Threshold elemental ratios: a mechanistic explanation for threshold declines in stream detritivorous insect species with nutrient enrichment?

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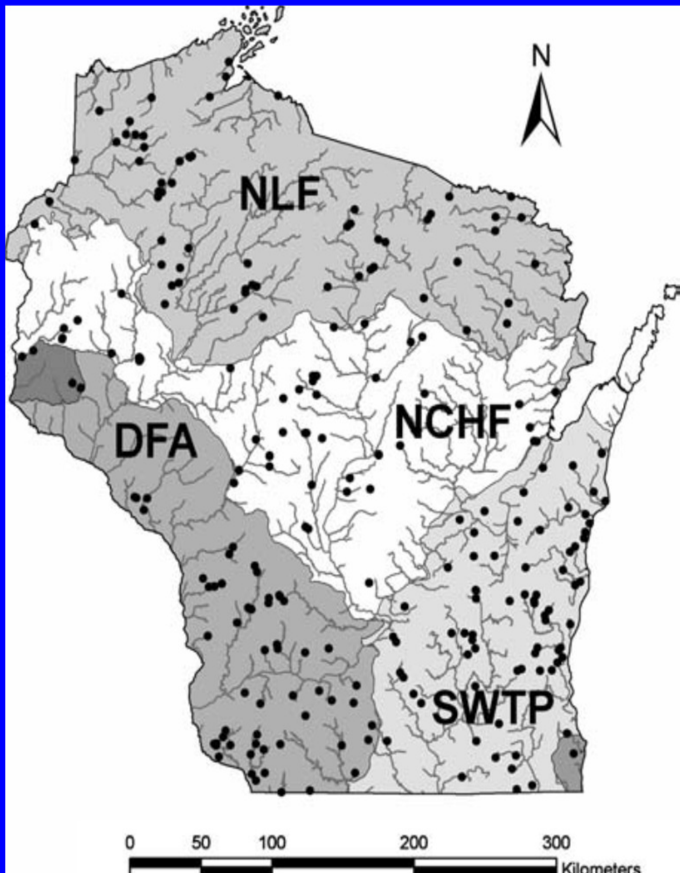
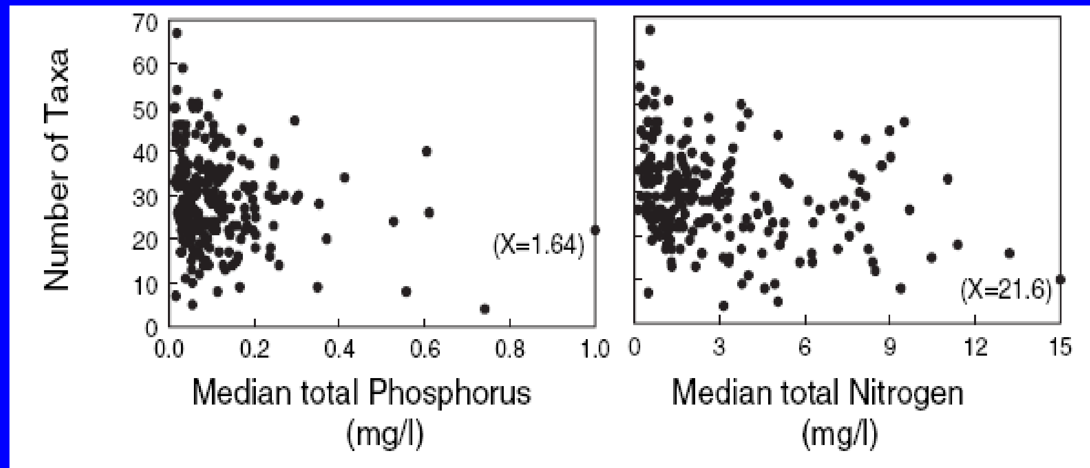
Thresholds and Nutrient Criteria



