

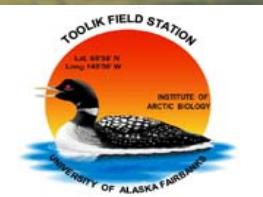
The Different Responses of Arctic Terrestrial and Aquatic Food Webs to Long-term Nutrient Additions

John C. Moore

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Stephanie Parker, Yamina Pressler, Gus Shaver, and Rodney
Simpson*

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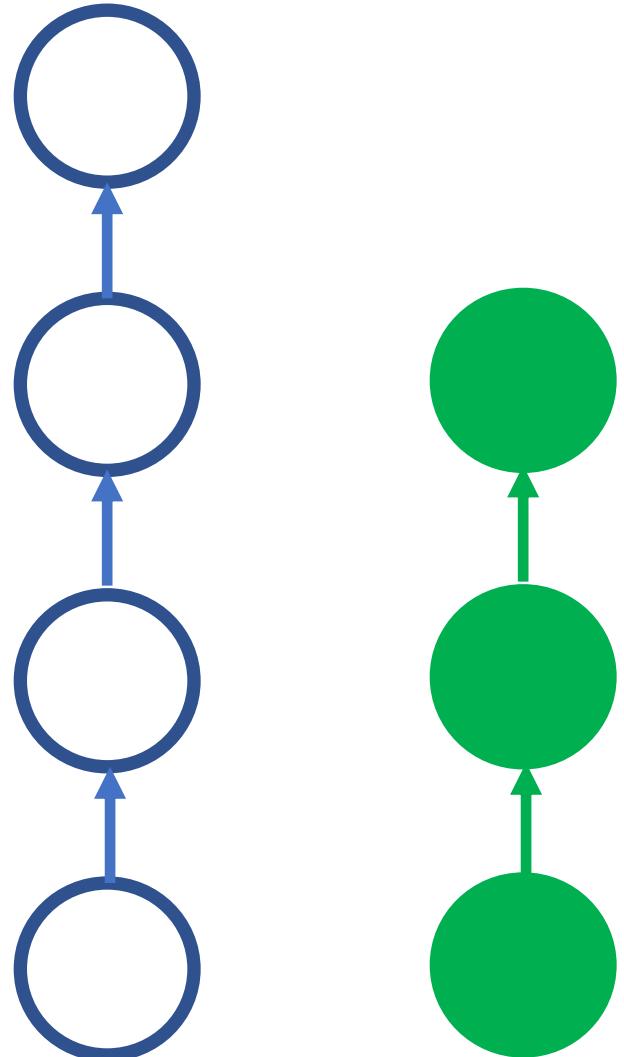
Objectives

Compare the **structure, C and N flux, and dynamics** of food webs within and across aquatic and terrestrial arctic ecosystems

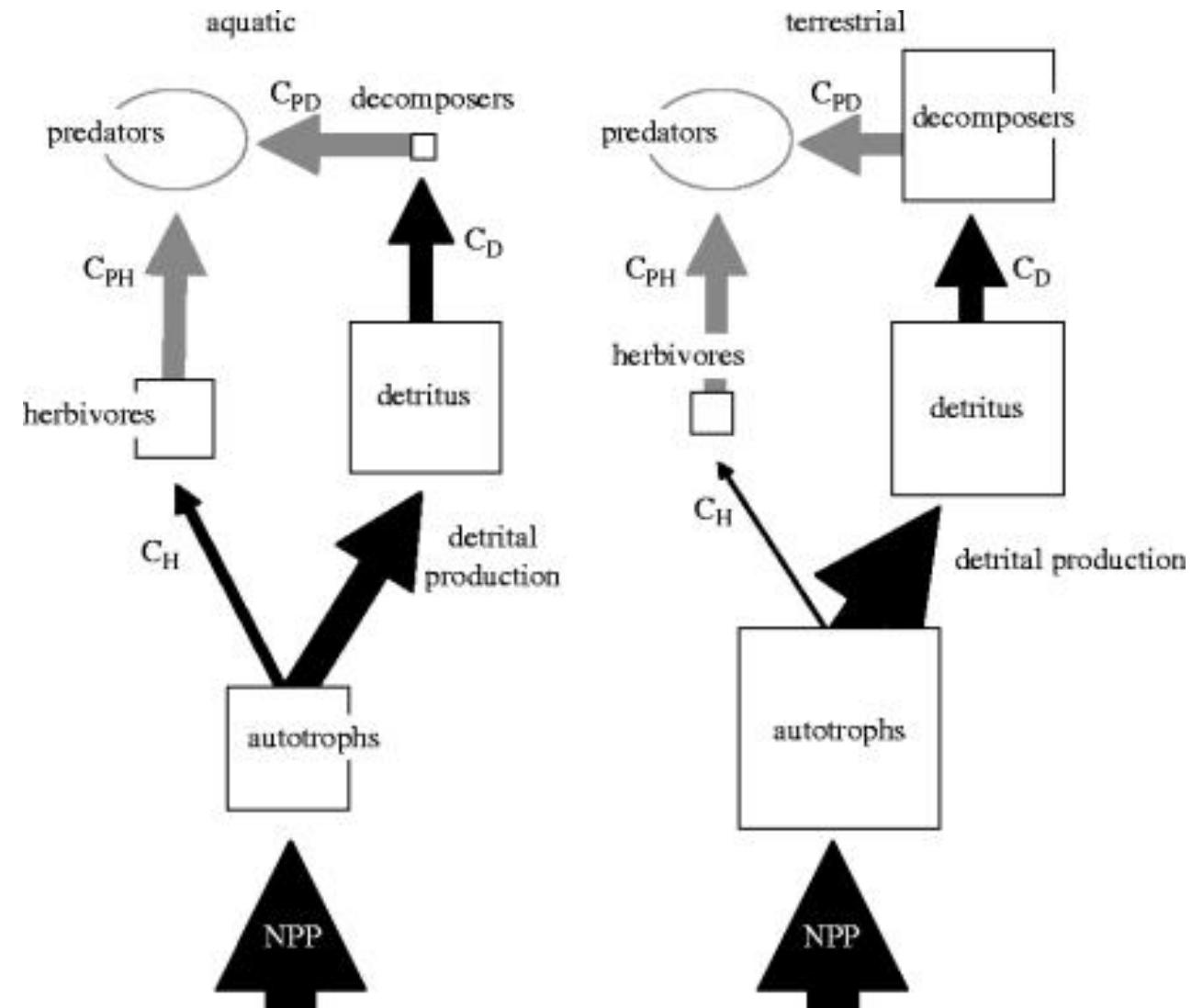
Terrestrial vs. Aquatic

Arctic Ecosystems

Trophic Structure



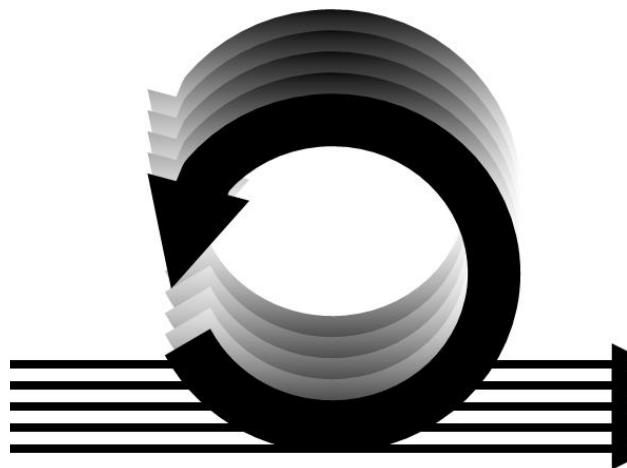
C and N Cycling



Shurin et al. (2006)

