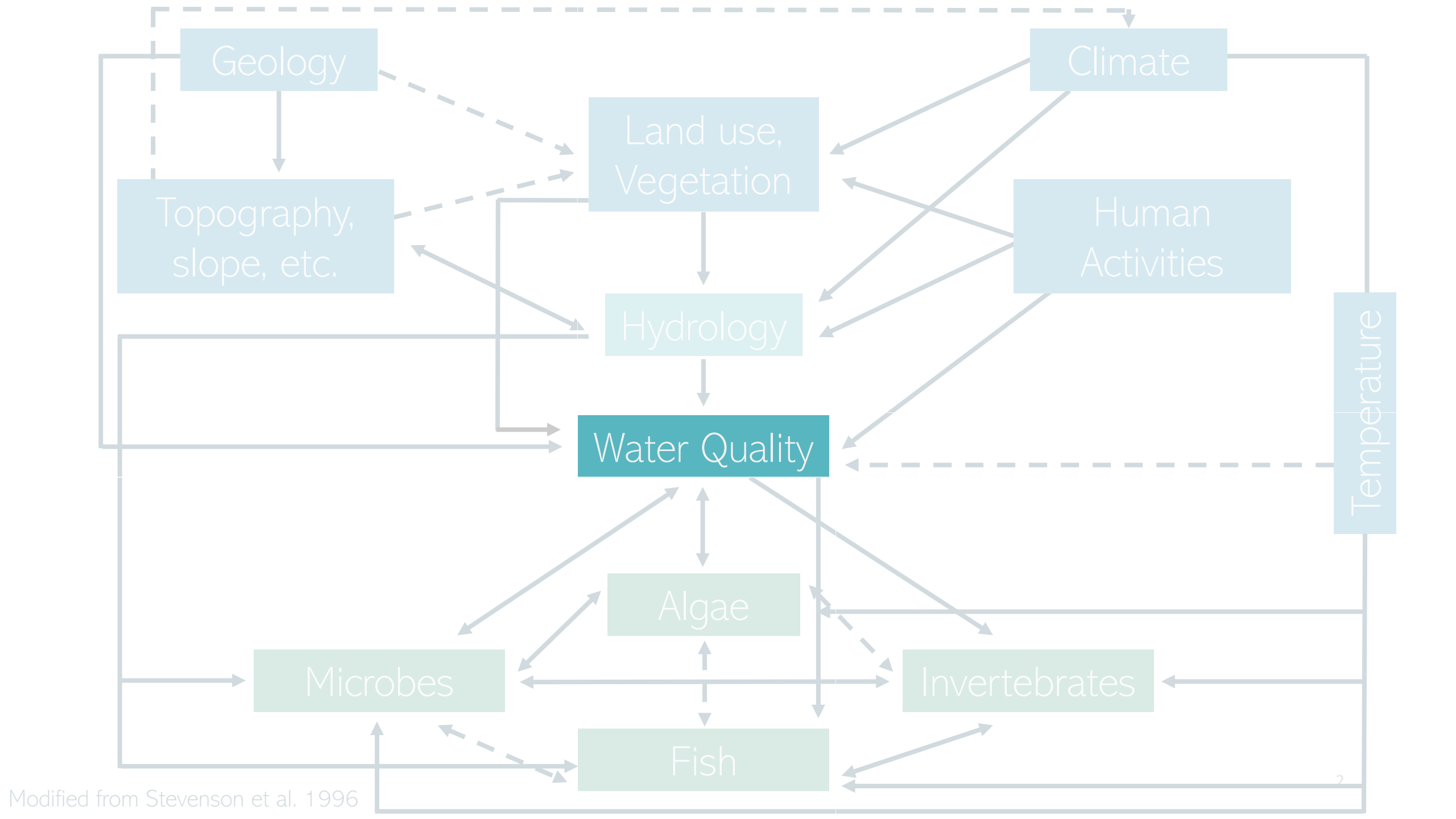
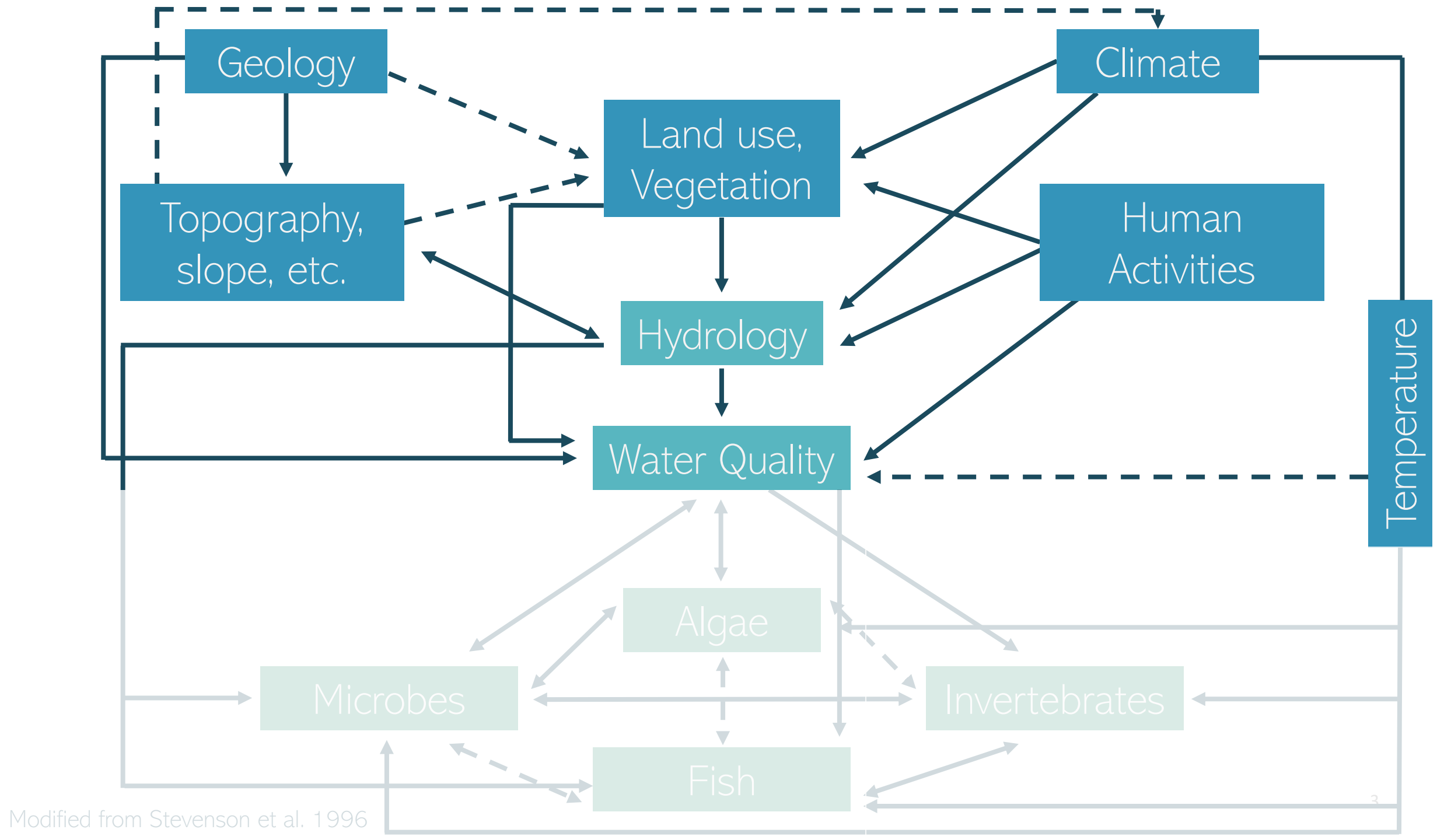
# Cumulative Impacts of Multiple Stressors on Stream Ecosystems: Periphyton Communities as Bioindicators

**Shelby Stenerson**, Rolf Vinebrooke, Jenna Cook, Blake Stuparyk, Jillian Lightbown, Craig Emmerton, Mark Graham, Faye Wyatt, Cristina Buendia-Fores, and Mina Nasr




Modified from Stevenson et al. 1996

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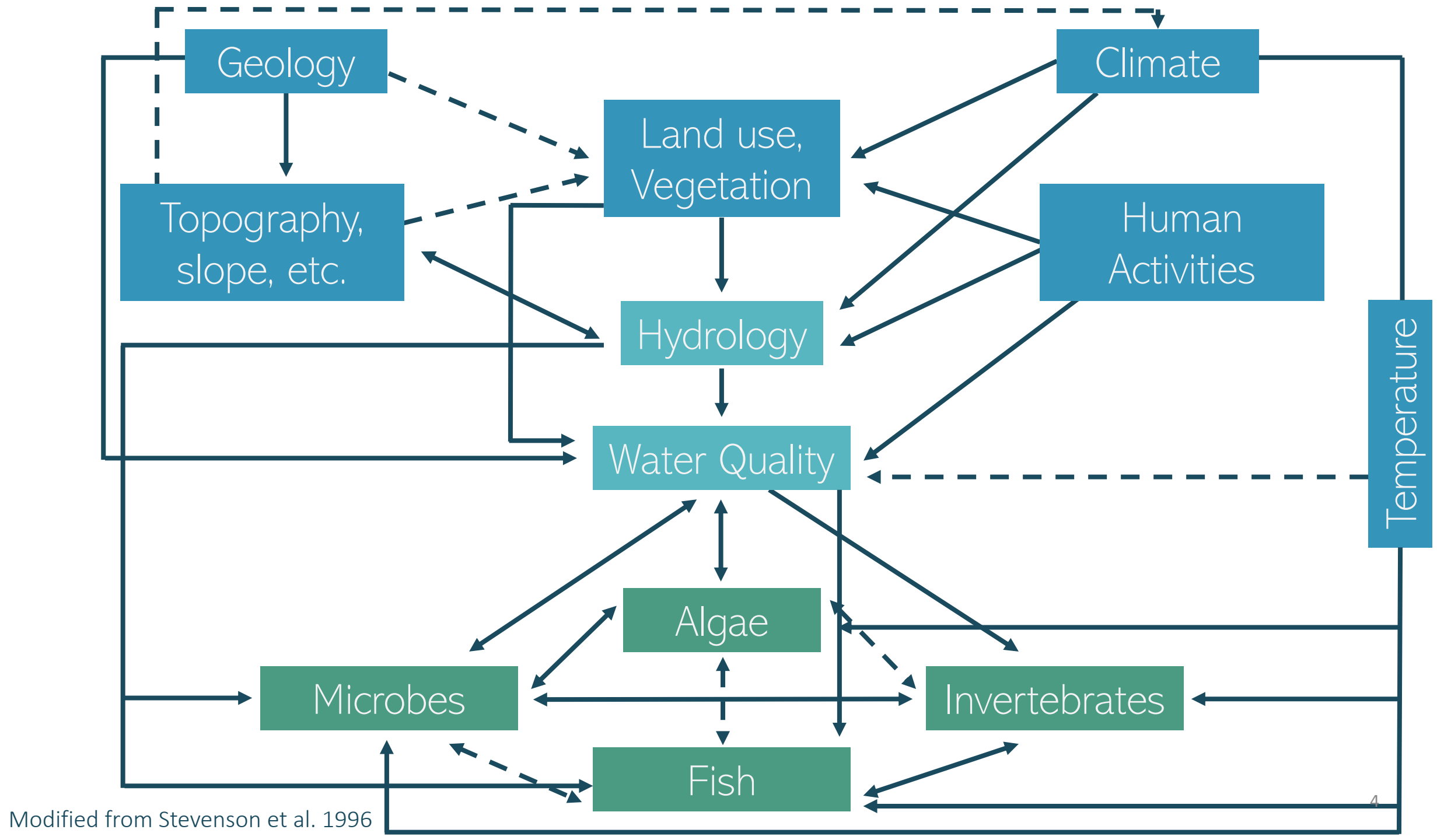
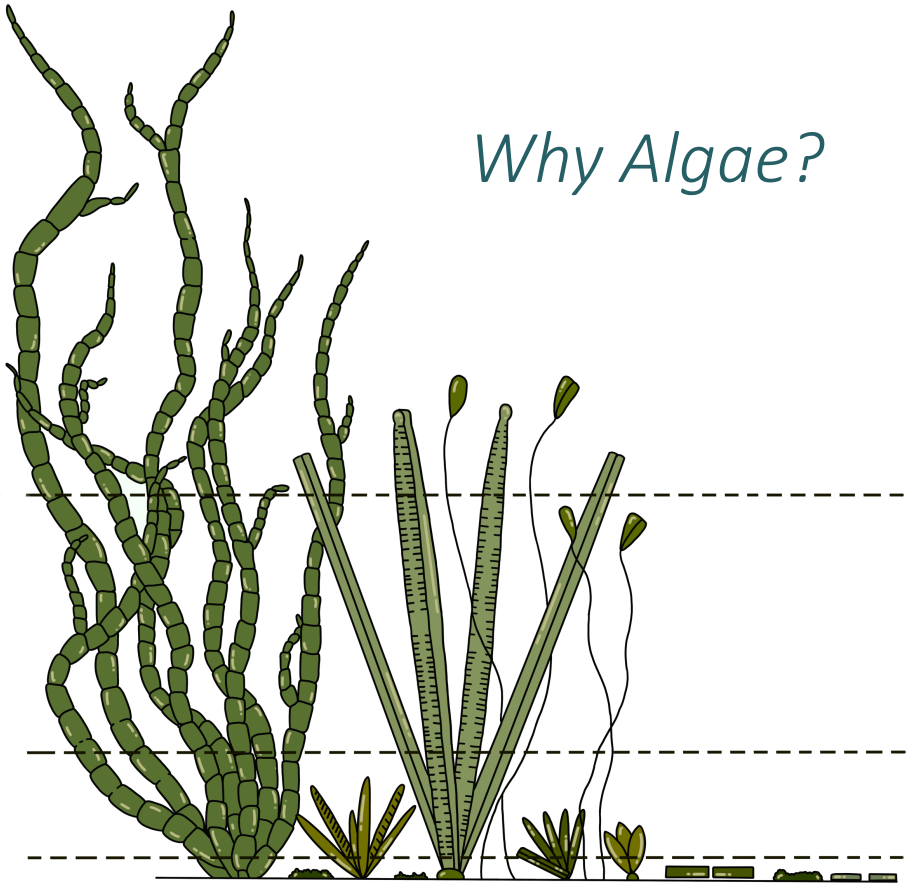



Modified from Stevenson et al. 1996

# *An Introduction to Bioindicators*

**Bioindicators** include biological processes, species, or communities and are used to **assess the quality of the environment** and how it **changes over time**.

