The Search for a Relict Prairie Graminoid Community in Western New York

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Abstract

During a period of increased temperatures and decreased precipitation in the Holocene epoch, certain prairie graminoid species colonized the deciduous forests of the northeastern United States. This prairie graminoid community typically occurred in openings within oak forest stands, leading the community to be termed an "oak opening." A survey of the vascular plant species identified within Mendon Ponds County Park (MPCP) in Mendon and Pittsford, New York between 1863 and 1943 noted the presence of one small oak opening (Goodwin 1943). I sought to relocate this oak opening and measure any changes in the abundance and composition of graminoid species. To determine if I had successfully relocated the oak opening, I compared the graminoid species composition of my oak opening site with the listed species composition of the original oak opening, and I compared the vegetation and soil characteristics of my proposed oak opening site with those of one meadow site and two forested sites with different canopy tree species. I identified four of the nine original prairie species in the oak opening site. Although I identified graminoid species in all four current sites, the species composition of the oak opening site was different from that of the meadow and forest sites. Graminoid percent cover, graminoid species richness, herbaceous vegetation percent cover, and soil organic matter content all varied significantly among sites. Although the oak opening site displayed some similarities to the forest and meadow sites, the overall differences in the vegetation and soil characteristics in combination with the species composition of the oak opening site led me to conclude that I had successfully relocated the oak opening described by Goodwin (1943). The future of the oak opening, however, remains unclear due to the spread of swallowwort (*Vincetoxicum spp.)*, an invasive perennial forb, throughout the site. Swallowwort has been shown to negatively impact communities by reducing floral and faunal diversity, decreasing butterfly populations, and usurping habitat used by grassland birds for nesting. The presence of invasive swallowwort threatens the persistence of the MPCP oak opening, a unique and locally rare floral community.

Introduction

Glaciation during the Pleistocene epoch shaped the landscape of western New York (Isachen *et al.* 2000). An abundance of glacial features, including eskers, kames, and kettles, are present within Mendon Ponds County Park (MPCP) located south of Rochester, NY. These glacial features support unique floral communities (Goodwin 1943). In 1943, Goodwin published a list of the vascular plant species identified within MPCP between 1863 and 1943. Among the plant communities he described, one assemblage was already rare within the park by 1943 (Goodwin 1943). An oak opening is an open land community consisting of graminoid species typically found within prairie habitat that occurs within oak forest stands on dry soils (Shanks 1966). Oak forest types dominated forests in western New York during the xerothermic phase of the Holocene epoch (Gordon 1939). This period of decreased rainfall and increased temperatures led to an increase in the number of oak openings and associated prairie species (Gordon 1939). As the climate in the northeastern United States became wetter during the later

phases of the Holocene, the dominant oak forest types were replaced by mixed hardwood forests leading to a decrease in the number of oak openings (Shanks 1966). Despite the decrease in abundance, oak forest types persisted in suitable habitats. A compendium of southwestern New York forest types described dry sites on steep slopes as the typical habitat of the mixed oak forest type (Gordon 1939). The mixed oak type includes black oak (*Quercus velutina*) and pignut hickory (*Carya glabra*) (Gordon 1939), both listed by Goodwin (1943) in his description of the oak opening at MPCP. Goodwin (1943) noted a small oak opening atop a kame northeast of Quaker Pond with a community of graminoid species typically associated with prairie habitat. The three dominant grass species in oak openings, all of which were included in Goodwin's (1943) description of the MPCP oak opening, are little bluestem (*Schizachyrium scoparius*), big bluestem (*Andropogon gerardii*), and Indian grass (*Sorghastrum nutans*) (Shanks and Goodwin 1943).