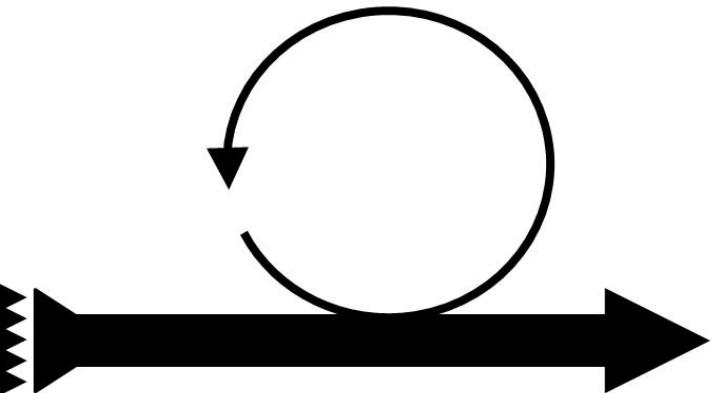


Terrestrial



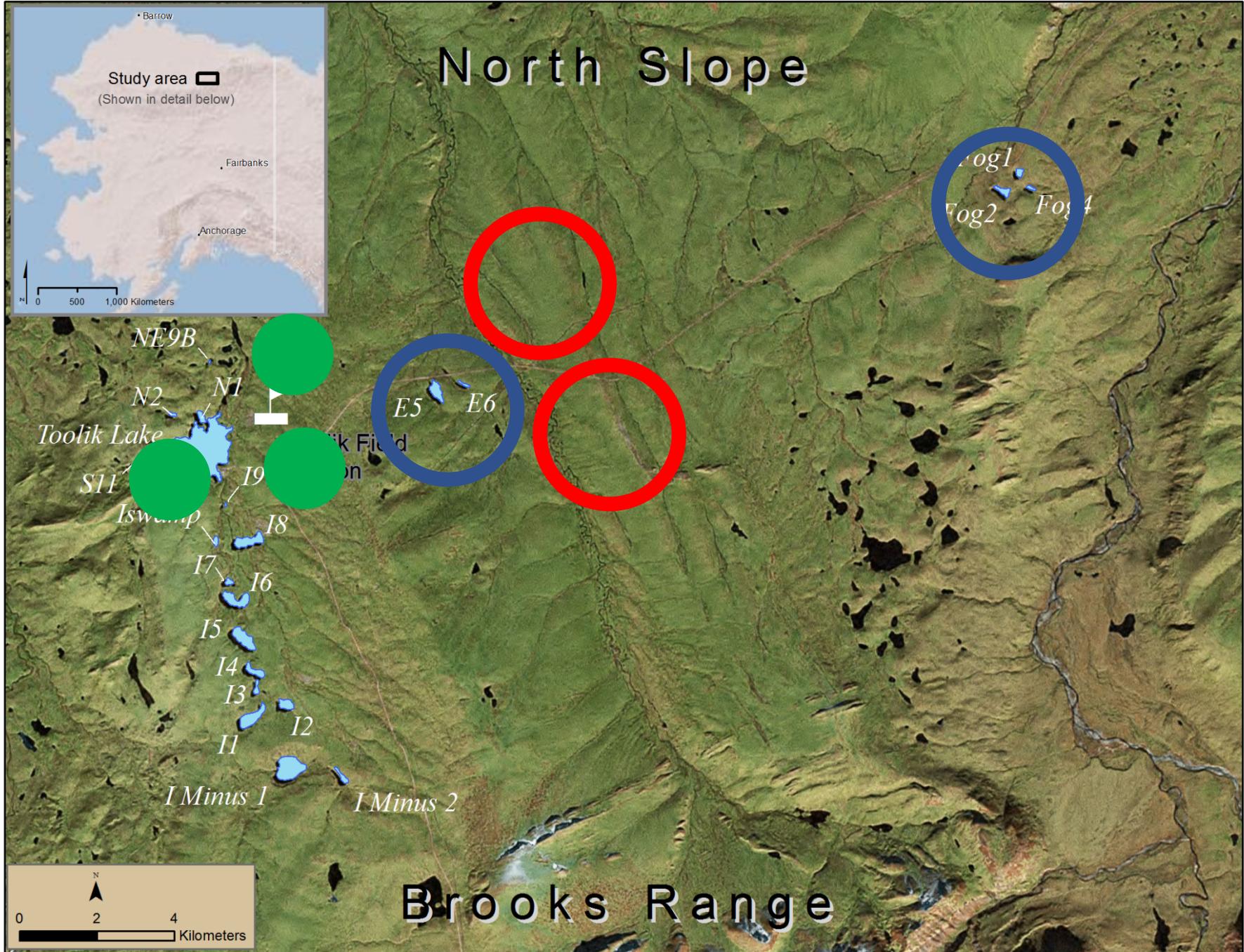
Each patch of the terrestrial landscape accumulates the nutrients upon which it relies over 1000s of years and leaks only a small fraction of these nutrients downslope each year.

Aquatic

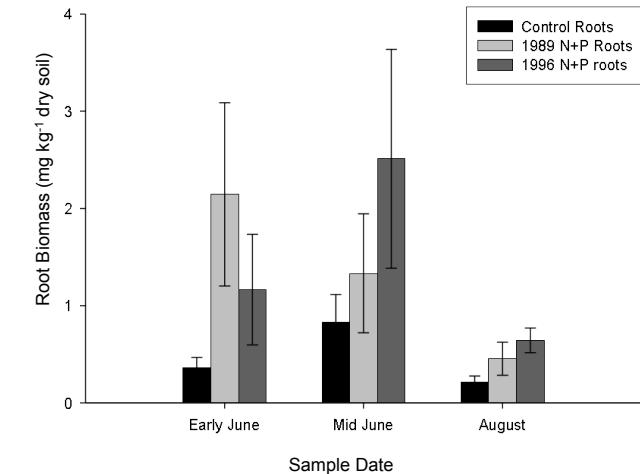
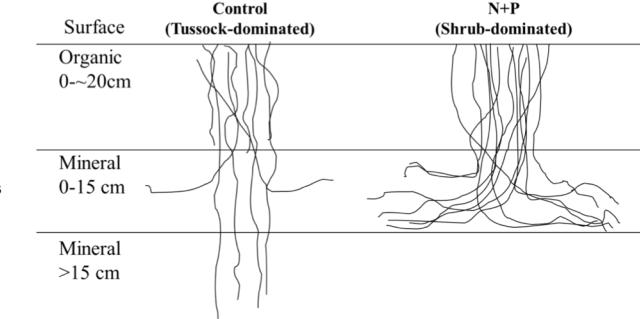
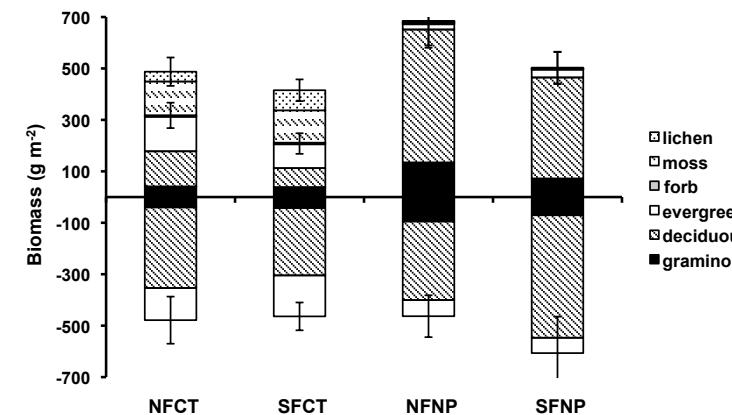


Each stream reach relies upon this slow leakage of nutrients from terrestrial ecosystems accumulated over 1000s of m² of the terrestrial landscape and most of these nutrients pass through the ecosystem.

The stream is strongly connected to the terrestrial landscape.



Terrestrial Response

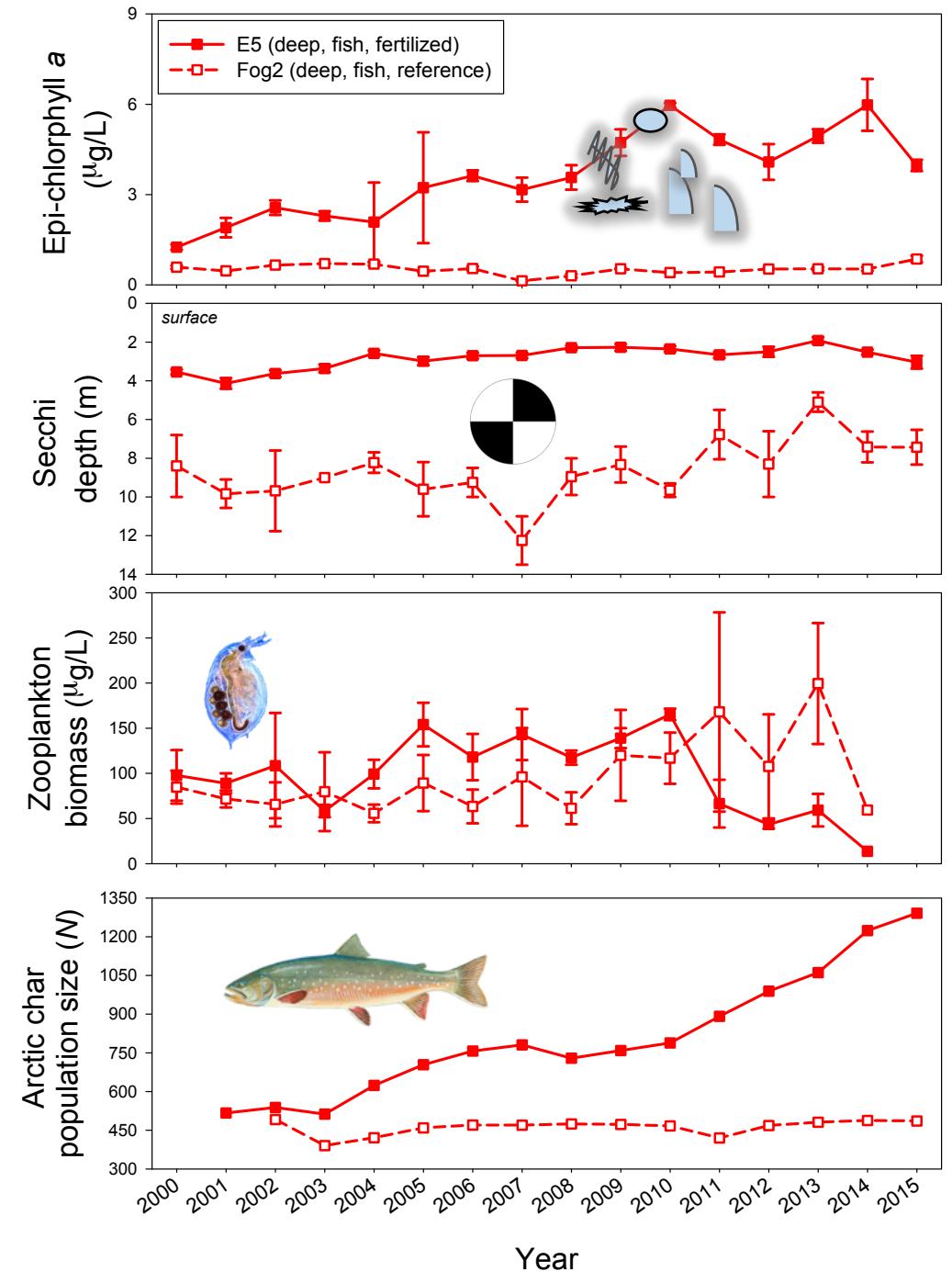


- Change in Plant Community Structure
- Increase in Plant Production
- Altered Tissue Quality

