Vernal Pools II: The Influence of Road Salt on Benthic Vernal Pool Communities

Patrick Dienzo, Sierra Hayes, Ripal Patel, and Patrick Vestal

Biology 210: Ecology(D. McGrath)

Abstract

Vernal pools are temporal bodies of water that provide habitat free of fish predators for diverse microinvertebrate communities, including microcrustaceans, such as fairy shrimp and copepods. Studies have shown that proximity to roads has negative impacts on vernal pool communities. This study explores the influence of roads, specifically road salt runoff, on benthic diversity and abundance. Water properties and their influence on benthic communities were investigated in six ephemeral pools in Sewanee, Tennessee, three of which were surrounded by paved road. We hypothesized that benthic abundance and diversity in vernal ponds adjacent to roads would be reduced. As a measure of the impact of roads measured water conductivity, pH, and turbidity weekly determine if these properties differed among ponds surrounded by forest or paved roads. Benthic diversity was sampled three times over six weeks. Roads did not have a significant effect on pond conductivity, pH, or turbidity among the ponds; nor, did they have a significant influence on benthic abundance and diversity. We did find that there was significant temporal variation in abundance and morphospecies richness over the span of six weeks. We hypothesize that weather-related influences, such as precipitation and temperature, that vary considerably between late winter and early spring, may be a primary influence on benthic abundance and diversity.

Introduction

Ephemeral ponds, also known as vernal pools, are temporal bodies of water that fill topographical depressions during winter and early spring, and drawdown during the summer months. The organisms that live in these ponds have developed life histories to cope with the dynamics of a vernal pool ecosystem. Vernal pools provide fish free habitat for a diverse assemblage of microcrustaceans, such as fairy shrimp and copepods. These habitats are also extremely important in the breeding rituals of some salamander species, such as the spotted salamander. The proliferation of some vernal pool species is dependent on water quality. Previous studies have shown that high salt concentrations in aquatic habits negatively affect populations due to higher water conductivity (Findlay, 2011). High concentrations of salts in water detrimentally affect aquatic organisms because it disrupts their osmotic balance with their water environments. Road salt has been documented to negatively affect salamander populations, but its influence is largely understudied (Karraker, 2008).

Currently, very little data exists for the influence of road salt on vernal pool habitats on the southern Cumberland Plateau in Tennessee. If we are to properly manage these aquatic habitats, more information is needed to determine appropriate measures to minimize our impacts to these areas. This study will be one of the first to provide information on the influence of roads on vernal pool microfauna. Our objectives in this study is to address the influence of roads on benthic abundance and diversity in vernal pool ecosystems, learn if road runoff containing dicing agents increases conductivity in forested versus road-side vernal pools, and to determine if high water conductivity influences benthic microcrustacean communities. We hypothesize that benthic abundance and diversity would be reduced in vernal pools adjacent to roads compared to ponds located in forested communities due to the influx of deicing agents from road runoff.

Methods

Figure 8: Map of Airport vernal pools , retrieved on March 18, 2011 from website http://maps.google.com/).

Figure 9: Map of Piney Point vernal pool, retrieved on March 18, 2011 from website http://maps.google.com/).

Figure 10: Map of Breakfield vernal pool ,retrieved on March 18, 2011 from website http://maps.google.com/).

Figure11: Map of Mushroom, vernal pool retrieved on March 18, 2011 from website http://maps.google.com/).

Our study site was on the southern Cumberland Plateau in Sewanee TN at six vernal pools for six weeks, from February 22 to March 30 of 2011. We studied the relationship between vernal pool properties and the benthic diversity with the proximity to a road.

•We used the In-situ Troll 9500 Series probe to measure the pH, conductivity, and turbidity at five random locations at each pond.

•We used a D-Net, basin, and 50ml tubes to take three benthic samples from three random sampling points at each pond. We used dissecting microscopes and an identification key to identify and quantify the various organisms present.

•We then graphed the results in Microsoft Excel and tested their significance with Anova and T-tests.

Results

Water Properties

•Mean conductivity was overall higher in vernal ponds adjacent to roads compared to ponds surrounded by forest.

•Mean turbidity values were higher in the three Airport locations compared to the forested vernal ponds except for Piney Point,

•which had the second highest turbidity among the six pools.

•Water pH at vernal ponds ranged from 4.2-4.6 except for Airport 3, which had a pH of 5.4, the most neutral water pH of all the ponds.

Benthic Abundance and Diversity

•There was no significant correlation between mean abundance and mean diversity between the six vernal pool benthic communities (Figure 8).

