

William Kish

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The Effects of Anthropogenic and Natural Parameters in Ephemeral Wetlands on Community Composition

Introduction

Wetlands are transitional areas between terrestrial and aquatic ecosystems that are either flooded or saturated for extended periods to produce hydric soil and support hydrophilic vegetation (Hongjun et al. 2010). Ephemeral wetlands are seasonal, temporary wetlands that are usually full during the late winter and early spring but dry up during the late spring and early summer (Ganguly and Smock, 2010). For this reason, ephemeral wetlands don't normally hold fish populations. They predominantly have amphibians like tadpoles and salamanders, reptiles like snakes and turtles, and crustaceans like crayfish and aquatic sow bugs. Wetland organisms, like any other organisms, are affected by many different parameters such as natural or human caused. These parameters can be categorized into either anthropogenic parameters like artificial pools and natural parameters like weather. This literature review is to discuss anthropogenic parameters and natural variations and how they affect the community composition of ephemeral wetlands and how to better recreate them. This is an important question since the construction and restoration of wetlands are often used to mitigate the loss of wetlands elsewhere (Russell and Beauchamp, 2017). While temporary wetlands are often one of the hardest wetland systems to recreate (Kolozsvary and Holgerson 2016). With a better understanding of how these parameters

can affect the community composition, ephemeral wetlands can be built to better mimic natural ones.

Anthropogenic Parameters

Anthropogenic parameters are human caused and can either directly or indirectly affect ephemeral wetlands and their organismal communities. The parameters that will be mentioned in this paper will include cattle grazing, row-crop agriculture, roadside pools, and artificial pools.

Kolozsvary and Holgerson (2016) recreated temporary pools based off reference pools from separate locations. After the study, it was found that the amphibian richness did not differ between natural and created pools. The occupancy didn't cluster to any type of pool indicating that assembly was similar across pool types. There were significantly more spotted salamander egg masses per unit area in the natural pools. With macroinvertebrates, family richness did not differ between created or natural pools either. These findings could be caused by many different parameters that were kept the same when recreating the wetlands. This study made sure the surrounding vegetation and physiochemical characteristics were the same as the reference pools (Kolozsvary and Holgerson 2016). O'Neil (2016) compared natural and artificial wetlands in multiple different states across 73 different ephemeral wetlands had comparable results. The community composition of invertebrates had no difference between natural and artificial wetlands. They found no statistical difference between diversity, abundance or taxa specific variables. This could be caused by the tolerance needed to live in a fluctuating natural habitat is mimicked by different anthropogenic disturbances (O'Neill et al. 2016).

Another anthropogenic parameter is the effect of cattle crazing and tilling for row-crop agriculture. Seventy-three ephemeral wetlands were sampled for crustaceans around areas that

were affected by cattle grazing and row-crop tilling. After the survey, it was found that wetlands with cattle grazing had generally more diversity and overall number of crustaceans. When it came to row-crop tilling, it was found that there was a lower diversity of crustacean taxa. A few reasons for positive effects of cattle grazing could be the cattle kept the water column clear resulting in less wetland vegetation density, transporting eggs, mixing egg banks, and creating microhabitats from their hoofprints. One cause for the lower diversity in ephemeral wetlands next to row-crop tilling could be the increased sedimentation run off which is detrimental to ephemeral wetlands (O'Neill et al. 2016).

Marty (2005) also studied the effects of cattle grazing on the community composition found comparable results. This study compared the diversity of invertebrate and native plant species of continuously grazed, seasonal grazing and not grazed at all wetlands. Overall, the continuously grazed wetlands had a higher diversity and invertebrate species richness when compared to the none grazed wetlands. It was concluded that nonnative plant species also decreased when in continuously grazed wetlands. A cause of this could be that cattle selectively forage on grasses, and that reduces the canopy cover of the pools and nonnative plant species resulting in an increase of the diversity of crustaceans and native plant species richness (Marty, 2005).

Lastly, roadside artificial pools are a little different than normal reconstructed or artificial pool. These pools fill up alongside the road with rain and run off while traditional artificial pools are purposely created and filled with water. This study compared the embryonic survival of spotted salamanders of natural forested pools and artificial roadside pools. It was found that the survivorship of spotted salamander embryos was low at 1 to 29% while the woodland pools

survivorship was ranged from 1 to 79%. Since amphibians have low tolerance to salinity, the use of deicing salts on the roads have negative effects on the survival of amphibians (Turtle 2000).

Natural Parameters

Natural parameters tend to be variables that are out of the control of man. Most notably are those that have to do with weather. The natural parameters that will be discussed are area, depth, age, size, distance from permanent water, water deficits, precipitation, and clustering versus isolation.

Area and depth on vernal pool biodiversity was examined in a study done by Platenkamp (1996). Plants and macroinvertebrates were the main concentration as it was found that area and depth had important effects on the plant composition and the occurrence of fairy shrimp. Both area and depth had positive correlations with the plant species composition. While depth had a positive affect and area had a negative effect on fairy shrimp occurrence. The depth and area also play a key role in the hydroperiod of an ephemeral pools regime. The duration of ponding and frequency of drying during the growing seasons all are affected by the area and depth of the pools as well. This was caused by deeper pools usually having higher counts of active fairy shrimp and deeper depths will have higher plant species richness (Platenkamp, 1996).

