Prairie Restoration Concepts for Petersburg State Game Area

Prepared by:
Jesse M. Lincoln
Michigan Natural Features Inventory
P.O. Box 13036
Lansing, MI 48901-3036

For:
Michigan Department of Natural Resources
Wildlife Division
2018

Report No. 2018-04

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

ACKNOWLEDGEMENTS

Funding for this project was provided by the Wildlife Division of the Michigan DNR. We express our sincere gratitude to the numerous DNR staff that helped administer and guide this project including Michael Donovan, Patrick Lederle, Ann LeClaire-Mitchell, Steve Chadwick, Mark MacKay, Mark Sargent, Zach Cooley, Nick Dohm, Brian Maki, Nathan Poley, Marshall Strong, and Jesse Bramer. This report relies on data collected by many present and former MNFI field scientists, especially: Dennis Albert, Mike Penskar, Joshua Cohen, and Bradford Slaughter. For their support and assistance throughout this project, we thank our MNFI colleagues, especially Rebecca Rogers, Helen Enander, Phyllis Higman, Kraig Korroch, Mike Monfils, Nancy Toben, Clay Wilton, and Aaron Kortenhoven, and Brian Klatt.

Suggested Citation:
Lincoln, J.M. 2018. Prairie Restoration Concepts for Petersburg State Game Area. Michigan Natural Features Inventory Report Number 2018-04, Lansing, MI. 19 pp.

Cover Photo: DNR Biologist Zach Cooley discusses prairie ecology with MNFI Ecologist Josh Cohen and Botanist Mike Penskar. July 2017. Photos throughout the document by Jesse M. Lincoln.

TABLE OF CONTENTS

INTRODUCTION

Ongoing survey efforts of state game areas have improved knowledge about the location and integrity of a variety of important natural areas. High-quality ecosystems provide a myriad of benefits to both game and non-game species and protecting existing systems is more feasible than intensive restoration of degraded systems or the creation of a new ecosystem. Within Petersburg State Game Area (SGA) there are important opportunities to restore and improve rare native grasslands.

During 2015, the Department of Natural Resources (DNR) and Michigan Natural Features Inventory (MNFI) conducted the Stage 1 survey of Petersburg SGA as part of the DNR's Michigan Forest Inventory (MiFI). This is part of a long-term effort by the DNR Wildlife Division (WLD) to document and sustainably manage areas of high conservation significance on state lands. The MNFI scientists collected basic stand data and helped identify exemplary natural community Element Occurrences (EOs). Information collected during the MiFI surveys was used to develop project sites for ecosystem restoration. Sites with largest zones of remnant prairie were prioritized and potential actions to address threats to these systems are outlined below. These potential project areas primarily focus on prairie with additional elements of oak openings or savanna considered in some areas. These habitats are unique and utilized by many wildlife species – including numerous featured species (i.e., white-tailed deer, wild turkeys, and pheasants).

The purpose of this project is to develop a landscape-level plan to restore prairies and savannas to improve ecological functioning and enhance ecosystem services, especially wildlife-based recreation. The objectives are

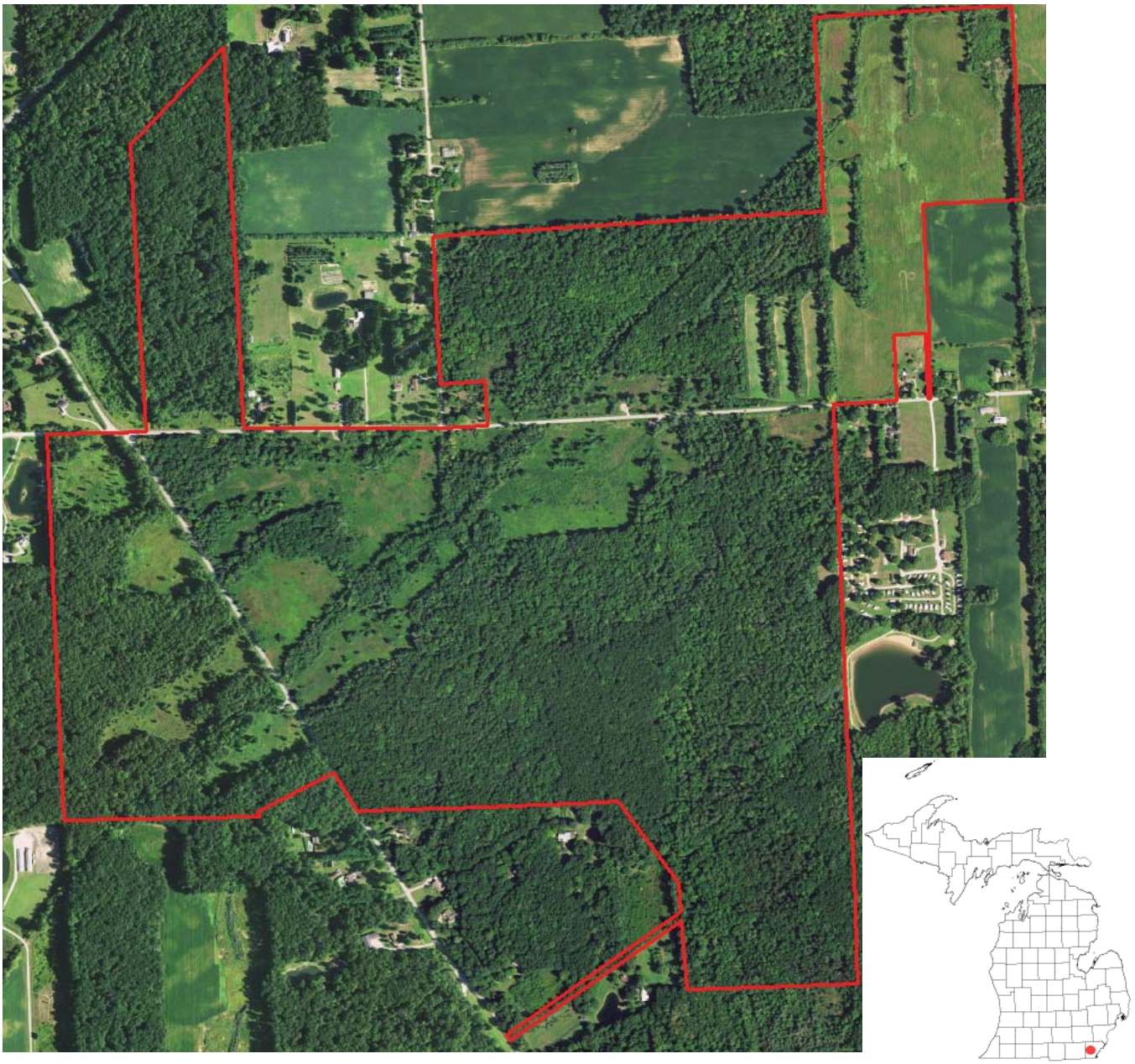

Figure 1. Compartment boundaries and land cover in and around Petersburg SGA.

to: 1) Collaborate with staff at Petersburg SGA to identify and prioritize high-quality prairie remnants for ecosystem management; 2) Provide management recommendations for each project area to improve wildlife habitat and expand existing native prairie and savanna systems; and 3) Develop a process for identifying and managing restoration opportunities to maximize benefits for game, non-game, and rare species in the context of improving ecosystem integrity.

Landscape Context

The regional landscape ecosystems of Michigan have been classified and mapped based on an integration of climate, physiography, soils, and natural vegetation (Albert 1995; Figure 2). This classification system can be useful for conservation planning and integrated resource management because it provides a framework for understanding the distribution patterns of species, natural communities, anthropogenic activities, and natural disturbance regimes. The classification is hierarchically structured with three levels in a nested series, from broad landscape regions called sections, down to smaller subsections and sub-subsections. Petersburg SGA occurs within the Southern Lower Michigan section and lies within the Washtenaw subsection and the Maumee Lake Plain (Lowlands) sub-subsection.

Washtenaw

The Washtenaw subsection is located in southeastern Lower Michigan and is characterized by glacial lakeplain, ground moraine, end moraine, and outwash plain. This subsection is characterized by the longest growing season in the state. The growing season ranges from approximately 130 days inland to 180 days along Lake Erie and Lake St. Clair in the east (Eichenlaub et al. 1990). Total annual precipitation averages between 28 and 36 inches, and total snowfall averages 30 to 50 inches. Surface glacial deposits, which are as thick as 300 feet near the inland margin of the subsection and locally less than 5 feet near the Lake Erie shoreline, are underlain by Pennsylvanian, Mississippian, Devonian, and Silurian marine and nearshore bedrock, including sandstone, shale, coal, marine limestone and dolomite, and gypsum and other evaporites (Dorr and Eschman 1984, Milstein 1987). Prevalent soils include sands, sandy loams, and loamy sands. Loams with clayey soils occur locally in areas of lakeplain. Prevalent vegetation types within this region historically included beech-sugar maple forest, oak savanna, swamp forest, wet prairie, and coastal marshes. The subsection has some of the most intensive urban, industrial, and agricultural land use in the state and much of the prairie, savanna, and coastal marshes have been eliminated or degraded. Remaining natural cover within this subsection is primarily fire suppressed oak-dominated forest (Albert 1995).