# *An Introduction to Bioindicators*



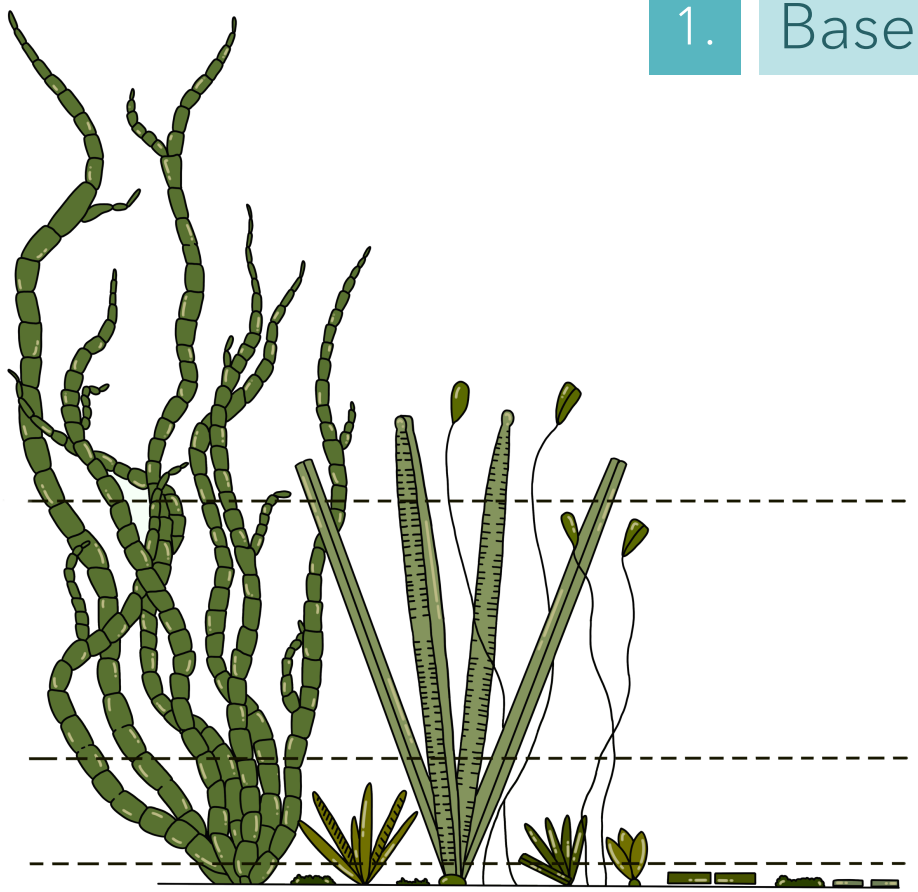
*Why Algae?*

Modified from Hoagland et al. 1982

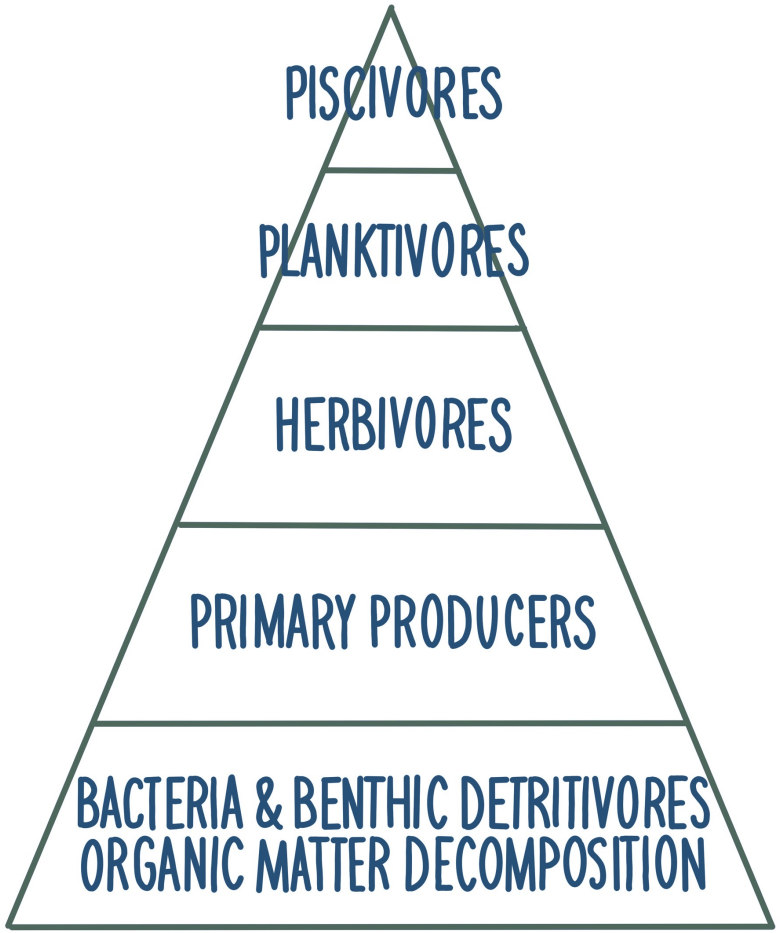
**Bioindicators** include biological processes, species, or communities and are used to **assess the quality of the environment** and how it **changes over time**.

# *The Power of Periphyton*

1. Base of aquatic food webs

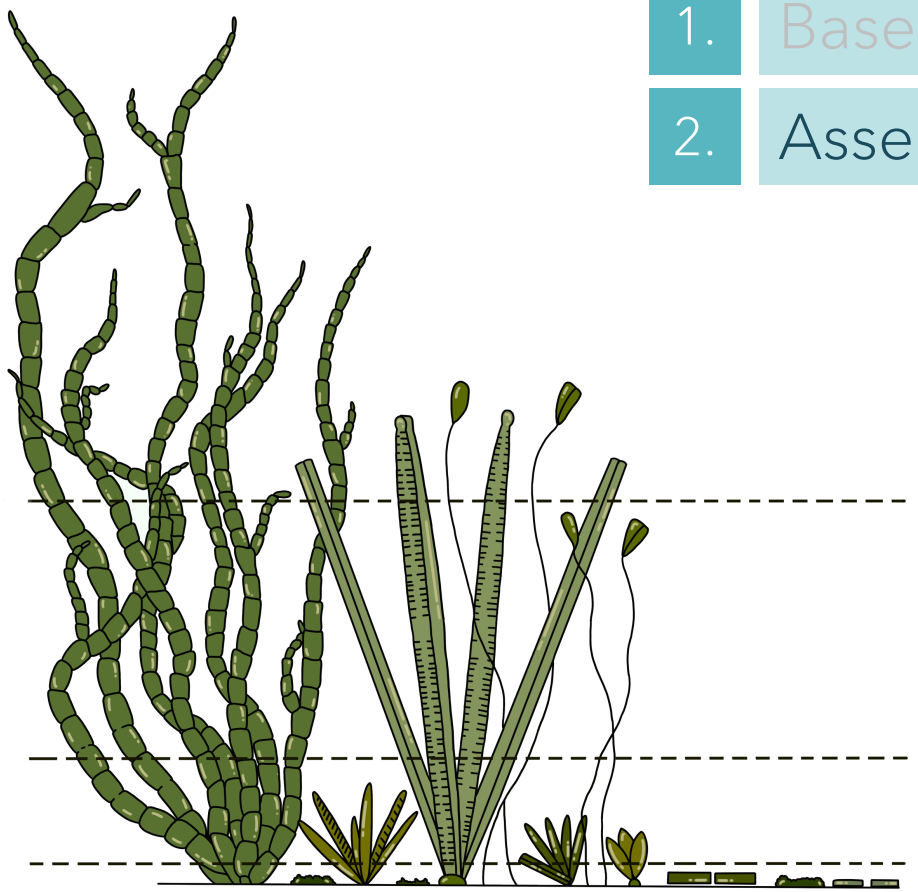


Modified from Hoagland et al. 1982



# *The Power of Periphyton*

1. Base of aquatic food webs
2. Assembles over time



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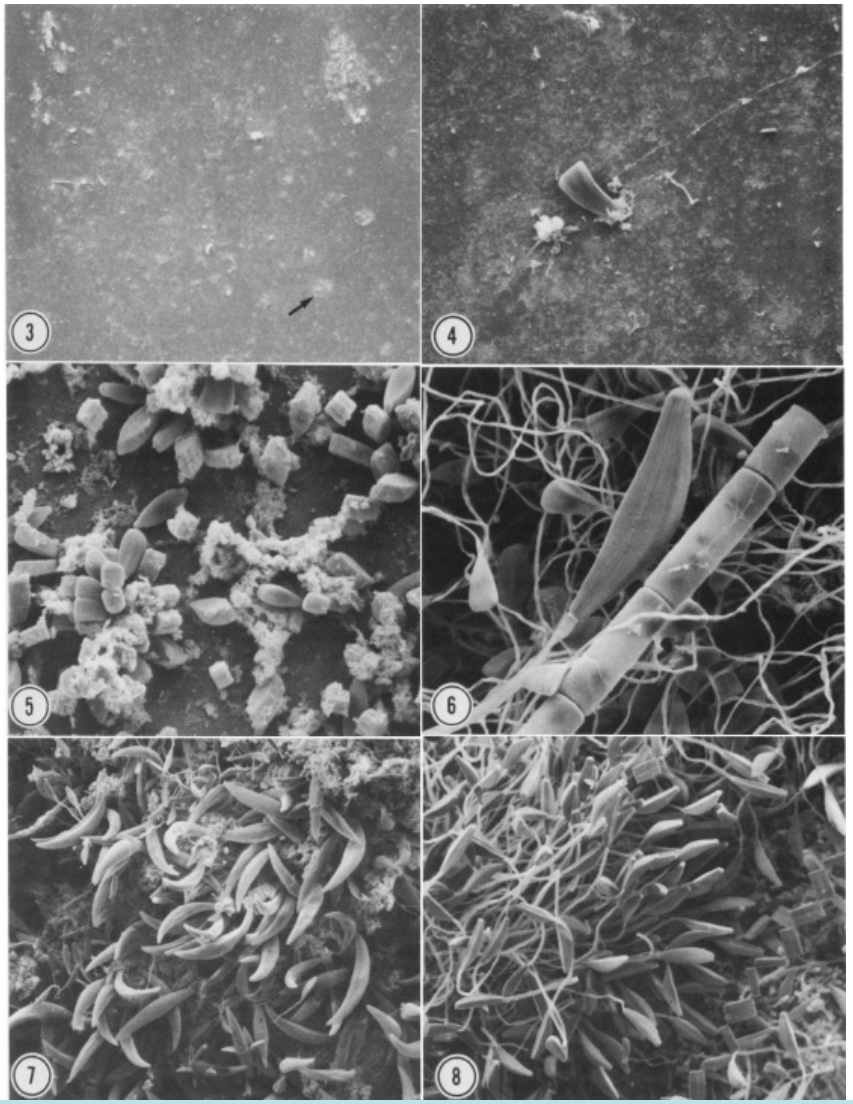
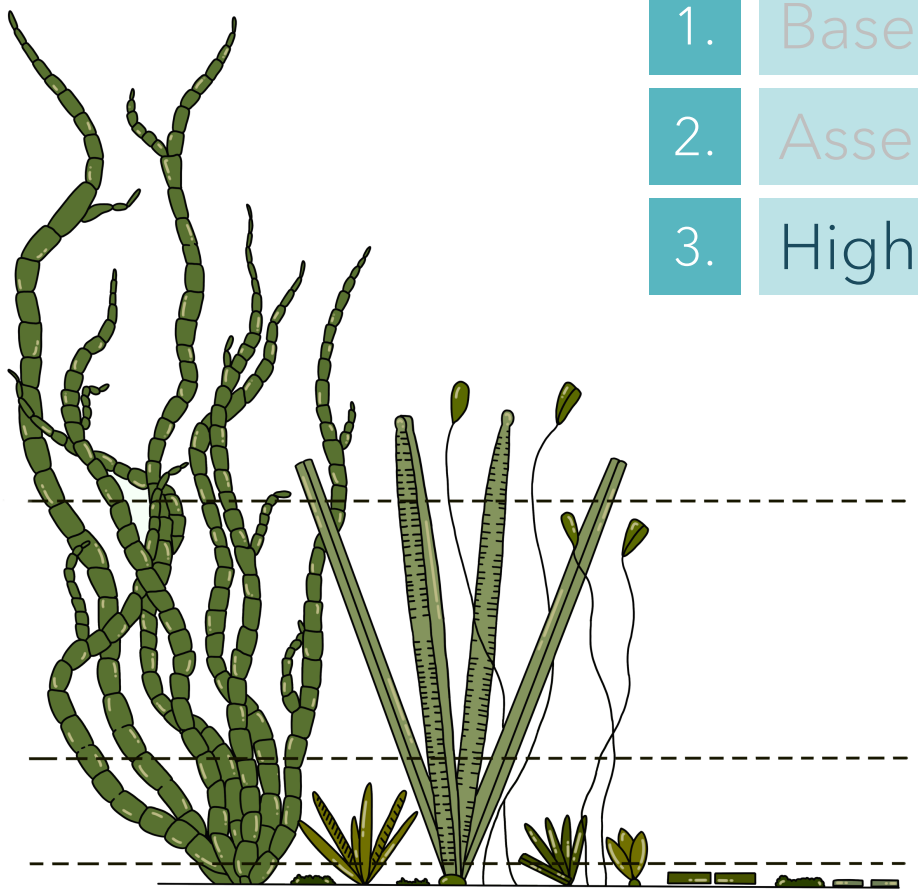


