Translocation of nutrients by freshwater mussels – alteration of ecosystem and community processes

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Organisms Influence Nutrient Cycling

- Nutrient storage → increase retention time
- Alter the nutrients limit production based on their needs (Vanni 2002)
- Evident when biomass is high (Small et al. 2009)

Why Mussels?
Losing Species

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  d
- M
  c
  b
  a
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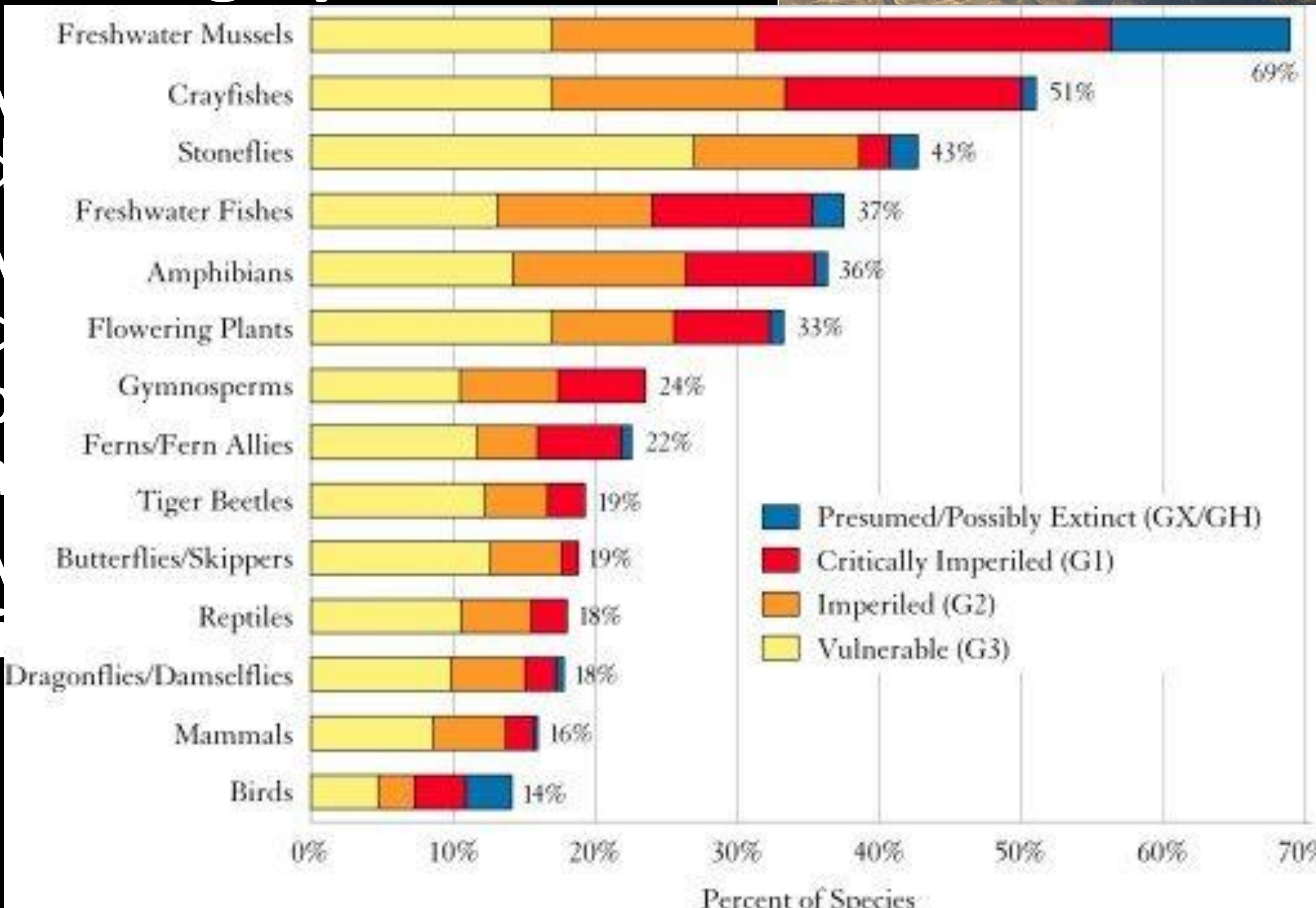

