**Discussion**

*Fish Diversity*

This preliminary analysis indicates that the most impactful factors on fish diversity are air temperature, nutrients, stream morphology, and precipitation. Despite deliberately choosing similar order streams, stream morphology, in accordance with RCC, plays a pivotal role in determining fish diversity (Cianfrani 2009). Table 2 indicates that nutrients alone (model.9) are not the best explanatory factors for fish diversity. Similarly, adding precipitation to nutrient variables isn’t the most powerful predictive model. Incorporation of stream-order driven characteristics in the form of a depth/width ratio to nutrient and climate factors creates a model with an R2 value of .94 (p-value=.008). Thus, the most robust model for predicting fish diversity incorporates climate, nutrient, and stream morphological characteristics.

Strong collinearities between nutrient concentrations and forests, temperature, and precipitation suggests that these linked processes influence fish diversity. Agriculture is a dominant land-use in all of these watersheds, so we suspect that fish diversity is mainly governed through processes that control nutrient inputs to streams. Excessive nutrients stimulate eutrophic processes which in turn degrade habitat for fish. Harmful eutrophic effects include harmful algal blooms and lower dissolved oxygen concentrations from bacterial metabolism (Lee 1991). According to Figures 1 and 3, Nutrients in the form of ammonia, nitrates, and phosphates have the strongest correlations with fish diversity. Their negative correlations (-.75, -.63, -.68) indicate that as nutrient content in streams increases, fish diversity decreases. In order to identify that nutrients are affecting fish diversity through eutrophication future analysis should first convert dissolved oxygen saturations to concentrations and identify minimum daily dissolved oxygen levels.

Contrarily, the positive correlations of precipitation and forest (r =.41 and .50 respectively) indicate that as precipitation and/or forest increases, fish diversity also increases. A strong negative collinearity between precipitation and ammonia (r = -.61) concentrations suggests that increasing precipitation decreases concentrations of ammonia. As rainfall increases nutrients from croplands runoff more frequently than drier climates. In drier areas, sediments become laden with salts and highly concentrated runoff from evaporation is the most likely factor influencing nutrient concentrations (Darwiche-Criado 2012). In order to corroborate this mechanism, we need to control for agricultural development in each watershed while monitoring post-storm runoff nutrient content at sites with a varying annual precipitation.

Temperature can regulate nutrient concentrations via evaporation and the ensuing concentration of solutes in remaining solution. Figure 1 indicates that average temperature is negatively correlated with fish diversity (r= -.63) and not surprisingly with annual precipitation (r= -.86). Since water temperature is not as good of a predictor of fish diversity, we suspect that the temperature of soils and evaporation before runoff reaches streams it the main regulatory mechanism of stream nutrients, rather than the evaporation of water from the stream channel. This mechanism would be supported by an analysis of the ground water nutrient content in watersheds with different mean annual air temperatures.

*Invertebrate Diversity*

Invertebrate diversity trends differ from those of fish diversity in all respects. Invertebrate diversity is positively correlated with phosphate concentrations (figure 7) and average temperature (figure 8). Eutrophication may reduce dissolved oxygen level below vertebrate thresholds without surpassing those of invertebrates. The loss of secondary predators (fish) alleviates predatory limitations on primary predators (invertebrates). Secondly, excessive nutrient inputs stimulate primary productivity and microbial activities, increasing available food sources for primary consumer invertebrates (Vinson and Hawkins 1998). These two effects, reduction in vertebrate predation and increased primary productivity, could result in the observed increase in the overall invertebrate diversity with nutrient concentrations. Further elaboration on this hypothesis should proceed with an analysis of functional diversity and abundances of invertebrates in relation to nutrient concentrations.

The positive correlation of nutrients with invertebrate is conflated with other environmental variables including acreage of forest, annual precipitation, air temperature, pH, and dissolved oxygen saturation (figure 6). As stated in the fish diversity discussion, climate factors such as precipitation and air temperature determine runoff nutrient concentrations via dilution through frequent rains or concentration of solutes via evaporation. I consider pH a dubious collinearity due to the variance in the scatterplot. Dissolved oxygen increases with phosphate concentrations (r = .51) which may indicate an increase in photosynthetic processes brought on by algal blooms stimulated by nutrient runoff (Lee 1991). In order to explain or discern between conflating environmental factors, future analysis should include monitoring dissolved oxygen levels over time and the co-existing nutrient levels. If indeed eutrophication is the main mechanism driving invertebrate diversity, then we can expect to see a rise in dissolved oxygen following runoff events. Additionally, we should observe drops in dissolved oxygen beyond fish tolerance levels in eutrophic streams.

The most effective model (Model.Backward has an R2 = .96) of invertebrate diversity includes precipitation, phosphate concentration, dissolved oxygen, and air temperature (Table 2). In contrast to simple linear regressions, the multivariate analysis indicates that invertebrate diversity is negatively correlated with precipitation, phosphates, and air temperature. This would mean that invertebrate diversity is similar to fish in regard to nutrient concentrations and air temperature. Again, an analysis of stream metabolism over time rather than a brief snapshot, could provide better insights towards which mechanisms are driving invertebrate diversity. Specifically, we need to examine invertebrate diversity correlated with dissolved oxygen, with the expectation of finding spikes and crashes in dissolved oxygen characteristic of eutrophic waters (Lee 1991).

*Conclusions*

Fish and Invertebrate diversities can be accurately predicted (R2 > .93) with multivariate linear models using 4 environmental factors. The most influential factors in predicting fish diversity include dissolved nutrients, air temperature, and stream depth/width ratio. I suspect that eutrophication is the mechanism by which fish diversity is limited and that air temperature and precipitation affect runoff nutrient concentrations through evaporative and dilutive processes. Linear and multivariate analyses of invertebrate diversities present conflicting relationships. Linear regressions suggest invertebrate diversity is positively correlated with nutrients and temperature, suggesting a positive impact of eutrophication on invertebrates. I suspect that a reduction in fish predators and boosts in primary productivity benefit invertebrate communities. The multivariate analysis indicates that invertebrate communities are affected by eutrophication events similarly to fish communities. This report provides merely the analysis of a snapshot in time, but provides the hypotheses and methods appropriate in our continued monitoring of these stream communities.

*Invertebrate Diversity*

The backwards model has higher R2 (0.959) and adjusted R2 (0.905) than Model.5 (0.751, 0.710 respectively).