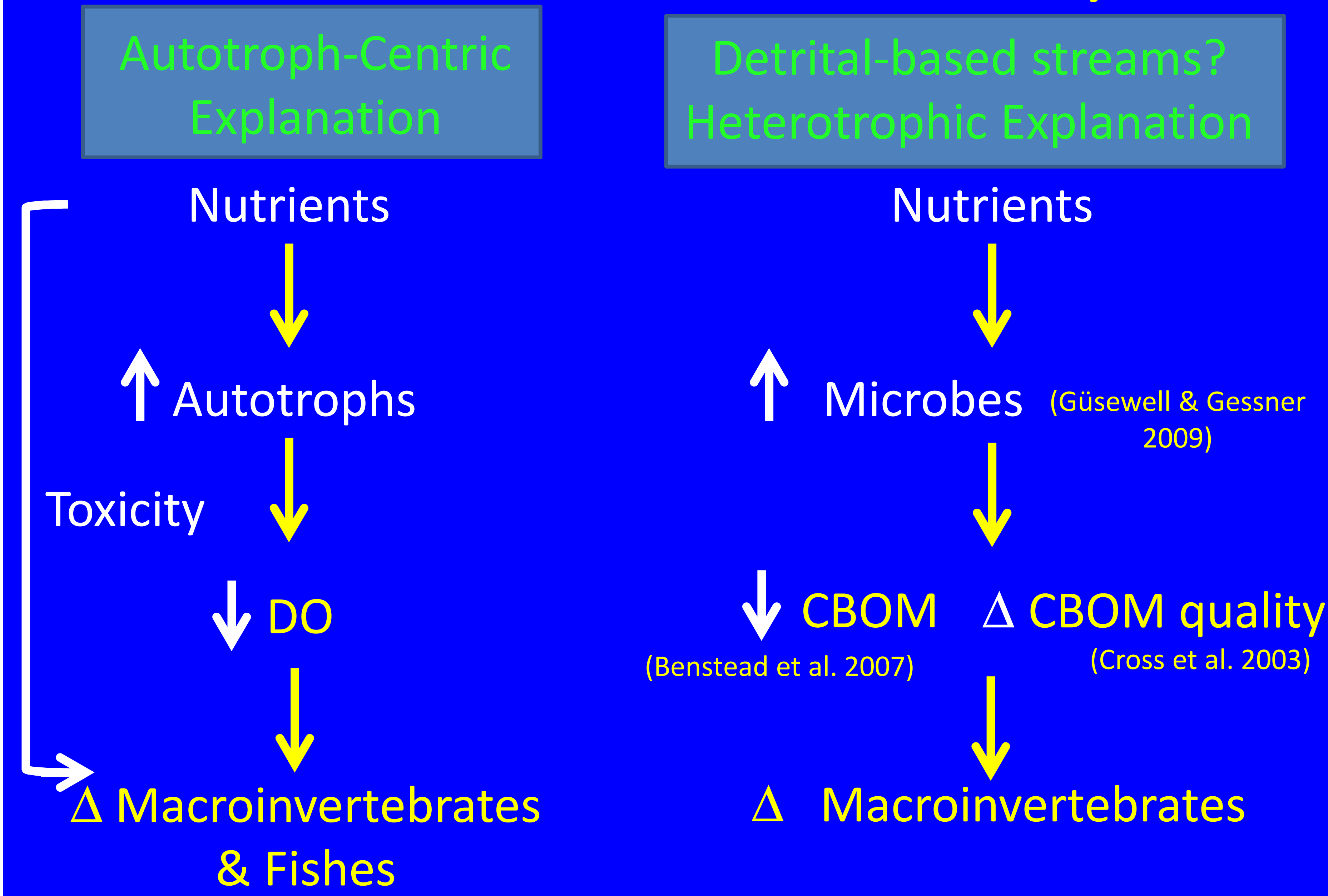


- **Mean and variance in richness decreases as nutrient concentrations increase**
- **Changepoint or threshold point for this can be used to establish water quality criteria**

What causes these threshold shifts as nutrient concentrations increase?

Wang et al., *Environmental Management*, 2007

N and P effects on stream ecosystems



CBOM Quality and Macroinvertebrates

- Decreasing C:P and C:N of CBOM can result in enhanced detritivore biomass and production (Cross et al. 2006; Greenwood et al. 2007)
- Invertebrates with low body C:P can respond more positively to enrichment than those with high body C:P (Cross et al. 2005; Singer and Battin 2007)
- Short-lived, faster-growing species have responded more positively to enrichment than have longer-lived, slower-growing species (Cross et al. 2005,2006).
- Coinciding threshold reductions in detritivore richness and mean species body C:P in Central Plains streams (Evans-White et al. 2009)

Ecology, 87(5), 2006, pp. 1325–1330

TOO MUCH OF A GOOD THING: ON STOICHIOMETRICALLY BALANCED DIETS AND MAXIMAL GROWTH

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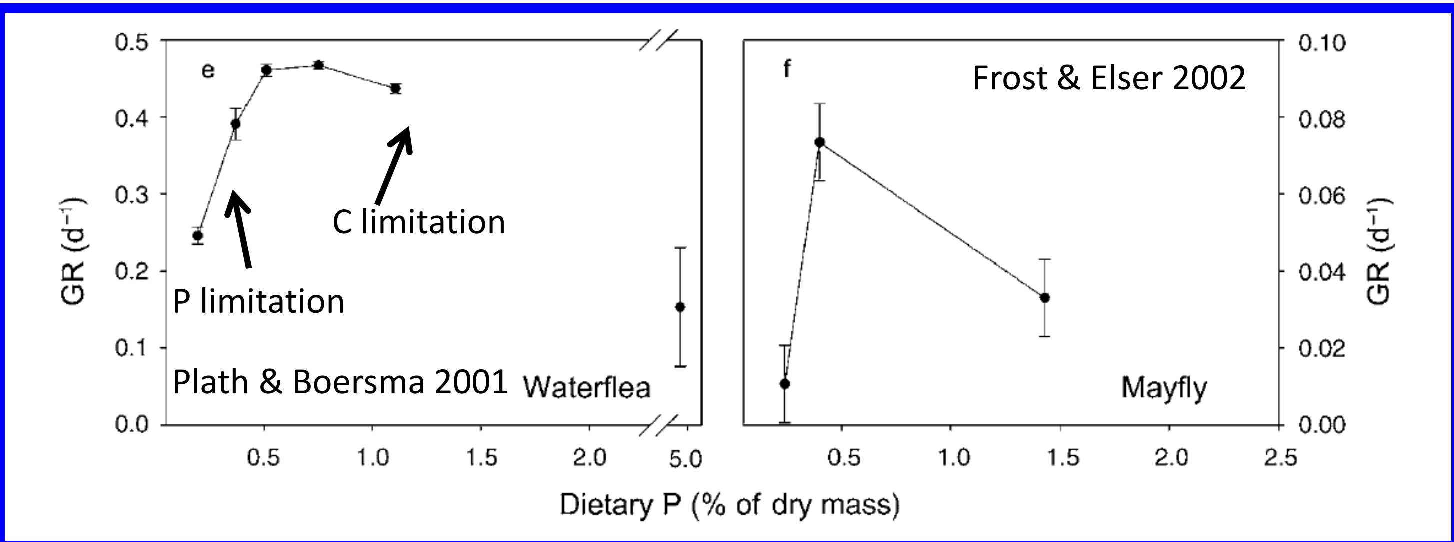
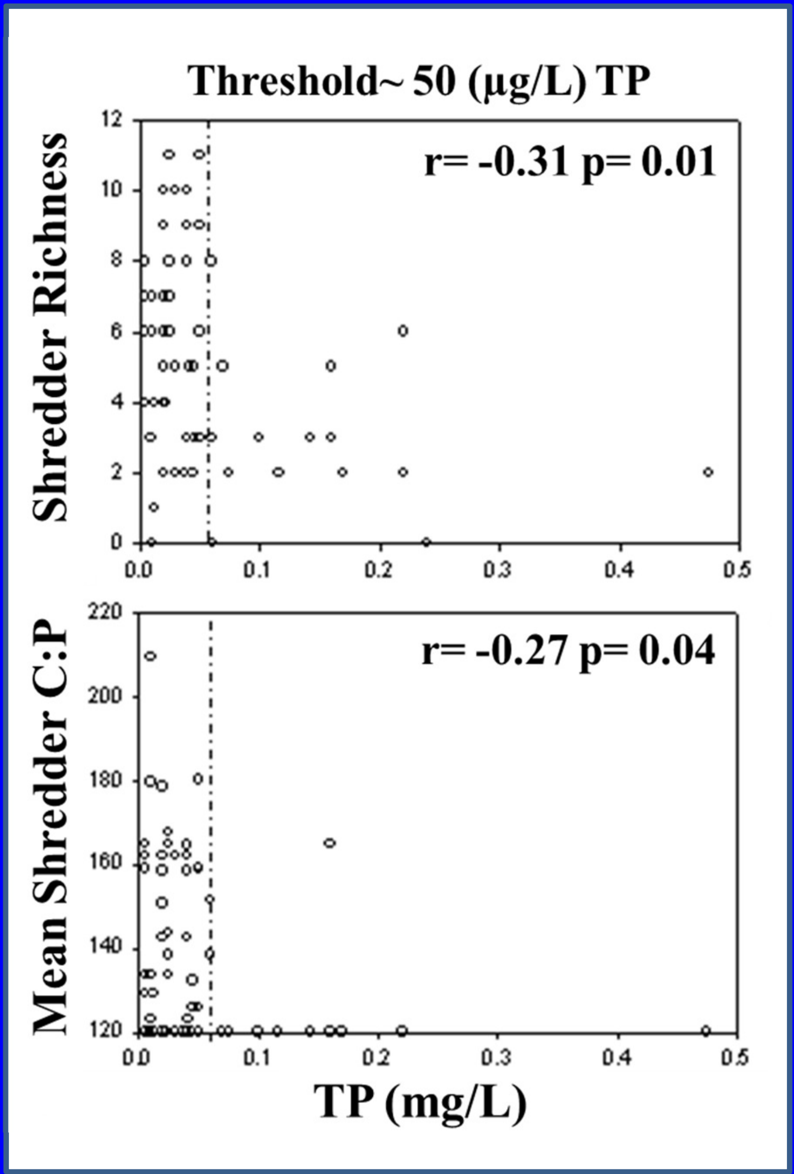
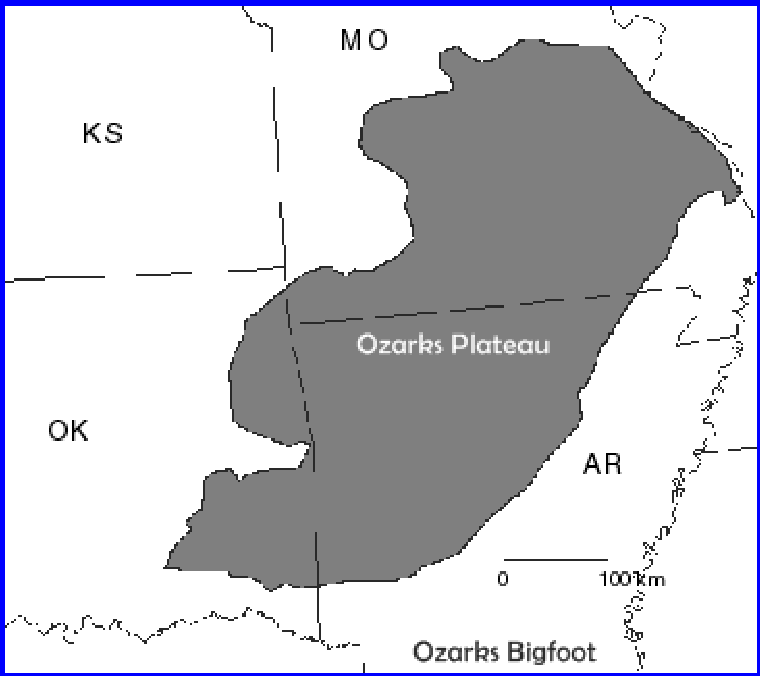