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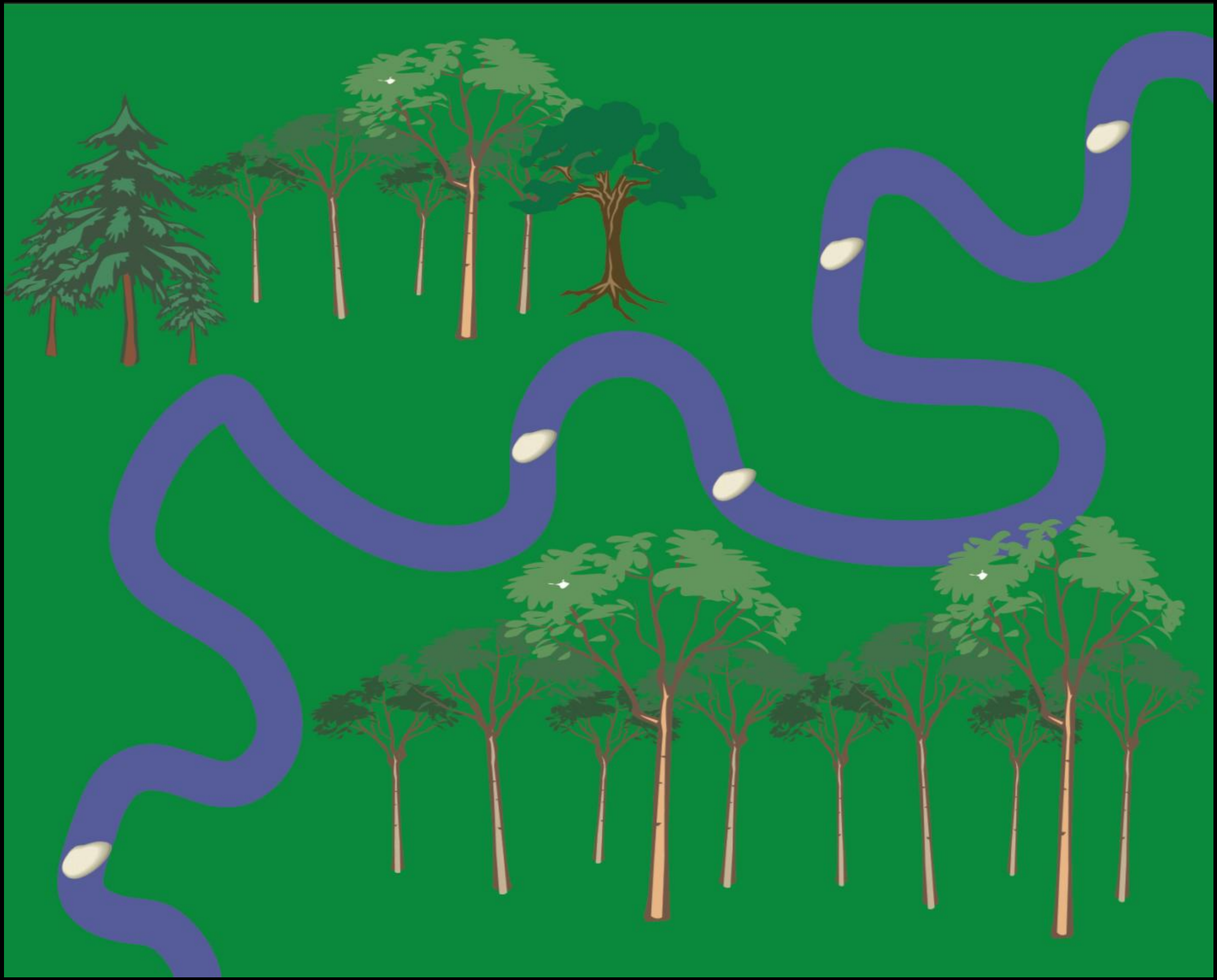
Vaughn & Hakenkamp, 2001, *Freshwater Biology*

