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Local Ecology Research Papers

Potential for wetland restoration at the Engeseth-Rinde Farm, Nerstrand, MN

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Potential for Wetland Restoration at the Engeseth-Rinde Farm, Nerstrand, MN

Analysis on the Invasive Reed Canary Grass (*Phalaris arundinacea*) and Soil Characteristics

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Abstract
Given the important ecological services wetlands provide, there has been significant interest in wetland restoration over the last 20 years in an attempt to restore the nearly three million ha of lost wetlands in North America. This study examines the potential restoration of the Engeseth-Rinde Farm in Nerstrand, MN. The area is currently managed by the Minnesota Department of Natural Resources as a Wildlife Management Area. The Minnesota DNR has plans to restore several native habitats within this area. The objectives of this study were to 1) provide a quantitative summary of the amount of invasive reed canary grass that has dominated this area, 2) provide the DNR with a soil analysis of each site, and 3) give restoration recommendations. Both sites demonstrated a strong presence of reed canary grass, although there was no significant difference in density between sites. Soil analysis revealed similar trends in soil characteristics, with a surprisingly low pH at both sites. Given the striking similarities between sites, it is clear both would benefit from restoration. We recommend the DNR target Site 6 first given its larger size and proximity to the forested areas to aid biodiversity. The results suggest that successful wetland restoration in the area could be valuable in the farm's regulation of water quality, biodiversity, and flood control.

Introduction

Wetlands provide important services for our ecosystem such as carbon storage, biodiversity conservation, fish production, water purification, flood and shoreline surge, and erosion control (Moreno-Mateos, 2012). According to Zedler (2003), wetlands can contribute nearly 40% of our renewable ecosystem services, yet account for only 1.5% of the earth's surface. Unfortunately, due to human activities, over half of the ecosystems that existed in the 20th century have been lost in places such as North America, Europe, Australia, and China. Fortunately, as research has increased, we now see the importance of restoration. In the last 20 years, North America has spent over $70 billion in an attempt to restore more than three million ha of lost wetlands (Zedler, 2003).

Research has demonstrated that wetland restoration often fails at retaining their original levels of biodiversity, functioning, and sustainability. Potential causes of this include: incorrect water levels, animals failing to use their designated site, and the presence of an invasive exotic species. It is important to know that not all wetlands perform their services equally well. For example, large wetlands support many bird species, while small wetlands are often home to rare plants (Moreno-Mateos, 2012). For this reason, researchers must explore a comprehensive restoration approach.

Reed canary grass (*Phalaris arundinacea*) was originally introduced from Europe for agricultural use (Maurer et al., 2003). Today, reed canary grass is an invasive species dominating wetlands in the midwest (Weiss, 2014). The grass has been planted for many years in places such as grass waterways, pastures, and roadsides because of its ability to swiftly establish itself, producing dense vegetation that can be used for erosion control and soil stabilization ("Invasive Species Control Information," 2008). The downside of this is that it often crowds out native vegetation and prevents the opportunity for foraging and nesting of wildlife. Reed canary grass has the potential to homogenize the habitat structure, alter hydrology, and limit tree regeneration by shading and crowding out seedlings (Wisconsin Reed Canary Grass Management Working Group, 2009).

While examining wetland restorations, reed canary grass is a common threat to the ecological integrity, as it often decreases the overall diversity and resilience of wetlands in the midwest (Wisconsin Reed Canary Grass Management Working Group 2009). This study will look specifically at the potential wetland restoration of the Engeseth-Rinde Farm in Nerstrand, MN. The restoration could have the potential to improve both the water quality and biodiversity of the wetland. The objectives of this study were to 1) determine the average density of reed canary grass at two wetlands within Prairie Creek, 2) compare soil characteristics (bulk density, % moisture, % organic matter, and pH) between sites, and 3) suggest potential management strategies for the invasive reed canary grass.

