Natural Features Inventory and Management Recommendations for Watkins Lake State Park

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Michigan Natural Features Inventory
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Cover Photo: Marsh Brook Fen in Watkins Lake State Park. Photo by Jesse M. Lincoln.

EXECUTIVE SUMMARY

Watkins Lake State Park, the most recent addition to Michigan's network of State Parks, is a large block of semi-continuous public land in southeast Lower Michigan, consisting of approximately 704 acres of Jackson County. Watkins Lake State Park occurs adjacent to Watkins Lake County Preserve, which is owned by the Washtenaw County Parks and Recreation Commission and consists of 405 acres of Washtenaw County. Together, the Watkins Lake State Park and County Preserve are important ecologically because they provide critical habitat for a myriad of game and non-game species, especially species that depend on non-forested wetlands and open upland habitat. Non-forested wetlands constitute over 19% of Watkins Lake State Park with over 13% of that acreage including high-quality prairie fen. Abandoned agricultural fields and pasture constitue over 30% of Watkins Lake State Park and provide critical habitat for grassland bird species. Within Jackson County, natural cover constitutes just 48% of the county. In comparison, natural cover constitutes approximately 74% of Watkins Lake State Park

During the 2016 field season, Michigan Natural Features Inventory (MNFI) completed Stage 1 Michigan Forest Inventory (MiFI) and surveys for exemplary natural communities, and began surveys for rare animals in Watkins Lake State Park. Surveys resulted in three new element occurrences (EOs) and provided information for updating an additional two EOs.

Natural community surveys focused on the open wetland complex along the Norvell Manchester Drain. MNFI ecologists updated an existing prairie fen EO that was previously only known from adjacent private land to the south and west. Surveys on both state and private lands resulted in the expansion of this prairie fen EO from two polygons to seven polygons and from 47 acres to 159 acres. We assessed the current ranking, classification, and delineation of this occurrence and detailed the vegetative structure and composition, ecological boundaries, landscape and abiotic context, threats, management needs, and restoration opportunities. The report provides a detailed description of this prairie fen as well as a comprehensive discussion of site-specific threats and stewardship needs and opportunities.

Surveys for rare grassland bird species included point-counts and meander surveys within upland grassland habitat. A total of 59 bird species were recorded during the point-count and meander surveys. We documented three rare grassland birds during these surveys, representing three new EOs within Watkins Lake State Park for Henslow's sparrow (*Ammodramus henslowii*, state endangered), grasshopper sparrow (*Ammodramus savannarum*, state special concern), and dicksissel (*Spiza americana*, state special concern).

We conducted visual encounter surveys for eastern massasauga (*Sistrurus catenatus*, federally threatened and state special concern), eastern box turtle (*Terrapene carolina carolina*, state special concern), and Blanding's turtle (*Emydoidea blandingii*, state special concern). No rare herptiles were documented during MNFI surveys. However, information from the general public and adjacent landowners was used to update an EO for massasauga and resulted in the expansion of this EO into Watkins Lake State Park.

We recommend that future surveys within Watkins Lake State Park include surveys for rare insect and plant species associated with prairie fen and savanna ecosystems, rare aquatic species associated with the Norvell Manchester Drain, and rare bats. In addition, we recommend additional surveys in the spring for rare herptiles associated with prairie fen and the adjacent uplands.

This report provides an overview of the landscape and historical context of Watkins Lake State Park, summarizes the findings of MNFI's surveys for high-quality natural communities and rare animal species, and discusses stewardship needs, opportunities, and priorities within the park. Specific management recommendations are provided for rare species and groups of rare species and also the natural community EO found within the park. In addition, to species-based and site-based stewardship discussion, general management recommendations for the park as a whole are provided.

Primary management recommendations for the Watkins Lake State Park include: 1) invasive species control throughout the park but focused in the high-quality prairie fen; 2) the use of landscape-scale prescribed fire focused in the open wetland complex and adjacent upland areas and with rotating non-fire refugia where fire-sensitive rare species occur; 3) the opportunistic restoration of oak savanna and barrens ecosystems; 4) the maintenance of the canopy closure of mature forest; 5) the reduction of fragmentation and promotion of connectivity across the park but focused in the vicinity of the high-quality wetlands; and 6) the careful prioritization of management efforts in the most critical habitats. Monitoring of these management activities is recommended to facilitate adaptive management.

ACKNOWLEDGMENTS

We thank the Michigan Department of Natural Resources (DNR) Parks and Recreation Division (PRD) for funding this effort to survey Watkins Lake State Park. Special thanks are due to PRD's Ray Fahlsing and Glenn Palmgren for overseeing this project. This report relies on data collected by the following Michigan Natural Features Inventory (MNFI) field scientists: Joshua Cohen, Mike Penskar, Jesse Lincoln, Aaron Kortenhoven, and Yu Man Lee. Editorial support and insightful comments were provided by Martha Gove, David Cuthrell, and Michael Monfils. Michael and Diana Arnold graciously provided access to their land and shared historical information about the landscape and data on massasauga. Finally, we thank the following MNFI colleagues: Kraig Korroch and Rebecca Rogers assisted with database management; Helen Enander offered technological support and helped produce maps and figures; and Robin Lenkart, Nancy Toben, Yu Man Lee, and Brian Klatt provided administrative support.

Michael Penskar, retired MNFI botanist, and Michael Arnold, private landowner, within Marsh Brook Fen. Mike Penskar provided his botanical expertise during ecological surveys of the prairie fen complex in Watkins Lake State Park. Michael Arnold provided historical information about the park and surrounding lands, data on massasauga, and access to his property, which ajoins the park and contains prairie fen that is part of the large fen complex flanking the Norvell Manchester Drain. Photo by Joshua G. Cohen.

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INTRODUCTION

Watkins Lake State Park, the most recent addition to Michigan's network of State Parks, is a large block of semi-continuous public land in southeast Lower Michigan, consisting of approximately 704 acres of Jackson County. Watkins Lake State Park occurs adjacent to Watkins Lake County Preserve, which is owned by the Washtenaw County Parks and Recreation Commission (WCPRC) and consists of 405 acres of Washtenaw County. Together, the Watkins Lake State Park and County Preserve are important ecologically because they provide critical habitat for a myriad of game and non-game species, especially species that depend on non-forested wetlands and open upland habitat. Non-forested wetlands constitute over 19% of Watkins Lake State Park with over 13% of that acreage including high-quality prairie fen. Abandoned agricultural fields and pasture constitue over 30% of Watkins Lake State Park and provide critical habitat for grassland bird species. Within Jackson County, natural cover constitutes just 48% of the county. In comparison, natural cover constitutes approximately 74% of Watkins Lake State Park (Figure 1).

During the 2016 field season, Michigan Natural Features Inventory (MNFI) completed Stage 1 Michigan Forest Inventory (MiFI) and surveys for exemplary natural communities, and began surveys for rare animals in Watkins Lake State Park. The Michigan Department of Natural Resources (DNR), Parks and Recreation Division (PRD) is responsible for managing Michigan's State Parks, Recreation Areas, Boating Access Sites, Harbors, Scenic Sites, State Forest Campgrounds, and Pathways. Part of PRD's stated mission is to "acquire, protect, and preserve the natural, historic, and cultural features of Michigan's unique resources." Within the division, the Stewardship Unit is charged with preserving, protecting, and restoring natural and cultural features. Preservation and restoration of the natural communities within State Parks and Recreation Areas, along with their constituent plants and animals, are core parts of the mission. The PRD and the WCPRC are in the process of writing a general management plan for Watkins Lake State Park and County Preserve. In this plan, the land is zoned for various levels of protection and use based on the location and type of its natural and cultural features. This project is part of a long-term effort by the PRD to document and sustainably manage areas of high conservation significance on state lands. This report provides an overview of the landscape and historical context of Watkins Lake State Park, summarizes the findings of MNFI's surveys for high-quality natural communities and rare animal species, and discusses stewardship needs, opportunities, and priorities within the park. Specific management recommendations are provided for rare species and groups of rare species and also the natural community EO found within the park. In addition, to species-based and site-based stewardship discussion, general management recommendations for the park as a whole are provided.

Ecoregions and Subsections

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**. Watkins Lake State Park lies within the Washtenaw subsection (Subsection VI.1), and within one sub-subsection, the Jackson Interlobate (Sub-subsection VI.1.3) (Figure 2).

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).

<u>Jackson Interlobate</u>

The Jackson Interlobate (VI.1.3) lies between the extensions of three separate glacial lobes that extended into southern Michigan approximately 16,000 years ago and comprises approximately the northern two thirds of the Interlobate region and lies between the two easternmost

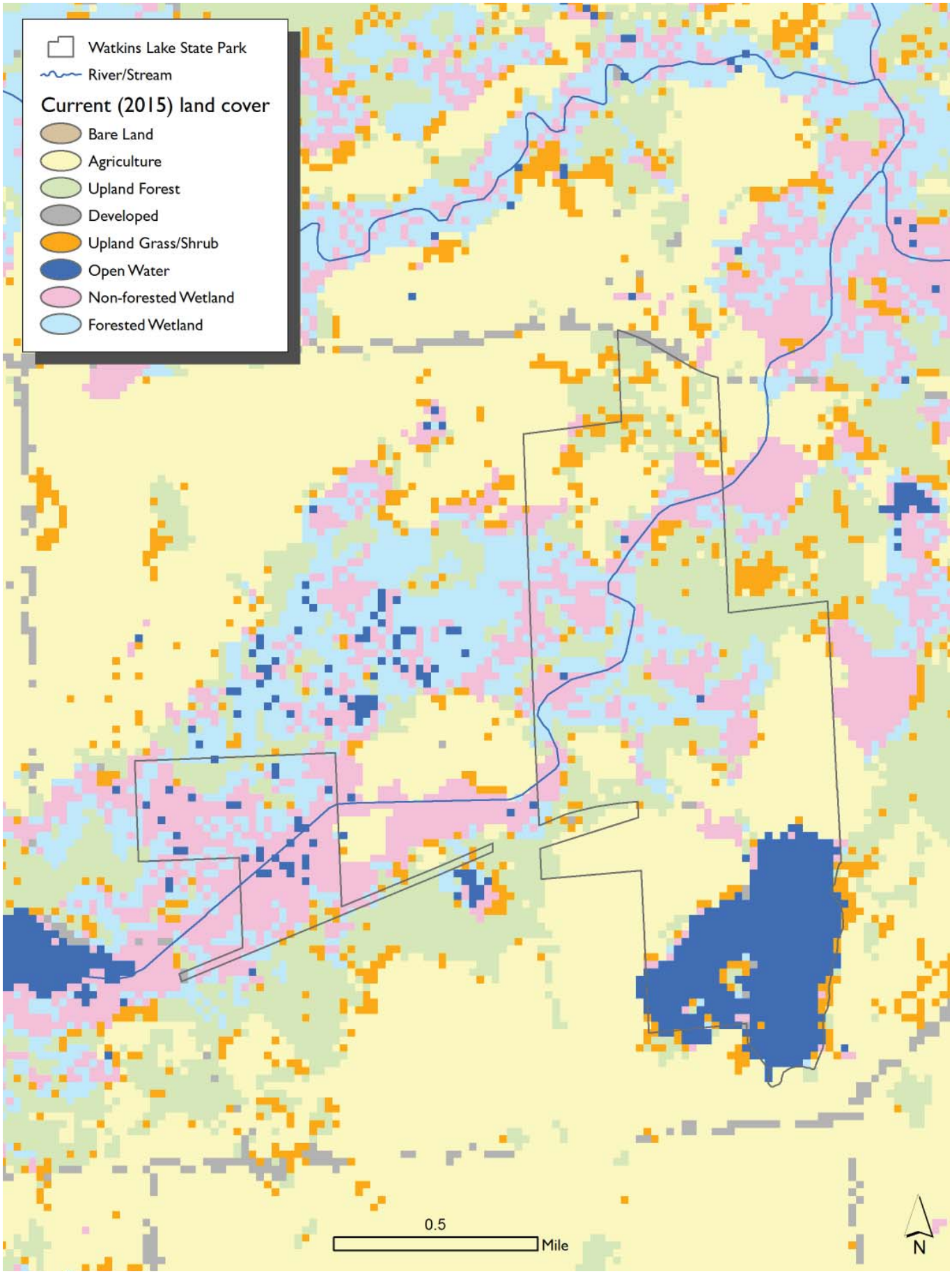


Figure 1. Current land cover of Watkins Lake State Park.

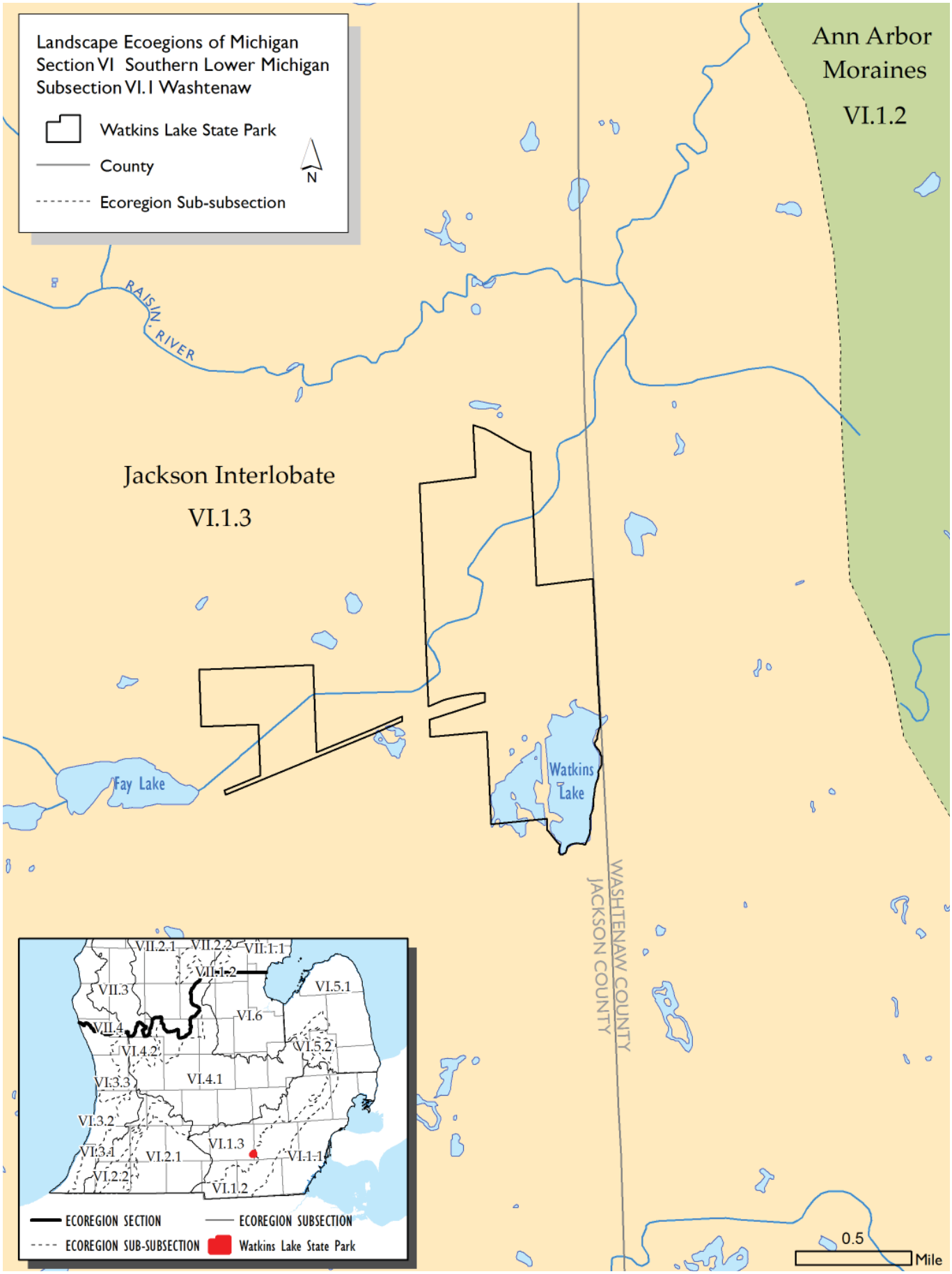


Figure 2. Ecoregions of Watkins Lake State Park (Albert 1995)

glacial lobes. The Kalamazoo Interlobate Subsection VI.2 comprises the remainder of the Interlobate. The Jackson Interlobate encompasses approximately 2,581 square miles and includes portions of Oakland, Livingston, Washtenaw, Jackson, Hillsdale, and Lenawee Counties. Geologically the area is underlain by Mississippian and Pennsylvanian bedrock, primarily sandstone (Dorr and Eschman 1984). The Jackson Interlobate is characterized by a long growing season of 140 to 150 days. Average rainfall ranges from 30 to 32 inches. Annual snowfall shows a similar trend, with an average of 40 to 50 inches. Winters are mild, and annual extreme minimum temperatures range from –22ºF to –28ºF. Due to the complex glacial ice activity that occurred in the region, the landscape exhibits a complicated topography characterized by large, steep ridges, broad outwash plains and channels, and numerous scattered depressions, ridges, and hills. The large ridges are sandy end moraines formed by glacial till (unsorted sediments) deposited at the front of a glacier, while the flatter outwash regions are a result of sediments that are carried away, sorted, and dropped by the melting water that flows from the front of a receding glacier (Figure 3). The numerous scattered depressions, smaller ridges, and hills are a result of ice stagnation that typically occurs at the receding edge of the glacier. Large chunks of ice break off and become surrounded by sandy glacial meltwater sediments. When the ice melted, depressions or pits remained on the otherwise smooth landscape (Dorr and Eschman 1984). Commonly, the glacier moves forward and recedes more than once over the same general area before the final retreat, causing a complex set of ice and sediment interactions. The resulting features on the landscape, known as “ice contact” features, include such commonly known formations as kames (small steep-sided hills), eskers (narrow, often winding ridges), and kettle lakes (steep-sided depressions, filled with water). These features can occur on both moraines and outwash, the latter often referred to as pitted outwash. The southeastern half of Watkins Lake State Park is characterized by coarse-textured end moraines and the northwestern half of the park is characterized by outwash (Figure 3). Outwash plains and channels are typically flat to gently sloping, in the 0 to 6 slope class, while end moraines and ice contact ridges can have slopes as steep as 20 to 40 percent.

The soils of the end moraines are typically well to excessively well-drained sands and gravelly sands, which on the more gentle slopes historically supported open savannas of black and white oak and hickory predominantly. Open savannas occurring on sandy moraines were described by General Land Office (GLO) surveyors as “oak openings”, “barrens”, “barren and scrubby timber”, or “scattered timber”. Wetlands on the lower slopes or in depressions on the moraines were characterized by mostly shrub, hardwood, or tamarack swamps. On the outwash, soils are more variable ranging from heavy, coarse deposits that are typically well drained, to shallow and finer deposits that are somewhat poorly to poorly drained. Large wetlands of various types including prairie fens, wet prairie, grass and sedge meadows, and swamp forests were typical of the poorly drained outwash. Prairie fens were concentrated along the margin between the uplands and the outwash where calcareous seepage is prevalent. The soils of upland ice-contact topography are typically excessively drained and like the steeper morainal slopes, supported oak forests, while the soils in the ice-contact depressions are poorly or very poorly drained and mostly supported narrow belts of shrub, hardwood, or conifer swamps surrounding kettle lakes. Most of the uplands have been farmed, except the steepest end moraines and ice-contact ridges, which have been maintained as woodlots or are now either recreational or wildlife management areas. Many of these steep ridges have been pastured in the past. Oak savannas either have been converted to farm land or have grown into closed-canopy oak forests due to fire suppression. Both residential development and agricultural land use have resulted in rapid eutrophication of lakes and degradation of many wetlands. Road construction and ditching have also modified the hydrology of many wetlands. Oak-hickory forest is the most prevalent current forest type and typically persists in small woodlots, usually less than 40 acres in size (Albert 1995).

Circa 1800s Vegetation

Interpretations of the GLO surveyor notes by MNFI ecologists indicated that the Watkins Lake State Park and surrounding area contained several distinct vegetation assemblages (Comer et al. 1995, Figure 4). Surveyors recorded information on the tree species composition, tree size, and general condition of the lands within and surrounding the Watkins Lake State Park. Circa 1800, the game area was predominantly forested with 53% of the area supporting Oak-Hickory Forest. A significant portion of the park (17% of the area) supported Black Oak Barren. Outwash channels and depressions historically supported forested swamps (13% of the area) with Mixed Conifer Swamp mapped for this area. Wet Prairie (7% of the area) was also prevealnt within the park, occurring in areas of outwash adjacent to the upland margin. The remainder of the park (10% of the area) was characterized by lakes.