- Reduced feeding or increased energy expenditure at high resource P levels.
- Threshold element ratio: point where growth limitation switches from one dietary element to another

Detritivore Thresholds – Ozark Highlands



(Evans-White et al. 2009)



Can changes in stream detrital quality cause this threshold decline in shredder richness in Ozark streams?

Objectives

1) Determine the relationship between leaf litter C:P and dissolved P concentration for 2 dominant Ozark tree species in the laboratory

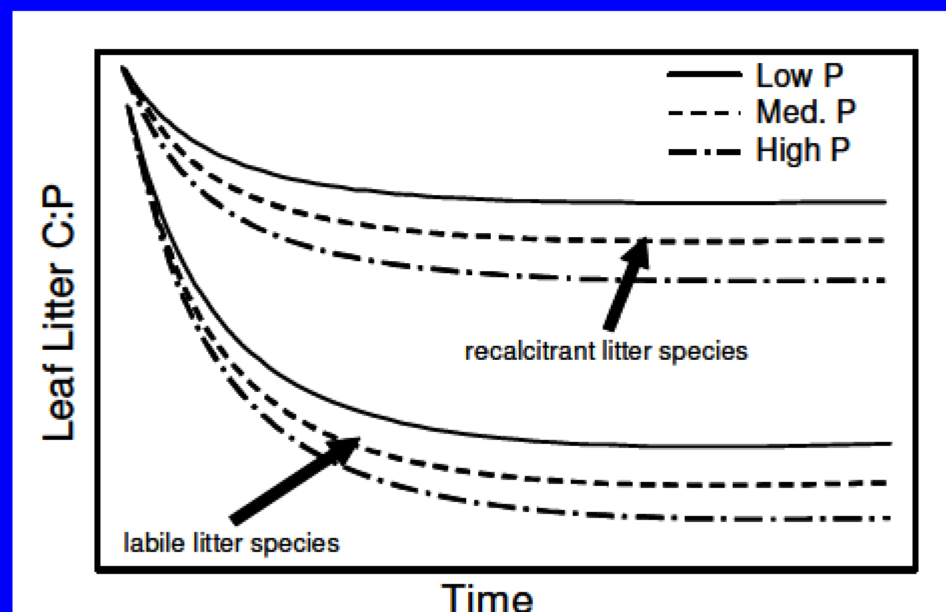
2) Determine whether shredding macroinvertebrate biomass and abundance was related to leaf litter C:P or TP in Ozark streams.