In the years following Goodwin's (1943) publication, changes in management practices have led to shifts in the vegetation of MPCP. By the 1920s, much of the area that would become MPCP had been cleared for pastoral and agricultural use (Fairchild 1926). Following the park's formation in 1930, agriculture ceased to allow reforestation; however, gravel mining, peat extraction, tree farming, and logging operations still took place within the park (Goodwin 1943). Over time, the utilization of the park for natural resources diminished, and in 1969 the park was declared a National Natural Historic Landmark (Monroe County Dept of Parks 2011). At present, the park maintains 30 miles of hiking trails and a 550-acre nature preserve (Monroe County Dept of Parks 2011). The shift from managing for resource extraction to managing for recreational use has promoted habitat restoration within much of the park. Currently, the park contains a variety of habitat types, including meadows, hardwood forests, swamps, bogs, grasslands, coniferous forests, and wetlands (Monroe County Dept of Parks 2011). I sought to determine whether the oak opening located by Goodwin (1943) had persisted to the present day, and, if so, to measure shifts in the abundance and species richness of the graminoids in the oak opening. There are obvious difficulties associated with identifying a small assemblage of plants that might have altered past the point of recognition. I surveyed the vegetation and soil characteristics of two forest plant communities with different canopy tree species and one meadow plant community near Quaker Pond to provide a comparison with my proposed oak opening site.

Methods

I sampled four sites at Mendon Ponds County Park, Mendon and Pittsford, Monroe County, New York between 31 October 2011 and 13 November 2011. The oak opening site was located on a sloping hillside northeast of Quaker Pond, on the southwestern section of the East Esker Trail, adjacent to Douglas Road between the Cavalry Lodge and the boat launch. I chose this location because a perfunctory inspection revealed that the site contained at least two of the characteristic prairie graminoid species described by Goodwin (1943) as oak opening inhabitants. I compared the oak opening site with three other sites. The forested sites were located on hilltops due east of the Quaker Pond Trail, approximately 300 m south of the trailhead. The pine-oak forest site was approximately 100 m east of the trail. Canopy tree species included eastern white pine (*Pinus strobus*), black oak, and white oak (*Quercus alba*). The black locust forest site was located on the top of an adjoining hill approximately 100 m east of the pine-oak site. Canopy tree species included black locust (*Robinia pseudoacacia*), black

cherry (*Prunus* serotina), and eastern white pine. The fourth site was located in a low-lying meadow approximately 200 m north of the pine-oak site.

At the approximate center of each site, I laid a 50-m transect line from north to south. I selected a point on the transect line using a random number table. Then, I randomly selected the number of meters east or west of the transect line at which to establish a one by one meter plot. I sampled three plots on the eastern side and three plots on the western side of the transect line. At each plot I measured the presence or absence of canopy cover using a densiometer, the species and diameter at breast height of all trees, the species and percent cover of all graminoids, and the percent cover of herbaceous vegetation. Percent cover was determined by visual inspection. I also noted the presence or absence of down woody material (DWM). I used a soil corer to collect three soil samples from each site. The samples were collected haphazardly near the beginning, middle, and end of the transect line. The three soil samples from each site were pooled to calculate soil moisture and soil organic matter content. Soil moisture was determined by comparing the mass of the pooled samples before and after drying at 104ºC for 24 hours. Soil organic matter (SOM) was estimated by calculating the average loss on ignition (LOI) of two subsamples from each site. The soils were dried at 104ºC for 24 hours and then combusted in a muffle furnace at approximately 360ºC for two hours. Loss on ignition was calculated using the difference in subsample masses before and after combustion. I used a one-way ANOVA to compare the effect of the site treatment on graminoid species richness and LOI. A Tukey post-hoc analysis was used to determine the individual relationships between significant treatments. Because the data were not normally distributed, I used a Kruskal-Wallis test to compare graminoid cover and herbaceous vegetation cover among sites.

Results

The combined plots contained seven graminoid species: *Agrostis alba, Panicum dichotomiflorum, Poa compressa, Poa palustris, Schizachyrium scoparium, Sorghastrum nutans,* and *Sporobolus vaginiflorus* (Table 1). I was unable to identify all grasses to the species level. Multiple individuals could only be identified as belonging to the *Poa* genus. Graminoid species that occurred within the three sites, but outside the plots, were *Bromus ciliatus, Juncus effusus, Juncus macer, Leptoloma cognatum*, and *Panicum clandestinum*. The oak opening plots contained *P. compressa, S. scoparium*, and *S. nutans*. All three species were listed by Goodwin (1943) as oak opening inhabitants. The pine-oak forest plots contained *P. compressa, P. palustris,* and *S. vaginiflorus*. The black locust plots contained only *P. compressa*. The meadow plots contained *A. alba, P. dichotomiflorum, P. compressa,* and *S. vaginiflorus*. *Poa compressa* was the only prairie species listed by Goodwin (1943) found within the pine-oak forest, black locust forest, and meadow plots.