Forested systems were found on steep end moraine and steep ice-contact ridges. Areas classified as Oak-Hickory Forest were described by the GLO surveyors as “well timbered oak and hickory”. The most prevalent tree species recorded in this area by the GLO surveyors in the forested uplands were white oak (*Quercus alba*) (overwhelmingly the most common tree noted) with prevalent canopy

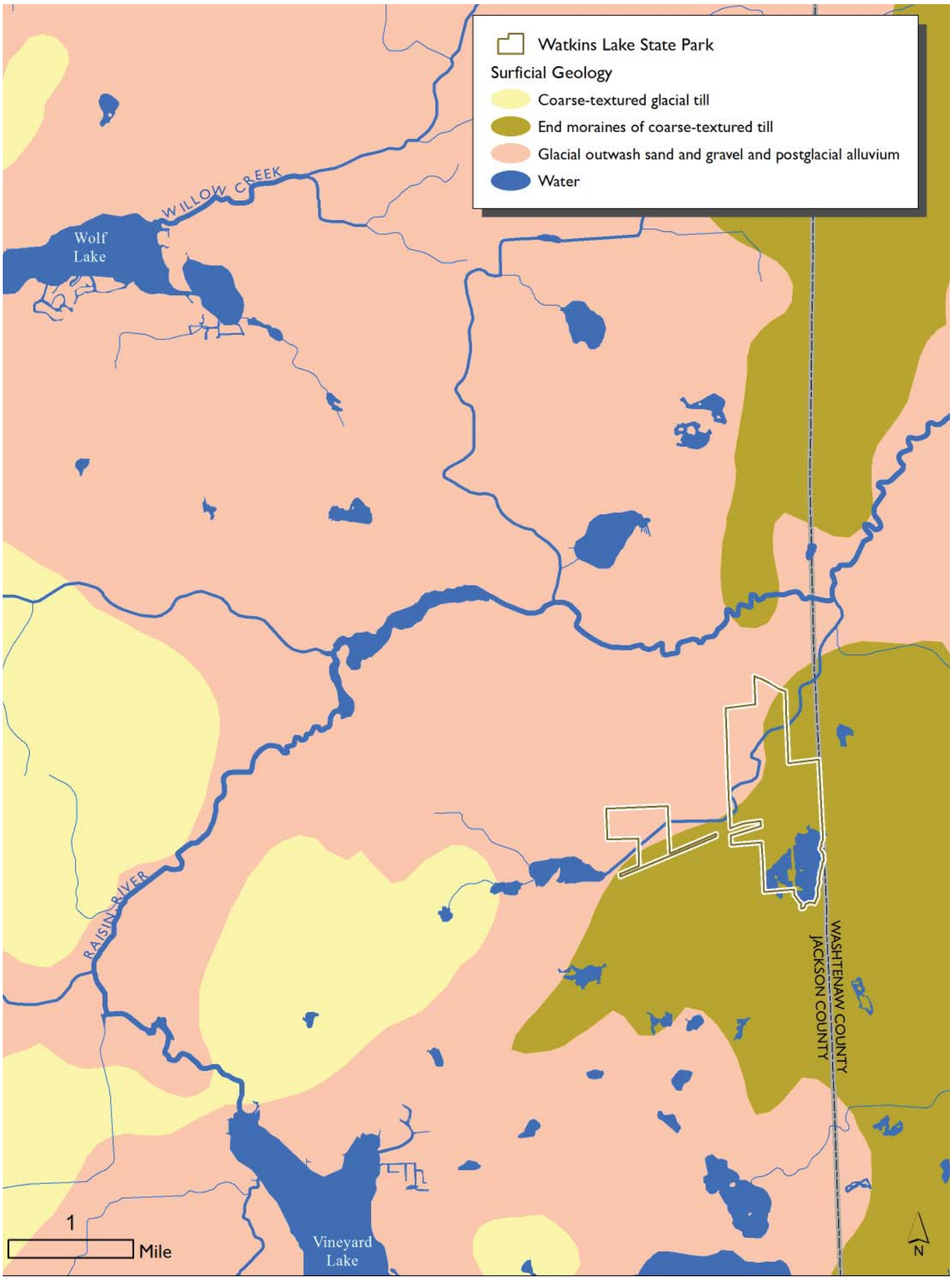


Figure 3. Surficial geology and relief of Watkins Lake State Park (Farrand and Bell 1982, USGS 2009).

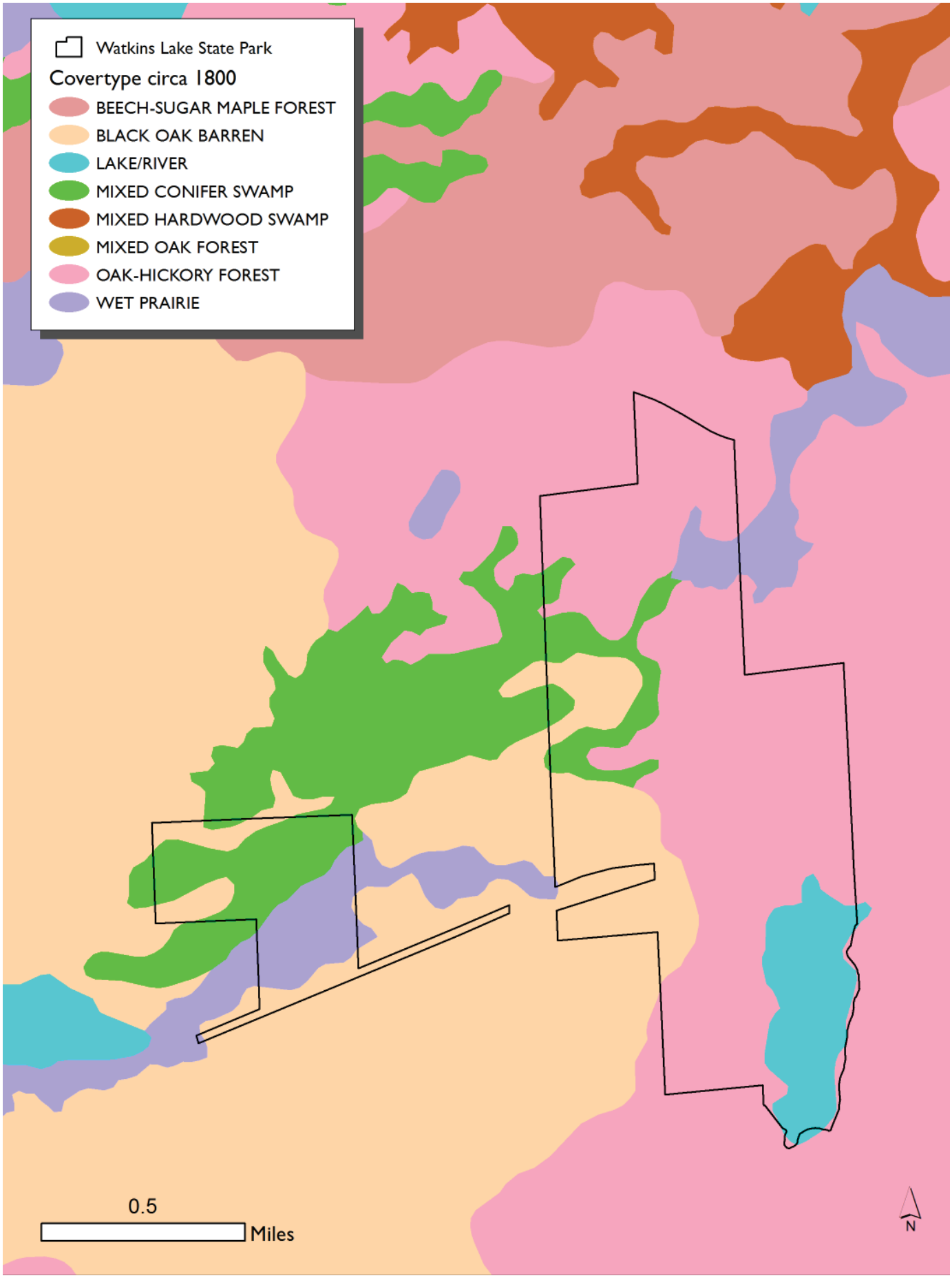


Figure 4. Circa 1800 vegetation of Watkins Lake State Park (Comer et al. 1995).

associates including black oak (*Q. velutina*), chinquapin oak (*Q. muehlenbergii*), bur oak (*Q. macrocarpa*), and hickories (*Carya* spp.). Within the areas classified as upland forest, recorded diameters of trees ranged widely from 10 to 102 cm (4 to 40 in) with an average of 41 cm (16 in) (N = 49).

Within southern Michigan, oak savanna and barrens were common on areas of well-drained gently sloping moraine and outwash and localized on slopes with southern and western aspects. Within southern Michigan, oak savanna and oak forest occurred in a shifting forest–savanna/barrens mosaic that varied in time and space depending on the frequency and intensity of fire disturbance events. Although mapped as predominantly forest on the circa 1800 map, much of the park likely transitioned to and from forest to savanna/barrens over long periods of time. Areas mapped as Black Oak Barren within the park and throughout the surrounding landscape likely included both dry savanna systems (oak barrens) as well as dry-mesic savanna (oak openings). Small pockets of prairie inclusions likely occurred within this savanna/barrens matrix. GLO surveyors noted pockets of upland prairie within the surrounding area including a "beautiful prairie" northwest of the the park. Areas classified as Black Oak Barren were described by the GLO surveyors as "first rate oak openings", "barren", "barren land", "thinly timbered oak and hickory" with undergrowth of oak and willows, "scattering shrub oak", and "open oaks". Repeated low-intensity fires, working in concert with drought and windthrow, maintained open conditions in these savanna/barrens ecosystems. Within dry-mesic savanna systems, such as oak openings, it is likely that annual or nearly annual fire disturbance was the primary factor influencing the vegetative structure and floristic composition. These fires occurred during the late spring, late summer, and fall since flammability peaks in the spring before grass and forb growth resumes and then again in the late summer and autumn after the above-ground biomass dies back (Grimm 1984). These fires were caused naturally by lightning strike and also set intentionally by indigenous peoples. Within southern Michigan, Native Americans probably played a significant role in maintaining savanna/barrens conditions through their use of fire as a land management tool (Cronon 1983, MacLeigh 1994). Throughout southern Michigan, Indian trails and encampments were often noted within areas identified by the GLO surveyors as oak savanna and oak barrens. A "path" was noted by GLO surveyors passing through oak barrens just west of the park. Sizable areas mapped as Black Oak Barren occur in the western portion of the park and throughout the surrounding landscape (Figure 4). The Black Oak Barrens within and adjacent to the park were characterized by scattered white oak as the overwhelming canopy dominant with chinquapin oak and hickories as common associates. Within these savanna and barrens areas, recorded diameters of canopy trees ranged from 10 to 102 cm (4 to 40 in) with an average of 34 cm (14 in) (N = 83).

Circa 1800, wetlands were concentrated along the margins of small streams, within kettle depressions, in poorly drained portions of outwash channels, and along lower slopes of moraines (Figure 4). As noted above, circa 1800 wetland cover types included Mixed Conifer Swamp (13% of the park) and Wet Prairie (7%). The Mixed Conifer Swamp class likely included rich tamarack swamp. Where the surveyors noted canopy composition of these swamps, tamarack (*Larix laricina*) was the prevalent canopy dominant with American elm (*Ulmus americana*) as an associate. Within these forested swamps, recorded diameters of canopy trees ranged from 13 to 61 cm (5 to 24 in) with an average of 33 cm (13 in) (N = 5). MNFI's open wetland classification for the circa 1800 map is very broad because within these systems the surveyors gathered limited information; this paucity of data does not allow for current ecologists to more specifically classify the wetlands encountered. The broad Wet Prairie cover type for the circa 1800 map likely included wet prairie, wet-mesic prairie, prairie fen, and southern wet meadow.

Current Land Cover

The land cover within the Watkins Lake State Park has changed significantly since 1800 due to agriculture, logging, grazing, deer herbivory, fire suppression, hydrologic alteration, and invasive species. The mosaic of aerial photographs from 1938 (Figure 5) shows how the expansion of agriculture and logging heavily impacted Watkins Lake State Park and the surrounding area. Lands that remained forested were typically areas of steep slope or poor drainage. Many of the forested patches that persisted were nevertheless selectively logged with many hardwoods, especially oaks, being harvested. In addition, where forests and wetlands occurred adjacent to agricultural lands, grazing was prevalent.

Much of the park was formerly agricultural lands that have been since abandoned due to unfavorable slope, drainage, and/or soil conditions. Many of these former agricultural areas remain as "old fields" that were likely kept open by grazing. Other areas of former agricultural fields are transitioning to habitat dominated by upland shrubs and/or low density trees or have reverted to early-successional forest. According to MiFI stand data, a significant portion of the park (30% of the area) is composed of abandoned agricultural lands or former pasture lands. MiFI stand types delineated in Watkins Lake State Park that fall within the broad class of non-forested upland include Cool Season Grass (17%), Low-Density Trees (11%), Autumn Olive/Honeysuckle (1.3%) and Upland Shrub (0.2%) (Figure 6).

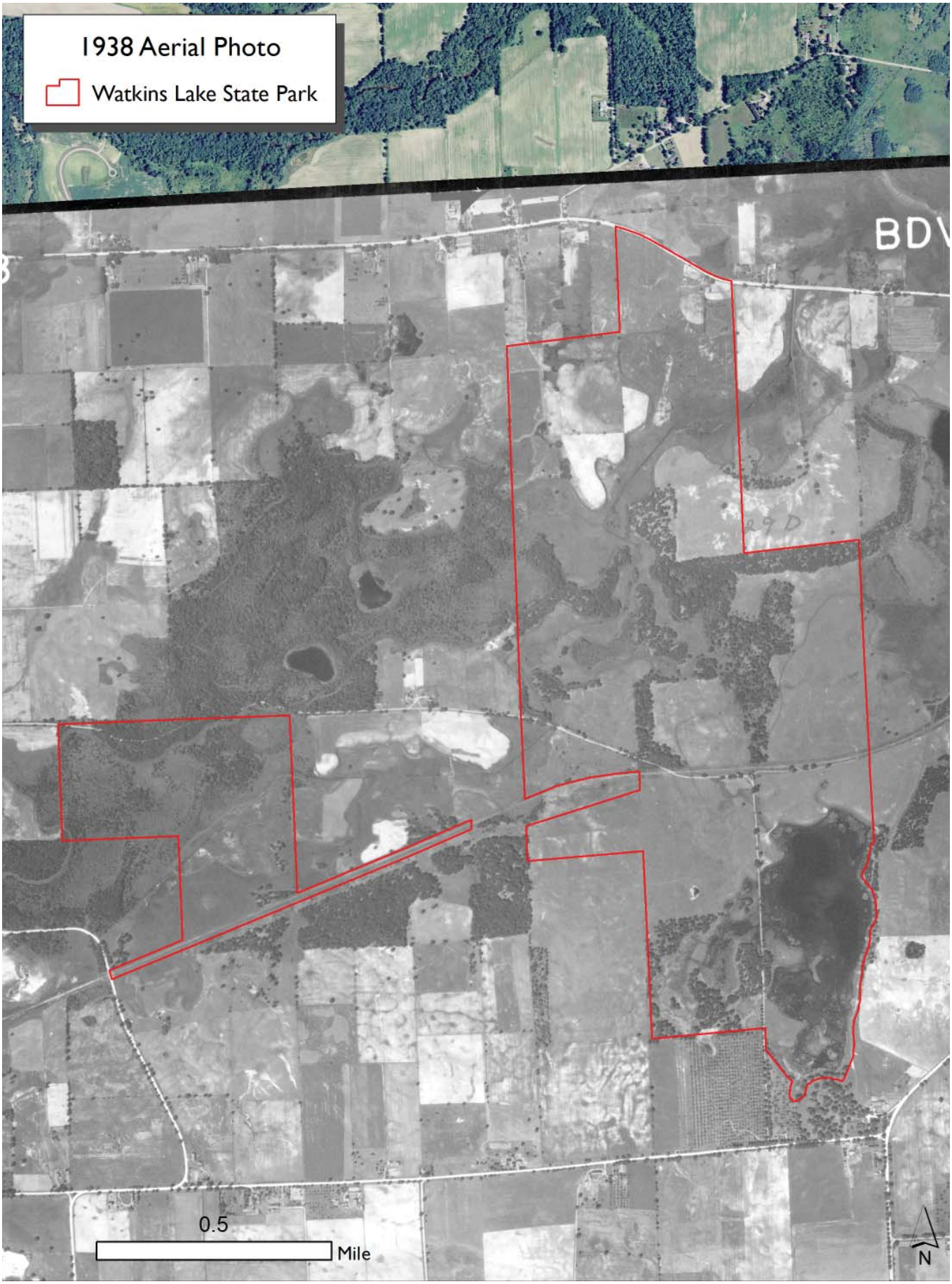


Figure 5. Mosaic of 1938 aerial photographs of Watkins Lake State Park (MNFI 2014).

Current land cover in Watkins Lake State Park still includes a significant component of deciduous upland forest (26% of the game area) (Figure 1). This forest is primarily composed of oak-hickory forest (dry-mesic southern forest) and early-successional forest. The majority of the upland forested systems within Watkins Lake State Park are early-successional forest with over 73% of the total forested acreage being less than 100 years old and 27% being over 100 years old. The stands of upland forest within the older age-class were recently logged. This logging event occurred after the sale of the land to the state and prior to the transfer of the land. The logging was a high grade, with the largest and best quality timber (mostly oaks) being removed from the overstory. MiFI upland forest stand types delineated in Watkins Lake State Park include White, Black, Northern Pin Oak (11%), Other Mixed Upland Deciduous (10%), Mixed Upland Deciduous with Cedar (4%), Maple, Beech, Cherry Association (0.8%), and Mixed Upland Forest (0.2%) (Figure 6). These forests occur throughout the park and are especially prevalent on moderate to steep end moraines and ice-contact ridges. Early-successional forests have established on lands that were logged and/or farmed. High levels of invasive shrub species occur within the understory of all forested stands. In addition, many of the oak and oak-hickory forest types are fire suppressed and have a significant component of mesophytic competition in the understory. As a result of competition and high levels of deer herbivory, oak regeneration is sparse throughout the understory of these forests.

Lakes and wetlands remain an important component of the park with open wetlands accounting for 19% of the area, open water accounting for 15% of the area, and forested wetlands accounting for 9% of the area (Figure 1). Open wetland types delineated in Watkins Lake Sate Park by MiFI stage 1 inventory include Fen (15%), Wet

Open wetlands, especially prairie fen, are an important component of Watkins Lake State Park with open wetlands accounting for 19% of the area and prairie fen accounting for 15%. Photo by Joshua G. Cohen.

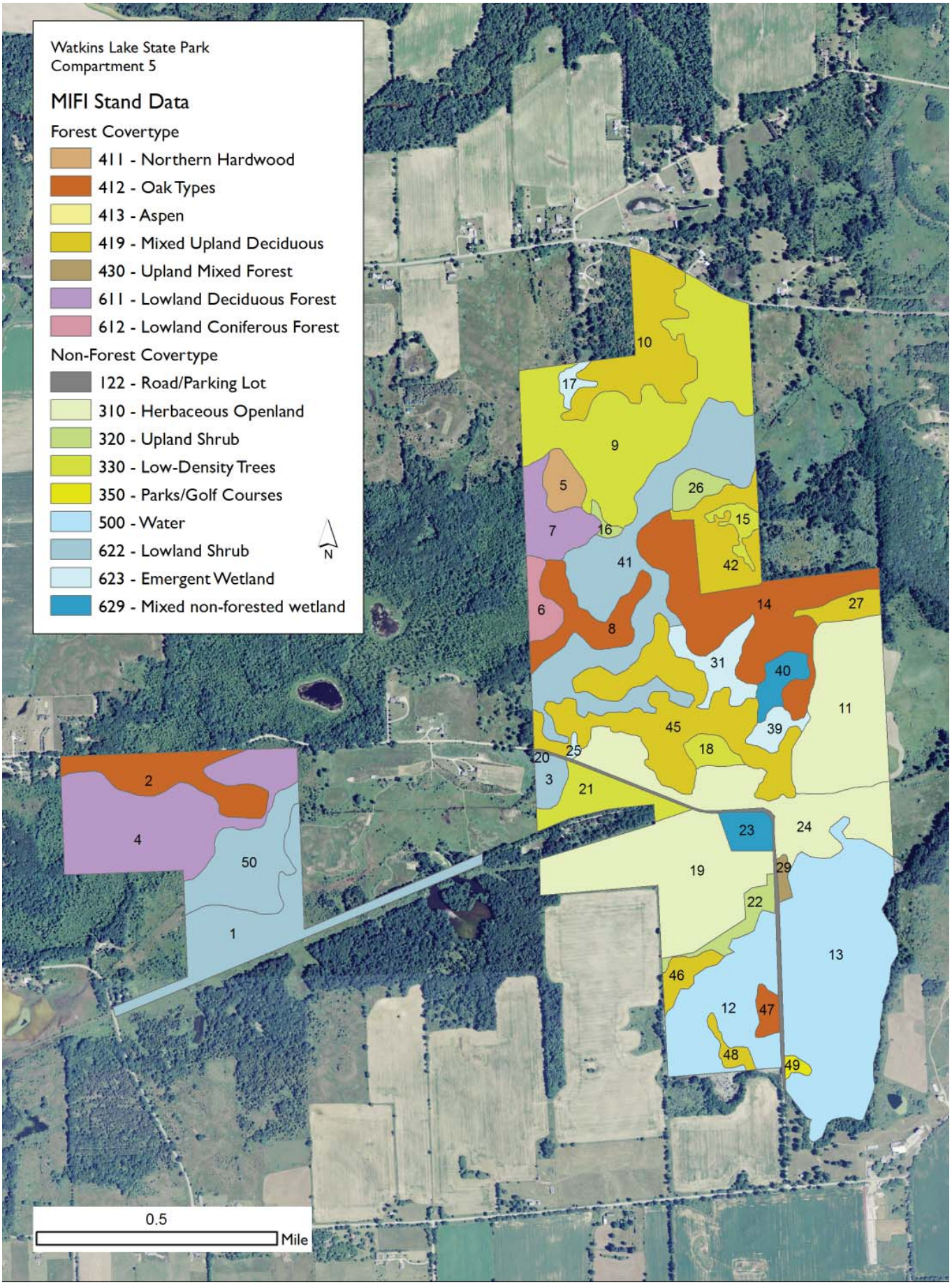


Figure 6. MiFI stand data for Watkins Lake State Park.

Meadow (2%), and Mixed Non-Forested Wetland (1.5%). Forested wetland types include Mixed Lowland Deciduous Forest (7%), Lowland Deciduous, Mixed Coniferous (1.6%), and Tamarack (0.7%) (Figure 6). Wetlands throughout Watkins Lake State Park have been impacted by hydrologic alteration (e.g., ditching and dredging), grazing, marsh haying, invasive species encroachment, and fire suppression.

Prior to the 2016 survey effort, one natural community element occurrence (EO), a prairie fen, was documented on private land just south and west of Watkins Lake State Park (Table 1) with the majority of the EO occurring to the west associated with Fay Lake. Surveys in 2016 identified high-quality prairie fen within Watkins Lake State Park and on adjacent private land and this EO has been greatly expanded from 47 acres to 159 acres. This natural community EO will be described in detail within the **Natural Community Results** section. High-quality fen constitutes approximately 13% of Watkins Lake State Park.

Despite the considerable loss of natural habitat due to conversion to agriculture and logging and degradation of remaining natural habitat due to deer herbivory, grazing, hydrologic alteration, invasive species encroachment, and fire suppression, a significant portion of Watkins Lake State Park supports high-quality wetland. In addition, compared to the surrounding fragmented landscape, Watkins Lake State Park is characterized by a significant portion of natural cover. As noted above, 74% of the park is natural cover. In comparison, 34% of the Washtenaw subsection (VI.1) and 50% of the Jackson Interlobate sub-subsection (VI.1.2) are natural cover.

