Natural Features Inventory and Management Recommendations for Barry State Game Area

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Cover Photo: Dry-mesic Southern Forest in Barry State Game Area. Photo by Michael A. Kost.

EXECUTIVE SUMMARY

Barry State Game Area (SGA) is one of the largest continuous blocks of public land in southwest lower Michigan, consisting of approximately 16,755 acres. In conjunction with adjacent Yankee Springs State Recreation Area, these two adjoining properties total more than 22,000 acres. Barry SGA provides critical habitat for a myriad of game and non-game species and supports over 1,500 acres of high-quality natural communities. The Barry SGA contains over 10,000 acres of forest and close to 800 acres of high-quality forest. Because the landscape surrounding Barry SGA is dominated by agriculture and rural development, the large area of forest within the game area serves as an important island of biodiversity for the local region, especially for interior-forest obligates. In addition, the numerous and diverse high-quality wetlands within the game area support an array of rare insects, herptiles, and birds. Barry SGA functions as a biodiversity "hotspot", especially for herptile species, and its numerous headwater streams and creeks function as high-quality aquatic habitat for numerous aquatic species.

Michigan Natural Features Inventory (MNFI) conducted Integrated Forest Monitoring, Assessment, and Prescription System (IFMAP) Stage 1 inventory and surveys for high-quality natural communities and rare animal species in Barry SGA as part of the Integrated Inventory Project for the Michigan Department of Natural Resources Wildlife Division. Surveys resulted in 45 new element occurrences (EOs) and provided information for updating an additional 30 EOs. In all, 50 species of greatest conservation need (SGCN) and 34 rare animal species have been recorded in Barry SGA with 29 SGCN and 14 rare animal species documented during the course of this project. In total, 130 EOs have been documented in Barry SGA including 60 animal EOs, 32 plant EOs, and 38 natural community EOs.

Surveys for exemplary natural communities relied on information collected during IFMAP Stage 1 inventories to help target the locations of potential new natural community Element Occurrences (EOs). Barry SGA supports 38 high-quality natural community EOs that include 13 different natural community types. During the summer of 2012, MNFI ecologists documented 23 new high-quality natural communities and also updated ten known high-quality community EOs. A total of 12 different natural communities were surveyed in 2013 including: bog (2 EOs), coastal plain marsh (1 EO), dry southern forest (1 EO), dry-mesic northern forest (2 EOs), dry-mesic southern forest (10 EOs), intermittent wetland (3 EOs), poor fen (1 EO), prairie fen (6 EOs), rich tamarack swamp (1 EO), southern wet meadow (3 EOs), submergent marsh (2 EOs), and wet prairie (1 EO). We assessed the current ranking, classification, and delineation of these occurrences and detailed the vegetative structure and composition, ecological boundaries, landscape and abiotic context, threats, management needs, and restoration opportunities. The report provides detailed descriptions of each site as well as a comprehensive discussion of site-specific threats and stewardship needs and opportunities.

The site descriptions for natural community EOs include discussion of rare plant populations documented within the high-quality natural communities. During the course of this project, we documented four new rare plant EOs and gathered information to update ten previously documented rare plant EOs. Newly documented rare plant species included three records for ginseng (*Panax quinquefolius*, state threatened) and one record for false boneset (*Kuhnia eupatorioides*, state special concern). Updates were processed for the following rare plant EOs: leadplant (*Amorpha canescens*, state special concern), tuberous Indian plantain (*Arnoglossum plantagineum*, state special concern), black-fruited spike-rush (*Eleocharis melanocarpa*, state special concern), upland boneset (*Eupatorium sessilifolium*, state threatened), goldenseal (*Hydrastis canadensis*, state threatened), northern bayberry (*Myrica pensylvanica*, state threatened), ginseng, tall beak-rush (*Rhynchospora macrostachya*, state special concern), and bald-rush (*Rhynchospora scirpoides*, state threatened). In total, 32 rare plant element occurrences of 18 different species have been recorded within Barry SGA.

Surveys for rare avian species included point-counts for forest songbirds and meander surveys for rare wetland birds. These surveys resulted in two new EOs and three updated records. We conducted morning surveys for rare songbirds at 49 point-count locations within forest and confirmed the occurrence of cerulean warbler (*Dendroica cerulea*, state threatened) and hooded warbler (*Setophaga citrina*, state special concern). In addition, point-count surveys resulted in documentation of eight additional SGCN: black-billed cuckoo (*Coccyzus erythropthalmus*), Acadian flycatcher (*Empidonax virescens*), eastern towhee (*Pipilo erythropthalmus*), northern flicker (*Colaptes auratus*), wood thrush (*Hylocichla mustelina*), red-headed woodpecker (*Melanerpes erythrocephalus*), worm-eating warbler (*Helmitheros vermivorum*), and yellow-billed cuckoo (*Coccyzus americanus*). During surveys for rare wetland birds, we documented new EOs for osprey (*Pandion haliaetus*, state special concern) and marsh wren (*Cistothorus palustris*, state special concern) and updated a common loon (*Gavia immer*, state threatened) occurrence. In addition to these three SGCN, we also observed an additional SGCN, Virginia rail (*Rallus limicola*). Including the rare bird species mentioned above, a total of 16 avian SGCN have been documented in Barry SGA, with 13 being recorded during the 2013 breeding season. In addition, eight rare bird species have been documented in the game area with five rare bird species being recorded during the 2013 breeding season.

We conducted visual encounter or meander surveys, basking turtle surveys, and breeding frog call surveys for rare amphibians and reptiles. Surveys and incidental observations by MNFI staff resulted in six updated records but no new element occurrences. Breeding call surveys reconfirmed three previously documented EOs of Blanchard's cricket frog (*Acris blanchardi*, state threatened). Visual encounter surveys in 2013 documented eastern box turtles (*Terrapene carolina carolina*, state special concern) at three different sites and one eastern massasauga (*Sisturus catenatus*, state special concern and federal candidate). In addition, MNFI staff found seven eastern box turtles and three Blanding's turtles (*Emydoidea blandingii*, state special concern) incidentally in the summers of 2010 and 2013. Herptile surveys resulted in the documentation of four additional SGCN: pickerel frog (*Lithobates palustris*), northern leopard frog (*Lithobates pipiens*), eastern hog-nosed snake (*Heterodon platirhinos*), and blue racer (*Coluber constrictor foxii*). Including the rare herptile species mentioned above, a total of 11 amphibian and reptile SGCN have been documented in the Barry SGA, with eight being recorded during this project. In addition, six rare herptile species have been documented in the game area with five rare herptile species being recorded since 2010 by MNFI staff.