Leaf Litter Laboratory Incubations

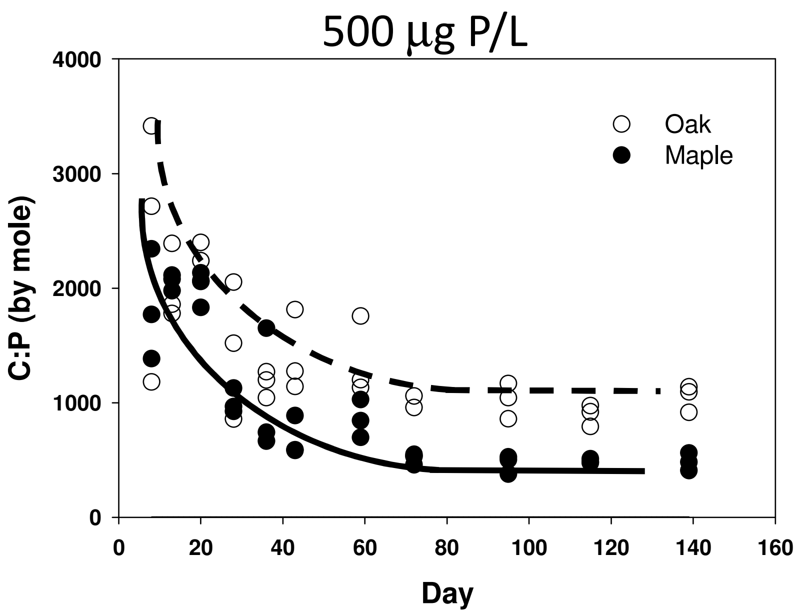
Experimental Design:

1. Crossed 2 leaf types (oak or maple) with 3 SRP levels (0, 50, or 500 µg/L added)
2. Sampled at 0, 5, 8, 13, 20, 28, 36, 43, 59, 72, 95, 115, and 139 days

Hypotheses:



Leaf Litter Laboratory Incubations



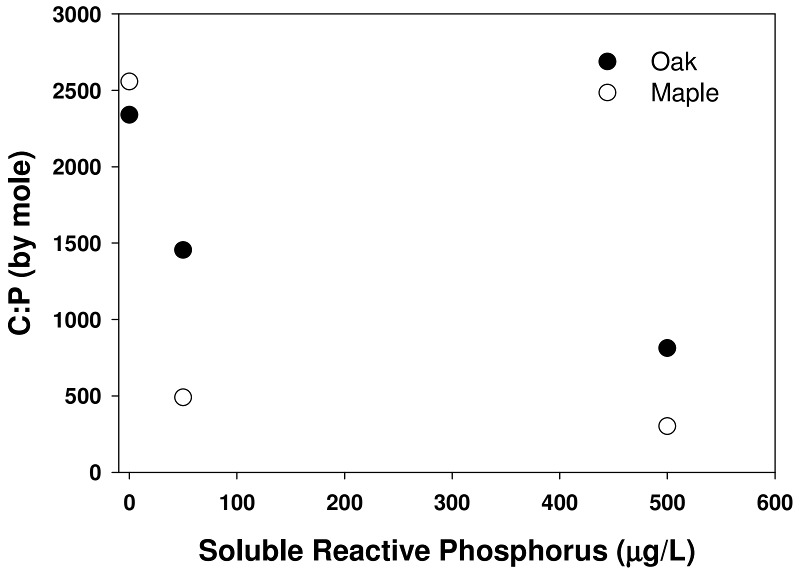
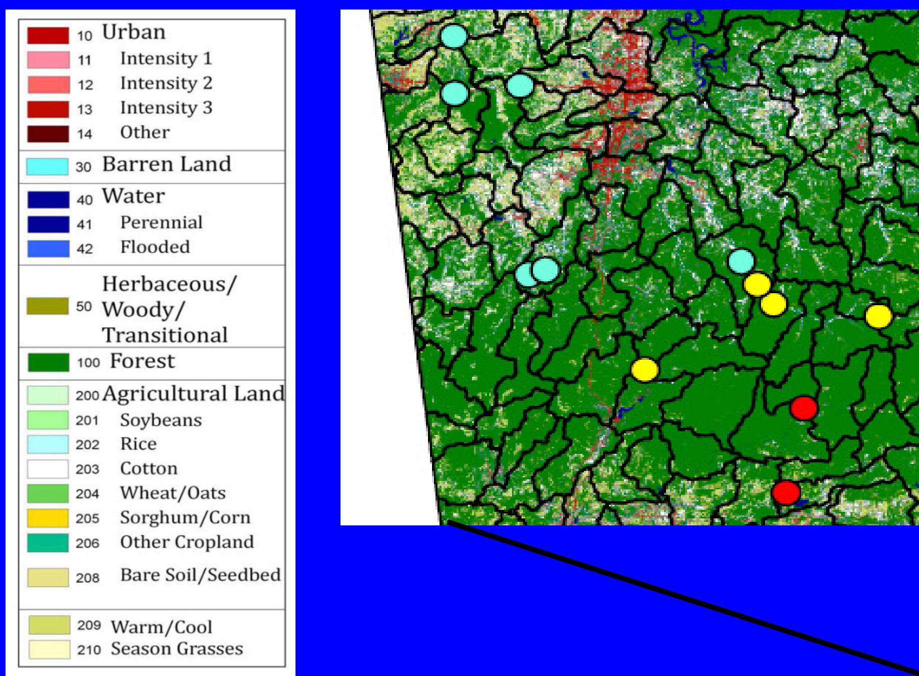


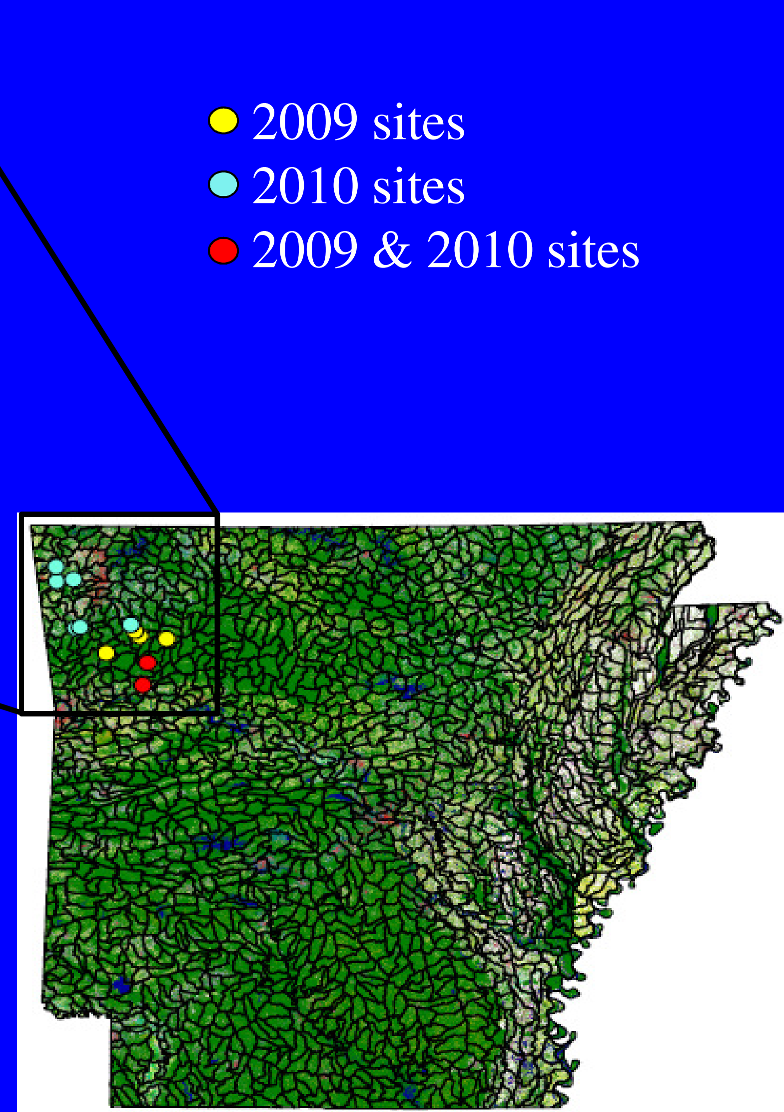
Table of Saturating Relationship Statistics with Time