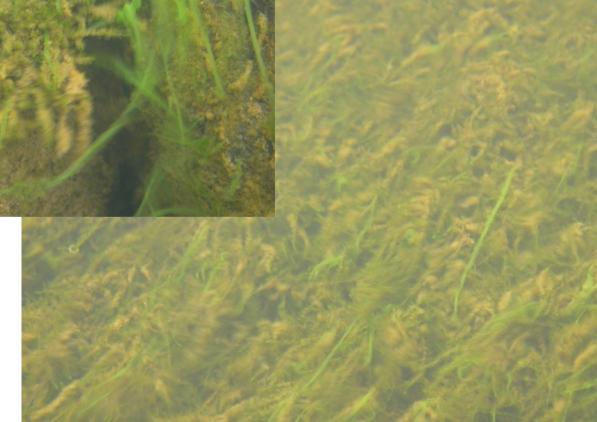
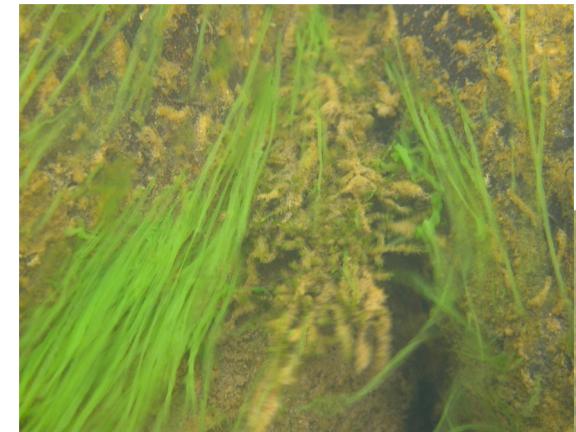
Lake Response



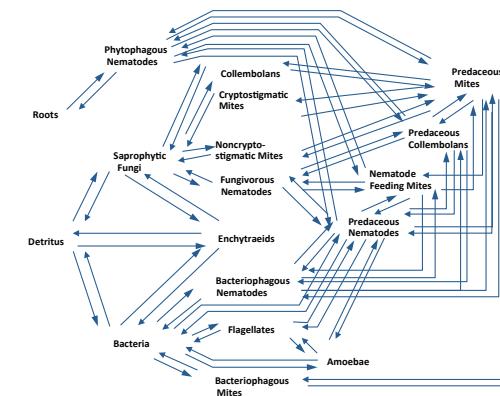
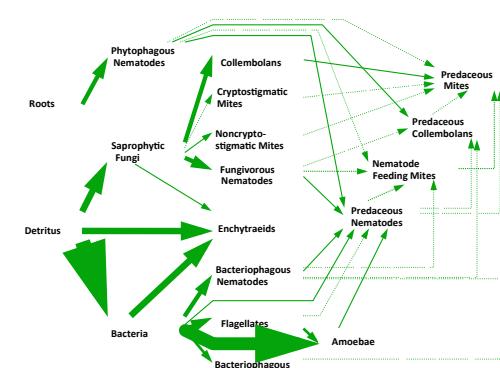
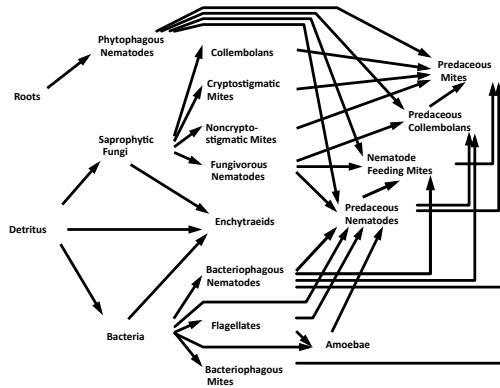
- Increase in Phytoplankton Production
- Increase in Arctic Char Population



Stream Response



- Increase in the diversity and abundance of primary producers
- Increase in detritus



Connectance

C

S

FCL

imax

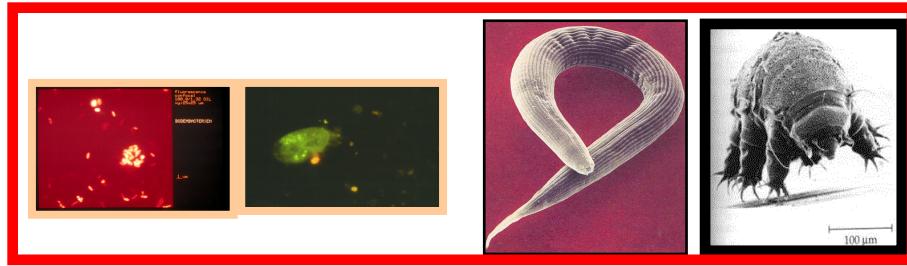
Energy Flux

Trophic Interactions

C and N Mineralization

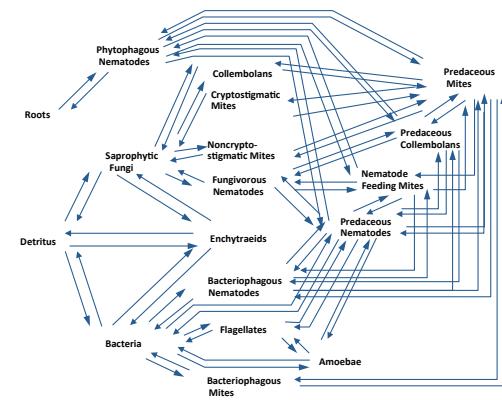
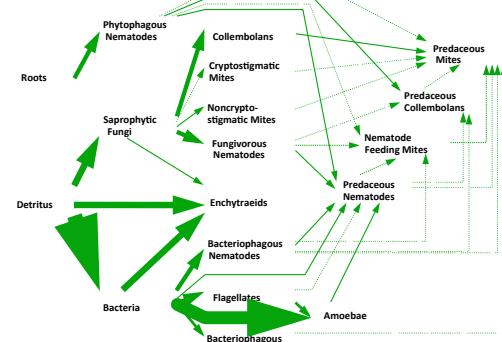
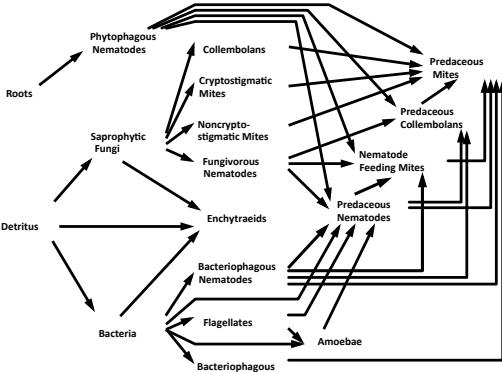
Functional

Jacobian Matrix
Stability
Return-Time



Niche-Based Functional Groups

Food Source
Feeding Mode
Habitat
Life History



Connectance

C

S

FCL

imax

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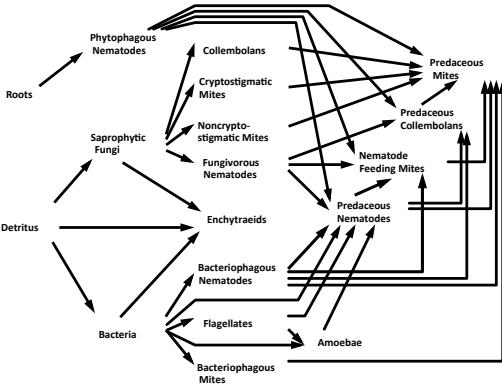
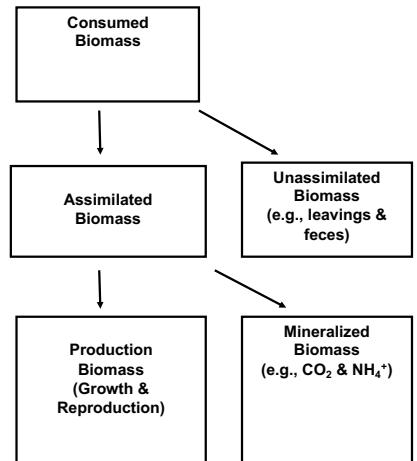
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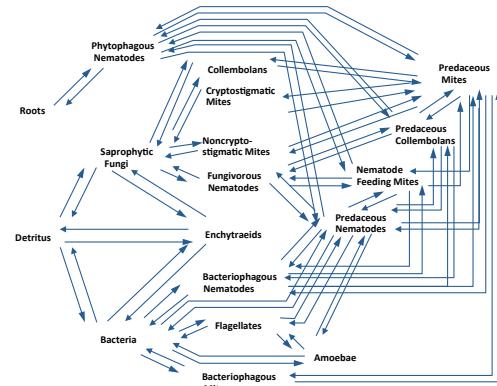
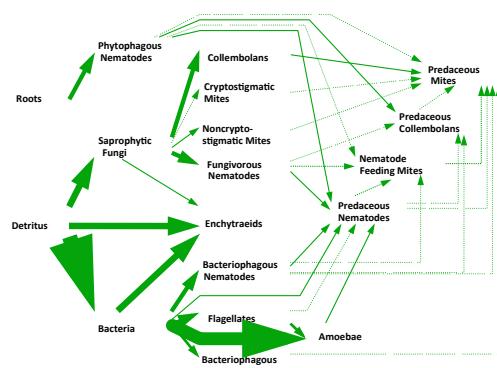


$$F_j = \frac{d_j B_j + M_j}{a_j p_j}$$

Prey_i → *Predator_j*

B_i

B_j





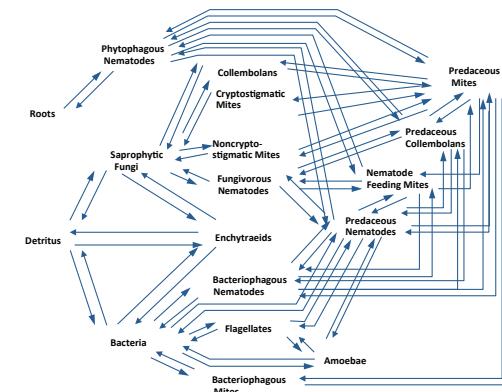
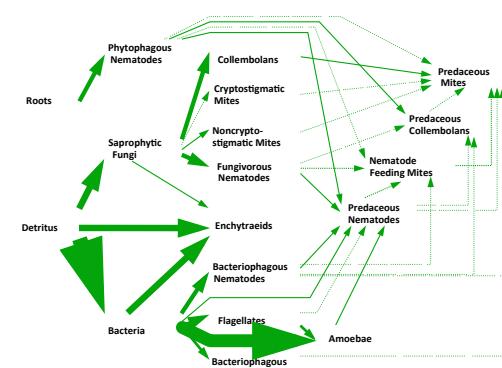
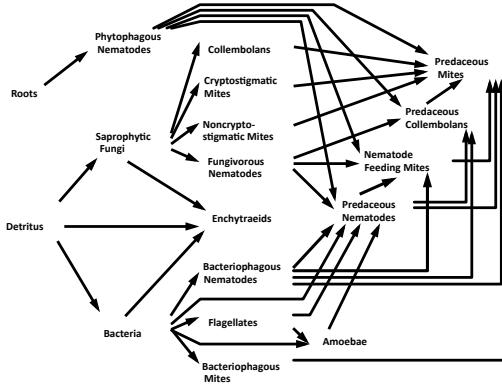
ODE – based dynamics of a population

