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A comparison of pond vegetation across three ponds with different management techniques

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Abstract

Prairie wetlands are a significant biological ecosystem which support an abundance of biodiversity. At St. Olaf College, in Northfield Minnesota, there is a restored prairie with several ponds that represent this biome. This study aims to compare the types of vegetation around three ponds that each represent a different management strategy: Big Pond, which had the water level lowered, West Coyote Pond, which was in an area with a recent prescribed burn, and East Coyote Pond as the control. Vegetation was surveyed in 1x20 meter transects extending out from the pond in order to determine the type of vegetation that surrounds each pond ranging from the pond shores to the surrounding prairie. Significant differences in richness and diversity were found between the three ponds. Both richness and diversity were significantly lower for West Coyote Pond, while highest for East Coyote Pond. Despite the low richness and diversity, West Coyote Pond had the highest density of vegetation. Only two species were common among the three ponds: cattails (*Typha sp.*) and reed canary grass (*Phalaris arundinacea*), and they were present in varying densities. The results of this study give insight into the effects of different management techniques on pond vegetation and will inform future management practices.

Introduction

Wetlands provide an environment for a variety of vegetation and can be a transitional area between a pond and the land surrounding the pond. The vegetation in a wetland may vary depending on the location and surrounding environment. Vegetational stages will change and can represent seral stages. Seral stages are successional stages of an ecosystem in the same general geographic area. Seral stages are useful in studying vegetation because they can be used to

understand succession and how vegetation changes over time (Powell 2012). Vegetational stages include pond plants, submergents, emergents, dense marsh plants, and wet prairies. Management strategies such as water drawdown and prescribed burns can impact the vegetation in wetland areas. In Northfield, Minnesota, St. Olaf College manages an area of restored prairie wetlands with several ponds. These ponds provide a study location for observing vegetation and vegetational stages surrounding ponds and in prairie wetlands. The various management techniques used can also be analysed and compared in this setting.

A wetland management strategy includes water drawdown. Lowering the water level in a pond can improve the survival of vegetation in the littoral zone, where benthic plants are rooted (Carmignani and Roy 2017). Drawdown exposes mudflats and allows seeds to germinate which will increase species diversity (Valk and Davis 1978). One pond at St. Olaf College, Big Pond, had the water level lowered as a management technique a few weeks prior to this study. Overall, drawdown can be an important management tool for pond and wetland ecosystems.

Another management strategy is prescribed burns. Burns are an important disturbance that allow for increased species diversity. Burning removes dead organic matter, removes invasive species, and allows the ecosystem to flourish. Burning has been found to increase plant species richness in wetlands that have experienced prescribed burns (de Szalay and Resh 1997). Burning is a common management practice and is usually beneficial to the ecosystem. At St. Olaf, West Coyote Pond was burned a few weeks before this study in order to manage the cattail population at the pond.

If the vegetation surrounding ponds is surveyed by counting and identifying plant species, then there will be some difference in the vegetation between ponds with different management strategies. The objectives of this study were first to observe the types of vegetation

immediately surrounding a pond in a prairie biome, second, to determine the types of vegetation around a pond that has recently experienced a drawdown and one that has recently experienced a prescribed burn, and, third, to compare vegetation types with different management techniques around ponds in terms of diversity, density, and general trends.

Methods

In order to investigate the objectives, a survey was conducted on the vegetation surrounding three ponds in restored prairie at St. Olaf College. The ponds surveyed were Big Pond, West Coyote Pond, and East Coyote Pond. Four 1x20 meter transects were used at each pond, one on each of the four sides of the pond (Figure 1). Each transect extended about 5 meters in the pond and the rest of the transect extended outwards away from the pond. Each transect was divided into four sections, each 5 meters long in order to observe a variety of vegetational stages. The vegetation was identified and counted within each plot and transect. Observations were made throughout the months of September, October, and November of 2020.

