The Ohio State University
Campus as a Living Laboratory

Miller Ecological Park: Thirty-Acre Field Restoration

Crystina Bakus; Callie Nauman; Jim Palus;
Sidney Rucker; Lauren Stewart

ENR 2367
OSU School of Environment and Natural Resources [12 pt]

December, 2013

Table of Contents

Figures

Executive Summary

Working with the Miller Ecological Park, our research aims to produce a blueprint for the future of the thirty-acre field. Collecting data of the field's soil characteristics, current health, and agricultural history, our project combines past, present, and future considerations in order to optimize the field's health. It is noted that dual applications of both post-emergence and pre-emergence herbicides were used annually. With this in mind, we have discussed the potential harm of herbicide carryover specifically from the FirstRate herbicide. The objective of our research is to develop a plan to convert half of the thirty-acre field into a wet prairie since this location is most suitable for saturated conditions and supportive of a diverse ecosystem. The rest of the field is best suited for mesic prairie. By dividing the thirty-acre field, we have optimized each section's ecological potential. Restoring the thirty-acre field into a healthy, self-sustainable ecological park will be a great benefit to the surrounding community of Lebanon. This park will offer many educational, leadership enhancement, and environmental benefits to humans, flora, and fauna.

Introduction

Ohio was once a heavily forested landscape interspersed with prairies that varied in size from vast expanses to just a few hundred square yards. These naturally open lands supported a diverse population of plant and animal life. Prairies, along with the forests, all but disappeared following European settlement. Today, conservation of our remaining prairies is critical to restore endangered prairie wildlife and prevent other wildlife from becoming vulnerable or endangered. When the first settlers moved to Ohio in the late 1700s, they found over three hundred prairie openings surrounded by forest, mostly located in the western half of the state. Over one thousand square miles of prairies most likely existed in Ohio. It is our ecological duty to restore these wetlands wherever land is available.

The Miller Ecological Park located in Lebanon, Ohio has recently purchased a new field to add to their existing land. Our research created a guideline for how the Miller Ecological Park can take steps for restoring the thirty-acre field into a self-sustaining mesic prairie and wet prairie. First, we must decide whether or not this thirty-acre field is suitable for sustaining a mesic prairie or wet prairie ecosystem. From there we can convert either the entire field into mesic prairie, or half of the field into a wet prairie and half mesic prairie. Throughout our research, we collected spatial data analysis, web soil surveys, geography maps, and other resources for guidelines in restoration projects to create our own guideline.

Lebanon History

The Miller Ecological Park is located in Lebanon, Ohio, located within Warren County. According to *A History of the State of Ohio*, Warren County was historically the home of wet prairies and cedar swamps (Atwater, 1838). Michigan Natural Features Inventory (Michigan Natural Feature Inventory [MNFI], n.d.) defines a wet prairie as “native lowland grassland occurring on level, saturated and/or seasonally inundated stream and river floodplains, lake margins, and isolated depressions” (MNFI, n.d.). Today, Lebanon, Ohio is scattered with farmland, mostly due to the conversion of wet prairies to agricultural plots upon settlement (MNFI, n.d.). Both anthropogenic and natural threats to the wet prairies should be considered when restoring the field.

The definition of a swamp, according to the Merriam-Webster dictionary, is “a wetland often partially or intermittently covered with water, and one dominated by woody vegetation” (Webster, n.d.). Historically, Warren County is the home of cedar swamps. An example of a cedar prairie in Ohio was the Great Black Swamp located in northwest Ohio. Remnants of the Great Black Swamp are still visible today (Hallett, 2011). The Great Black Swamp was discovered to have very fertile soil when small areas were drained, which drove drainage on a widespread scale. In addition, the trees were also removed for the use of infrastructure and development (Hallett, 2011). The richness of the soil allowed for fertile agricultural land, similar to that of wet prairies, and the lumber harvested became a profitable commodity (Hallett, 2011). Restoration efforts are now being performed to restore parts of the Great Black Swamp back to its original glory. Using the Great Black Swamp as a case study, the active restoration strategies could also be implemented in restoring the Miller Ecological Park’s field to a cedar swamp.