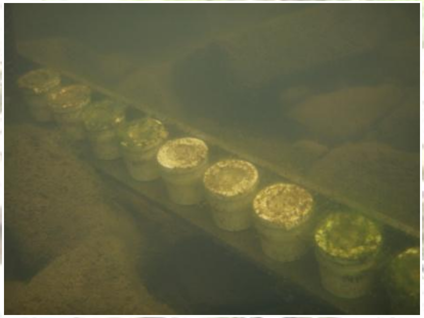
Patchy Distribution



Mussel beds can be separated by a stream distance of 800m – 2500 meters in undisturbed systems

Design

- **Deployment**
  - Nutrient Diffusing Substrates (12 replicates per site) placed in stream → left for 18 days
    - C, +N, +P, +NP
  - Water parameters measured (Temp, DO, pH, Conductivity, Turbidity)
  - Water Chemistry Samples (TN, TP, DOC)





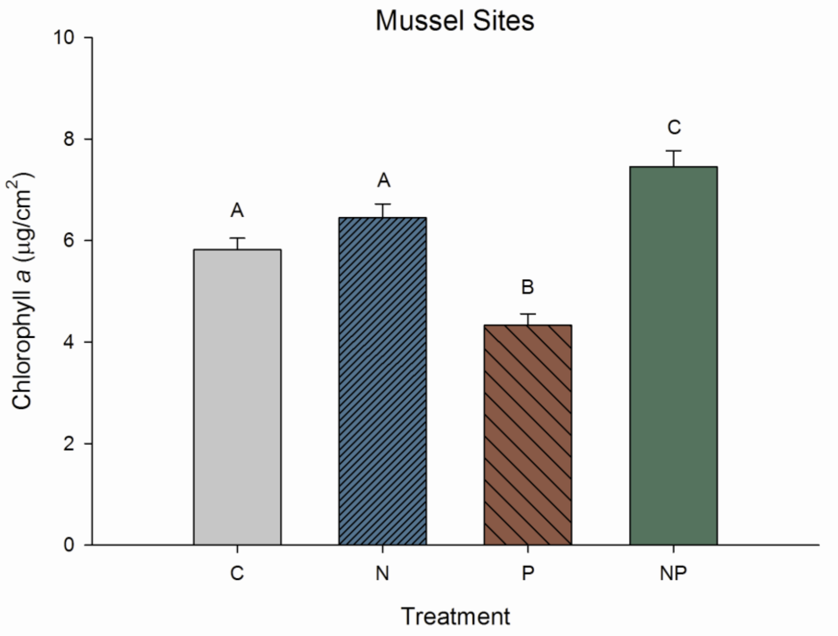
Design Cont

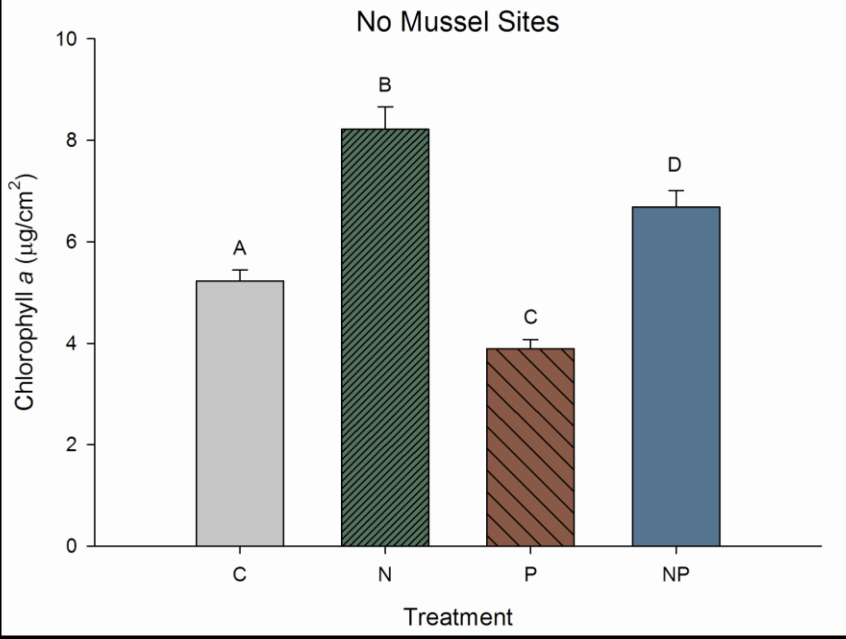
- **Post**
  - – Nutrient diffusing substrates removed
    - Chlorophyll *a* biomass quantified
  - – Water parameters measured again
  - – Periphyton samples
  - – Water chemistry samples (TN, TP, DOC)
  - – Mussel densities quantified (10 – $0.25m^2$ quadrats)
  - – Excretion experiments for common species


ALUMINUM FOIL

NDS Results

- Mussel Sites – co-limitation
  - Significant ANOVA ($p < 0.001$)
- Non-mussel sites – N-limited
  - Significant ANOVA ($p < 0.001$)

