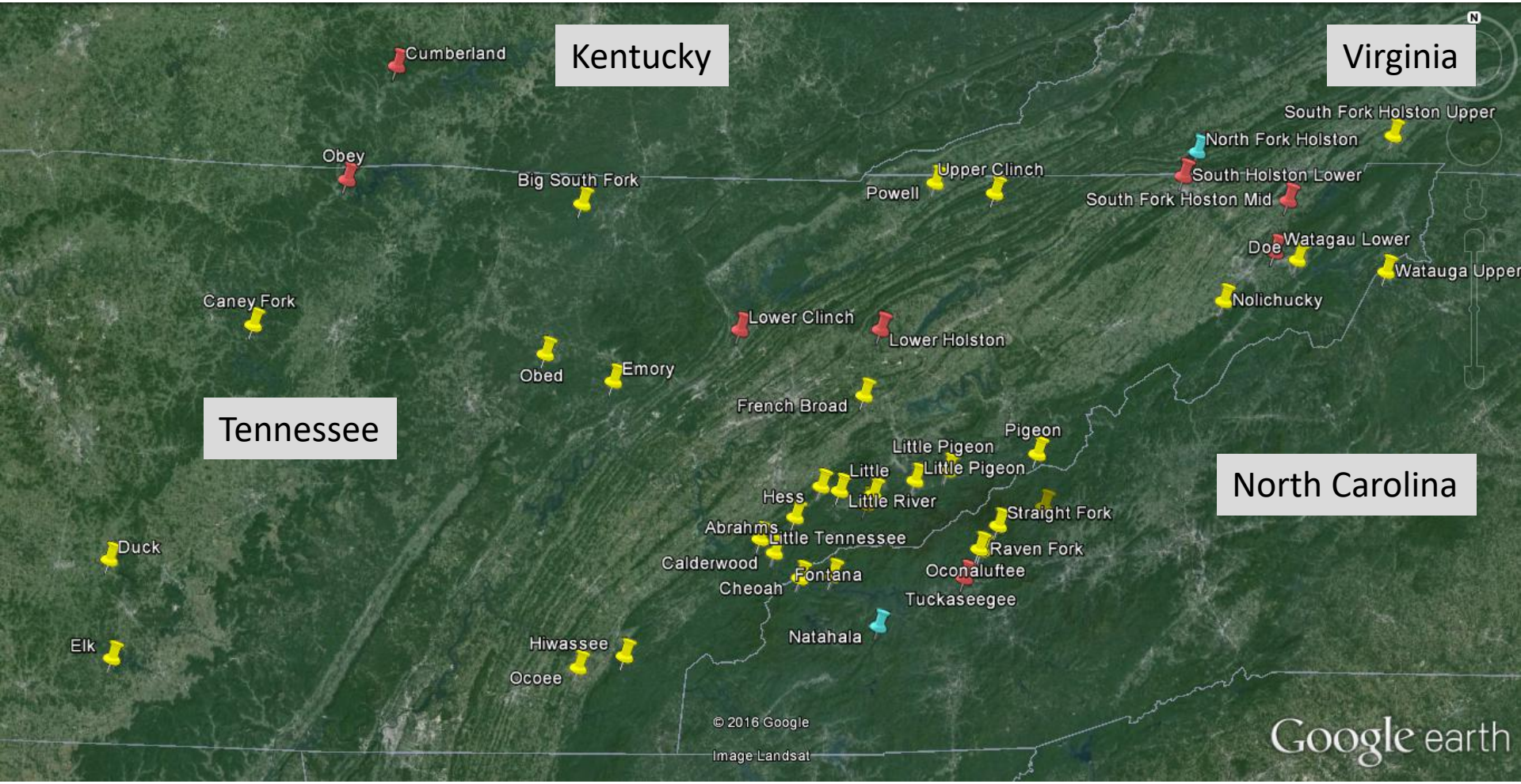
- Changes physical habitat
  - Homogenizes habitat
  - Changes near-bed velocities (Larned et al. 2011)
  - Changes macroinvertebrate structure (Kilroy et al. 2006, Larned et al 2007, Gillis and Chalifour 2010, and many more)
  - Fish impacts (James and Chips 2016)

- Mechanisms for changes?
  - Increases overall organic matter (Reid and Torres 2014)
  - Epiphytes (Spaulding 2007)

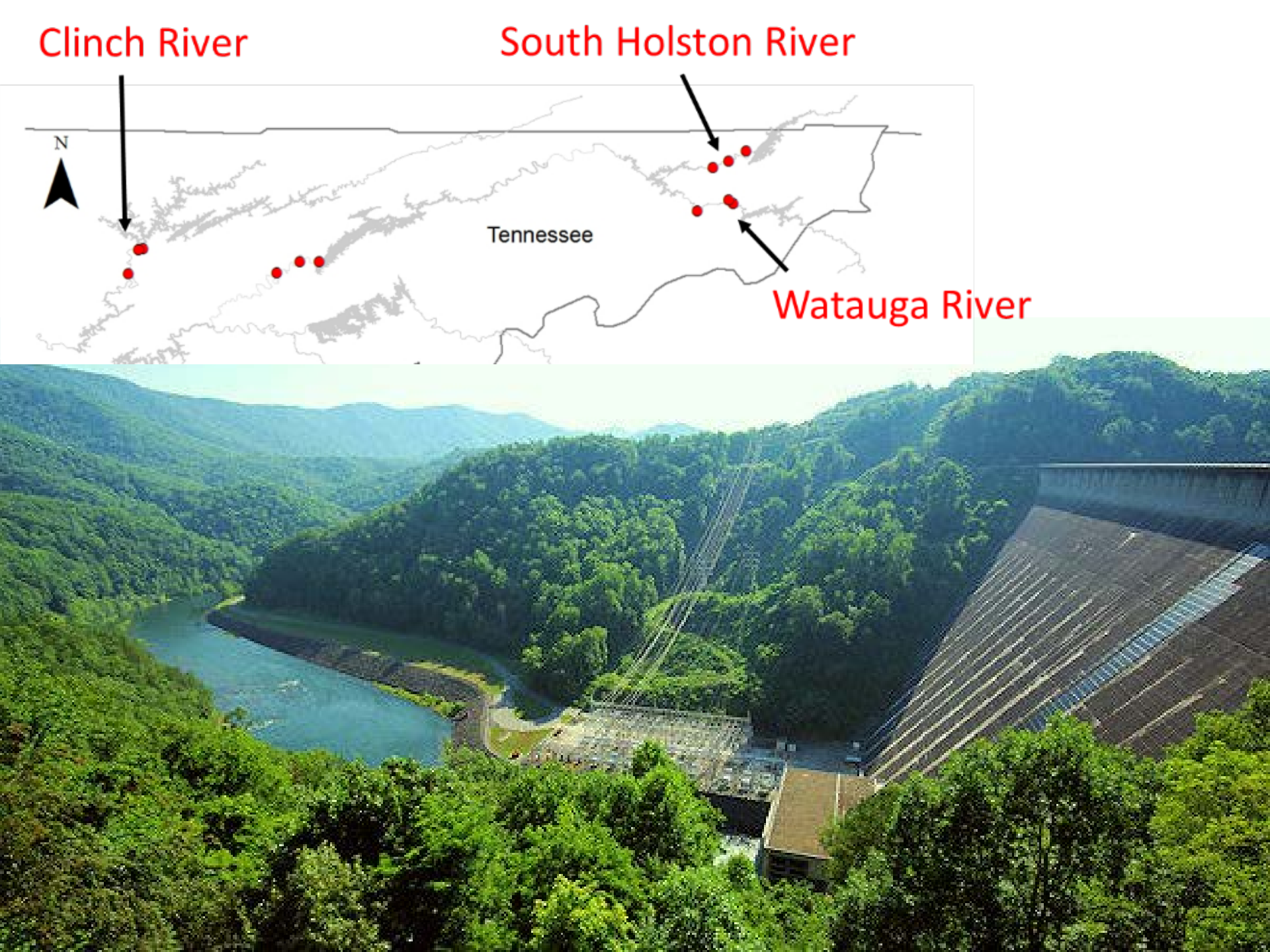
Does Didymo alter food web structure and/or food resource use of macroinvertebrates and trout?


