

Trait-wise investigation of phytoplankton communities reveals predictable responses to seasonal environmental variation

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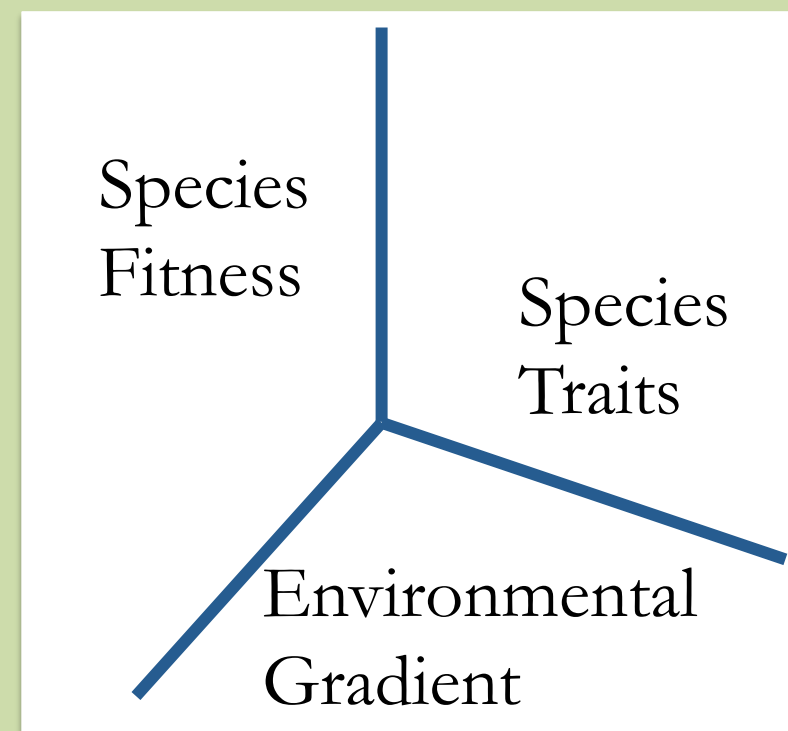
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Introduction

Trait-based approaches have been proposed as an exciting answer to many of the problems we see in community ecology. Explanations based on quantitative traits may reveal patterns that can be applied across systems and give greater predictive power in the face of changing climate and community makeup. In this study, we tested the ability of a trait-based approach to predict community composition and species growth rate in the algal community of a temperate lake.

The Trait-Based Test

To apply this type of analysis we need 3 types of information: species **fitness**, species **traits**, and an **environmental gradient**. These data can define a surface that models the composition of the community in response to environmental change or understand the community assembly in a given situation.