Surveys for rare insects consisted of sweep netting, visual meander surveys, and nighttime blacklighting. These surveys resulted in two new EOs and three updated records. We documented one new record for pine tree cricket (*Oecanthus pini*, state special concern) and updated an existing tamarack tree cricket (*Oecanthus laricis*, state special concern) record. Blacklighting surveys resulted in one new record for regal fern borer (*Papaipema speciosissima*, state special concern) and the update of two records for angular spittlebugs (*Lepyronia angulifera*, state special concern). Including these rare insect species, a total of 16 rare insects (all are SGCN) have been documented in the Barry SGA, with four rare insect species being recorded during this project.

We performed surveys for unionid mussels at 11 sites in Glass Creek, a tributary of Glass Creek, Basset Lake, Basset Creek, and Hill Creek. Seven of the 46 mussel species known to occur in Michigan were found in this survey. Results included documenting four new EOs including two slippershell (*Alasmidonta viridis*, state threatened) EOs and two ellipse (*Venustaconcha ellipsiformis*, state special concern) EOs. Including slippershell and ellipse, four rare aquatic species (all SGCN) have been documented in the Barry SGA: the two non-listed mussel SGCN documented were cylindrical papershell (*Anodontoides ferussacianus*) and creek heelsplitter (*Lasmigona compressa*).

Primary stewardship recommendations for the Barry SGA include: 1) invasive species control focused in high-quality natural areas especially wetland ecosystems, 2) the use of landscape-scale prescribed fire with rotating non-fire refugia where fire-sensitive rare species occur, 3) the maintenance of the canopy closure of mature forest ecosystems, 4) the reduction of fragmentation across the game area but focused in the vicinity of high-quality natural communities and along riparian corridors, 5) the opportunistic restoration of oak savanna ecosystems, 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

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Dry-mesic southern forest, Barry State Game Area. Photo by Michael A. Kost.

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INTRODUCTION

Barry State Game Area (SGA) is important ecologically because it is one of the largest continuous blocks of public land in southwest lower Michigan, consisting of approximately 16,755 acres. In conjunction with adjacent Yankee Springs State Recreation Area (SRA), these two adjoining Michigan Department of Natural Resources' (DNR) properties total more than 22,000 acres. Barry SGA provides critical habitat for a myriad of game and non-game species and supports over 10,000 acres of forest. Because the landscape surrounding Barry SGA is dominated by agriculture, the large area of forest within the game area serves as an important island of biodiversity for the local region (Figure 1). In addition, the numerous and diverse high-quality wetlands and lakes within the game area support a wide array of rare insects, herptiles, avian, plant, and aquatic species. Numerous high-quality headwater streams and creeks pass through the game area and provide critical habitat for a diverse array of aquatic species. Prior to this project, numerous rare species and high-quality natural communities had been documented in Barry SGA (Tables 1-6). Before 2010, 75 element occurrences (EOs) had been documented for Barry SGA composed of 55 rare species occurrences and 15 high-quality natural communities. Of those rare species occurrences, three were aquatic EOs, 25 were insect EOs, 17 were herptile EOs, 7 were bird EOs, and 28 were plant EOs. Forty-five species were represented by these occurrences and seven natural community types were represented in these 15 natural community EOs (Tables 1-6).

From 2010 to 2013, Michigan Natural Features Inventory (MNFI) conducted Integrated Forest Monitoring, Assessment, and Prescription System (IFMAP) Stage 1 inventory and surveys for additional exemplary natural communities and rare animals in Barry SGA as part of the Integrated Inventory Project. This project is part of a long-term effort by the Michigan DNR Wildlife Division 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 Barry SGA, summarizes the findings of MNFI's surveys of Barry SGA for high-quality natural communities and rare animal species, and discusses stewardship needs, opportunities, and priorities within the game area. Specific management recommendations are provided for rare species and groups of rare species and also for each natural community EO found within the game area. In addition, to species-based and site-based stewardship discussion, general management recommendations for the game area 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**. Barry SGA lies within the Kalamazoo Interlobate subsection (Subsection VI.2), and within two sub-subsections, the Battle Creek Outwash Plain (Sub-subsection VI.2.1) and the Cassopolis Ice-Contact Ridges (Sub-subsection VI.2.2). Approximately the northwestern quarter of the game area occurs in the Battle Creek Outwash Plain (approximately Compartment 1) and the remainder of the game area (approximately Compartments 2-7) occurs in the Cassopolis Ice-Contact Ridges (Figure 2).

Kalamazoo Interlobate

The Kalamazoo Interlobate subsection is the southern portion of an interlobate area between three glacial lobes, which formed approximately 13,000 to 16,000 years ago. Glacial end moraines, ice-contact ridges, and outwash plains that characterize this area are the result of contact between these three glacial lobes. The entire interlobate is more than 150 miles long and the flat plain within the region was the northernmost extension of the "Prairie Peninsula", as described by Transeau (1935). Kettle lakes, kettle depressions, and streams are numerous throughout the subsection. The subsection is entirely underlain by Mississippian (Paleozoic) shale (Dorr and Eschman 1984, Milstein 1987) of variable depth with prevalent soils including sands and sandy loams. The Kalamazoo Interlobate is one of the warmest subsections in the state. The average growing season ranges from approximately 140 days at the north edge of the subsection to more than 160 days in the southwest (Eichenlaub et al. 1990). Average annual precipitation ranges from 32 inches in the north to 38 inches in the southwest. During the relatively long growing season, most precipitation is associated with passing cold fronts and showers caused by air mass instability. The winters are mild and average snowfall ranges from 50 inches in the east to more than 60 inches in the southwest near Lake Michigan. The western portion of this subsection, which encompasses Barry SGA, receives considerable lake-effect snows. Extreme minimum temperature ranges from -22.5 °F in the south to -30.5 °F