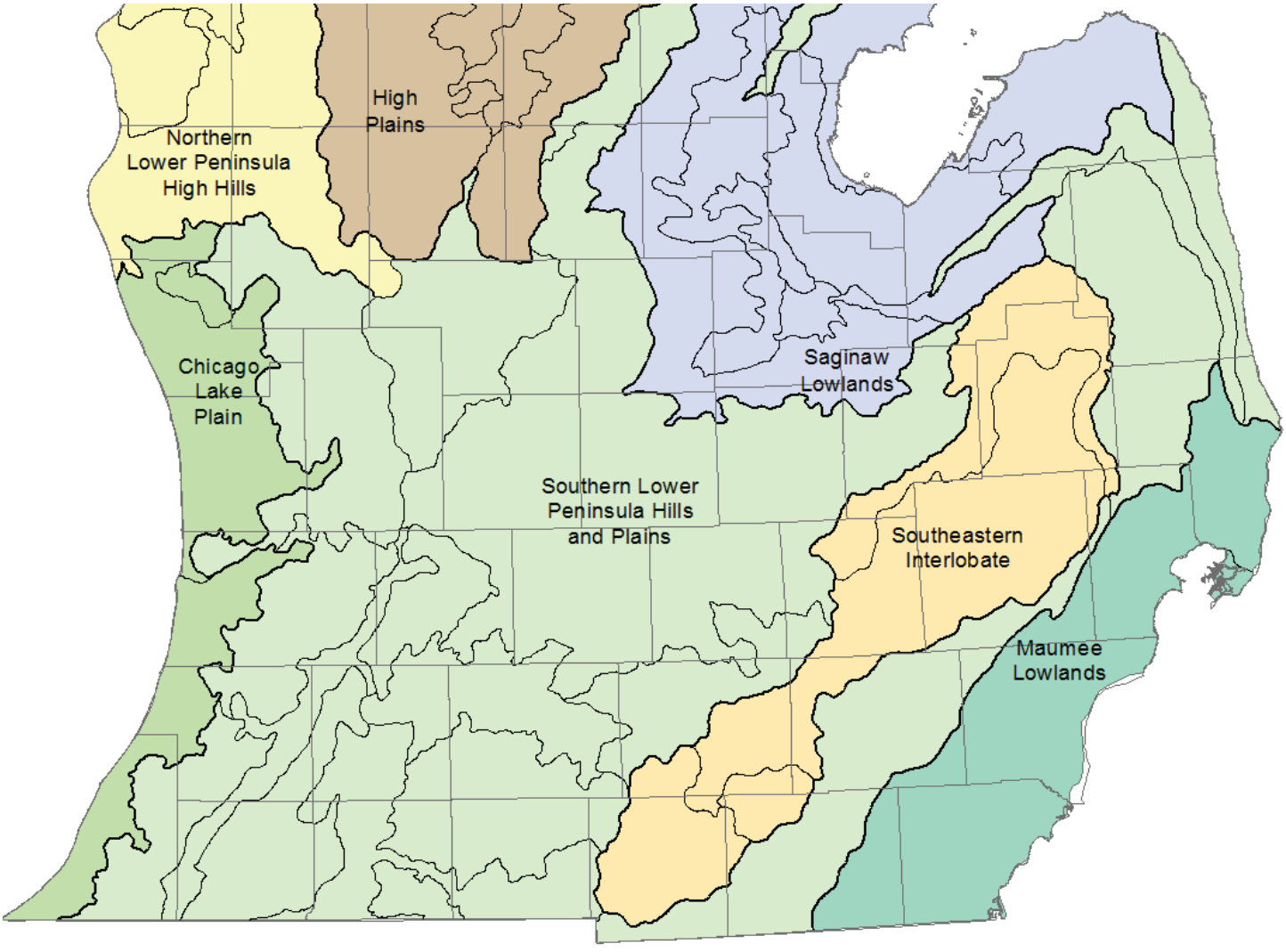

Figure 2. Ecoregions of southern Michigan. Petersburg SGA occurs in the southern portion of the Maumee Lowlands.

Maumee Lake Plain

The Maumee Lake Plain is a flat, clay lakeplain dissected by broad glacial drainageways of sandy soil. The southern two-thirds of the sub-subsection, where Petersburg SGA occurs, is clay lakeplain, with several broad channels of lacustrine sand. The northern third is primarily lakeplain with clay soils. Beach ridges and small sand dunes are common on the sand channels. Lakeplain throughout this area is broad and flat. Wet loamy and clayey soils are prevalent with sandy soils localized. Soil permeability is generally low and soils are calcareous at shallow depth.

Historically, extensive Great Lakes marsh occurred along the entire coast of Lakes Erie and St. Clair (Figure 3). The marshes, which extended into water four to five feet deep, were one to two miles wide in places and extended for miles up major rivers. Upland of the marshes there was typically a broad zone of swamp forest but locally along Lake St. Clair and Lake Erie, one- to three-mile wide expanses of wet prairie occurred. Extensive coastal complexes of Great Lakes marsh, lakeplain prairie, and lakeplain oak openings occurred throughout the region. The upland vegetation varied depending on soil compositions with areas of sandy lakeplain supporting lakeplain oak openings and areas of clay lakeplain supporting beech-sugar maple forest in well drained areas and wet-mesic flatwoods in moderately drained areas. Areas of poorly drained clay lakeplain supported deciduous swamp forest.

Within the Maumee Lake Plain there is a long history of land use by humans, beginning with Native American farming and likely use of fire to maintain open conditions in the prairies and savannas. The clay soils of the sub-subsection were among the first areas in Michigan farmed by European settlers. The lake-moderated climate and productive soils resulted in early and intensive agricultural development. Much of the lakeplain has been ditched and tiled for agricultural usage. As a result, many of the coastal ecosystems within this region have been eliminated or degraded. Thus, the natural communities of this region have been shaped by many factors, including changes in lake level, historic fire, conversion to agriculture, hydrological alterations, invasive species, and decades of fire suppression (Cohen et al. 2016).

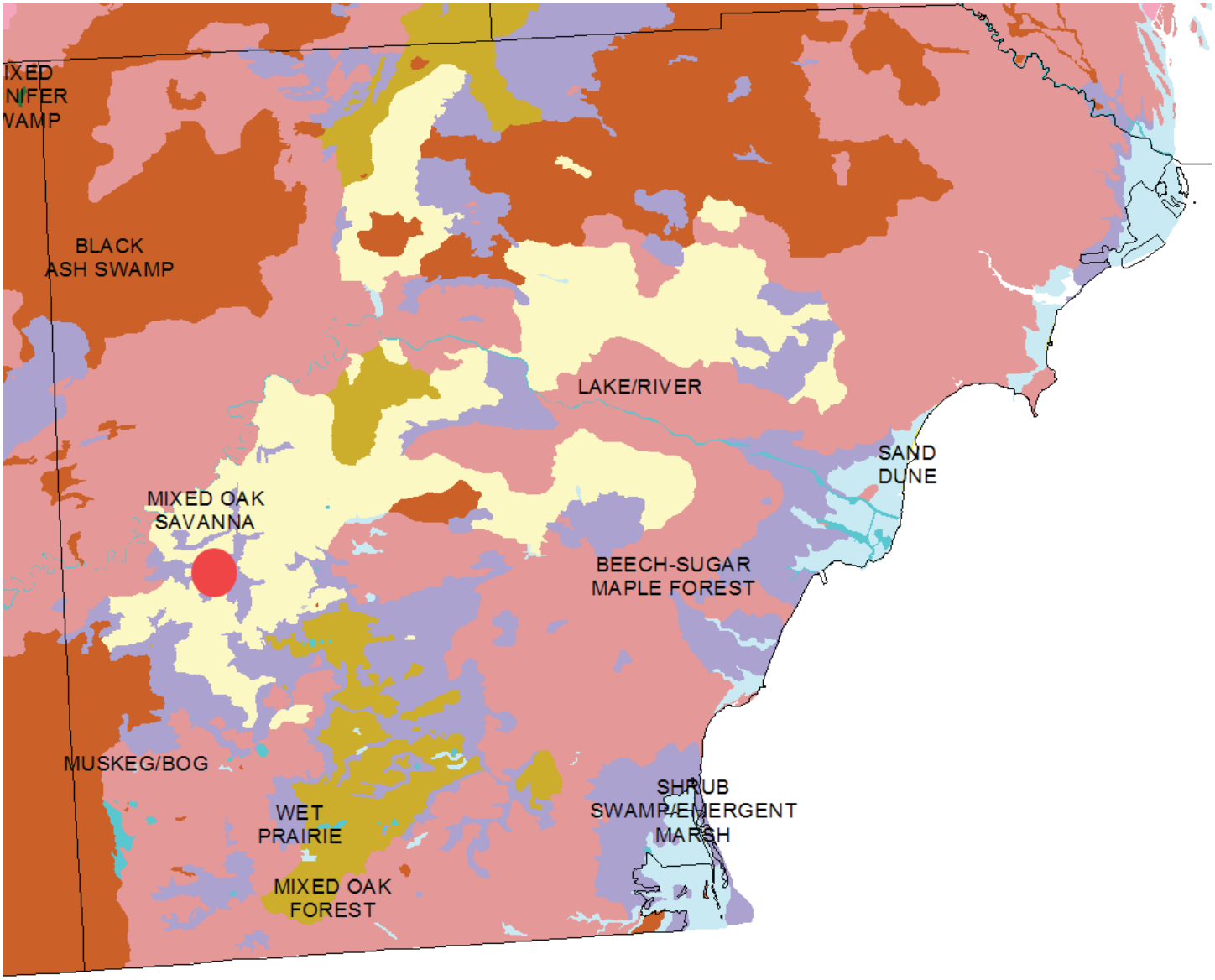

Figure 3. Circa-1800 vegetation cover of southeast Michigan (Comer 1997). The red dot is the location of Petersburg SGA.

Natural Community Descriptions

This section describes the natural communities historically found within Petersburg SGA. Around 1800, prairie and oak openings or savanna were the dominant natural community types in Petersburg SGA (Figure 4). Agriculture has had a significant impact on the local landscape but those the impacts appear to have been less severe within the game area, as seen in imagery from 1938 (Figure 6). Regionally the most important examples of natural prairie remnants tare within Petersburg SGA. Much of the landscape has been altered over the past two centuries and ecosystems that were once widespread have become infrequent and degraded. Additionally, much of the areas within the game area that were once prairie have converted to early-successional forest. There are still important remnants of important natural communities that locally persist in a functioning state within Petersburg SGA (Albert 1995). The high-quality natural communities in Petersburg SGA are pockets of remnant prairie, though some stands of mature, closed-canopy oak forest that were likely historically oak openings are also of ecological significance. The specific community type of primary interest is mesic sand prairie and this report also incorporates the oak openings that were historically part of the regional landscape.

Mesic Sand Prairie

Mesic sand prairie is a critically imperiled natural community within the state, with only 5 occurrences across the state. Mesic sand prairie is a native grassland community occurring on sandy loam, loamy sand, or sand soils on nearly level glacial outwash plains and lakeplains in both the northern and southern Lower Peninsula. Sites that support mesic sand prairie experience fluctuating water tables, with relatively high water tables occurring in the spring followed by drought conditions in late summer and fall. Thus, the community contains species from a broad range of moisture classes, but is dominated by species of upland affinity. Dominant grasses include little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), and Indian grass (*Sorghastrum nutans*).