$$X_i = r_i X_i - \sum_j c_{ij} X_i X_j$$

$$X_j = -d_j X_j - \sum_k c_{jk} X_j X_k + e_j \sum_i c_{ij} X_i X_j$$

$$\begin{bmatrix} \alpha_{11} = -c_{11} X_1^* & \alpha_{12} = -c_{12} X_1^* \\ \alpha_{21} = a_2 p_2 c_{12} X_2^* & \alpha_{22} = 0 \end{bmatrix}$$

$$\lambda_{\max} = \frac{\alpha_{11} + \sqrt{\alpha_{11}^2 + 4\alpha_{12}\alpha_{21}}}{2}$$



Connectance

C

S

FCL

imax

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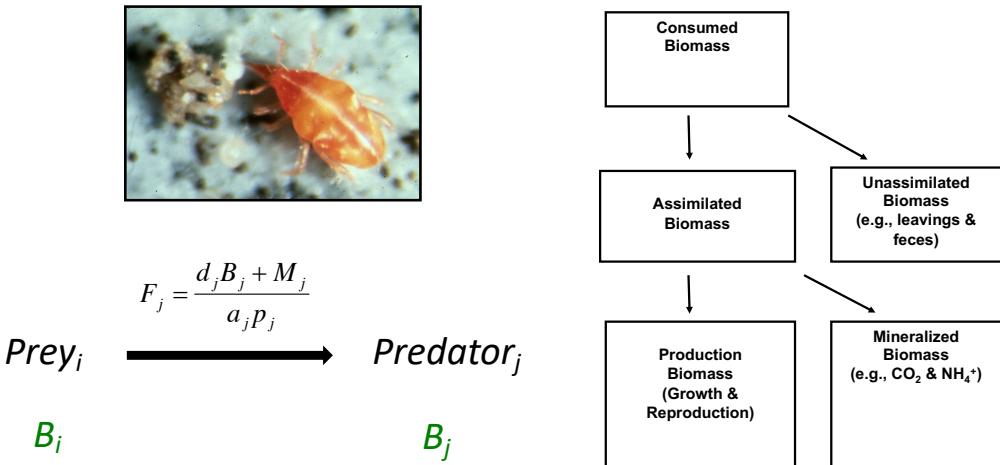
Energy Flux

Trophic Interactions

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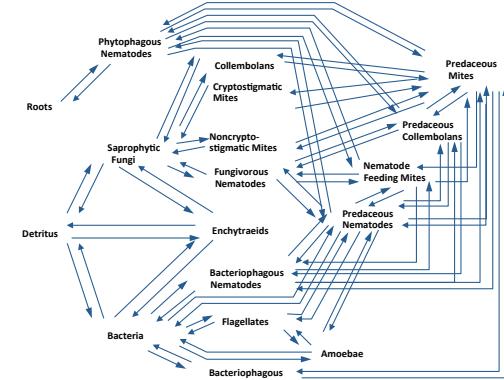
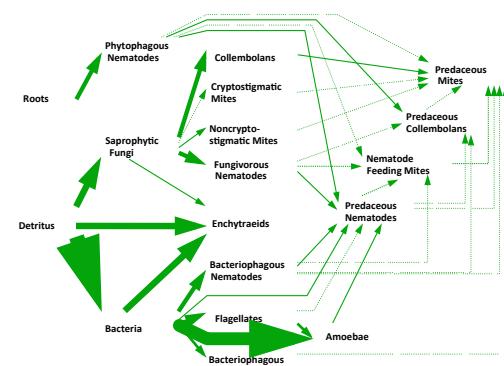
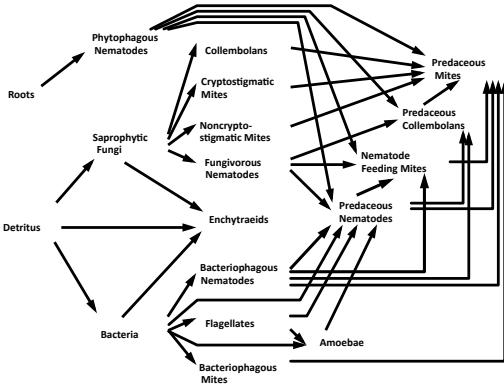
ODE – based dynamics of a population :

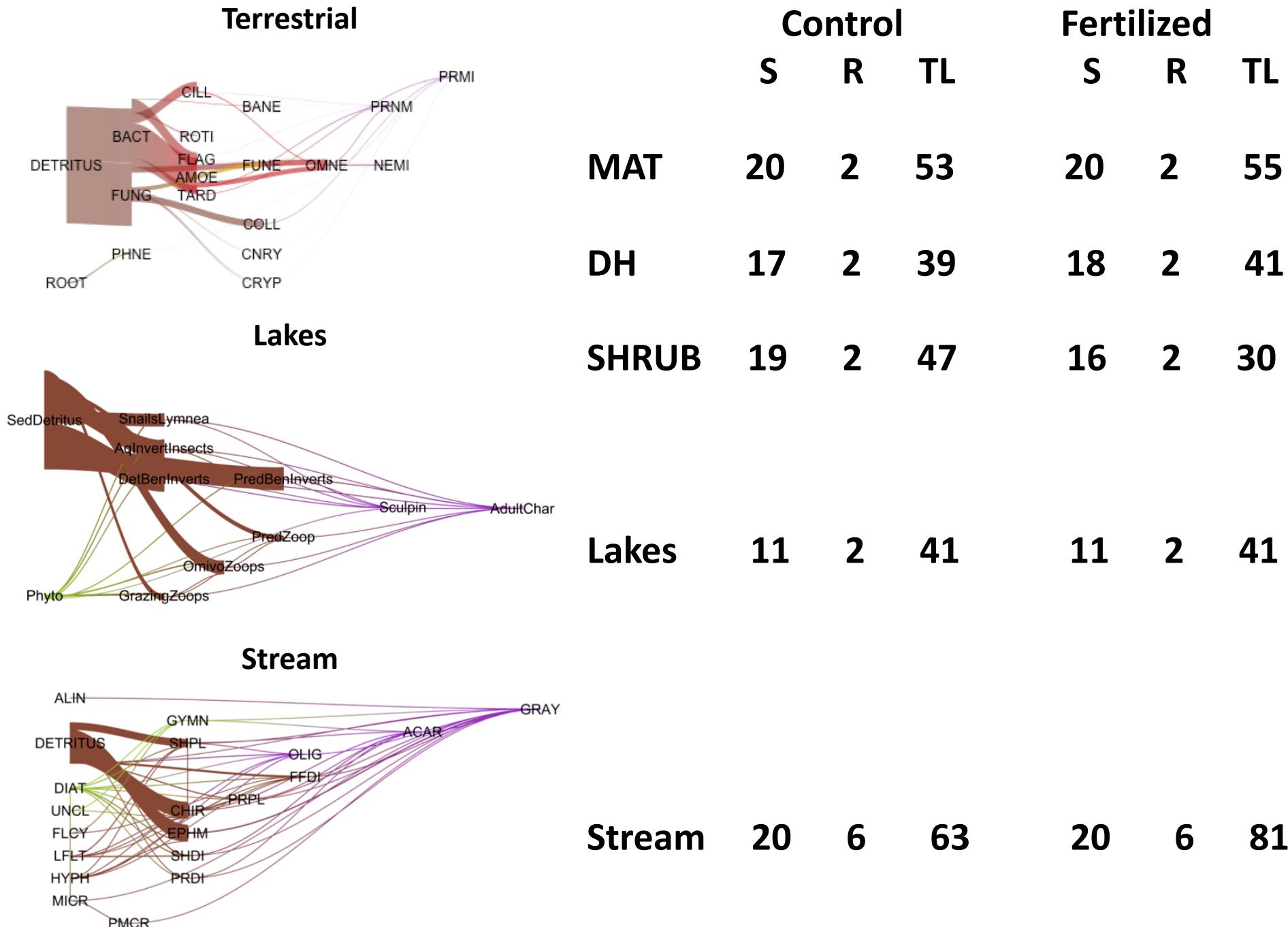
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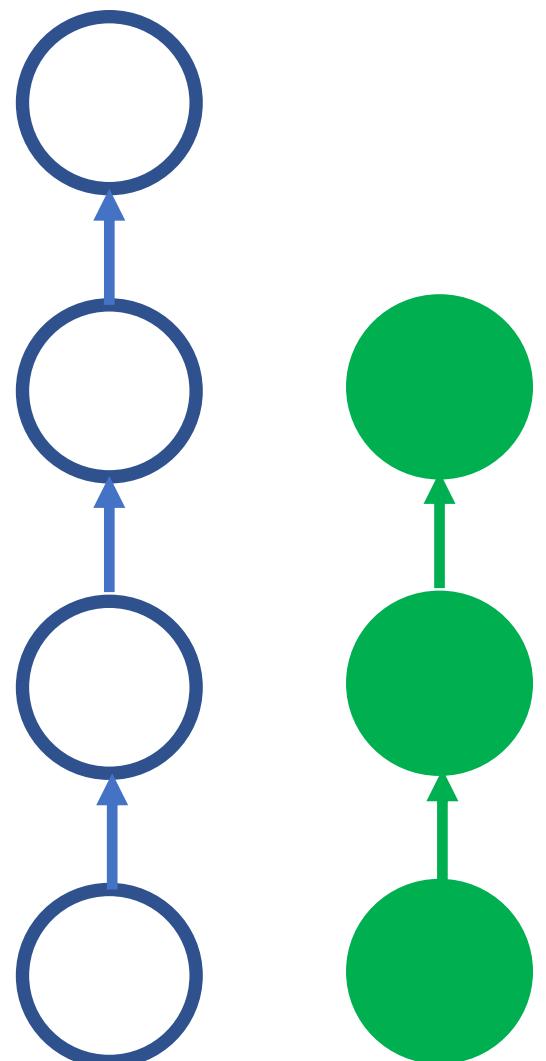
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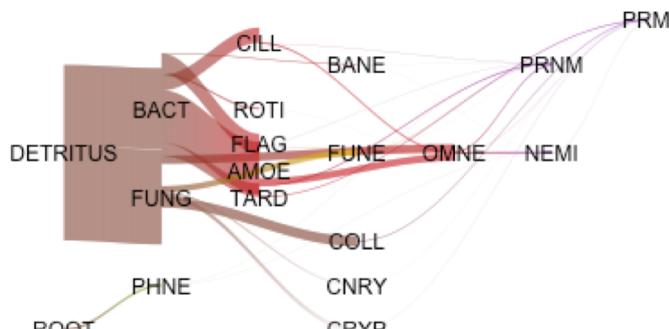