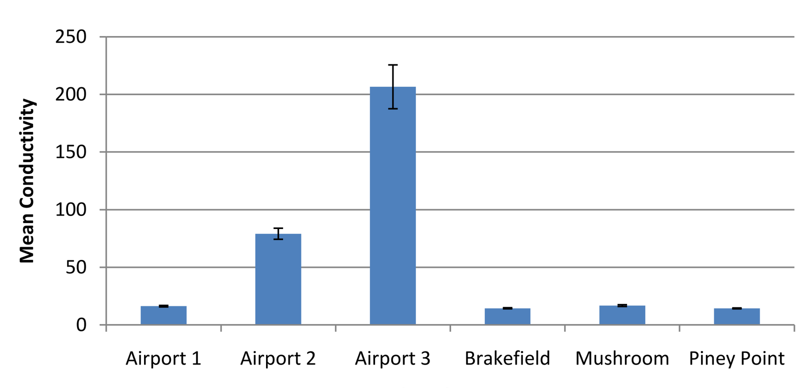

Figure 1: Mean conductivity values (μs/cm AC) for six vernal pools found on the Cumberland Plateau in Sewanee, TN from February 22 to March 29, 2011.

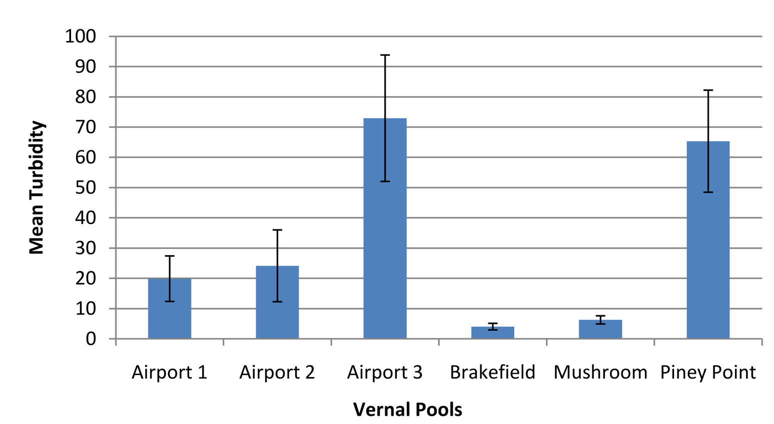

Figure 2: Mean turbidity values (NTUs) for six vernal pools found on the Cumberland Plateau in Sewanee, TN from February 22 to March 29, 2011.

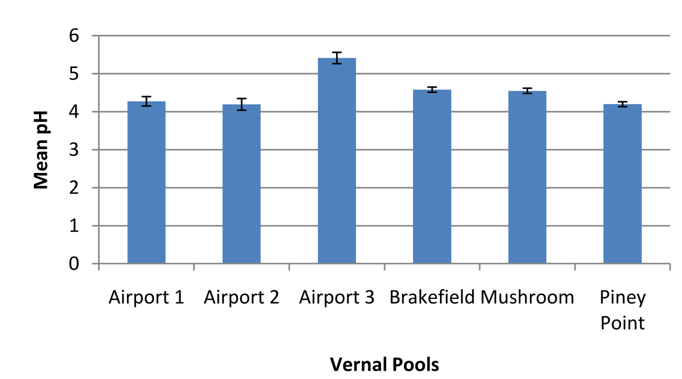

Figure 3: Mean pH for six vernal pools found on the Cumberland Plateau in Sewanee, TN from February 22 to March 29, 2011.

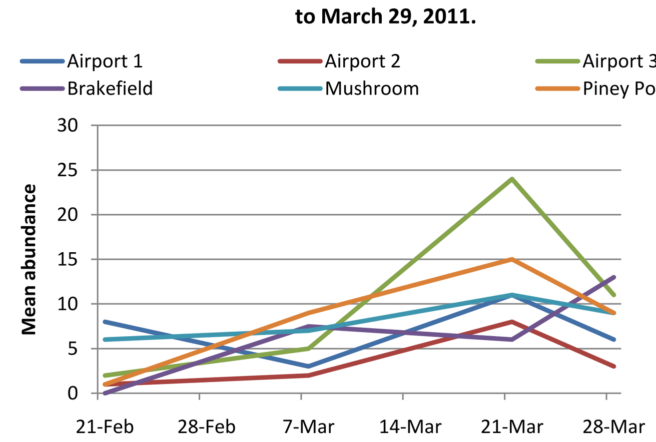

Figure 5: Mean abundance over time for benthic communities at six vernal pools found on the Cumberland Plateau in Sewanee, TN from Febrauary 22 to March 29, 2011.