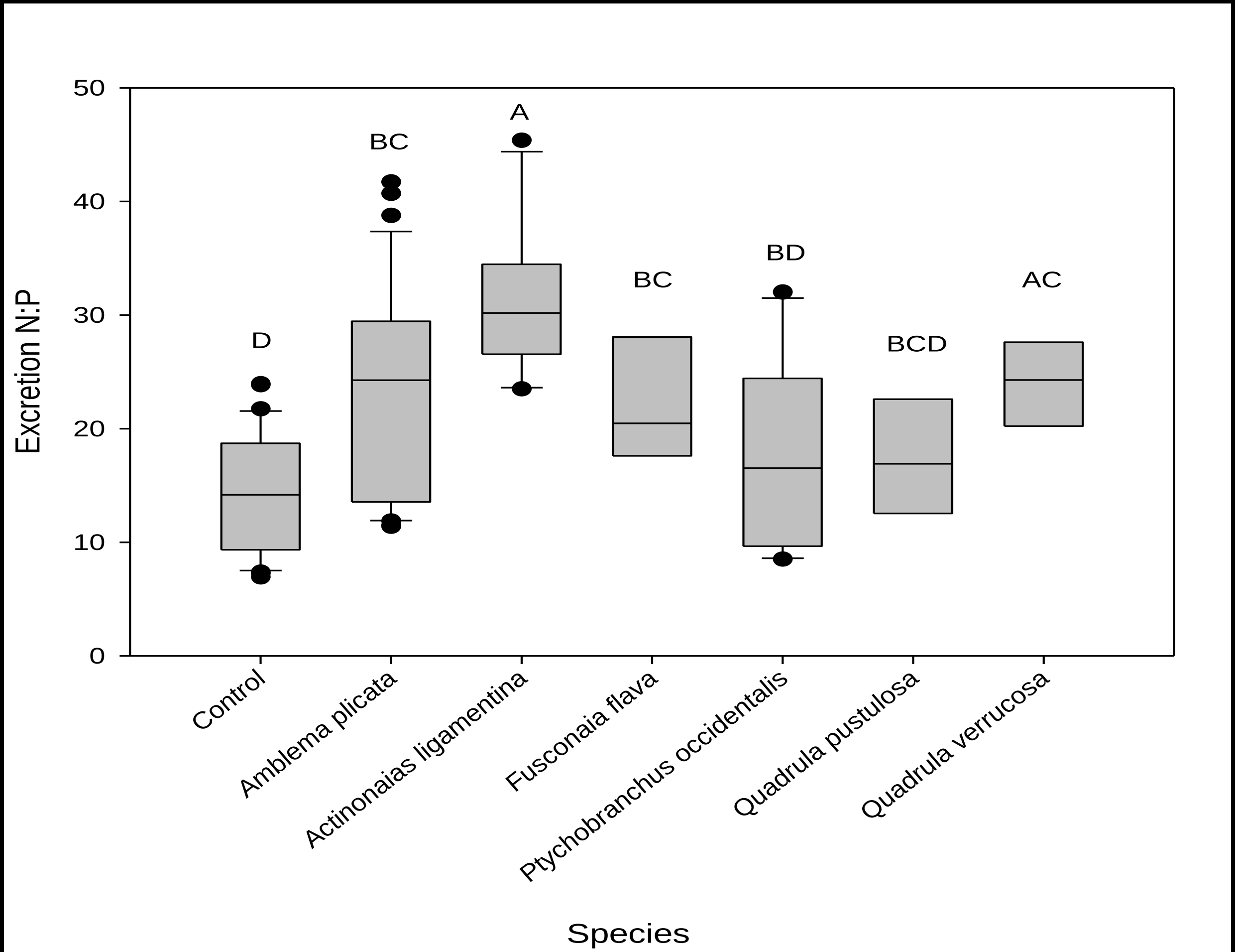




What’s the Mechanism?