Agricultural History

In order to truly evaluate the current condition of the field we must look at the field’s history. The thirty-acre field has been cultivated by the same farmer for the thirty years leading up to the Miller Ecological Park purchase. This allows for a complete thirty-year history of both the surface and internal characteristics of the thirty-acre field. An interview with the current farmer, who wishes to remain anonymous, allowed insights into the practices used on the field. The farmer revealed that the field had never endured a significant amount of economic damage due to insects, pests, and diseases. He stated that the field maintains itself very well, and there is little to no water-logging, erosion, ponding or flooding. The farmer has been implementing conservation tillage and no till for the past five years. He stated that five years ago he did run a disc plow through the field to turn over the corn stubble. That being said, the field has not been truly plowed since 1986. He has been practicing crop rotation with corn, soybean and wheat. By looking at the past farming history, it is safe to say that the thirty-acre field has maintained its health during each season. Once the soybeans are removed, there should be no immediate nutrient health concerns in the soil. If persistent rain occurs in the spring, erosion could become a problem. However, since the farmer implemented no till on the field, there will be residual stubble from this year's crop as seen in *Figure 1*. Stubble will allow fresh organic matter for spring growth as well as a catchment for soil erosion caused by wind and water.

Figure 1. Photo of the thirty-acre field at MEP in early November. Corn and Soybean stubble organic matter build up is displayed in the field. (Photo Credit Crystina Bakus).

One of the main concerns during restoration when a field is used for agriculture is chemical residue, or herbicide carryover (Loux et al., 2013). Soil absorptive capacity for herbicide increases as organic matter and clay content increases because microbial and chemical degradation reactions occur mainly in the soil solutions. Chemicals can cause surface and groundwater contamination, eutrophication, habitat loss, and other degradation to the soil and surrounding wildlife. The farmer used both pre and post-emergence herbicide on his field annually. He used the herbicides Roundup PowerMAX and FirstRate. Roundup PowerMAX is a group nine mode of action (Loux et al., 2013). This means it is an EPSP inhibitor, which inhibits enzymes involved in the production of several amino acids. The primary ingredient is Glyphosate (Loux et al., 2013). Glyphosate is a translocated herbicide that controls emerged annual and perennial grass and broadleaf weeds. Translocated means the chemical is absorbed through the leaves of the plant, and systematically runs its course throughout the entire plant body, until the entire plant, including the roots, dies. Glyphosate is a very common and well-known herbicide used in agricultural practices. FirstRate is a group two herbicide (Loux et al., 2013). This means it is an ALS inhibitor, which inhibits the enzyme involved in the synthesis of several amino acids. Cloransulam-methyl is a translocated sulfonamide that controls many annual and broadleaf weeds including: ragweed, velvetleaf, lambsquarter, pigweed, and cocklebur. First Rate Herbicide contains the active ingredient cloransulam-methyl, which is one of the active chemicals that have a surface and groundwater contamination advisory (Loux et al., 2013). We must take the contamination advisory into consideration when we talk about the possibility of introducing a wet prairie. The growth of grasses and shrubs in the wet prairies could be affected by the residual cloransulam-methyl. We advise Miller Ecological Park to watch for signs of residual cloransulam-methyl in the ground and surface water the following spring.

Herbicide Carryover

The possibility of herbicide carryover should be taken into consideration due to its detrimental effects. In terms of large-scale crop production, the application of heavy doses of insecticides, herbicides, pesticides and fertilizers can be harmful to the soil chemistry and surrounding ecological areas. The current farmer has applied post pre-emergence and post-emergence herbicide throughout his farming career on the thirty-acre field. He sprayed Roundup PowerMAX and FirstRate herbicide. According to the Material Safety Data Sheets (MSDS) labels on both of these herbicides, FirstRate is the only herbicide that needs to be closely monitored. FirstRate herbicide has a warning for surface and ground water contamination on its application label. With this advisory, the field could potentially be contaminated with the active ingredient cloransulam-methyl due to over application of FirstRate on the thirty-acre field. If the active ingredient has already contaminated the surface and/or groundwater, the field may take a longer period of time to grow healthy native species. According to the Pesticide Environment Stewardship website, crop rotation, cover crops, proper drainage, and proper seedbed preparation are the best methods for reducing herbicide carryover due to the chemicals. However, since the current farmer implements conservative farming practices and no-till, there are not as many options to choose from in order to rid the soil of herbicide carryover. The best plan of action for Miller Ecological Park is to obtain a current soil sample of the field to test the degree of herbicide carryover. From here the park can decide whether or not to leave the field as a fallow crop, or plant native grassland and wet prairie species for the plants to uptake the active ingredient from the herbicide.