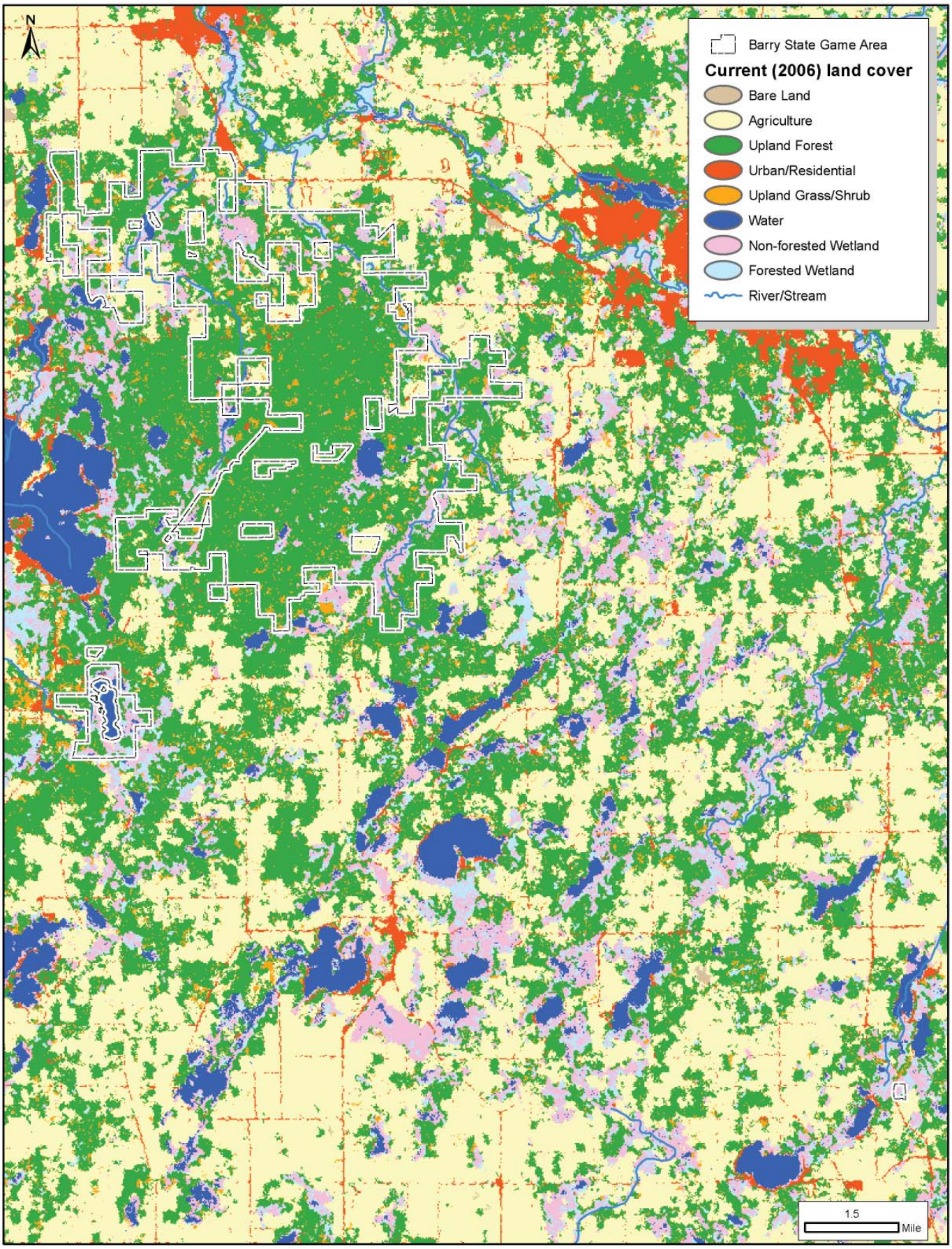


Figure 1. Current land cover of Barry State Game Area (NOAA 2008).