Both canopy cover and DWM were present at all pine-oak forest and black locust forest plots and absent at all oak opening and meadow plots (n = 6 plots per site). Only one tree was found in any of the plots. The tree was a black locust with a dbh of 15.6 cm located in the black locust forest site. The soil moisture contents of the pine-oak forest (13.754%) and meadow (13.392%) sites were less than those of the black locust forest (16.271%) and oak opening (15.321%) sites.

Graminoid cover and herbaceous vegetation cover were significantly different among sites (Table 2). The median graminoid cover at the meadow site (95.0%) was much higher than the median graminoid cover at the oak opening (31.0%), pine-oak forest (10.5%), and black

locust forest (0%) sites. The median herbaceous vegetation cover at the oak opening site (60.0%) was higher than that of the black locust forest (20.0%), pine-oak forest (10.0%), and meadow (5.0%) sites. Both the mean graminoid cover and mean herbaceous vegetation cover followed the same pattern as the median graminoid cover (Figure 1) and median herbaceous vegetation cover (Figure 2), respectively.

Graminoid species richness and SOM varied significantly among sites (Table 3). Graminoid species richness was significantly lower at the black locust forest site than at the oak opening and meadow sites (Figure 3). The graminoid species richness of the pine-oak site was not significantly different from any other site. The SOM content at the oak opening site was significantly less than that of all other sites (Figure 4). The two forested sites did not differ statistically in SOM content, but the forested sites' SOM contents were significantly greater than that of the meadow site.

Discussion

In order to assess the likelihood that I successfully relocated Goodwin's (1943) oak opening, I compared the current graminoid inhabitants of the oak opening site I located with those described by Goodwin, and I compared the vegetation and soil characteristics of the oak opening site I located with those at two forested sites and one meadow site. Of the nine prairie remnant graminoid species listed by Goodwin (1943), I found three of the species within the plots and one of the species outside the plots at the oak opening site (Table 4). Two of the prairie species I located within the plots, *S. scoparium* and *S. nutans*, are dominant oak opening species (Shanks and Goodwin 1943). Goodwin (1943) described the other two species, *P. compressa* and *J. tenuis*, as abundant and common within the park, respectively. Of the remnant prairie species that were not present, *Carex pennsylvanica*, *Danthonia spicata*, and *Luzula multiflora* flower in the spring and summer (Brown 1979), rendering fall identification difficult. The presence of two dominant oak opening species and two other listed oak opening species within the site suggests that I successfully relocated the oak opening, particularly as three of the nine listed prairie remnant species were unlikely to be found due to the season of sampling.

In his description of the oak opening, Goodwin (1943) emphasized the singularity of the vegetation and soil characteristics compared to the surrounding landscape. Therefore, I assumed that the oak opening, if still present, would differ significantly from the forested and meadow sites in the vegetation and soil characteristics I measured. I found both differences and similarities between the oak opening site and the other three sites. All four sites contained *P. compressa*, one of the characteristic oak opening grasses (Goodwin 1943). This result was not surprising as *P. compressa* was described as abundant within the park (Goodwin 1943). The graminoid species richness of the oak opening was not significantly different from that of the meadow or pine-oak forest sites. However, there was little overlap in the graminoid species present in the plots (Figure 5). The difference in graminoid species composition between the oak opening site and the forest and meadow sites lends support to the conclusion that I successfully relocated Goodwin's (1943) oak opening.

The oak opening exhibited a higher graminoid percent cover than the forested sites, but a lower graminoid cover than the meadow site. As the meadow and oak opening sites were both open lands with no tree cover, the large difference in graminoid cover between the sites was unexpected. However, the oak opening site contained much greater herbaceous vegetation cover than the meadow site. The median herbaceous vegetation cover at the oak opening site was 12

times that of the meadow site. Interestingly, the increased graminoid cover within the meadow site did not lead to greater species richness. This result may be due to the presence of a dominant graminoid species. The percent cover of the species with the highest percent cover (*Poa spp.*) was over three times greater than the percent cover of all other graminoid species combined. Conversely, within the oak opening site, the percent cover of the species with the highest percent cover was less than 1.5 times greater than the combined percent cover of the other graminoid species.