Methods

Site Description

The study was conducted at the Engeseth-Rinde section of the Prairie Creek Wildlife Management Area in Nerstrand, MN. The land has been farmed since the mid-1800s and once had a railroad running through it that has since been removed. In 2008, the process of putting the land under conservation began where the site was transferred to state ownership as a management area ("Friends of Prairie Creek," 2017). It is currently under the supervision of the Minnesota Department of Natural Resources. The land has since been divided into multiple sections as seen in Figure 1. After reviewing data compiled from the St. Olaf wetland restoration group from the spring of 2017, this study specifically examined Site 6 and Site 7 as potential wetland restoration areas. It is important to note that while both sites were saturated with water in the spring (as stated by the St. Olaf group), there was no standing water when this study was conducted in the fall. Each site was sampled in October 2017.

Sampling

Reed canary grass analysis:

A line-intercept technique was used to measure the amount of reed canary grass at each site according to the guidelines in the Field and Laboratory Methods for General Ecology (Brower, Zar, and von Ende, 1998). Site 6 was split up into three transects 16 m apart, while Site 7 was much smaller and split into two transects 10 m apart. For each transect, a measuring tape was extended by stakes and elevated 3 m. Beginning at one end of the tape, each stem of reed canary grass within 1 cm of the tape was counted for 1 m straight and repeated at every 4 m interval until reed canary presence ended.

Soil characteristic analysis

The start of each transect at each site was used for soil samples. Three samples were taken at Site 6 and two samples were taken at Site 7. A soil tube sampler was used to extract soil from the top 15 cm. Each sample was placed in a sealed plastic bag and brought into the laboratory for determination of soil bulk density, % soil moisture, % soil organic content, and pH.

Data Analysis

Soil analysis values (bulk density, % soil moisture, % soil organic content, pH) were calculated in Excel by following the guidelines of Brower, Zar, and von Ende (1998). Analysis of variance (ANOVA) to compare density of reed canary and soil characteristics between sites was performed using version 3.3.1 of R and the R-Commander module.

Results

______Both sites demonstrated severe evidence of reed canarygrass invasion. Table 1 demonstrates that each site had similar levels of reed canary density as there was no significant difference in density between the two sites (Site 7: mean= 35.8 grasses/m; Site 6: mean=35.6 grasses/m).

After comparing soil characteristics between sites (bulk density, % moisture, % organic matter, pH) using ANOVA there was only a significant difference in % soil moisture between sites (see Table 2). Site 7 had significantly higher moisture than Site 6: 51.1% and 39.9% respectively (p= 0.035). Soil from both sites were relatively acidic, with an average pH of about 5.1. There was no significant difference in soil bulk density between sites: Site 7 mean= 0.928 g/cm3 and Site 6: mean= 0.991g/cm3. Similarly, there was no significant difference among sites in % soil organic matter : Site 7 9.0% and Site 6: 10.6%.

Discussion

After assessing Sites 6 and 7 on the Engeseth-Rinde farm, I found the dominance of reed canary grass to be the greatest threat to the area's biodiversity and the largest barrier to successful restoration. My aim was to provide a restoration recommendation to the Minnesota DNR about which site they should focus their restoration attention to first. After evaluating both site’s reed canary density and soil characteristics, there was no significant difference between the two sites besides in their % moisture values. Both sites had a reed canary density of about 35 stems/linear m, which is evidence on just how severely these wetlands are invaded with reed canary grass.

The soil pH values may be evidence for how reed canary grass can homogenize the habit they invade. While the St. Olaf Environmental studies group found pH values ranging from 7.6 to 8.3, this study found much lower pH values in the 5-5.1 range. Current literature (Palmer, 2016) claims that invasive species can alter soil conditions to the detriment of the native species, and these changes often persist even after the invader is removed. Studies from Wisconsin and Ohio indicate that reed canary grass can tolerate pH ranging from 6.0 to 8.1, while in Tennessee, reed canary grass is known to tolerate soil pH as low as 5 (Klopatek and Stearns, 1978). These values prove just how tolerable reed canary grass are to varying pH values and may provide insights into their competitive advantage against other species. It is also important for the Minnesota DNR to consider the pH of the soil in their management plans. Restoration is often unsuccessful if nutrient pollution and soil fertility are not addressed. Furthermore, if planting of native species is part of the restoration plan, they must ensure these species can tolerate the low soil pH of these sites.