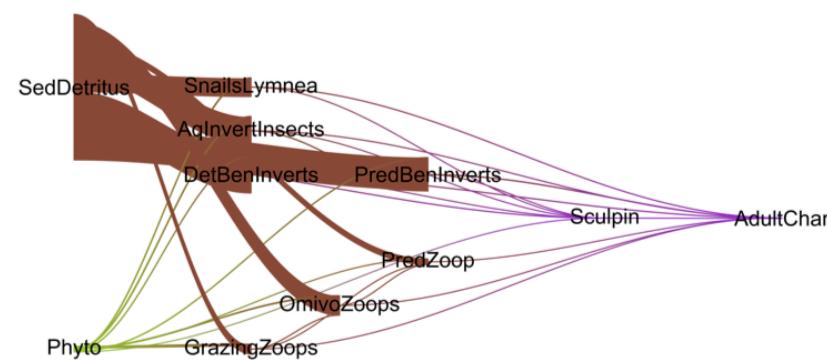
Food Chains



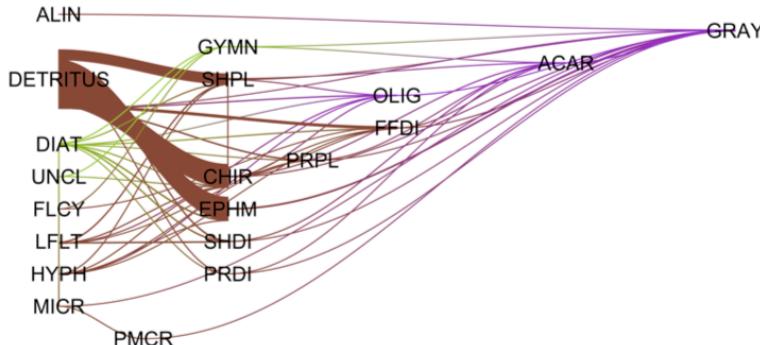
Terrestrial



Lakes



Stream



Control

Mean Max

MAT

5.66

9

Fertilized

Mean Max

5.75

9

DH

4.97

8

SHRUB

5.34

9

Lakes

3.5

6

3.87

7

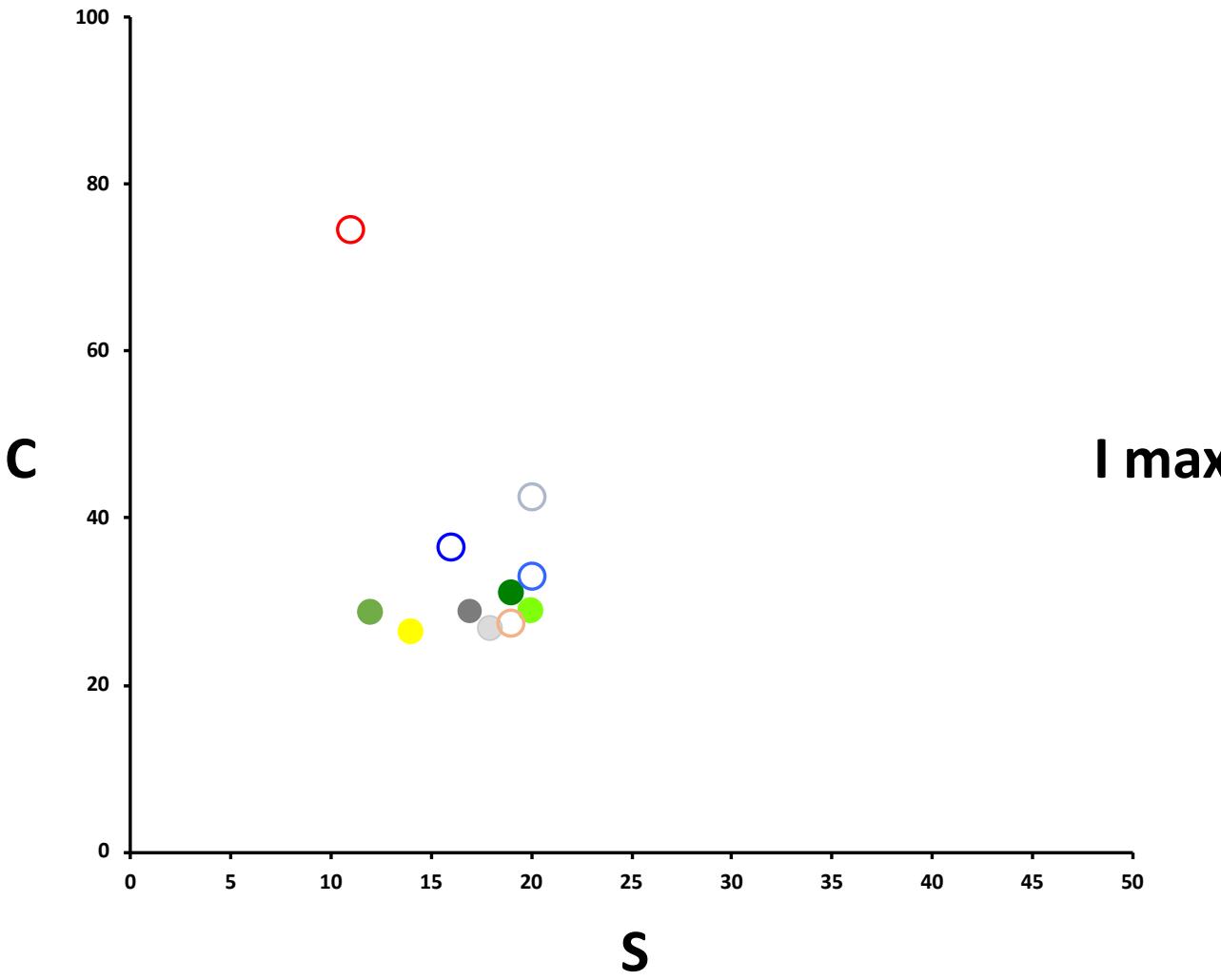