The soil characteristics of the oak opening site were somewhat contradictory. The oak opening site had the second-highest soil moisture content, which was approximately one percent less than that of the black locust forest site. While the soil moisture contents of the pine-oak forest and meadow sites were between one and three percent less than those of the oak opening and black locust forest sites. I had anticipated that the oak opening would have the lowest soil moisture content because dependence on dry soils for establishment is a defining characteristic of oak openings (Shanks 1966). The high relative soil moisture content of the oak opening site might have been caused by the proliferation of herbaceous species within the site. At 60 percent cover (Table 1), the herbaceous vegetation could have considerable effects on the site's soil characteristics. Also, the soil samples were collected in the center of the site along the transect line, where the herbaceous species were most abundant. Further exploration of the site's soil moisture content, particularly in graminoid-dominated sections, is warranted. As expected, the oak opening site possessed a significantly lower SOM content than all other sites. Oak openings form on dry, nutrient-poor soils (Goodwin 1943). Thus, the low SOM content of the oak opening site provides support for the conclusion that I successfully relocated Goodwin's (1943) oak opening.

The fidelity between the species found within the oak opening site and those listed by Goodwin (1943), as well as the differences in soil and vegetation characteristics between the oak opening site and the forested and meadow sites, led me to conclude that I had relocated the oak opening site. However, although the oak opening was recognizable, significant changes had occurred since Goodwin's (1943) survey. First, only four of the nine prairie remnant species were present. While some of the "missing" species might have been present in the site in an unidentifiable form, the absence of *A. gerardii*, one of the dominant oak opening species (Shanks and Goodwin 1943), indicated that changes in species composition were likely to have taken place. Second, although the abundances of herbaceous vegetation species were not listed, the extent of herbaceous vegetation cover visible in pictures of other oak openings within Monroe County from the 1940s is not nearly as great as the extent of herbaceous vegetation cover at present (Pictures 1-4). The herbaceous vegetation cover in the oak opening site consisted primarily of *Vincetoxicum spp.*, invasive perennial forbs introduced to North America in the middle to late 1800s (Sheeley and Raynal 1996). There were no sightings of *Vincetoxicum* within MPCP between 1863 and 1943 (Goodwin 1943), nor was *Vincetoxicum* described in a later survey of the flora of Monroe County (Shanks 1966). The presence of *Vincetoxicum spp.* within MPCP is troubling because *Vincetoxicum* readily forms dense monocultures, leading to decreased floral and faunal species diversity, reduced monarch butterfly (*Danaus plexippus*) populations, and decreased nesting habitat for grassland birds (DiTommaso *et al.* 2005). While sampling I noticed that *Vincetoxicum* was most abundant throughout the center of the oak opening, relegating the graminoid species to the edges of the site. If left unmanaged, *Vincetoxicum* is likely to continue spreading throughout the oak opening, potentially extirpating a locally unique floral assemblage that has persisted since the Holocene epoch.

Tables and Figures

Graminoid Species	Oak Opening	Pine-Oak Forest	Black Locust Forest	Meadow
Agrostis alba				X
Bromus ciliatus				*
Juncus effusus		*		
Juncus macer (tenuis)	*^{L}	*^{L}		
Leptoloma cognatum				*
Panicum clandestinum		*		
Panicum dichotomiflorum				X
Poa compressa	X^{L}	X^{L}	X^{L}	X^{L}
Poa palustris		X		
Schizachyrium scoparium (Andropogon scoparius)	X^{L}			
Sorghastrum nutans	X^{L}			*^{L}
Sporobolus vaginiflorus	*	X		X

Table 1. Graminoid species identified at four sites at Mendon Ponds County Park, New York. Species identified within the site, but not within a measured plot are indicated by *. Species found within one or more plots at a site are indicated by X. Species described by Goodwin (1943) as prairie remnant species are indicated by X^{L} or *^{L}.

	Graminoid Cover				Herbaceous Vegetation Cover			
	Median	Ave Rank	H (adj)	P (adj)	Median	Ave Rank	H (adj)	P (adj)
Oak Opening	31.0	13.5	17.32	0.001	60.0	19.9	13.05	0.005
Pine-Oak Forest	10.5	10.1			10.0	10.7		
Black Locust Forest	0.0	5.0			20.0	13.8		
Meadow	95.0	21.4			5.0	5.7		

Table 2. Site treatment on graminoid cover and herbaceous vegetation cover at four sites in Mendon Ponds County Park, New York (n = 6 plots per site, df = 3) determined using a Kruskal-Wallis test.