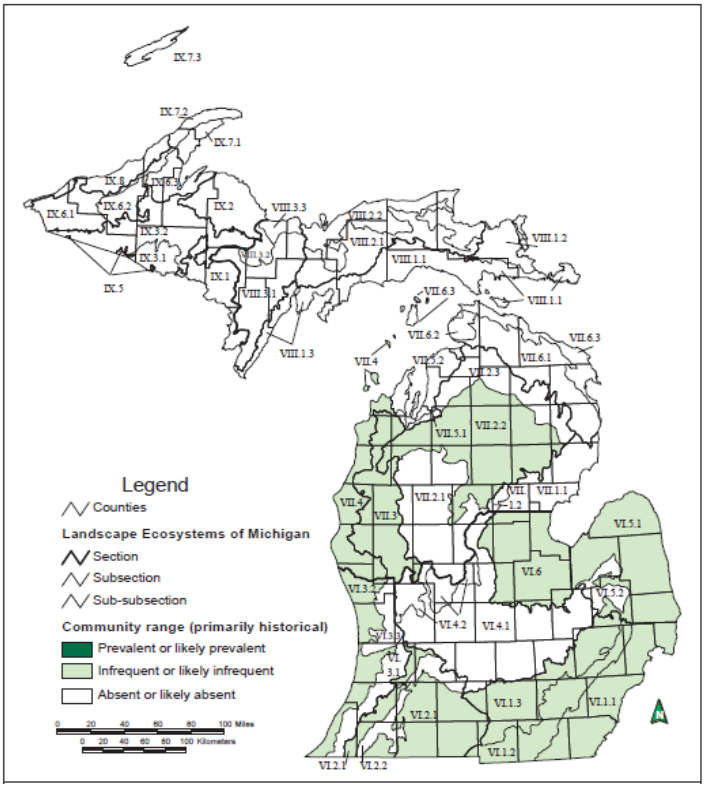

Figure 5. Statewide distribution of mesic sand prairie (Albert et al. 2008).

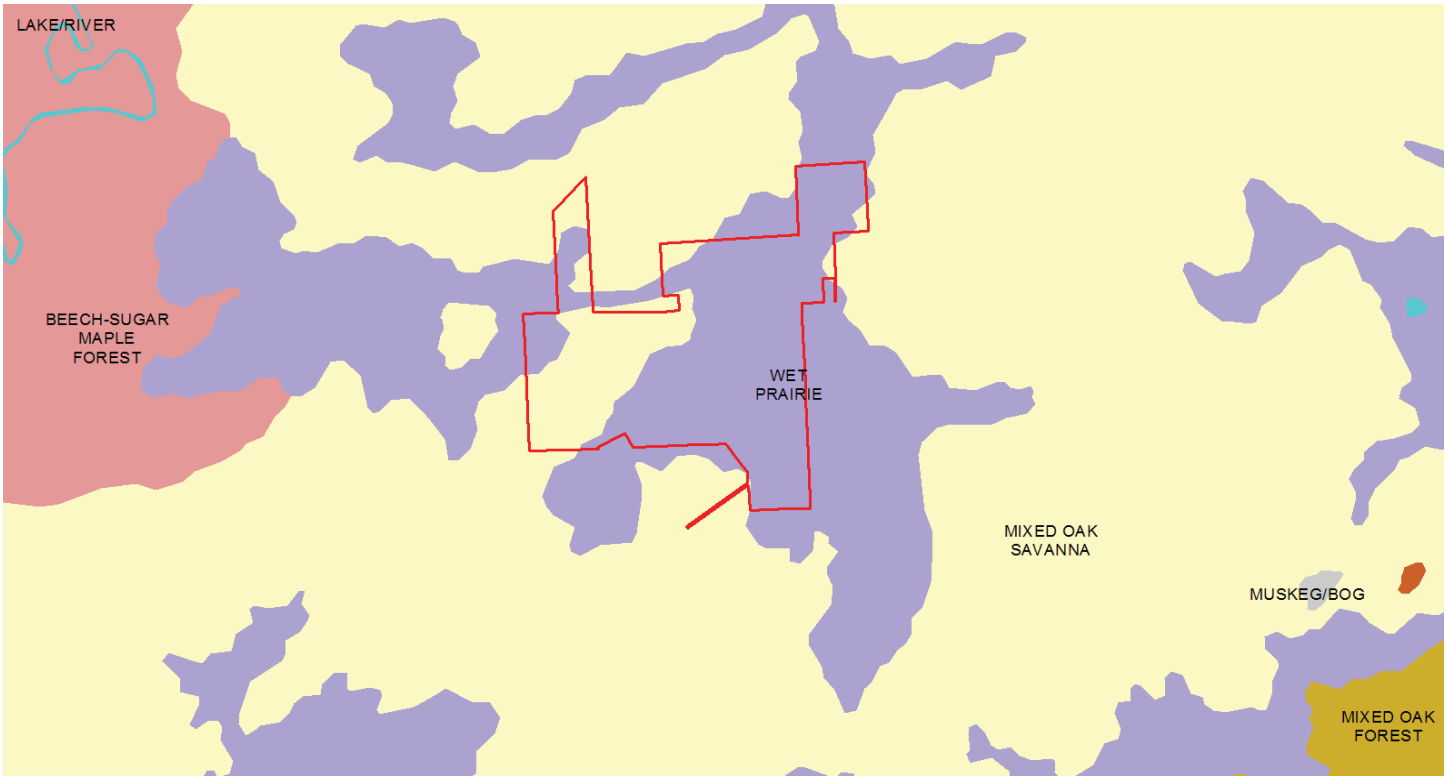

Figure 4. Circa-1800 vegetation cover of landscape around Petersburg SGA (outlined in red) was a shifting mosaic of savanna and prairie (Comer 1997).

Seasonal and annual water level fluctuations and sandy soils create conditions suitable for plant species representing a broad range of moisture tolerances, primarily species requiring mesic to dry conditions. Prior to European settlement in the early 1800s, fires of natural and anthropogenic origin limited encroachment by shrubs and trees. 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.

Dominant grasses include little bluestem, big bluestem, and Indian grass. Pennsylvania sedge (*Carex pensylvanica*) is often common. Low areas transitional to wet-mesic prairie or wet-mesic sand prairie have increased dominance of bluejoint grass (*Calamagrostis canadensis*), cordgrass (*Spartina pectinata*), sedges (*Carex* spp.), rushes (*Juncus* spp.), and bulrushes (*Scirpus* spp.). Common forbs include colic root (*Aletris farinosa*), thimbleweed (*Anemone cylindrica*), spreading dogbane (*Apocynum androsaemifolium*), arrow-leaved aster (*Symphyotrichum urophyllum*), tall coreopsis (*Coreopsis tripteris*), smooth scouring rush (*Equisetum laevigatum*), flowering spurge (*Euphorbia corollata*), wild-strawberry (*Fragaria virginiana*), northern bedstraw (*Galium boreale*), tall sunflower (*Helianthus giganteus*), alum root (*Heuchera americana*), path rush (*Juncus tenuis*), false dandelion (*Krigia biflora*), prairie phlox (*Phlox pilosa*), old-field cinquefoil (*Potentilla simplex*), black-eyed Susan (*Rudbeckia hirta*), stiff goldenrod (*Solidago rigida*), Missouri ironweed (*Vernonia missurica*), and arrow-leaved violet (*Viola sagittata*). The following shrubs and trees are occasional to common, especially in fire-suppressed occurrences: red maple (*Acer rubrum*), quaking aspen (*Populus tremuloides*), oaks (*Quercus* spp.), sumacs (*Rhus* spp.), pasture rose (*Rosa carolina*), raspberries (*Rubus* spp.), and sassafras (*Sassafras albidum*). Canada bluegrass (*Poa compressa*), an invasive species, is common in some sites (Cohen et al. 2014; Kost et al. 2007).

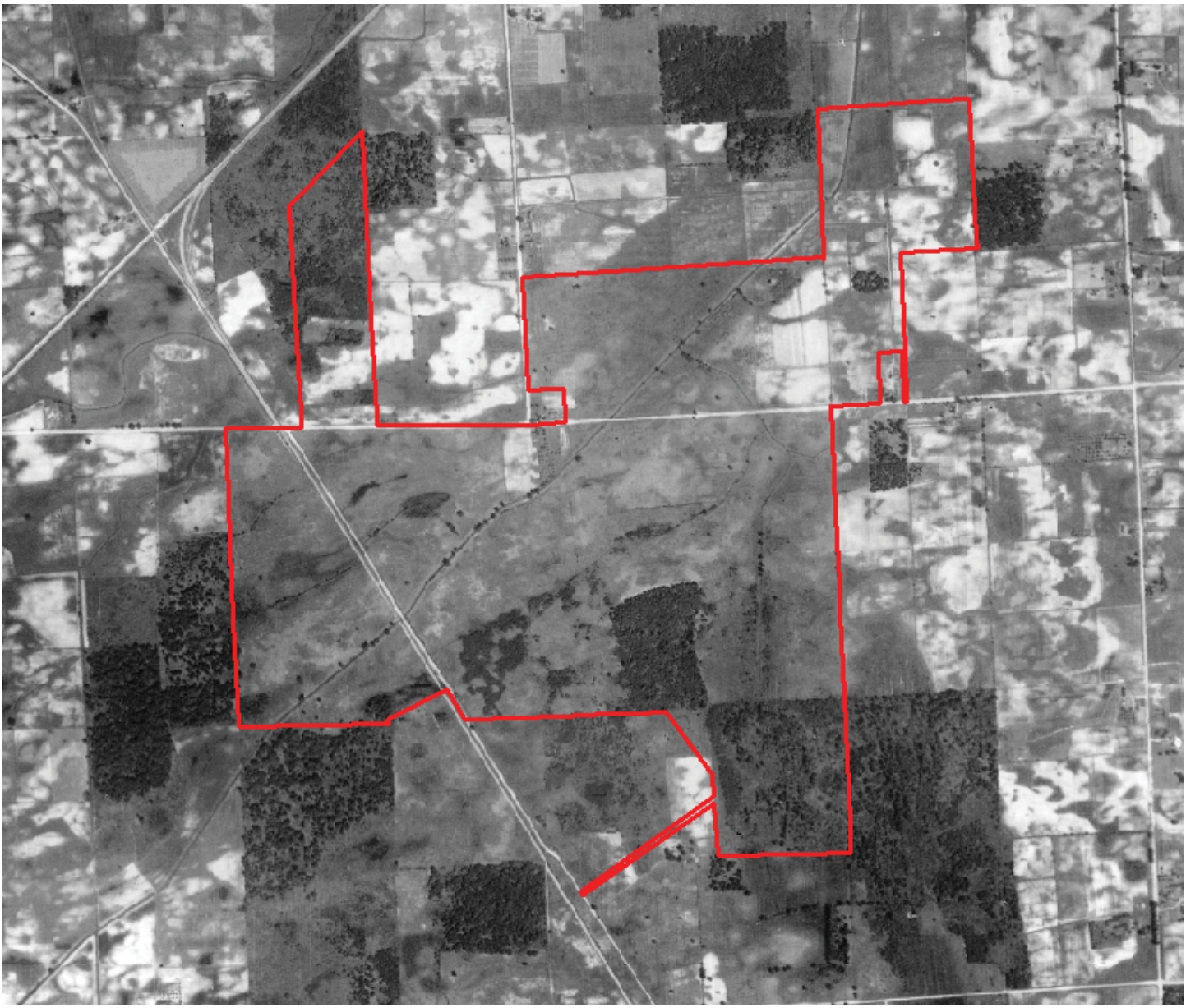

Figure 6. Imagery from 1938 shows the extent of ditching in the game area, the historic extent of forests, and the impact of agriculture in the area surrounding Petersburg SGA.