The Dirty Details

In order to devise a plan for the park's future layout, we must consider all physical details in our decision. What occurs below the surface can alter what is above. While conducting research on the geological and soil aspects of the thirty-acre field, we found many detailed characteristics within the soil. Understanding the classification of soil taxonomy can broaden our understanding of how the soil mechanics work. According to the *Keys to Soil Taxonomy* the field is classified as a Mollisol (Natural Resources Conservation Service [NRCS], 2006). Mollisols typically form under a grassland cover. Their parent material is typically base-rich and calcareous and includes limestone and loess. The main processes that lead to the formation of grassland Mollisols are decomposition, humification, and pedoturbation. They also have deep, high organic matter, nutrient-enriched surface soil (A horizon). Next we look at the Order, which according to NRCS (NRCS, 2006) are Aquolls. Order is a taxonomic rank comprised of families sharing a set of similar nature or character. Order in a hierarchical classification of organisms is generally in between Class and Family. Aquolls have a layer above a densic, lithic, or paralithic contact or in a layer at a depth between 40 and 50 cm from the mineral soil surface, and aquic conditions for some time in normal years. Further into classification specifics, we find the field has the Suborder Argiaquolls. Suborder is a taxonomic category of related organisms ranking between an order and a family. It is better known as a subdivision of an Order. This means it has an argillic horizon (NRCS, 2006). This specie of horizon is a subsurface horizon with a significantly higher percentage of phyllosilicate clay than the overlying soil material. It shows evidence of clay illuviation. Illuviation is the deposition in an underlying soil layer of colloids, soluble salts, and mineral particles leached out of an overlying soil layer.

Looking at the Web Soil Survey map provided by the NRCS website in *Figure 2*, the majority of the thirty-acre field is Brookston Silty Clay Loam (denoted Br on Web Soil survey Map). Brookston has poorly drained characteristics; the potential for surface runoff is negligible to low. The apparent high water table ranges from 15 cm above the surface to 30 cm below the surface (United States Department of Agriculture [USDA], 2011). Permeability is moderate in the subsoil and moderately slow in the underlying material. Native vegetation for Brookston soils includes deciduous forest, marsh grasses, and sedges.

Figure 2. Soil Map from the NRCS Website of the thirty-acre field.

Mesic Prairies

The Miller Ecological Park's recently acquired thirty-acre field has shown attributes that suggest it is an excellent site for prairie reconstruction. First and foremost, the site meets some of the "ideal conditions" for a mesic prairie. These conditions include no shaded areas, no existing woody plants, moderate soil fertility and moisture, loamy soil, and little slope (Blakeman, 2002). Since the site will be directly converted from an agricultural field, we know the area has full sunlight, little vegetation, and will be primarily flat. By looking at *Figure 2*, we can see that sixty percent of the field has a well-drained soil series. This type of soil is best for mesic prairie, the most common type of prairie in Ohio. Mesic prairies grow in moderate soil and climate conditions and offer the most biodiversity, making them a good addition to the park (Ohio Prairie Facts, 2013).

An important factor in the land's potential is that it is being used after a soybean crop rotation. Not only does this provide a bare field, but soybean fields are particularly good for mesic prairie restoration sites. Post harvested soybean fields are flatter and have firmer soil than other crop fields. This is important because unlike production crops, mesic prairies thrive best in firm soils. Firm soil allows for prairie plants to be planted closer to the surface. By being planted near the surface, the seeds have higher germination rates and have less competition between lower level weed seeds. Another benefit comes from crop rotation in the field, which leaves leftover soybean and corn stubble. This stubble is known to resist weed growth, which is one of the primary issues when reconstructing a mesic prairie (Blakeman, 2002). We have learned from the farmer that there has been little to no tilling on the site since 1986. This is excellent because the soil will not be as loose as in repeatedly tilled sites, thus aiding in soil firmness. When soil is tilled continuously, especially by the deep tilling that often accompanies farming, there is a higher chance of weed germination. Deeply tilled land allows for lower level seeds to sprout and take over. Since the site was previously used for agriculture production, the field is in a very good state for mesic prairie restoration.