Wupatki National Monument in Arizona, USA is home to many ephemeral wetlands, mostly natural rock formations that can hold water that home macroinvertebrates and amphibians. Graham (2002) conducted a study where different parameter were examined to observe what affects the species richness in these pools, most notably was the distance to permanent bodies of water, pool size, and the pools age. Age had very little effect on the species richness, while only affecting specific macroinvertebrates absence or presence. Current pool size

was slightly related to the richness and identify of certain macroinvertebrates. Pools close to permanent water had the highest amount of species opposed to pools far away from permanent water which had the lowest amount of species. One reason for this is that in permanent bodies, established communities have shown great resistance to immigration. Since temporary pools dry up, and the immigration to permanent bodies is unlikely, it results in an increase of ephemeral pool diversity and richness (Graham, 2002).

Precipitation is an important parameter than can determine if the pool will be full or dry. Brooks (2004) discovered that periods of significant water deficit cause an increase in pool drying levels. Pools that dried earlier in previous years had experienced low water deficits. These conditions can negatively affect the reproduction rate and success of amphibian species (Brooks, 2004). Ripley and Simovich (2008) used precipitation, habitat duration and size to test the crustacean communities in 34 vernal pools over the course of six years. In those six years, it was discovered that species richness depended on the pools filling with water and pools had the highest species richness in the years with the highest precipitation. Pond depth was also found to be a better predictor of species richness than habitat duration, but habitat duration and habitat depth are strongly correlated so both together can predict overall species richness. An explanation for these results could be that longer-lived pools have different resources that species respond to like algal growth (Ripley and Simovich, 2008).

Ephemeral wetlands in nature can be found either clustered close together or isolated. Clustered pools and isolated pools amphibian composition was compared in a study done by Dyke (2016). Clustered pools were discovered to have higher species richness with ten species while isolated only had four. For frog species that occurred in both pool types, there was a higher relative abundance at the clustered pools. Detection probability of amphibians was highest in the

clustered pools than the isolated pools for all but one amphibian's species. This could be caused by many amphibian's species extinction decreases but immigration increases when in the presence of neighboring pools (Dyke et al. 2016).

Conclusion

There are a lot of different parameters that can affect the community composition of ephemeral wetlands. A lot of anthropogenic and natural parameters seemed to be negative, but there were a few that had positive effects.

First, it was discovered that there was no significant difference between amphibian or invertebrate communities between natural and artificial vernal pools. Cattle grazing had a surprisingly positive affect on the native plant and crustacean communities while row-crop agriculture had a negative effect. Roadside vernal pools had negative effects on the embryonic survivorship of salamanders. Most natural parameters had a positive effect while there were some outliers collected from some studies. Area and depth are found to be highly correlated but can have different affects depending on the organism. For instance, fairy shrimp's occurrence was positively affected by depth but not area while plant composition was positively affected to both area and depth. The pools age and size had little to do with the overall species composition, but the closer to a permanent body of water increased the species richness. There was a positive effect on the species composition with a higher amphibian diversity and abundance when pools were clustered.

The parameters that positively affect community composition are as followed: cattle grazing, distance to permanent body of water, and the clustering of ephemeral wetlands (Table

1). Pool area and depth should also be a focus, but depending on the species, area and or depth could be beneficial or harmful (Platenkamp, 1996).

Table 1. Parameters summarized into one table. Anthropogenic Parameters (AP) and Natural Parameters (NP). (Kolozsvary and Holgerson, 2016, O'Neill et al. 2016, Marty, 2005, Turtle, 2000, Platenkamp 1996, Graham, 2002, Brooks, 2004, Ripley and Simovich, 2008, Dyke et al. 2016).

Type of Parameter	Parameter	Affect	Organism(s)
AP	Artificial Pools	No significant difference in composition compared to natural pools	Amphibians and invertebrates
AP	Cattle Grazing	Increases Diversity and richness	Crustaceans and Native Plants
AP	Agriculture	Decreases Diversity	Crustaceans
AP	Roadside Pools	Lowers Survival	Amphibians
NP	Pool Area	Positive affect on composition; negative affect on occurrence	Plants; fairy shrimp
NP	Pool Depth	Positive affect on composition and occurrence	Plants and fairy Shrimp
NP	Pool Age	Little to no effect on composition or occurrence	Overall species
NP	Current Pool Size	Slight relation to richness	Overall species
NP	Distance from Permanent Body of Water	Increases richness when closer to permanent body	Overall species
NP	Water deficits	Water deficits decrease reproductive rates	Amphibians
NP	Rainfall	Increased rainfall increases richness	Crustaceans
NP	Clustering	Increases diversity and richness	Amphibians

Conservation efforts need to focus on ephemeral wetlands that are clustered together and near permanent bodies of water. They should be deep and if possible continuously grazed by cattle in a region that has high precipitation. Since those parameters may not exist out in nature all together, these parameters should try to be replicated in either reconstructed or constructed

ephemeral wetlands. Future work for this study would be to directly test physiochemical parameters, like pH and dissolved oxygen content, on the community composition. With more data in how physiochemical parameters affect the community composition, there will be a more complete understanding of what affects the community composition of ephemeral wetlands and how to better mimic them.

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