	Graminoid Species Richness					LOI (g/kg)				
	Mean	SE	S	R^2 (adj)	P	Mean	SE	S	R^2 (adj)	P
Oak Opening	2.00^{A}	0.447	0.8991	32.70	0.012	20.717^{C}	0.345	0.7454	98.89	<0.001
Pine-Oak Forest	1.17^{AB}	0.307				37.912^{A}	0.346			
Black Locust Forest	0.33^{B}	0.211				34.937^{A}	0.645			
Meadow	2.00^{A}	0.447				28.447^{B}	0.685			

Table 3. Site treatment on graminoid species richness and loss on ignition (LOI) for four sites at Mendon Ponds County Park, New York (n = 6 plots per site for graminoid species richness, n = 2 for LOI, df = 3 for all variables) determined using One-way Analysis of Variance. Variable means with different letters were significantly different as determined by a Tukey *post hoc* test.

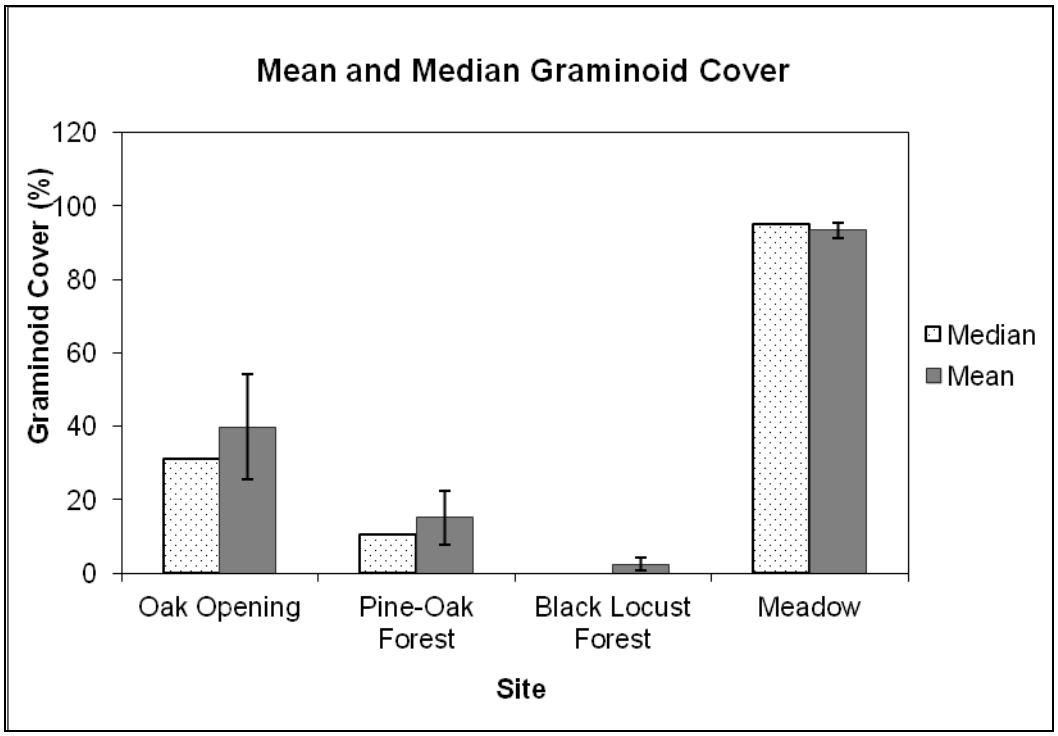

Figure 1. Mean and median graminoid cover for four sites at Mendon Ponds County Park, New York (n = 6 plots per site, mean ± SE). Median graminoid cover per site was significantly different at p = 0.001 as determined using a Kruskal-Wallis test.