It is often thought that mesic prairies start as self-sustainable sites that will grow naturally, but this is not the case. There are multiple ways to restore a mesic prairie, each unique to the individual site. Most prairies will not recover solely on planted seeds, but the planting style will help determine the rate of success. There are three ways to plant seeds for mesic prairies: hand broadcasting, cultipacking, and drill seeding. Hand broadcasting would be best for the park, because it is the only non-equipment based procedure and it is the most cost effective. During hand broadcasting, seeds are manually raked into the soil. While this process has the lowest production rate, it allows for a more natural distribution of plants. However, most grasses will not go to seed during their first year, so it is recommended to transplant grasses at the site to jumpstart the reproduction process and reduce erosion (Recreating a Prairie, 2013). It is also important to remember that since the site is bare, it is susceptible to weeds and invasive species. There are many ways to avoid unwanted species: herbicides, manual removal, mowing, and prescribed burns. Conversely, a new study showed that by reducing the nitrogen to carbon ratio in the soil by adding carbon mediums, for example sawdust, the area will support native species growth. This is because nitrogen rich soil allows for quick growing plants, predominantly invasive species, to thrive. The addition of carbon to the soil will slow growing plants and have a better chance at dominating due to less competition (Ohio Prairie Facts, 2013).

Knowledge of field maintenance is important for the future, but it is just as important to know what makes a good mesic prairie. Researchers suggest that mesic prairies are most effective at a ratio of sixty percent grasses and forty percent wildflowers. Most mesic prairie grasses are universal and are able to grow on any site. Bog bluestem is one of the best grasses to start a mesic prairie with (*Andropogon gerardii*). Bog bluestem develops dense and deep roots, which makes it a good competitor against unwanted species while also helping to stop erosion. Restored mesic prairies have relatively low biodiversity, only about ten species per site. Managers should know the importance of reestablishing mesic prairies with sturdy and stable plants, allowing the mesic prairie plants to survive long enough to become self-sustaining. After four years, plants typically will produce enough seeds to consistently regenerate and become naturally stable. At this time, it is suggested that site managers introduce new species into the more "barren" areas of the land to create biodiversity (Recreating a Prairie, 2013).

Wet Prairies

As earlier defined, wet prairies are native lowland grasslands that occur on level, saturated, and/or seasonally inundated stream and river floodplains. Associated soils are primarily loam or silt loam with neutral pH, high organic content, and good water-retaining capacity. Organic deposits, or muck, are absent or, at most, form only a thin layer over mineral soil (MNFI, 2008). The open conditions of these prairies and the diversity they support are maintained by fire and water level fluctuations. Flooding, ponding, or high water tables inhibit the growth of trees and shrubs. Furthermore, fire helps maintain species diversity by facilitating seed germination, opening microsites for seedling establishment and growth of small species, and releasing important plant nutrients that bolster plant growth, flowering, and seed set (Kost et al. 2007).

By understanding what conservation status the thirty-acre field has, we can recommend a more suitable plan. Conservation status ranks are assessed and documented at three distinct geographic scales-global (G), national (N), and state (S). The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment, with 1 meaning critically imperiled to 5, which is secure.

With fewer than 100 occurrences nationwide covering less than 10,000 acres, wet prairies have been attributed a G3 conservation status, indicating they are globally vulnerable. G3 stands for Global Conservation Status Ranks, which is vulnerable. This translates that the area is at moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors. More specifically, wet prairies have been given an S3 ranking in Ohio since there are only four individual habitats, indicating state vulnerability. S3 stands for Subnational Conservation Status Rank, which is also vulnerable. This means that the area is at moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.

The cause of their scarcity is primarily conversion to agriculture following European settlement (Steinauer and Collins 1996). Remaining sites are threatened further by hydrologic alteration, nutrient enrichment, siltation, fire suppression, shrub and tree encroachment, and destruction of upland buffers. All of these issues are, in some way, interrelated. For example, fire suppression and hydrologic alterations promote tree and shrub invasion, resulting in reduced fine-fuels needed to support a fire. Nutrient enrichment, fire suppression, and hydrologic alteration favor invasive plants. The primary invasive species threatening wet prairies include glossy buckthorn (*Rhamnus frangula*), reed (*Phragmites australis*), narrow-leaved cattail (*Typha angustifolia*), hybrid cattail (*Typha x glauca*), and purple loosestrife (*Lythrum salicaria*) (Steinauer and Collins 1996).