Stream

3.23

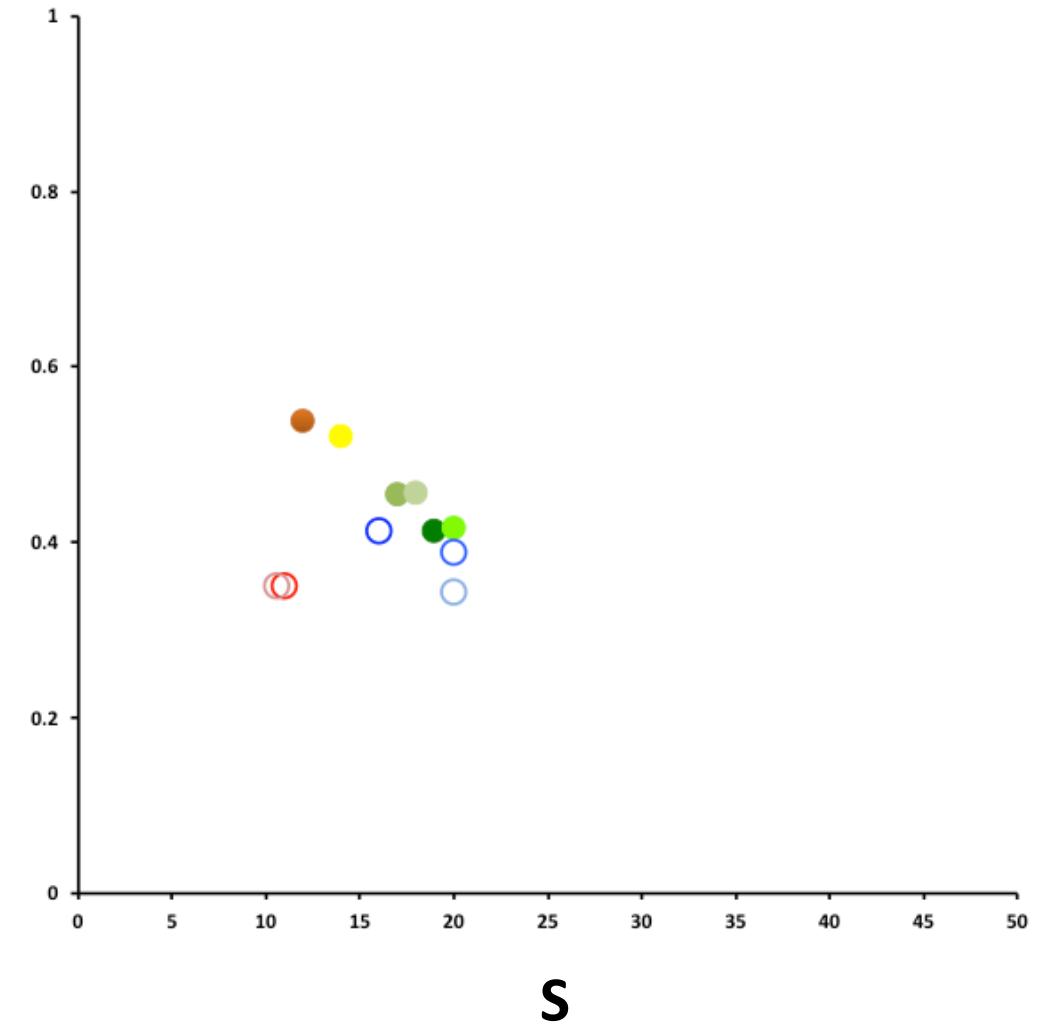
6

3.87

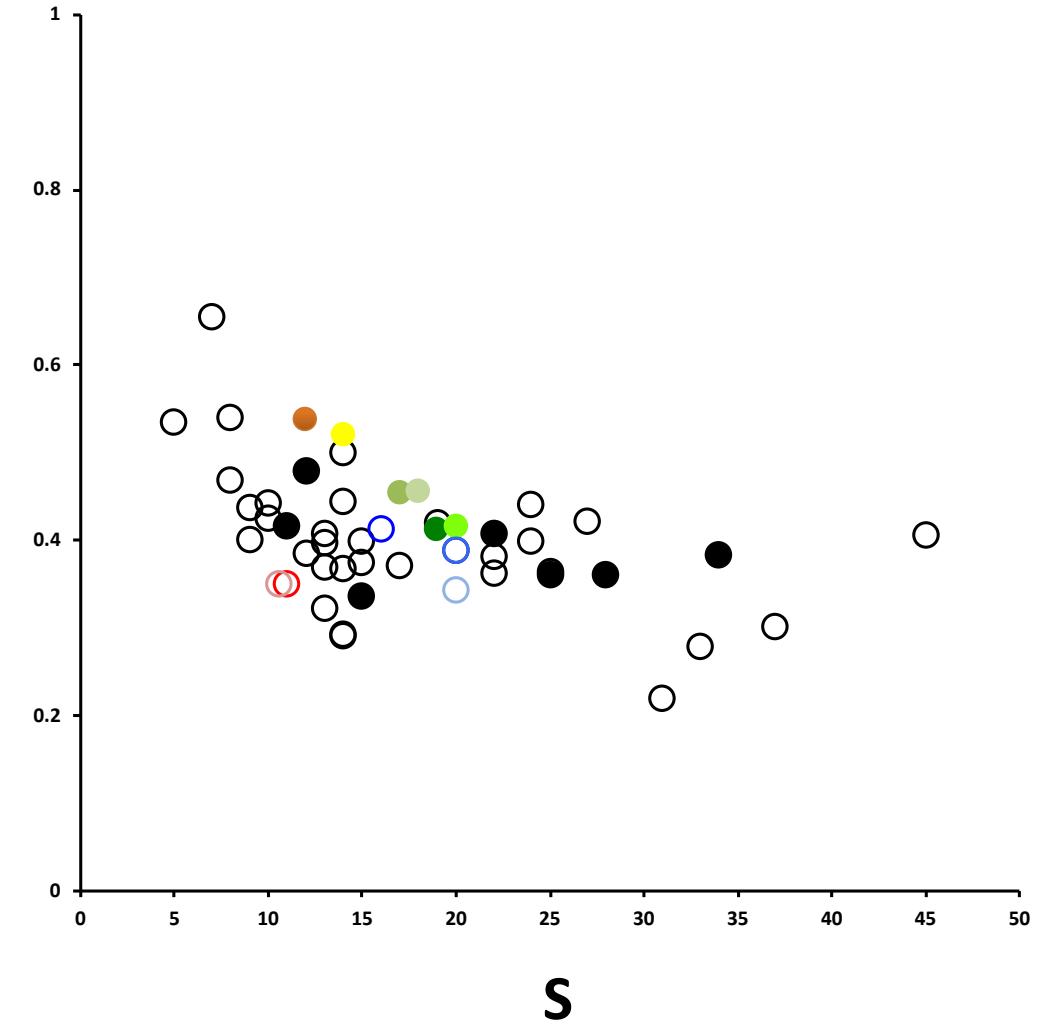
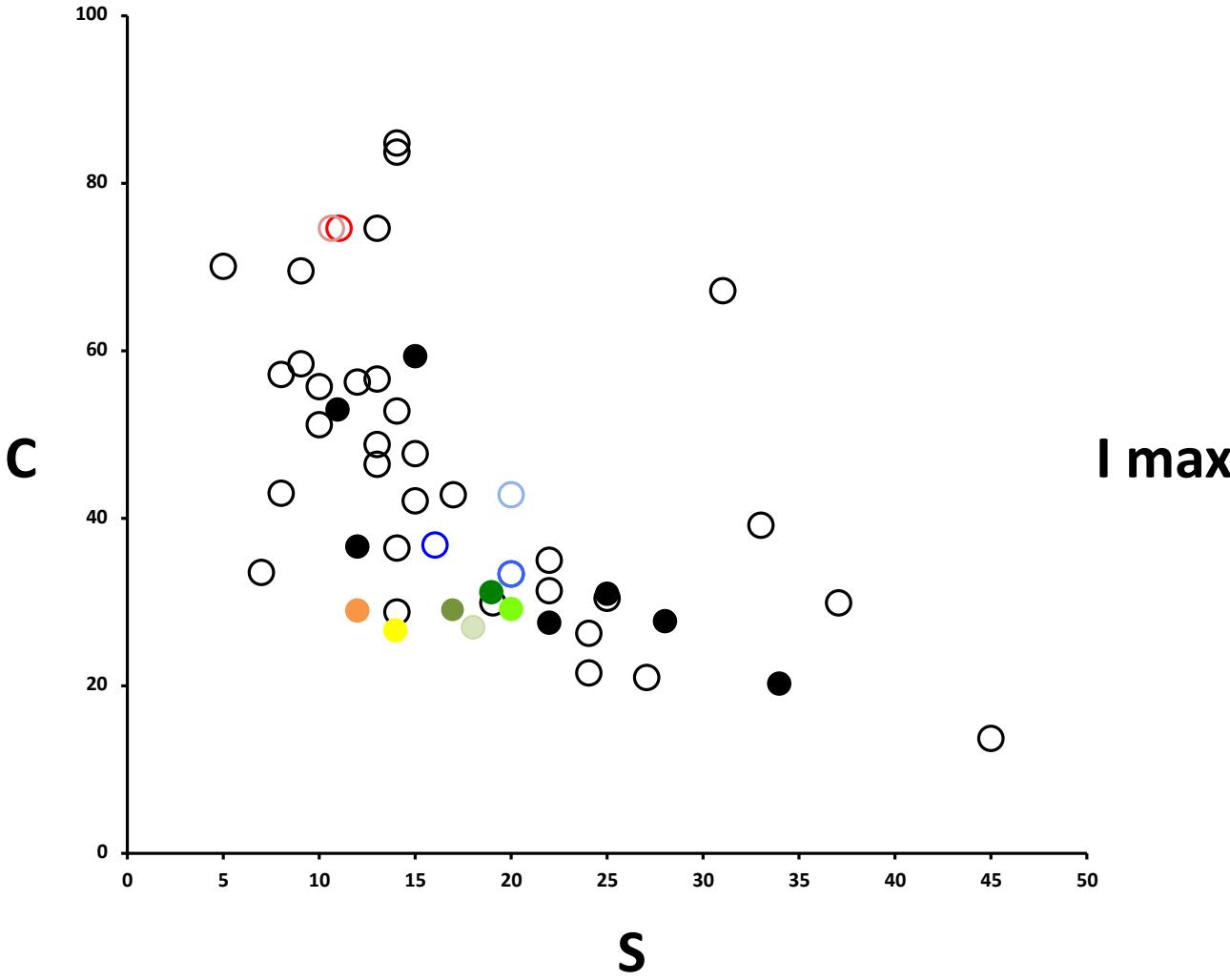
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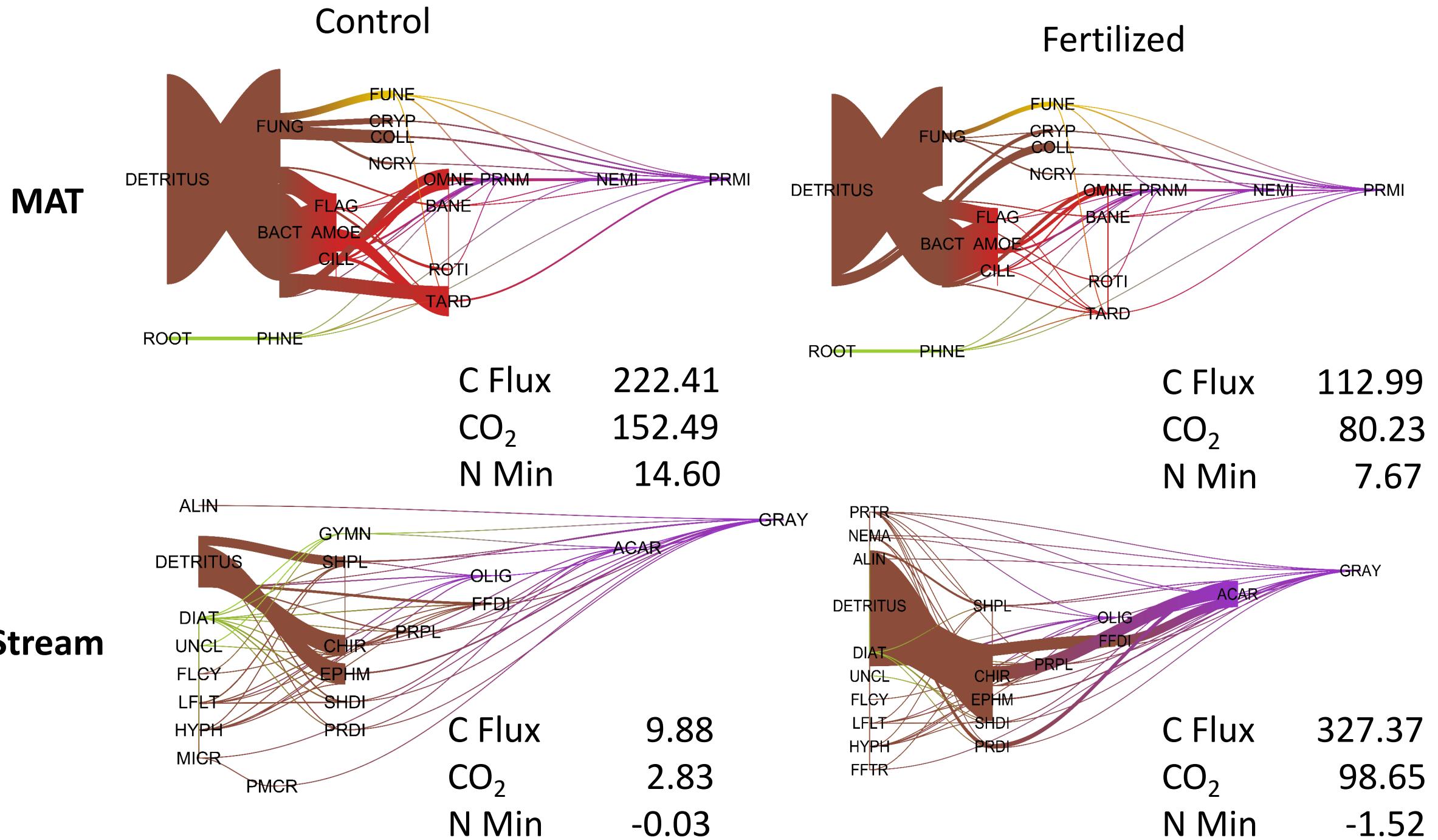
I max