Unfortunately I cannot make my restoration recommendation as to which site the DNR should focus on first based on the data I obtained. There was little statistical difference between the two sites and both sites were severely taken over by reed canary. Based on the larger size and more central location of Site 6, my recommendation would be to focus restoration attention there first. The proximity of Site 6 near the forested areas allows for uninterrupted habitat connectivity, which could aid in maintaining biodiversity. In addition, after reviewing the observations of wildlife by the St. Olaf Environmental Studies Group, Site 6 is known to already provide a habitat and food for animals such as snakes, birds, possums, and wild turkey. They also mention that, given the long shape of Site 6, it is an ideal location for the DNR to look into adding a walking path. While wetlands are known to aid in biodiversity conservation, water quality, and flood control, they are also can act as a source of recreation (Minnesota DNR, 2017). I recommend the DNR consider adding a path in their management plans as it could provide a space for non-intrusive educational opportunities and wildlife observation.

There are several different approaches to consider when removing reed canary grass, each has their own benefits. Mowing is recommended to remove biomass and nutrients and is a substitute for fire although not as effective. Mowing is beneficial before reed canary grass seed heads appear and can help reduce biomass before herbicide treatment . Herbicide treatments work to reduce plan height, deplete rhizome reserves, and increase light to promote competition (Wisconsin Reed Canary Grass Management, 2009). Herbicides can also work to try out reed canary grass before burning. In addition, burning removes biomass and litter. It is recommended to use burning as a technique to reduce reed canary grass in the late spring after reed canary grass is active but before native species break dormancy (Wisconsin Reed Canary Grass Management, 2009). Adams and Galatowitsch (2006) found that spring burns of reed canary grass reduced the density of its seed bank and encouraged the resettlement of native species. Furthermore, they found that herbicide treatment in the fall was twice as effective as applying herbicide in the spring.

My recommendation for the DNR would be to implement an aggressive approach to controlling reed canary by using a combination of mowing, burning, and herbicide treatment starting at Site 6. The DNR should couple the removal of reed canary grass with the introduction of competitive native species like rattlesnake grass (*Glyceria canadensis*), lake sedge *(Carex lacustris)*, bluejoint *(Calamagrostis canadensis)*, and rattlesnake grass *(Glyceria canadensis)* (Minnesota DNR, 2017). These methods alone will most likely not prevent recolonization of reed, so I recommend that removals take place over multiple years.

Conclusions

This study examined the restoration potential of the Engeseth-Rinde Farm in Nerstrand, MN. It provided a quantitative assessment of the reed canary at Sites 6 and 7 of the property and found no significant difference in density between the two sites. Soil analysis found no significant difference among characteristics between sites besides in % moisture. Site 7 had significantly higher moisture than Site 6. My study is an extension of the St. Olaf Environmental Studies Group from the spring of 2017, but my results were able to give a quantitative assessment of reed canary linear density that the previous group did not provide. My recommendation is that the Minnesota DNR focus restoration attention on Site 6 first. Restoration of Site 6 may reveal successful removal techniques for suppressing reed canary growth and can help decide the right approaches if they decide to move forward with future restoration plans at different wetlands within the property. Future qualitative and quantitative assessments of the sites may inform the progression of restoration. While there was no standing water in the fall, the Environmental Studies Group in the spring noted both sites were saturated with water. Continuous evaluation in future years during both seasons is necessary to assess patterns in these wetlands.