Macrophytes
FBOM
Filamentous Algae
Rock Biofilms
Didymo

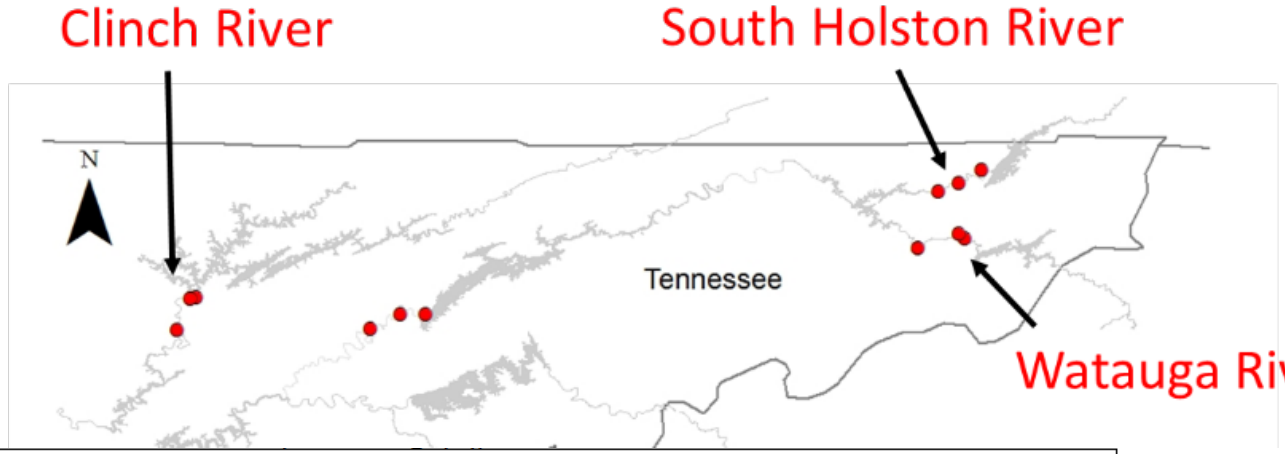
Current Tennessee Regional Distribution

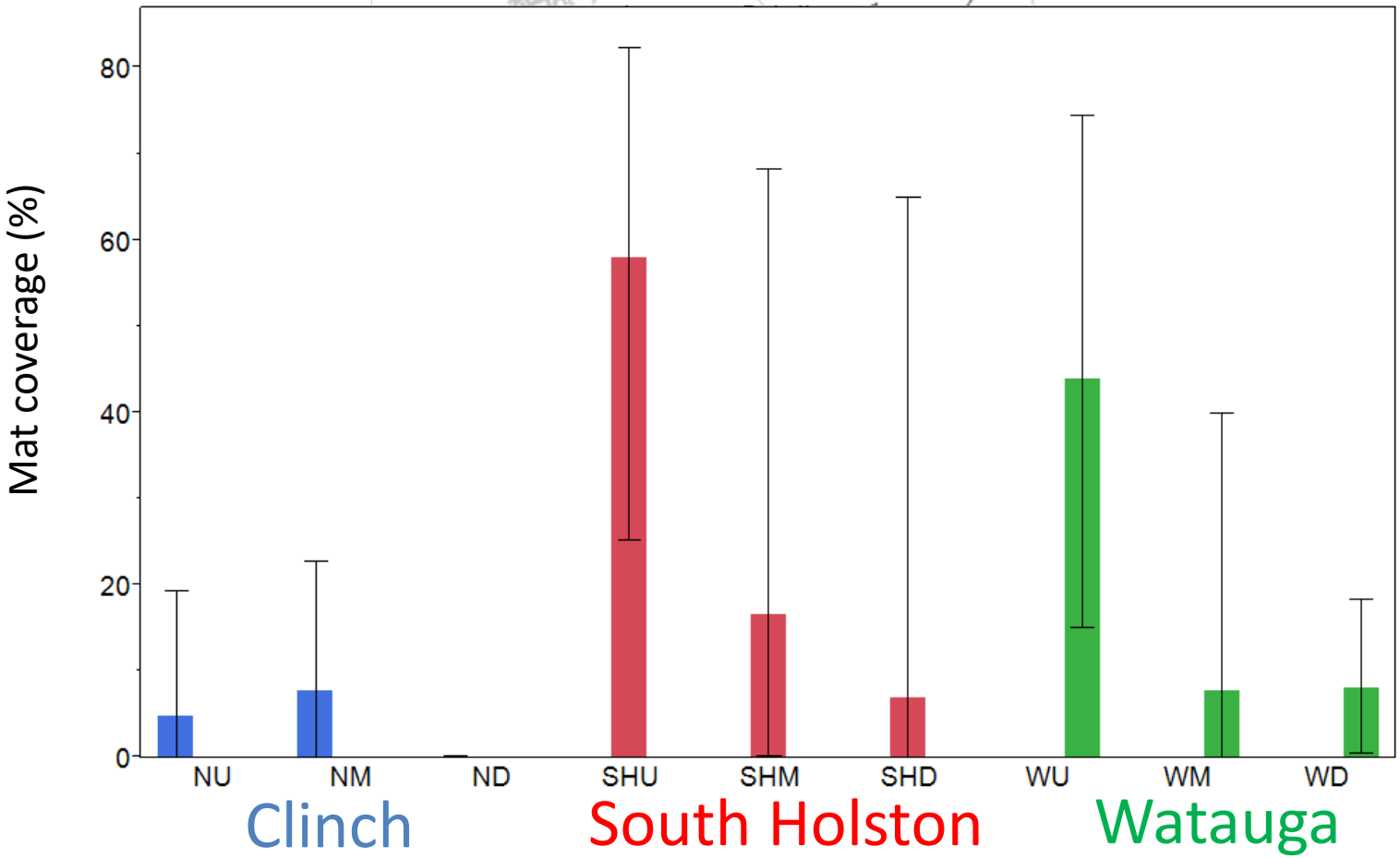


Monitoring for *Didymosphenia geminata*: An Environmental DNA Approach.
Funded by GSMFC Aquatic Invasive Species Program

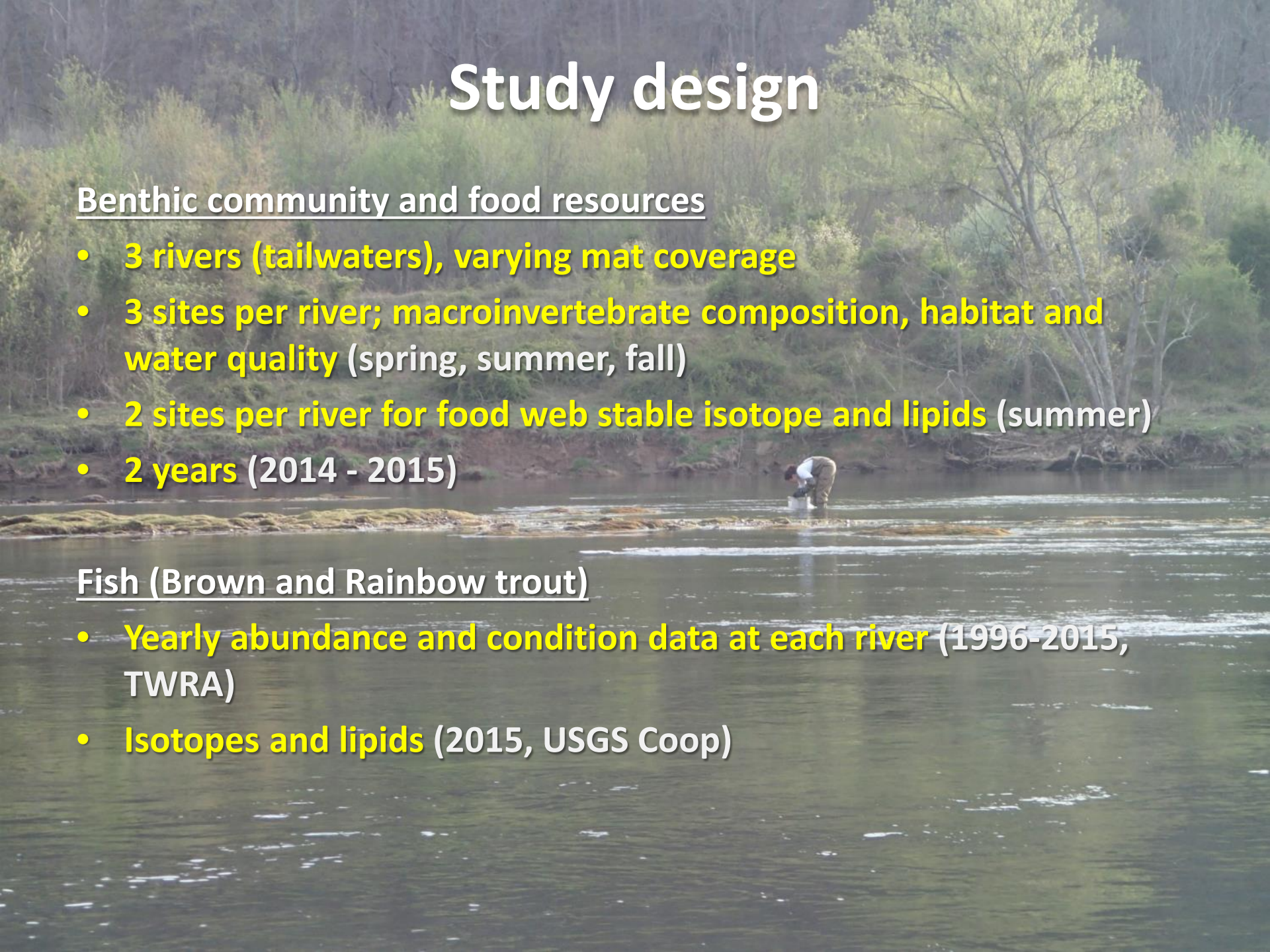

Clinch River
South Holston River
N
Tennessee
Watauga River

Didymo Coverage (2014-2015)