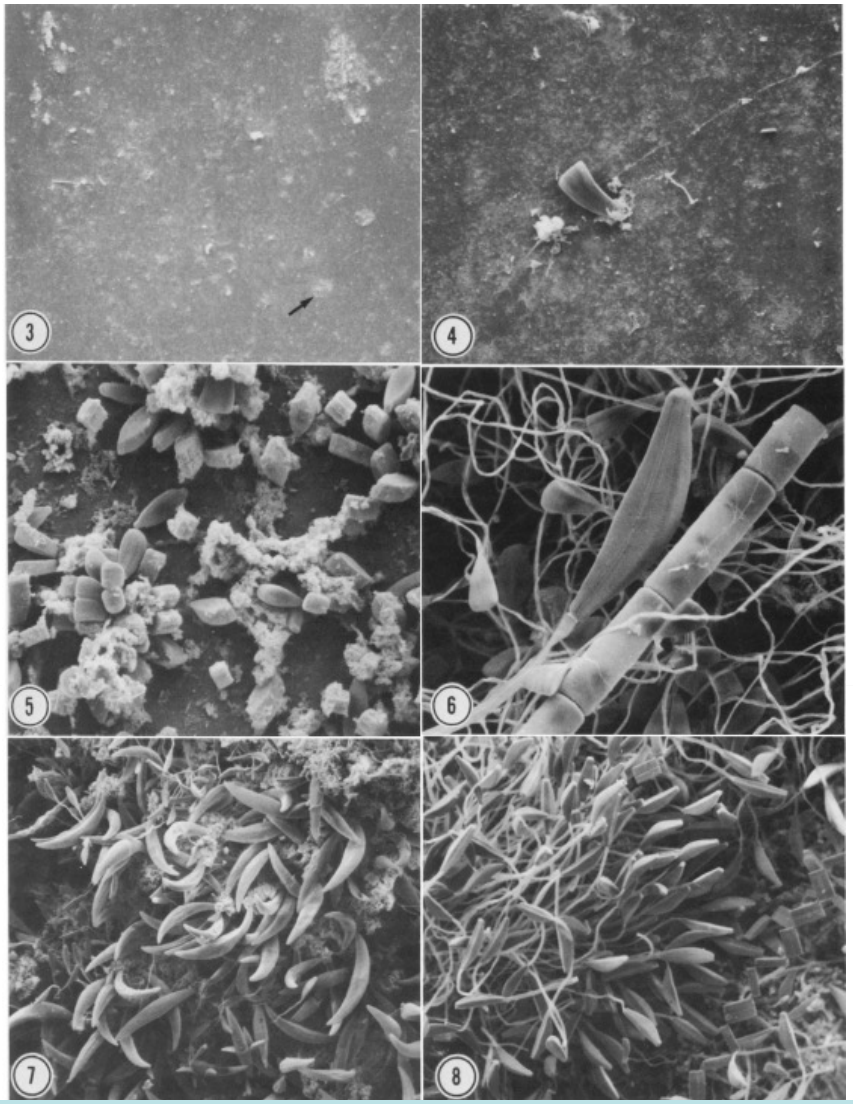

Periphyton growth across 4 weeks

# *The Power of Periphyton*

1. Base of aquatic food webs
2. Assembles over time
3. High species diversity



Modified from Hoagland et al. 1982



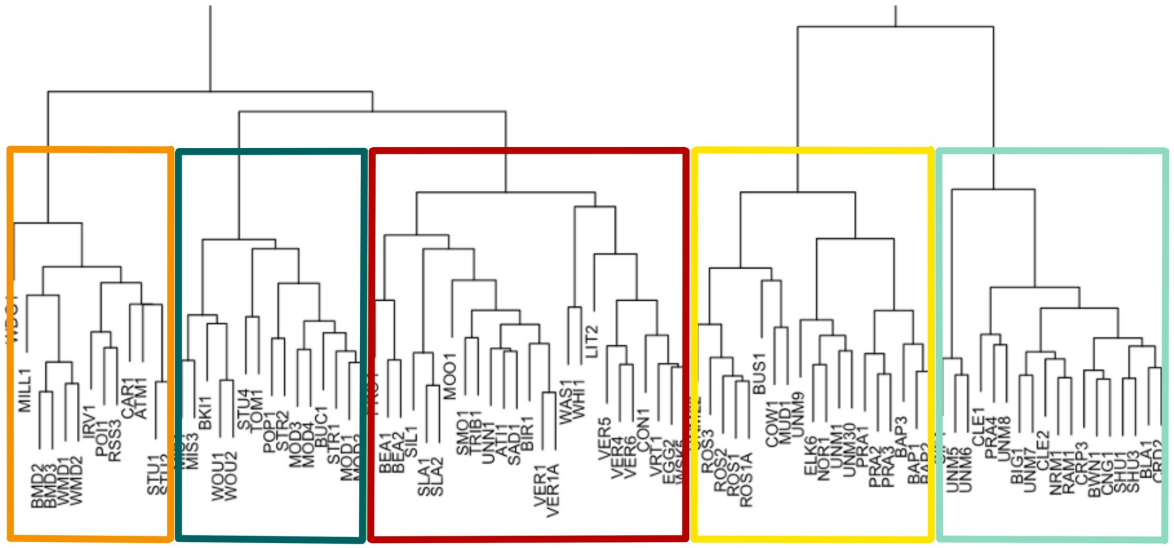

Periphyton growth across 4 weeks

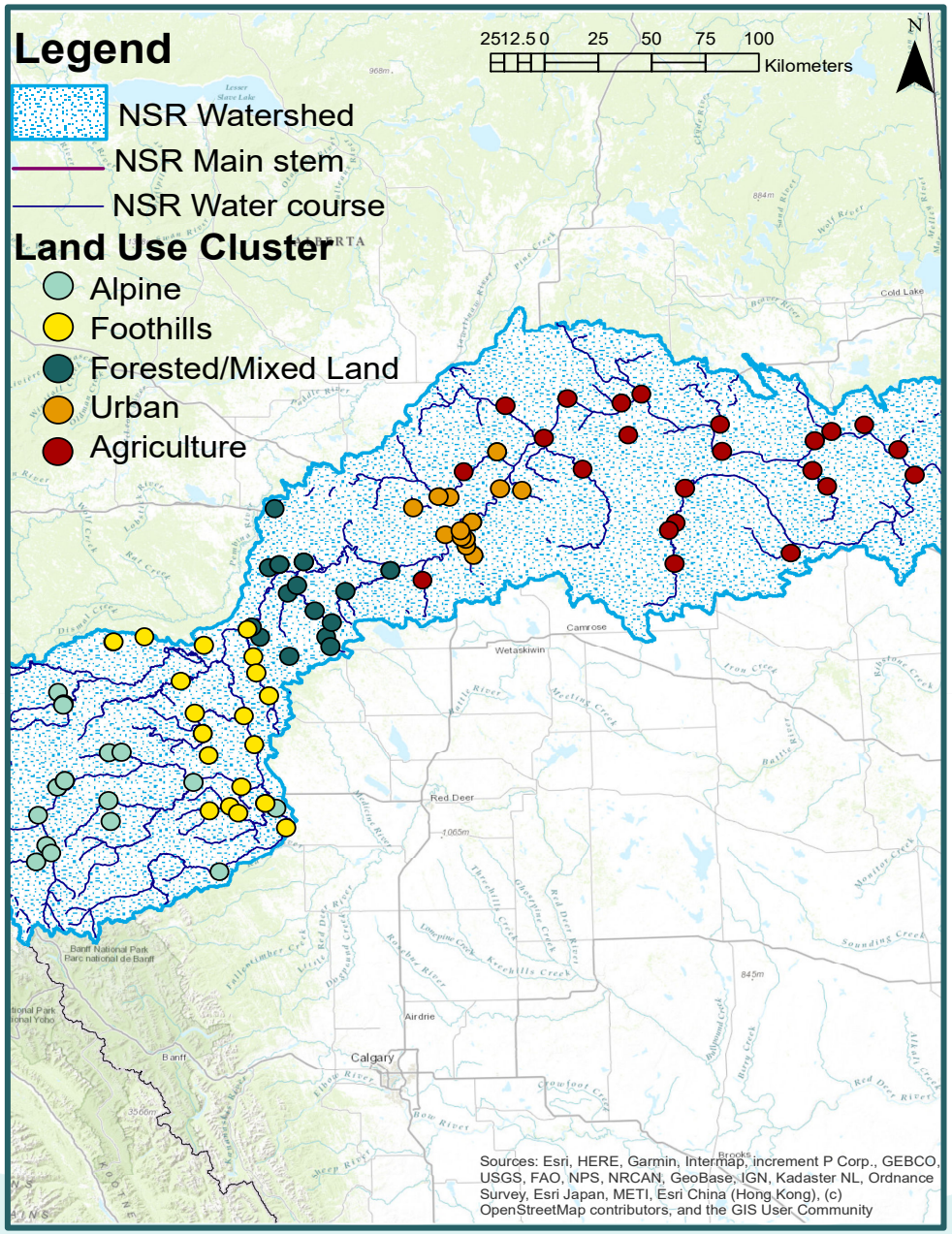
Disentangle the influences of local and regional factors on benthic algal community structure in tributary streams of the North Saskatchewan River Basin.

Can regional land-use characteristics be used to reliably predict benthic algal community structure?

# *Site Selection*

Based of 63 geospatial variables we clustered our sites into **5 main land use clusters,** and over the course of 3 years sampled a total of **93 sites**.