High-quality prairie fen constitutes over 13% of Watkins Lake State Park. Photo by Jesse M. Lincoln.

METHODS

Throughout this report, all high-quality natural communities and state and federally listed rare species are referred to as elements and their documented occurrence at a specific location is referred to as an element occurrence or "EO."

Natural Community Survey Methods

A natural community is defined as an assemblage of interacting plants, animals, and other organisms that repeatedly occurs under similar environmental conditions across the landscape and is predominantly structured by natural processes rather than modern anthropogenic disturbances (Cohen et al. 2015). Protecting and managing representative natural communities is critical to biodiversity conservation, since native organisms are best adapted to environmental and biotic forces with which they have survived and evolved over the millennia (Kost et al. 2007). According to MNFI's natural community classification, there are 77 natural community types in Michigan (Kost et al. 2007, Cohen et al. 2015). Surveys determined the ranking, classification, and delineation of documented occurrences and detailed the vegetative structure and composition, ecological boundaries, landscape and abiotic context, threats, management needs, and restoration opportunities. The primary goal of this survey effort is to provide resource managers and planners with standardized, baseline information on documented natural community EOs. This baseline information is critical for facilitating site-level decisions about biodiversity stewardship, prioritizing protection, management and restoration, monitoring the success of management and restoration, and informing landscape-level biodiversity planning efforts.

Field Surveys

Each potential natural community was evaluated employing Natural Heritage and MNFI methodology, which considers three factors to assess a natural community's ecological integrity or quality: size, landscape context, and condition (Faber-Langendoen et al. 2008). If a site meets defined requirements for these three criteria (MNFI 1988) it is categorized as a high-quality example of that specific natural community type, entered into MNFI's database as an element occurrence, and given a rank based on the consideration of its size, landscape context, and condition. Ecological field surveys were conducted during the growing season (from June to September of 2016) to evaluate the condition and classification of the sites. To assess natural community size and landscape context, a combination of field surveys, aerial photographic interpretation, and Geographic Information System (GIS) analysis was employed. Typically, two to three days were dedicated to each site, depending on the size and complexity of the site. For sites that occur on multiple ownerships, surveys were restricted to state lands unless permission was granted to access other ownerships.

For each site visited, an Ecological Community Field Survey Form (Appendix 1) and a Threat Assessment Form (Appendix 2) were completed. The Threat Assessment Form allows for the scoring of each observed threat in terms of severity, scope, and reversibility. For the purposes of this form, severity was defined as the level of damage to the site caused by the threat, scope was defined as the geographic extent of impact of the threat, and reversibility was defined as the probability of controlling the threat and reversing the damage.

The ecological field surveys typically involved:

a) compiling comprehensive plant species lists and noting dominant and representative species

b) systematically searching for rare plant species during appropriate survey windows

c) describing site-specific structural attributes and ecological processes

d) measuring tree diameter at breast height (DBH) of representative canopy trees and aging canopy dominants

e) analyzing soils and hydrology

f) noting current and historical anthropogenic disturbances

g) evaluating potential threats (using the Threat Assessment Form, each observed threat was ranked in terms of its severity, scope, and reversibility, and scores for these categories were summed to generate an overall threat score)

h) ground-truthing aerial photographic interpretation using GPS (Garmin and HP iPAQ units were utilized)

i) taking digital photos and GPS points at significant locations

j) surveying adjacent lands when possible to assess landscape context

k) evaluating the natural community classification and mapped ecological boundaries

l) assigning element occurrence ranks

m) noting management needs and restoration opportunities

Following completion of the field surveys, the collected data were analyzed and transcribed to update or create EO records in MNFI's statewide biodiversity conservation database (MNFI 2017). Natural community boundaries were mapped and re-mapped. Information from these surveys was used to produce the site description, threat assessment, and management recommendations for the one natural community EO that was documented in Watkins Lake State Park. This information is provided in the following **Natural Community Survey Results** section.

Rare Animal Survey Methods

We identified rare animal target species for surveys using historical distribution within Michigan, past occurrences in or near Watkins Lake State Park (Table 2), communication with PRD staff and local landowners, and the presence of potential habitat within the park. A variety of information sources were used to determine if potential habitat occurred within the park, including natural community ground surveys, aerial photography, and communication with local landowners and PRD staff. In addition, rare animal surveys were limited to the mid to late growing season because access to the park was not granted until June of 2016. Based on the synthesis of this information and the time limitations for the 2016 field season, we focused rare species surveys on rare grassland birds in open upland habitat and eastern massasauga (*Sistrurus catenatus*, federally threatened and state special concern) in non-forested wetlands and adjacent uplands. We conducted surveys for these target animal species in appropriate potential habitats during time periods when targeted elements were expected to be most active and detectable (e.g., breeding season for grassland birds). Surveys were done to identify new occurrences and update and/or expand existing occurrences. Additional targets for survey identified within Watkins Lake State Park included rare insect species associated with prairie fen and savanna ecosystems, rare aquatic species associated with the Norvell Manchester Drain, and rare bats. Due to time and funding restrictions in 2016, surveys for these groups of species will be conducted during the 2017 field season.

Grassland Bird Surveys

Grassland bird surveys were conducted in Watkin's Lake State Park as part of a rapid assessment to determine which grassland bird species were present in the newly created State Park. Surveys targeted the following three species: Henslow's sparrow (*Ammodramus henslowii*, state endangered), grasshopper sparrow (*Ammodramus savannarum*, state special concern), and dicksissel (*Spiza americana*, state special concern). Surveys for rare grassland birds were carried out in the largest blocks of suitable habitat available as determined from aerial images and ground observation. Contiguous grassland areas of at least 4 ha (10 ac) in area were considered potential habitat for target species. Within Watkins Lake State Park, three focal areas were identified as having suitable habitat to support grassland birds. These areas were: Compartment 1, Stands 11 and 14, which corresponds to the large hayfield that begins on the north end of Watkins Lake and extends north (Area 1); Compartment 1, Stand 19, which corresponds to the hayfield immediately west of Arnold Road (Area 2); and Compartment 1, Stand 9, which corresponds to the grassland area west of the Norvell Manchester Drain and south off of Austin Road (Area 3) (Figures 6 and 7). In Areas 1 and 2, a 250 X 250 meter grid of possible survey points was overlaid over the potential survey stands (Figure 7). Surveys were conducted at these points on June 11th, 2016 starting at 7:00 am and ending at 5:30 pm. We recorded the species and number of individuals observed during three independent periods (2 min, 3 min, and 5 min) for a total of 10 minutes at each station (Ralph et al. 1995). Grassland birds were opportunistically recorded while moving between point-count stations within the targeted survey areas. In Area 3 a meander survey was conducted over a 60 minute time frame and all grassland birds seen and heard were recorded. Approximately 1000 meters were traversed during this meander survey (Figure 7).

Herptile Surveys

Surveys for rare reptile species were conducted at Watkins Lake State Park in the fall of 2016. Surveys targeted the eastern massasauga (*Sistrurus catenatus*, federally threatened and state special concern), but also focused on the eastern box turtle (*Terrapene carolina carolina*, state special concern) and Blanding's turtle (*Emydoidea blandingii*, state special concern) based on their ranges in the state and the presence of suitable habitat for these species within the park. These species have been identified as Species of Greatest Conservation Need (SGCN) in Michigan's updated Wildlife Action Plan, with the eastern massasauga and eastern box turtle also identified as focal or priority SGCN for conservation action (Derosier et al. 2015). Eastern box turtles were historically recorded to the west of the park (Table 2). Surveys also had potential for detecting several additional amphibian and reptile SGCN. These included the pickerel frog (*Lithobates palustris*), blue racer (*Coluber constrictor foxii*), northern ribbon snake (*Thamnophis sauritus septentrionalis*), and Butler's gartersnake (*Thamnophis butleri*). Visual encounter surveys were conducted for the target species. Surveys focused on identifying new occurrences or expanding existing occurrences. We also recorded other amphibian and reptile species encountered incidentally during surveys in 2016.

Visual encounter surveys were conducted for the eastern massasauga and other rare herps at Watkins Lake State Park on September 1st, 8th, 11th, 15th, 24th, and 25th in 2016

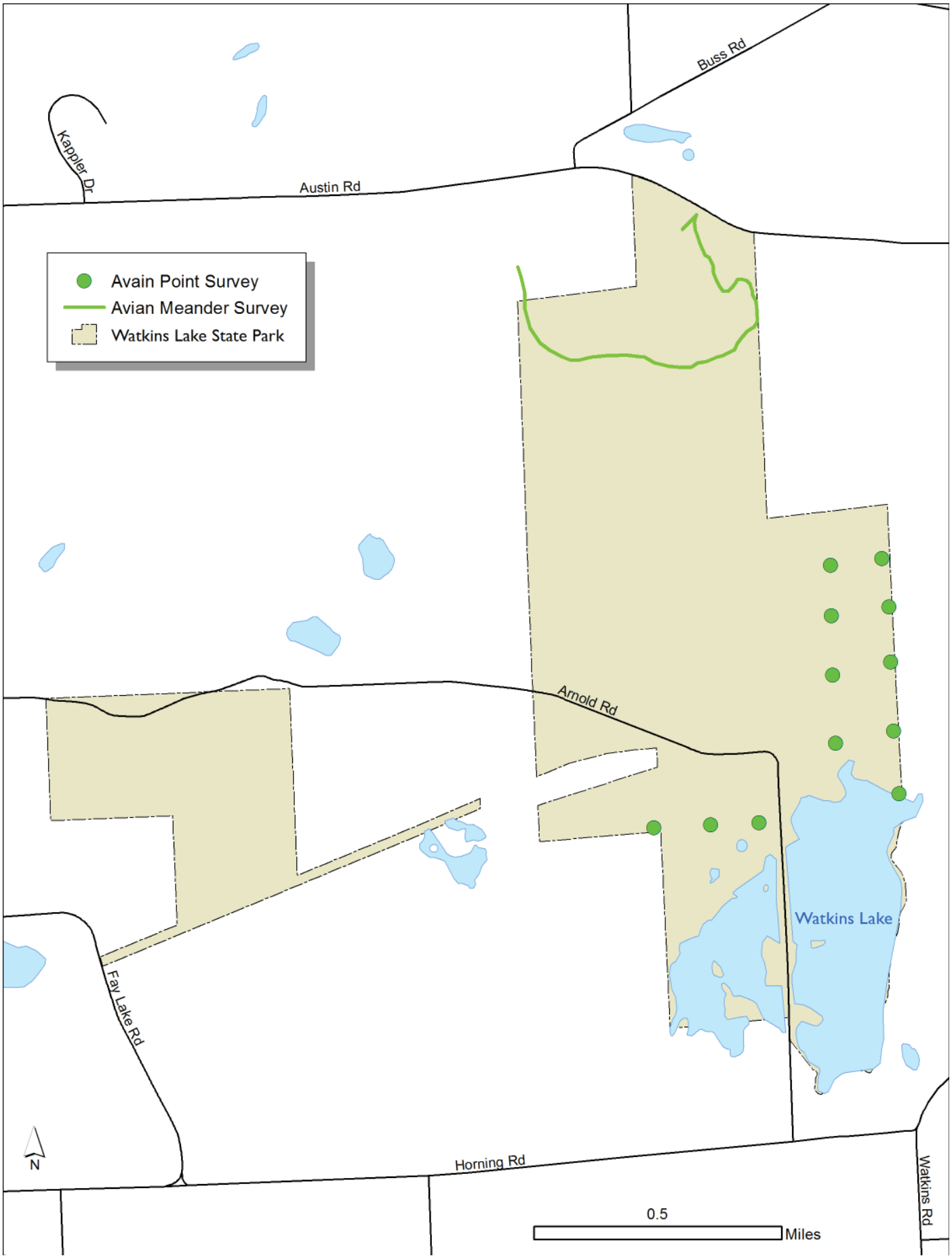


Figure 7. Locations of grassland birds point-counts and meander surveys conducted in Watkins Lake State Park.

using a standard method for surveying for amphibians and reptiles (Campbell and Christman 1982, Corn and Bury 1990, Crump and Scott 1994). We also followed the recommended standard survey protocol for the eastern massasauga developed by Casper et al. (2001) and the U.S. Fish and Wildlife Service. Visual encounter surveys were conducted primarily in prairie fen and adjacent open upland habitats associated with the middle portion of the Marsh Brook West Fen (EO ID 20823) east of Fay Lake Road and the northern portion of the Marsh Brook East Fen (EO ID 20825) south of Austin Road (Figure 8). Surveys consisted of one or two surveyors walking slowly through areas with suitable habitat for survey targets, inspecting retreats, and looking for basking, resting, and/or active individuals on the surface or under vegetation and other cover. Visual encounter surveys were conducted during daylight hours and under appropriate weather conditions when target species were expected to be active and/or visible [i.e., between 60-80°F (16-27°C), wind less than 15 mph, no or light precipitation].

Survey data forms (Appendix 3) were completed for all herptile surveys, and survey routes and locations were recorded with a Samsung Tablet A using the Backcountry Navigator Pro application for smartphones and tablets. We recorded all reptiles and amphibians encountered during surveys. The species, number of individuals, age class, location, general habitat, behavior, and time of observation were noted. Weather conditions and start and end times of surveys also were recorded. Photos were taken of herptile species encountered during surveys, whenever possible, for supporting documentation. Observations of rare herptile species were used to update existing occurrences in Michigan's Natural Heritage Database (MNFI 2017).

Approximately 30% of Watkins Lake State Park is composed of abandoned agricultural lands or former pasture lands. Large blocks of this open, grass-dominated upland provide suitable habitat for rare grassland birds, which were targeted for surveys in 2016. Photo by Aaron P. Kortenhoven.

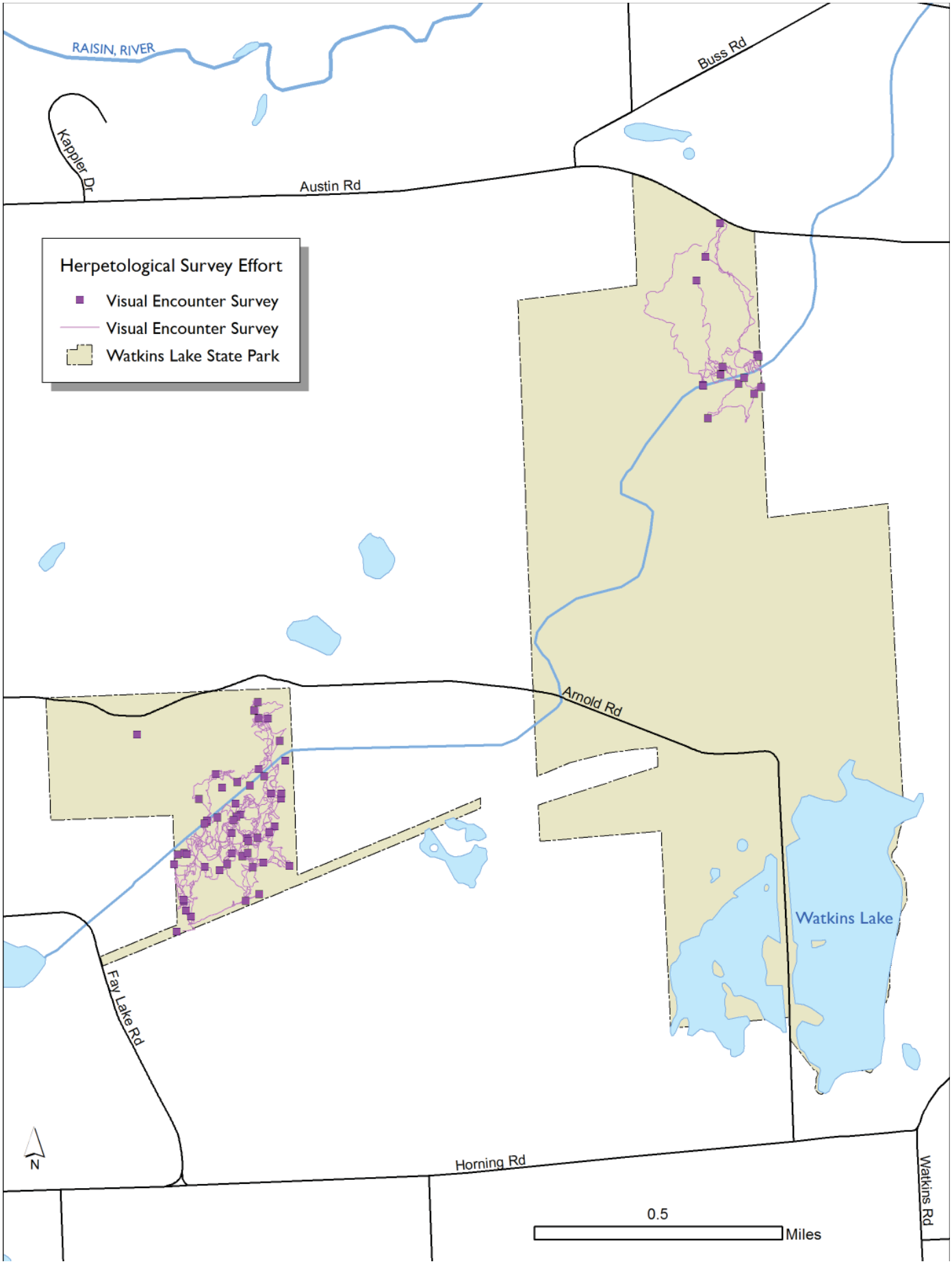


Figure 8. Locations of herptile surveys conducted in Watkins Lake State Park in 2016.

RESULTS

During the first year of surveys at Watkins Lake State Park MNFI documented three new EOs and provided information for updating an additional two EOs (Tables 1 and 2). Data compiled on these EOs was entered into MNFI's Biotics database (MNFI 2017). The locations in Watkins Lake State Park of the natural community and rare species occurrences (both new and prior occurrences) are illustrated in Figures 9 through 11. The Results section is divided into two sections, a **Natural Community Survey Results** section and a **Rare Animal Survey Results** section. The **Natural Community Survey Results** section provides in depth description of the natural community EO documented at Watkins Lake State Park as well as a site-specific threat assessment and management recommendations. The **Rare Animal Survey Results** section describes survey results for rare grassland birds and herptiles.

Natural Community Survey Results

During the summer of 2016 MNFI ecologists updated an existing prairie fen EO that was previously only known from adjacent private land to the south and west. Surveys on both state and private lands resulted in the expansion of this prairie fen EO from two polygons to seven polygons and from 47 acres to 159 acres. The following site summary contains a detailed discussion for this prairie fen EO and also includes the following information:

a) site name
b) natural community type
c) state and global rank (see Appendix 4 for ranking criteria)
d) current element occurrence rank
e) size
f) locational information
g) digital photographs
h) aerial photographs with mapped natural community boundary
i) detailed description
j) threat assessment
k) management recommendations

2016 natural community surveys in Watkins Lake State Park resulted in the documentation of over 90 acres of prairie fen within the park. Photo by Jesse M. Lincoln.

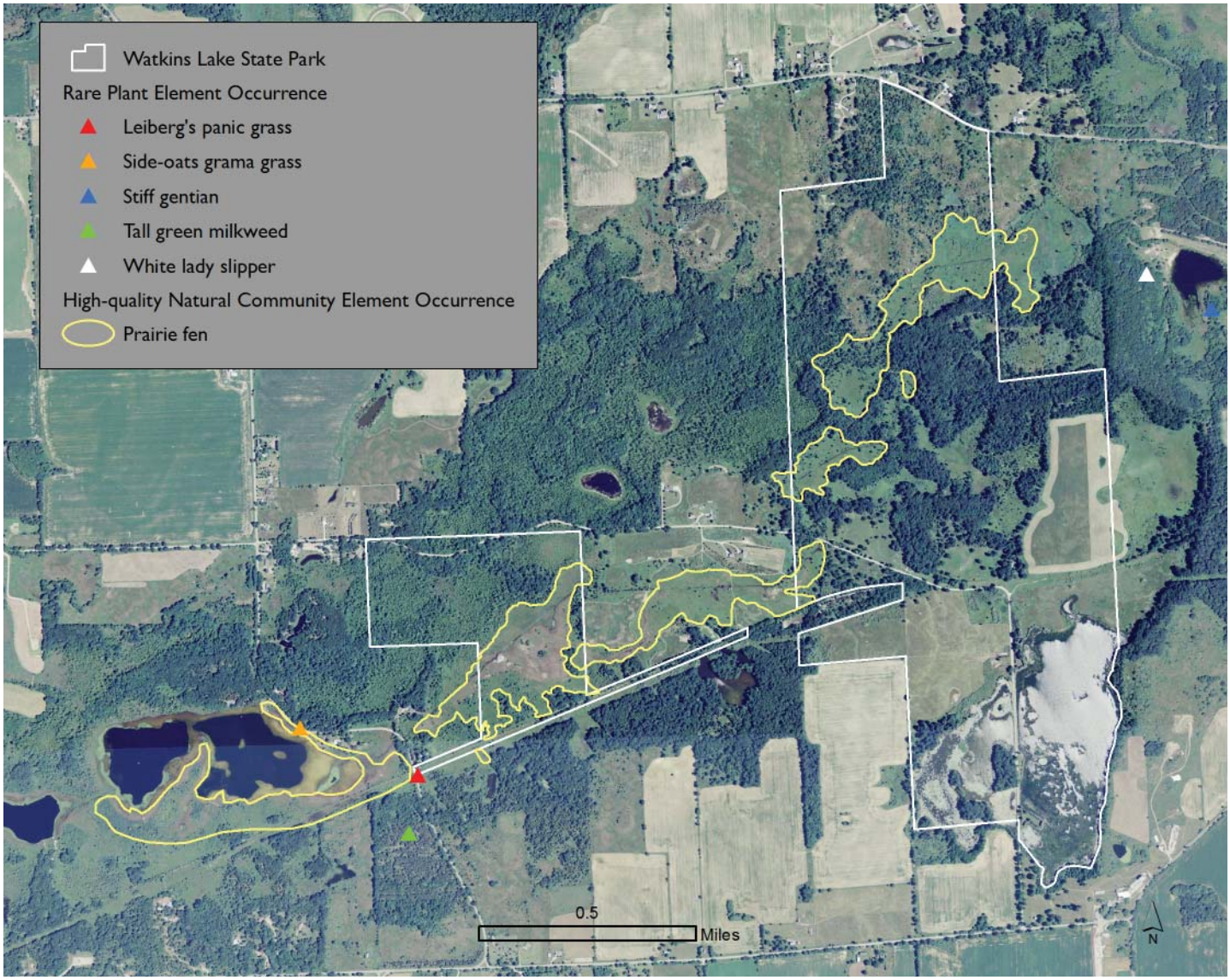


Figure 9. Natural community and rare plant element occurrences in and adjacent to Watkins Lake State Park.