Study design



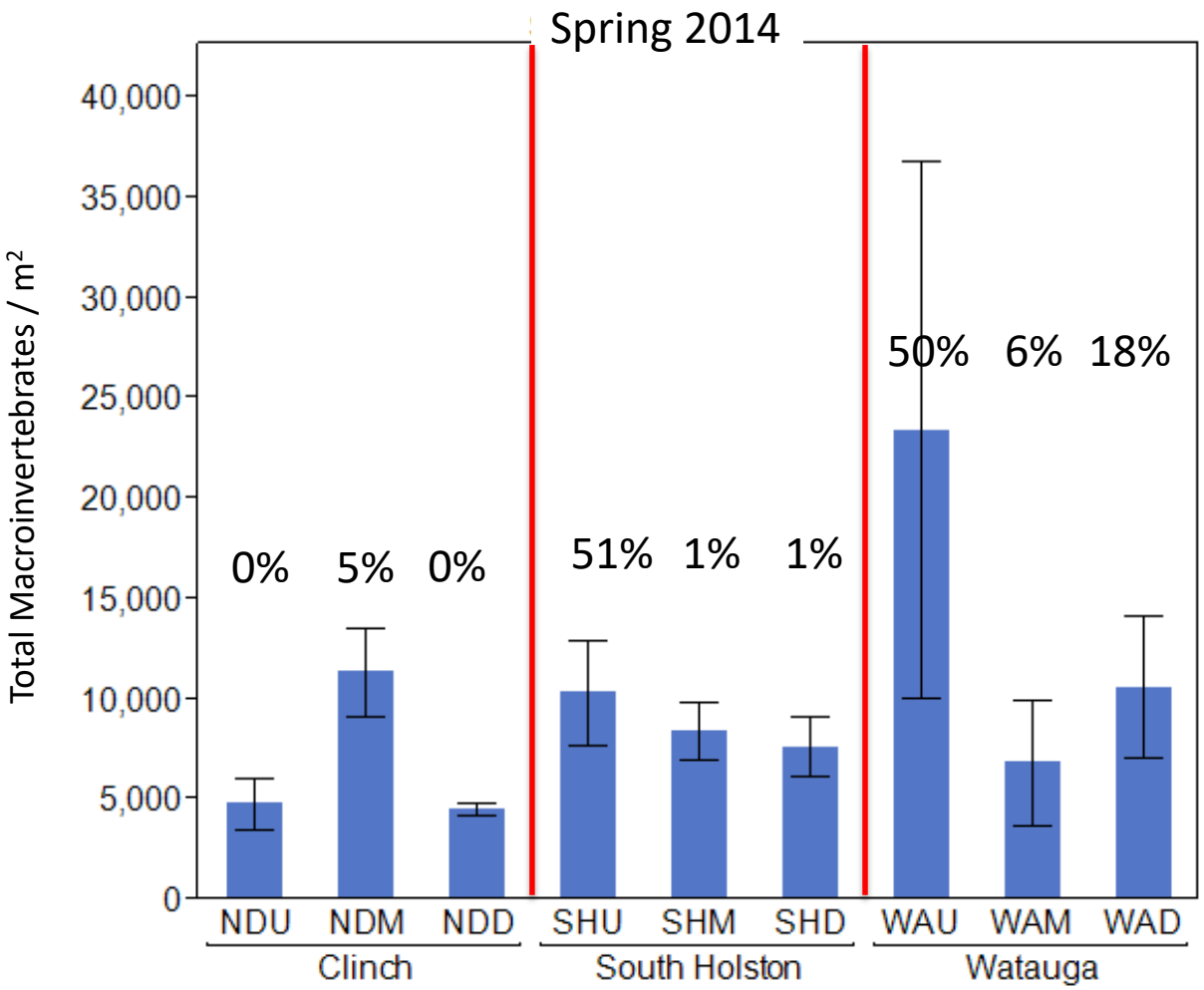
Benthic community and food resources

- 3 rivers (tailwaters), varying mat coverage
- 3 sites per river; macroinvertebrate composition, habitat and water quality (spring, summer, fall)
- 2 sites per river for food web stable isotope and lipids (summer)
- 2 years (2014 - 2015)

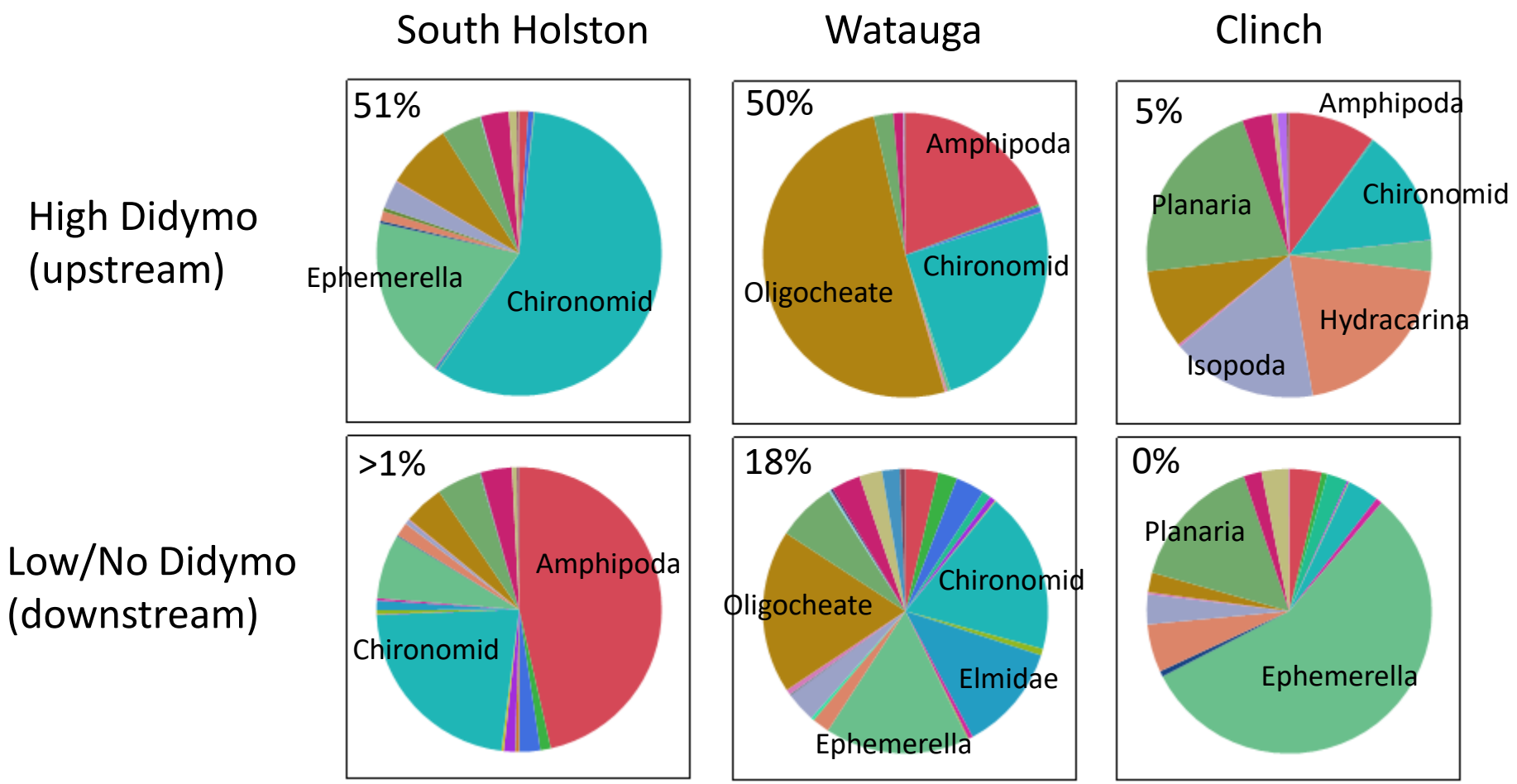
Fish (Brown and Rainbow trout)

- Yearly abundance and condition data at each river (1996-2015, TWRA)
- Isotopes and lipids (2015, USGS Coop)