Several calculations were performed to determine richness, diversity, and density. Shannon and Simpson diversity indices were calculated in order to determine diversity, and a pair-wise analysis was done to compare diversity across the different ponds and determine significant differences. An ANOVA test was performed in RStudio to determine differences in density, and pairwise T-tests were used to determine any significant differences in densities between the ponds. A significance value of 0.05 was used to determine significance.

Results

There were several trends and differences observed in the vegetation around each pond. Big Pond was the pond where the management strategy of drawdown had been implemented.

There were several vegetation stages that could be identified and were characterized by different types of dominant vegetation. Outside of the mudflat area, this pond had the grass *Bromus ciliatus*, approximately 5 to 10 meters from the start of the transect. Beyond this was mostly smartweed (*Polygonum amphibium*), and past the smartweed was reed canary grass (*Phalaris arundinacea*). The smartweed was around 10-15m and reed canary grass was dominant past 10 meters. This pond also had some cattails (*Typha sp.*) and some buffalo grass (*Bouteloua dactyloides*).

The pond that had a recent burn was West Coyote Pond. West Coyote Pond was characterized by cattails as the dominant vegetation. Cattails were most abundant at 5-10 meters from the water but were present all around the pond, extending past the 20m of the transect. There was also reed canary grass present at this pond, mostly past 10 meters. Besides cattails and reed canary, there were few other species at West Coyote, this pond had the lowest richness and diversity (Table 1). Despite this, this pond had the most total plants counted (768) and the highest density of plants (9.6/meter).

East Coyote Pond had experienced neither management strategy. East Coyote pond was also dominated by cattails and reed canary grass was found there. Like West Coyote Pond, there were also sedges (*Carex sp.*) and rushes (*Juncus sp.*), but this pond had the highest diversity (Figure 2). East Coyote Pond had other species such as aster (*Symphyotrichum novae-angliae, Symphyotrichum ericoides*), goldenrod (*Solidago altissima*), and nodding beggarticks (*Bidens cernua*).

Across the three ponds surveyed, East Coyote Pond had the highest species richness with 15 species (Table 1). East Coyote also had the highest species diversity (Table 1). Both Shannon and Simpson species indices were calculated for each pond and East Coyote Pond and Big Pond

were found to have similar levels of diversity. West Coyote had significantly lower diversity, and a pairwise analysis between the three ponds confirmed that this difference was significant (p-value <0.05). There were also differences in densities between the three ponds. ANOVA and t-tests were conducted to determine the significance of these differences. It was found that Big Pond had significantly lower plant density than the other two ponds (p-value <2e-16, Table 2 and Figure 2). The densities of cattails and reed canary grass were also compared because these species were the only plants that were found at all three ponds. There was a significant difference in the cattail density between Big Pond and West Coyote Pond, but not between the other ponds (p-value: 0.0001288). There was no significant difference in the density of reed canary grass between the three ponds.

Discussion

As expected, there were differences in the types of vegetation surrounding ponds with different management practices. It has been observed that ponds and the areas surrounding them represent seral stages in vegetation; from the edge of the water there are emergent plants, dense marsh plants, and wet prairies (Weller 1981). The trend explains the differences in dominant vegetation moving away from the water surrounding the pond. Much of the dominant vegetation observed, such as cattails and smartweed, are commonly found in shallow marshes. Reed canary grass and some of the vegetation unique to East Coyote Pond, such as aster and goldenrod, are considered to comprise fresh (wet) meadows (Eggers and Reed 1997).

Two previous studies have observed the vegetation around Big Pond (Kugler 1993, Lucas 2002). In 1993, the dominant species were reed canary grass and *Bromus ciliatus* (Kugler 1993). Ten years later in 2002, a year after a drawdown, the dominant species at Big Pond were goldenrod and reed canary grass (Lucas 2002). The dominant vegetation found at Big Pond in

this study include reed canary grass and *Bromus ciliatus*, making it more similar in composition to the 1993 condition than the post-drawdown 2002 condition.