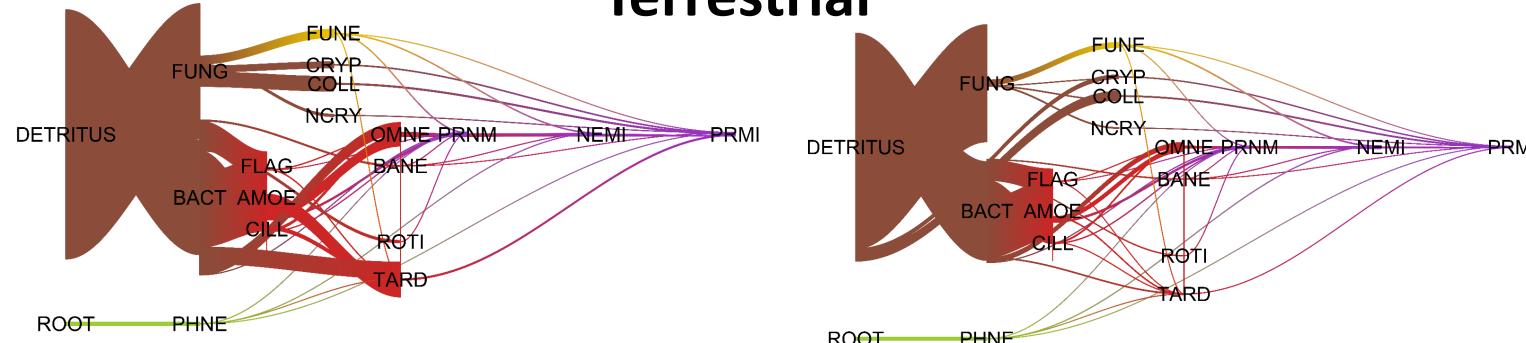
- Terrestrial and Aquatic Webs do not differ in terms of functional diversity
- Webs differ in terms of complexity and stability