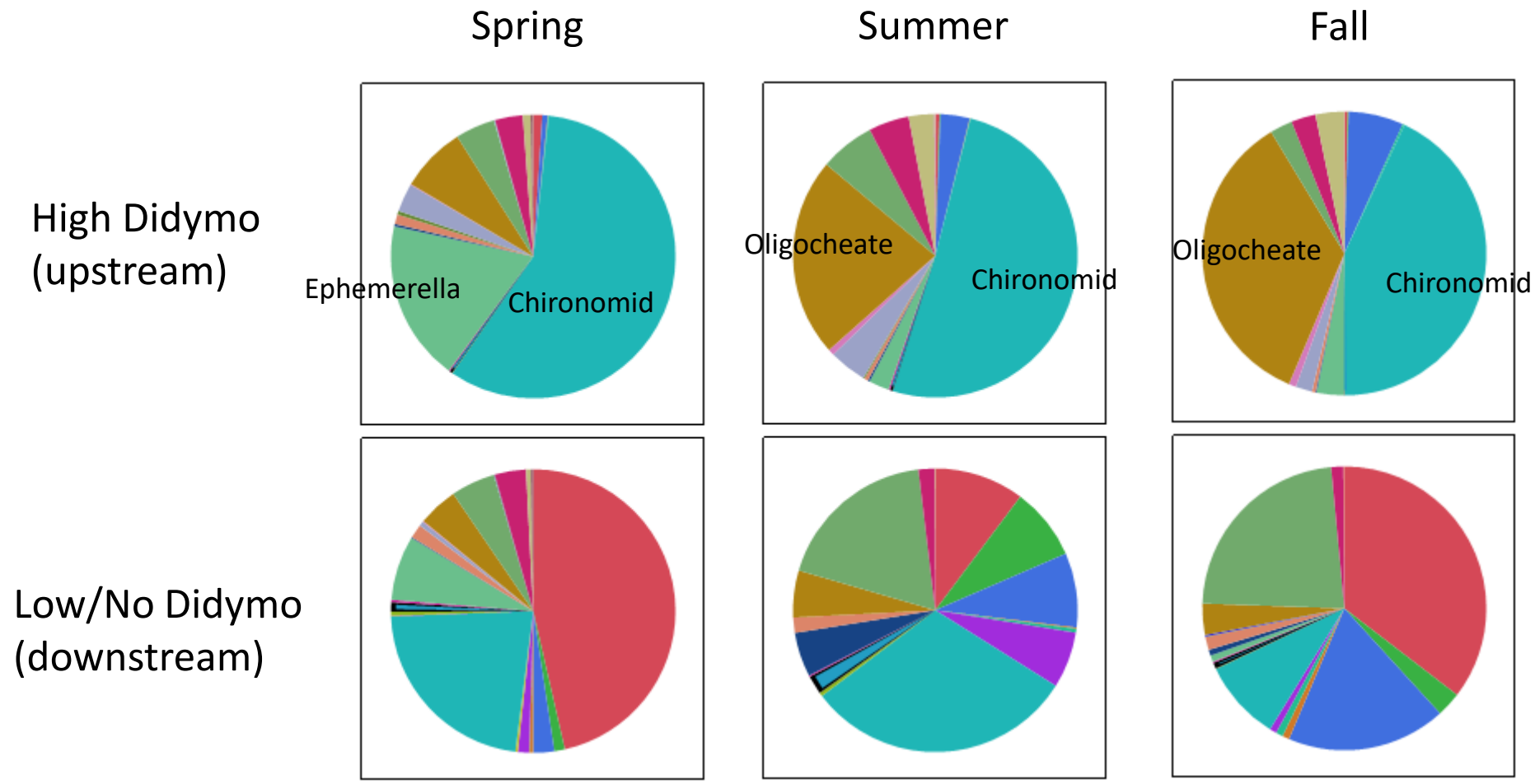
Macroinvertebrate Abundance



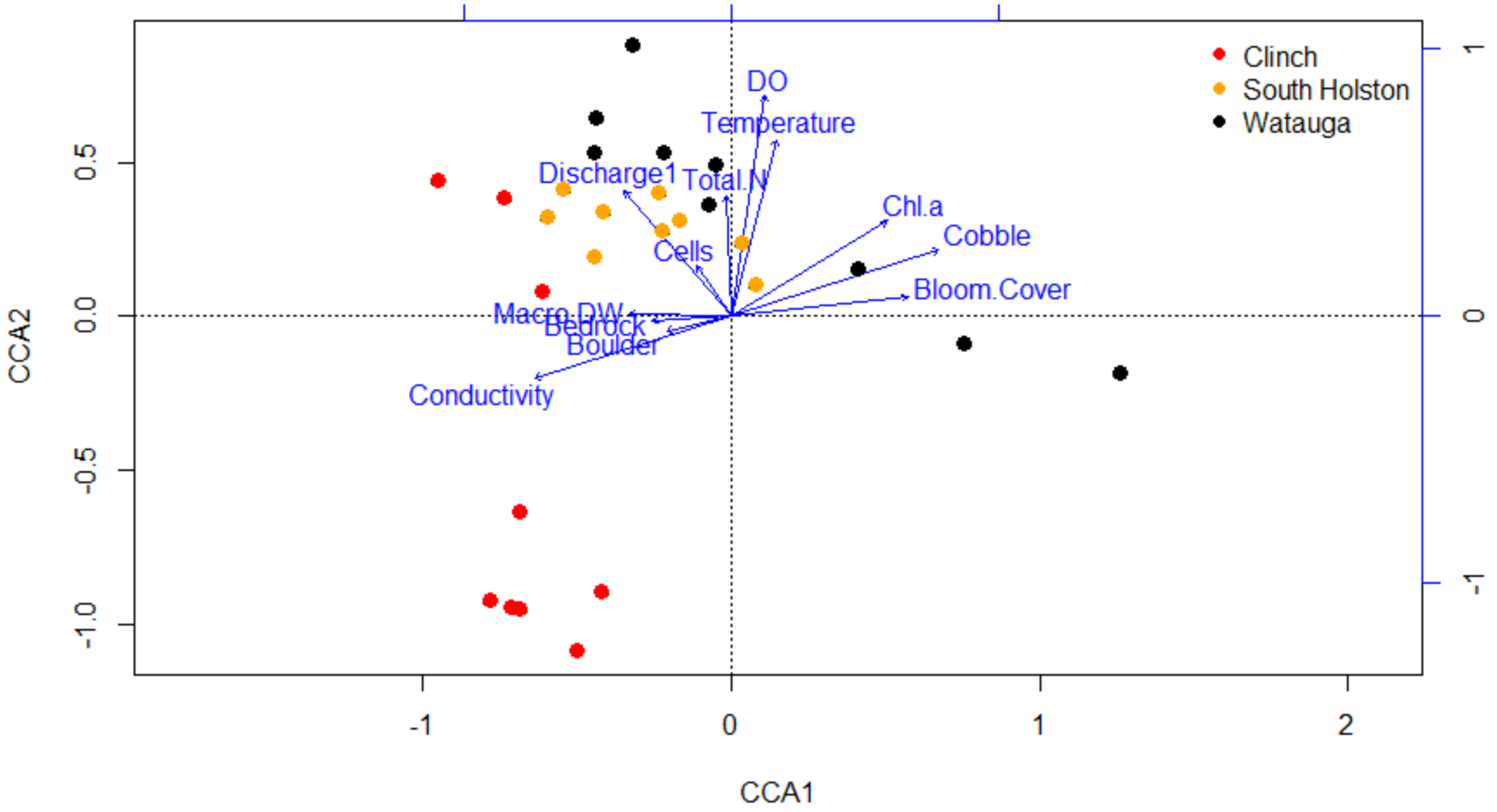
Macroinvertebrate Composition: Spring 2014