West Coyote Pond had undergone a controlled burn. This pond had the lowest richness and diversity of the ponds studied, but it had the highest density (Tables 1 and 2). The pond had been burned recently, only a few months before data was collected. Likely, there was not sufficient time for biodiversity to increase after the burn event. Other studies have also found reduced biodiversity after fires, likely due to species specific reaction to burning (Pastro et al. 2011). In the next few years after the burn it is expected that certain species, such as heath aster and other prairie flowers, will increase, but none of these species were observed near West Coyote Pond (Kirsch and Kruse 1972).

Based on previous surveys of ponds in the St. Olaf natural lands by Kugler (1993) and Lucas (2002), I predicted a Shannon Index ranging from 0.2 to 1 and a Simpson Index ranging from approximately 0.09 to 0.4 for each pond. The calculated Shannon Index for each pond was in the predicted range, but the Simpson Index was higher for both Big Pond and East Coyote Pond (Table 1). This implies that the diversity of Big Pond (and East Coyote) has increased. The diversity of West Coyote Pond was lower than the range predicted which implies that the diversity is decreasing. This may be due to how recent the burn was and the density of cattails around this pond.

The results of the density analysis have several implications for future management practices. Big Pond has significantly lower density of cattails than the other ponds, implying that drawdown could reduce cattail density. Cattails are emergent vegetation so lowering the water level could reduce the range where they can grow and reduce their density (Sojda and Solberg 1993). It is also insightful that a pond recently experiencing a burn had lower species richness

and diversity than other ponds. This indicates that burning does not increase biodiversity immediately and other methods might be preferable for increasing wetland biodiversity. Future studies could be done to determine the long term effects of burning and drawdown on biodiversity.

Conclusion

After surveying three ponds at St. Olaf College in prairie wetlands, it was determined that there were significant differences in the vegetation present at each pond. These differences were also seen in differences in species richness, diversity, and density. The pond that had recently been burned, West Coyote Pond, had the lowest richness and diversity, but the highest plant density. These results imply that burning could have a negative effect on biodiversity, but burning combined with management of planting new species could increase diversity. The results of this study give insight into the effect of different management practices on wetland biodiversity and the types of vegetation found in wetlands.

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Literature Cited

Carmignani, J. R., and A. H. Roy. 2017. Ecological impacts of winter water level drawdowns on lake littoral zones: a review. Aquatic Sciences 79:803–824.

Eggers, S. D., and D. M. Reed. 1997. Wetland plant and plant communities of Minnesota and Wisconsin. US Army Corps of Engineers, St. Paul District, Minnesota.

Kirsch, L. M., and A. D. Kruse. 1972. Prairie Fires and Wildlife:15.

Kugler, K. 1993. Comparative study of vegetative growth between two wetland sites in Rice County, Minnesota.

Lucas, L. 2002. Evaluating a wetland: distribution and abundance of vegetation in Skoglund pond since the 2001 pond drawdown.

Pastro, L. A., C. R. Dickman, and M. Letnic. 2011. Burning for biodiversity or burning biodiversity? Prescribed burn vs. wildfire impacts on plants, lizards, and mammals. Ecological Applications 21:3238–3253.

Powell, D. 2012. A Stage Is A Stage Is A Stage…Or Is It? Successional Stages, Structural Stages, Seral Stages. White Paper.

Sojda, R. S., and K. L. Solberg. 1993. Management and control of cattails in D. H. Cross and P. Vohs, editors. Waterfowl management handbook. US Fish and Wildlife Service, Fort Collins, Colorado.

de Szalay, F. A., and V. H. Resh. 1997. Responses of wetland invertebrates and plants important in waterfowl diets to burning and mowing of emergent vegetation. Wetlands 17:149–156.