N:P of excretion

If N:P < 20, N is scarce relative to P

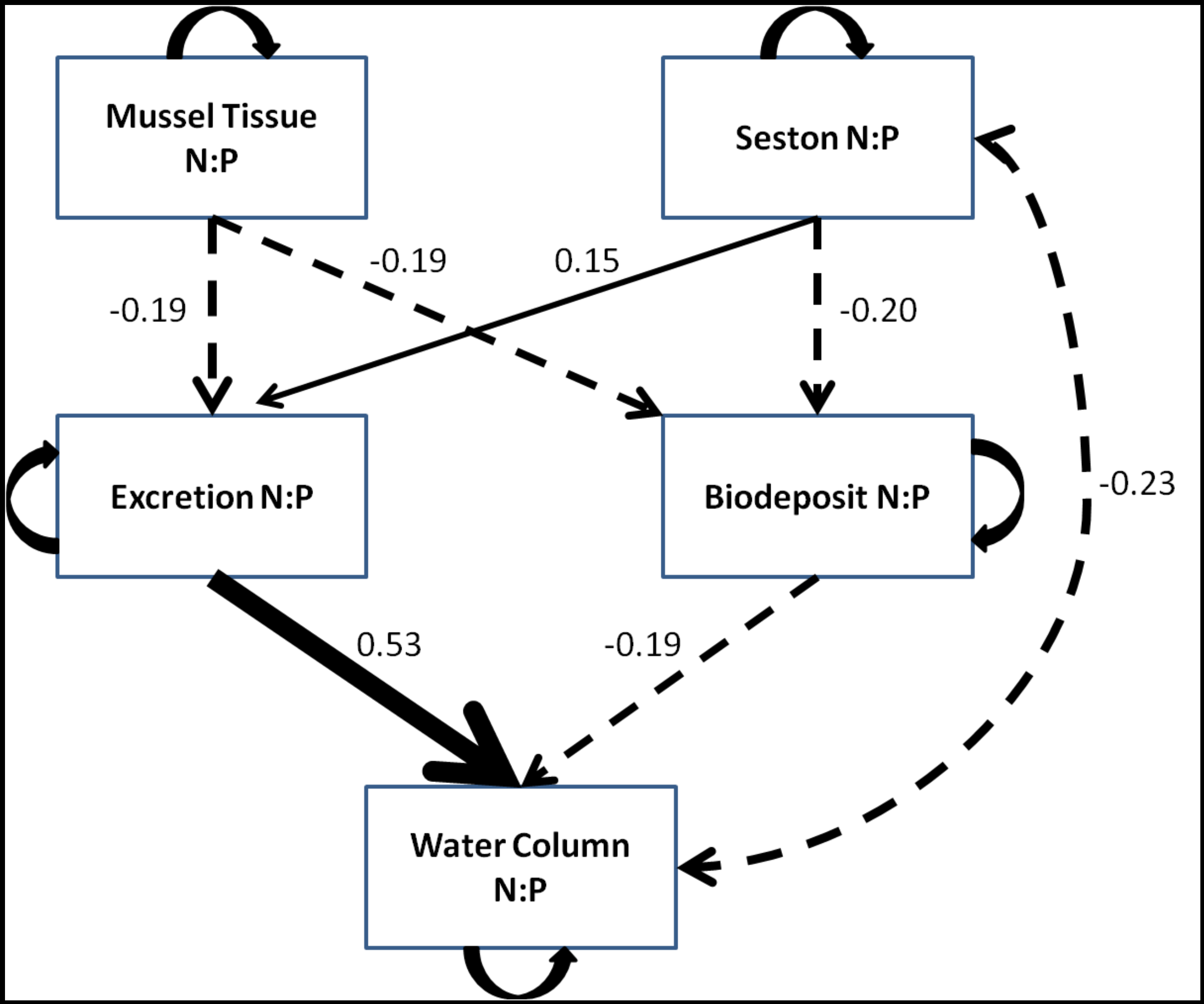


On average, **mussels increase N:P by 11.73 ± 1.3**