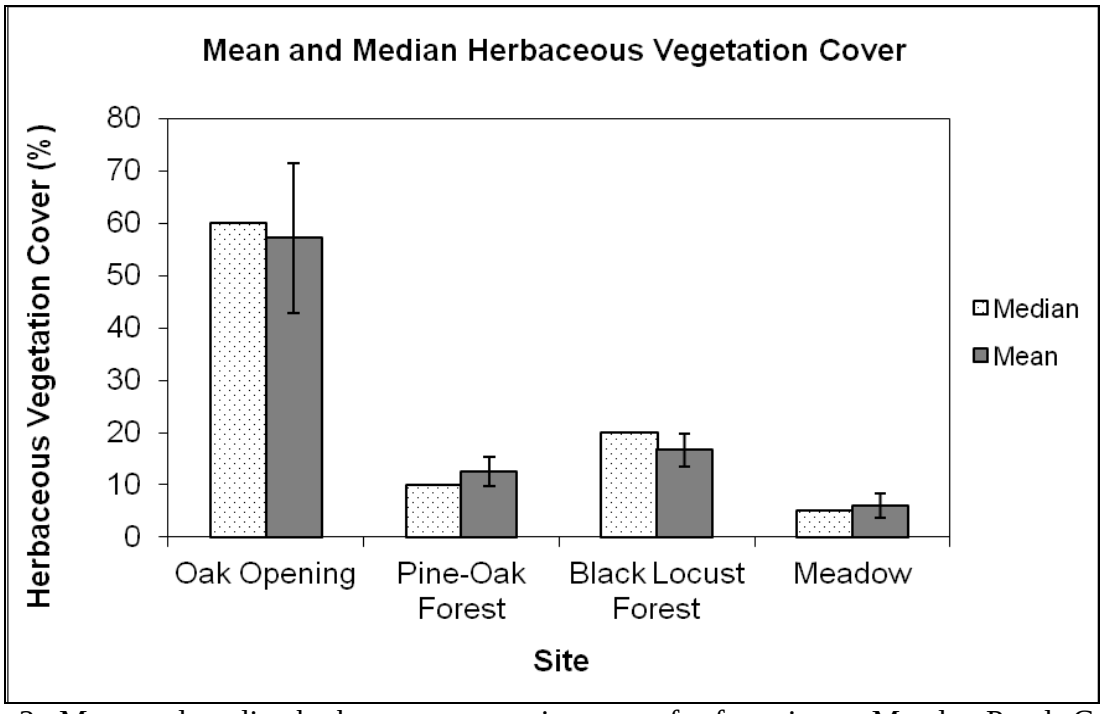

Figure 2. Mean and median herbaceous vegetation cover for four sites at Mendon Ponds County Park, New York (n = 6 plots per site, mean ± SE). Median herbaceous vegetation cover per site was significantly different at p = 0.005 as determined using a Kruskal-Wallis test.

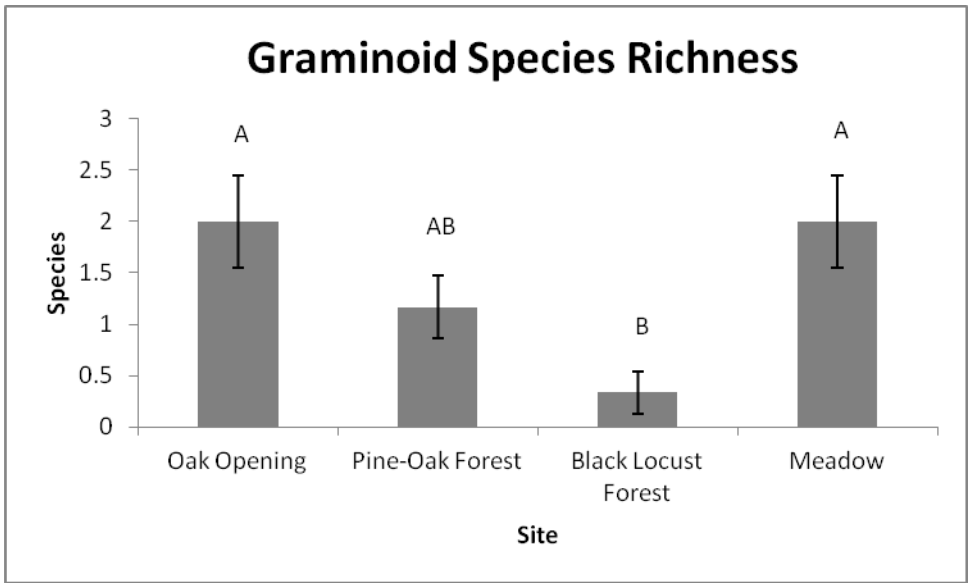

Figure 3. Graminoid species richness for four sites at Mendon Ponds County Park, New York (n = 6 plots per site, mean ± SE, treatments with different letters were significantly different at p = 0.012 as determined using One-way Analysis of Variance with a Tukey *post hoc* test).