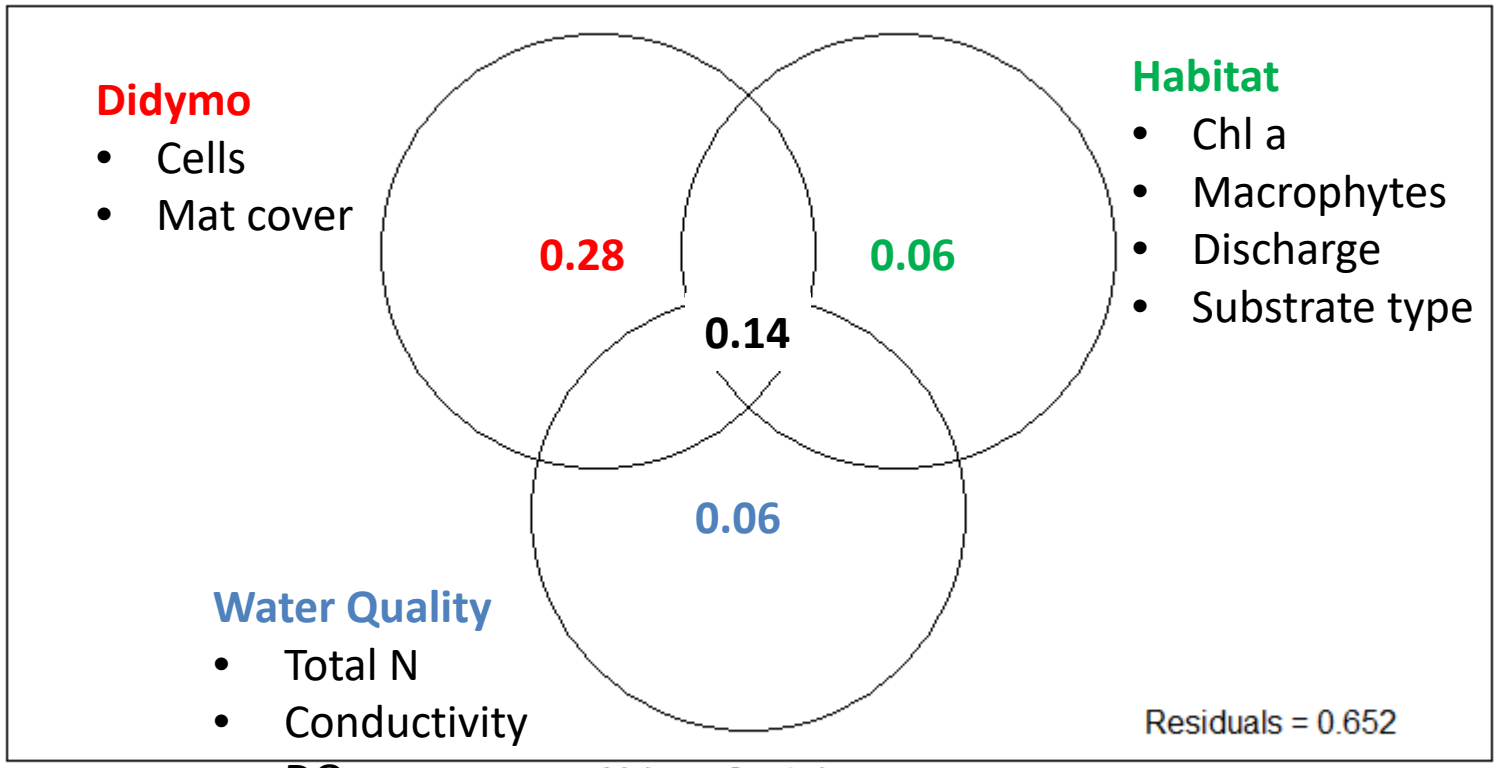
South Holston River Temporal Trends



Spring 2014 CCA

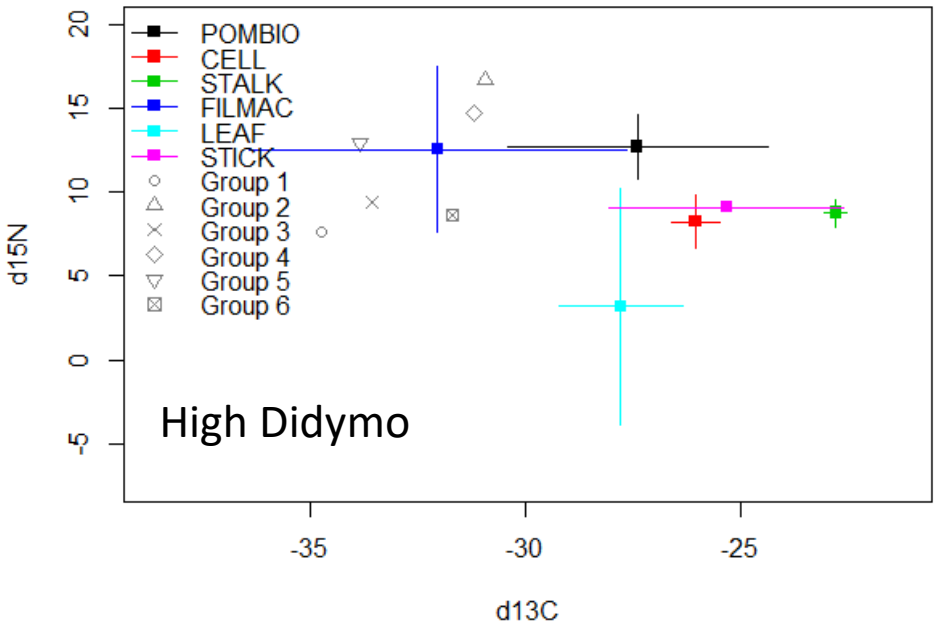


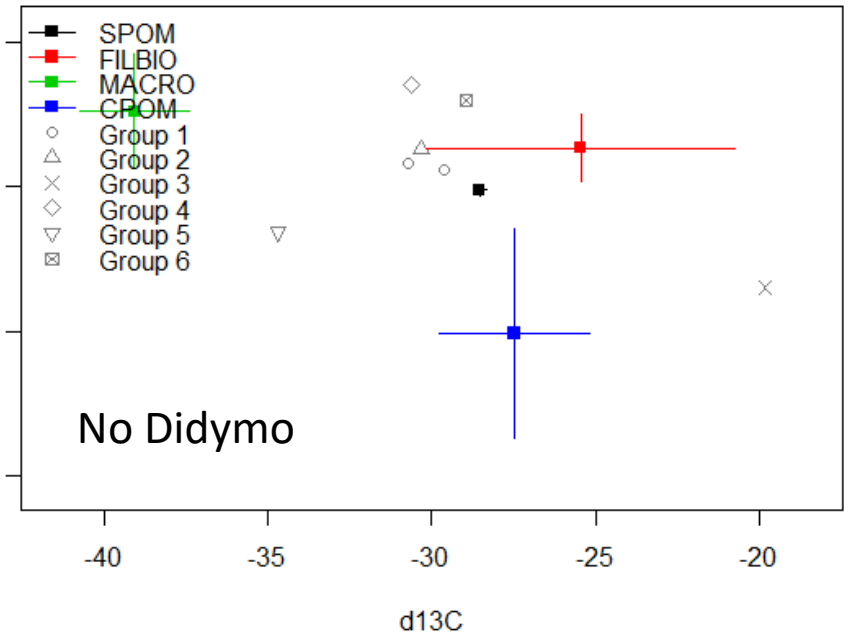
Variance Partitioning: Spring 2014



Resource Use Change: South Holston River

- Stable isotopes: 2014

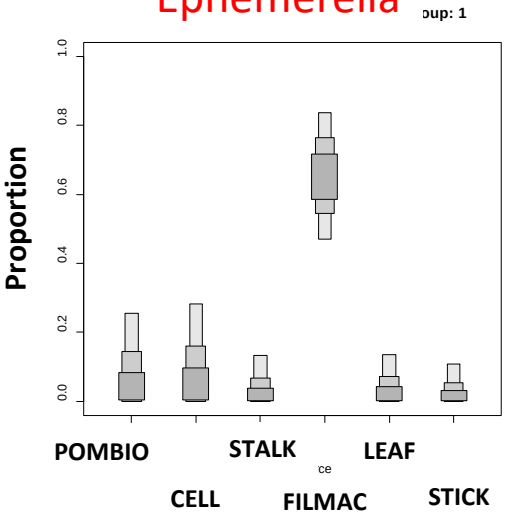




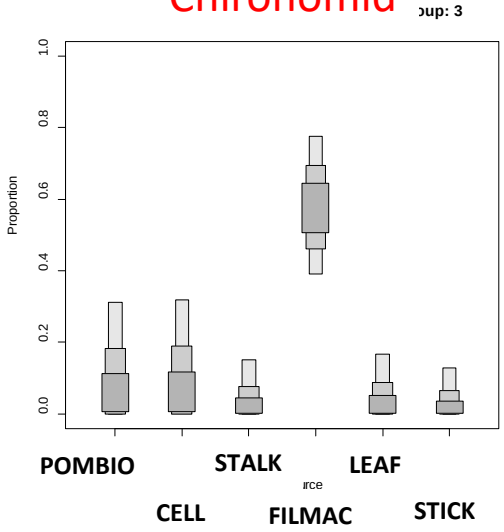
High Didymo

Low/No Didymo

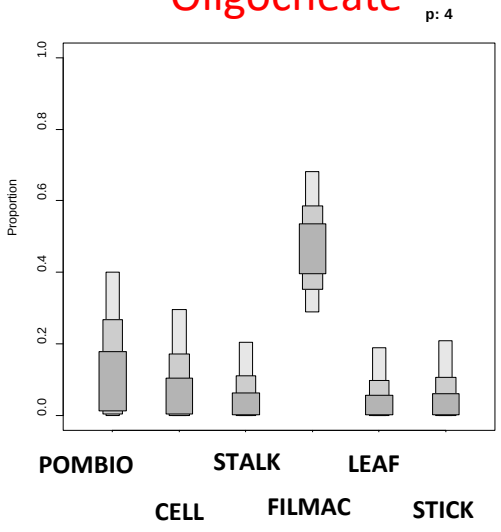
Ephemerella

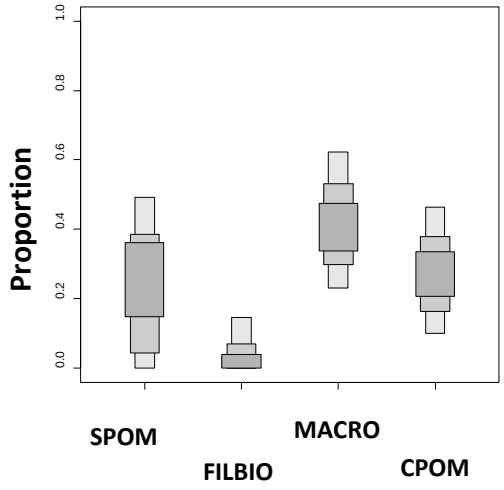