- Based on my excretion experiments

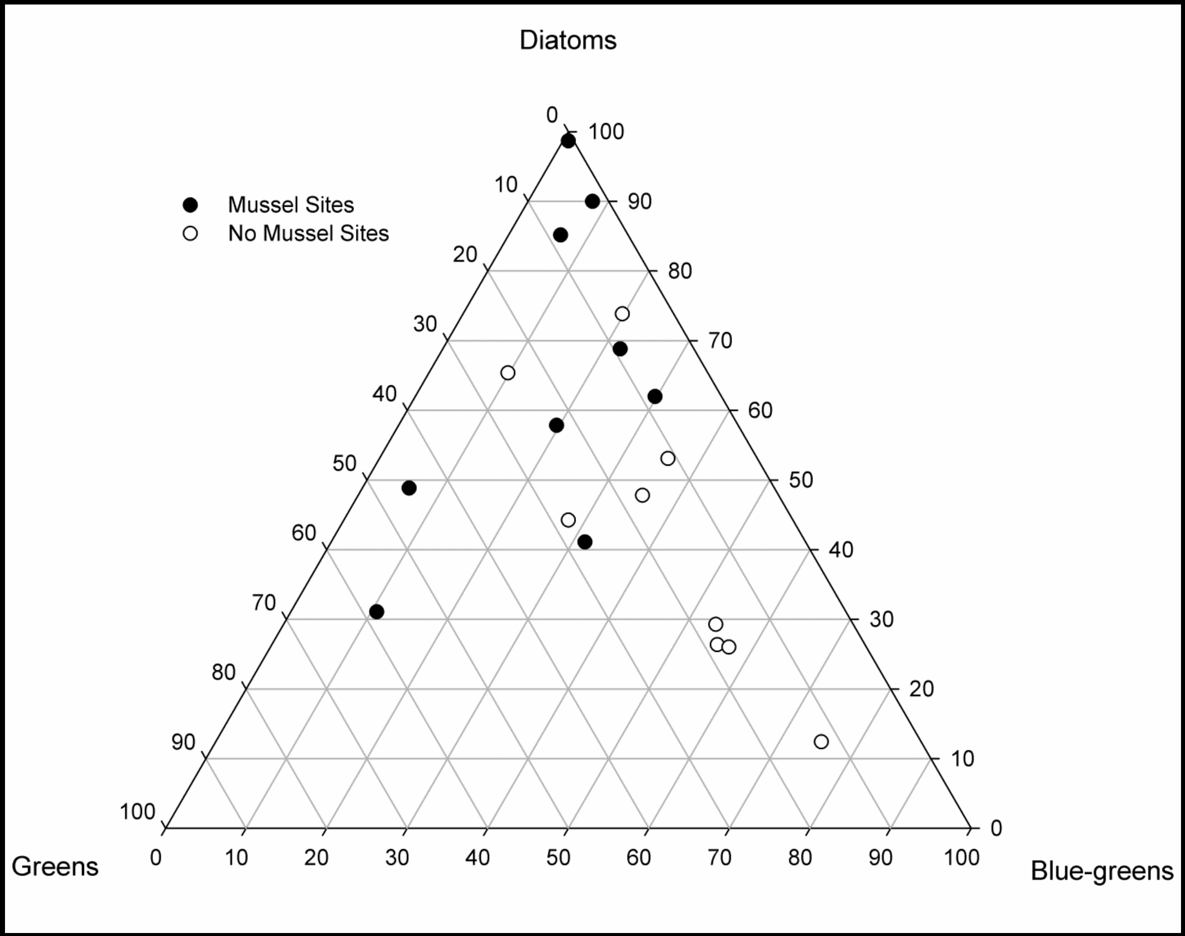
Path Analysis – just with the data from the mussel sites