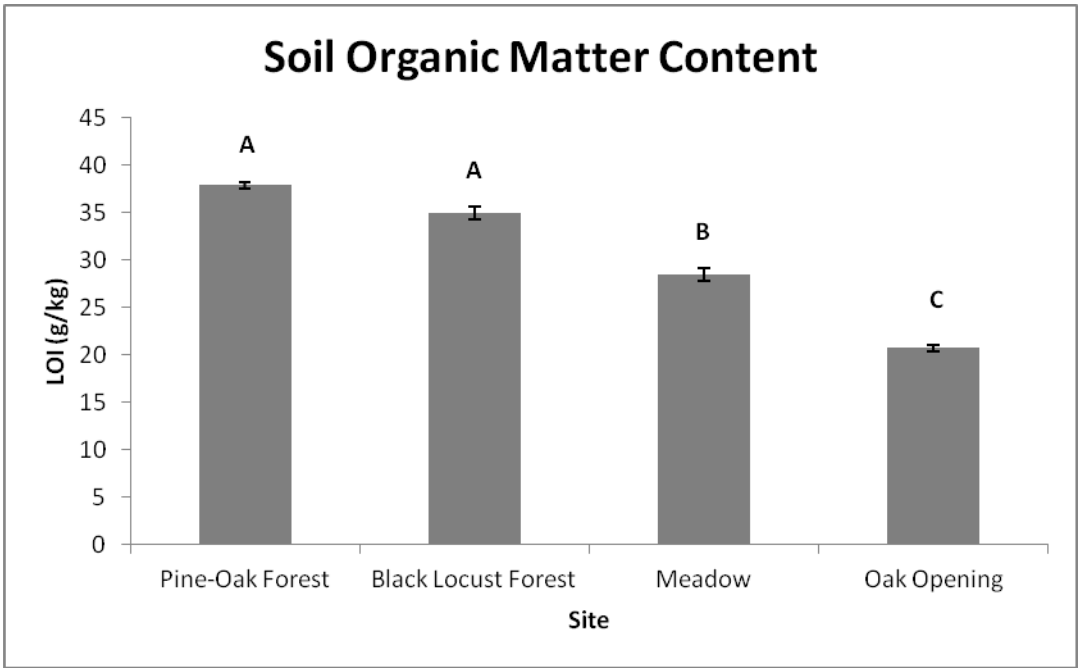

Figure 4. Soil organic matter content as determined by loss on ignition (LOI) for four sites at Mendon Ponds County Park, New York (n = 2, mean ± SE, treatments with different letters were significantly different at p < 0.001 as determined using One-way Analysis of Variance with a Tukey *post hoc* test).