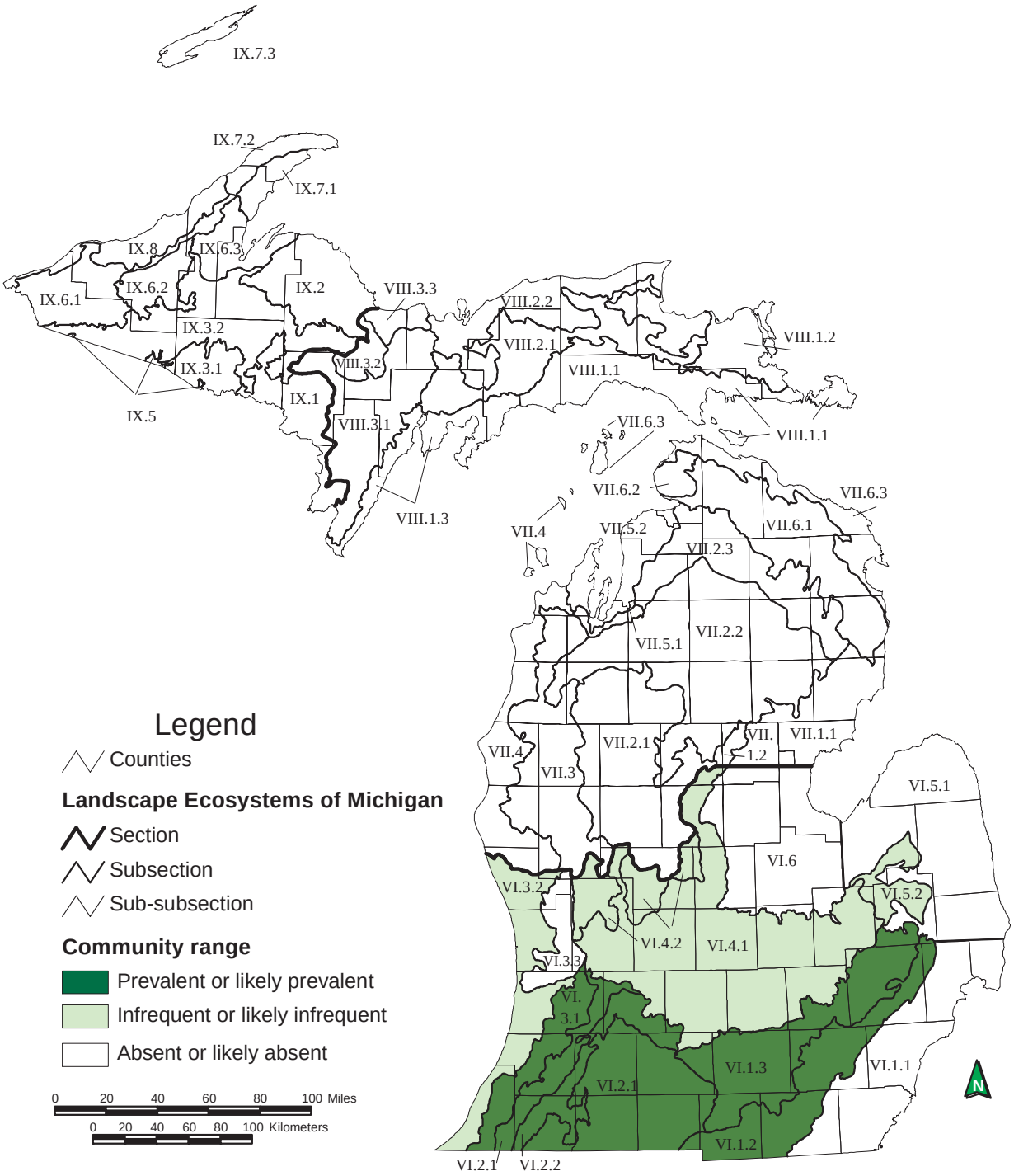
Table 1. Natural community element occurrence for Watkins Lake State Park and the immediate vicinity. EO rank abbreviations are as follows: BC, good to fair estimated viability; and C, fair estimated viability. * indicates that the site was newly documented in 2016 and sites within Watkins Lake State Park are **emboldened**. "P" refers to parent EO, and "S" refers to sub-EO.

Site Name	Community Type	EO ID	EO Rank	Year First Observed	Year Last Observed	Global Rank	State Rank
Marsh Brook West Fen*	**Prairie Fen**	**20823 (P)**	**BC**	**2016**	**2016**	**G3**	**S3**
Fay Lake Fen	Prairie Fen	12366 (S)	C	1997	1997	G3	S3
Arnold Fen*	Prairie Fen	20824 (S)	BC	2016	2016	G3	S3
Marsh Brook East Fen*	**Prairie Fen**	**20825 (S)**	**BC**	**2016**	**2016**	**G3**	**S3**

SITE SUMMARY

PRAIRIE FEN

Overview: Prairie fen is a groundwater influenced wetland community dominated by graminoids, forbs, and shrubs. The community occurs in glacial outwash plains and outwash channels on moderately alkaline peat and marl in the southern Lower Peninsula. Prairie fen is often associated with headwater streams and cold, calcareous, groundwater-fed springs at the margins of steep end moraine ridges. Natural processes that determine species composition and community structure include calcareous groundwater seepage and lateral flow, fire, insect outbreaks, and flooding by beaver. Variation in the flow rate and groundwater volume influences vegetation patterning and results in distinct zones of vegetation, some of which support a diversity of calciphilic plants. Prairie fen is dominated by sedges, grasses, and other graminoids (Kost et al. 2007, Cohen et al. 2015).



Map 1. Distribution of prairie fen in Michigan (Albert et al. 2008).

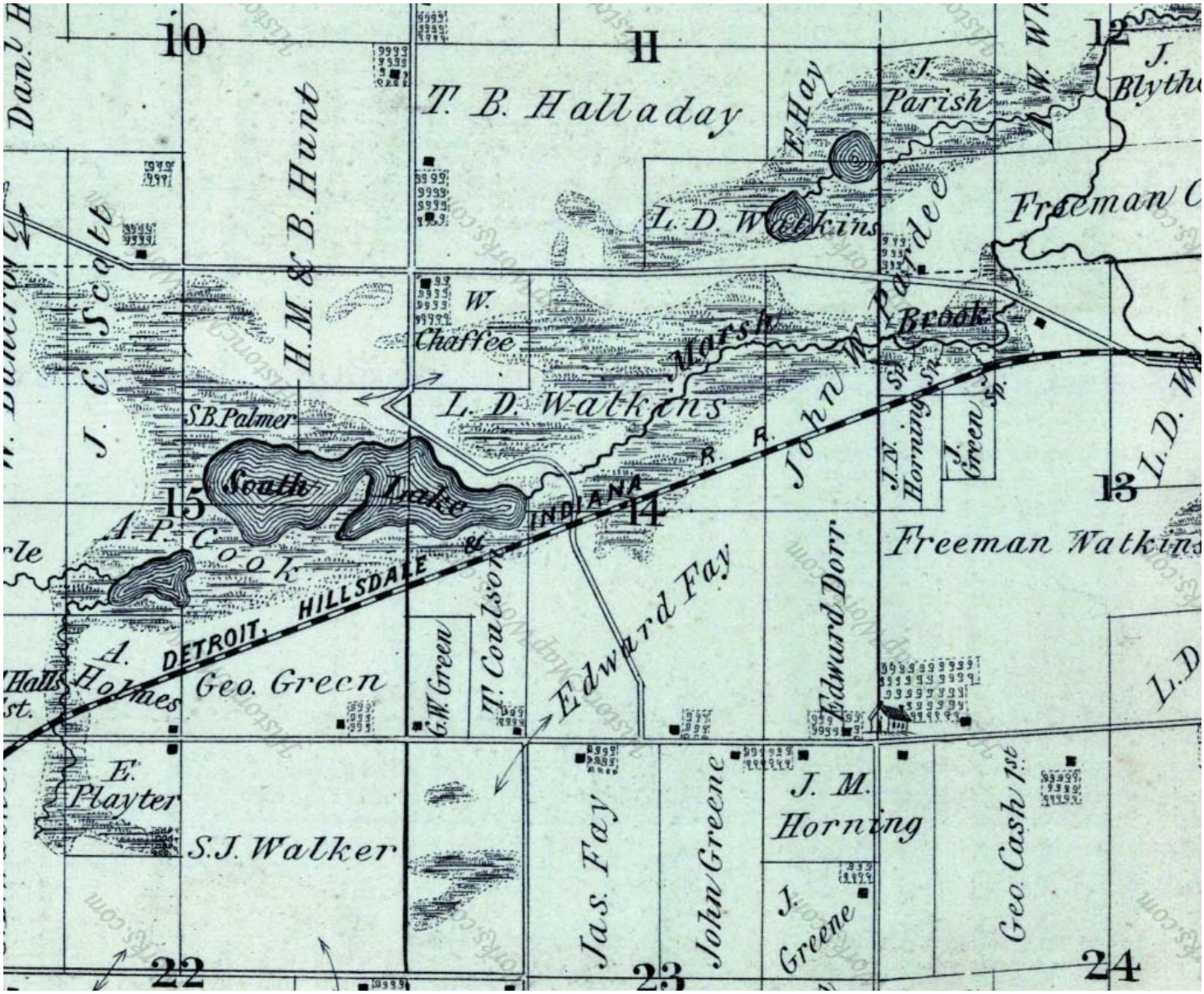
1. Marsh Brook Fen
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Size: 159 acres
Location: Watkins Lake State Park Compartment 1, Stands 1, 3, 41, and 50
Element Occurrence Identification Number: 20823 (Parent EO), 12366 (Sub-EO), 20824 (Sub-EO), and 20825 (Sub-EO)

Site Description: This sloping prairie fen is located on poorly drained outwash in a large wetland complex associated with the Norvell Manchester Drain, which was formerly Marsh Brook (Map 2). This drain was likely constructed in the 1940s as part of the Works Progress Administration during the New Deal (Michael Arnold personal communication). The fen consists of seven total polygons with three polygons within the state park in the northeastern portion of the park (Marsh Brook East Fen, EO ID 20825), one polygon primarily on private land between the two blocks of state land (Arnold Fen, EO ID 20824), one polygon in the southwestern portion of the park (Marsh Brook West Fen, EO ID 20823), one small polygon just south of this southwestern polygon (Marsh Brook West Fen, EO ID 20823), and one polygon on private land to the west adjacent to Fay Lake (Fay Lake Fen, EO ID 12366) (Figure 9). Despite occurring on different parcels of state and private land, these polygons of fen are all part of the same open wetland complex associated with the Norvell Manchester Drain. This fen complex is therefore treated as the same element occurrence with the Parent EO (EO ID 20823) having three Sub-EOs (EO IDs 12366, 20824, and 20825) (Table 1). Classifying the separate fen sites as Sub-EOs allows for the data collected at the distinct sites to remain independent. Throughout the open wetland complex, the fen transitions to southern wet meadow and southern shrub-carr. In addition, open wetlands transition locally to swamp forest including rich tamarack swamp and southern hardwood swamp. Along the upland margin of the fen there are localized pockets of wet-mesic prairie and adjacent upland slopes infrequently support remnant degraded oak openings

The floristic composition and structure of the prairie fen are shaped by natural processes, fire suppression, altered hydrology, and locally, invasive species encroachment. Cold, calcareous groundwater rich in calcium and magnesium carbonates flows through the community's saturated and alkaline organic soil and generates minerotrophic conditions. The soils of the prairie fen are characterized by typically deep (> 1 meter) hemic to sapric peats (pH 7.4-8.0) and marl (pH 7.5-8.0). Organic soil composition is variable with peats overlying marls in much of the fen (30-40 cm deep in one sampled location) and areas of marl bed occurring locally with marl depth greater than a meter. Because the soils remain saturated throughout the year, aerobic bacteria that break down plant materials are much reduced, resulting in the buildup of partially decayed plant debris or peat. Marl, found throughout the fen, forms as a result of the metabolic activity of algae growing in water rich in calcium and magnesium carbonates. Several marl ponds and marl flats occur within the fen. The margins of some of the marl ponds are characterized by floating mats of fen vegetation.Within the fen on the private land between the state parcels, several spring-fed ponds occur within the fen and are characterized by surprising depth (> 3 meters deep) as well as interesting coral-like structures of eroded peat beneath the water. In addition, this section of fen includes an area with a marl mound perched atop tufa shelves that are ringed by small groundwater-fed streams. Throughout the complex, the fen is characterized by small-scale gradients in soil moisture and soil chemistry associated with sphagnum hummocks, carex tussocks, and ant mounds. The diverse microtopography generates microsite heterogeneity that contributes to the fen's high floristic diversity. Animal trails occur throughout the fen and contribute to the structure of the wetland as well.

The fen is diverse due to structural heterogeneity resulting from fine-scale gradients in hydrology and soil chemistry and moisture. Zones within the wetland complex include fen meadow, marl flats, shrub fen, and tamarack savanna. The marl flats of the prairie fen are dominated by beaked spike-rush (*Eleocharis rostellata*), hardstem bulrush (*Schoenoplectus acutus*), beak-rush (*Rhynchospora capillacea*), pitcher-plant (*Sarracenia purpurea*), and horned bladderwort (*Utricularia cornuta*). Areas of fen meadow and shrub fen are dominated by graminoids including sedges (*Carex lasiocarpa, C. sterilis,* and *C. stricta*), beaked spike-rush, and hardstem bulrush. The ground cover is diverse and dense with characteristic herbaceous species including twig-rush (*Cladium mariscoides*), goldenrods (*Solidago rugosa, S. patula, S. canadensis,* and *S. riddellii*), marsh fern (*Thelypteris palustris*), bog valerian (*Valeriana uliginosa*), beak-rush, marsh blazing-star (*Liatris spicata*), fringed brome (*Bromus ciliatus*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), cordgrass (*Spartina pectinata*), golden ragwort (*Packera aurea*), false asphodel (*Triantha glutinosa*), Kalm's lobelia (*Lobelia kalmii*), golden alexanders (*Zizia aurea*), black-eyed Susan (*Rudbeckia fulgida*), small fringed gentian (*Gentianopsis virgata*), purple meadow-rue (*Thalictrum dasycarpum*), common mountain mint

(*Pycnanthemum virginianum*), swamp betony (*Pedicularis lanceolata*), slender wheat grass (*Elymus trachycaulus*), and pitcher plant. The invasives narrow-leaved cat-tail (*Typha angustifolia*), purple loosestrife (*Lythrum salicaria*), and reed canary grass (*Phalaris arundinacea*) are locally common within the fen. In addition, Canada thistle (*Cirsium arvense*) was noted as uncommon within portions of the fen. Shrubby cinquefoil (*Dasiphora fruticosa*) is dominant in the low shrub layer, which ranges from sparse to scattered (5-15%) in the marl flats and fen meadows, and dense (40-70%) in the shrub fen and tamarack savanna. Additional characteristic low shrubs include bog birch (*Betula pumila*), alder-leaved buckthorn (*Rhamnus alnifolia*), common juniper (*Juniperus communis*), poison sumac (*Toxicodendron vernix*), swamp gooseberry (*Ribes hirtellum*), and swamp rose (*Rosa palustris*). The tall shrub layer is scattered (5-10%) to patchy (20-40%) with characteristic species including poison sumac, bog birch, tamarack (*Larix laricina*), red-cedar (*Juniperus virginiana*), dogwoods (*Cornus* spp.), willows (*Salix* spp.), and nannyberry (*Viburnum lentago*). Due to fire suppression, the fen is being invaded locally by woody species. Invasive shrubs found within the fen include glossy buckthorn (*Frangula alnus*) and autumn olive (*Elaeagnus umbellata*), with both species being being locally common. The scattered overstory (1-5% canopy coverage) is dominated by stunted conifers with tamarack and red-cedar and canopy associates including red maple (*Acer rubrum*), trembling aspen (*Populus tremuloides*), and American elm (*Ulmus americana*). Overstory trees range in diameter at breast height from 5 to 15 cm and in height from 3 to 6 m tall. One hundred and eighteen native, vascular plant species were noted within this prairie fen during the 2016 surveys.



Map 2. Historical map of Watkins Lake State Park and surrounding area (Everts and Stewart 1874).

Marsh Brook West Fen (EO ID 20823). Photos by Joshua G. Cohen.

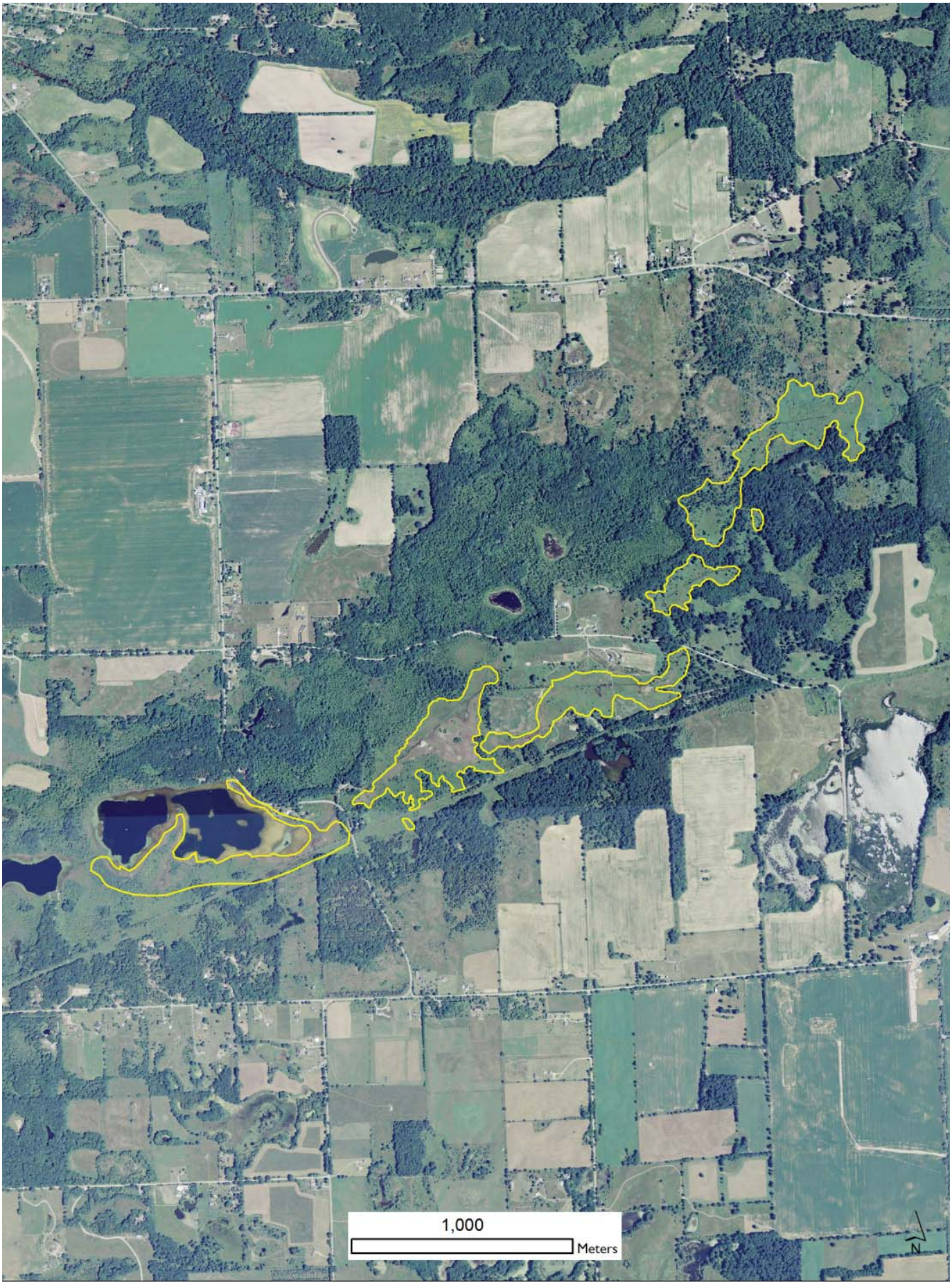
Threats: Species composition, vegetative structure, and successional trajectory of the fen are influenced by groundwater seepage, fire suppression, altered hydrology, and invasive species encroachment. The construction of the Norvell Manchester Drain has likely significantly impacted the hydrology of the fen and the surrounding wetland complex. In addition, the construction of the railroad grade that occurs along the southern margin of the wetland complex also likely locally impacted the wetland's hydrology. Invasive species occur throughout the fen and their presence is likely correlated with the altered hydrology and decades of fire suppression. As noted above, invasive plants found within the fen include glossy buckthorn, autumn olive, purple loosestrife, narrow-leaved cat-tail, Canada thistle, and reed canary grass. Reed canary grass was planted throuhgout the region to provide bedding material for farm animals (Michael Arnold personal communication). Glossy buckthorn and autumn olive are locally common in areas of shrub fen and along the upland margin of the fen. Purple loosestrife, narrow-leaved cat-tail, and reed canary grass are locally common in areas of fen meadow and in adjacent southern wet meadow, and Canada thistle occurs infrequently in portions of the fen.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce woody encroachment. Allowing fire to extend into adjacent uplands will also benefit the fen as there are adjacent upland areas where prairie species likely persist in the seedbank or understory, particularly in areas of remnant wet-mesic prairie and degraded oak openings (e.g., Compartment 1, Stands 9, 16, and 26). It is imperative that controlled burning within the wetland complex be restricted from areas where narrow-leaved cat-tail occurs to prevent the further spread of this fire-tolerant species. Clusters of narrow-leaved cat-tail can be controlled through herbicide spot treatment. Because massasauga have been documented in the surrounding landscape and likely occur throughout the fen, if prescribed fire is implemented, rotating non-fire refugia should be established within the fen. In addition to use of prescribed fire, clusters of buckthorn and autumn olive could be cut and herbicided and purple loosestrife could be controlled by using biocontrol agents. To avoid negative impacts to rare and sensitive species, the removal of invasive vegetation in combination with the use of wetland approved herbicides is recommended during the dormant season. Extreme care should be taken to minimize damage to native fen vegetation when treating invasives with chemicals. Maintaining a buffer of natural communities surrounding the prairie fen will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment and nutrient loading from run-off. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species should be implemented. Pursuit of acquisition of adjacent private lands supporting prairie fen or discussion of compatible management with private landowners is recommended.