Valk, A. G. van der, and C. B. Davis. 1978. The role of seed banks in the vegetation dynamics of prairie glacial marshes. Ecology 59:322–335.

Weller, Milton W. 1981. Freshwater marshes: ecology and wildlife management. University of Minnesota Press. P.18-22, 35, 51-57.

Figures

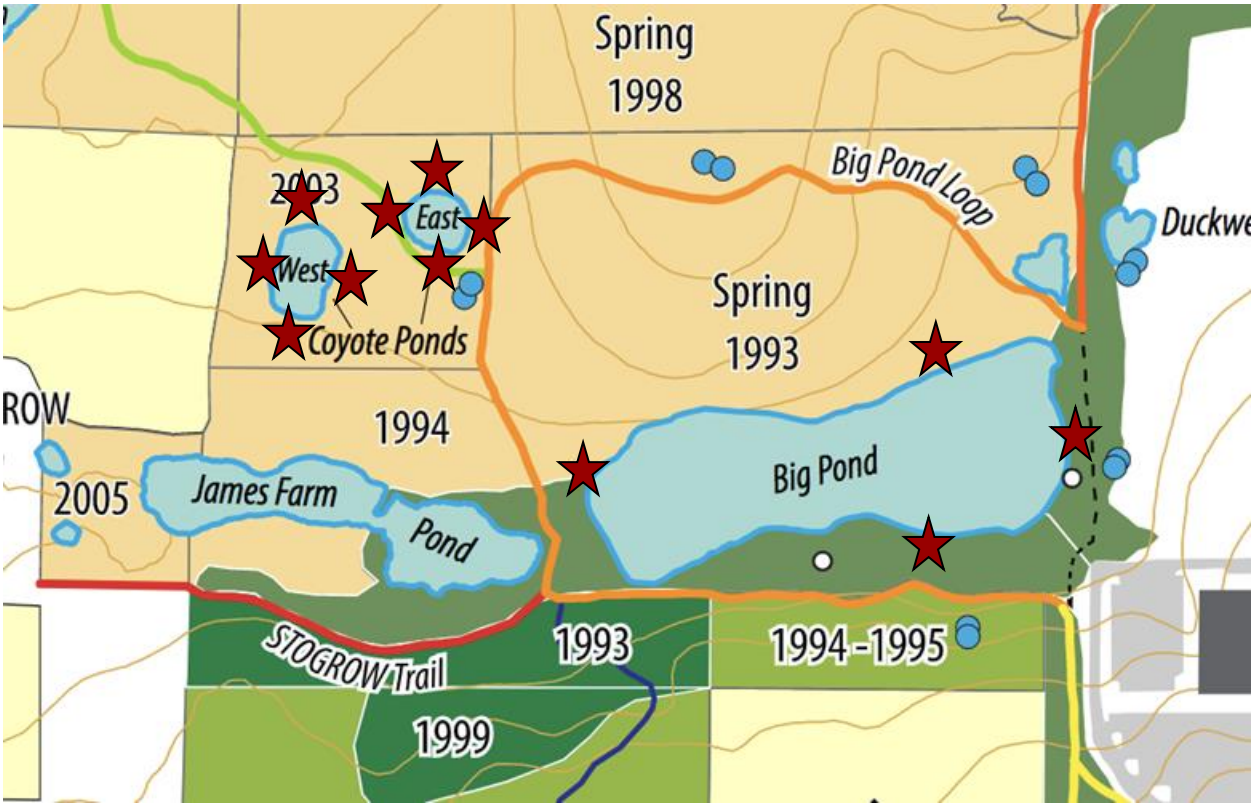

Figure 1. Diagram of the study sites. The three ponds surveyed were Big Pond, West Coyote Pond, and East Coyote Pond. The red stars represent where the transects were placed and data was collected.