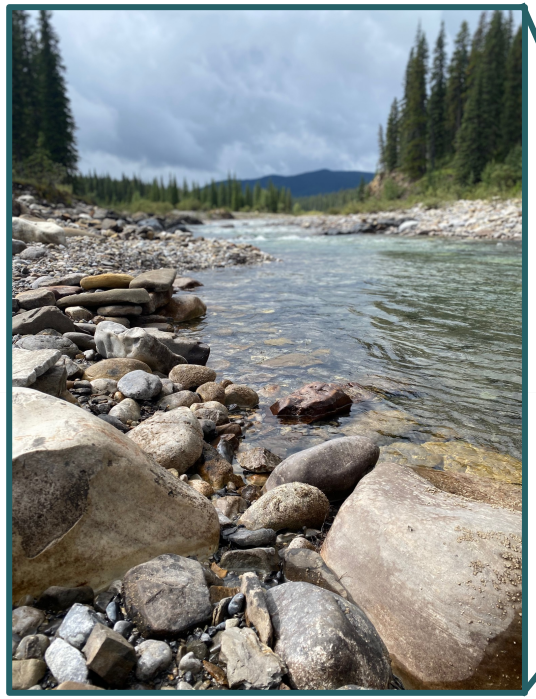



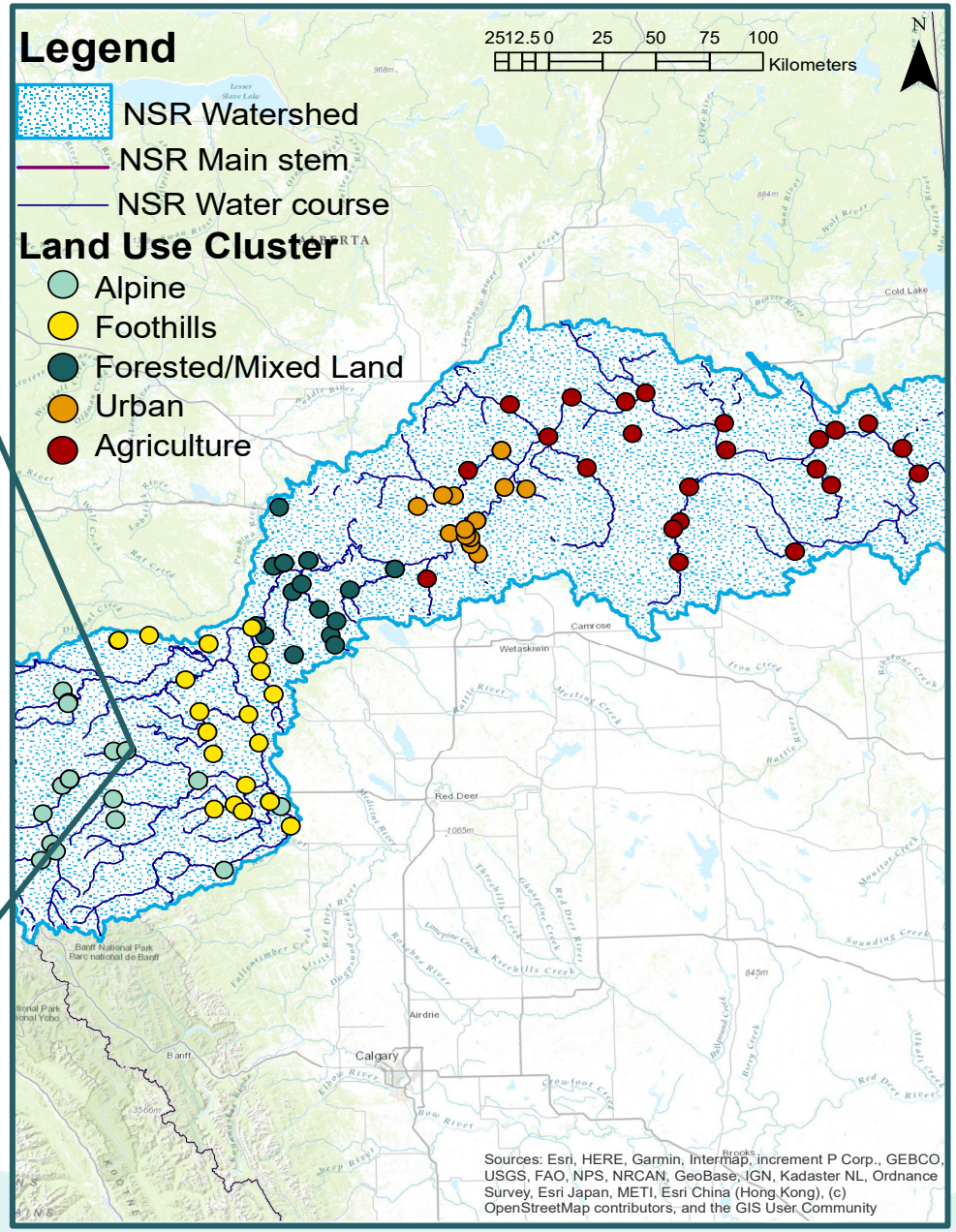

Created by Jillian Lightbown

# *Algal Collection*

At each site, a total of **30 rocks** were sampled:

- **10 for taxonomic analysis**
- 10 for pigment analysis
- 10 for microbial analysis



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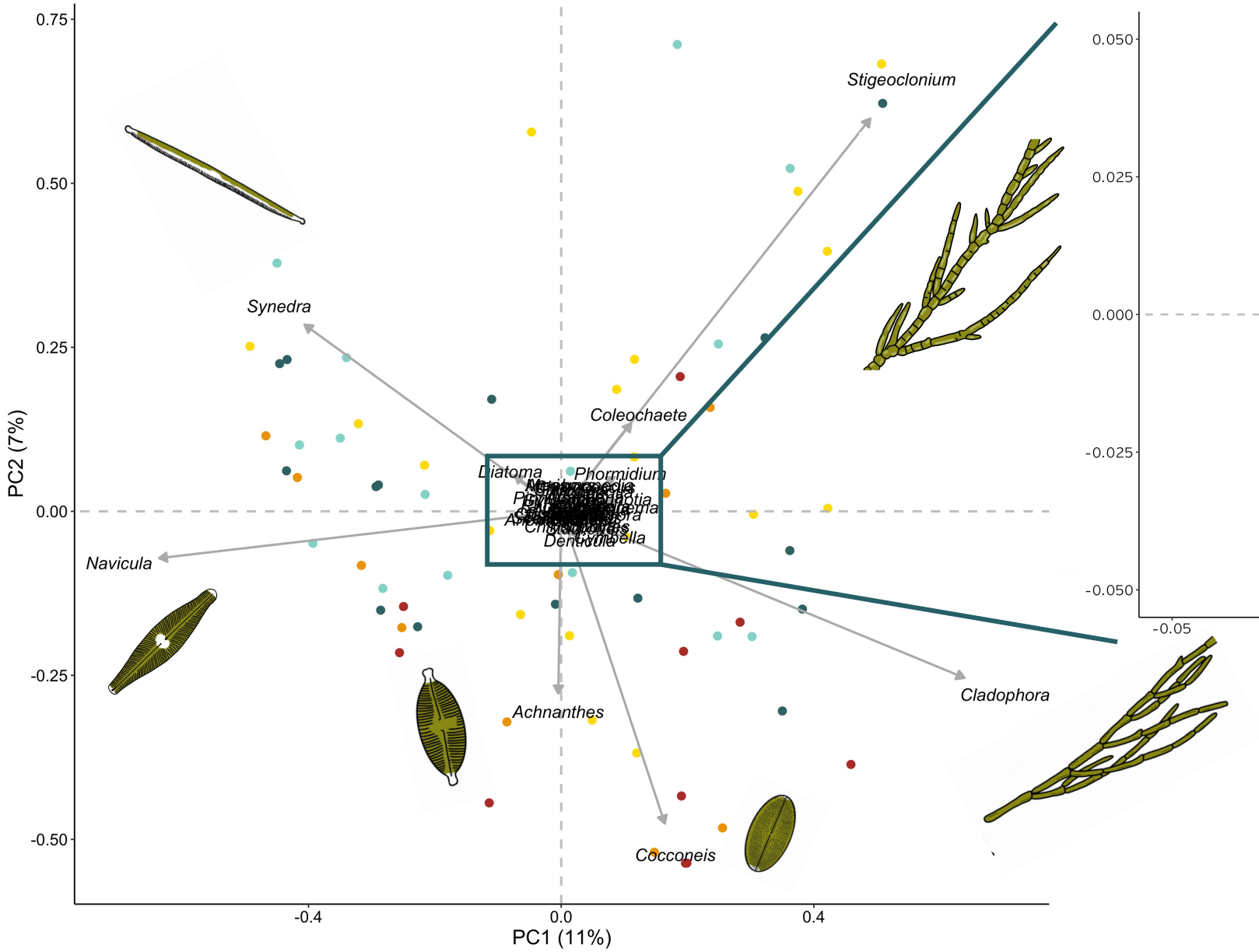
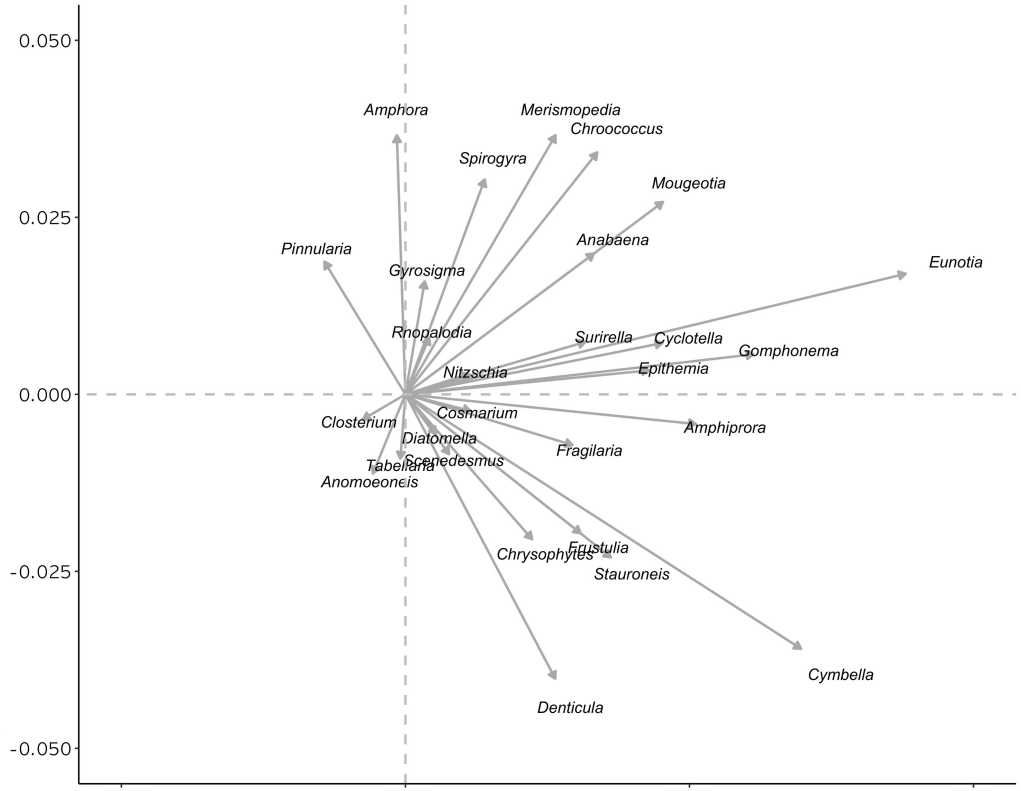
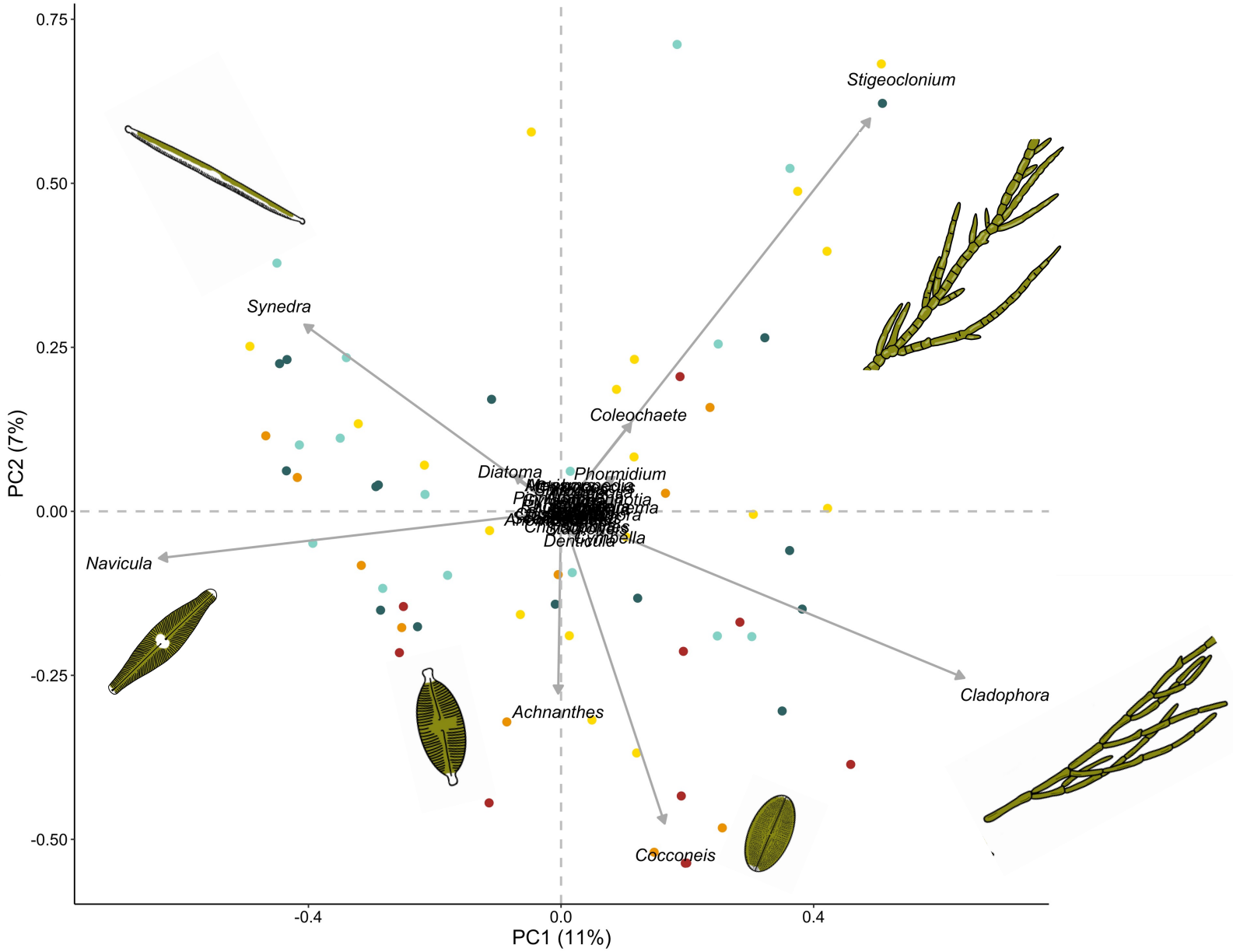