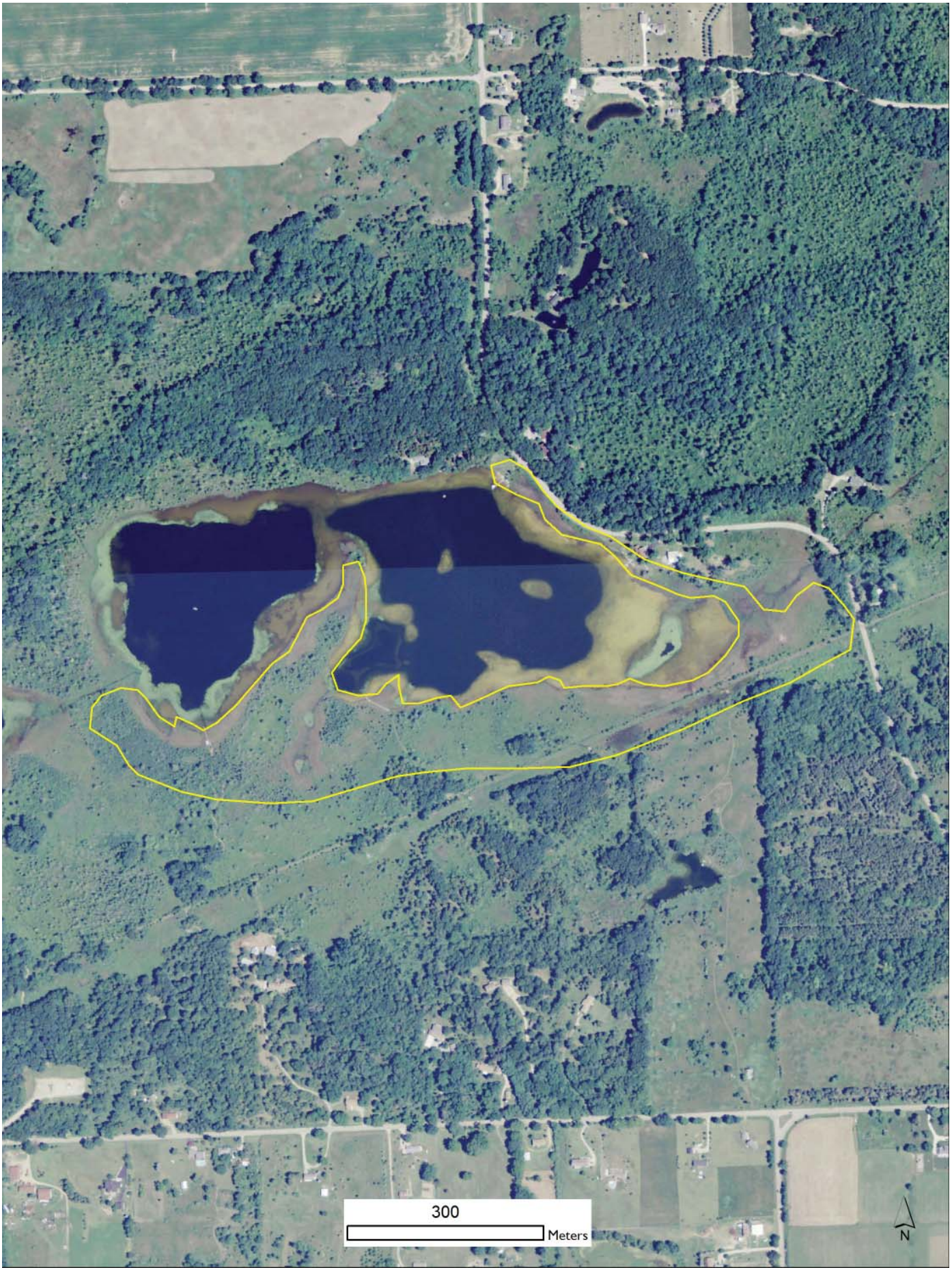
Purple loosestrife within the Marsh Brook East Fen. Photo by Joshua G. Cohen.

Marsh Brook East Fen (EO ID 20825). Photo by Joshua G. Cohen.

Arnold Fen (EO ID 20824). Photo by Joshua G. Cohen.



2014 aerial photograph of Marsh Brook Fen (EO ID 20823).



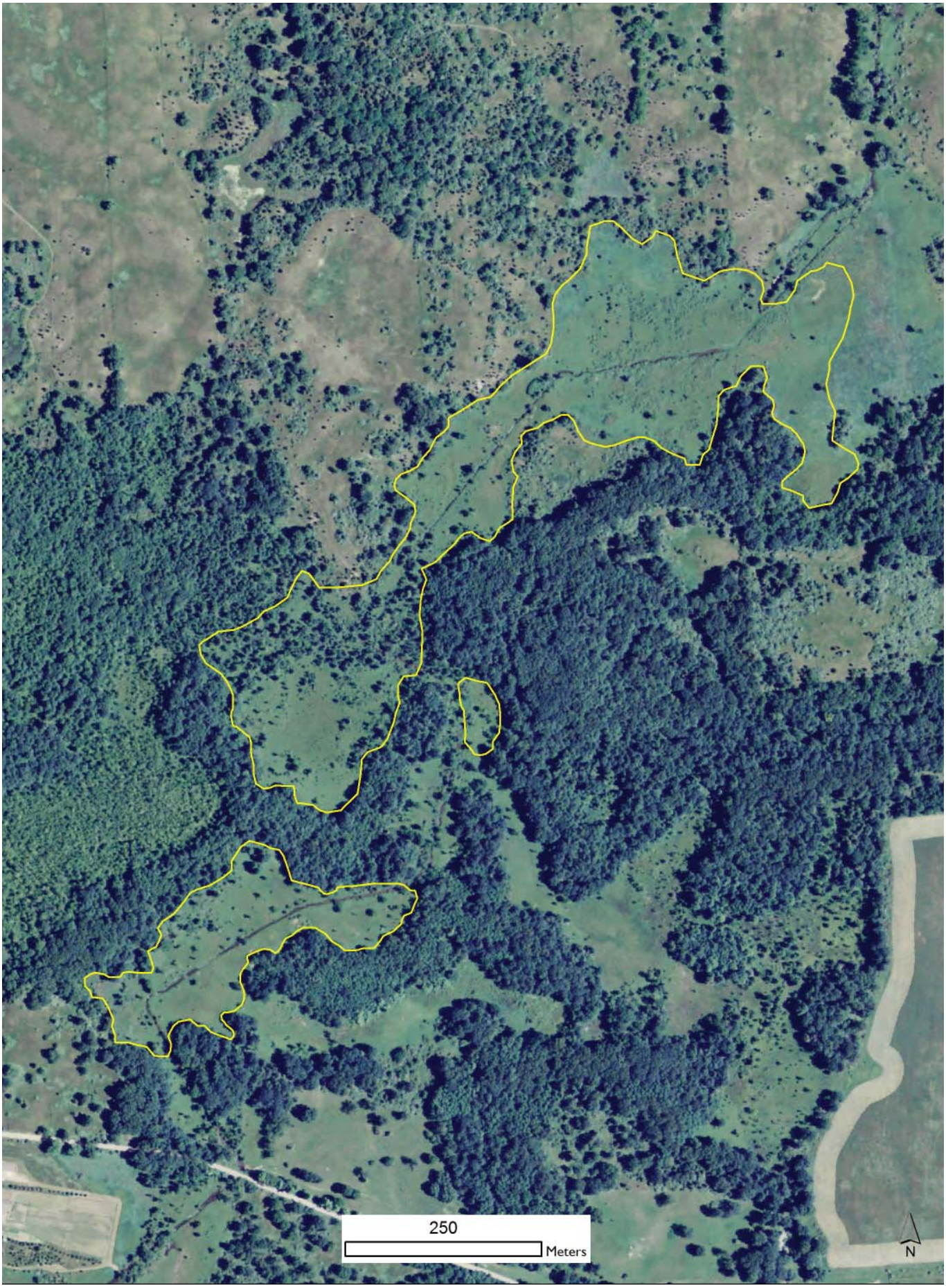
2014 aerial photograph of Fay Lake Fen (EO ID 12366, Sub-EO).

2014 aerial photograph of Marsh Brook West Fen (EO ID 20823, Parent EO).

Marsh Brook West Fen (EO ID 20823). Photos by Joshua G. Cohen (above) and Jesse M. Lincoln (below).

2014 aerial photograph of Arnold Fen (EO ID 20824, Sub-EO).

Spring-fed pond (above) and marl mound (below) within the Arnold Fen (EO ID 20824). Photos by Joshua G. Cohen.



2014 aerial photograph of Marsh Brook East Fen (EO ID 20825, Sub-EO).

Marsh Brook East Fen (EO ID 20825). Photos by Joshua G. Cohen.

Rare Animal Survey Results

Birds

We conducted grassland songbird surveys at 12 points within Area 1 and Area 2 of Watkins Lake State Park (Figure 7). Henslow's sparrow, grasshopper sparrow, and dicksissel were recorded at 42%, 8%, and 16% of the points, respectively. We recorded a total of 55 avian species at these 12 survey points. Aside from the three targeted species, three additional and unlisted grassland bird species were recorded: upland sandpiper (*Bartramia longicauda*), bobolink (*Dolichonyx oryzivorus*), and savannah sparrow (*Passerculus sandwichensis*). During nine point counts conducted in Area 1, we observed seven Henslow's sparrow, two dicksissel, thirty-six bobolink, one sedge wren (*Cistothorus platensis*), and one eastern meadowlark. Yellow-billed cuckoo (*Coccyzus americanusv*) was heard in the adjacent forest during point counts. During three point counts conducted in Area 2, we observed two grasshopper sparrows. During the meander survey in Area 3, 18 species were recorded. In addition to bobolink, additional grassland bird species documented in this area included eastern meadowlark (*Sturnella magna*) and field sparrow (*Spizella pusilla*). No rare grassland bird species were recorded in Area 3.

A total of 59 bird species were recorded during the point count and meander surveys. We recorded three new element occurrences for Henslow's sparrow (EO ID 20714), dicksissel (EO ID 20716), and grasshopper sparrow (EO ID 20717) (Table 2, Figure 10). These three rare grassland bird species have been identified as Species of Greatest Conservation Need (SGCN) in Michigan's updated Wildlife Action Plan (Derosier et al. 2015). In total, seven Henslow's sparrows, two dicksissels, and two grasshopper sparrows were observed. Six of the 59 species recorded are considered featured species for habitat management by the Wildlife Division of the Michigan DNR. These species are eastern meadowlark, mallard (*Anas platyrhynchos*), bobolink, eastern bluebird (*Sialia sialis*), upland sandpiper, and Canada goose (*Branta canadensis*). In addition, a bald eagle (*Haliaeetus leucocephalus*, state special concern) nest was documented on the west side of Watkins Lake in 2012 (EO ID 19090).

Grasshopper sparrow (*Ammodramus savannarum*, state special concern). Photo by Aaron P. Kortenhoven.

Table 2. Newly documented and previosuly known rare species element occurrences at Watkins Lake State Park and in the vicinity. State status abbreviation of "E" signifies state endangered, "SC" signifies state special concern, and "T" signifies state threatened. Federal status abbreviation of "LE" signifies federally endangered, and "LT" signifies federally threatened. EO rank abbreviations are as follows: A?, possibly excellent estimated viability; BC, good or fair estimated viability; C, fair estimated viability; D, poor estimated viability; E, verified extant; and H, historical. * indicates the EO was newly documented in 2016 and ** indicates the EO was updated with information obtained in 2016 surveys. EOs that occur within the park are **emboldened**.

Common Name	Scientific Name	State Status (Federal Status)	EO ID	EO Rank	Year First Observed	Year Last Observed
AQUATIC SPECIES						
Elktoe	*Alasmidonta marginata*	SC	15272	E	2000	2000
Purple wartyback	*Cyclonaias tuberculata*	T	5827	E	1975	2010
Purple wartyback	*Cyclonaias tuberculata*	T	15273	E	2000	2001
Wavyrayed lampmussel	*Lampsilis fasciola*	T	10287	C	1929	2010
Wavyrayed lampmussel	*Lampsilis fasciola*	T	17768	H	1958	1958
Rainbow	*Villosa iris*	SC	15277	E	1929	2010
Rainbow	*Villosa iris*	SC	18512	H	1975	1975
BATS						
Northern long-eared bat	*Myotis septentrionalis*	SC (LT)	20011	E	1998	1998
Indiana bat	*Myotis sodalis*	E (LE)	9446	A?	1995	2005
BIRDS						
Henslow's sparow*	***Ammodramus henslowii***	**E**	**20714**	**BC**	**2016**	**2016**
Grasshopper sparrow*	***Ammodramus savannarum***	**SC**	**20717**	**C**	**2016**	**2016**
Bald eagle	***Haliaeetus leucocephalus***	**SC**	**19090**	**E**	**2012**	**2012**
Dicksissel*	***Spiza americana***	**SC**	**20716**	**E**	**2016**	**2016**
HERPTILES						
Eastern massasauga**	***Sistrurus catenatus***	**SC (LE)**	**19058**	**BC**	**2010**	**2016**
Eastern massasauga	*Sistrurus catenatus*	SC (LE)	8701	BC	1994	2004
Eastern box turtle	*Terrapene carolina carolina*	SC	5755	H	1905	1905
PLANTS						
Tall green milkweed	*Asclepias hirtella*	T	6088	D	1981	1981
Side-oats grama grass	*Bouteloua curtipendula*	E	16910	C	2008	2008
White lady slipper	*Cypripedium candidum*	T	4733	BC	1990	1990
Leiberg's panic grass	*Dichanthelium leibergii*	T	6980	C	1981	2008
Stiff gentian	*Gentianella quinquefolia*	T	17059	BC	2009	2009

Unlisted grassland bird species recorded at Watkins Lake State Park included bobolink (*Dolichonyx oryzivorus*) (pictured above), upland sandpiper (*Bartramia longicauda*), and savannah sparrow (*Passerculus sandwichensis*). Photos by Aaron P. Kortenhoven.

Dicksissel (*Spiza americana*, state special concern) (above) and Henslow's sparrow (*Ammodramus henslowii*, state endangered) (below). Photos by Aaron P. Kortenhoven.

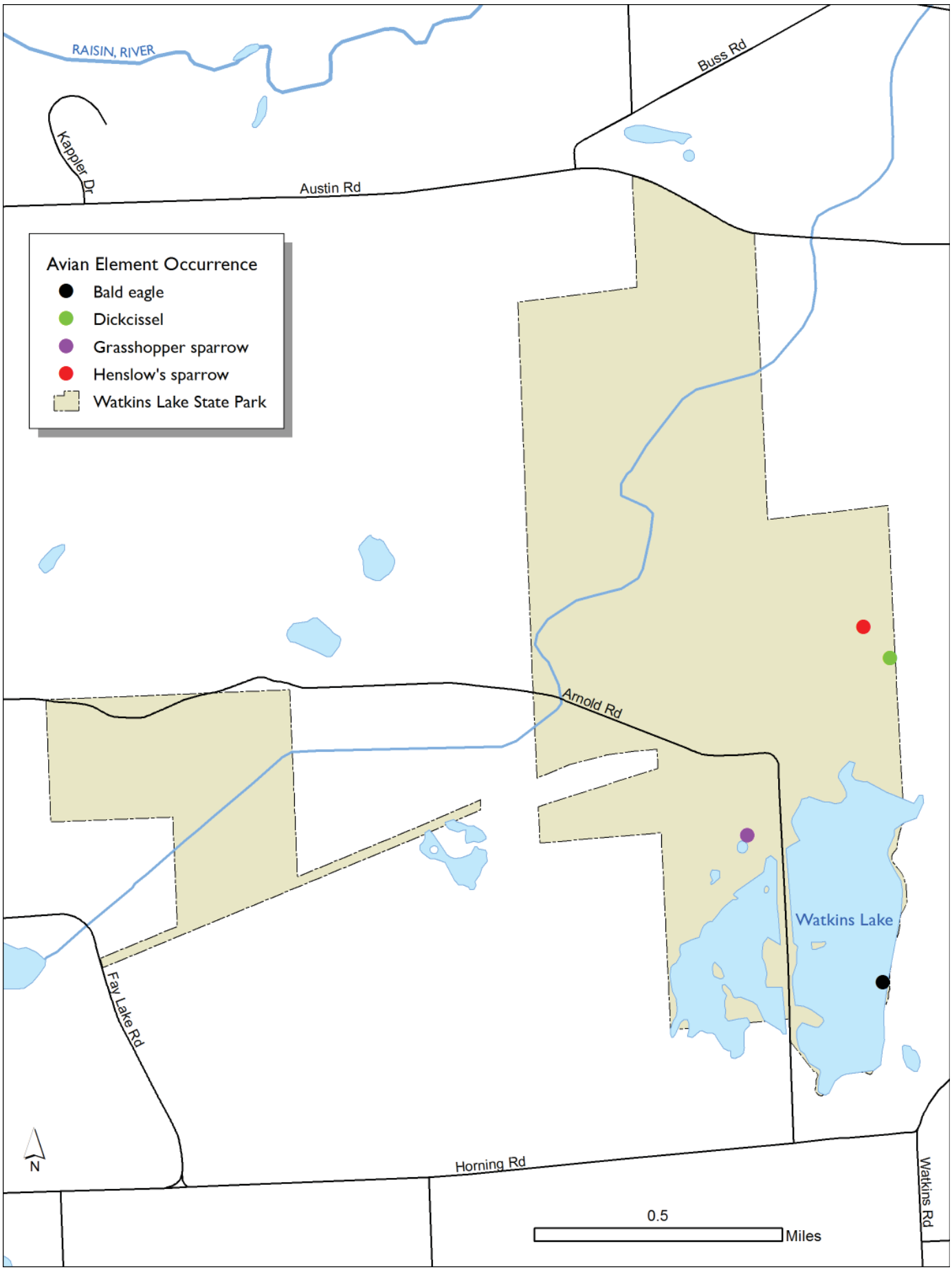


Figure 10. Rare bird element occurrences within Watkins Lake State Park.

Herptiles

No eastern massasaugas or other rare and/or declining reptile or amphibian species were encountered during herptile surveys at Watkins Lake State Park in 2016. Several northern leopard frogs (*Lithobates pipiens*), green frogs (*Lithobates clamitans*), and an eastern gartersnake (*Thamnophis sirtalis sirtalis*) were observed in the prairie fen in the central portion of the Marsh Brook West Fen (EO ID 20823) on September 1st and 11th. Although no rare and/or declining amphibian or reptile species were observed during the surveys, suitable habitat for the eastern massasauga and other target herptile species were found in the prairie fen and adjacent uplands. Suitable habitats for additional SGCN also appeared to be available on this site. Although some invasive plant species (i.e., purple loosestrife, narrow-leaved cattail, glossy buckthorn, multi-flora rose, reed canary grass, and autumn olive) were found in both fens and/or adjacent uplands, most of the fen appears to be good quality habitat for eastern massasaugas. However, some parts of the fens, particularly in Marsh Brook East Fen (EO ID 20825), are undergoing woody shrub encroachment, which can reduce habitat quality for eastern massasaugas.

Although MNFI's herptile surveys in 2016 were not able to document eastern massasaugas at Watkins Lake State Park, the occurrence of this species in the park and on adjacent private lands was confirmed by reports from the general public and adjacent landowners. On Oct 11th, an eastern massasauga was killed on Arnold Road within the park south of the Marsh Brook East Fen (EO ID 20825) (Figure 11). This observation was reported to the park manager of Watkins Lake State Park, and was confirmed with a photograph of the dead snake. Additionally, private landowners who own property immediately adjacent to the west parcel of Watkins Lake State Park south of Arnold Road have reported seeing massasaugas on their property every year, normally in the spring and after heavy rains (Michael Arnold personal communication), and have provided photo documentation of the species' occurrence on their property. Their property is within and/or adjacent to the Arnold Fen (EO ID 20824) and just east of the Marsh Brook West Fen (EO ID 20823). There have also been additional reports of massasaugas in and around the park (Ray Fahlsing, personal communication) with adjacent landowners referring to the area as "rattlesnake country".

Documentation of eastern massasaugas within Watkins Lake State Park on Arnold Road and south of Arnold Road in 2016 represents an update to a previously documented eastern massasauga EO located about 1 – 2.5 km (0.6 – 1.5 mi) to the southeast (Fay Lake, EO ID 19058) (Figure 11), MNFI 2017). Element occurrence specifications for the eastern massasauga developed by NatureServe specify that occupied sites separated by 5 km of suitable habitat, 1 km of unsuitable habitat, and/or barriers (i.e., busy highway or highway with obstructions such that snakes rarely, if ever, cross successfully; major river with consistently fast flow; densely urbanized area dominated by buildings and pavement) should constitute separate EOs (Hammerson 2002). Sites that don't meet these specifications should be part of the same EO. As a result, the eastern massasauga observations documented in and adjacent to Watkins Lake State Park in 2016 represent an update of the existing EO around Fay Lake.

Additionally, another massasauga EO (EO ID 8701) has been documented north of Buss Road about 2.6 – 3.5 km (1.6 - 2.2 mi) to the northeast from the massasauga sites documented in 2016 (Table 2, Figure 12). Recent studies on massasauga movements and home ranges have found that paved roads represent almost complete barriers to massasauga movement and dispersal (The Center for Reptile and Amphibian Conservation and Management 2004, Shepard et al. 2008a, Shepard et al. 2008b). Because West Austin Road, which is a paved road, separates the Fay Lake EO from the massasauga EO along Buss Road (EO ID 8701) to the northeast, these are separate element occurrences.

Eastern massasauga road-kill along Arnold Road. Photo by Heidi Doman.