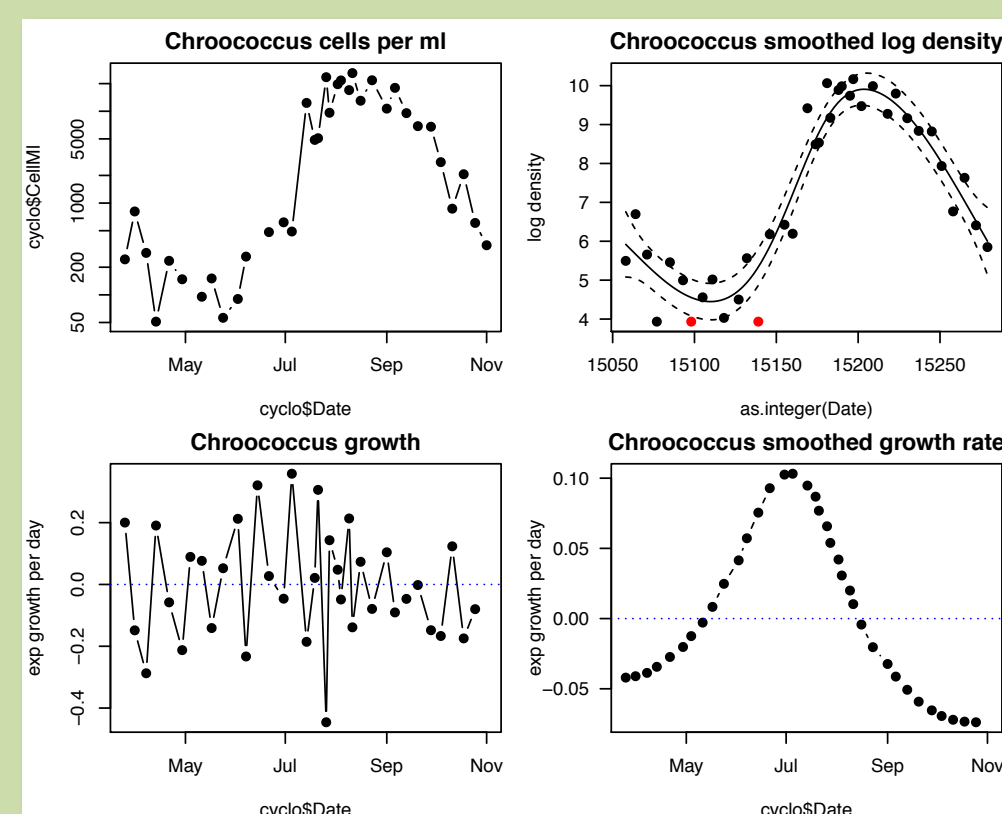


Species Fitness

- Abundance
 - Biovolume calculated from size measurements
- Growth rate
 - Smoothing using a GAM function

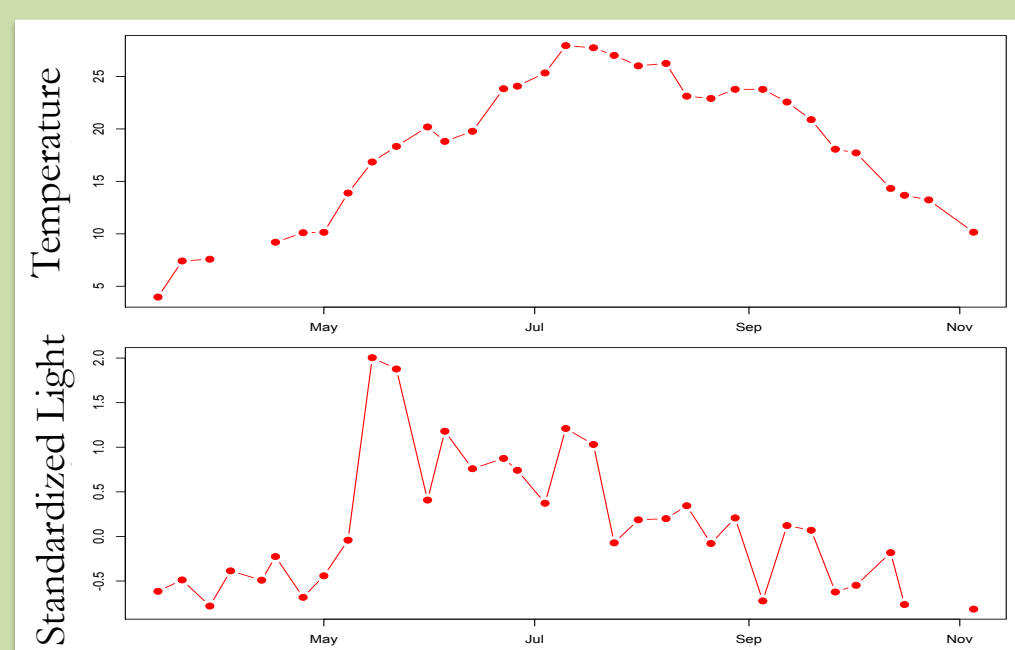
Environmental Gradients

- Total Phosphorus
- Average light in the mixed layer
- Temperature
- Total zooplankton biomass



Species Traits

- Traits chosen to correspond to environmental drivers
 - Grazing resistance
 - Phosphorus affinity (PAff)
 - Optimal Temperature (TOpt)
 - Light Affinity (LAff)
- No tradeoffs apparent between any trait pairs or triplets