- Alpine
- Foothills
- Forested/Mixed Land
- Urban
- Agriculture

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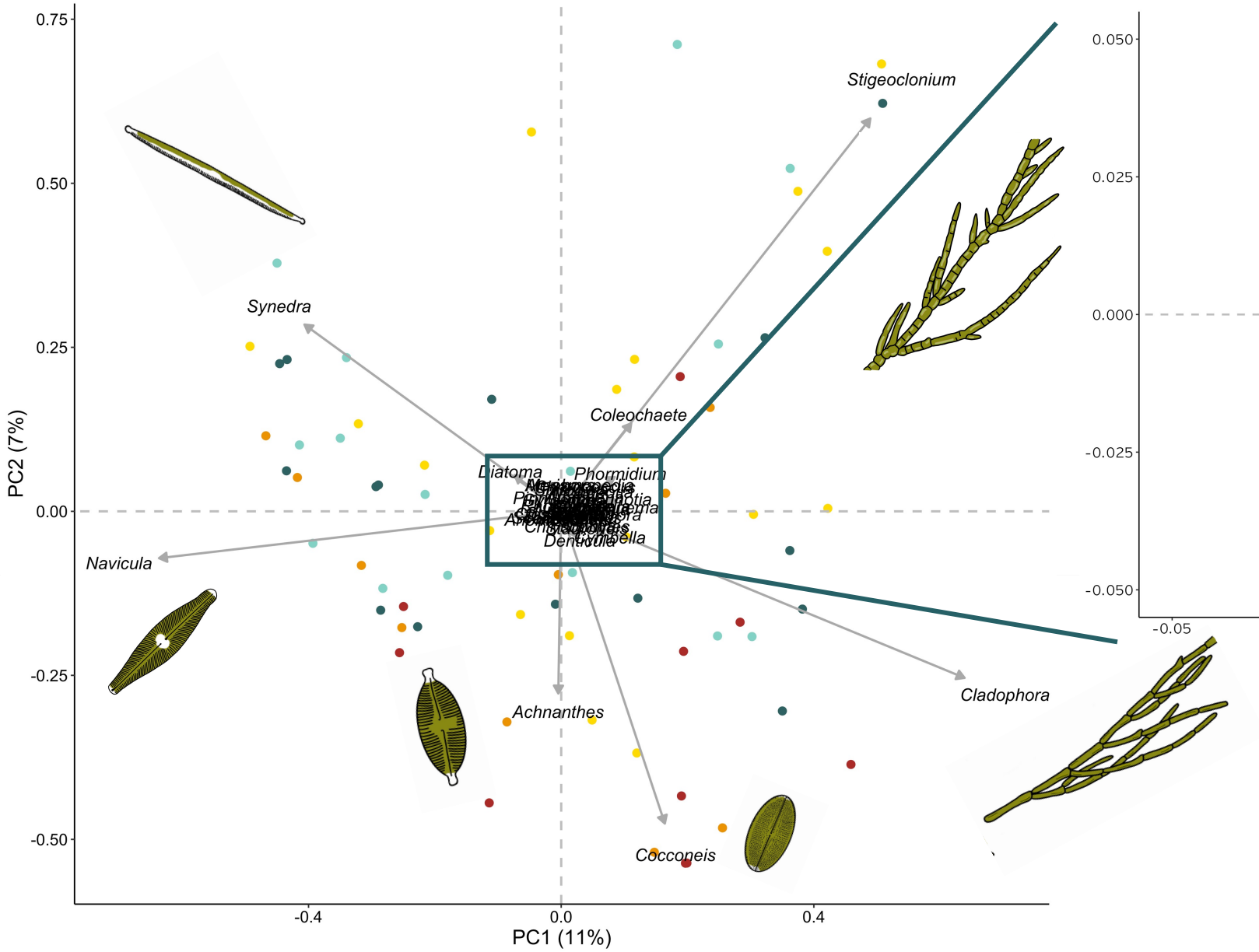