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Tables and Figures:

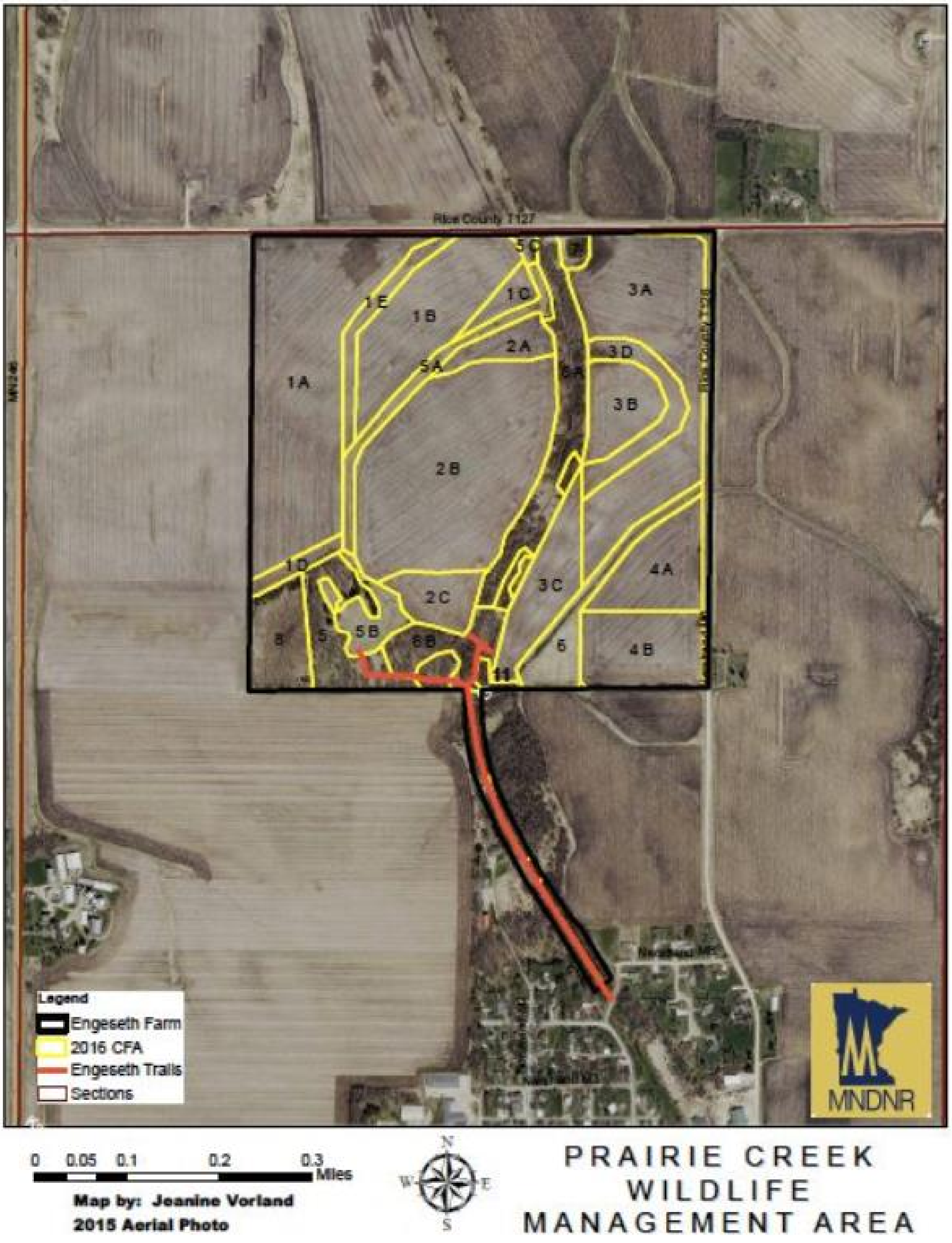

Figure 1: Map of Prairie Creek Wildlife Management Area

Figure 2: Site 6 view of the area (left). Close up of the invasion of reed canary grass (right)

(A)(B)

Figure 3: Site 7 (A) View of the wetland in October 2017. (B) Image from the St. Olaf Environmental studies students showing Site 7 flooded in the spring of 2017

Table 1: Analysis of variance (ANOVA) of reed canary grass shows no statistically significant difference of mean linear density between Site 6 and Site 7