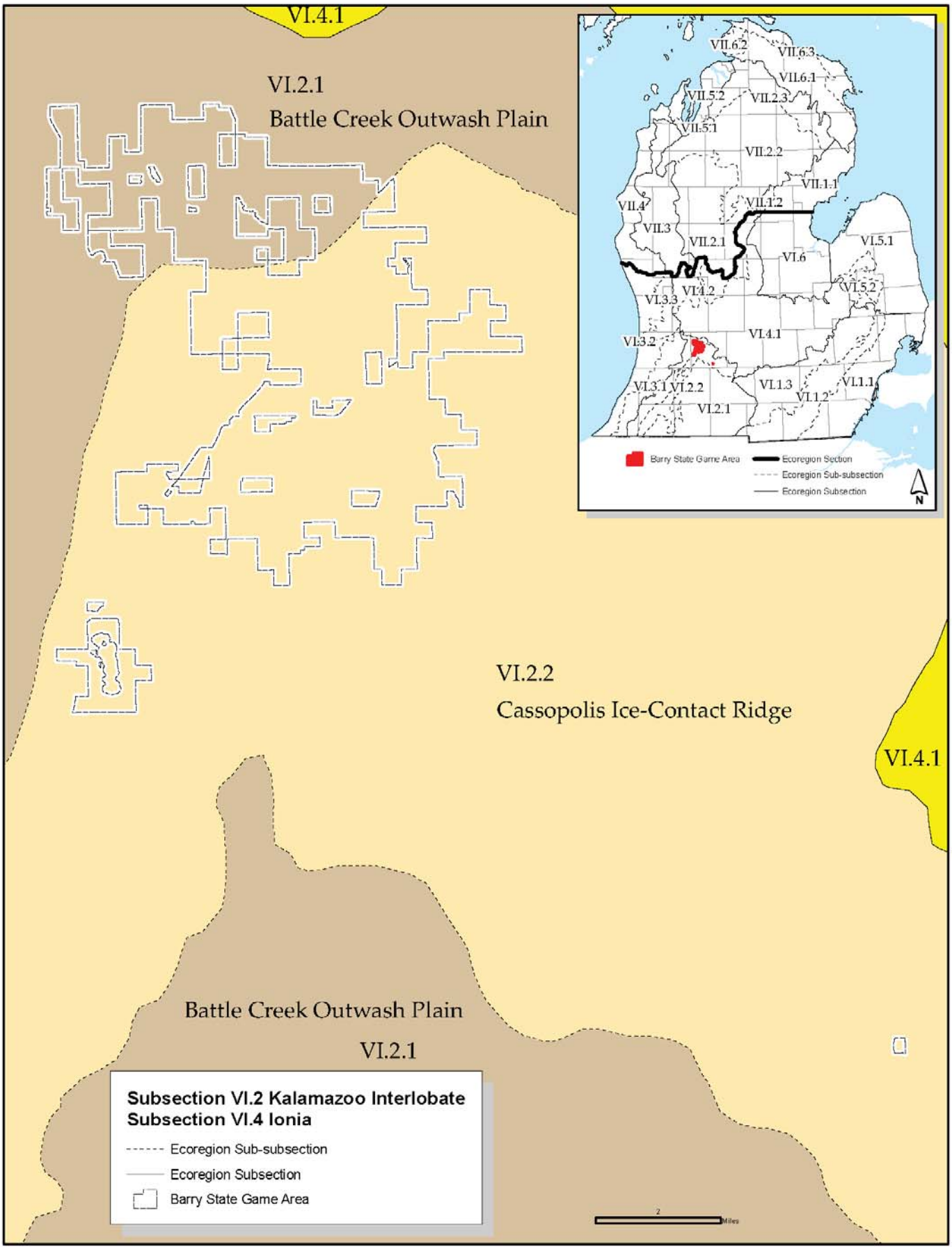


Figure 2. Ecoregions of Barry State Game Area (Albert 1995)

in the extreme north. Prevalent vegetation types within this region historically included oak savanna, oak-hickory forest, prairie (including upland and palustrine types), swamp forest, and prairie fen. Due to fire suppression, agriculture, and residential development, much of the prairie and savanna have been eliminated or degraded. Remaining natural cover within this subsection is primarily oak-dominated forest (Albert 1995).

Battle Creek Outwash Plain

The Battle Creek Outwash Plain (VI.2.1) is a broad, flat outwash plain containing numerous small lakes and wetlands and small ridges of ground moraine (Figure 3). Portions of the outwash are excessively drained and fire prone, while other areas are poorly drained, with numerous kettle lakes and wetlands. Numerous streams and headwater streams occur within this region. Outwash deposits of sand and gravel cover more than half of the sub-subsection. Soils are primarily well drained sands and loamy sands and less frequently sandy loams. Poorly drained mineral and organic soils are concentrated in the narrow outwash channels and in the kettle depressions. More than 80% of the outwash plain is in the 0 to 6% slope class. Small areas of ground moraine and even end moraine are scattered throughout the outwash plain but are concentrated in the southeastern portion of the sub-subsection. Historically the areas of well-drained outwash plain supported fire-dependent tallgrass prairie and oak savanna. Islands of ground moraine supported savanna and oak woodland and steeper end moraines supported oak woodland and oak forest. Areas of poorly drained outwash plain, outwash channels, and kettle depressions supported swamp forest, wet prairie, prairie fen, and wet meadow. Today the majority of the prairie and savanna systems have been eliminated due to fire suppression and agricultural conversion and forests and wetlands persist locally, typically in areas with excessive or poor drainage (Albert 1995).

Cassopolis Ice-Contact Ridges

The Cassopolis Ice-Contact Ridges (VI.2.2) consists of steep, narrow bands of end-moraine and ice-contact ridges (Figure 3). The ridges are broken periodically by outwash channels. The height of the ridges ranges from 50 to 200 feet and the glacial drift is 250 to 350 feet thick (Akers 1938). Kettle lakes and depressions are common, as are linear lakes and wetlands that occupy abandoned drainageways or glacial meltwater streams. Many of the smaller kettles are now occupied by bogs or shrub or forested wetlands. Many streams originate near the margins of the sub-subsection associated with seepage areas and prairie fens. The soils are characterized by well drained loamy and gravelly sands in the uplands and poorly drained organic soils in the kettle depressions and drainageways. Historically the steep ridges were dominated by oak-hickory forest with white pine (*Pinus strobus*) a common co-dominant in the northern third of the sub-subsection. Oak savanna occurred locally on some south and west aspects and on some of the more gently sloping ridges. Kettle depressions and drainageways supported bogs, shrub swamps, and forested wetlands. Although many of the steep ridges were cleared for crops or grazed by livestock, many of the farms failed and much of the sub-subsection has converted back to forest with some portions never having been cleared. Oak-hickory forest remains the prevalent forest type and many of the kettle wetlands persist. White pine-oak forests occur locally. In addition, the margins of the sub-subsection still support many prairie fens, although these wetlands have been degraded by fire suppression and invasive species encroachment (Albert 1995).

Circa 1800s Vegetation

Interpretations of the General Land Office (GLO) surveyor notes by MNFI ecologists indicated that the Barry SGA 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 Barry SGA. Areas of steep end moraine and ice-contact ridges supported oak-hickory forest and mixed oak forest, the two most prevalent cover types within the game area (covering 42% and 21% of the game area at the time of the GLO survey, respectively). These forests were described by the surveyors as “oak timber (with) no undergrowth”, “timbered thinly with oaks, gently rolling”, and “no undergrowth, thinly timbered”. Ground fires likely maintained the open understory conditions noted by the surveyors. These fires were likely both natural wildfires ignited by lightning strike and also intentionally set by Native Americans. Numerous “Indian trails” were noted by the surveyors throughout the area and several Native American encampments or “wigwams” were observed. Abundant tree species recorded in this area by the GLO surveyors in the uplands classified as oak-hickory forest (White Oak, Black Oak, Hickory Forest) and mixed oak forest (Black Oak, White Oak Forest) included white oak (*Quercus alba*), black oak (*Q. velutina*), and chinquapin oak (*Q. muehlenbergii*). Less frequently recorded trees were hickories (*Carya* spp.), basswood (*Tilia americana*), American beech (*Fagus grandifolia*), aspen (*Populus* sp.), paper birch (*Betula papyrifera*), and American elm (*Ulmus americana*). One small polygon of Beech-Sugar Maple Forest was recorded in the southeast portion of the game area (in Compartment 5) and was dominated by sugar maple (*Acer saccharum*), white oak, beech, and black oak. Within the forested areas, recorded diameters of canopy white oak, the most prevalent canopy tree, ranged from 10 to 81 cm with an average of 28 cm (N = 291). Recorded diameters of all canopy species also range from 10 to 81 cm with an average of 29 cm (N = 381).