Model Chisquare = 3.7156 Df = 3
Pr(>Chisq) = 0.29386
Goodness-of-fit index = 0.97884

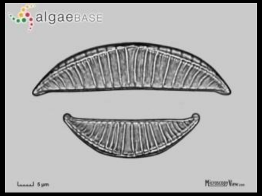


C:N -> similar results

Differences in Periphyton Functional Group Representation



- Non-mussel / N-limited sites tended to have higher abundances of blue-greens (significant t-test; $p < 0.005$)
  - Some non-mussel sites had N-fixing diatoms – *Epithemia spp.*



Dependent on stream and site type

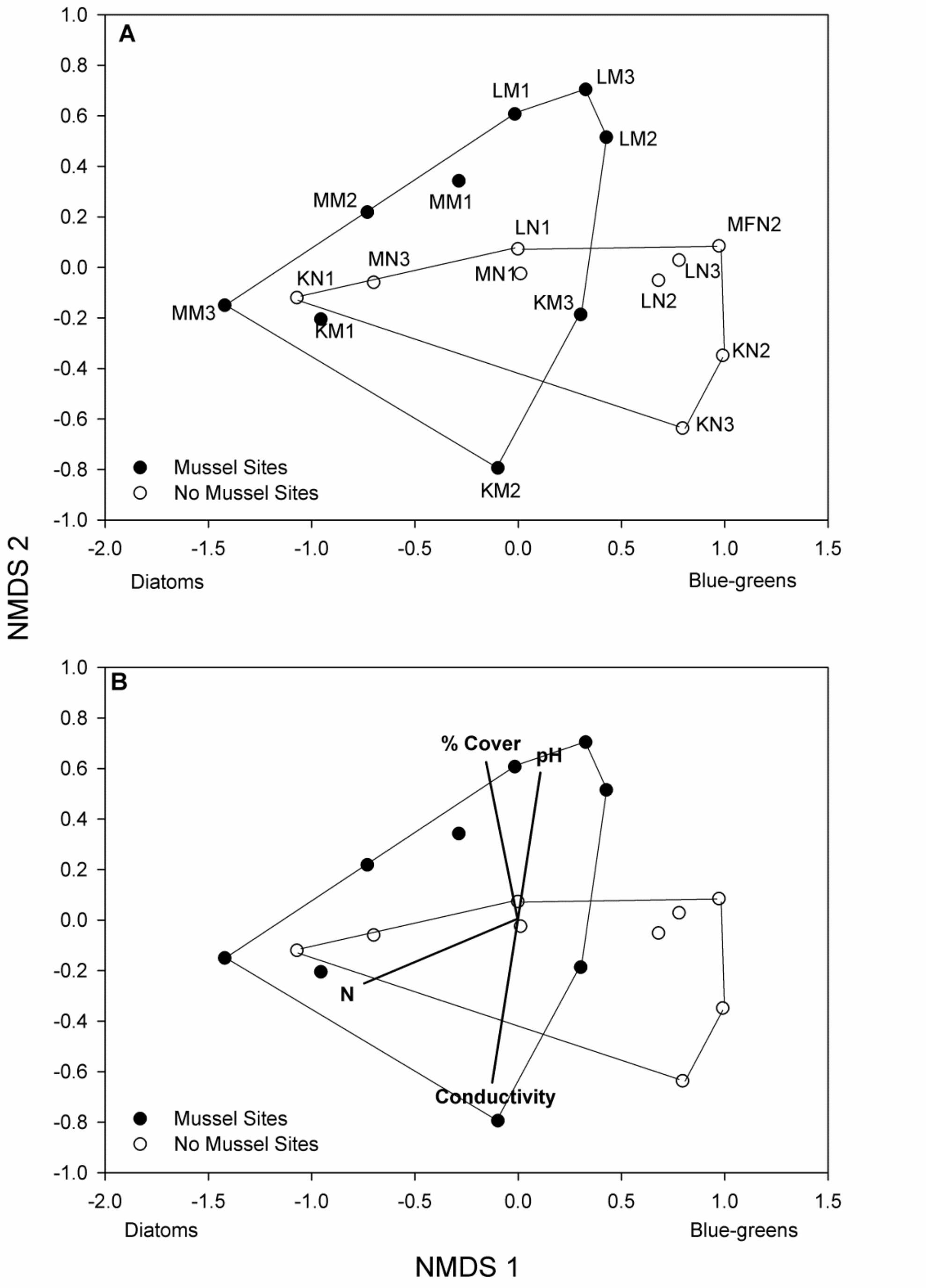
-Based on identification to genus

-NMDS uses species-occurrence data alone to identify the axes that best explain variation

-Convex hulls added to show partitioning between site types

-Joint plots placed over NMDS ordination to investigate environmental drivers.

PerMANOVA – River ($p = 0.002$), Mussel ($p = 0.48$), interaction ($p = 0.04$)



Implications and Next Steps….

- Interception of nutrients moving downstream – altering availability through translocation
- Alter nutrients limiting algae growth
- Alter algae species composition
- Next -
  - What is the contribution of mussels to nutrient demand?
  - What is the impact of die-offs?

Areal Excretion Comparison

- Mussels (this study)