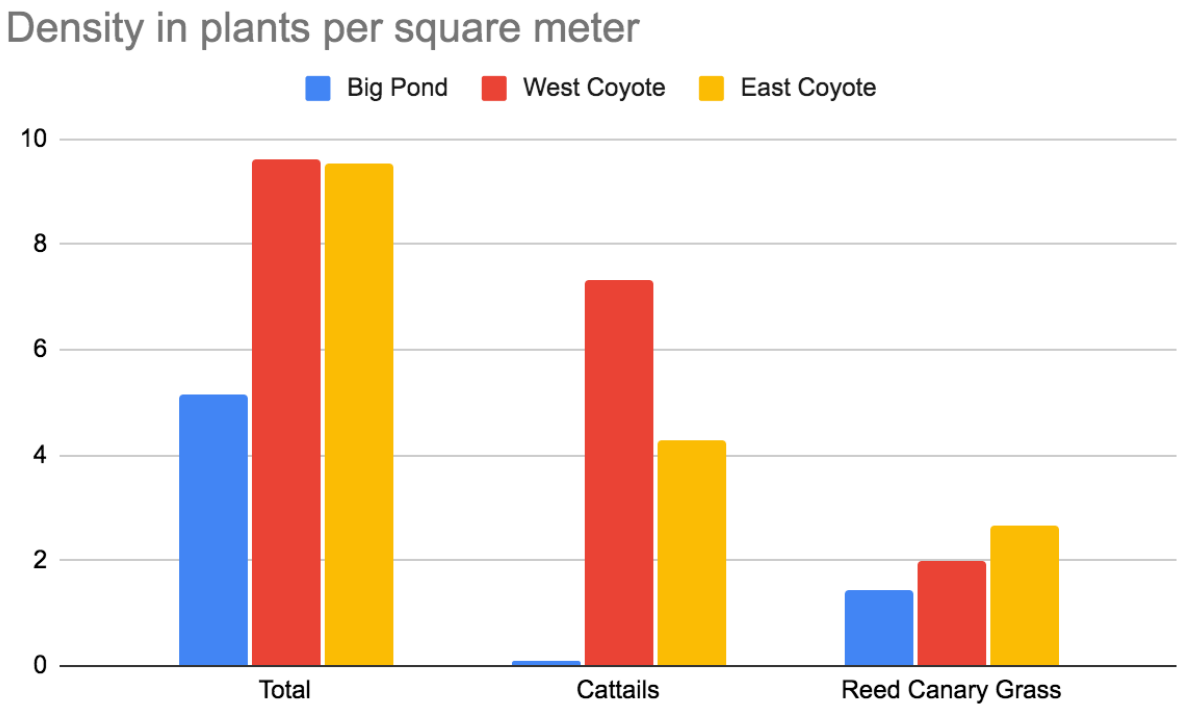

Figure 2. Visual representation of densities for various species across the three ponds surveyed. Cattails and reed canary grass were compared because they were the only species that were common across the three ponds. There were significant differences in the total densities (p-value: <2e-16) and the density of cattails (p-value: 0.000973), but not in the densities of reed canary grass (p-value: 0.441).

Table 1. Species richness and diversity of the three ponds surveyed. There was a significant difference in the Simpson diversity index between West Coyote Pond and the other two ponds (p-value <0.05). There was no significant difference between Big Pond and East Coyote Pond (p-value >0.05).

	Big Pond	West Coyote	East Coyote
Richness	12	4	15
Shannon (H')	0.66	0.38	0.70
Simpson (D')	0.7	0.27	0.71
Variance of Ds	0.000201	0.000144	0.00319

Table 2: Average densities. Cattails and reed canary grass were compared because they were the only species common among the three ponds.

Plant Density	**Big Pond**	**East Coyote Pond**	**West Coyote Pond**	**p-value**
Total	5.1625	9.55	9.6	<2e-16
Cattail	0.1125	4.275	7.3375	0.000973
Reed Canary Grass	1.45	2.675	2	0.441