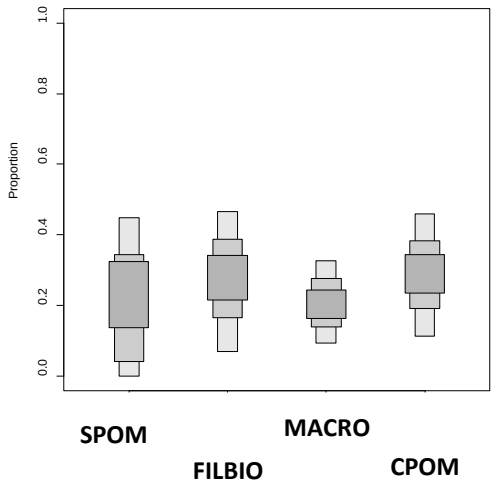
Chironomid

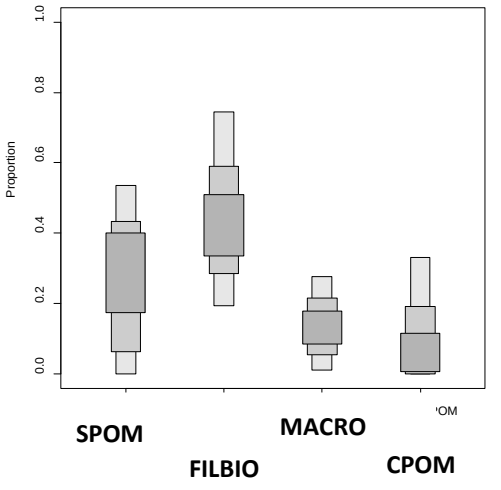


Oligocheate



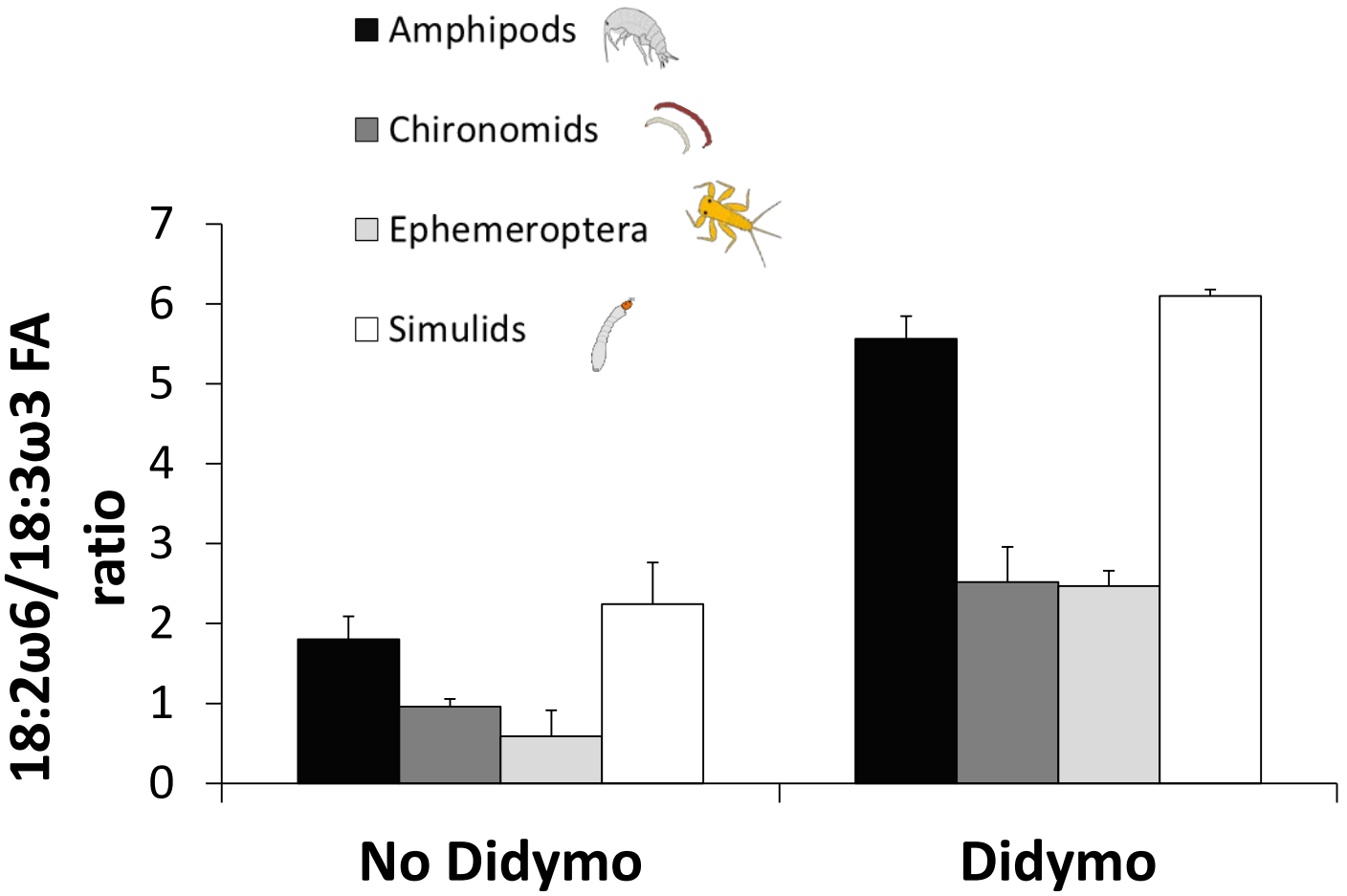




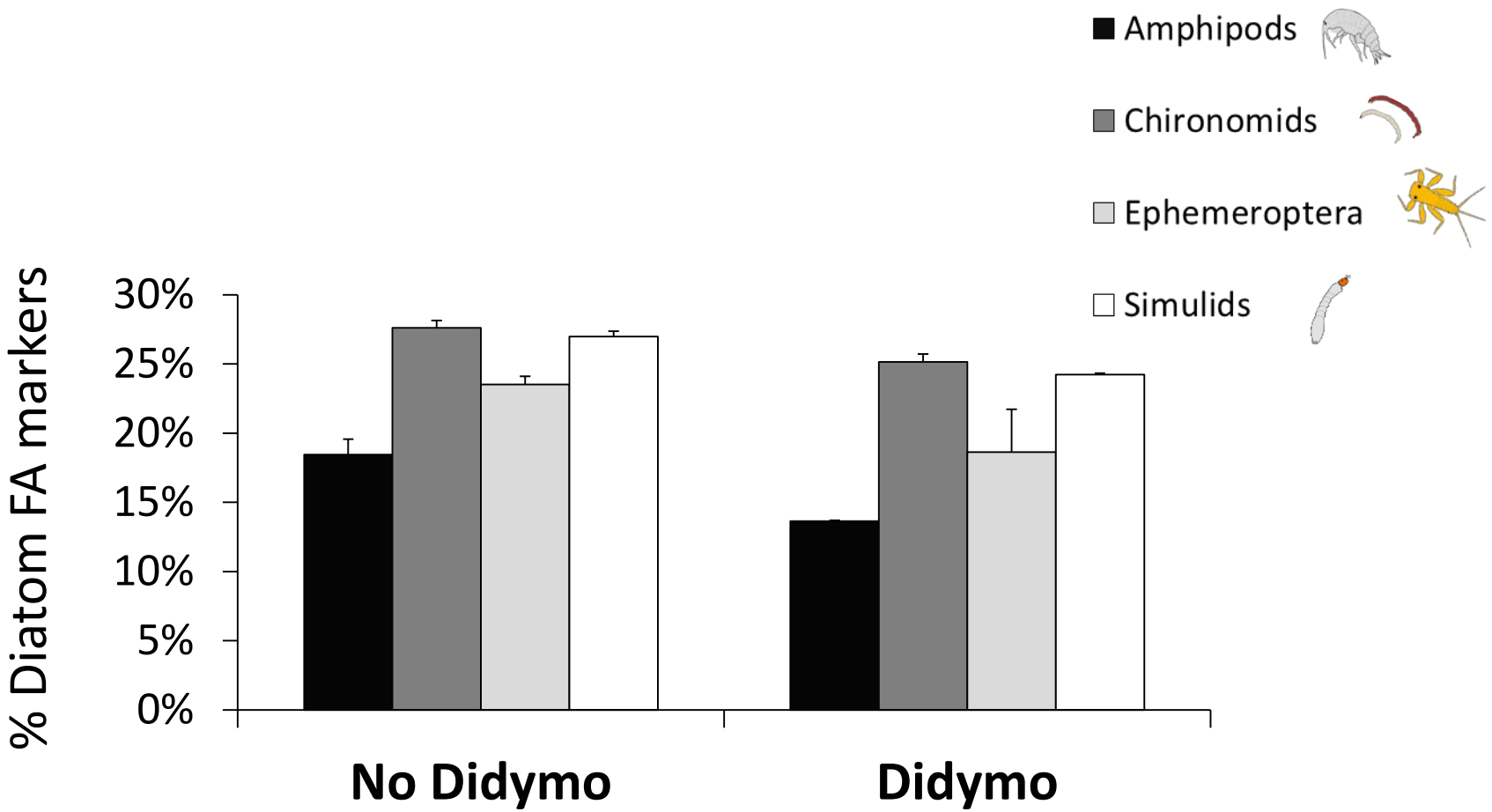


3.4/0.8 – C/N enrichment factors

Simulids, Amphipods, and Planarians showed the same trends

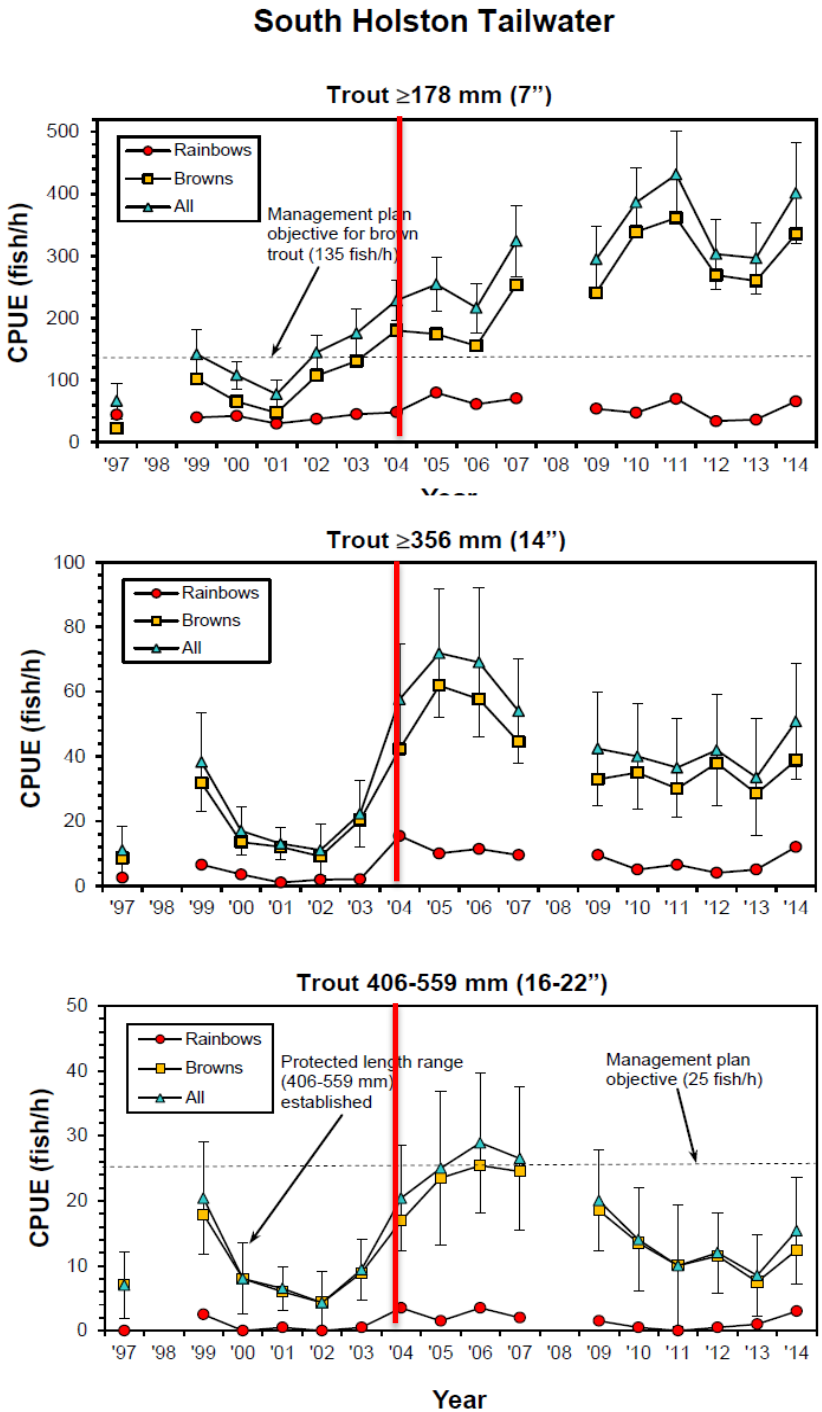


Increase in the 18:2ω6/18:3ω3 ratio in the presence of Didymo suggests a shift food source from biofilms to vascular plants, like macrophytes.