Ants, particularly the genus *Formica*, play an important role in mixing and aerating prairie soils as they continually build and abandon mounds, overturning large portions of prairie soil in the process. Other important species contributing to soil mixing and aeration include moles, mice, skunks, and badgers. This prairie community provides important early successional habitat for deer and turkey. Deer regularly visit prairies in the summer when warm-season grasses are growing. The new growth is more palatable than cool-season grasses during this time of year. This has also been observed as an area with a high concentration of fawning deer, perhaps because the tall grasses provide abundant dense cover. Turkeys use these areas for brooding and also for foraging due to an abundance of insects. The presence of aspen at the margins of wet prairies also creates an ideal situation to manage aspen, particularly with fire. The prevalence of aspen is an ideal component for both deer and grouse. Grassland birds have been documented in the prairies of this area and this community type has potential to accommodate additional species of rare birds (e.g., prairie warbler and Henslow's sparrow) with continuing restoration. Expansion of this community type could lead to increased use by birds requiring grassland or early successional forest habitat.

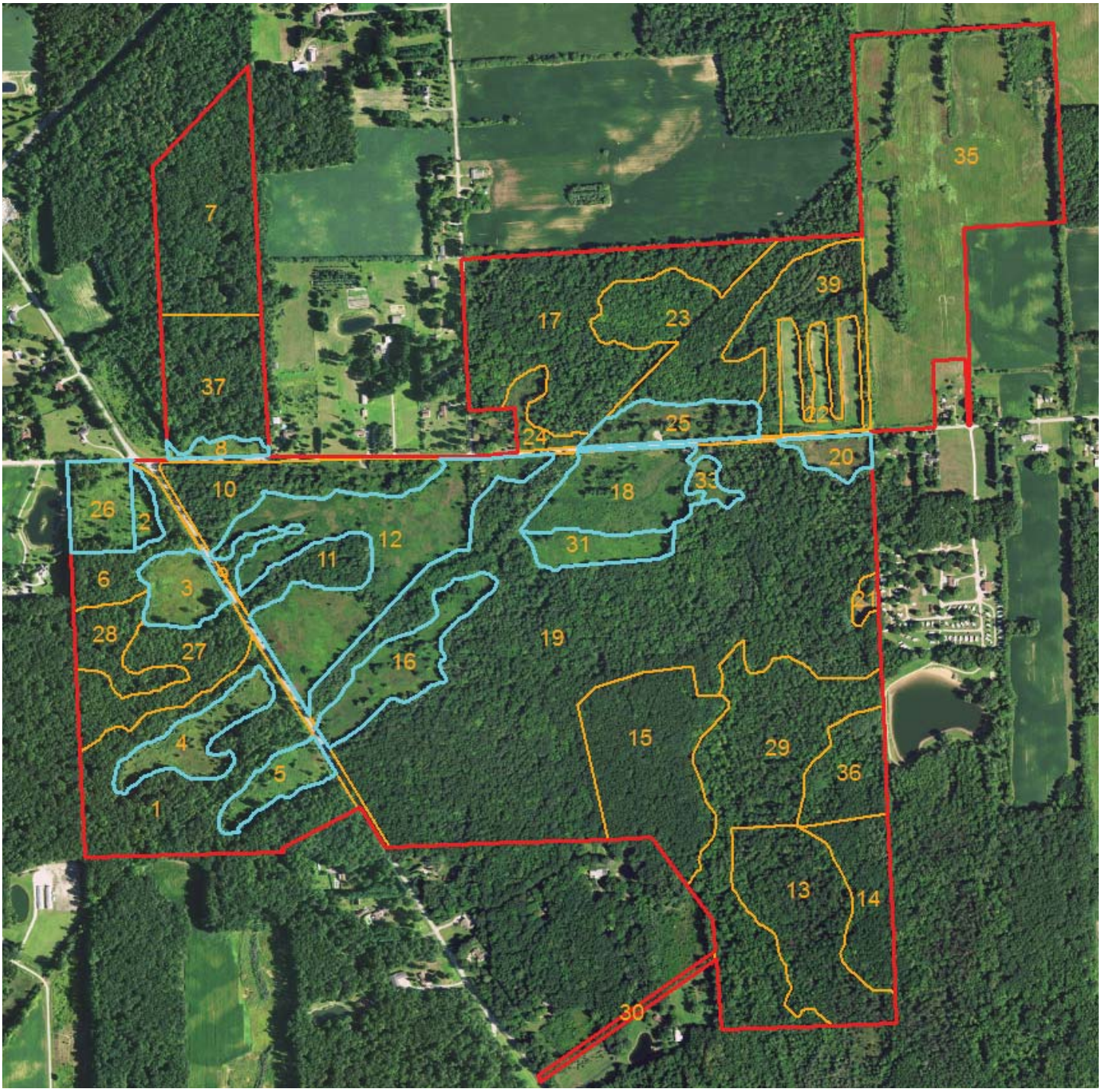

Figure 7. Petersburg SGA has several openings with characteristic prairie vegetation, highlighted in blue. Some of these openings were not included in project areas but are still worthy of attention from managers.

Oak Openings

Oak openings were also historically prevalent throughout the region. The majority of this community type was lost to agricultural development and it is currently a critically imperiled system with only one example remaining. Oak openings are fire-dependent savannas dominated by oaks, having between 10 and 60% canopy, with or without a shrub layer. The predominantly graminoid ground layer is composed of species associated with both prairie and forest communities.

The oak openings are a fire-dependent savanna community, dominated by oaks and characterized by ground layer of species associated with both prairie and forest communities. Oak openings occur within the southern Lower Peninsula on glacial lakeplains on sand ridges, level sandplains, or adjacent depressions. Open conditions were historically maintained by frequent fire, and in depressions, by seasonal flooding. Oak openings persist when fire, hydrology, and/or drought prevent canopy closure. The character of oak openings can differ dramatically, primarily as the result of varying fire intensity and frequency, which are influenced by climatic conditions, soil texture, topography, and landscape context (i.e., proximity to water bodies and fire-resistant or fire-conducing plant communities). Infrequent, high-intensity fires kill mature oaks and produce openings with abundant scrubby oak sprouts. Park-like openings, with widely spaced trees and an open grass understory, are maintained by frequent, low-intensity fires, which occur often enough to restrict maturation of oak grubs. Frequent fires also maintain high grass and forb diversity by deterring the encroachment of woody vegetation and limiting single species dominance. Presently, the prevalent catalyst of fires is lightning strike, but historically Native Americans played an integral role in the fire regime, accidentally and/or intentionally setting fire to savanna and prairie ecosystems. In low areas, seasonally high water levels play an important role in maintaining the open condition of oak openings. Dominant canopy species of droughty sand ridges are black oak (*Quercus velutina*) and white oak (*Q. alba*). Bur oak (*Q. macrocarpa*), pin oak (*Q. palustris*), and swamp white oak (*Q. bicolor*) are prevalent on flat, poorly drained areas. Canopy and subcanopy associates of ridges include hickory species (*Carya* spp.), green ash (*Fraxinus pennsylvanica*), and sassafras. Canopy associates of swales include green ash, silver maple (*Acer saccharinum*), red maple (*A. rubrum*), and cottonwood (*Populus deltoides*). The ground layer consists of species typical of mesic sand prairie and lakeplain wet-mesic prairie. Ground flora of sandy ridges is characterized by big bluestem, bluejoint grass, Pennsylvania sedge, blazing star (*Liatris* spp.), little bluestem, and Indian grass. Shrubs of sandy ridges include serviceberries (*Amelanchier* spp.), bearberry (*Arctostaphylos uva-ursi*), New Jersey tea (*Ceanothus americanus*), sweetfern (*Comptonia peregrina*), gray dogwood (*Cornus foemina*), American hazelnut (*Corylus americana*), hawthorns (*Crataegus* spp.), huckleberry (*Gaylussacia baccata*), cherries (*Prunus* spp.), sumacs (*Rhus* spp.), dewberry (*Rubus flagellaris*), and blueberries (*Vaccinium* spp.). Common ground flora in swales includes bluejoint grass, tussock sedge (*Carex stricta*), sedge (*C. aquatilis*), twig-rush (*Cladium mariscoides*), switch grass (*Panicum virgatum*), Virginia mountain mint (*Pycnanthemum virginianum*), and cordgrass. Prevalent shrubs in swales include black chokeberry (*Aronia prunifolia*), buttonbush (*Cephalanthus occidentalis*), dogwoods (*Cornus* spp.), winterberry (*Ilex verticillata*), shrubby cinquefoil (*Dasiphora fruticosa*), and willows (*Salix* spp.).

Photo 1. Butterfly weed (*Asclepias tuberosa*) is a native milkweed that is host to Monarch butterflies and found within the area's prairies and savannas.

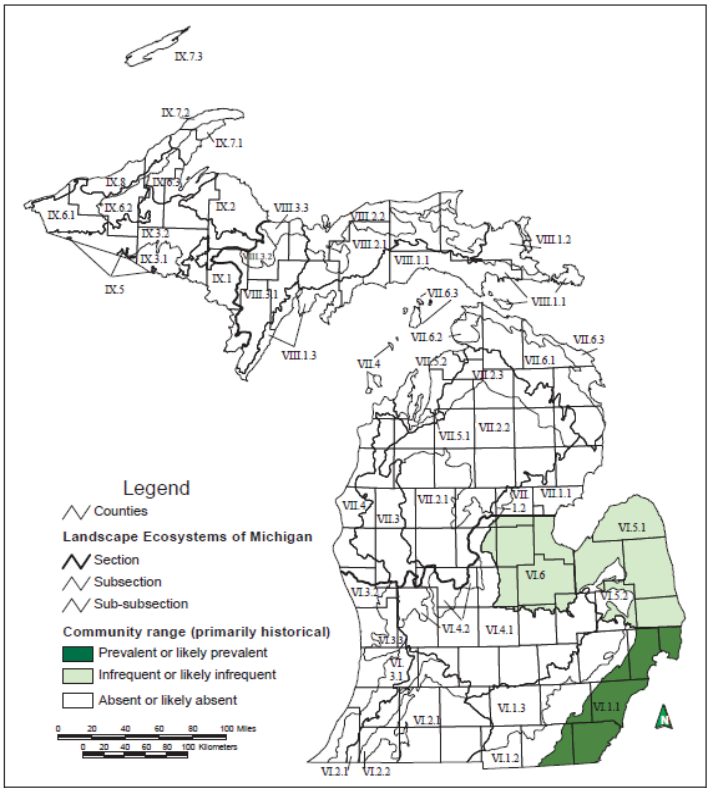

Figure 8. Statewide distribution of lakeplain oak openings (Albert et al. 2008).