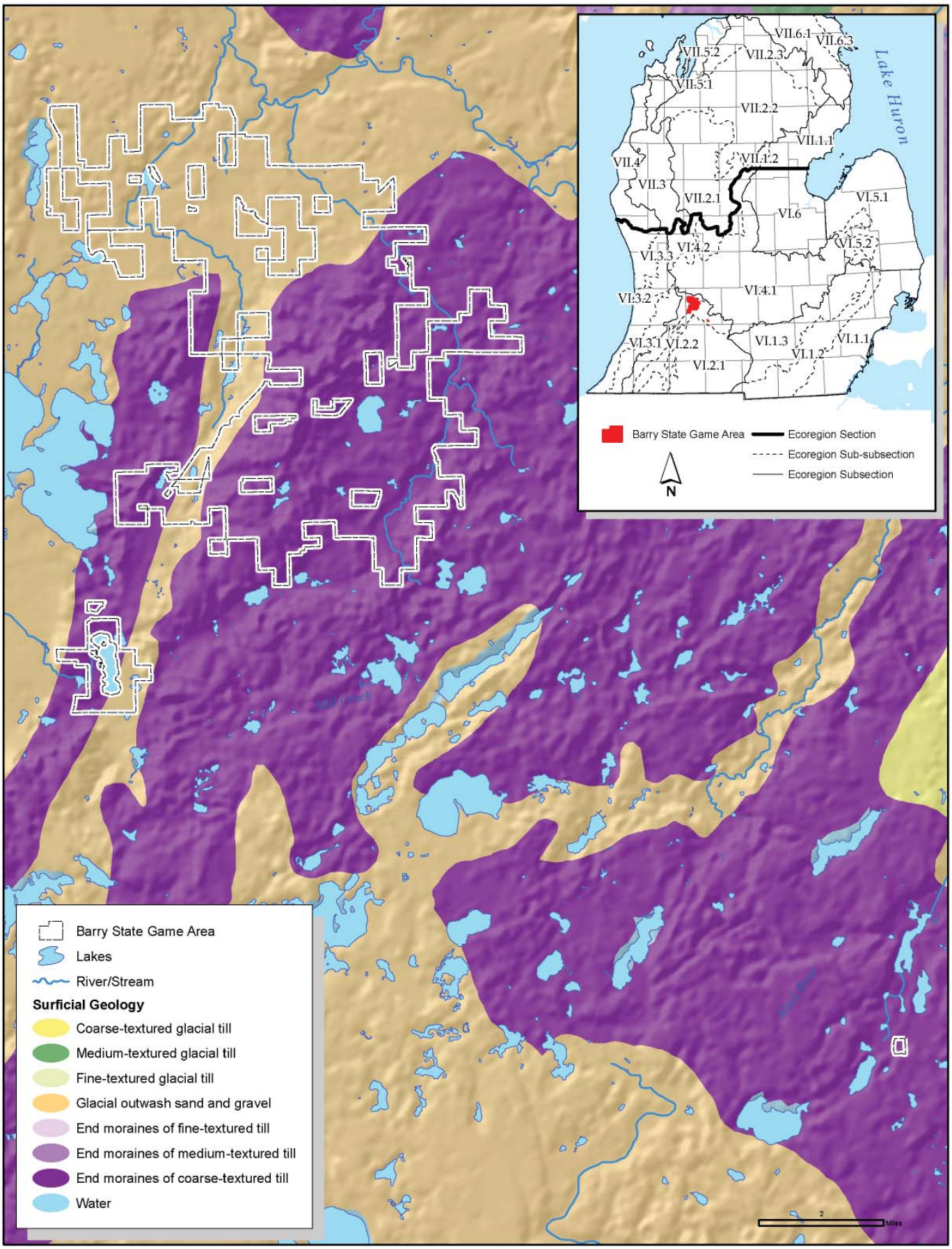


Figure 3. Surficial geology and relief of Barry State Game Area (Farrand and Bell 1982, USGS 2009).