Statistical Methods

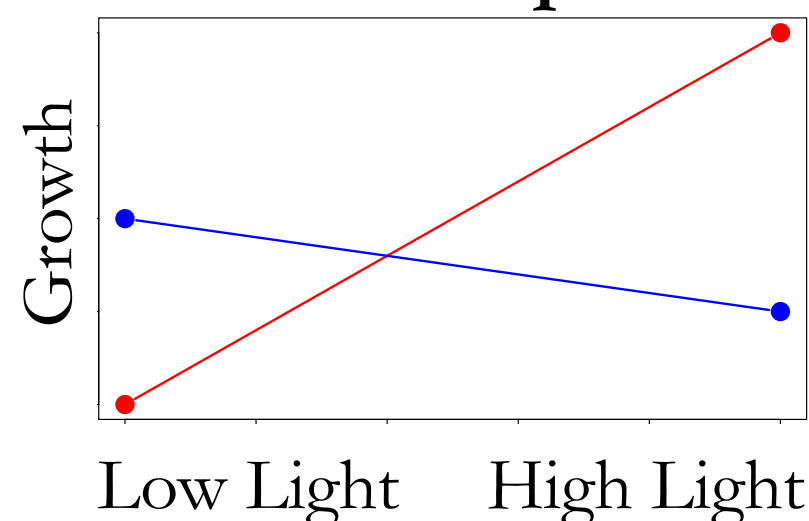
1) Weighted Average Trait Analysis

- Simple average of the trait of all community members at each sampling date weighted by biomass
- Regressed against the environmental gradient

2) Growth Rate

- Multi-level modeling technique used to extract a random effect of each environmental factor on each species
- These random effects (here called growth responses) are regressed against the species traits

An Example with Light Growth Response



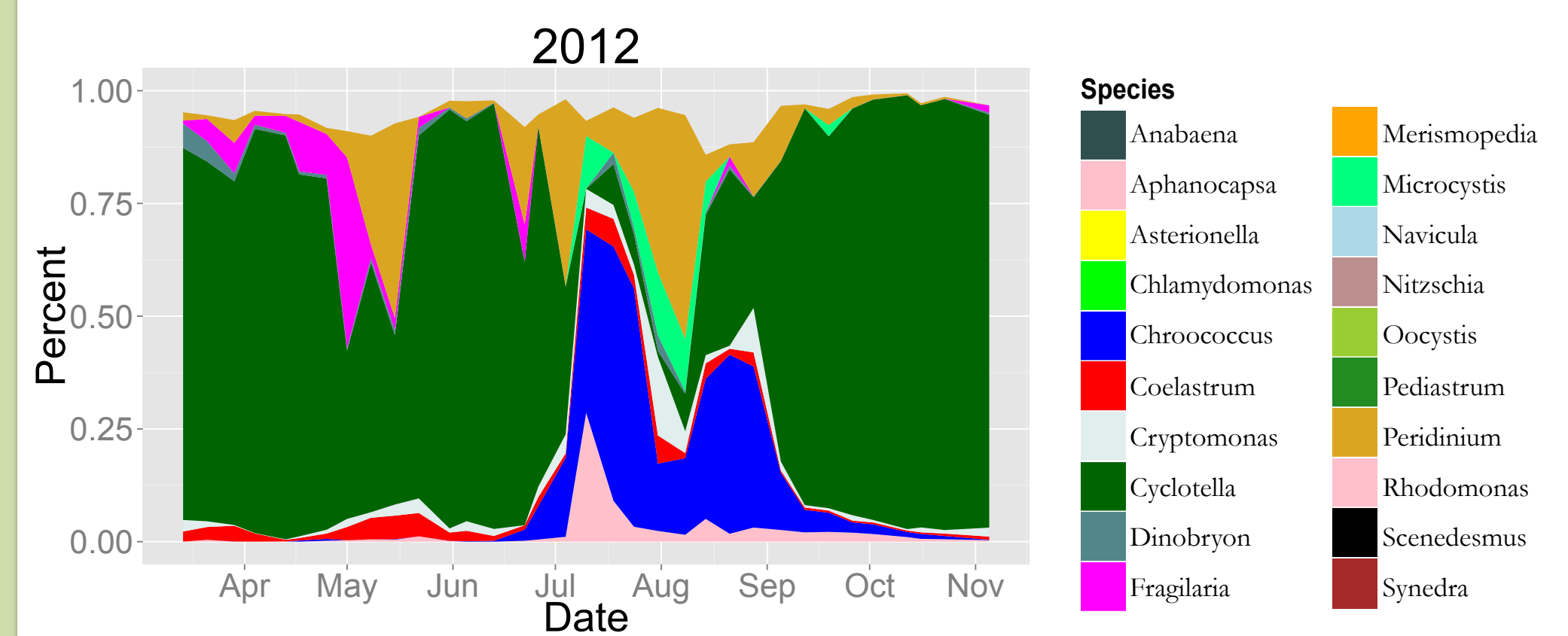
More negative growth response => Better Competitor