PROJECT AREAS

Four project areas have been identified and prioritized based on relative quality of the prairie remnants in the area. Additional factors considered were: ease of treatments, presence of rare taxa, existing features for burn breaks, and additional communities that would benefit from management actions. Together, the project areas comprise 263 acres and are one of the largest prairie restoration projects in the state.

The recommendations outlined below are aimed at improving existing high-quality habitats that have not been totally invaded and restoration efforts would still have an increased chance of achieving goals. These prairie systems are some of the rarest ecosystems in the region and require active management to prevent further degradation. Many are in relatively good condition and the proposed projects would have positive impacts on a sizeable proportion of the state's remaining prairie systems.

Prairies are one of the most imperiled natural communities in our region and their scarcity and the fragmented nature of the remaining examples highlight the needs for restoration efforts. Additionally, promoting ecological integrity of the prairies benefits turkey, pheasant, and white-tailed deer. Including the forested areas in the project areas will help restore the savanna structure to the oak openings systems which are particularly beneficial to turkey and deer. This approach will also protect the oak resource that provides a critical food source for wildlife. Using prescribed fire in these forested systems

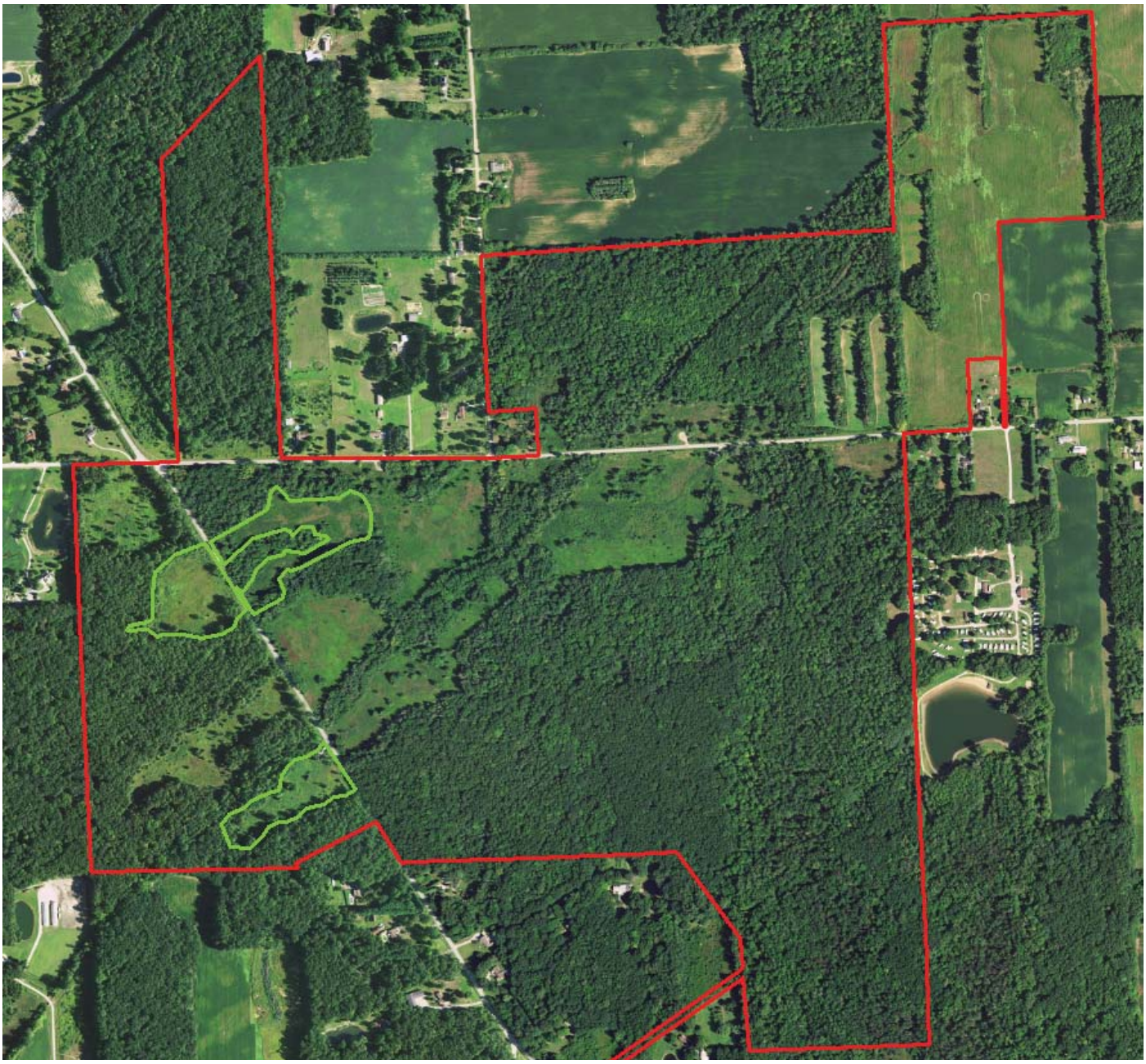

Figure 9. Though there are several areas within Petersburg SGA with prairie vegetation, only a small subset of those openings have been determined to be high-quality and included in MNFI's spatial database. These areas are highlighted in green.

Table 1. Element Occurrences of Petersburg SGA. Karner blue butterfly was last observed in 1986 and reintroduced in 2008. Its presence has not been confirmed since its reintroduction and its status is unknown. EO Rank abbreviations: A = Excellent estimated viability, B = Good estimated viability, C = Fair estimated viability, D = Poor estimated viability, E = Extant, viability not assessed, H = Historical Record. Status abbreviations: SC = Special Concern, T = Threatened, E = Endangered, X = Extirpated from Michigan, L denotes federal status.

Common Name	Scientific Name	EO ID	EO Rank	Status	First Observed	Last Observed	Stands
Natural Communities							
Mesic sand prairie		5005	C	S1	1978	2017	3, 5, 12
Plants							
Hairy angelica	*Angelica venenosa*	3799	BC	SC	1980	2015	3, 12
Tall green milkweed	*Asclepias hirtella*	375	CD	T	1970	2014	3, 16, 20
Trailing wild bean	*Strophostyles helvula*						
Willow aster	*Symphyotrichum praealtum*	15866	A	SC	2005	2015	3, 4, 5, 12, 16, 18, 31, 33
Birds							
Lark sparrow	*Chondestes grammacus*	20399	E	E	2008	2015	3, 4, 12, 24
Insects							
Karner blue butterfly	*Lycaeides melissa samuelis*	5246	X?	LE	1965	1986 (2008)	3, 5, 12
Blazing star borer	*Papaipema beeriana*	12949	AB	SC	1992	2014	3, 33
Culver's root borer	*Papaipema sciata*	4297	AC	SC	1990	2012	3, 18
Silphium borer moth	*Papaipema silphii*	18729	BC	T	2011	2011	25

with the explicit goal of reducing the canopy and subcanopy will decrease competition among remaining trees, promote greater oak regeneration, and increase the native herbaceous component of the ground layer; thereby improving habitat for wildlife and promoting the ecological integrity of the oak openings.

The restoration work required for these systems is complex and requires a nuanced and adaptable approach with a long-term vision of promoting ecosystem integrity. The primary management recommendations are to reintroduce fire as a critical disturbance factor and control invasive species within the prairie remnants and in the surrounding landscape using prescribed fire, mechanical removal, and herbicide application. A sustained and concentrated effort to implement fire and control invasive species in the highest quality prairie remnants is recommended. Fire intervals of one to three years bolster graminoid dominance, increase overall grass and forb diversity, and remove woody cover of saplings and shrubs. In addition, we suggest varying the seasonality of the prescribed fire to reduce woody encroachment of glossy buckthorn as well as native shrubs (e.g., dogwoods, willows, etc.) that are increasing due to fire suppression. Conducting burns in late spring after leafout or during the growing season is recommend because energy reserves are already partially depleted, and resprouting vigor is low, particularly for clonal species.

The restriction of burning to spring time is a management concern. Fires have the greatest impact on those plants that are actively growing at the time of the burn. Repeated fires at the same time of year impacts the same species year after year, and over time can lower floristic diversity. For example, forbs that flower in early spring often overwinter as a green rosette or may have buds very close to the soil surface and in the litter layer. Repeated burns in early spring can be detrimental to such species. Fires historically burned in a variety of seasons, including spring, during the growing season, and fall. The natural communities in Petersburg SGA likely historically burned primarily in late summer and early fall. Varying the seasonality of prescribed burns to match the full range of historical variability better mimics the natural disturbance regime and leads to higher biodiversity.

If resources cannot be dedicated to all project areas for a prolonged period, then managers should consider focusing on one or two areas and dedicating resources at these sites for several seasons to achieve sustainable results. The proposed project areas are introduced in order of priority, but the implementation of the work will depend on the discretion of the managers. Keeping detailed records of the treatments and monitoring the project areas before and after implementation are critical to determine the success of the work and to make adjustments as priorities change and new threats emerge.

Photo 2. Hairy angelica (*Angelica venenosa*) is a species of special concern found throughout many of the prairie openings in Petersburg SGA.

Petersburg SGA is an ecologically unique place with opportunities to conserve some of Michigan's rarest natural heritage. Prairies are a globally imperiled natural community with less than 1% of their historic extent remaining. Of the 9 documented mesic sand prairies in Michigan, only 5 remain in a condition recognizable as prairie. Of those that remain, the examples found at Petersburg are among the largest and most intact. These projects are designed to protect these places and the wildlife that utilizes them.

Elsewhere in the region, prairies have been created where none existed and recreated where agriculture removed the natural cover. We are not questioning those actions but we caution against applying such methods here. The remnants that exist here are a unique and tenuous window into the past and their natural composition – though surely altered – should be preserved to as high of a degree as possible. Thus, managers should avoid adding additional plant species to satisfy a notion of what constitutes a prairie. We don't know everything that was here historically and we don't know what is yet to be expressed from the seed bank with sound restoration practices. The addition of species to satisfy a concept of a prairie would complicate and reduce our understanding of these unique and complex systems. This is a restoration project, not a gardening experiment. Likewise, amending the soil can alter the soil chemistry and permanently change the composition of the prairie and its successional trajectory.

It is also important to note that areas with prairie vegetation that were not part of the following project areas are worthy of attention and provide important value to species that rely on prairie habitat. These may be isolated pockets or persist in a degraded state but should still be recognized as ecologically significant areas that are important to protect and incorporate into management actions when resources allow and when deemed appropriate by area managers. These Stands include 4, 8, 24, and 25.