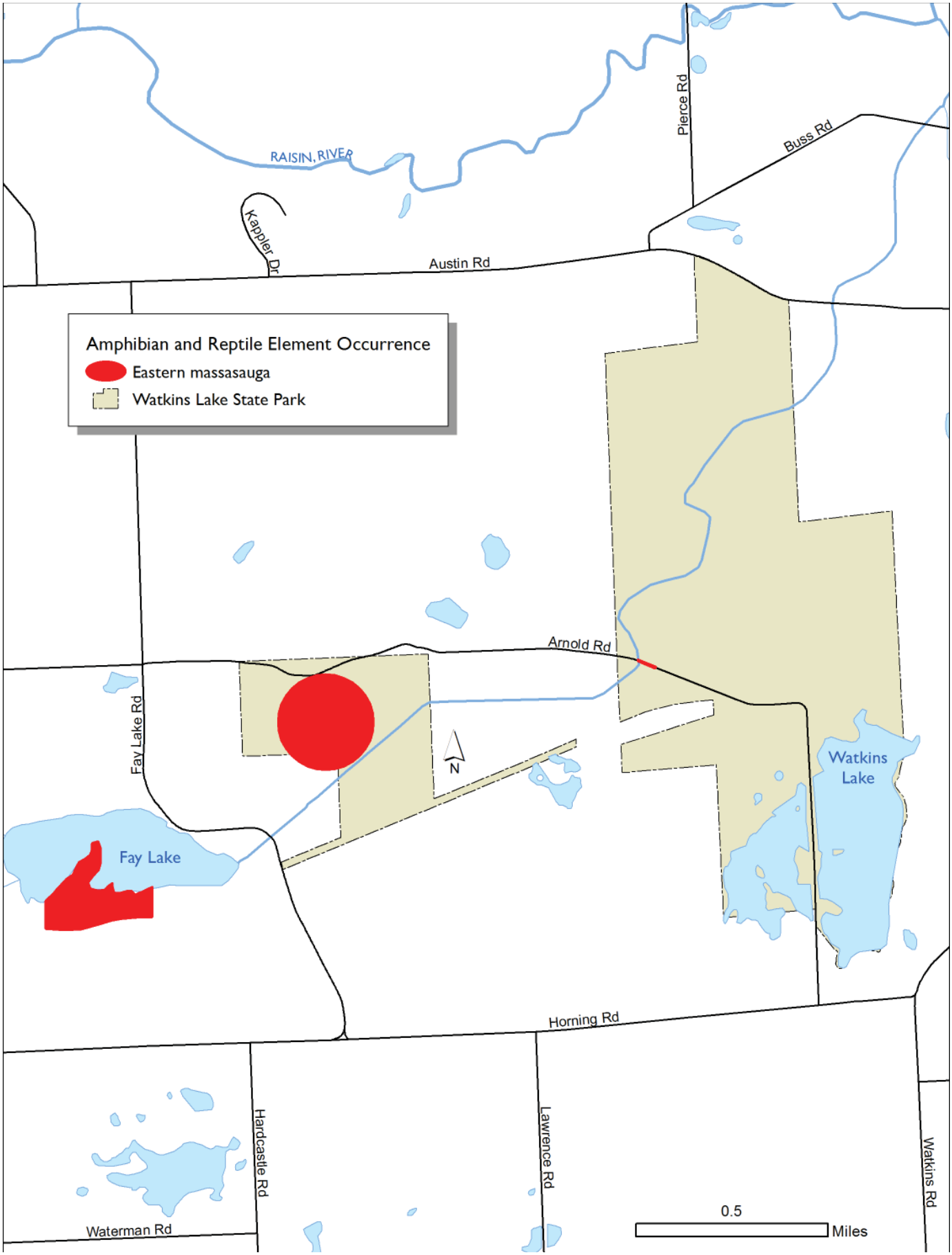


Figure 11. Eastern massasauga element occurrence (EO ID 19058) within and nearby Watkins Lake State Park.

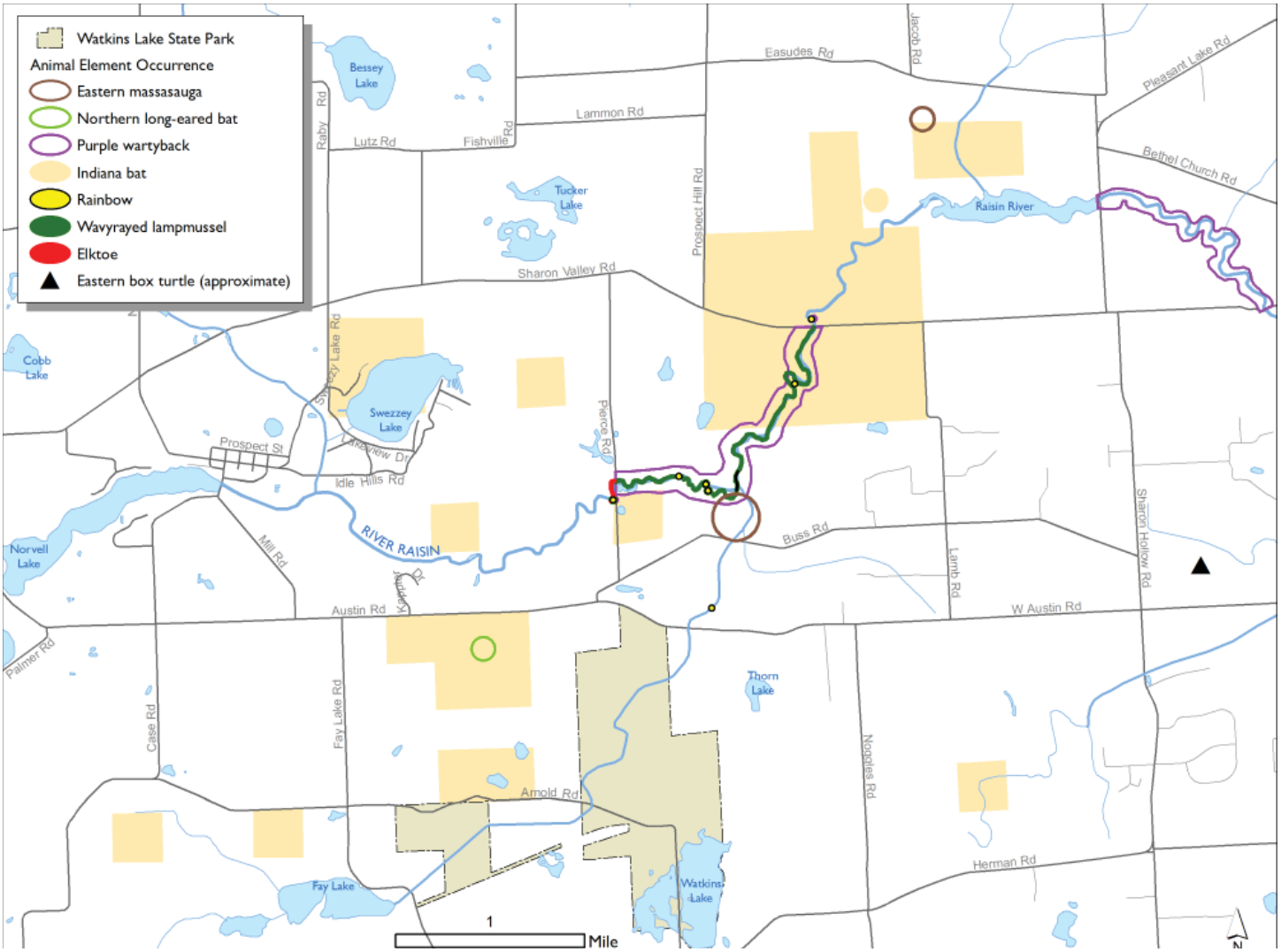


Figure 12. Rare animal species occurring in the vicinity of Watkins Lake State Park.

Eastern massasauga (*Sistrurus catenatus*, state special concern and federally endangered). Photo by Barb Barton.

DISCUSSION

Natural Community Discussion and Recommendations

In addition to the specific management recommendations provided in the above **Natural Community Survey Results** section, we provide the following general management recommendations for your consideration. We encourage invasive species control throughout the park but focused in the high-quality prairie fen, the use of landscape-scale prescribed fire, the opportunistic restoration of oak savanna and barrens ecosystems, the maintenance of the canopy closure of mature forest, the reduction of fragmentation and promotion of connectivity across the park but focused in the vicinity of the high-quality wetlands, and the careful prioritization of stewardship efforts in the most critical habitats. Finally, monitoring of these management activities is recommended to facilitate adaptive management.

Invasive Species Control

Invasive species pose a major threat to species diversity and habitat heterogeneity within Watkins Lake State Park. By out-competing and replacing native species, invasive species can change floristic composition of natural communities, alter vegetative structure, and reduce native species diversity, often causing local or even complete extinction of native species (Harty 1986). Invasive species can also upset delicately balanced ecological processes such as trophic relationships, interspecific competition, nutrient cycling, soil erosion, hydrologic balance, and solar insolation (Bratton 1982). Advanced regeneration in the understory of the forested stands in Watkins Lake State Park is influenced by the interaction of competition from invasive shrubs, fire suppression, and deer herbivory. Lastly, non-native invasive species often have no natural predators and spread aggressively through rapid sexual and asexual reproduction.

As noted in the above discussion of the prairie fen, numerous invasive species were documented occurring locally within the open wetland complex including narrow-leaved cat-tail, glossy buckthorn, purple loosestrife, reed canary grass, and Canada thistle. In addition, invasive plant species are a prevalent component of the understory and ground cover of the upland stands throughout the park. The following invasives were noted as locally dominant within the forested uplands within the park: Japanese barberry (*Berberis thunbergii*), Morrow honeysuckle (*Lonicera morrowii*), autumn olive, multiflora rose (*Rosa*

Reed canary grass occurs locally along the Norvell Manchester Drain. Control of invasive species within the prairie fen and adjacent open wetlands is a stewardship priority for Watkins Lake State Park. Photo by Joshua G. Cohen.

multiflora), hedge-parsley (*Torilis japonica*), garlic mustard (*Alliaria petiolata*), and orchard grass (*Dactylis glomerata*). Invasive species that were not documented as problematic within the park but have been documented in the area include Oriental bittersweet (*Celastrus orbiculata*), tree-of-heaven (*Ailanthus altissima*), and dog-strangling vine (*Vincetoxicum rossicum*) (Slaughter and Cohen 2016). These pernicious invaders have great potential to erode biodiversity should they become established. Newly establishing invasive species should be removed as rapidly as possible, before they infest additional areas. Invasive species abstracts, which include detailed management guidelines, can be obtained at the following website: https://mnfi.anr.msu.edu/invasive-species/best-control-practice-guides.cfm

We recommend that invasive species management at Watkins Lake State Park should focus on controlling populations of pernicious invasive species within the high-quality fen and also in the immediately adjacent uplands. Prescribed fire can be employed as the primary mechanism for reducing invasive species at the landscape scale in upland forests and targeted prescribed fire and spot treatment through cutting and/or herbicide application can be employed locally within priority high-quality sites. We encourage this multi-faceted approach and emphasize that improving the landscape context surrounding the high-quality wetlands is critical and that reducing background levels of invasive species will reduce the seed source for these invaders. We strongly encourage the implementation of monitoring within the high-quality prairie fen and throughout actively managed areas to gauge the success of restoration activities at reducing invasive species populations. In addition, periodic early-detection surveys should be implemented to allow for the identification of invasive species that have yet to establish a stronghold within Watkins Lake State Park.

Fire as an Ecological Process

Much of the land within Watkins Lake State Park historically supported fire-dependent ecosystems, including oak barrens, dry-mesic southern forest, prairie fen, and wet prairie. In the past, lightning- and human-set fires frequently spread over large areas of southern Michigan and other Midwestern states, helping to reduce colonization by trees and shrubs, fostering regeneration of fire-dependent species, and maintaining the open physiognomy or structure of many ecosystems (Curtis 1959, Dorney 1981, Grimm 1984). In the absence of frequent fires, prairie and open oak savanna and barrens have converted to closed-canopy forests dominated by shade-tolerant native and invasive species (Cohen 2001, Lee and Kost 2008). The conversion of oak savanna and prairie ecosystems to closed-canopy forest typically results in significant reductions in species and habitat diversity (Curtis 1959, McCune and Cottam 1985, McClain et al. 1993, Wilhelm 1991). Efforts to restore savanna, barrens, and prairie within Watkins Lake State Park will depend on the implementation of frequent prescribed fire.

Closed-canopy dry-mesic southern forests within Watkins Lake State Park are also negatively impacted by fire suppression and are experiencing strong regeneration of thin-barked, shade-tolerant or mesophytic trees, such as red maple, and invasive shrubs such as Japanese barberry, multiflora rose, and autumn olive. These native and invasive mesophytic species compete with oaks and contribute to the regeneration failure of oaks. Within oak-dominated forested ecosystems, a sustained, landscape-scale, fire-management program would reduce the density of shade-tolerant seedlings, saplings, and invasive shrubs and help facilitate increased recruitment of fire-adapted and fire-dependent shrubs, oaks, and herbaceous species.

Plant communities benefit from prescribed fire in several ways. Depending on the season and intensity of a burn, prescribed fire may be used to decrease the cover of invasive woody species, and increase the cover of native grasses and forbs (White 1983, Abrams and Hulbert 1987, Tester 1989, Collins and Gibson 1990, Glenn-Lewin et al. 1990, Anderson and Schwegman 1991). Prescribed fire helps reduce litter levels, allowing sunlight to reach the soil surface and stimulate seed germination and enhance seedling establishment (Daubenmire 1968, Hulbert 1969, Knapp 1984, Tester 1989, Anderson and Schwegman 1991, Warners 1997). Important plant nutrients (e.g., N, P, K, Ca, and Mg) are elevated following prescribed fire (Daubenmire 1968, Viro 1974, Reich et al. 1990, Schmalzer and Hinkle 1992). Burning has been shown to result in increased plant biomass, flowering, and seed production (Abrams et al. 1986, Laubhan 1995, Warners 1997, Kost and De Steven 2000). Prescribed fire can also help express and rejuvenate seed banks, which may be especially important for maintaining species diversity (Leach and Givnish 1996, Kost and De Steven 2000). Many host plants for rare insect species are fire-dependent plant species.

Although prescribed fire typically improves the overall quality of habitat for many animal species, its impact on rare animals should be considered when planning a burn. Larger, more mobile, and subterranean animals can temporarily move out of an area being burned. Smaller and less mobile species can die in fires; this includes some rare insects (Panzer 1998) and reptiles. Where rare invertebrates and herptiles are a management concern, burning strategies should allow for ample refugia to facilitate effective post-burn recolonization (Siemann et al. 1997). Insects and herptiles, characterized by fluctuating population densities, poor dispersal ability, and patchy distribution, rely heavily on unburned sanctuaries from which they can reinvade

burned areas (Panzer 1998). Dividing large contiguous areas into two or more separate burn units or non-fire refugia that can be burned in alternate years or seasons can protect populations of many species. This allows unburned units to serve as refugia for immobile invertebrates and slow-moving herptile species, such as eastern box turtle. When burning relatively large areas, it may be desirable to strive for patchy burns by burning either when fuels are somewhat patchy or when weather conditions will not support hot, unbroken fire lines (such as can occur under atypically warm, dry weather and steady winds). These unburned patches may then serve as refugia, which can facilitate recolonization of burned patches by fire-sensitive species. In addition, burning under overcast skies and when air temperatures are cool (<13 °C or 55 °F) can help protect reptiles, because they are less likely to be found basking above the surface when conditions are cloudy and cool. Conducting burns during the dormant season (late October through March) may also help minimize impacts to reptiles.

We recommend the implementation of prescribed fire at a landscape-scale and the creation of large burn units (e.g., several hundred acres in size). If resources for burning are limited, we recommend that prescribed fire be prioritized for the high-quality prairie fen and adjacent upland stands. We also recommend that the seasonality of burns be varied across the park. Prescribed fire is often seasonally restricted to spring. 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 impact the same species year after year, and over time, can lower floristic diversity (Howe 1994, Copeland et al. 2002). 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 these species. Historically, fires burned in a variety of seasons, including spring, during the growing season, and fall (Howe 1994, Copeland et al. 2002, Petersen and Drewa 2006). The natural communities historically found at Watkins Lake State Park, including oak barrens, wet prairie, prairie fen, and dry-mesic southern forest, likely 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 (Howe 1994, Copeland et al. 2002). In other words, pyrodiversity (that is, a diversity of burn seasons and fire intensity) leads to biodiversity.

Repeated early spring burns are of particular concern in dry-mesic southern forest and degraded oak savanna and barrens where a goal for prescribed burning is control of woody species. Prior to bud break and leaf flushing, the vast majority of energy in a woody plant is stored in roots as carbohydrate reserves (Richburg 2005). As plants expend energy to make leaves, flowers and fruits, these carbohydrate reserves diminish, reaching a seasonal low during flowering and fruiting. As fall approaches, energy root reserves are replenished. Thus, when woody species are top-killed by early spring fires, they are able to resprout vigorously using large energy stores, a phenomenon seen frequently with sassafras (*Sassafras albidum*), black locust (*Robinia pseudoacacia*), and sumac (*Rhus* spp.) (Cohen et al. 2009). However, if burns are conducted later in the spring after leafout, or during the growing season, energy reserves are already partially depleted, and resprouting vigor is lower, particularly for clonal species like sassafras, sumac, and black locust (Axelrod and Irving 1978, Reich et al. 1990, Sparks et al. 1998).

Resource managers restrict prescribed fire to the early spring for numerous reasons including ease of controlling burns, greater windows of opportunity for conducting burns because suitable burning conditions are often most prevalent this time of year, and to reduce the probability of detrimentally impacting fire-sensitive animal species, such as herptiles (e.g., eastern box turtle). Although these are all legitimate reasons, we feel that the long-term benefits of diversifying burn seasonality across the park outweigh the costs and that ultimately, successful restoration of fire-dependent ecosystems at Watkins Lake State Park will depend on expansion of the burn season beyond early spring. Several techniques for reducing the risk to fire-sensitive species can be employed during burns in the summer and fall. For example, burn specialists can establish rotating refugia within large burn units and avoid burning within and around rotted logs, vernal pools, and seepage areas.

Savanna, Barrens, and Prairie Restoration

Although no high-quality oak openings, oak barrens, or prairies were documented during the course of the surveys, oak barrens and wet prairie ecosystems historically occurred on approximately 17% and 7% of Watkins Lake State Park, respectively (Figure 4). In addition, the following three rare plants associated with savanna and prairie ecosystem have been documented in the vicinity of the state park: Leiberg's panic grass (*Dichanthelium leibergii*, state threatened), tall green milkweed (*Asclepias hirtella*, state threatened), and side-oats grama grass (*Bouteloua curtipendula*, state endangered) (Table 2, Figure 9). As noted above, areas mapped as Black Oak Barren within the park and throughout the surrounding landscape likely included both dry savanna systems (oak barrens) as well as dry-mesic savanna (oak openings) and small pockets of prairie inclusions likely occurred within this savanna/barrens matrix. As noted above, surveys in 2016 documented remnant wet-mesic prairie and degraded oak

openings adjacent to the open wetland complex. Stands within the park that support prairie/savanna/barrens flora in the ground cover and may have supported prairie/savanna/barrens systems in the past include: Compartment 1, Stands 2, 8, 9, 14, 16, 23, and 26 (Figure 6). In addition, upland inclusions within praie fen Stand 1 include small savanna remnants, especially along the eastern boundary of the stand.

Pursuing targeted restoration of savanna, barrens, and prairie remnants within Watkins Lake State Park is recommended because these rare ecosystems support a high-level of biodiversity and numerous rare species. We recommend that these prairie and savanna remnants be managed in conjunction with the adjacent prairie fen complex. Restoration of these open ecosystems is also beneficial to numerous game species, including wild turkey (*Meleagris gallopavo*) and white-tailed deer (*Odocoileus virginianus*). Oak savanna restoration efforts that combine repeated prescribed fire application in conjunction with mechanical thinning are most likely to succeed where populations of relict savanna plants persist (Lettow et al. 2014).

The first management step for oak savanna and barrens restoration is the restoration of the savanna/barrens physiognomy through prescribed fire and/or selective cutting or girdling. Where canopy closure has degraded the savanna/barrens character, resource managers can selectively cut or girdle the majority of trees (White 1986), leaving between 10 and 60% canopy closure. When possible, using prescribed fire to reduce understory coverage before thinning operations is recommend, and several prescribed fires may be necessary to control invasives and mesophytic species in the understory. However, many degraded savannas and barrens that have been long deprived of fire often contain a heavy overstory and understory component of shade-tolerant species that cannot initially be controlled by prescribed fire alone but need to be removed by mechanical thinning (Abella et al. 2001, Peterson and Reich 2001). Many of the shade-tolerant shrubs in the understory of savanna/barren remnants are invasive species that require intensive management to eliminate. Where enough fine fuels remain, repeated understory burns can be employed to control the undesirable underbrush (Apfelbaum and Haney 1991). Some species such as autumn olive, honeysuckles, and red maple can be controlled with repeated burns. However, mechanical thinning or girdling in conjunction with application of specific herbicides may be necessary to eliminate tenacious invasive shrubs. To maximize the effectiveness of woody species removal, herbicide should be immediately applied directly to the cut stump or girdled bole, and efforts should be concentrated during appropriate stages in plant growth cycles (i.e., when root metabolite levels are lowest late in the growing season or during the winter) (Reinartz 1997, Solecki 1997). The process of restoring the open canopy conditions and eliminating the understory should be conducted gradually, undertaken over the course of several years taking care to minimize colonization by invasive plants, which can respond rapidly to increased levels of light and soil disturbance. As noted by Botts et al. (1994), too rapid a reduction in canopy can lead to severe encroachment of weedy species. Managers should also be mindful that cutting remnant savanna/barrens and failing to apply prescribe fire soon after mechanical treatment can actually expedite the loss of savanna/barrens through forest succession. The incremental opening of the canopy, especially when preceded by multiple prescribed fires and followed by repeated prescribed fires, can result in the germination of savanna/barren species dormant in seedbanks during fire suppression, reduce competition for savanna/barren species, and also create suitable seed beds for oak regeneration.