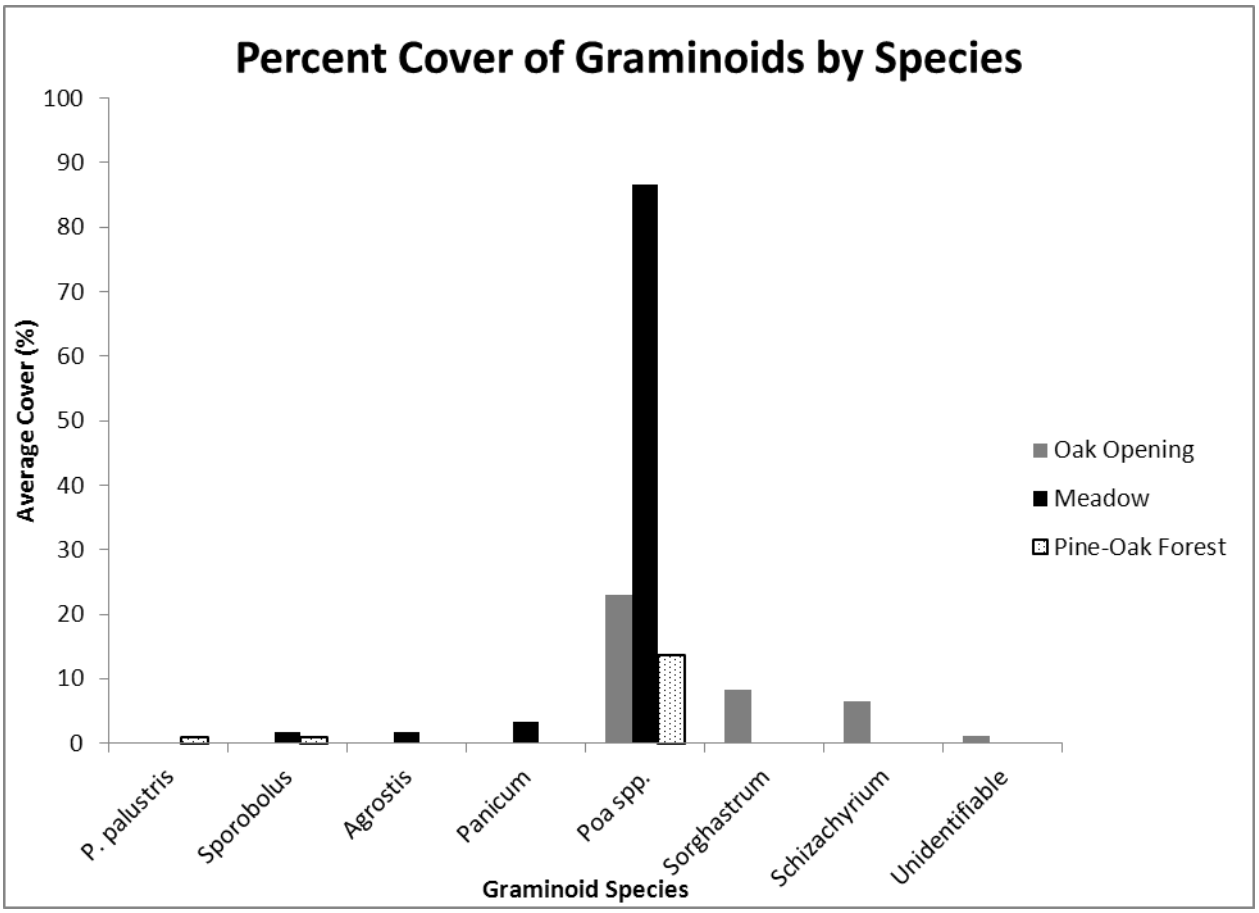

Figure 5. Differences in the presence and average percent cover of graminoid species in the oak opening, pine-oak forest, and meadow sites in Mendon Ponds County Park, New York.

Prairie Remnant Graminoids	Listed Frequency	Average Cover in Oak Opening Site
Andropogon gerardii (A. furcatus)	Infrequent	
Schizachyrium scoparium (Andropogon scoparius)	Common	6.5%
Sorghastrum nutans	Occasional	8.3%
Poa compressa	Abundant	23.0%*
Danthonia spicata	Common	
Panicum sphaerocarpon	Common	
Carex pennsylvanica	No listing	
Juncus tenuis (J. macer)	Common	X
Luzula multiflora	Common	

Table 4. Comparison of the nine prairie remnant graminoid species listed as oak opening inhabitants by Goodwin (1943) and the qualitative frequency of the species within Mendon Ponds County Park, New York with the average cover of the graminoid species found within the proposed oak opening site. *Juncus tenuis* was found outside the plots at the site, preventing calculation of average cover. (*The *Poa* species within the plots could only be identified to the genus level. Because *P. compressa* was the only *Poa* species identified outside the plots, I assumed that the individuals within the plots were also *P. compressa*.)

Picture 1. *Sorghastrum nutans* and *Schizachyrium scoparium* in an oak opening located near Pittsford, Monroe County, New York (Shanks 1966).

Picture 2. Oak opening located in Rush, Monroe County, New York (Shanks 1966).

Picture 3. *Vincetoxicum spp.* (foreground) and *Schizachyrium scoparius* (background) in oak opening site, Mendon Ponds County Park, Monroe County, New York. Picture taken on 13 November 2011.

Picture 4. Pervasiveness of *Vincetoxicum spp.* throughout oak opening site at Mendon Ponds County Park, Monroe County, New York. Picture taken on 13 November 2011.

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