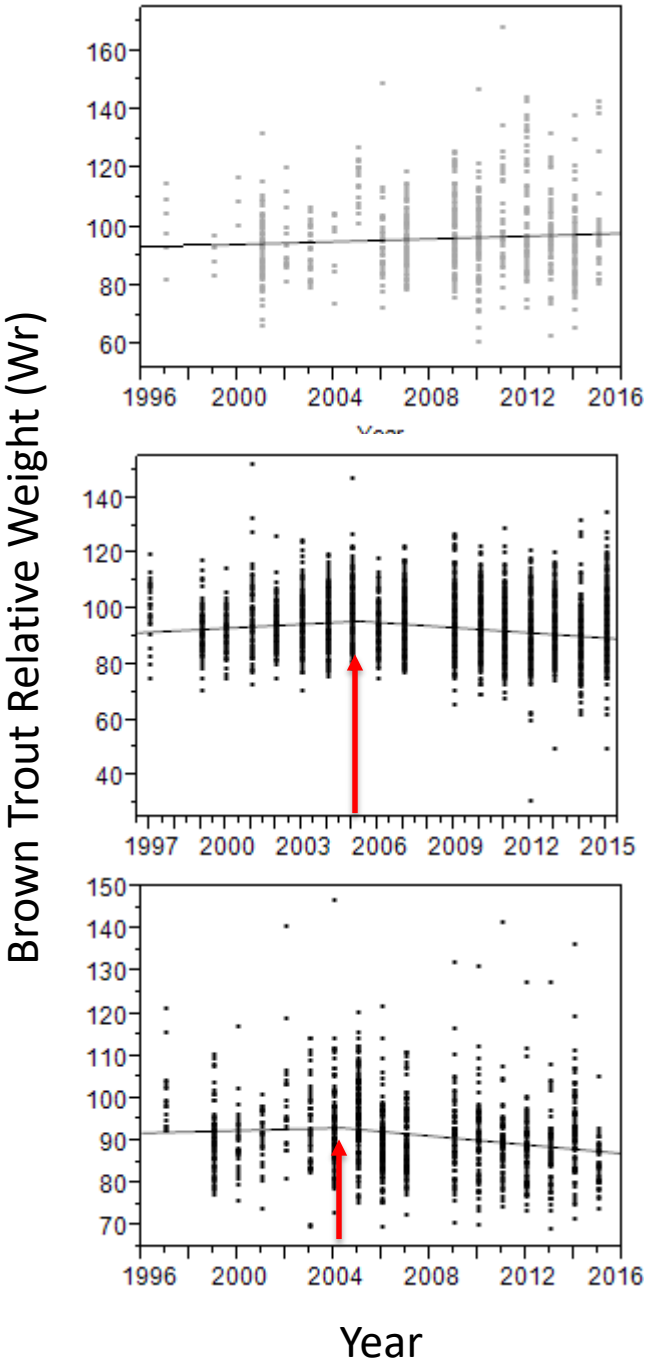


There is a reduced reliance on diatoms for consumers following introduction of Didymo.

Fish:
(Brown trout)



Habera et al. 2014. Region IV trout fisheries report: 2014. Tennessee Wildlife Resources Agency.