	P (µg/L)	C:Psat	AdjR^2	P-value
Oak	50	1455	0.57	<0.001
Maple	50	489	0.77	<0.001
Oak	500	814	0.43	<0.001
Maple	500	302	0.80	<0.001

- Saturating relationship between C:Psat and P concentration.
- Saturation value lower for maple than for oak leaves.

Field Patterns in CBOM and Shredders with P Enrichment





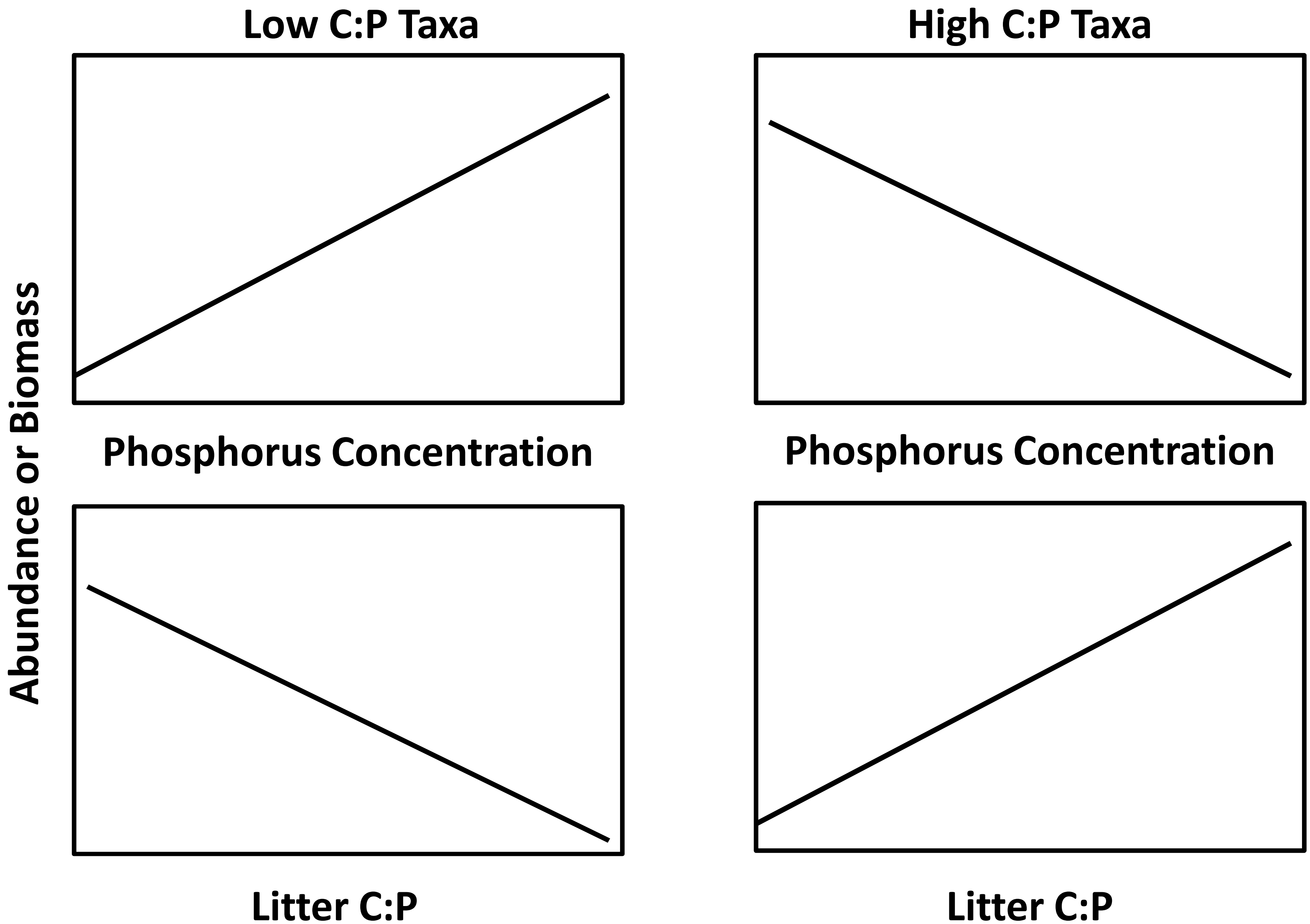
Sites were selected to comprise nutrient gradients:

TP: 8-62 (µg/L)