  - N: 94 – 440 μmol N m^{-2} hr^{-1}
  - P: 10.35 – 35.5 μmol P m^{-2} hr^{-1}

- Invasive Snails (Hall et al. 2003 – *Frontiers in Ecology & the Environment*)
  - N: 557.14 μmol N m^{-2} hr^{-1}

- Fish (McIntyre et al. 2008 - *Ecology*)
  - N: 97.5 μmol N m^{-2} hr^{-1}
  - P: 3.1 μmol P m^{-2} hr^{-1}

- Shrimp (Benstead et al. 2010 – *Freshwater Biology*)
  - N: 0.26 – 37.5 μmol N m^{-2} hr^{-1}
  - P: 0.015 – 1.1 μmol P m^{-2} hr^{-1}

Drought and Heat

Further Research

- Nutrient uptake experiments -> demand
- Pre (2010) and Post (2012) Drought
- Example from a Little River site:
  - Change in areal excretion rates – loss of 102.3 μmol N hr^{-1} m^{-2} & 10.1 μmol P hr^{-1} m^{-2}
  - Change in nutrient storage – loss 52.1 kg of N storage & 18.8 kg of P storage
- Hypothesize species composition shifts due to thermal tolerance (Spooner and Vaughn 2008)
  - Context dependent

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ANY QUESTIONS?

"Mussels are not dismissible, even by those who have little interest in the natural world. Their presence is a signature of healthy aquatic ecosystems, to which they contribute as living water filters."

- E.O. Wilson