< 178 mm

No breakpoint
Linear Slope = 0.24

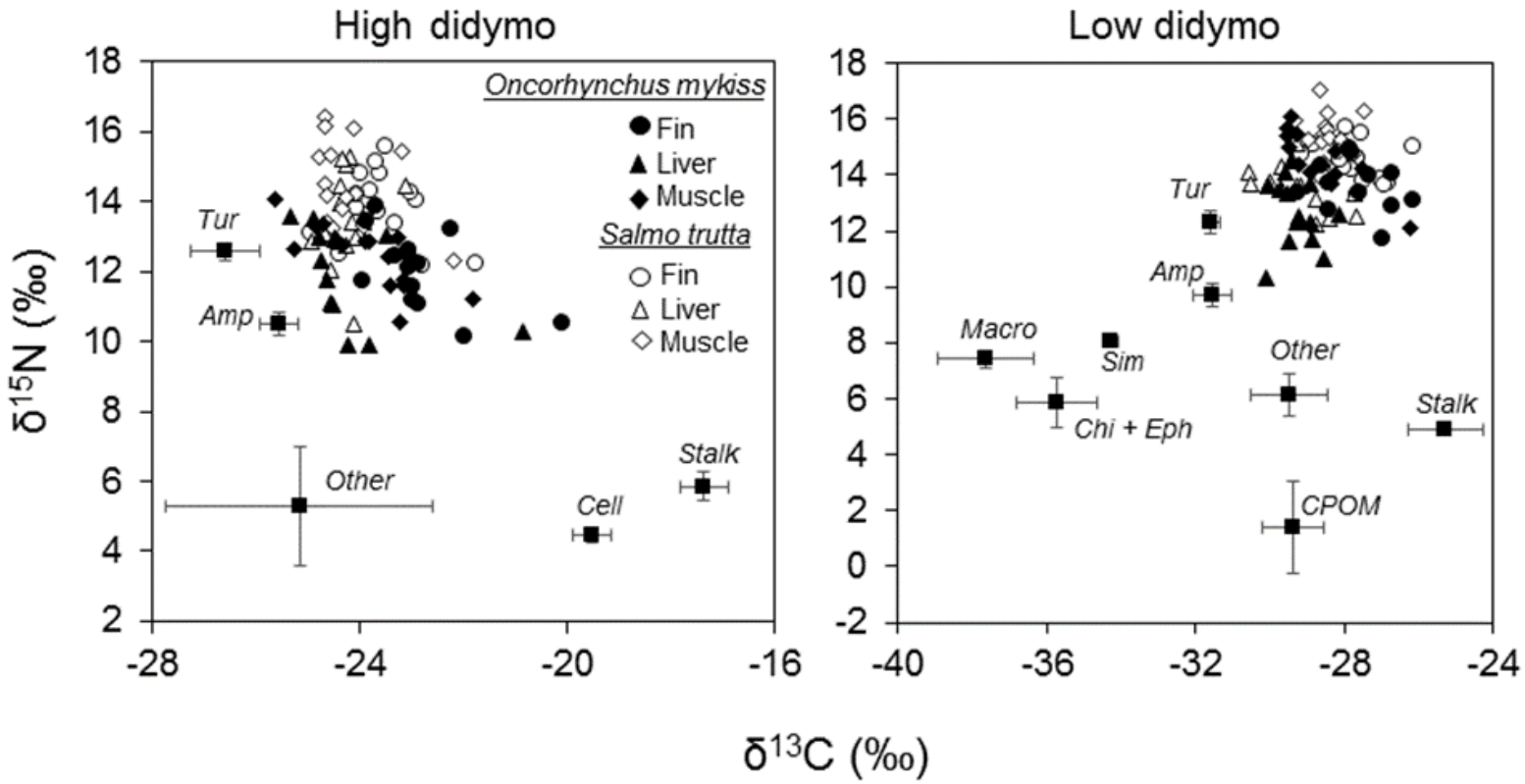
179-356 mm

Breakpoint at 2005
Pre 2005 slope = 0.51
Post 2005 slope -1.14

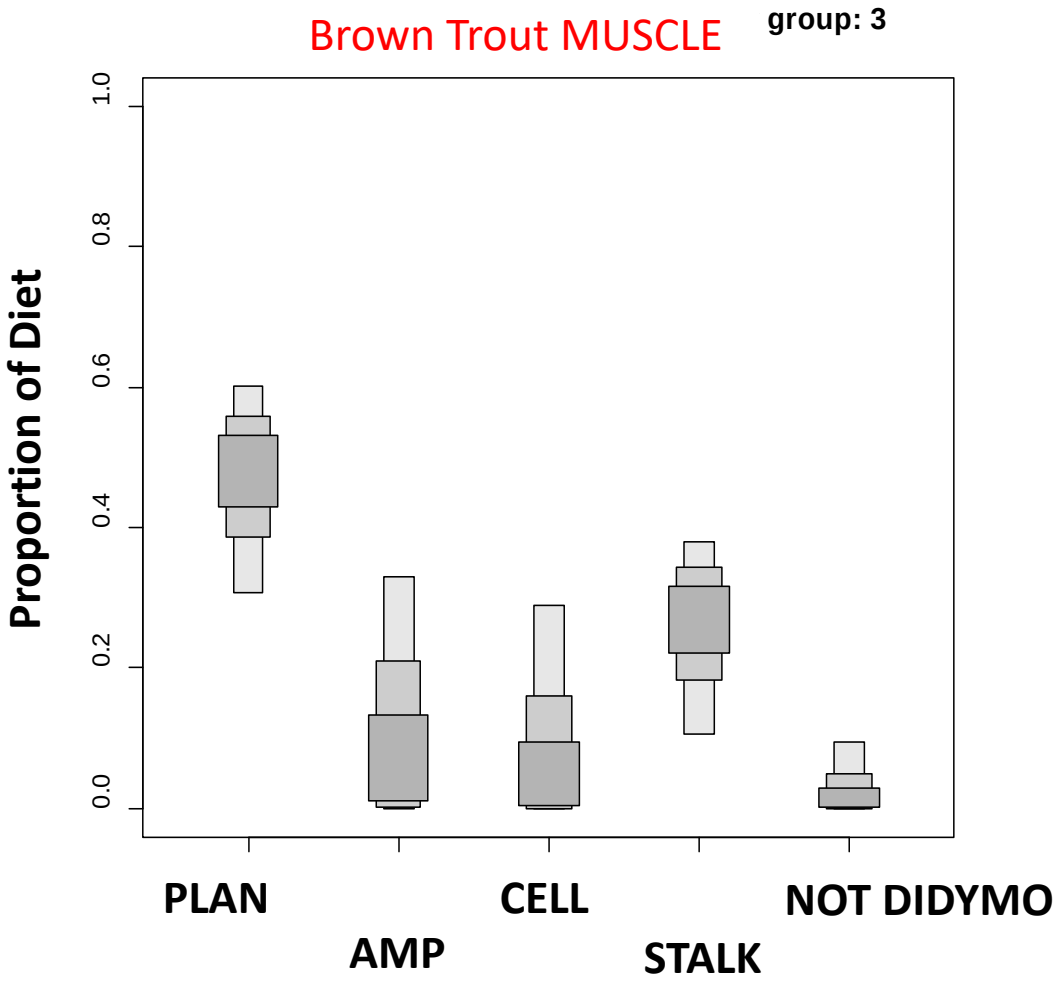
357-778 mm

Breakpoint at 2004
Pre 2004 slope = 0.18
Post 2004 slope -0.70

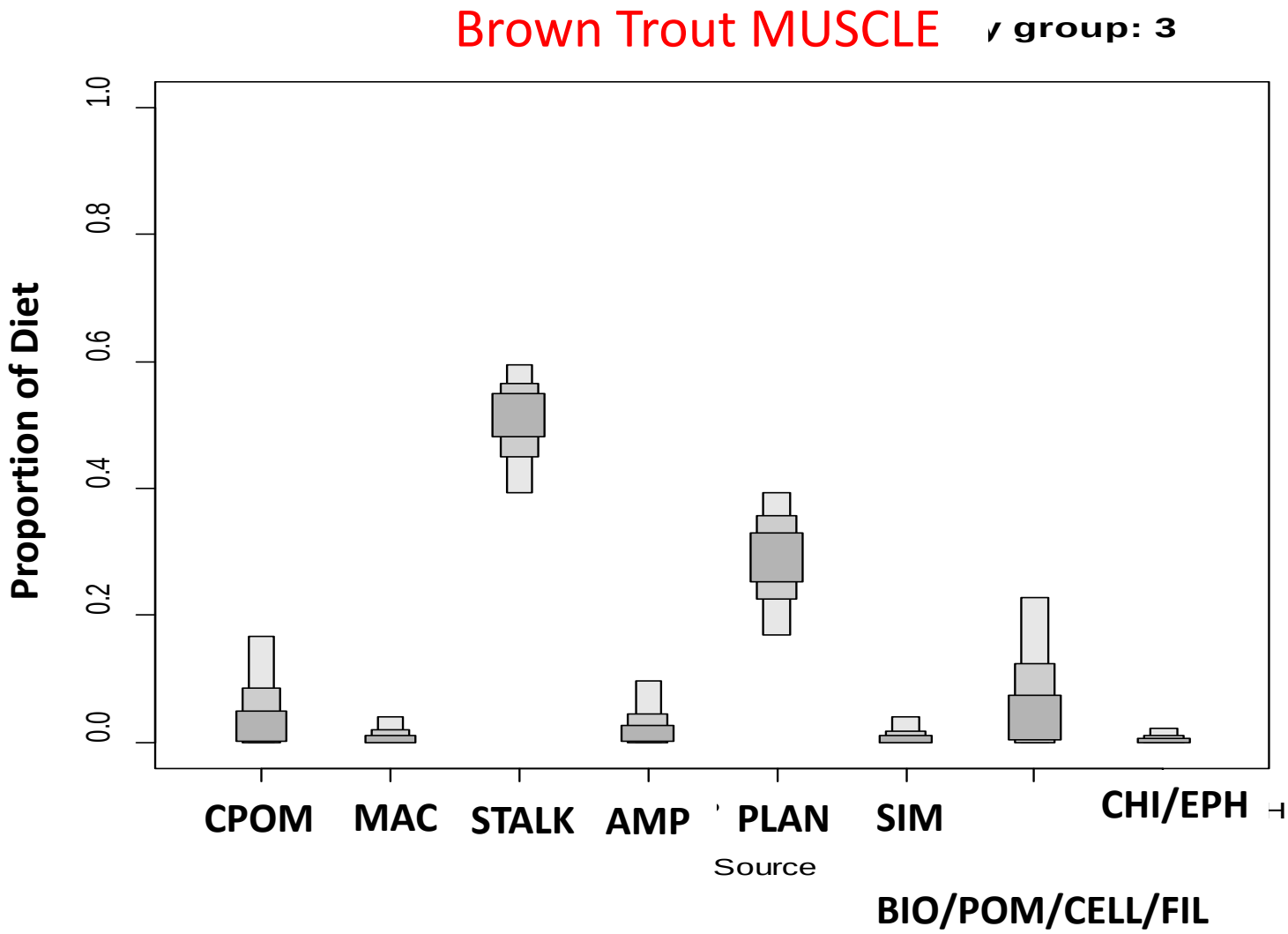
Trout Stable Isotopes



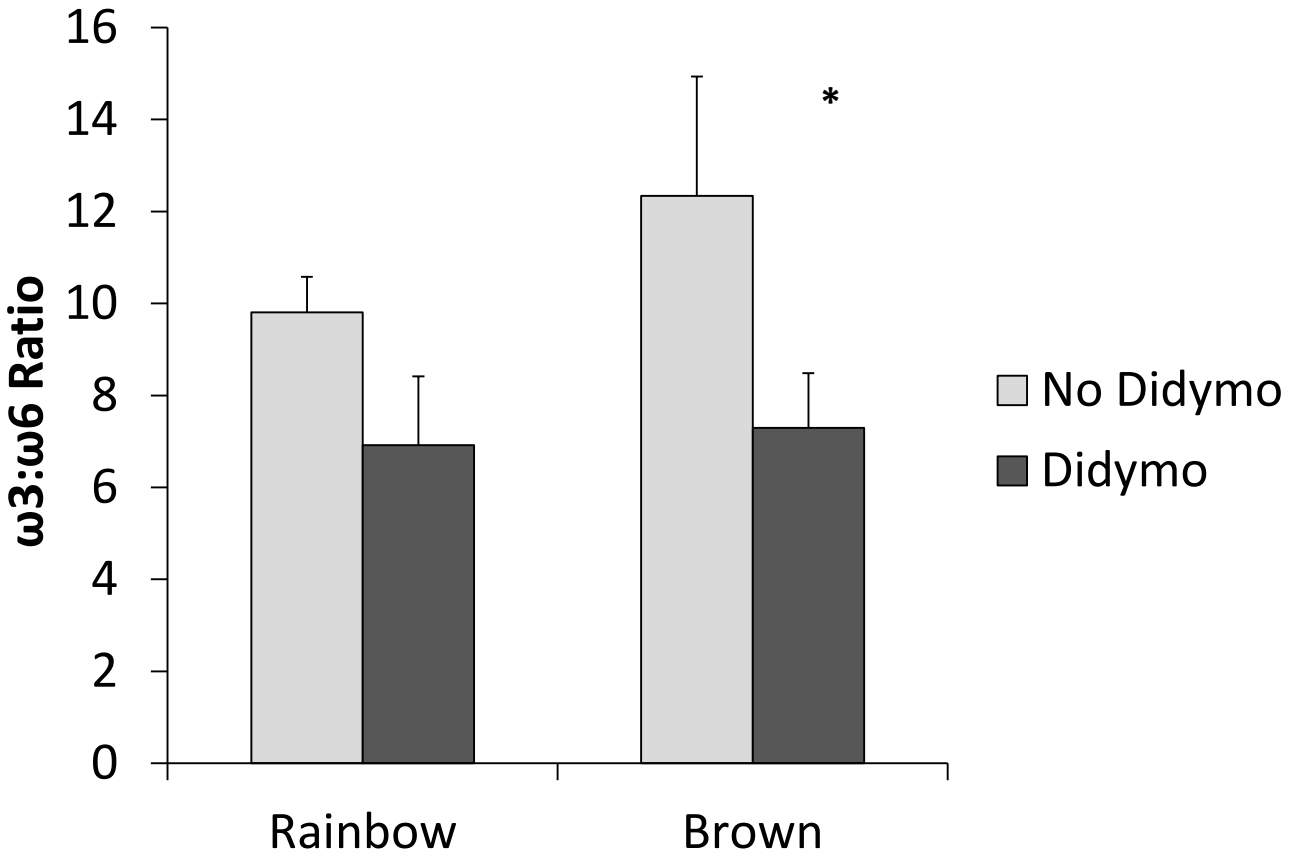
Watauga River– High Didymo



South Holston River- Low Didymo



Trout Lipids



Conclusions

Macroinvertebrates

- Food resources switching with mat coverage >50%. Eating resources that did not get covered. - Biofilms to macrophytes.
- Did not assimilate Didymo cells or stalks.
- Lipids had same trend as isotopes.
- Less reliance on diatoms in general.
- Effects less severe in “Patches” than “Blankets”.

Conclusions

Trout

- Browns and Rainbows primarily assimilating flatworms, amphipods, and Didymo stalk at high and low Didymo sites.
- Stalk signature could be epiphytes?
- Stalks increase chironomid midge and oligochaete worm abundance, but the strongest isotopic signatures came from turbellarians and amphipods, which are typically found outside of mats.

Conclusions

Trout

- Still missing part of the trout food web.
- Small trout: Didymo good?
  - Fitness not impacted despite increasing density.
- Large trout: Didymo not good?
  - Decreased abundance and fitness, but still a great fishery.

Acknowledgements

- GCMFA and USFWS
- Jon O'Brien, Canisius College
- Many undergraduate and graduate students
- Tennessee Tech USGS Fisheries Cooperative Unit