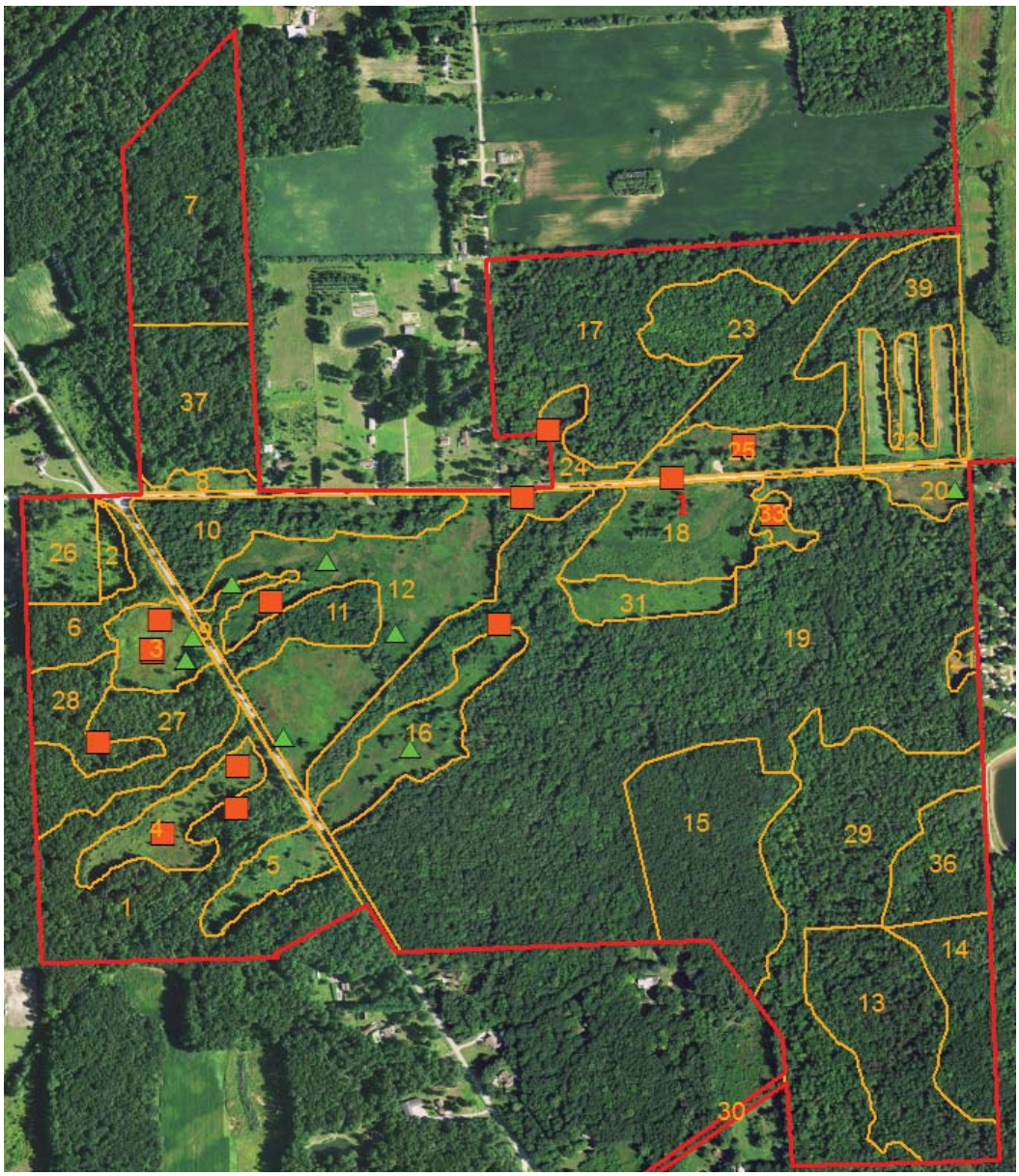

Figure 10. Locational information of the rare plants (green triangles) and animals (red squares) found in Petersburg SGA.

Project Area 1: Minong Prairie - East

Stands: 10, 11, and 12. Total project area is 47 acres.

This area was selected as the highest priority project area because a portion of the prairie has been identified as an intact remnant and it is the largest area of unfragmented prairie in the game area. Thus, the area has excellent potential to provide additional habitat for pheasants. Existing features such as roads and drainage ditches that act as burn breaks such that no additional investments of resources are required to establish a permanent burn unit. Additionally, there is a concentration of rare species in Stand 12 (Table 1, Figure 10) and the management of this area with the goal of ecosystem restoration will benefit these taxa. We recommend continuing the application of prescribed fire to the system as the primary management action. The use of prescribed fire is paramount and regular burns should be planned and the seasonality of those burns varied to maximize biodiversity and mimic the historic fire regime.

Project Area 1 has a portion of remnant prairie in the northwestern portion of Stand 12. Additional areas with prairie species throughout Stand 12 are potentially areas that were planted or naturally reestablished after agricultural operations. There is also a small opening in the northeast portion that was historically a homestead. Stands 10 and 11 are forested were included in this project area as they were non-forested in 1938 and were historically part of the prairie/oak opening complex. These forested areas should not be the focus of initial restoration work but should be included in prescribed burns to shift towards an oak opening component and thereby significantly improve habitat for deer and turkey. The inclusion of the forested areas in prescribed burns will create variable age classes of aspen and promote potential grouse habitat. Expansion and maintenance of the grassland complex will also benefit rare grassland birds.

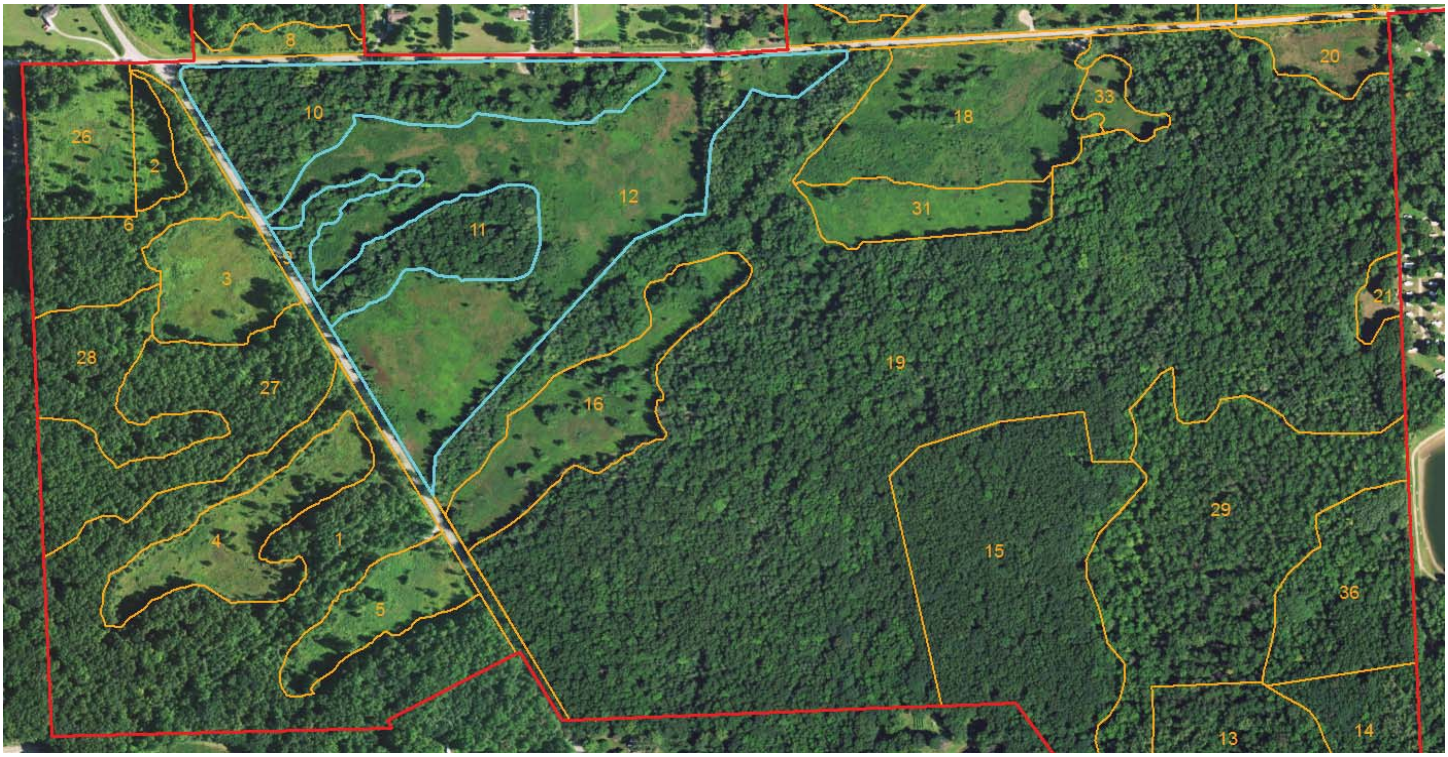

Figure 11. Project Area 1 is highlighted in blue. Characteristic prairie vegetation occurs throughout Stand 12 and along the roads. The forested areas in Stands 10 and 11 should be included in the habitat work as these were historically part of a fire-adapted landscape and may still harbor prairie vegetation throughout.

Photo 3. Portions of Project Area 1 exhibit an abundance of characteristic prairie vegetation. Special attention should be afforded these areas, particularly with the treatment of invasive species and judicious application of herbicides.

Photo 4. Other portions of Project Area 1 were impacted by agriculture and have lower diversity and a greater component of invasive species. However, these areas still support an abundance of native vegetation. The margins of these openings are being are being encroached by woody vegetation, such as autumn olive and quaking aspen. Application of fire will reduce non-native shrubs and create a variable age class of aspen.

Project Area 2: Prairie/Oak Openings

Stands: 15, 16, 18, 19, 20, 31, and 33. Total project area is 165 acres.

This is the largest project area outlined in this report. There are multiple pockets of grasslands that were historically prairie but were apparently impacted by agriculture and have a smaller subset of characteristic prairie vegetation and are impacted by invasive species to a greater degree than the highest quality prairie examples in Petersburg SGA. Despite the marginal ecological integrity of the grasslands in this specific project area, there is a significant component of native prairie vegetation throughout these openings and management activities are warranted. Rare plants and animals have been documented within the non-forested areas and the habitat type is rare enough to justify management attention in these places. Prairie openings include Stands 16, 18, 20, 31, and 33. Additionally, within this project area there is important forested habitat that would benefit from management actions, particularly prescribed fire.