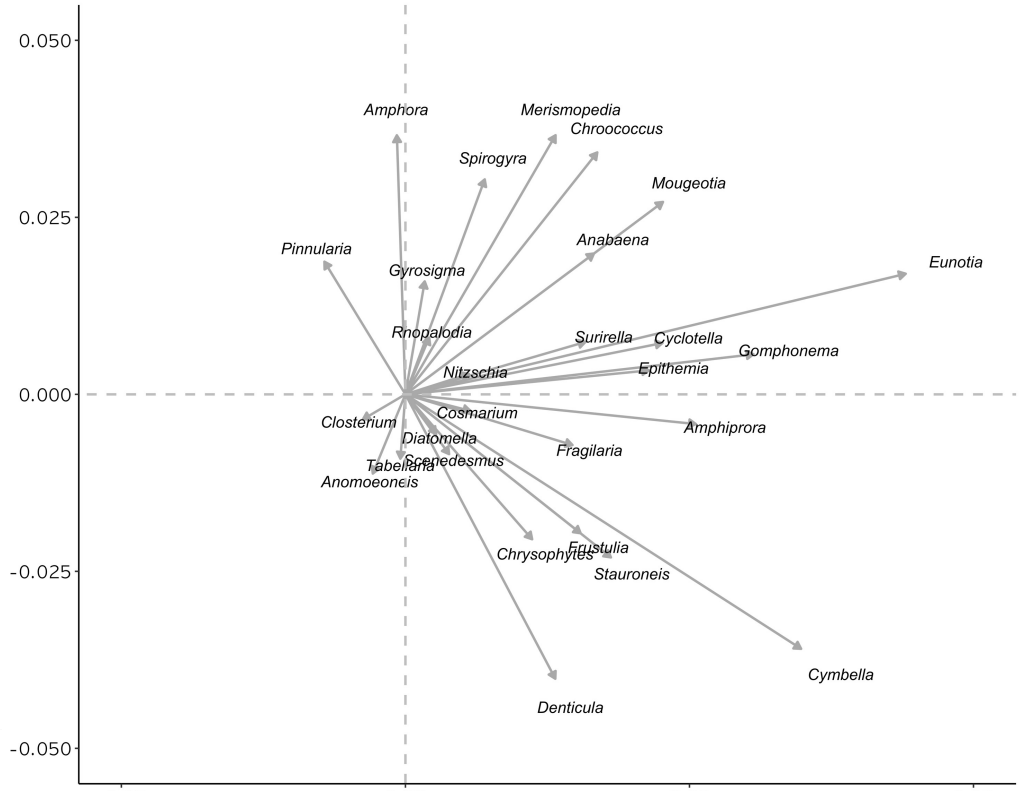


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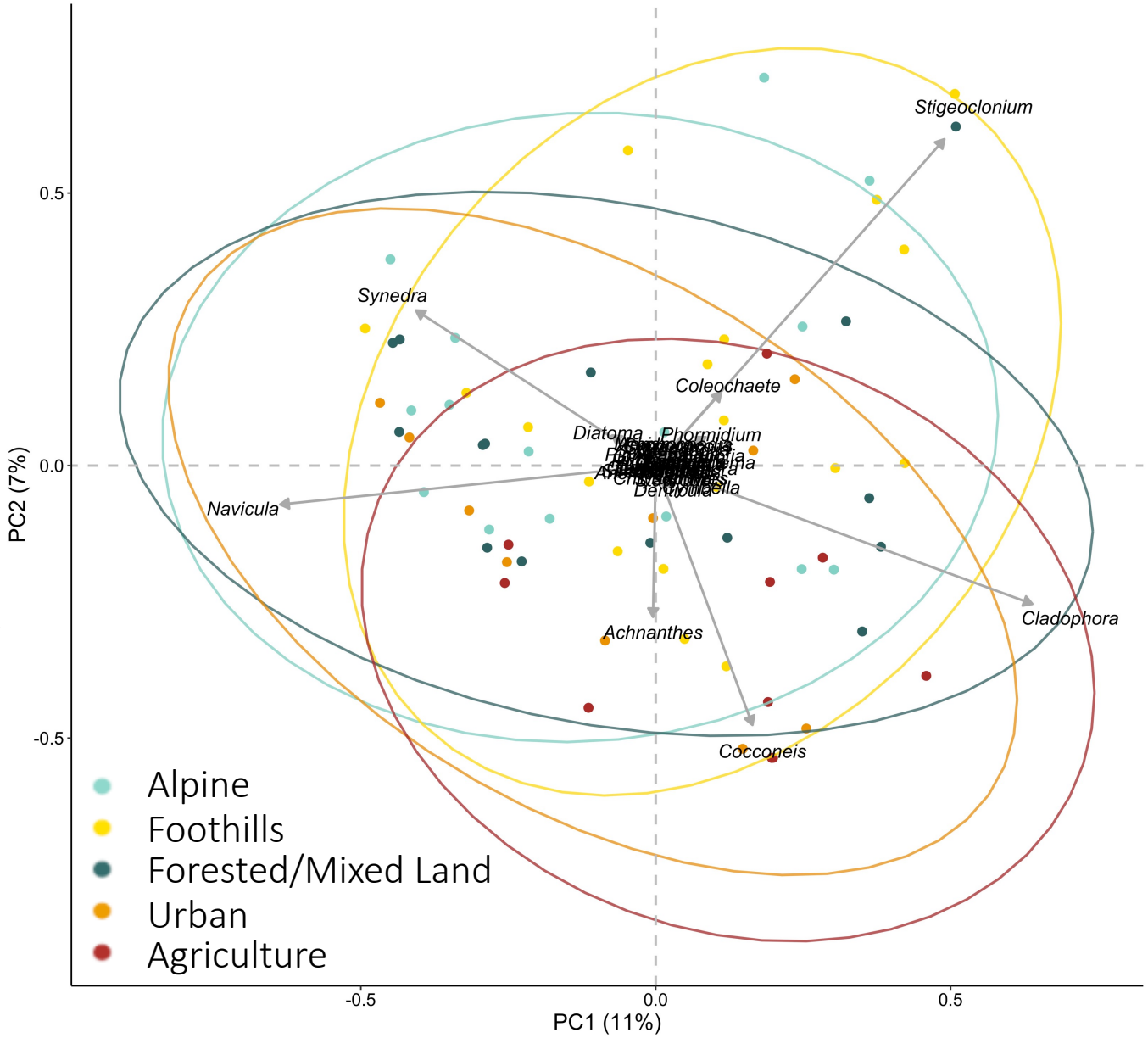
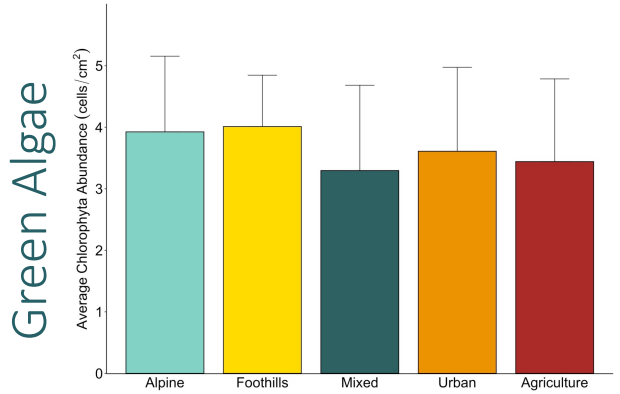
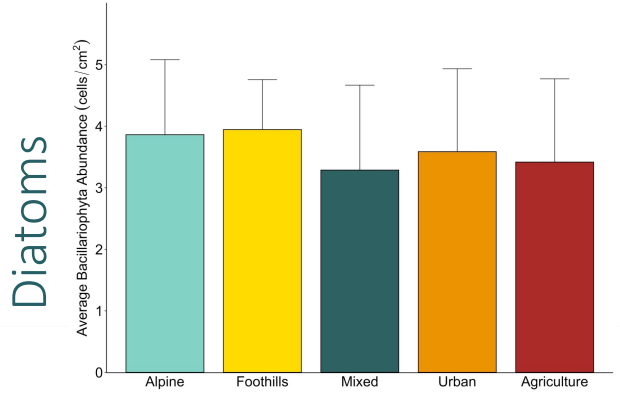
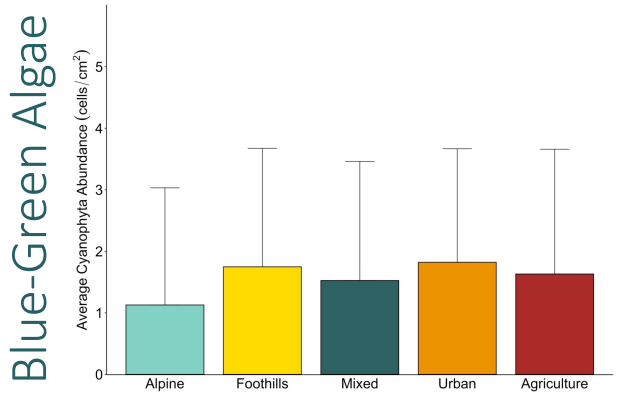
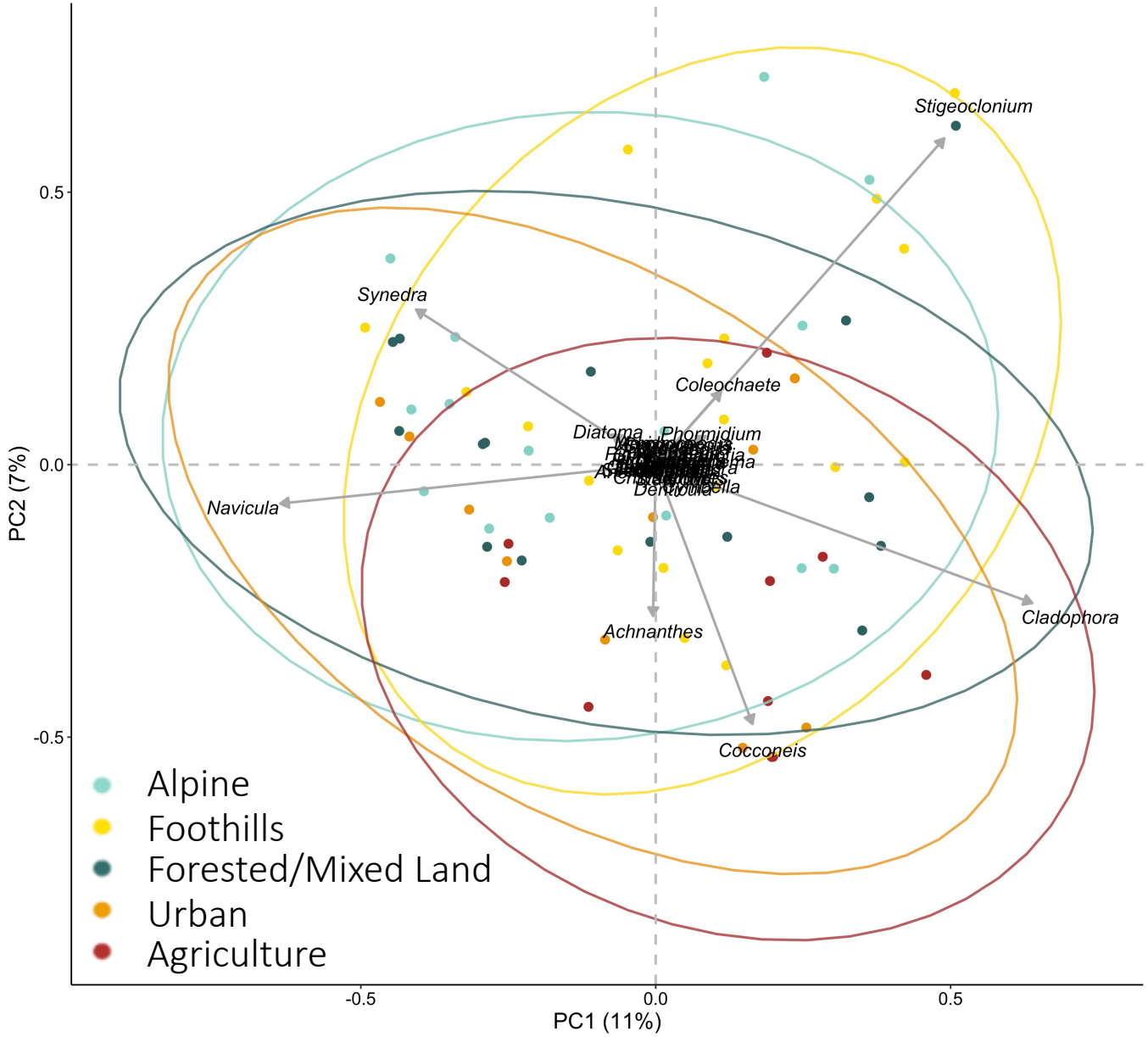

Stigeoclonium
Synedra
Coleochaete
Diatoma
Phormidium
Navicula
Cladophora
Achnanthes
Cocconeis
Alpine
Foothills
Forested/Mixed Land
Urban
Agriculture
PC2 (7%)
PC1 (11%)
0.5
0.0
-0.5
-0.5
0.0
0.5


Green Algae
Average Chlorophyta Abundance (cells/cm²)
Alpine
Foothills
Mixed
Urban
Agriculture


Diatoms
Average Bacillariophyta Abundance (cells/cm²)
Alpine
Foothills
Mixed
Urban
Agriculture


Blue-Green Algae
Average Cyanophyta Abundance (cells/cm²)
Alpine
Foothills
Mixed
Urban
Agriculture

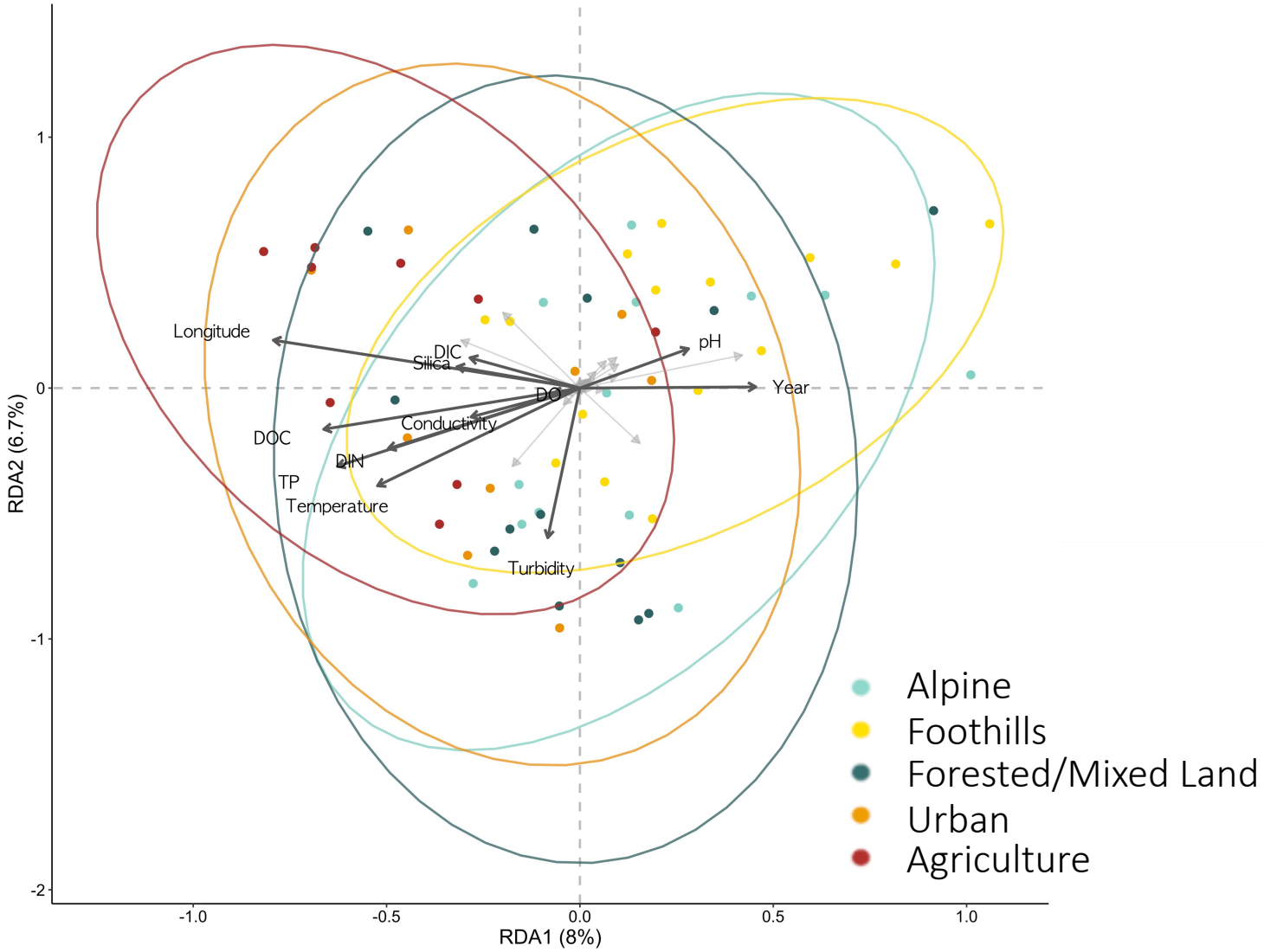



Regional factors, i.e., land use categories, **can not reliably predict community composition**.

Disentangle the influences of local and regional factors on benthic algal community structure in tributary streams of the North Saskatchewan River Basin.

Can regional land-use characteristics be used to reliably predict benthic algal community structure?

Can local factors (i.e. water chemistry) help elucidate the pattern behind benthic algal community structure?