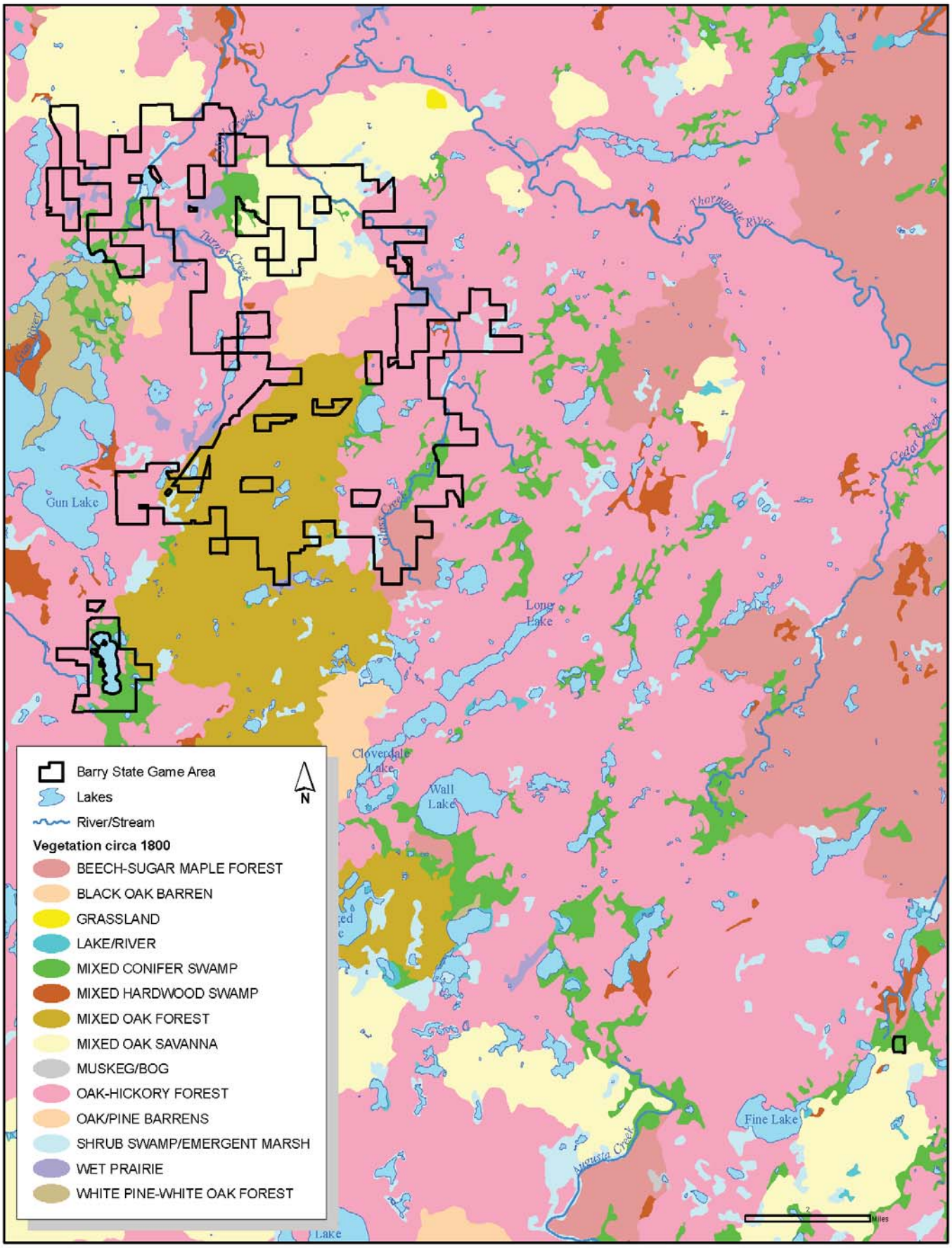


Figure 4. Circa 1800 vegetation of Barry State Game Area (Comer et al. 1995).

Oak savanna was common on areas of well-drained outwash and gently sloping moraine and localized on slopes with southern and western aspects. At the time of the GLO survey, oak savanna (Oak Openings) occurred on approximately 12% of the game area and drier oak barrens occurred on approximately 8% of the game are. Repeated low-intensity fires, working in concert with drought and windthrow, maintained open conditions in these oak savanna 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). As noted above, these fires were caused naturally by lightning strike and also set intentionally by indigenous peoples. Within southwestern Michigan, Native Americans probably played a significant role in maintaining savanna conditions through their use of fire as a land management tool (Cronon 1983, MacLeigh 1994). Indian trails and encampments were noted throughout the areas identified by the GLO surveyors as oak savanna and oak barrens. These open, fire-dependent oak ecosystems were primarily found in the northern portion of the game area (in portions of Compartments 1, 2, and 4) within the Battle Creek Outwash Plain and along the margin of the Cassopolis Ice-Contact Ridges (Figure 4). Along the interface of these two sub-subsections, fires from the Battle Creek Outwash Plain likely spread into the adjacent morainal and ice-contact features of the Cassopolis Ice-Contact Ridges. Fire disturbance generated dynamic natural community patterns with oak savanna, oak woodland, and oak forest shifting across the landscape depending on fire frequency and severity. The GLO surveyors described these areas mapped as oak savanna as "Oak openings (with) no understory" and "thinly timbered". Small pockets of grassland and "dry prairie" were also noted in this area. Scattered canopy trees recorded in areas of Oak Openings included white oak, black oak, chinquapin oak, and bur oak (*Quercus macrocarpa*). Drier Oak Barrens were characterized by white oak, black oak, and chinquapin oak. A small oak-pine barrens was observed just west of the game area with scattered canopy trees including white pine (*Pinus strobus*), white oak, and black oak. Interestingly, this was the only area where the surveyors recorded white pine within Barry SGA. Within the savanna areas, recorded diameters of canopy trees ranged from 10 to 79 cm with an average of 33 cm (N = 88). The larger size of canopy trees within the savanna systems compared to the forested systems was perhaps due to the tree in the savannas being open grown and facing less competition from other trees.

Circa 1800, wetlands were scattered throughout the game area, concentrated along the margins of kettle lakes, within kettle depressions, in poorly drained portions of outwash plain and outwash channels, within abandoned drainageways, and along creek margins (Figure 4). Prevalent circa 1800 wetland cover types included Mixed Conifer Swamp (7% of game area), Shrub Swamp/ Emergent Marsh (2.5%), Wet Prairie (1.5%), and scattered pockets of Mixed Hardwood Swamp (0.1%). In addition, 0.3% of the game area was classified as Lake/River and submergent wetland types such as submergent marsh, coastal plain marsh, and intermittent wetland likely occupied portions of these kettle lakes. The Mixed Conifer Swamp class likely included rich tamarack swamp and to a lesser extent, hardwood-conifer swamp. Where the surveyors noted canopy composition of these conifer swamps, small-diameter tamarack (*Larix laricina*) was prevalent with infrequent black ash (*Fraxinus nigra*). MNFI's open wetland classification for the circa 1800 map is very broad because the surveyors gathered limited information that would allow for current ecologists to classify the wetlands encountered. The very broad Shrub Swamp/Emergent Marsh cover type for the circa 1800 map likely included southern shrub-carr, inundated shrub swamp, prairie fen, poor fen, bog, southern wet medow, emergent marsh, coastal plain marsh, and intermittent wetland. Areas classified as Wet Prairie, likely included a range of wetland types including wet prairie, wet-mesic prairie, prairie fen, and southern wet meadow. In addition, margins of the morainal features were likely characterized by prairie fens.