The loss of wet prairies has far-reaching consequences as they play integral roles in the landscape. They provide several ecosystem services such as water filtration, nutrient cycling, wildlife habitat, and flood control. Biodiversity can be maintained in these lowland grasslands with the use of prescribed fire in conjunction with cutting and/or spraying herbicides on invasive species. Restoration of some sites may require hydrologic alteration, and efforts are often necessary to restrict nutrient and sediment inputs. A high priority should be placed on restoring upland natural communities that border wet prairies in order to improve hydrology and provide refuge for flood-intolerant species during periods of high water. Such management efforts will help to reduce the impacts of hydrologic alteration, siltation, fire suppression, shrub and tree encroachment, and, most significantly, the destruction of upland buffers.

Benefits

The restoration of this former agricultural field into prairie land will provide multiple benefits for the Miller Ecological Park and the environment as a whole. Since wet prairies are part of the historic ecosystem regime of Warren County, we propose that portions of the 30-acre soybean field of the Miller Ecological Park be converted to wet prairie. These would be best suited in the southern portion of the field with the Brookston soils, as that area is poorly drained. When partnered with mesic prairies, wet prairies will support higher bird diversity because they support both grassland and wetland bird communities (Hoffman and Sample 1988). Restoring part of the field to wet prairie would add a historic feature to the park, while turning it into an ideal location for birdwatchers and other wildlife watchers. The species found may include Sora (*Porzana carolina*), Marsh Wren (*Cistothorus palustris*), Red-winged Blackbird (*Agelaius phoeniceus*), and Swamp Sparrow (*Melospiza georgiana*) (Cornell Lab of Ornithology, n.d). Mesic prairies support grassland bird species, small mammal species such as moles, mice, skunks, and badgers, and large mammals like whitetail deer *(Odocoileus virginianus)* (MNFI).

In addition, wet prairies can create better downstream water quality by filtering nutrients and sediments from the surrounding landscape and reducing rapid flow rates during storm events. It can also serve to improve the quality of the other wetlands in the park by creating additional habitat through which the species of those ecosystems may move between, as well as simply increasing the total area of viable habitat. Additionally, research has suggested that prairies, and more specifically Big Bluestem (*Andropogon gerardii*), are valuable carbon sinks. This means that prairie habitats are instrumental in mitigating climate change brought on by high levels of carbon in the atmosphere.

Above all else, mesic and wet prairies offer educational opportunities for local schools to teach about ecological processes and how different ecosystems interact and depend upon one another. Ideally, these prairies would help the students in the surrounding schools to connect with nature and encourage physical activity in a healthy and stimulating environment.

These new prairie ecosystems in the Miller Ecological Park would provide the centerpieces from which other ecosystems – upland prairie, early succession forest, etc. – could radiate from, creating a wide buffer which would ultimately increase habitat quality in the area. In addition, these thriving ecosystems will provide future research opportunities in land allocation, environmental development, and native plant and animal species management.

Our research shows the field is ready to convert back to its original state, shown in this photo taken on our latest trip to Miller Ecological Park in early November (*Figure 3*) there are already signs of first succession within the field. This means that the field has a great opportunity to grow easily into the designated mesic prairie and wet prairie ecosystems. The field has already begun to convert naturally back to its original state, meaning it will become self-sustainable and can successfully thrive for years to come.

Figure 3. Photo taken early November of the thirty-acre field. Evidence of first succession within the field. (Photo Credit Crystina Bakus).

Discussion

In order to optimize the health of the thirty-acre field, we must utilize all aspects of the field. Looking back at the Web Soil Survey of the thirty-acre field (*Figure 2*) we can categorize the field into two separate landscapes. Since the Brookston silty clay loam has very low permeability compared to the other soil series in the field, the wet prairie would be best settled in the Brookston series. Taking into consideration that clay and loam take a long time to drain water, it is safe to say that water in the Brookston soil series could potentially have ponding and water logging conditions. By implementing a wet prairie with this soil series, plants will be able to utilize the excess water to their advantage without the harmful effects of disease and water logging conditions. The other percent of the field that does not include the Brookston silty clay loam has moderate to good permeability. This means that during a heavy rain storm water will be able to sufficiently drain in that soil series without the risk of excessive runoff. In these areas we will recommend the implementation of a mesic prairie. A mesic prairie will be able to thrive in these healthy organic soil series and will not run the risk of poor infiltration. Future research could focus on restoring specific native flora and fauna, management of invasive flora and fauna, boardwalks, hiking trails, and even educational signage throughout the park.