Fire is the single most significant factor in preserving savanna, barrens, and prairie ecosystems. Once open-canopy conditions have been re-established, the reintroduction of fire is essential for the maintenance of floristic composition and structure. In some instances, prairie grasses may need to be seeded or planted to provide an adequate fuel matrix to support frequent burns (Botts et al. 1994, Packard 1997a, 1997b). Seed and plant donors should come from local sources and similar vegetative communities (Apfelbaum et al. 1997). In addition to maintaining open canopy conditions, prescribed fire promotes internal vegetative patchiness and high levels of grass and forb diversity, deters the encroachment of woody vegetation and invasive species, and limits the success of dominants (Bowles and McBride 1998, Leach and Givnish 1999, Abella et al. 2001). Numerous studies have indicated that fire intervals of one to three years bolster graminoid dominance, increase overall grass and forb diversity, and remove woody cover of saplings and shrubs (White 1983, Tester 1989, Abella et al. 2001). Once the structure has been securely established, burning at longer time intervals can be employed to allow for seedling establishment and the persistence of desirable woody plants. Apfelbaum and Haney (1991) recommend gaps of five to ten years to allow for canopy cohort recruitment. Varying the burn interval from year to year and by season can increase the diversity of savanna, barrens, and prairie remnants.

Resource managers in southern Michigan face a complex management dilemma. Following decades of fire suppression, oak savanna, barrens, and prairie communities have converted to closed-canopy systems. Many of these dry-mesic forests provide critical habitat for forest-dwelling

species, such as Neotropical migrant birds. Conversion of these closed-canopy forests to savanna, barrens, or prairie would likely favor species that are generalists and edge-dwellers. Robinson (1994) expressed concern that fire management and savanna restoration may exacerbate the formidable problems of forest fragmentation in the Midwest (e.g., cowbird parasitism and nest predation by mesopredators such as raccoons). In addition, the high proportion of edge-like habitat of savannas, barrens, and prairies leaves them susceptible to invasion by aggressive invasive and native plants (Solecki 1997). Conversion of forest to savanna, barrens, or prairie requires a long-term commitment to invasive species control and fire restoration (Peterson and Reich 2001). Resource managers must weigh the costs and benefits of each option and regionally prioritize where to manage for savanna, barrens, and prairie systems. Savanna, barrens, and prairie remnants selected for restoration should be large in size, with good landscape context, and have a high probability of success. Due to the high levels of biodiversity within these landscapes and the rarity of many of the fire-dependent communities and species, sustained conservation efforts within savanna, barrens, and prairie landscapes are likely to pay rich dividends (Leach and Givnish 1999).

Setting Stewardship Priorities

Threats such as invasive species and fire suppression are common across Watkins Lake State Park. Because the list of stewardship needs for the park may outweigh available resources, prioritizing activities is a pragmatic necessity. In general, prioritization of stewardship should focus on the highest quality examples of the rarest natural community types and the largest sites. Biodiversity is most easily and effectively protected by preventing high-quality sites from degrading, and invasive plants are much easier to eradicate when they are not yet well established, and their local population size is small. Within Watkins Lake State Park, we recommend that stewardship efforts be focused in the areas of high-quality prairie fen since these wetlands harbor high levels of biodiversity and provide potential habitat for numerous rare plant and animal species. We suggest that the Marsh Brook West Fen (EO ID 20823) be the highest stewardship priority because of the unique juxtaposition of high-quality prairie fen and remnant oak openings and wet-mesic prairie.

Oak openings remnant along the margin of prairie fen in Watkins Lake State Park (Marsh Brook West Fen within Compartment 1, Stand 1). Implementing prescribed fire within the prairie fen and adjacent uplands is recommended as a high stewardship priority. Photo by Jesse M. Lincoln.

Monitoring

We recommend that monitoring be implemented at Watkins Lake State park, concentrated within the high-quality prairie fen but also throughout actively managed areas. Monitoring can help inform adaptive management by gauging the success of restoration at meeting the goals of reducing invasive species populations, limiting woody encroachment in understories of fire-prone systems, and fostering regeneration in fire-dependent ecosystems. Assessing the impacts of prescribed fire on herptile populations should also be a component of the burning program, especially following potential burns in the summer and fall, and can help direct adaptive management. In addition, monitoring deer densities and deer herbivory will allow for the assessment of whether deer browsing threatens floristic structure and composition and whether active measures to reduce local deer populations are needed.

Rare Animal Discussion and Management Recommendations

Grassland Birds

Given that this area was until recently an active cattle ranch, Areas 1 and 2 were actively managed for hay production and grazing pasture. As a result, much of these areas provide excellent habitat for grassland birds. If possible, we recommend that these areas continue to be managed as grassland. This can be achieved by implementing prescribed burning within these areas in the late fall or late-season mowing or hay harvest. We suggest that these fields be divided into sections with an alternated burn/harvest time in order to maintain suitable grassland bird cover. In Area 2, actions should be taken to eradicate spotted knapweed (*Centaurea maculosa*) before it takes over. Currently there are only a few small patches of knapweed present within the southeast corner of the stand. Special attention should be given to autumn olive (*Elaeagnus umbellata*) in Area 3. We recommend that the autumn olive be managed by mechanical removal combined with herbicide treatment while the population is at a relatively low level.

We recommend conducting grassland songbird point counts periodically to monitor use of the game area by rare species and track grassland bird assemblages over time. These surveys would allow us to determine if the stands where rare songbirds were observed continue to be occupied over time and would provide an opportunity to monitor the effects of management actions on these and other species of management interest. Because rare species often are not detected even when present, additional surveys would also help determine if rare songbirds occur at sites where the habitat appeared suitable, but they were not observed. Within Area 2, point counts were conducted around mid-day, which is beyond the peak bird vocalization period. It is possible that additional rare grassland bird species, such as Henslow's sparrow, were present in the area but remained silent. We also recommend additional surveys be conducted for short-eared owl (*Asio flammeus*, state endangered) and northern harrier (*Circus cyaneus*, state special concern). Short-eared owls could utilize the grassland habitat within the park during the winter months and northern harrier could utilize both the grassland habitat and adjacent open wetland complex.

Herptiles

Although targeted surveys in the fall of 2016 were not able to document the eastern massasauga in Watkins Lake State Park, incidental reports from the general public and adjacent private landowners confirmed the occurrence of eastern massasaugas in the park. The massasauga observations within Watkins Lake State Park updated and expanded a previously documented EO of the eastern massasauga around Fay Lake (EO ID 19058) to the southwest. The Fay Lake EO was first and last documented at this site in 2010 (MNFI 2017). Suitable habitat for massasaugas occurs throughout the Marsh Brook West Fen (EO ID 20823), Arnold Fen (EO ID 20824), Marsh Brook East Fen (EO ID 20825), and Fay Lake Fen (EO ID 12366), and adjacent wetlands and uplands. As a result, it is likely the massasauga population extends to the north of Arnold Road through the Marsh Brook East Fen and to the south of Fay Lake, but this needs to be verified. Additional surveys should be conducted in these areas to determine the extent and distribution of the massasauga population in the Watkins Lake State Park and adjoining lands. Although eastern massasaugas can be detected anytime throughout the active season, the best times to survey for the species is in the spring when the snakes are emerging and the vegetation is sparse, and in mid-late summer when males are moving to find females, and gravid females are basking and getting ready to give birth (Casper et al. 2001).

Based on NatureServe's generic guidelines for ranking species occurrences, the Fay Lake EO was ranked as having good to fair estimated viability or probability of persisting into the foreseeable future (i.e., at least 20-30 years), if current conditions prevail (Hammerson et al. 2008). Although the size of this population is unknown, it has been ranked as having good to fair viability because of the extensive suitable habitat available at this site, numerous reports of the species from the area, and the protected nature of the state park and some of the surrounding lands (e.g., The Nature Conservancy owns and manages some habitat around Fay Lake). However, there are several threats that may impact the viability of this EO. These include habitat loss and fragmentation due

to disruption of natural ecological processes, hydrological alterations, vegetative succession, invasive species, residential and agricultural development, and roads. Road mortality, predation, and/or intentional killing by people are additional potential threats to this population.

Maintaining a viable population of the eastern massasauga and associated herptile species requires maintaining or restoring large complexes of open wetland and adjacent upland habitats. Eastern massasaugas utilize open wetlands, such as prairie fens, wet meadows, wet/wet-mesic prairies, bogs, and emergent marshes (Szymanski et al. 2016). They also utilize open and forested uplands, including prairies, savannas, barrens, old fields, upland deciduous, coniferous, or mixed forests, and forest openings, for foraging, basking, gestation, parturition (i.e., giving birth to young), and dispersal (Reinert and Kodrich 1982, Harding 1997, Szymanski 1998, Johnson et al. 2000, Lee and Legge 2000, Bissell 2006, Bailey 2010, DeGregorio et al. 2011). Massasaugas overwinter in upland habitats adjacent to wetlands or in the transition zone between wetland and upland habitats (Bissell 2006, Smith 2009). The prairie fen within Watkins Lake State Park and adjacent upland habitats currently provide extensive areas of suitable habitat for eastern massasaugas, although there are some areas that are experiencing vegetative succession from woody shrubs and/or encroachment by invasive species. These areas should be closely monitored, and treated or restored if possible (e.g., north side of the creek in the Marsh Brook West Fen EO).

Maintaining suitable microhabitats also is critical. Eastern massasaugas require open, elevated microhabitats to bask and warm up during cool conditions, and shade or cover during hot and/or sunny conditions to thermoregulate. Microhabitats that massasaugas use to thermoregulate include sedge and grass hummocks, live and dead herbaceous vegetation, shrubs, muskrat and beaver lodges, burrows, and woody debris (Lee and Legge 2000). Bissell (2006) and Bailey (2010) found that massasaugas were associated with sites that had high percentages (i.e., >50-60%) of live and dead herbaceous cover. Massasaugas also need refugia or cover to hide from predators and for foraging, and gravid females give birth to live young often in or under burrows, stumps, logs, or other woody debris (Harding 1997, Lee and Legge 2000, Ernst and Ernst 2003). Massasaugas overwinter in crayfish or small mammal burrows, old stumps, and root systems of dead and live trees and shrubs (Moore 2004, Bissell 2006, Smith 2009).

Management practices such as prescribed burning, mechanical vegetation control, and chemical control are important for maintaining and restoring wetland and upland habitats for eastern massasaugas and other herptiles. However, these management practices also have potential to cause injury or death to reptiles and amphibians. Adjusting the timing and/or manner in which these management practices are conducted can reduce the potential for adversely impacting eastern massasaugas and other herptile species. Extending the management interval (e.g., burning every 3-4 years instead of every 1-2 years), and/or conducting management on only a portion of the available habitat at a site and leaving some refugia also can help reduce adverse impacts to massasaugas and other herptile species. If this site is enrolled in the State of Michigan's Eastern Massasauga Candidate Conservation Agreement with Assurances (CCAA), management activities at this site will need to comply with management guidelines specified in the CCAA.

In addition to habitat loss, massasaugas in the Watkins Lake State Park may be impacted by roads and road mortality, as indicated by the massasauga road mortality that was observed in 2016. Road mortality can significantly impact adult and/or juvenile survivorship and population viability. Roads can significantly impact amphibian and reptile populations by acting as barriers to movement for some species (e.g., massasaugas), and/or causing substantial mortality of adults and juveniles, especially of turtles (Ashley and Robinson 1996, Wood and Herlands 1997, Haxton 2000, The Center for Reptile and Amphibian Conservation and Management 2004, Steen and Gibbs 2004, Aresco 2005, Lee and Monfils 2008, Shepard et al. 2008a, Shepard et al. 2008b, Kingsbury pers. comm.). Massasauga populations also may be sensitive to small increases in adult and juvenile mortality. Based on population viability models, Seigel and Sheil (1999) found that massasauga populations were stable when adult survival rate was > 78% per year and neonate/first year was > 20% per year. But the probability of extinction within 100 years increased to > 40% when annual adult and neonate mortality rates increased by only 3 to 4% (Seigel and Sheil 1999). Road mortality and the impact of roads on the massasauga population in the park should be monitored and furthered investigated. Where herptile road mortality is an issue, installing fencing (e.g., vinyl erosion control fencing) along roads in conjunction with existing culverts can be an effective and relatively inexpensive method for reducing road mortality, at least temporarily (Aresco 2005, Patrick et al. 2010).

Potential exists for additional rare and/or declining herptile species and/or SGCN to be documented within Watkins Lake State Park. These include the spotted turtle (*Clemmys guttata*, state threatened), eastern box turtle, Blanding's turtle, pickerel frog, and smooth green snake (*Liochlorophis vernalis*) in the open wetland habitats, and the northern ring-necked snake (*Diadophis punctatus*) and gray ratsnake (*Pantherophis spiloides*, state special concern) in the

adjacent forests. Kirtland's snake (*Clonophis kirtlandii*) is a state endangered species that also has potential to occur in the sedge meadow and prairie fen habitats within Watkins Lake State Park, particularly in areas with crayfish burrows. Additional targeted surveys for these species would help determine whether these species occur within Watkins Lake State Park, and would help inform management of these sites.

Future Survey Needs

As noted above, rare species surveys were limited to the mid to late growing season because access to the park was not granted until June of 2016. In 2017, MNFI plans to conduct surveys in Watkins Lake State Park for rare insect and plant species associated with prairie fen and savanna ecosystems, rare aquatic species associated with the Norvell Manchester Drain, rare bats, and rare herptile species in the prairie fen complex and adjacent uplands in the spring to early summer.

In addition to the rare species documented within Watkins Lake State Park (Figures 9, 10, and 11), numerous rare species have been documented in the vicinity of the park (Table 2, Figures 9 and 12). Several rare plants have been documented in the vicinity of Watkins Lake State Park including several species associated with savanna/barrens/prairie habitat and several species associated with prairie fen (Table 2, Figure 9). The following three savanna/barrens/prairie species have been recorded just west of the park: tall green milkweed (*Asclepias hirtella*, state threatened), side-oats grama grass (*Bouteloua curtipendula*, state endangered), and Leiberg's panic grass (*Dichanthelium leibergii*, state threatened). We recommend that surveys for these species be conducted within areas of degraded barrens/savanna and also within remnant patches of wet-mesic prairie along the prairie fen margins. We also recommend spring surveys for rare plants associated with prairie fen. White lady slipper (*Cypripedium candidum*, state threatened) was documented just east of Watkins Lake State Park in a small prairie fen associated with Thorn Lake. Stiff gentian (*Gentianella quinquefolia*, state threatened) has also been recorded near Thorn Lake and could potentially occur within Watkins Lake State Park within the open wetland complex on mineral soils and also potentially within areas of degraded savanna.

An abundance of rare mussel species have been recorded to the north of Watkins Lake State Park associated with River Raisin and its tributaries including elktoe (*Alasmidonta marginata*, state special concern), purple wartyback (*Cyclonaias tuberculate*, state threatened), wavyrayed lampmussell (*Lampsilis fasciola*, state threatened), and rainbow (*Villosa iris*, state special concern) (Table 2, Figure 12). Although Marsh Brook, which is now the Norvell Manchester Drain, has been significantly impacted by straightening and draining, the drainage still harbors potential for supporting rare aquatic species, especially mussels. The drain is fed by cold groundwater seepage and headwater streams, is shallow, and is characterized by substrate that is associated with mussel habitat (i.e., cobble, gravel, and pebble). We therefore recommend surveys of the Norvell Manchester Drain for live unionids and shells using both visual and tactile survey methods.

Two rare bat species have been documented just north of Watkins Lake State Park: Indiana bat (*Myotis sodalis*, state and federally endangered) and northern long-eared bat (*M. septentrionalis*, state special concern and federally threatened) (Table 2, Figure 12). Riparian areas within Watkins Lake State Park could potentially provide summer habitat for both of these species. Indiana bats roost and form maternity colonies under loose bark or in hollows and cavities of mature trees in the riparian forest. In Michigan, savanna habitats adjacent to riparian corridors may have been historically important for roost sites, as the bats are thought to prefer sun-exposed trees for maximum warmth at the northern limit of their range. During the summer, northern long-eared bats roost singly or in colonies underneath bark and in cavities or in crevices of both live trees and snags. Given the proximity of the documented occurrences of these bat species to the park, we recommend implementing mistnetting surveys for Indiana bat and northern long-eared bat during the 2017 field season if sufficient funding is available.

Groundwater-fed headwater stream feeding into the Norvell Manchester Drain. We recommend conducting surveys for rare unionid mussels within this drainage. Photo by Joshua G. Cohen.

CONCLUSION

Over the course of the project, MNFI documented three new element occurrences (EOs) and provided information for updating an additional two EOs. Surveys for exemplary natural communities resulted in updating an existing prairie fen EO that was previously only known from adjacent private land to the south and west. Surveys on both state and private lands resulted in the expansion of this prairie fen EO from two polygons to seven polygons and from 47 acres to 159 acres. We assessed the current ranking, classification, and delineation of this occurrence and detailed the vegetative structure and composition, ecological boundaries, landscape and abiotic context, threats, management needs, and restoration opportunities. The report provides a detailed description of this prairie fen as well as a comprehensive discussion of site-specific threats and stewardship needs and opportunities.

Four rare bird species have been documented in the park with three rare grassland bird species being recorded during the 2016 breeding season following point-count and meander surveys. We documented new EOs for Henslow's sparrow (*Ammodramus henslowii*, state endangered), grasshopper sparrow (*Ammodramus savannarum*, state special concern), and dicksissel (*Spiza americana*, state special concern).

Visual encounter surveys for rare herptiles did not result in any documented rare species. However, during the course of the project, information provided by adjacent landowners and the general public was utilized to update an eastern massasauga (*Sistrurus catenatus*, federally threatened and state special concern) EO. This EO represents the sole rare herptile EO for the park.

We recommend that future surveys within Watkins Lake State Park include surveys for rare insect and plant species associated with prairie fen and savanna ecosystems, rare aquatic species associated with the Norvell Manchester Drain, rare bats, and rare herptiles associated with prairie fen and the adjacent uplands with these herptile surveys focused in the spring and early summer.

Primary management recommendations for the Watkins Lake State Park include: 1) invasive species control throughout the park but focused in the high-quality prairie fen; 2) the use of landscape-scale prescribed fire focused in the open wetland complex and adjacent upland areas and with rotating non-fire refugia where fire-sensitive rare species occur; 3) the opportunistic restoration of oak savanna and barrens ecosystems; 4) the maintenance of the canopy closure of mature forest; 5) the reduction of fragmentation and promotion of connectivity across the park but focused in the vicinity of the high-quality wetlands; and 6) the careful prioritization of management efforts in the most critical habitats. Monitoring of these management activities is recommended to facilitate adaptive management.

Invasive species pose a major threat to species diversity and habitat heterogeneity within Watkins Lake State Park. Numerous invasive species were documented occurring locally within the open wetland complex. In addition, invasive plant species are a prevalent component of the understory and ground cover of the upland stands throughout the park. We recommend that invasive species management at Watkins Lake State Park should focus on controlling populations of pernicious invasive species within the high-quality prairie fen and also in the immediately adjacent uplands. Managers should bear in mind that invasive plants are much easier to eradicate when they are not yet well established, and their local population size is small. Prescribed fire can be employed as the primary mechanism for reducing invasive species at the landscape scale in upland forests and targeted prescribed fire and spot treatment through cutting and/or herbicide application can be employed locally within priority high-quality sites. We encourage this multi-faceted approach and emphasize that improving the landscape context surrounding the high-quality wetlands is critical and that reducing background levels of invasive species will reduce the seed source for these invaders. We strongly encourage the implementation of monitoring within the high-quality prairie fen and throughout actively managed areas to gauge the success of restoration activities at reducing invasive species populations. In addition, periodic early-detection surveys should be implemented to allow for the identification of invasive species that have yet to establish a stronghold within Watkins Lake State Park.

Much of the land within Watkins Lake State Park historically supported fire-dependent ecosystems, including oak barrens, dry-mesic southern forest, prairie fen, and wet prairie. Fire historically helped to reduce colonization by trees and shrubs, fostered regeneration of fire-dependent species, and maintained the open structure of many ecosystems. In the absence of frequent fires, fire-suppressed wetlands such as prairie fen and wet prairie are becoming degraded due to woody encroachment or have converted to shrub-carr and swamp forests. This conversion of fire-dependent open wetland to shrub- or tree-dominated systems typically results in significant reductions in diversity at the species and habitat levels. Regular prescribed fire management within open wetlands can help reduce native woody cover and invasive species and also promote high species diversity. As noted by the GLO surveyors, much of the region was dominated by barrens

or savanna ecosystems. In the absence of frequent fires, prairie and open oak savanna and barrens have converted to closed-canopy forests dominated by shade-tolerant native and invasive species. The conversion of oak savanna and prairie ecosystems to closed-canopy forest typically results in significant reductions in species and habitat diversity. Efforts to restore savanna, barrens, and prairie within Watkins Lake State Park will depend on the implementation of frequent prescribed fire. In addition, due to fire suppression, dry-mesic southern forests within Watkins Lake State Park are experiencing strong regeneration of thin-barked, shade-tolerant mesophytic trees and invasive shrubs and failure of oak to regenerate. Within dry-mesic forested ecosystems, a sustained, landscape-scale, fire-management program would reduce the density of shade-tolerant understory and help facilitate increased recruitment of fire-adapted native species.

We recommend the implementation of prescribed fire at a landscape-scale and the creation of large burn units (e.g., several hundred acres in size). We recommend that prescribed fire be prioritized for the high-quality prairie fen and immediately adjacent systems, especially those upland stands with barrens and savanna plants. Where rare herptiles are a management concern, burning strategies should include the use of multiple subunits managed on a rotational basis and allow for ample refugia to facilitate effective post-burn recolonization.

In general, prioritization of stewardship within Watkins Lake State Park should focus on the highest quality examples of the rarest natural community types and the largest sites. Biodiversity is most easily and effectively protected by preventing high-quality sites from degrading, and invasive plants are much easier to eradicate when they are not yet well established, and their local population size is small. Within Watkins Lake State Park, we recommend that stewardship efforts be focused in the areas of high-quality prairie fen since these wetlands harbor high levels of biodiversity and provide potential habitat for numerous rare plant and animal species. We recommend that the Marsh Brook West Fen be the highest priority for biodiversity stewardship within the park.

Marl flat within the Marsh Brook Fen. Photo by Joshua G. Cohen.

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Michigan Natural Features Inventory

Ecological Community Field Survey Form

MICHIGAN STATE UNIVERSITY EXTENSION

SURVEY INFORMATION

Survey date: _____ Time: from _____ to _____ Sourcecode: _____

Surveyors (principal surveyor first, include first & last name):

_____

Weather conditions: _____

Revisit needed? ☐ Yes ☐ No Why? ☐ Complete community survey ☐ Rare species survey ☐ Invasive plant survey ☐ Monitoring

FILING

Survey site: _____ Site name: _____

IDENTIFICATION (Identify community if known positively, or provide closest alliance/association if not known)

Community Name: _____ Overall Rank: _____ EOID: _____ EO #: _____

If classification problems, explain:

Photo/slide taken? ☐ Yes ☐ No Where has photo been deposited? _____

If associated plot, list project name, and reference #:

_____

LOCATIONAL INFORMATION

Township/Range/Section: _____ County: _____

DIRECTIONS: Provide detailed directions to the observation (rather than the survey site). Include landmarks, roads, towns, distances, compass directions.