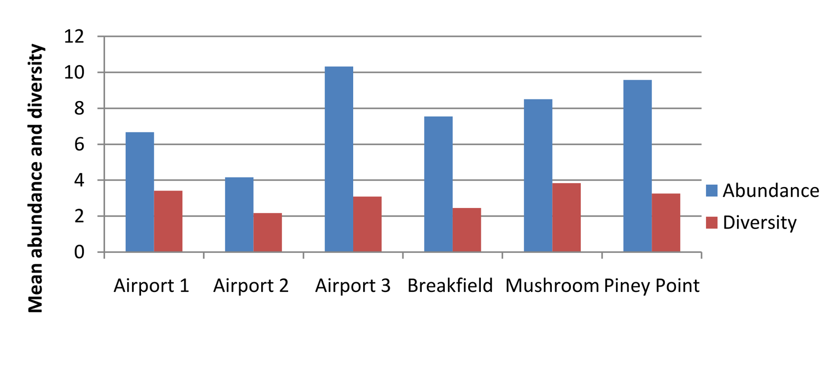

Figure 4: Mean abundance and diversity of benthic communities collected in six vernal pools found on the Cumberland Plateau in Sewanee, TN from February 22 to March 29, 2011.

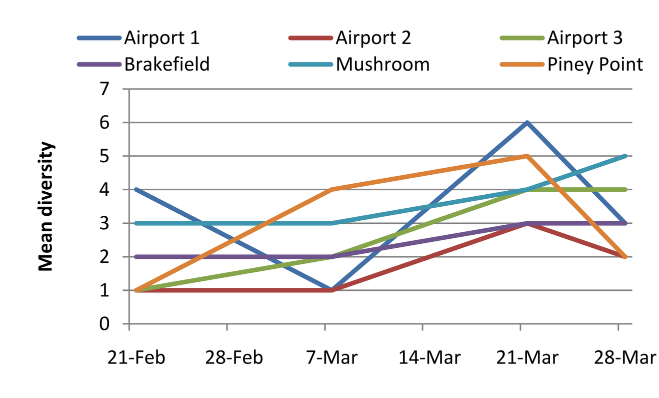

Figure 6: Mean diversity over time for benthic communities at six vernal pools found on the Cumberland Plateau in Sewanee, TN from Febrauary 22 to March 29, 2011.

Conclusions

Water sampling at three vernal pond locations surrounded by forests and three pools surrounded by roads revealed significant differences in conductivity, turbidity, and pH ($p<0.001$), however, the impact of these differences did not affect benthic abundance ($p=0.310$) and diversity ($p=0.154$). Conductivity was elevated in ponds surrounded by Airport Road, especially Airport 3, whose location adjoins the site of a former railroad track. Over the years, the limestone gravel bed would have leached calcium carbonate, which would have elevated the amount of impurities in the water at Airport 3, thus increasing its conductivity. Conductivity in ponds surrounded by forests, however, was low and varied little.

Mean turbidity values were overall higher in the three Airport locations and Piney Point. Sedimentation resulting from runoff and road construction were likely factors in the higher turbidity readings for the vernal ponds adjacent to Airport Road. As with conductivity, site history involving the railroad likely contributed to the elevated turbidity readings in Airport 3. Vernal ponds surrounded by forests had low mean turbidity readings, except Piney Point, which likely receives sediment inputs from the nearby walking trails.

With the exception of Airport 3, vernal ponds surrounded by roads had lower water pH than vernal ponds in forested areas. Road runoff as well as local site soil conditions could have made these vernal pools more acidic. The anomalous mean pH observed for Airport 3 was likely neutralized from the old limestone railroad bed that once occupied the site.

Even though conductivity, turbidity, and water pH did not have a significant influence on benthic abundance and biodiversity, there was a significant effect of temporal variation on these benthic communities in the vernal ponds sampled in these study ($p<0.001$). Over time, both abundance and biodiversity generally increased among the six ponds, peaked at March 22nd, and then decreased. Abundance and species richness likely increased in the days leading to March 22nd due to favorable ambient air temperatures. The decline in abundance and biodiversity may be the result of a freezing event on March 26th. In addition, predation from larval salamander populations may have had an effect on these vernal pool benthic communities.

Literature Cited

•Colburn, E.A. 2004. Vernal Pools: Ecology and Conservation. McDonald and Woodward Publishing Company, Granville, OH. 426 pp.

•Findlay, S.E.G. and V.R. Kelly 2011. Emerging indirect and long-term road salt effects on ecosystems. *Annals of the New York Academy of Sciences*: The Year in Ecology and Conservation Biology 1223: 58–68

•Karraker, N.E. 2008. Impacts of Road Deicing Salt On The Demography Of Vernal Pool- Breeding Amphibian. *Ecological Applications*, 18(3): 724–734

•Schneider, D. W., and T.M. Frost. 1996. Habitat duration and community structure in temporary ponds. Journal of the North American Benthological Society 15:64-86.

•Thorp, J.H. and A.P. Covich 1991. Ecology and Classification of North American Freshwater Invertebrates.Academic Press Publishing Company, San Diego, California

Acknowledgements

We would like to thank Dr. Deborah McGrath of the Biology department for her relentless pursuit of excellence and editing.