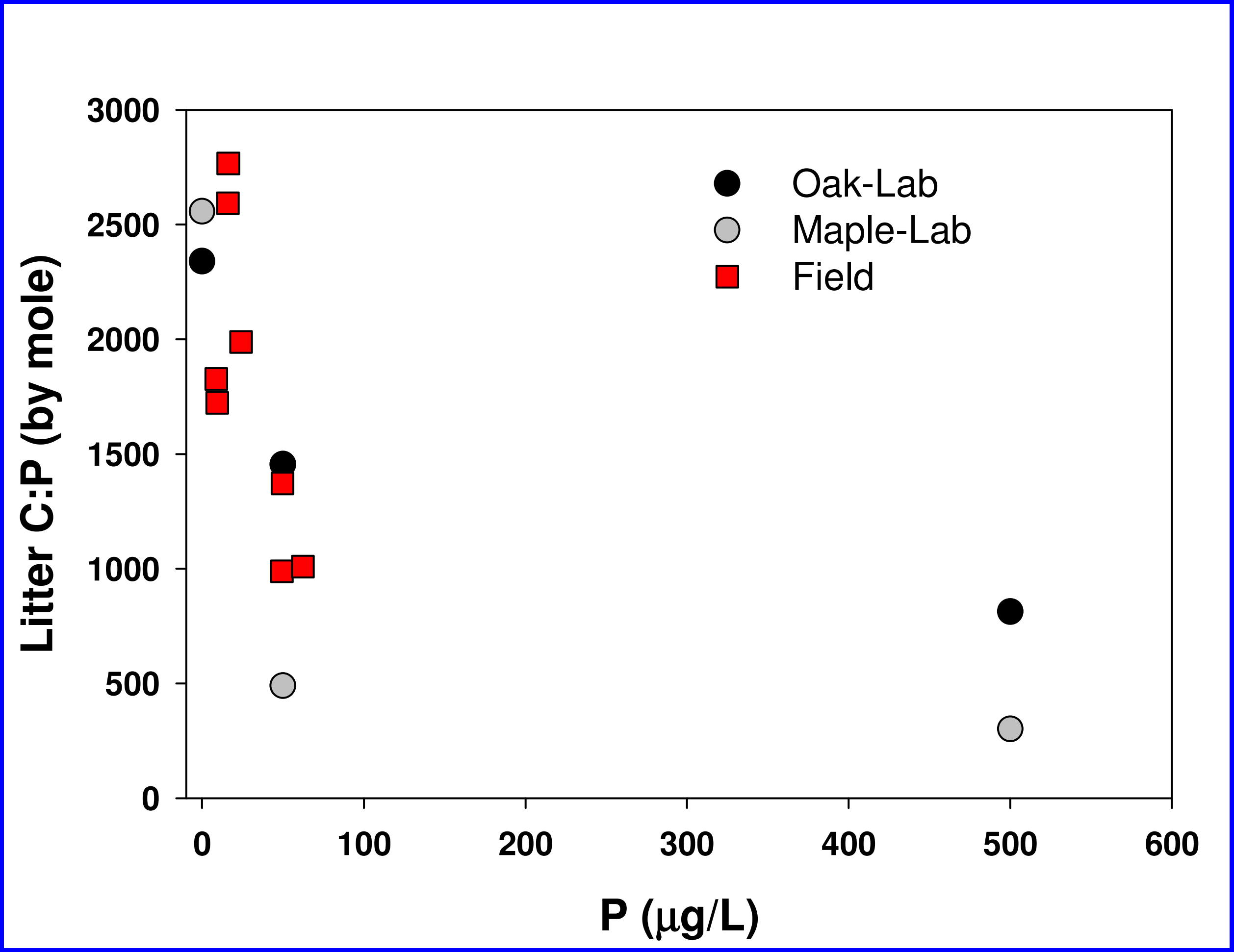
NO_3^-+NO_2^--N: 0.28-4.17 (mg/L)

Turbidity- 0.8-2.7 (NTU)

Hypotheses


Low C:P Taxa
High C:P Taxa
Abundance or Biomass
Phosphorus Concentration
Phosphorus Concentration
Litter C:P
Litter C:P

Patterns in CBOM C:P and Quantity Ozark Streams



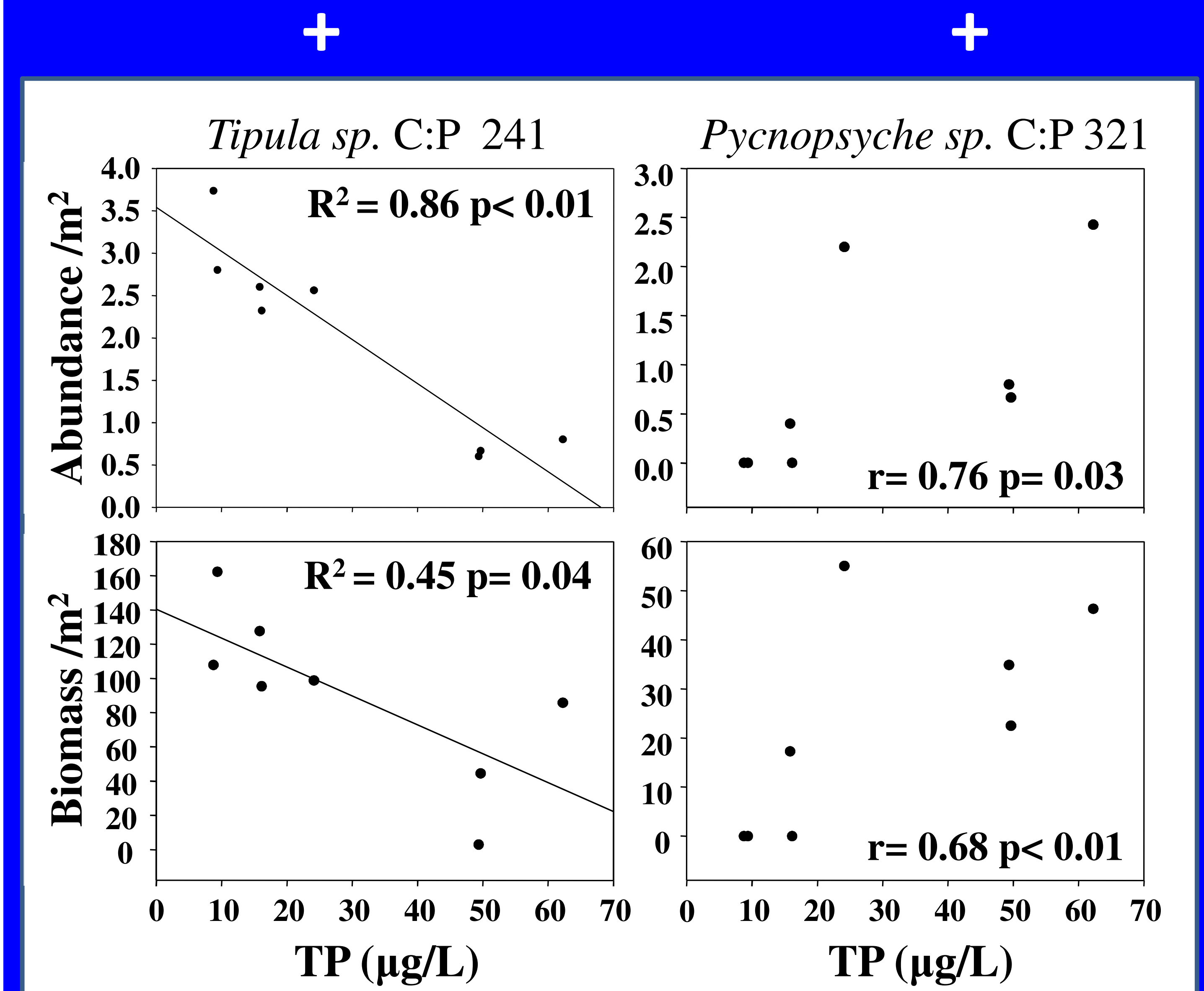
Leaf C:P decreased with increasing stream TP (R^2=0.56, p<0.01)