Conclusion

Less than eight percent of all grasslands worldwide are protected. The least protection of any biome on earth is temperate grasslands at less than one percent, including North America's Great Plains. To restore the thirty-acre field back to its natural composition would be the best recommendation. Looking at the site specifics, we have determined that about forty percent of the field is made of Brookston soil. This soil series is dominated by saturated conditions. Due to these conditions, a wet prairie would be most suitable. The other sixty percent of the field contains soil characterized by moderate to good drainage. This area would be best for grassland.

Restoring the thirty-acre field to its natural landscape will help to improve the biodiversity and health of the surrounding ecosystem. Miller Ecological Park can utilize this restored landscape for education programs, aesthetics, improved water quality, and biodiversity. There are many benefits that can be gained from restoring the thirty-acre field to a beautiful extension of the Miller Ecological Park's outlay. By taking steps to successfully restore the field to a self-sustainable grassland and wet prairie, Miller Ecological Park can create a wonderful new addition to Warren County.

Works Cited (APA)

Atwater, C. (1838). Part One. A History of the State of Ohio, Natural and Civil (pp. 25-27). Cincinnati: Sterotyped by Glezen & Shepard.

Cornell Lab of Ornothology. (n.d.).*Birds*. Retrieved October 20, 2013, from http://www.birds.cornell.edu/ Page.aspx?pid=1478

Blakeman, J.A., Geiger, D. (2002). Successfully Preparing a Site for Growing a Prairie. *The Ohio Prairie Gazette*. 2(4), 1-7. http://meec.udayton.edu/Publications/Successful%20 prairie %20establishment.pdf

Hallett, K. (2011, April 14). History of the Great Black Swamp [Blog post]. Retrieved from The Black Swamp Journal website: http://blogs.bgsu.edu/blackswampjournal /2011/04/14 / history-of-the-great-black-swamp/

Hoffman, R., & Sample, D. (1988). Birds of wet-mesic and wet prairies in Wisconsin. *Passenger Pigeon*, *50*(2), 143-152.

Kost, M., Albert, D., Cohen, J., Slaughter, B., Schillo, R., Weber, C., et al. (2007). Natural Communities of Michigan: Classification and Description. *Michigan Natural Features Inventory*, *21*, 7-21.

Loux, M. M, Doohan, D., Dobbels, F. A., & Reeb, B. (2013). *Weed Control Guide for Ohio and Indiana*. Columbus OH: The Ohio State University. 9-178.

NatureServe. (2009, February 2). *NatureServe Conservation Status*. Retrieved November 20, 2013, from http://www.natureserve.org/explorer/ranking.htm

Natural Resources Conservation Service. (2006). *Keys to Soil Taxonomy*. Blacksburg, VA: Pocahontas.

Natural Resources Conservation Service Soil Survey Staff. (n.d). *Custom Soil Resource Report for Warren County, Ohio Miller Ecological Park*.[Photograph]. Retrieved September 9, 2013 from http://websoilsurvey.sc.egov.usda.gov/App/Home Page.htm

Recreating a Prairie. (2013). Lady Bird Johnson Wildflower Center. Retrieved from http://www.wildflower.org/ howto/show.php?id=22&frontpage=true

Steinauer, E., & Collins, S. (1996). Prairie Conservation: preserving North America's most endangered ecosystem. *Prairie Ecology*, *19*, 2-26.

United States Department of Agriculture. (2011).*Brookston Series*. Retrieved September 22, 2013 from U.S Department of Agriculture's website: https://soilseries.sc.egov.usda.gov/OSD_Docs/B/BROOKSTON.html

Webster. (n.d.). *Swamp*. Retrieved October 20, 2013, from Merriam-Webster website: http://www.merriam-webster.com/dictionary/swamp

Wet Prairie. (2008, February 4). Retrieved October 20, 2013, from Michigan Natural Resource Inventory website: http://mnfi.anr.msu.edu/communities/community.cfm?id=10665

Wet Prairie. (n.d.). *Michigan Natural Features Inventory*. Retrieved October 20, 2013, from http://mnfi.anr.msu.edu/communities/community.cfm?id=10665

Wisconsin All-Bird Conservation Plan. (n.d.). *Wisconsin Bird Conservation Initiative*. Retrieved October 20, 2013, from http://www.wisconsinbirds.org/plan/habitats/WetPrairie.html