The return of fire to these ecosystems is the fundamental tool required to meet the goal of protecting and expanding prairie ecosystems. Objectives within this project area are to reduce woody vegetation in the prairies and the reduce the abundance of maple in the forested stands, particularly the subcanopy of Stand 15. These objectives can most effectively be met with the repeated application of prescribed fire. Stand 15 is an oak forest with trees over 100 years old. It was forested in the 1930s and appears to have never been tilled. Based on landscape context, this was likely part of an oak opening and may have intact soil biota and seed bank. Therefore, this forest has real potential to return to the savanna state of oak openings. Ideally, Stand 15 would be connected to the prairie openings in Stands 16 and 31 through the application of prescribed fire and potentially selective timber harvest in Stand 19. The objectives being to improve and expand prairie and savanna, improve habitat for game species in Stand 19, protect the oak resource by reducing competition from mesophytic invaders, and create a landscape more reflective of a historic condition.

Though there are existing features that function as burn breaks for most of this project area, additional burn breaks will need to be established to create a permanent project area that can readily be burned. New breaks will need to be established along the southern boundaries of Stands 15 and 19. The boundary would need to then extend up the eastern edge of the project area, between Stands 15 and 29 and then up to Stand 20 to connect to the road.

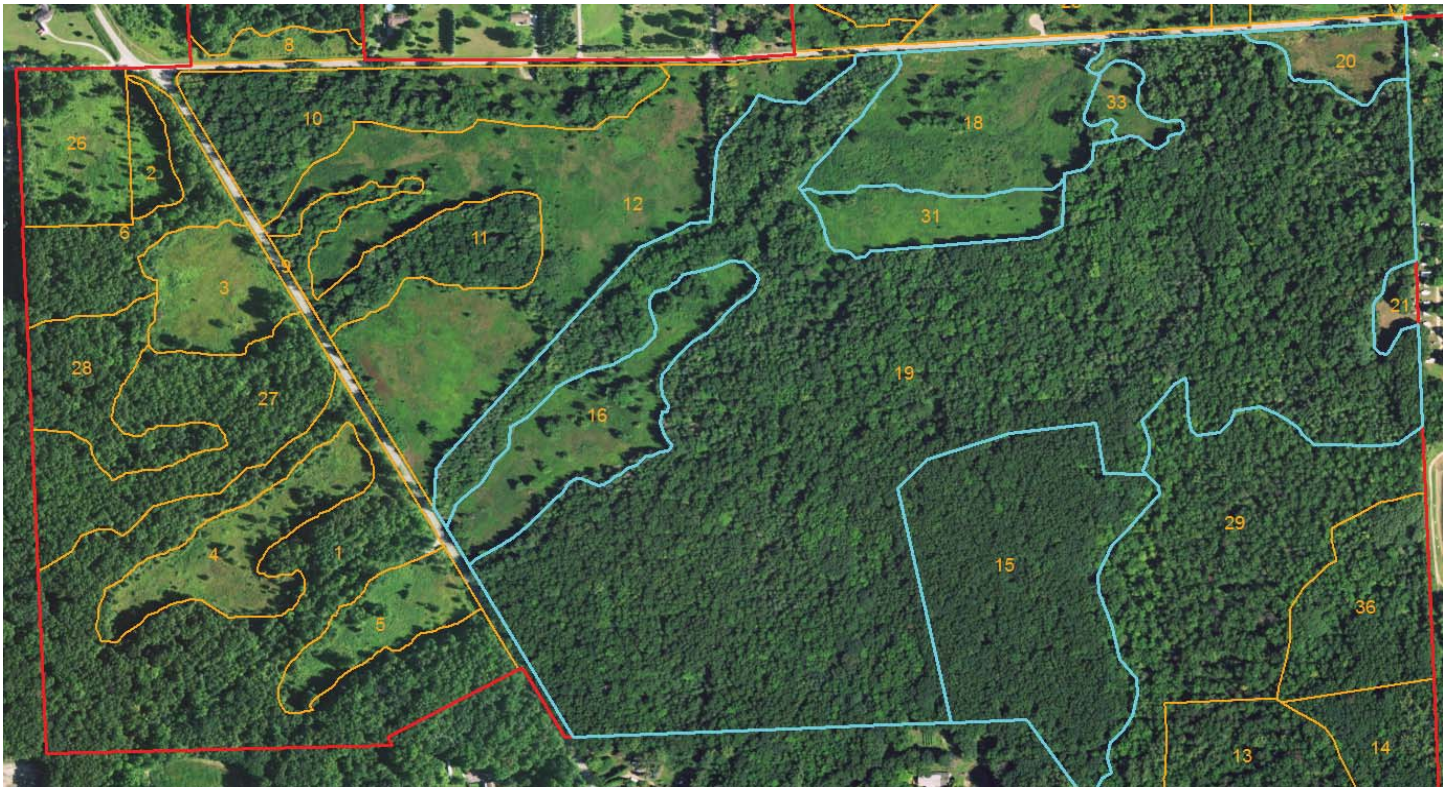

Figure 12. Project Area 2 is highlighted in blue. Characteristic prairie vegetation occurs throughout Stands 16, 18, 20, 31, and 33. The forested areas in Stands 15 is particularly high-quality and could be managed as oak opening. Ideally, Stands 15 and 19 would be improved to savanna state through repeated application of prescribed burns. It is likely that the native seedbank within Stand 15 is somewhat intact as it appears to not have been tilled.

Photo 5. Project Area 2 encompasses a mature oak forest in Stand 15. This forest was likely historically an oak opening, based on landscape context. Fire suppression has greatly reduced the herbaceous component of this ecosystem and allowed red maple to dominate the subcanopy. Returning fire with the goal of reducing the maple component would increase oak regeneration and improve habitat for wildlife.

Photo 6. MNFI Botanist Mike Penskar surveys the prairie opening in Stand 16. There is an abundance of characteristic prairie vegetation throughout. However, autumn olive and other invasive species are locally abundant. Berry-bearing invasive shrubs are often clustered under black cherry trees which tend to attract birds that consume these non-native fruits and frequently defecate under the cherry trees.

Project Area 3: Minong Prairie - West

Stands: 2, 3, 6, 26, 27, and 28. Total project area is 36 acres.

Within Project Area 3 areas of prairie habitat occur in Stands 2, 3, and 26, with the highest quality prairie and greatest concentration of rare taxa documented in Stand 3. The surrounding forested stands were included as they fall within the boundaries created by existing features that would function as burn breaks. Additionally, these forested areas were treeless in the 1930s, suggesting that ditching and fire suppression facilitated the transition from wet prairie to forested wetland. With fire and potential selective tree removal, these forested areas could transition towards a savanna state. Throughout much of Stands 27 and 28 there is minimal herbaceous vegetation and opening of the canopy and application of prescribed fire would doubtless increase the value of these areas to wildlife. Stands 6 (southwest portion) and 28 have the best potential to be converted to a savanna from their from current state as closed canopy.

Throughout the project area, returning fire is a priority. Ideally, the openings could be reconnected with prescribed fire but it is not presently clear how well fire will carry through the entirety of the project area. Shrub removal and selective timber harvest may be required in order to facilitate the spread of prescribed fire and improve the ability of land managers to burn without having to ignite at more than one point. This project area has existing burn breaks along the roads and along an old drainage ditch through Stand 27 that may need some improving if it is to function as a burn break. It is necessary establish a permanent burn break along the western edge along private property where no feature currently exists. It may be prudent to expand the project area to include the opening in Stand 4, which was more impacted by agriculture but has an abundance of prairie vegetation that was likely planted. If Stand 4 is included in the project area, the drainage ditch between Stands 4 and 5 would function as the southern boundary.

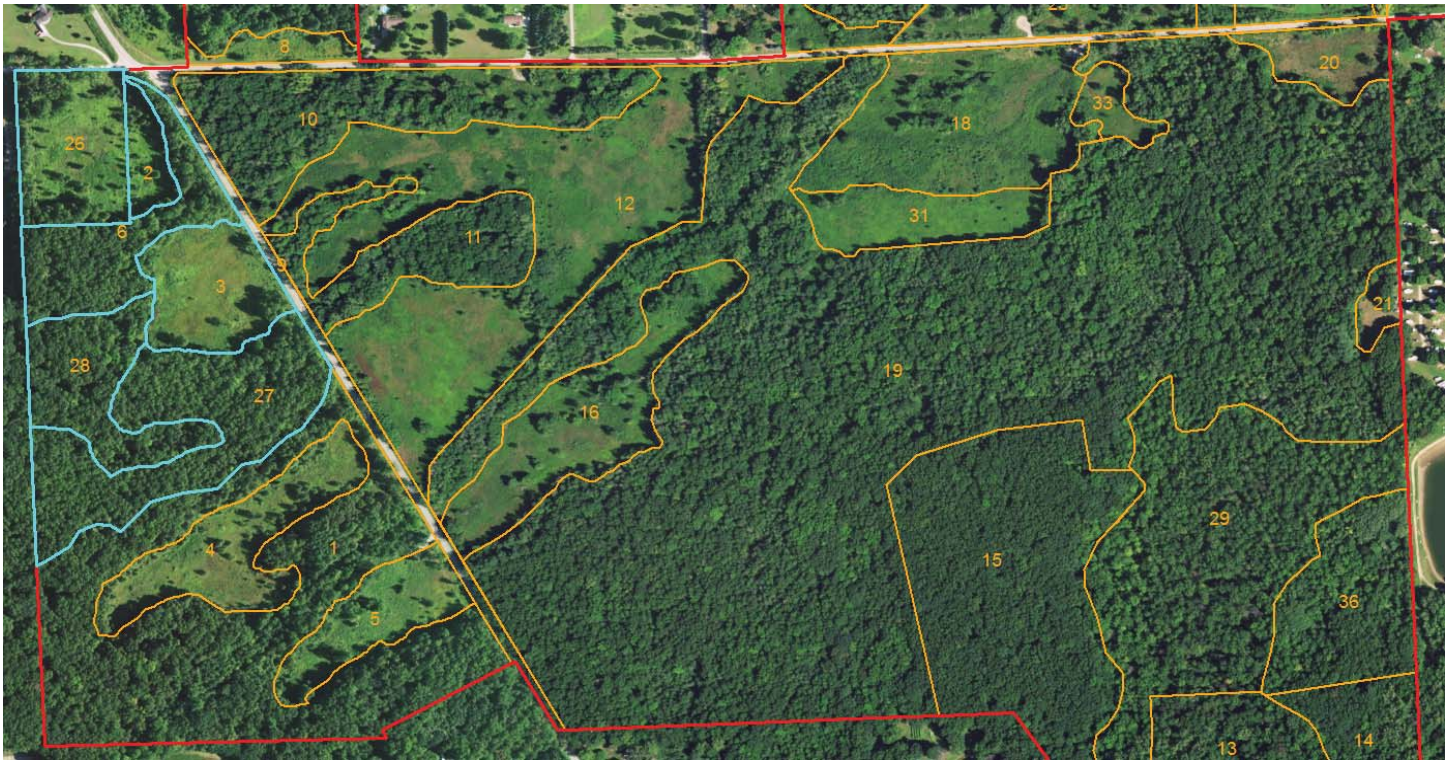

Figure 13. Project Area 3 is highlighted in blue. Characteristic prairie vegetation occurs throughout Stands 2, 3, and 26 with the highest quality remnant in Stand 3. The forested areas in this project area are void of characteristic prairie vegetation but were historically non-forested and might revert to a historic prairie condition with repeated application of prescribed fire.