Leaf C:N decreased with increasing stream nitrate (R^2=0.50, p=0.03)

Patterns in shredder biomass and abundance

Order	Family	Genus	C:P	Enrichment response
Diptera	Tipulidae	***Tipula***	241	+
Trichoptera	Limnephilidae	***Pycnopsyche***	321	+
Ephemeroptera	Ephemerellidae	***Ephemerella***	340	+/Ø
Plecoptera	Nemouridae	***Amphinemura***	385	-
Plecoptera	Taeniopterygidae	***Strophopteryx***	437	-

Tipula and *Pycnopsyche sp.*

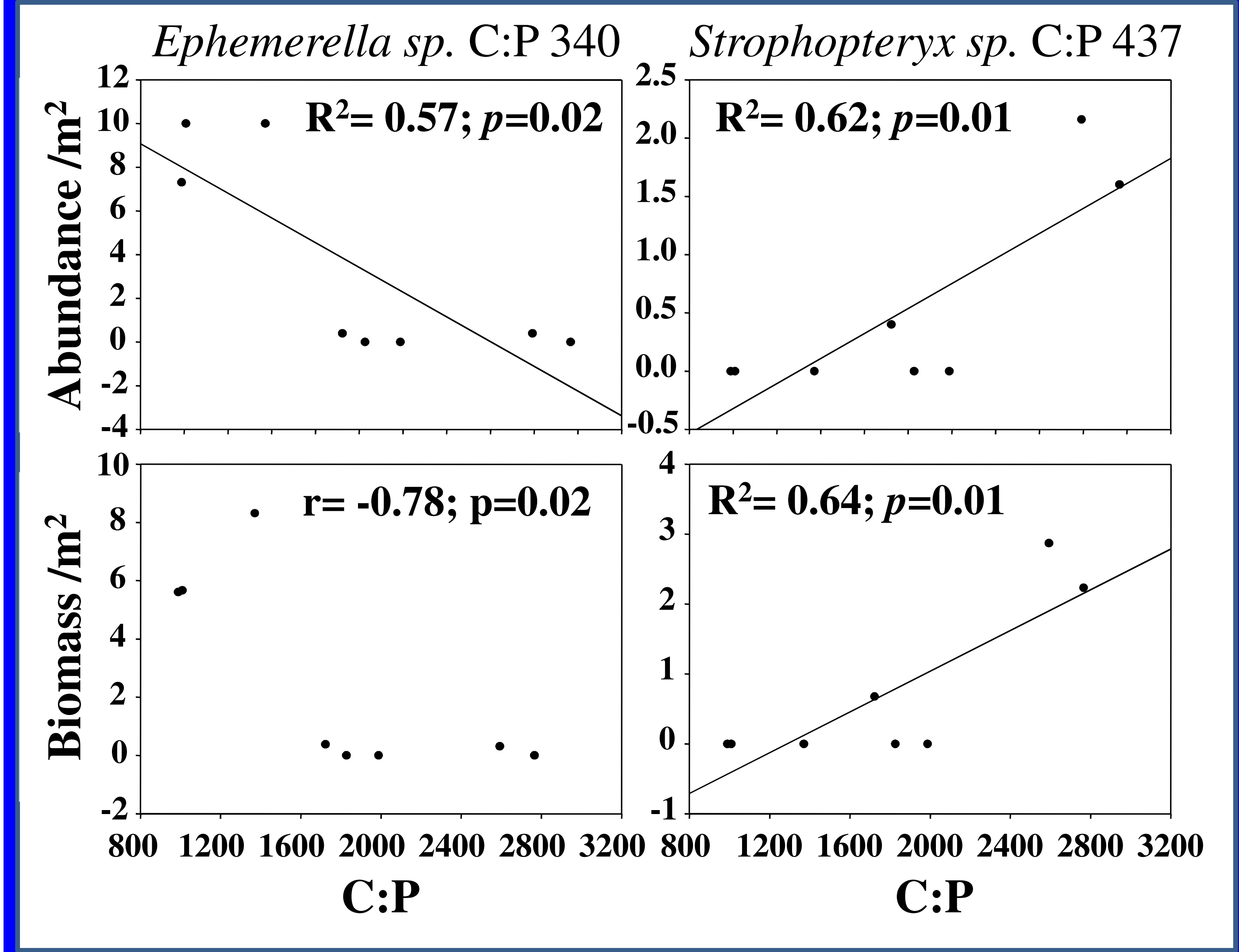


Tipula sp. abundance and biomass negatively correlated with TP.

Pycnopsyche sp. Abundance and biomass positively correlated with TP.