Landowner type: ☐ Public ☐ Private ☐ Other: _____

Landowner Contact Information: _____

Notes: _____

Was a GPS used? ☐ Yes ☐ No Type of unit: _____ Unit number: _____

Waypoint name/#: _____ File name: _____

Latitude: _____ Longitude: _____

Feature Information (mandatory): _____ Source feature: ☐ Single Source EO ☐ Multiple Source EO

SIZE - Measure of the area of the Element at the observed location.

Observed area (unit): ☐ Acres ☐ Hectares Type of measurement: ☐ Precise ☐ Estimate

Basis for estimate: _____

SIZE RANK (comments): _____

CONFIDENCE EXTENT

Indicate whether there is confidence that the observed area represents the full extent of the community element at that location.
(Y = confidence that the full extent is known; N = confidence that the full extent is not known; ? = uncertainty whether full extent is known)

☐ Yes ☐ No ☐ ? _____

LANDSCAPE CONTEXT - An integrated measure of the quality of biotic and abiotic factors, structures and processes surrounding the observed area, and the degree to which they may affect the continued existence of the Element at that location. Component of landscape context for communities are: 1) landscape structure and extent, 2) condition of the surrounding landscape (i.e., community development/maturity, species composition and biological structure, ecological processes, and abiotic physical/chemical factors.) Factors to consider include integrity/fragmentation, stability/old growth, richness/distribution of species, presence of invasive species, presence of invasive species, degree of disturbance, changes to ecological processes, stability of substrate, and water quality.

SURROUNDING LAND USE AND LAND COVER:

Percent natural cover: ☐ >90% ☐ >75% ☐ >50% ☐ >25% ☐ <25% Road density: ☐ HIgh ☐ Medium ☐ Low

Check all that apply

Dominant land use:

- ☐ Natural cover
- ☐ Managed timber/forest
- ☐ Agriculture
- ☐ Mining
- ☐ Urban/suburban
- ☐ Other: _____

Dominant land cover:

- ☐ Upland forest
- ☐ Savanna/grassland
- ☐ Forested wetland
- ☐ Non-forested wetland
- ☐ Agriculture
- ☐ Urban
- ☐ Other: _____

1. Comment on the relative integrity/fragmentation of the surrounding landscape

2. List native plant communities in surrounding landscape

3. Comment on invasive plants present in surrounding area and describe resulting impacts

List disturbances (either natural or caused by humans) and ecological processes (e.g., hydrologic and fire regimes) in surrounding area

- ☐ Logging
- ☐ Grazing/browsing
- ☐ Agriculture
- ☐ Soil erosion
- ☐ Mining
- ☐ Dumping
- ☐ Trails/roads
- ☐ ORV/vehicular disturbance
- ☐ Hydrologic alteration (drainage, ditches, blocked culverts, etc.)
- ☐ Fire supression
- ☐ Other: _____
- ☐ Plant disease: _____
- ☐ Insect damage: _____
- ☐ Exotic animal activity: _____
- ☐ Herbivore impact (e.g., deer): _____
- ☐ Invasive plants: _____
- ☐ Wild fire
- ☐ Prescribed fire
- ☐ Windthrow
- ☐ Ice storm
- ☐ Ice scour
- ☐ Desiccation
- ☐ Flooding
- ☐ Beaver flooding
- ☐ Beaver chewed trees
- ☐ Other: _____

LANDSCAPE RANK (comments)**:**

CONDITION: ABIOTIC DATA

Geology

Igneous Rocks

- ☐ Granitic (Granite, Schyolite, Syenite, Trachyte)
- ☐ Dioritic (Diorite, Dacite, Andesite)
- ☐ Gabbroic (Gabbro, Basalt, Pyroxenite, Peridotite, Diabase, Traprock)
- ☐ Rhyolite
- ☐ Other: _____

Metamorphic Rocks

- ☐ Felsic Gneiss and Schist (Granitic)
- ☐ Mafic Gneiss and Schist
- ☐ Slate
- ☐ Quartzite
- ☐ Other: _____

Sedimentary Rocks

- ☐ Volcanic Conglomerates
- ☐ Breccias
- ☐ Sandstone
- ☐ Siltstone (calcareous or noncalcareous)
- ☐ Limestone and Dolomite
- ☐ Gypsum
- ☐ Shale
- ☐ Other: _____

Landform

Glacial

- ☐ Lake plain
- ☐ End or lateral moraine
- ☐ Ground moraine (till plain)

Ice Contact Feature

- ☐ Drumlin
- ☐ Esker
- ☐ Kame
- ☐ Kettle
- ☐ Lake bed
- ☐ Outwash channel

Outwash

- ☐ Outwash channel
- ☐ Outwash plain
- ☐ Pitted outwash
- ☐ Other: _____

River/Lakeshore

- ☐ Shoreline
- ☐ Sand dune
- ☐ Barrier dune
- ☐ Spit
- ☐ Offshore bar
- ☐ Riverine estuary
- ☐ Delta
- ☐ Stream bed
- ☐ Stream terrace
- ☐ Alluvial fan
- ☐ Alluvial flat
- ☐ Alluvial terrace
- ☐ Dike
- ☐ Other: _____

Aeolian

- ☐ Dunes
- ☐ Aeolian sand flats
- ☐ Other: _____

Other

- ☐ Cliff
- ☐ Ledge
- ☐ Lakeshore bedrock outcrop
- ☐ Ridgetop bedrock outcrop
- ☐ Inland level-to-sloping bedrock outcrop
- ☐ Ravine
- ☐ Seep
- ☐ Slide
- ☐ Talus
- ☐ Other: _____

Organic Soil Deposits:

Core One: GPS Point _____

	Depth	pH
☐ Fibirc Peat:		
☐ Hemic Peat:		
☐ Sapric Peat (muck):		
☐ Marl (depth):		
☐ Other (describe):		

Comments:

Core Two: GPS Point _____

	Depth	pH
☐ Fibirc Peat:		
☐ Hemic Peat:		
☐ Sapric Peat (muck):		
☐ Marl (depth):		
☐ Other (describe):		

Comments:

Core Three: GPS Point _____

	Depth	pH
☐ Fibirc Peat:		
☐ Hemic Peat:		
☐ Sapric Peat (muck):		
☐ Marl (depth):		
☐ Other (describe):		

Comments:

Mineral Soil Depth (average): _____

pH: _____

Surface Soil Texture (Upper 10 cm of soil profile)

- ☐ Sand
- ☐ Loamy sand
- ☐ Sandy loam
- ☐ Loam
- ☐ Silt loam
- ☐ Sandy Clay loam
- ☐ Clay loam
- ☐ Silty clay loam
- ☐ Sandy clay
- ☐ Clay
- ☐ Silty clay
- ☐ Other: _____

Soil Series: _____

Comments:

Wetland Mineral Soil Indicators:

- ☐ Gleyed soils (list soil texture and depth):

_____

- ☐ Iron mottling (list soil texture and depth):

_____

Depth to saturation: _____

Depth to water table: _____

Hydrologic Regime:

Wetlands:

- ☐ Intermittently flooded
- ☐ Permanently flooded
- ☐ Semipermanently flooded
- ☐ Temporarily flooded (e.g., floodplains)
- ☐ Seasonally flooded (e.g., seasonal ponds)
- ☐ Saturated (e.g., bogs, perennial seeps)
- ☐ Unknown

Non-Wetlands:

- ☐ Wet Mesic
- ☐ Mesic (moist)
- ☐ Dry-Mesic
- ☐ Xeric (dry)

Groundcover:
(with >5% cover, 20 m x 20 m area)

_____ % Bedrock
_____ % Wood (>1cm)
_____ % Litter, duff
_____ % Large rocks (cobbles, boulders >10 cm)
_____ % Small rocks (gravel, 0.2 - 10 cm)
_____ % Bare soil
_____ % Water
_____ % Other
100% (Total = 100%)

Light:

- ☐ Open
- ☐ Partial
- ☐ Filtered
- ☐ Shade

Cowardin System:

- ☐ Upland
- ☐ Riverine
- ☐ Lacustrine
- ☐ Palustrine

Slope:

Measured Slope: _____ ° _____ %

☐ Flat	0°	0%
☐ Gentle	0 - 5°	0 - 9%
☐ Moderate	6 - 14°	10 - 25%
☐ Somewhat steep	15 - 25°	26 - 49%
☐ Steep	26 - 45°	50 - 100%
☐ Very Steep	45 - 69°	101 - 275%
☐ Abrupt	70 - 100°	276 - 300%
☐ Overhanging/sheltered	> 100°	> 300%

Aspect (down slope):

Measured Aspect: _____ ° (N = 0°)

☐ Flat	
☐ Variable	
☐ N	338 - 22°
☐ NE	23 - 67°
☐ E	68 - 112°
☐ SE	113 - 157°
☐ S	158 - 202°
☐ SW	203 - 247°
☐ W	248 - 292°
☐ NW	293 - 337°

Topographic position:

- ☐ Ridge, summit, or crest
- ☐ High slope (upper slope, convex slope)
- ☐ Midslope (middle slope)
- ☐ Lowslope (lower slope, footslope)
- ☐ Toeslope (alluvial toeslope)
- ☐ Low level (terrace lakeplain, outwash plan, lake bed, etc)
- ☐ Channel
- ☐ Other: _____

Soil Type - Describe soil profile, pH, and method of assessment

CONDITION: VEGETATIVE FIELD DATA FOR THE ELEMENT

DBH (indicate cm or inches) of several dominant tree species, include age in years of cored trees:

Species	DBH(AGE)	DBH(AGE)	DBH(AGE)	DBH(AGE)	DBH(AGE)	DBH(AGE)

Density:

	Tree canopy	Shrub layer	Herb layer
Closed			
Open			
Patchy			
Sparse			
Absent			

Appendix 1. Ecology Community Field Survey Form (continued)

Complete one or more of the quantitative vegetation data boxes below. If completing only box indicate whether data represents a synthesis of overall community or community is relatively homogeneous throughout.

QUANTITATIVE VEGETATION DATA FOR THE ELEMENT

Method used (e.g., ocular estimation, quantitative transect, fixed plot, prism plot): _____

Sample Point 1: _____ GPS Point: _____

STRATA	COVER CLASS	DOMINANT SPECIES in order to relative importance (>> much greater than, > greater than, and =)
T2 - Tree Canopy		
T3 - Subcanopy		
S1 - Tall Shrub		
S2 - Low Shrub		
G - Ground cover		
N - Nonvascular		
V - Woody Vine		

Cover Class *

1	trace
2	0.1 - 1%
3	1 - 2%
4	2 - 5%
5	5 - 10%
6	10 - 25%
7	25 - 50%
8	50 - 75%
9	75 - 95%
10	> 95%

Sample Point 2: _____ GPS Point: _____

STRATA	COVER CLASS	DOMINANT SPECIES in order to relative importance (>> much greater than, > greater than, and =)
T2 - Tree Canopy		
T3 - Subcanopy		
S1 - Tall Shrub		
S2 - Low Shrub		
G - Ground cover		
N - Nonvascular		
V - Woody Vine		

Cover Class *

1	trace
2	0.1 - 1%
3	1 - 2%
4	2 - 5%
5	5 - 10%
6	10 - 25%
7	25 - 50%
8	50 - 75%
9	75 - 95%
10	> 95%

Sample Point 3: _____ GPS Point: _____

STRATA	COVER CLASS	DOMINANT SPECIES in order to relative importance (>> much greater than, > greater than, and =)
T2 - Tree Canopy		
T3 - Subcanopy		
S1 - Tall Shrub		
S2 - Low Shrub		
G - Ground cover		
N - Nonvascular		
V - Woody Vine		

Cover Class *

1	trace
2	0.1 - 1%
3	1 - 2%
4	2 - 5%
5	5 - 10%
6	10 - 25%
7	25 - 50%
8	50 - 75%
9	75 - 95%
10	> 95%

Sample Point 4: _____ GPS Point: _____

STRATA	COVER CLASS	DOMINANT SPECIES in order to relative importance (>> much greater than, > greater than, and =)
T2 - Tree Canopy		
T3 - Subcanopy		
S1 - Tall Shrub		
S2 - Low Shrub		
G - Ground cover		
N - Nonvascular		
V - Woody Vine		

Cover Class *

1	trace
2	0.1 - 1%
3	1 - 2%
4	2 - 5%
5	5 - 10%
6	10 - 25%
7	25 - 50%
8	50 - 75%
9	75 - 95%
10	> 95%

CONDITION - An integrated measure of the quality of biotic and abiotic factors, structures and processes within the observed area, and the degree to which they may affect the continued existence of the Element a that location. Factors to consider include evidence of stability/presence of old growth, richness/distirbution of species, presence of invasive species, degree of disturbance, changes to ecological processes, stability of substrate and water quality.

1. Species composition:

2. Community structure:

3. Ecological processes:

Natural and Anthropogenic Disturbance: information on disturbances(s) (either natural or caused by humans)

- ☐ Logging
- ☐ Grazing/browsing
- ☐ Agriculture
- ☐ Soil erosion
- ☐ Mining
- ☐ Dumping
- ☐ Trails/roads
- ☐ ORV/vehicular disturbance
- ☐ Hydrologic alteration (drainage, ditches, blocked culverts, etc.)
- ☐ Fire supression
- ☐ Other: _____

- ☐ Plant disease: _____
- ☐ Insect damage: _____
- ☐ Exotic animal activity: _____
- ☐ Herbivore impact (e.g., deer): _____
- ☐ Invasive plants: _____

- ☐ Wild fire
- ☐ Prescribed fire
- ☐ Windthrow
- ☐ Ice storm
- ☐ Ice scour
- ☐ Desiccation
- ☐ Flooding
- ☐ Beaver flooding
- ☐ Beaver chewed trees
- ☐ Other: _____

Comment on disturbance(s) and changes to ecological processes (e.g., hydrologic and fire regimes) within in observed area:

Comment on invasives present within the observed area and describe resulting impacts:

CONDITION RANK (comments):

MANAGEMENT CONSIDERATIONS

Threats (e.g., fire suppression, invasive species, ORVs, hydrologic alteration, logging, high deer densities etc.)

Management (stewardship and restoration), **Monitoring and Research Needs** for the Element at this location (e.g., burn periodically, open the canopy, control invasives, ban ORV's, remove drainage ditches, clear blocked culvert, break drain tile, reduce deer densities, study effects of herbivore impacts)

Protection Needs for the Element at this location (e.g., protect the entire marsh, the slope and crest of slope)

SUMMARY OF ELEMENT OCCURRENCE

General Description of the Element: Provide a brief "word picture" of the community focusing on abiotic and biotic factors. Describe the landforms, geological formations, soils/substrates, topography, slope, aspect, hydrology, aquatic features, vegetative layers, significant species etc.

Description of the Vegetation: Describe variation within the observed area in terms of vegetation structure and environment. Describe dominant and characteristic species and any inclusion communities. If a mosaic, describe spatial distribution and associated community types.

OVERALL RANK (comments):

Appendix 1. Ecology Community Field Survey Form (continued)

SPECIES LIST

Group and record species for each relevant strata (e.g., Overstory, Sub-canopy, Tall Shrub, Low Shrub, Ground Cover).
For each species, include abundance rank: **D = dominant A = abundant C = common O = occasional U = uncommon R = scarce L = local (modifier)**

Appendix 1. Ecology Community Field Survey Form (continued)

Sketch the most descriptive cross-section through the natural community, depicting the topography, vegetative structure and composition:

Appendix 1. Ecology Community Field Survey Form (continued)

GPS WAYPOINTS AND DESCRIPTIONS

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Appendix 2. Threat Assessment Form

Threat	Severity	Scope	Reversibility	Threat Score	Comments
Invasive Species					
Fire Suppression					
Deer Herbivory					
ORV Activity					
Hydrologic Alteration					
Infrastructure/ Trail Development					
Water Quality/ Contamination					
Invasive Plant #1:					
Invasive Plant #2:					
Invasive Plant #3:					
Invasive Plant #4:					
Invasive Plant #5:					

Rank each observed threat in terms of **Severity**, **Scope**, and **Reversibility** on a scale of 1 to 5.
Severity is the level of damage to the site and a score of 1 means the site is slightly damaged and a score of 5 means the site has been extensively damaged.
Scope is the geographic extent of impact and a score of 1 means the threat occupies a trace area within the site and a score of 5 means the threat is ubiquitous.
Reversibility is the probability of controlling the threat and reversing the damage and a score of 1 means the threat can be easily controlled and a score of 5 means the threat is unlikely to be controlled.
Threat Score is a sum of the rankings for **Severity**, **Scope**, and **Reversibility**.

Severity:

5: Without action, the community will likely be destroyed or eliminated (beyond restoration) within 10-15 years

4: Without action, the community will likely be seriously degraded (potentially lowered by 1 EO Rank) within 10-15 years

3: Without action, the community will likely be moderately degraded (potentially lowered by 1/2 EO Rank) within 10-15 years

2: Without action, the community will likely be slightly impaired by this threat within 10-15 years

1: Without action, the community may be slightly impaired by this threat within 15+ years

0: No threat

Scope:

5: Threat impacts the entire community EO (90%+)

4: Threat impacts large portions of the community EO (roughly 50-89%)

3: Threat impacts moderate portions of the community EO (roughly 15-49%)

2: Threat impacts localized portions of the community EO (roughly 5-14%, possibly in several scattered small patches)

1: Threat impacts only one small patch within or on the edge of the community EO, or is currently outside EO in the vicinity but likely to impact EO within the next 10 years

0: No threat

Reversibility:

5: Threat is not reversible (e.g., parking lot/paving)

4: Threat is reversible but not practically affordable without major investment of $ and time (potentially hundreds of thousands of dollars or full time staff effort)

3: Threat is reversible but moderately difficult and requires a fair investment of $ and/or time (potentially tens of thousands of dollars or 2+ weeks of staff time/year)

2: Threat is reversible at relatively low cost (potentially several days of staff time/year or up to a few thousand dollars)

1: Threat is easily reversible with only a few hours of effort (potentially annually) by a small group of people such as volunteers or state workers

0: No threat

Appendix 3. Rare Herptile Survey Form.

STATE LANDS INVENTORY SPECIAL ANIMAL SURVEY FORM - HERPS

I. LOCATION INFORMATION

Site Name _____ Stand Number(s)_____ Date_____

Observer(s)_____ Stand classifications_____

Quad_____County_____ Town, Range, Sec_____

Directions/access _____

_____

GPS Unit Type & #: _____ GPS Waypoint(s): _____ GPS Track(s): _____

II. SURVEY INFORMATION

Time Start _____ Time End _____ Weather: Air Temp – Start_____End _____ RH – Start_____ End_____

Sky Code – Start _____ End _____ Wind Code - Start _____ End _____ Precip Code - Start_____ End _____

Target species/group & survey method_____

Target/rare species found? Yes No Comments: _____

Habitat for target species/group found? Yes No Comments: _____

Species found (common or rare)	Number	Location (GPS, landmarks)	Notes (habitat, behavior, condition, etc.)

Survey comments (area surveyed, potential for other rare species, revisit warranted, photos taken? etc.)

_____

_____

_____

III. GENERAL SITE DESCRIPTION (describe in relation to species surveyed for – presence, quantity, and quality of appropriate habitat, crayfish burrows, hostplants/nectar sources, dominant vegetation, natural communities, habitat structure, etc.)

_____

_____

_____

_____

IV. MANAGEMENT CONSIDERATIONS

Threats (e.g., ORV's, excessive mt. bike use, grazing, structures, past logging, plantations, development, erosion, ag, runoff, hydrologic alteration, etc.) _____

_____

Exotic species (plants or animals)_____

_____

Stewardship Comments _____

_____

01/05/2016

Appendix 3. Rare Herptile Survey Form (continued).

V. LISTED ANIMAL OR PLANT SPECIES or COMMUNITY EOS _____

_____

_____

VI. ADDITIONAL ASSOCIATED SPECIES FOUND

Species found (common or rare)	Number	Location (GPS, landmarks)	Notes (habitat, behavior, condition, etc.)

VII. Map/drawing of general area surveyed and approximate locations of suitable habitat and/or rare species found

Wind Codes (Beaufort wind scale):

0 = Calm (< 1 mph) smoke rises vertically

1 = Light air (1-3 mph) smoke drifts, weather vane inactive

2 = Light breeze (4-7 mph) leaves rustle, can feel wind on face

3 = Gentle breeze (8-12 mph) leaves and twigs move, small flag extends

4 = Moderate breeze (13-18 mph) moves small tree branches, twigs & leaves, raises loose paper

5 = Strong breeze (19-24 mph) small trees sway, branches move, dust blows

6 = Windy (> 24 mph) larger tree branches move, whistling

Precipitation Codes:

0 = None

1 = Mist

2 = Light rain or drizzle

3 = Heavy rain

4 = Snow/hail

Sky Codes:

0 = Sunny/clear to few clouds (0-5%)

1 = Mostly sunny (5-25% cloud cover)

2 = Partly cloudy, mixed variable sky (25-50%)

3 = Mostly cloudy (50-75%)

4 = Overcast (75-100%)

5 = Fog or haze

01/05/2016

Appendix 4. Global and State Element Ranking Criteria

GLOBAL RANKS

G1 = critically imperiled: at very high risk of extinction due to extreme rarity (often 5 or fewer occurrences), very steep declines, or other factors.

G2 = imperiled: at high risk of extinction due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors.

G3 = vulnerable: at moderate risk of extinction due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors.

G4 = apparently secure: uncommon but not rare; some cause for long-term concern due to declines or other factors.

G5 = secure: common; widespread.

GU = currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

GX = eliminated: eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.

G? = incomplete data.

STATE RANKS

S1 = critically imperiled in the state because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state.

S2 = imperiled in the state because of rarity due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the state.

S3 = vulnerable in the state due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.

S4 = uncommon but not rare; some cause for long-term concern due to declines or other factors.

S5 = common and widespread in the state.

SX = community is presumed to be extirpated from the state. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.

S? = incomplete data.