Photo 7. The prairie remnant in Stand 3 is surrounded by young lowland forest. Based on imagery from 1938 and historic cover types, these forests were likely wet prairie that converted to forest in response to ditching and fire suppression. It is possible that these areas could be returned to a prairie or savanna state with prescribed fire and careful thinning of the forest canopy throughout the project area.

Photo 8. MNFI Botanist Mike Penskar (left) and Ecologist Josh Cohen (right) complete surveys of the prairie remnant in Stand 3. With repeated application of prescribed fire and thinning of the surrounding forests, this high-quality remnant could be expanded and connected to the other openings in Project Area 3 (Stands 2 and 26).

Project Area 4: Minong Prairie - South
Stands: 1 and 5. Total project area is 15 acres.

Project Area 4 is the smallest of the project areas detailed in this report. The opening is one of the highest quality areas with excellent plant diversity and a minimal legacy of agriculture. There are existing features that can be used as burn breaks: a drainage ditch along the northwestern boundary in Stand 1 and the road along the northeastern boundary. There would need to be a fire line constructed along the southern boundary of this project area.

This area is in need of active management as there is an abundance of woody vegetation at the margins and throughout much of the prairie. Fire is the preferred management tool and repeated application is recommended. Winter mowing with a wetblade could also be implemented in order to reduce woody encroachment and protect the prairie habitat. Extending the fire into the forested area surrounding the prairie opening would expand areas with prairie vegetation, create savanna structure, and improve habitat for wildlife. Promotion of savanna structure could be expedited by thinning of the canopy and reducing the understory in concert with prescribed fire.

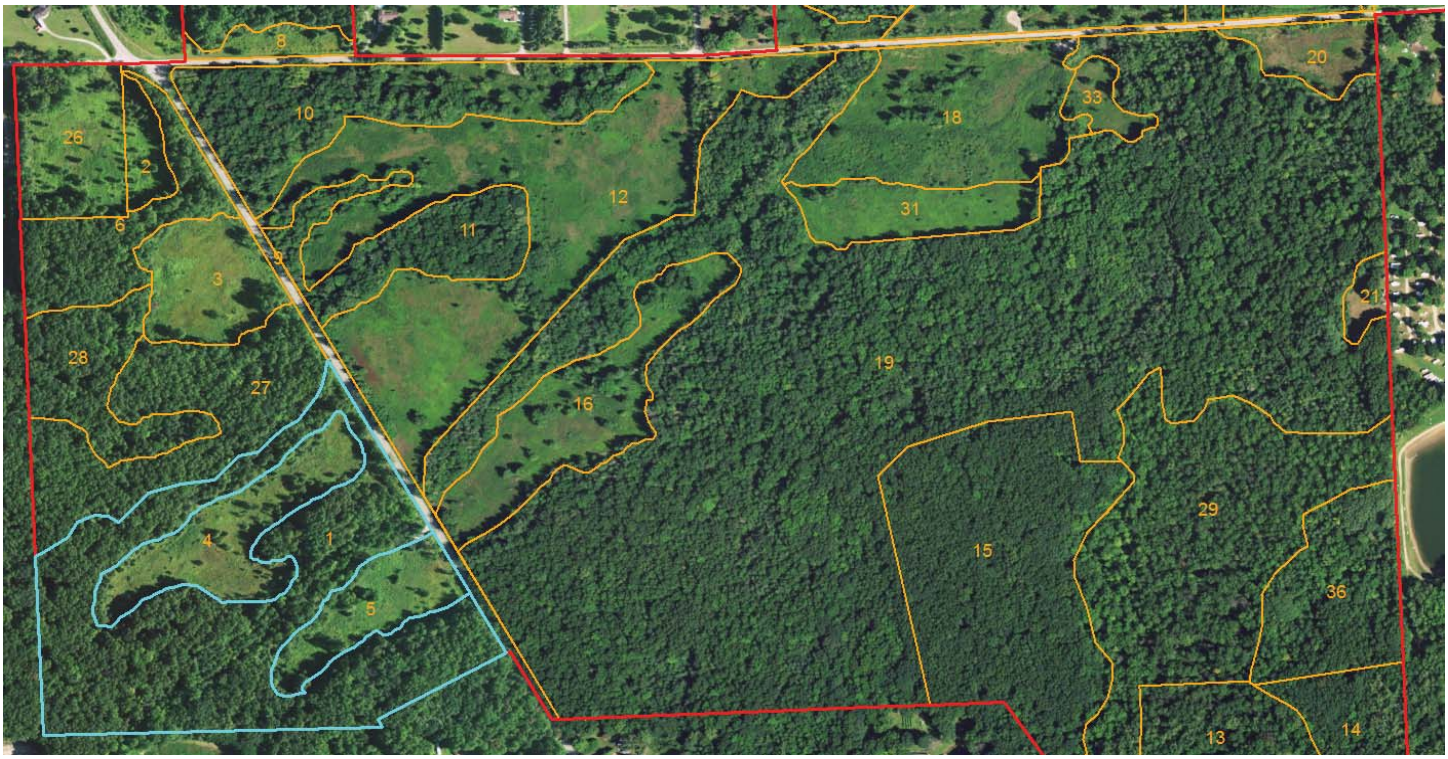

Figure 14. Project Area 4 is highlighted in blue (does not include Stand 4). Stand 5 is a remnant mesic sand prairie with a high diversity of characteristic prairie vegetation. This opening is being encroached by cherry and aspen and needs repeated prescribed fire. Winter mowing with a wet blade may be a good alternative when burning isn't an option.

Photos 9 and 10. The prairies in Petersburg SGA support a myriad of flowering plants - including culver's root (left) and Michigan lily (right) - not seen in more degraded iterations of this community type. Active management, particularly with prescribed fire applied at various times of the year and regular intervals, will improve the diversity of plants and animals that utilize the habitats.

CONCLUSIONS

The project areas outlined in this report highlight some of the most important prairie remnants in the region. Michigan once had hundreds of thousands of acres of prairie and more than 99.9% of that has been lost to agriculture and development. The prairies at Petersburg are a critical piece of our state's natural heritage and are worthy of attention. These systems benefit a myriad of rare species and provide important habitat to turkeys, white-tail deer, and pheasants.

For these projects to succeed at maintaining and improving the ecological integrity of the prairies, they will need attention for several years. Beyond application of fire and removal of undesirable species, this involves an adaptive management approach, including: continually surveying for invasive species, assessing the effectiveness of the timing of prescribed fire, photo-monitoring to track changes over time, and assessing populations of rare species.

Long term success also requires a clear understanding of the importance and rarity of this resource and being able to convey its significance to hunters as well as DNR staff involved with the project. The duration of these restoration efforts span more than one individual's career and the protection of these places relies on an ability to communicate their value.

Photo 11. The prairie remnants that persist in Petersburg SGA exist in an array of conditions: from relatively high-quality, to quite degraded. Some areas of historical prairie are now forest and others are still recognizable as their historic state. These communities don't remain in a constant state and require careful and consistent attention to protect their ecological integrity. The prairie remnants within Petersburg SGA are arguably some of the most important in the state and are worthy of such attention.

LITERATURE CITED

Albert, D.A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: A working map and classification. USDA, Forest Service, North Central Forest Experiment Station, St. Paul, MN.

Albert, D.A., J.G. Cohen, M.A. Kost, B.S. Slaughter, and H.D. Enander. 2008. Distribution Maps of Michigan's Natural Communities. Michigan Natural Features Inventory, Report No. 2008-01, Lansing, MI. 314 pp.

Cohen, J.G., M.A. Kost, B.S. Slaughter, and D.A. Albert. 2014. A Field Guide to the Natural Communities of Michigan. Michigan State University Press, East Lansing, MI. 362 pp.

Cohen J.G., B.S. Slaughter, and J.M. Lincoln. 2016. Lakeplain Prairie Surveys and Management Recommendations for St. John's Marsh State Wildlife Area. Michigan Natural Features Inventory Report Number 2016-20Lansing, MI. 23 pp.

Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Corner, and D.W. Schuen. 1995. Michigan's presettlement vegetation, as interpreted from the General Land Office Surveys 1816-1856. Michigan Natural Features Inventory, Lansing, MI. Digital map.

Dorr, J.A., Jr., and D.F. Eschman. 1970. Geology of Michigan. University of Michigan Press, Ann Arbor, MI. 470 pp.

Eichenlaub, V.L., J.R. Harman, F.V. Nurnberger, and H.J. Stolle. 1990. The climatic atlas of Michigan. University of Notre Dame Press, Notre Dame, IN. 165 pp.

Faber-Langendoen, D., J. Rocchio, P. Comer, G. Kudray, L. Vance, E. Byers, M. Schafale, C. Nordman, E. Muldavin, G. Kittel, L. Sneddon, M. Pyne, and S. Menard. 2008. Overview ofNatural Heritage Methodology for Ecological Element Occurrence Ranking based on Ecological Integrity Assessment Methods [Draft for Network Review]. NatureServe, Arlington, VA.

Faber-Langendoen, D., W. Nichols, J. Rocchio, J. Cohen, J. Lemly, and K. Walz. 2015. Ecological Integrity Assessments and the Conservation Value of Ecosystem Occurrences: General Guidance on Core Heritage Methodology for Element Occurrence Ranking. NatureServe, Arlington, VA.

Kost, M.A., D.A. Albert, J.G. Cohen, B.S. Slaughter, R.K. Schillo, C.R. Weber, and K.A. Chapman. 2007. Natural Communities of Michigan: Classification and Description. Michigan Natural Features Inventory Report Number 2007-21, Lansing, MI. 314 pp.

Michigan Natural Features Inventory (MNFI). 1988. Draft criteria for determining natural quality and condition grades, element occurrence size-classes and significance levels for palustrineand terrestrial natural communities in Michigan. Michigan Natural Features Inventory, Lansing, MI. 39 pp.

Michigan Natural Features Inventory (MNFI). 2016. Biotics database. Michigan Natural Features Inventory, Lansing, MI.

Milstein, R.L. 1987. Bedrock geology of southern Michigan. Lansing, MI: State of Michigan, Department of Natural Resources, Geological Survey Division. 1 map (1:500,000).