Abundance and Biomass

-,Ø   +

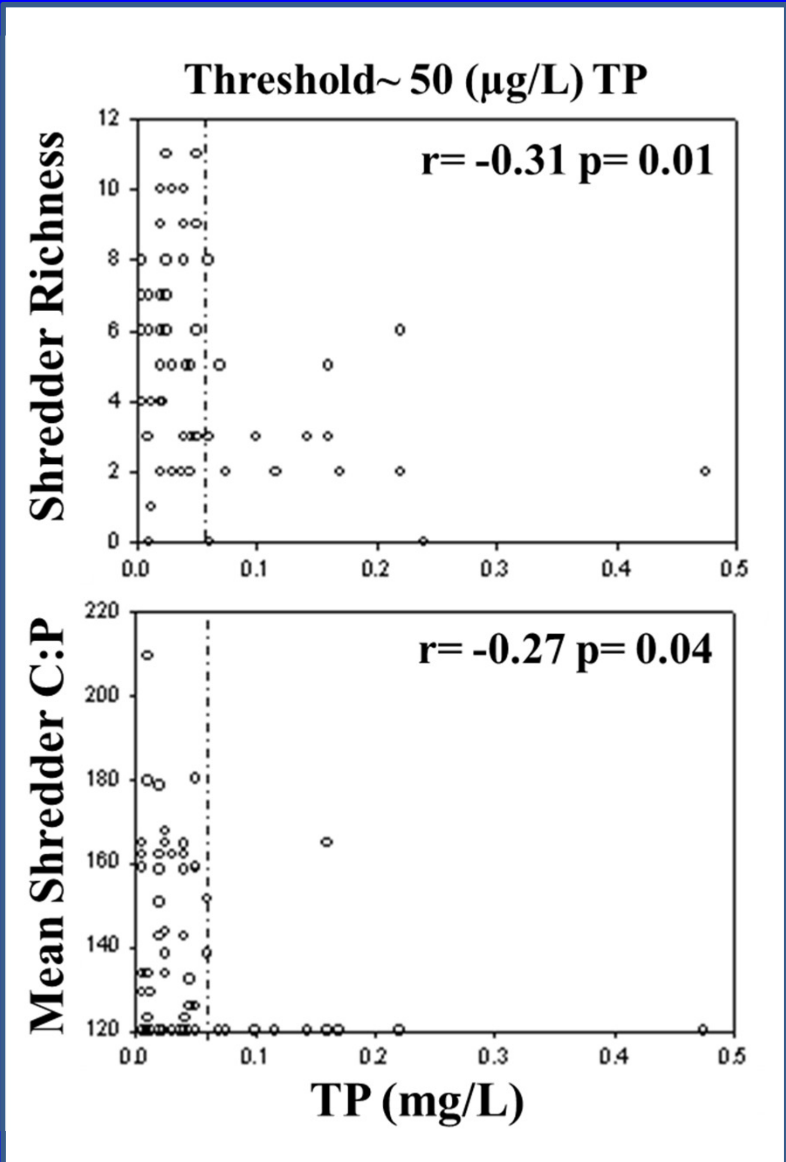


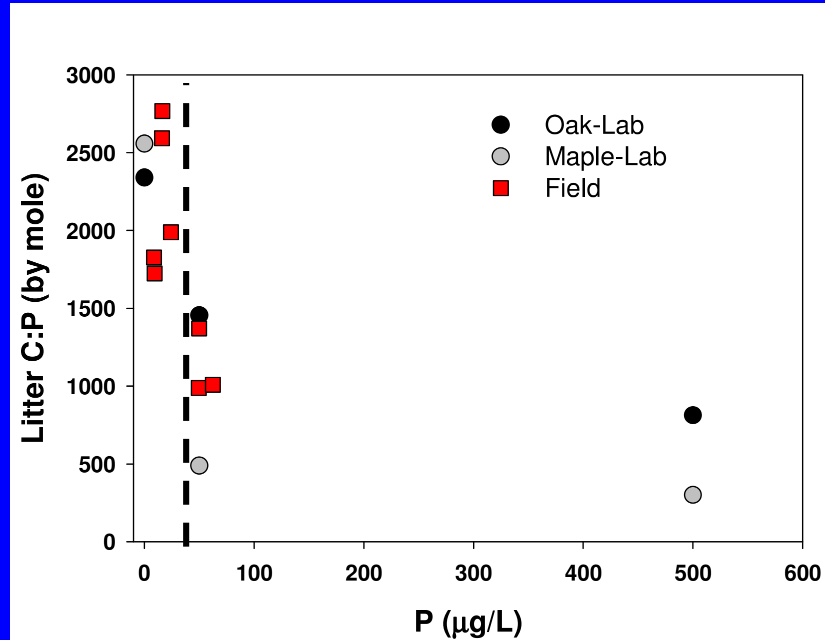
Ephemerella sp. Abundance and biomass <u>negatively</u> correlated with leaf C:P.

Amphinemura sp. (C:P = 385) Abundance and biomass <u>was not correlated</u> with leaf C:P or TP.

Strophopteryx sp. Abundance and biomass <u>positively</u> correlated with leaf C:P.

Conclusions





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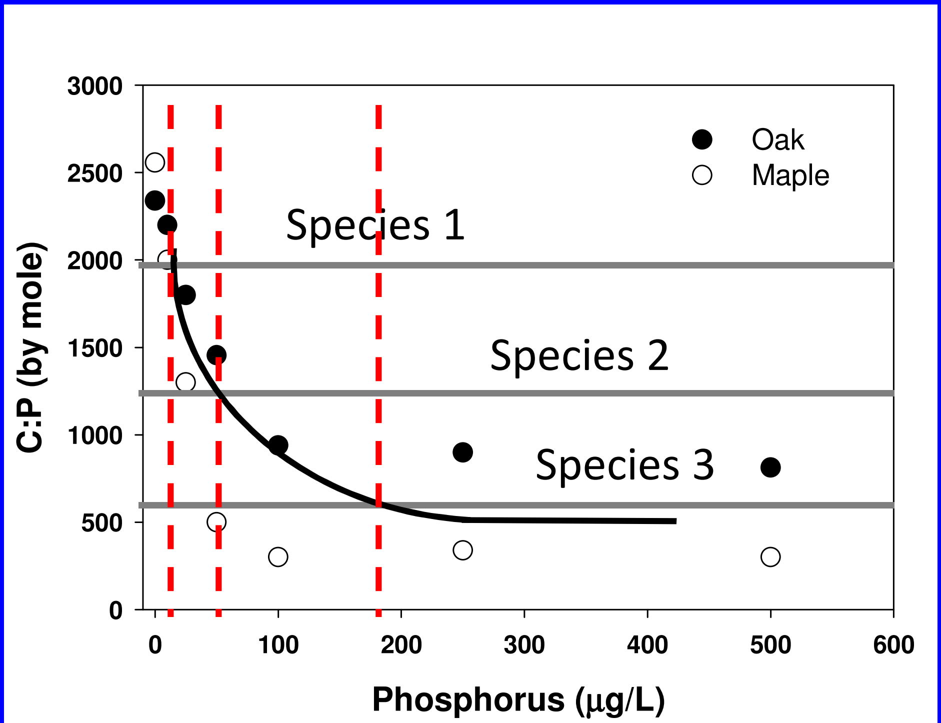
Future Plans

- Examine shredding macroinvertebrate growth responses to CBOM enrichment in the laboratory
- Estimate $TER_{C:P}$ and determine if it provides predictive framework for the order of species losses as nutrient concentrations increase.



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