**Arctic Webs follow similar patterns to other webs
in terms of structure, complexity and stability**



Terrestrial

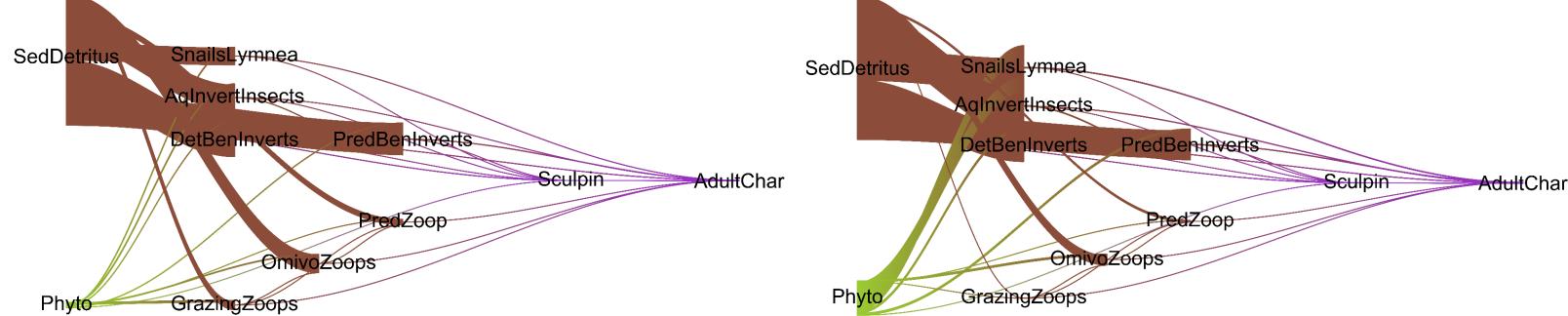


C CO₂ N_{min}

MAT .51 .53 .52

DH .93 .70 .64

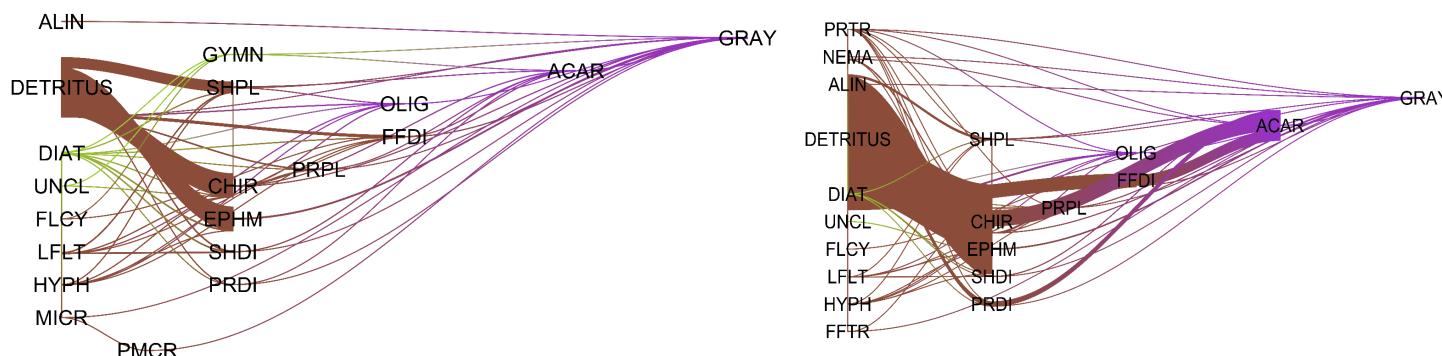
Lakes



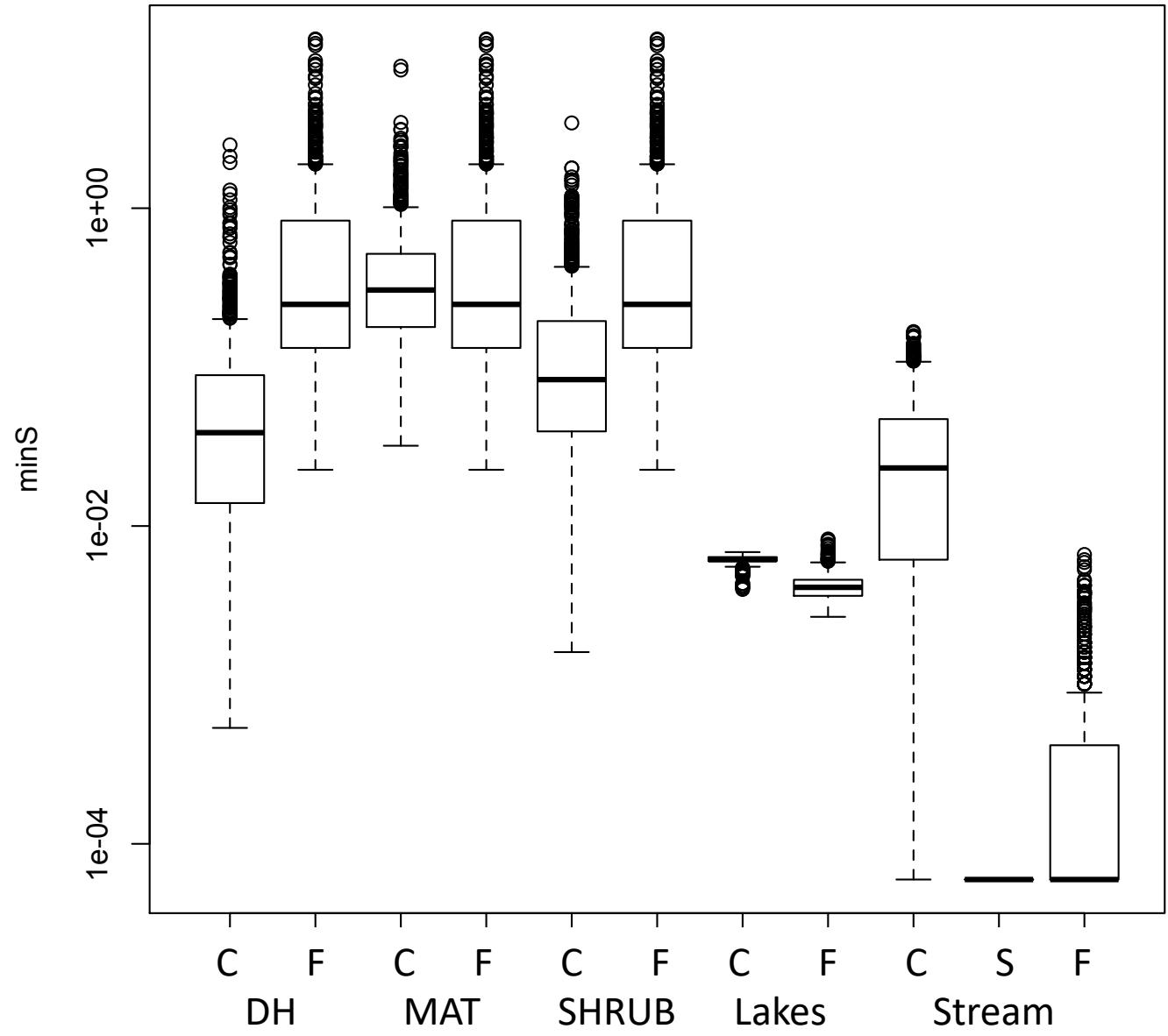
SHRUB .49 .52 .56

Lakes 1.73 1.60 1.22*

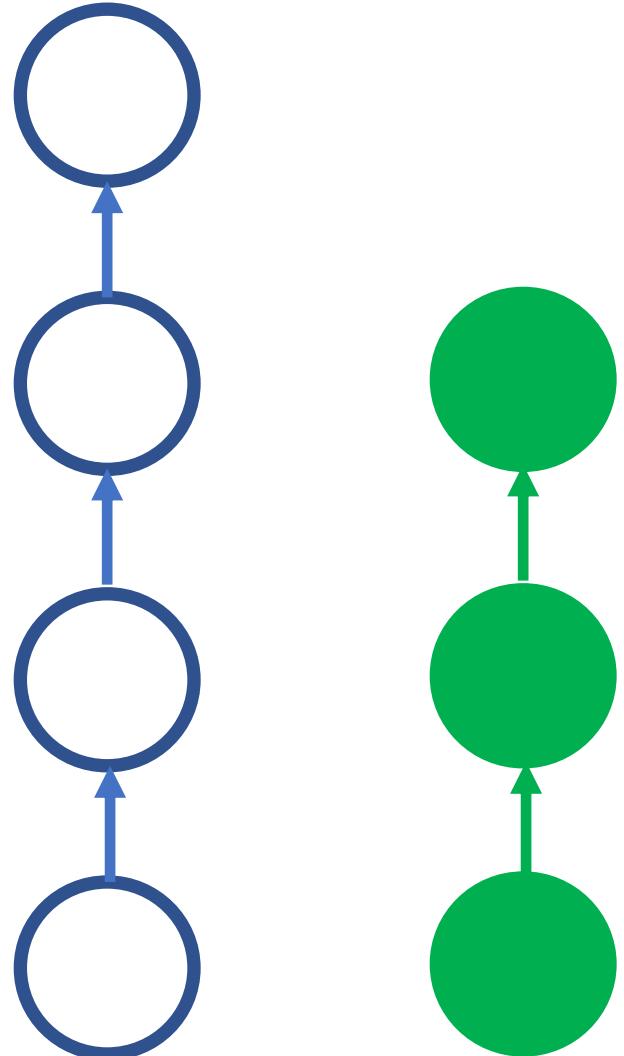
Streams



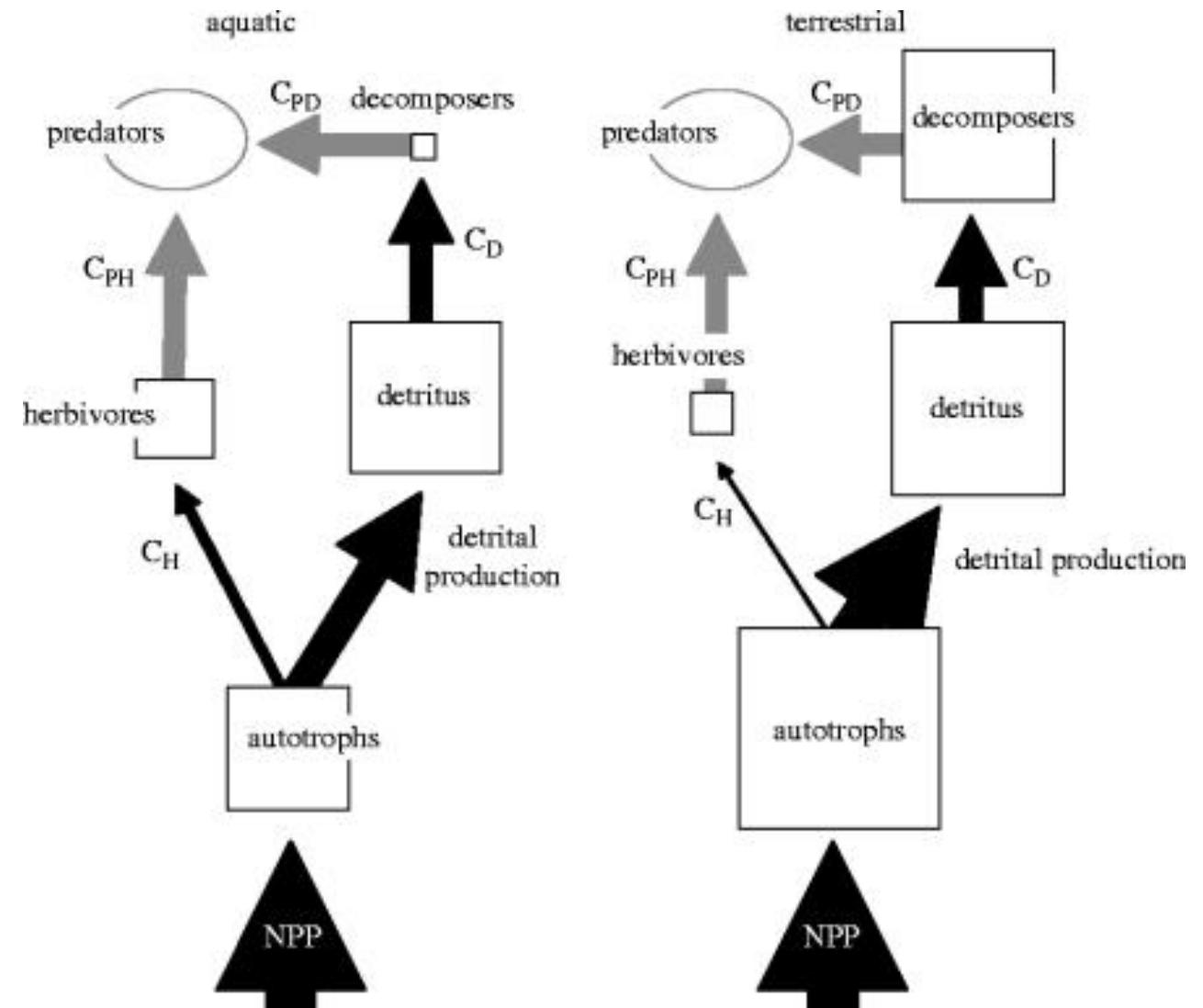
Streams 33.13 34.86 50.67*



Trophic Structure



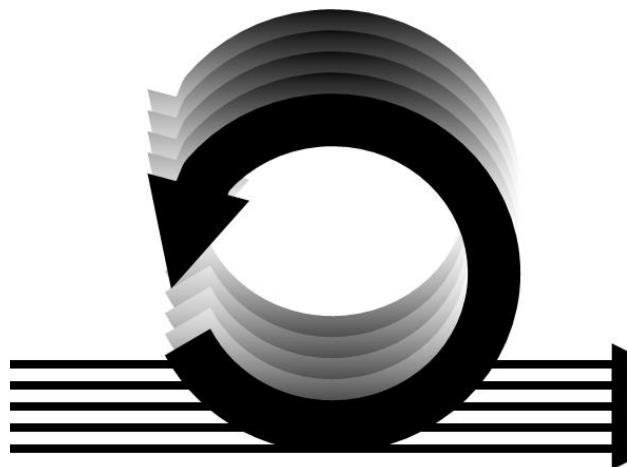
C and N Cycling



Shurin et al. (2006)

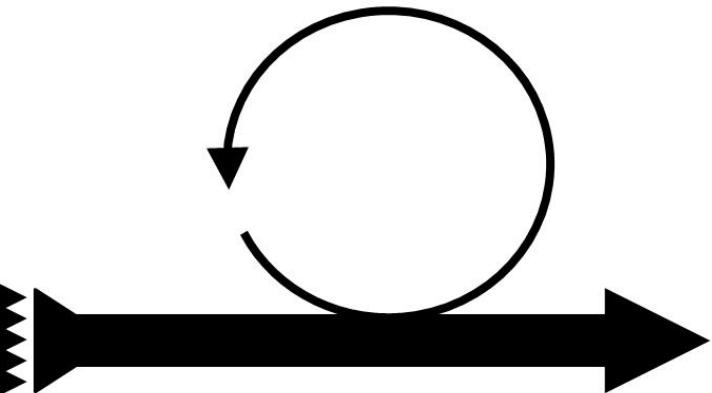


Terrestrial



Each patch of the terrestrial landscape accumulates the nutrients upon which it relies over 1000s of years and leaks only a small fraction of these nutrients downslope each year.

Aquatic



Each stream reach relies upon this slow leakage of nutrients from terrestrial ecosystems accumulated over 1000s of m² of the terrestrial landscape and most of these nutrients pass through the ecosystem.

The stream is strongly connected to the terrestrial landscape.

Questions?