- Alpine
- Foothills
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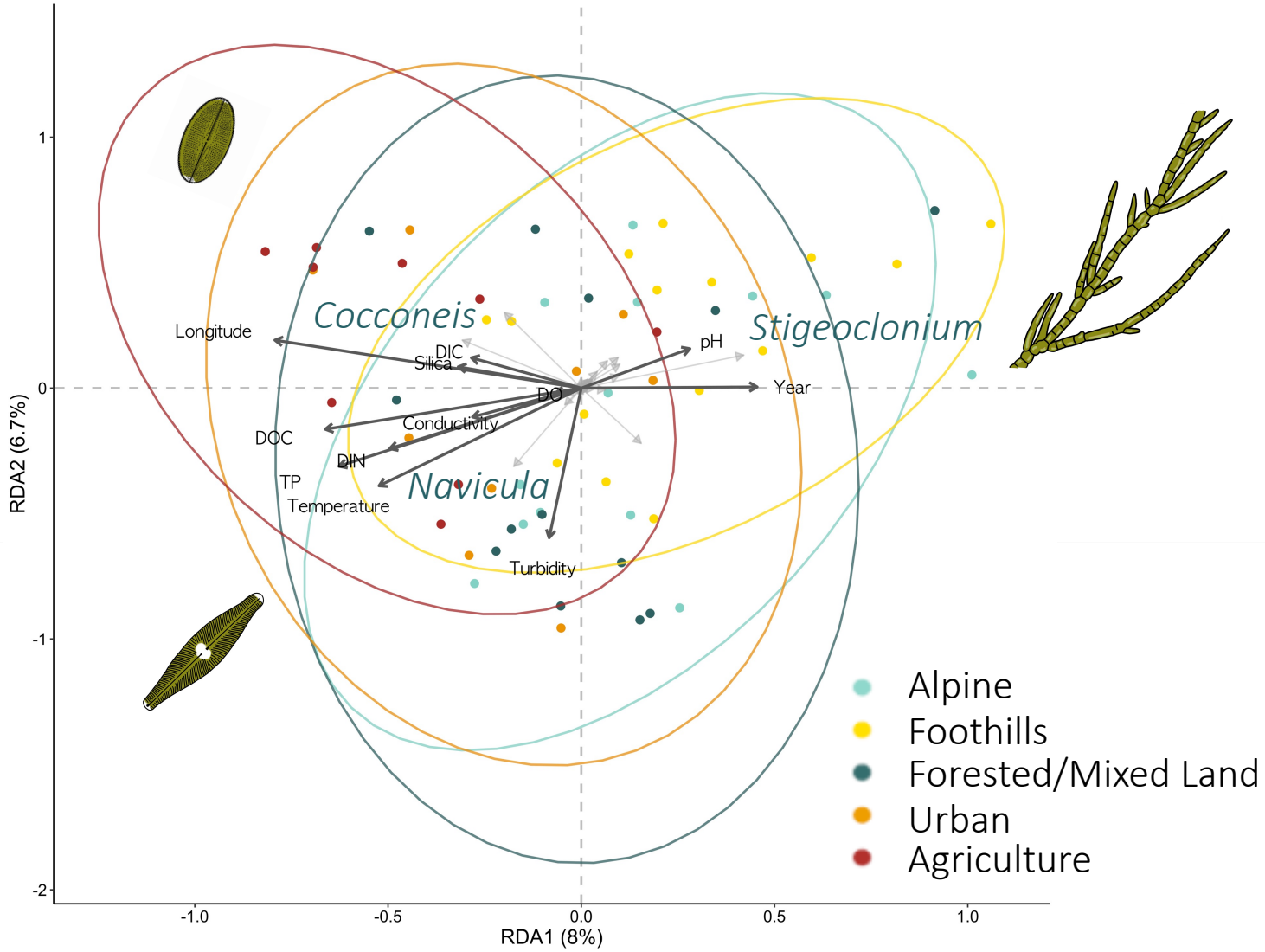
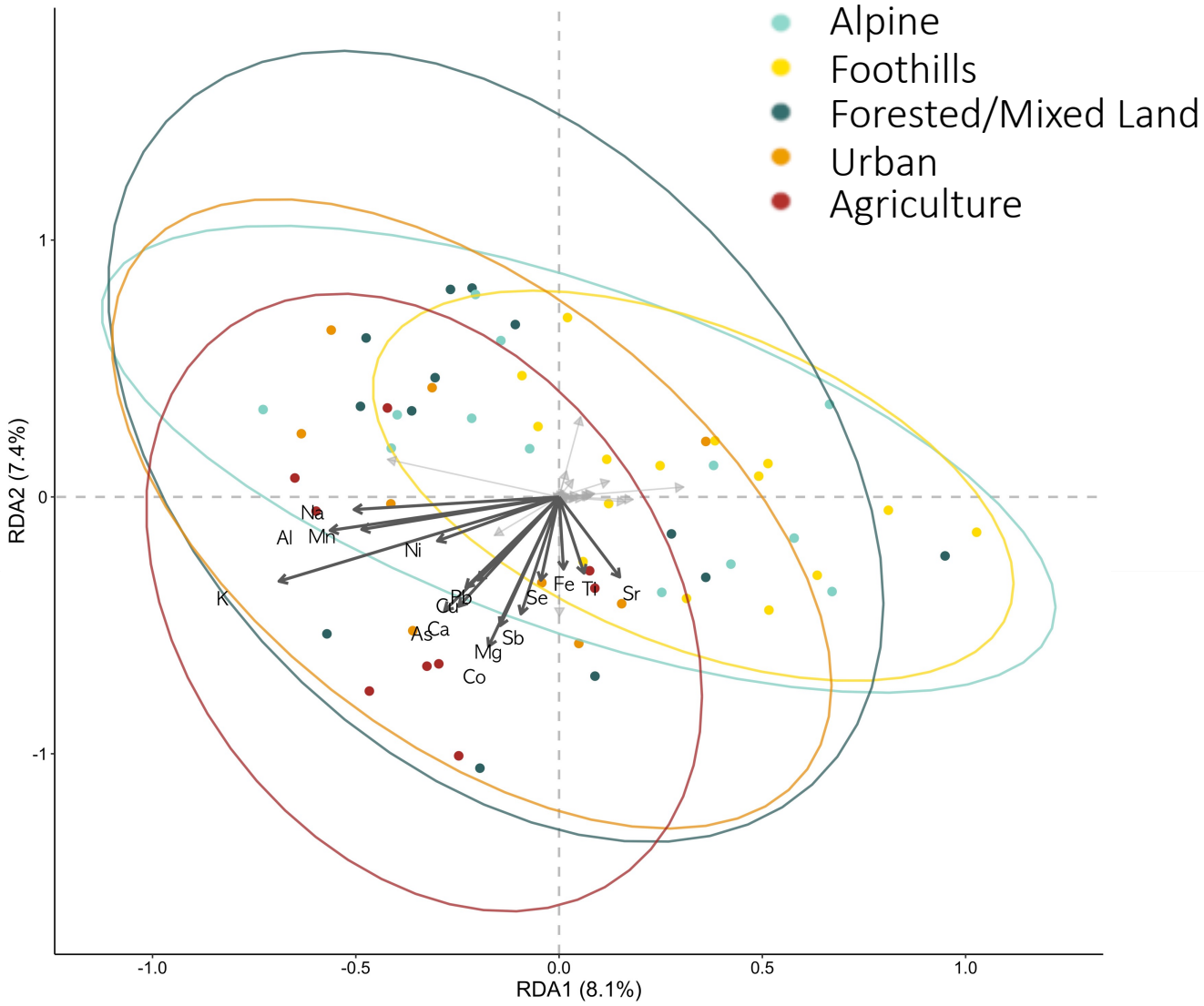
- Agriculture

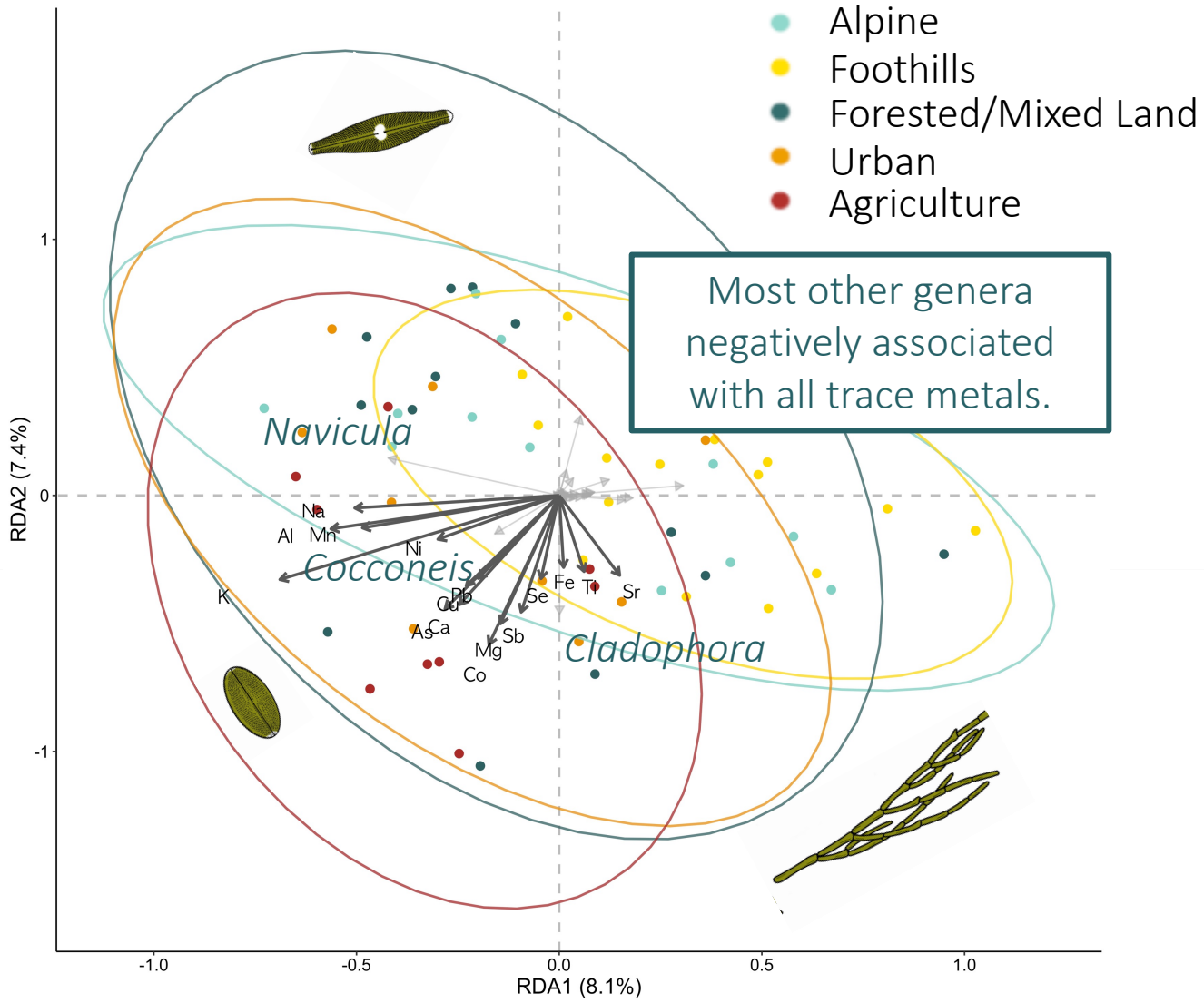



***Stigeoclonium* sp.:** positively associated with an increase in pH, and negatively associated with increasing nutrients and temperature, higher abundance in foothills and alpine sites.

***Navicula* sp.:** positively associated with an increase in turbidity, temperature and nutrients (nitrogen and phosphorus).

***Cocconeis* sp.:** positively associated with dissolved inorganic carbon and silica, higher abundance in agricultural land use sites.


Alpine
Foothills
Forested/Mixed Land
Urban
Agriculture
RDA2 (7.4%)
RDA1 (8.1%)
1
0
-1
-1.0
-0.5
0.0
0.5
1.0
Na
Al
Mn
Ni
K
Pb
Cu
Se
Fe
Ti
Sr
As
Ca
Sb
Mg
Co




*Cladophora* sp.: positively associated with an increase in Iron (Fe), Selenium (Se), and Titanium (Ti).

*Navicula* sp.: positively associated with an increase in Sodium (Na), Aluminum (Al), and Manganese (Mn).

*Cocconeis* sp.: positively associated with an increase in Nickel (Ni), Potassium (K), Lead (Pb), and Copper (Cu).

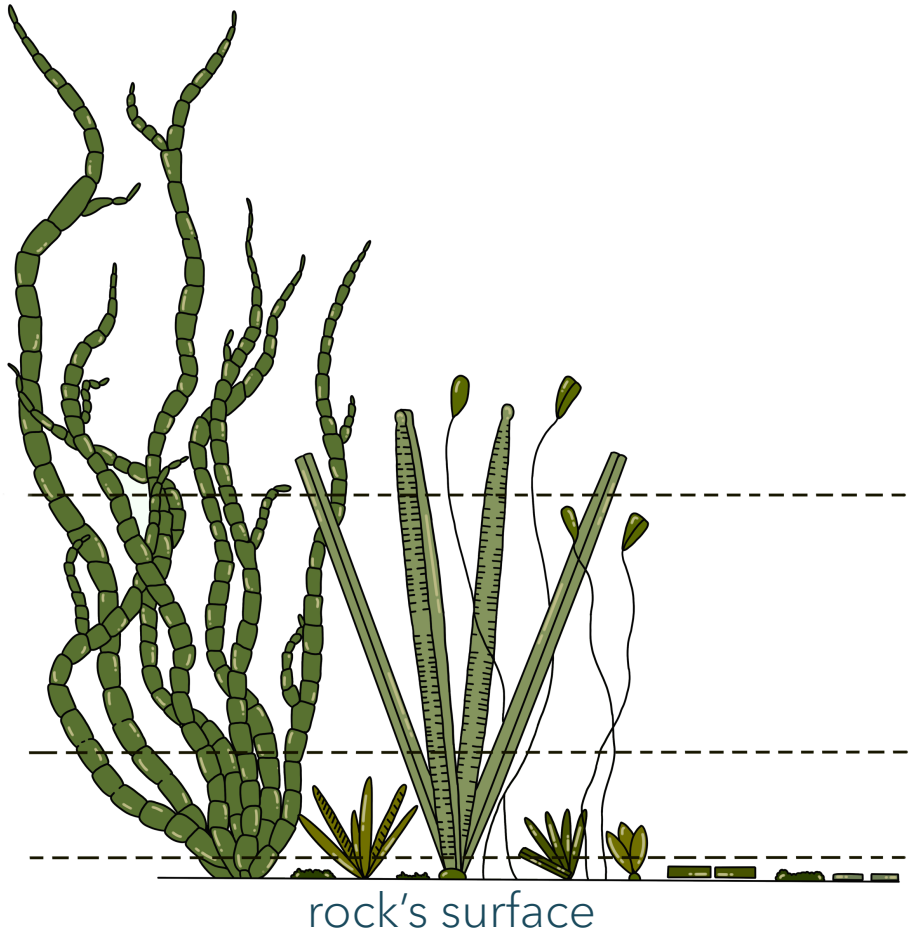
Disentangle the influences of local and regional factors on benthic algal community structure in tributary streams of the North Saskatchewan River Basin.

Can regional land-use characteristics be used to reliably predict benthic algal community structure?

Can local factors (i.e. water chemistry) help elucidate the pattern behind benthic algal community structure?

How are these changes in community structure impacting ecosystem function?