Higher LAff => Better Competitor

$$\text{Growth} \sim 1/\text{LAff}$$

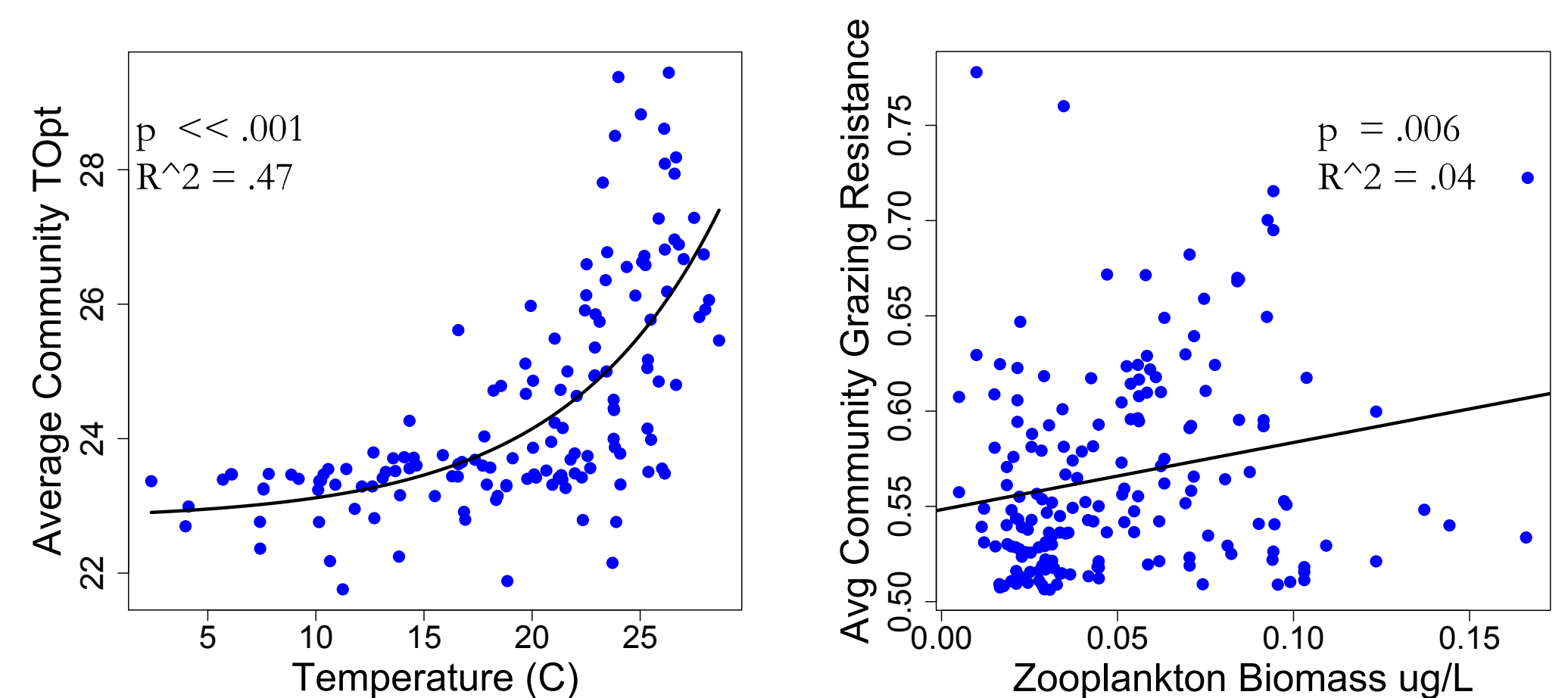
Gull Lake, SW Michigan, USA

Gull Lake is a meso-oligotrophic lake, 32m deep and 7 x 1.6 km in size. Lake surveys were conducted from 2006-2012 weekly from ice out to ice in. Phytoplankton and zooplankton were enumerated, and physical and chemical measurements were made, through the water column over the deepest part of the basin. All results are shown for the mixed layer or the first 4 m of depth, whichever was shallower.