Current Land Cover

The land cover within the Barry SGA has changed significantly since 1800 due to fire suppression, logging, agriculture, and hydrologic alteration. The mosaic of aerial photographs from 1938 (Figure 5) shows how logging and the expansion of agriculture heavily impacted the Barry SGA 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 white pine, oaks, and sugar maple being harvested. In addition, where forests and wetlands occurred adjacent to agricultural lands, grazing was prevalent. Much of the game area was formerly agricultural lands that have been since abandoned due to steep slopes and/or sandy soils. Many of these areas have reverted to early-successional forest. Former oak savanna and oak barrens were typically converted to agriculture. In areas of oak barrens, the sandy soils were unsuitable for long-term agriculture and the fields were typically abandoned. Pine plantations were often established in these areas since planted pines stabilized the

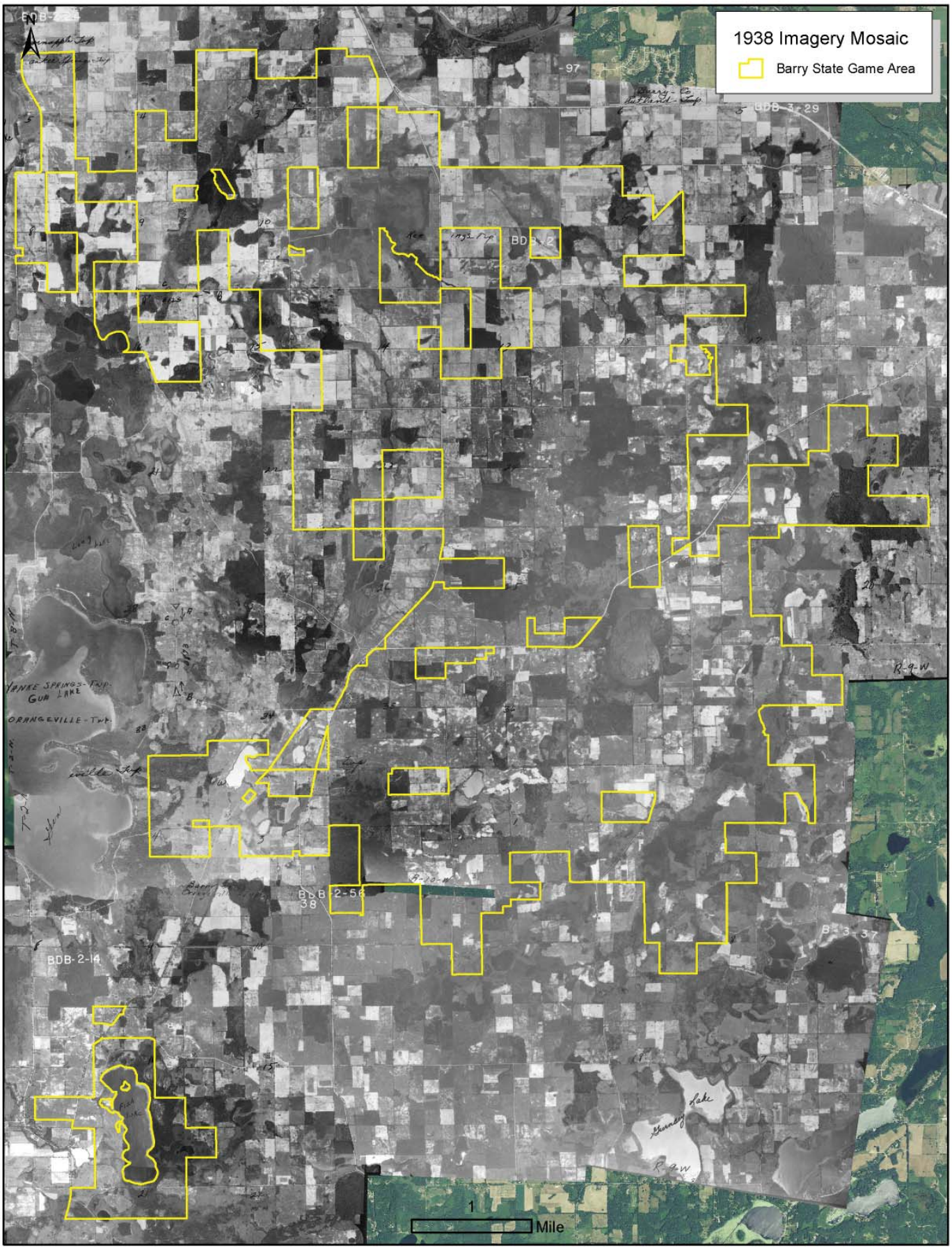


Figure 5. Mosaic of 1938 aerial photographs of Barry State Game Area (MNFI 2014b).

exposed soils and were one of the few crops able to grow in such drought prone areas.

Current land cover in Barry SGA is dominated by deciduous forest (51% of the game area) (Figure 1). This forest is primarily composed of oak-hickory forest (dry-mesic southern forest), oak forest (dry-mesic southern forest and dry southern forest), and early-successional forest. IFMAP stand types delineated in Barry SGA that fall within the broad class of deciduous forest include Mixed Upland Deciduous, Oak Types, Aspen Types, Northern Hardwood, and Other Upland Deciduous. These forests occur throughout the game area and are especially prevalent on moderate to steep end moraine and ice-contact ridges. Some of these forests occur in areas of former oak barrens and oak savanna that have converted to closed-canopy forest following fire suppression. Early-successional forests have established on lands that were logged and/or farmed. High levels of invasive shrub species occur within the understory of the early-successional forests. In addition, many of the upland 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 forest understory. Mixed forest occurs on 10% of the game area and includes forest dominated by oaks and white pine (i.e., Mixed Upland Conifers, Natural Pines, and Upland Mixed Forest). Mixed forest along with pine plantations (8% of game area) are concentrated in areas of outwash with well-drained sandy soils.

A significant portion of the game area (approximately 12%) is composed of open uplands that include managed agricultural crops (both forage crops and row crops), abandoned agricultural fields dominated by old-field herbaceous species and/or upland shrubs, and openings managed for warm and cool season grasses. These open uplands occur throughout the game area.