# *The Functional Frontier*

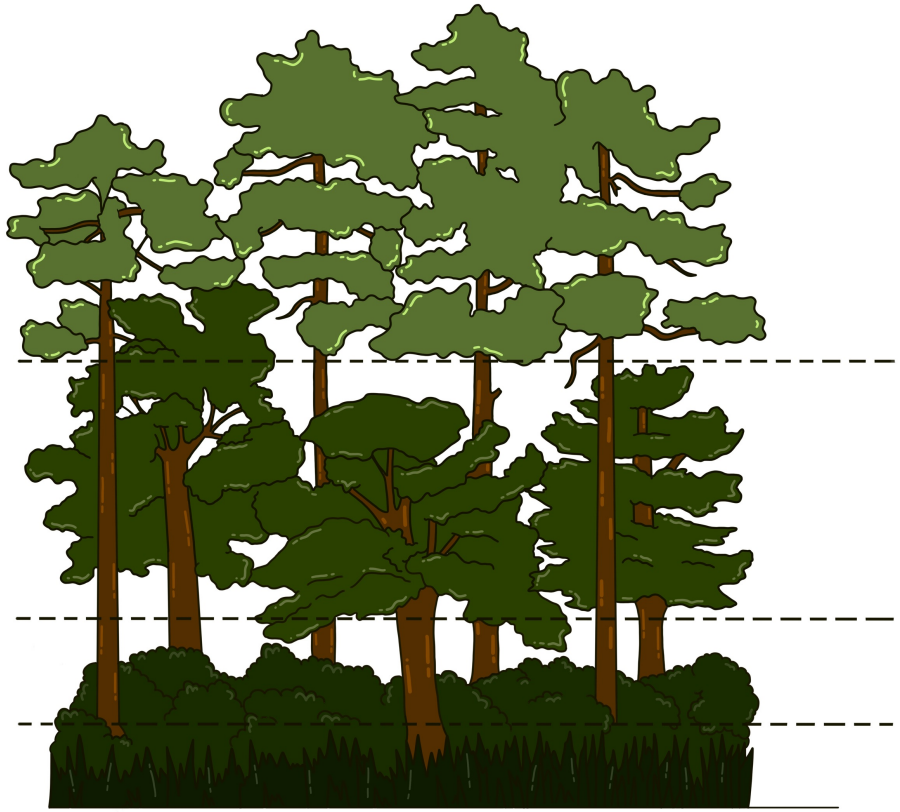



canopy layer

midstory layer

shrub layer

ground cover



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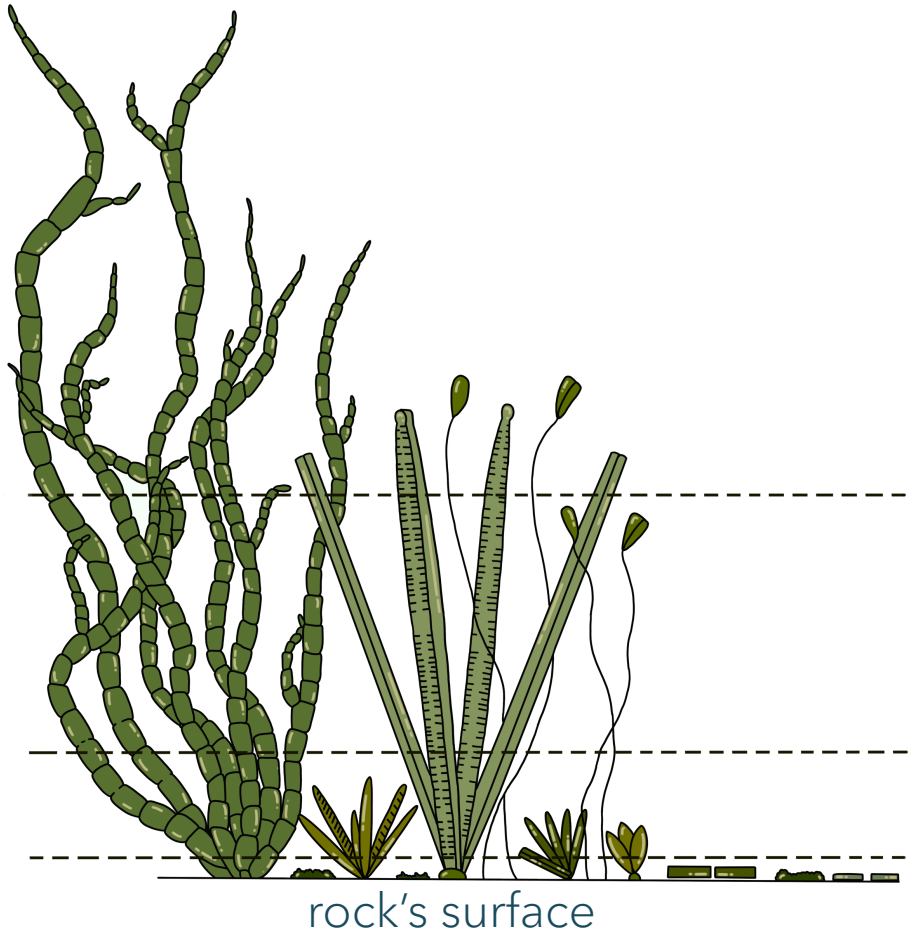
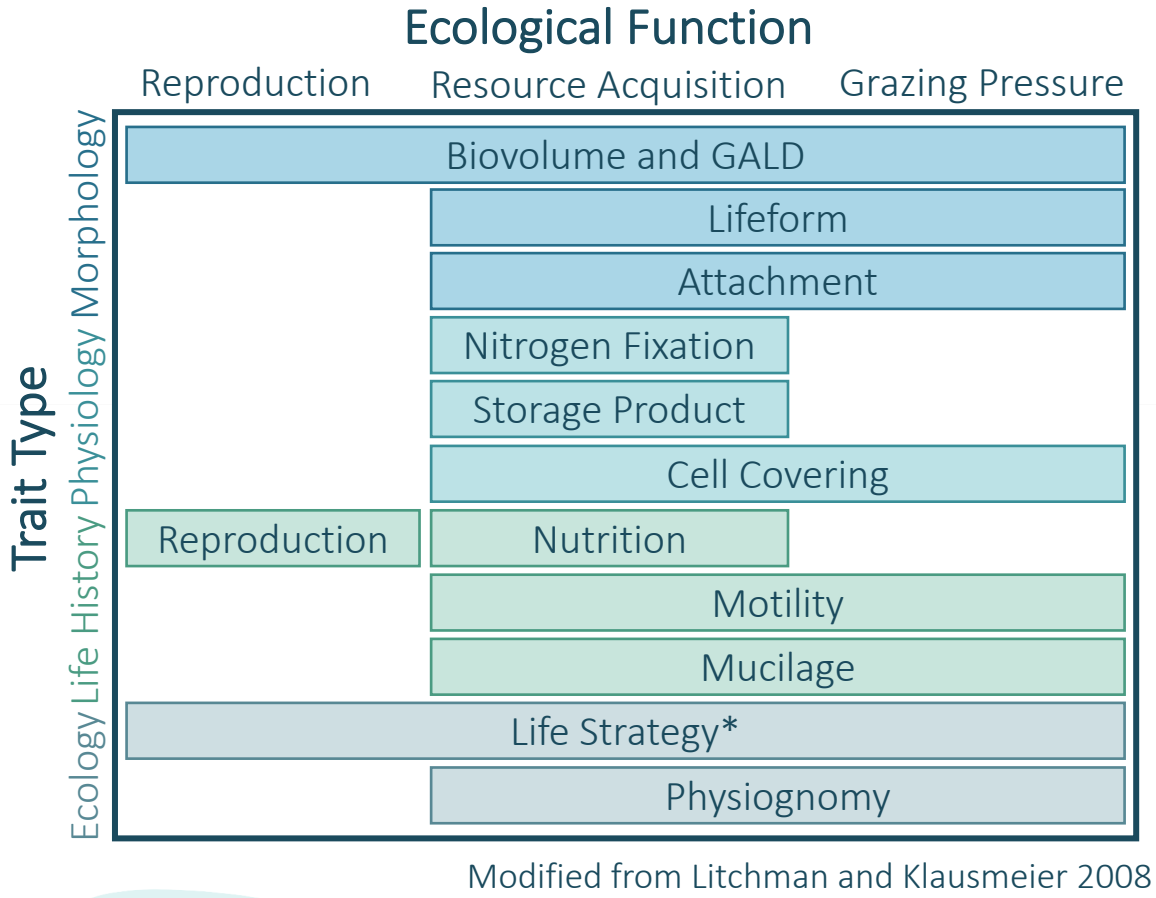



Modified from Litchman and Klausmeier 2008

# *In Summary …*

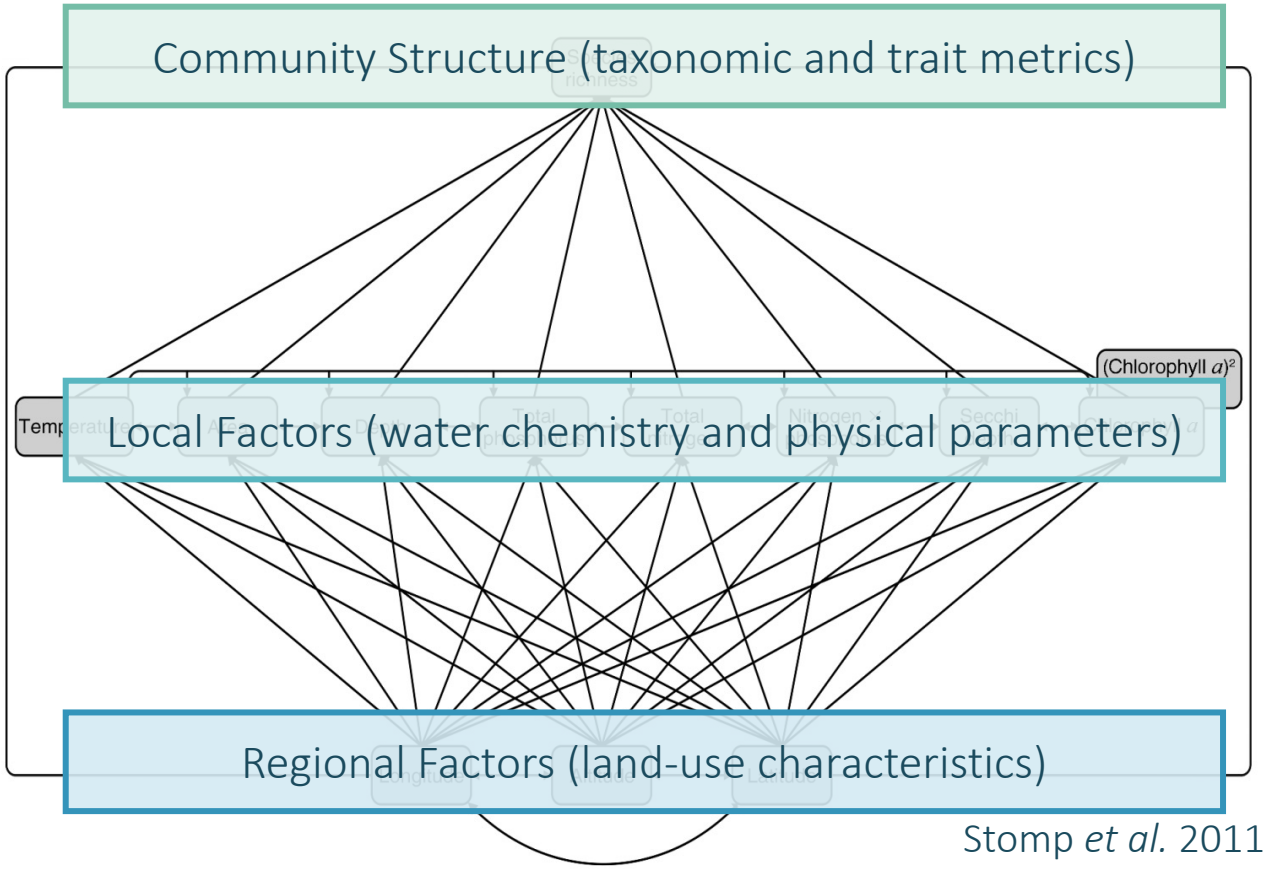
Regional factors can not be used to reliably predict community structure, but with the addition of local factors, such as water chemistry, we can start to see some patterns in community structure.

Categorizing how algal communities are structured across the NSR is essential for us to determine any changes that occur in the future.

# *In Summary …*

**Next steps for the project include:**

- Finalize trait data and assess how they are changing across the watershed.
- Analyzing rare occurrence genera separately from high abundance genera.
- Assess the association between regional and local factors to determine if there are **indirect effects** .




Stomp *et al.* 2011

# Acknowledgements


University of Alberta Team:

- Dr. Rolf Vinebrooke and Lab
- Dr. Maya Bhatia and Lab
- Dr. Mark Poesch and Lab
- Summer Lab Assistants

Alberta Environment Team:

- Dr. David Roberts
- Dr. Anas Mohammed



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