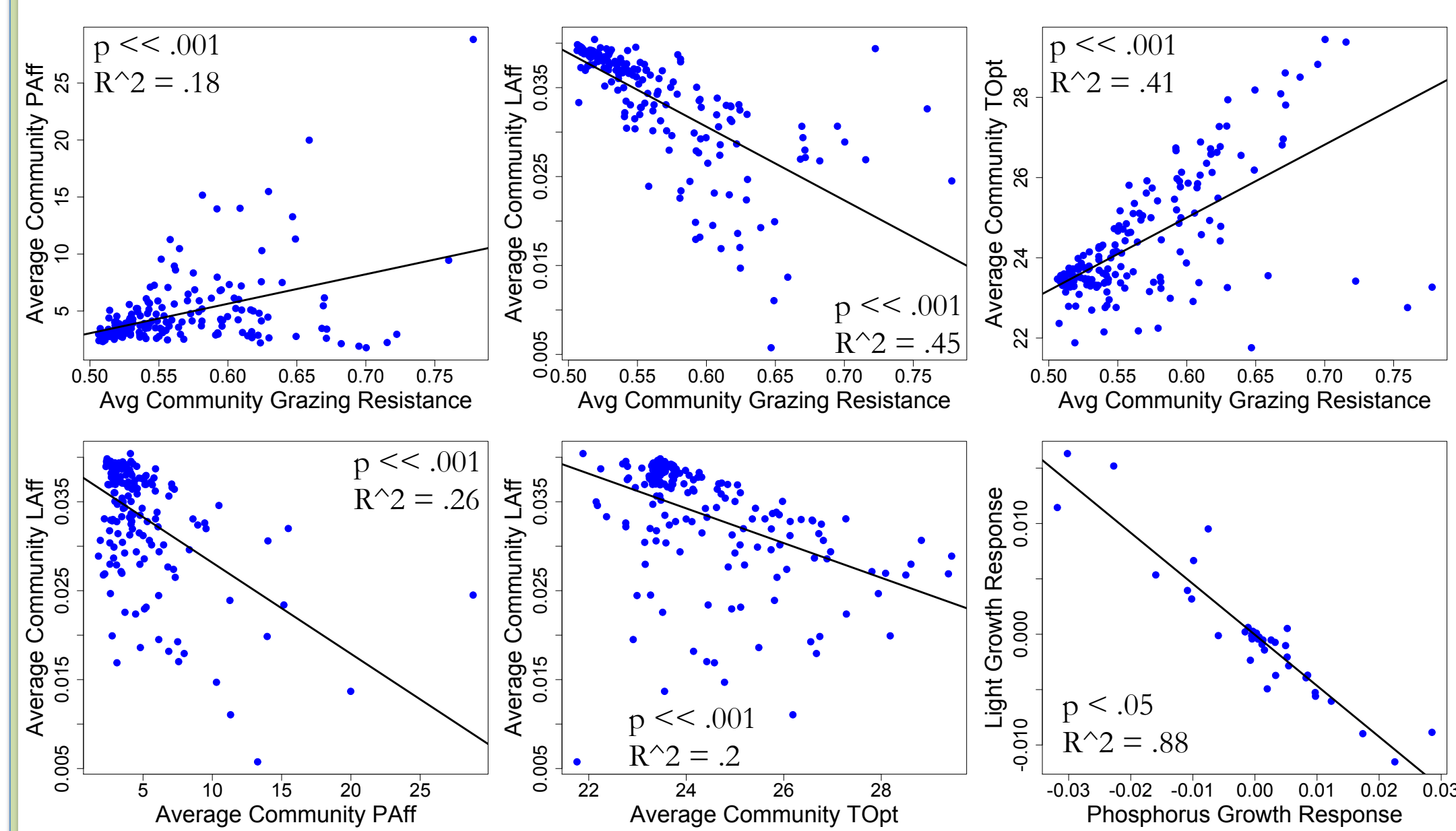


Results

Average community trait versus environment



Tradeoffs in community trait and growth response



Conclusions

The community average temperature optimum and grazing resistance was predicted by the environmental gradient, allowing a trait-based approach to make some conclusions about relative abundance. It did not however show any predictive power for species growth rates. This could be because of poorly representative traits gleaned from the literature. I will be conducting trait assays of my own to better examine this. The negative correlations apparent in the growth responses and community level traits are intriguing and indicative of some axis we haven't measured.