Site	**Mean Density (stems/linear m)**	**Std. Deviation**	**n**
Seven	35.85714	14.0431	14
Six	35.57143	12.99835	21

p-value=0.951			

Table 2: Analysis of variance (ANOVA) of soil characteristics by site. % Moisture is the only characteristic that showed a statistically significant difference (p=0.0352) between sites

	Site	Mean	Std. Deviation	n
Soil Bulk Density (g/cm3)	Seven	0.9280	0.0658	2
p-value=0.29	Six	0.9910	0.1300	3
% Moisture	Seven	51.0616	0.0109	2
p-value=0.0352	Six	39.8709	0.0403	3
% organic matter	Seven	8.9679	0.0189	2
p-value=0.233	Six	10.6042	0.0062	3
pH	Seven	5.0807		2
p-value=0.868	Six	5.0514		3

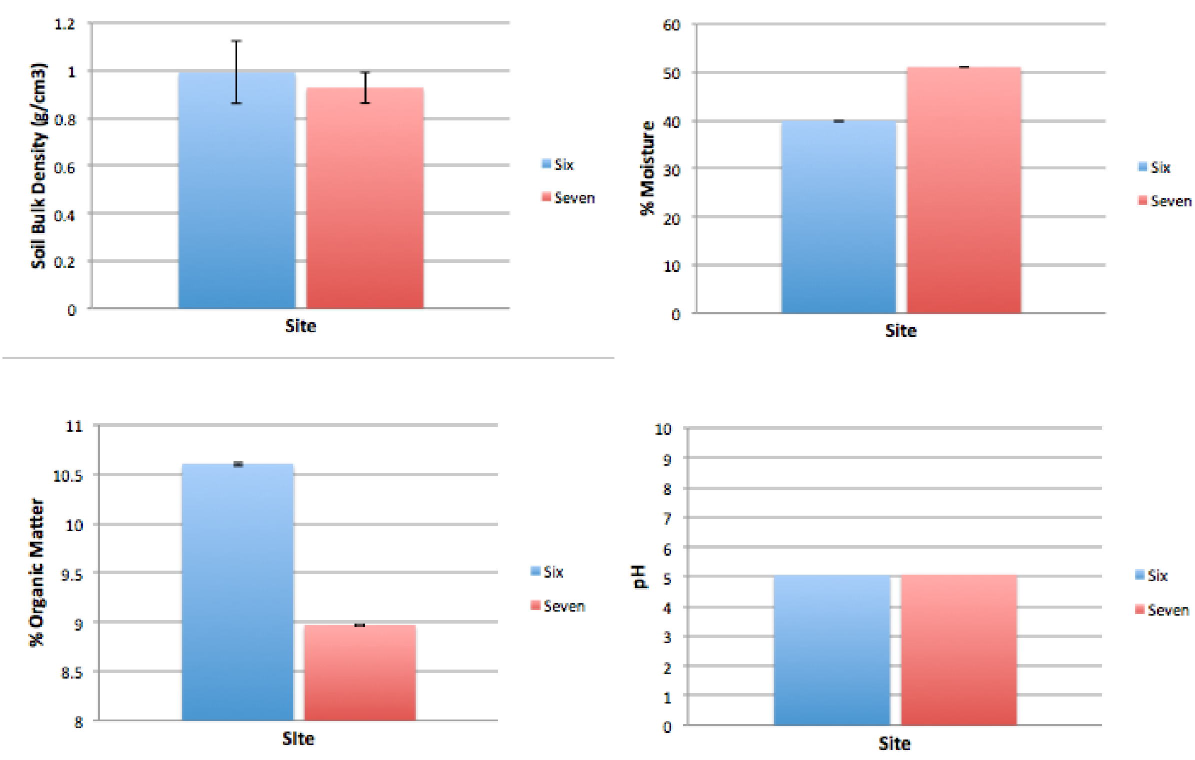

Figure 4: Graphical representations of soil characteristic values seen in Table 2.