Lakes and wetlands remain an important component of the game area with lakes accounting for approximately 3% of the area, open wetlands accounting for <1%, shrub wetlands accounting for approximately 9%, and forested wetlands accounting for 5% of the area. Open wetland types delineated in Barry by IFMAP stage 1 inventory include Bog, Cattail, Fen, Mixed Emergent Wetland, Mixed Non-Forested Wetland, Wet Meadow, and Wet Prairie. Shrub wetland types include Alder/Willow, Inundated Shrub Swamp, Mixed Lowland Shrub, Shrub-Carr, and Treed Bog. Forested wetland types include Lowland Coniferous Forest, Lowland Deciduous Forest, and Lowland Mixed Forest. Wetlands throughout Barry SGA have been impacted by fire suppression, hydrologic alteration (e.g., ditching and dredging), grazing, marsh haying, and invasive species encroachment.

Despite the considerable loss of natural habitat due to conversion to agriculture and logging and degradation of remaining natural habitat due to fire suppression, deer herbivory, grazing, hydrologic alteration, and invasive species encroachment, a significant portion of Barry SGA supports high-quality natural communities. Prior to the 2012 survey effort a total of 15 natural community element occurrences (EOs) were documented within Barry SGA (Table 1). These EOs represented eight different natural community types including bog (1 EO), coastal plain marsh (1 EO), dry southern forest (1 EO), dry-mesic southern forest (4 EOs), prairie fen (5 EOs), southern wet meadow (1 EO), wet prairie (1 EO), and wet-mesic prairie (1 EO). These natural community EOs will be described in detail within the Natural Community Results section along with a summary of the twenty-three new natural community EOs documented in 2012. Documented high-quality natural communities constitute over 9% of Barry SGA.

Barry State Game Area is dominated by deciduous forest with oak-hickory forest or dry-mesic southern forest as the prevalent cover. Photo by Michael A. Kost.

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. 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). Surveys assessed the current ranking, classification, and delineation of these 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 each natural community EO. 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 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 July to September of 2012) 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, a minimum of a half day to a day was dedicated to each site, depending on the size and complexity of the site. For sites that occur on multiple ownerships, surveys were restricted to SGA portions of the occurrences unless permission was granted to access other ownerships.

The ecological field surveys typically involved:

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

b) describing site-specific structural attributes and ecological processes

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

d) analyzing soils and hydrology

e) noting current and historical anthropogenic disturbances

f) evaluating potential threats

g) ground-truthing aerial photographic interpretation using GPS (Garmin and Ashtech Mobile Mapper 10 units were utilized)

h) taking digital photos and GPS points at significant locations

i) surveying adjacent lands when possible to assess landscape context

j) evaluating the natural community classification and mapped ecological boundaries

k) assigning or updating element occurrence ranks

l) noting management needs and restoration opportunities or evaluating past and current restoration activities and noting additional 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 2014). Natural community boundaries were mapped or re-mapped. Information from these surveys and prior surveys, if available, was used to produce site descriptions, threat assessments, and management recommendations for each natural community occurrence, which appear within the upcoming Natural Community Surveys Results section.

Rare Animal Survey Methods

We identified rare animal target species for surveys using historical distribution within Michigan, past occurrences in or near Barry SGA, and the presence of potential habitat within the game area. A variety of data sources were used to determine if potential habitat occurred within the game area, including natural community occurrences, IFMAP descriptions, aerial photography, and on-the-ground observations. We conducted surveys for 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). Surveys were done to identify new occurrences, update and/or expand existing occurrences, and revisit historical occurrences of select rare species. In addition to documenting rare species, we also recorded observations of species of greatest conservation need (SGCN) identified in Michigan's Wildlife Action Plan (Eagle et al. 2005).

Birds

Barry SGA supports potential habitat for a variety of bird species. We conducted standardized forest songbird point counts, meandering kayak floats for wetland birds, and roadside stops near forested areas suitable for rare songbirds during the spring and summer of 2013. Surveys were done at known occurrences and at sites with potential habitat during periods when the target species were most active.

Forest Songbirds

We conducted forest point counts to target the following species: cerulean warbler (*Dendroica cerulea*, state threatened), hooded warbler (*Setophaga citrina*, state special concern), and Louisiana waterthrush (*Seiurus motacilla*, state special concern). We generated grids of sampling points in each targeted stand using the Jenness Enterprises Repeating Shapes tool (Jenness 2012) within ESRI ArcMap version 10.0 (ESRI, 2013). Sampling points consisted of an off-set 150 m by 150 m array, beginning 250 m inside compartment/stand boundaries. The points were given a unique identification number and uploaded to a GPS unit for field location. Forty-nine points were situated in select forested stands (Figure 6). In addition to surveying for rare songbirds, point-count sampling was employed to gather baseline information about the forest bird community, including relative abundance, species richness, and bird diversity.

Ralph et al. (1995) noted that it is usually more desirable to increase the number of independent point-count stations than to conduct repeated surveys at a smaller number of locations, so we visited each point only once. Surveys were conducted from June 12th through June 18th, 2013 between sunrise and four hours after sunrise. 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 min at each station (Ralph et al. 1995). Use of the three survey periods provides flexibility in making comparisons with other surveys (e.g., North American Breeding Bird Surveys) and commonly used protocols. Each bird observation was assigned to one of four distance categories (0-25 m, 25-50 m, 50-100 m, and >100 m) based on the estimated distance from the observer to facilitate future distance analyses and refinement of density and population estimates. Qualitative information about the available songbird habitat (e.g., dominant overstory species, suitability for rare species) was noted at each point.

Wetland Birds

The following wetland-obligate bird species were our primary survey targets: American bittern (*Botaurus lentiginosus*, state special concern), least bittern (*Ixobrychus exilis*, state threatened), king rail (*Rallus elegans*, state endangered), common gallinule (*Gallinula chloropus*, state threatened), marsh wren (*Cistothorus palustris*, state special concern), black tern (*Chlidonias niger*, state special concern), and common loon (*Gavia immer*, state threatened). We searched the MNFI Biotics database for known occurrences of rare wetland birds in the game area (Table 3). Inventories were conducted at known occurrences and additional sites with suitable habitat. Meandering kayak surveys were done at Fish Lake and Otis Lake during May and June of 2013. Surveys began at or shortly after sunrise and ended around 11:00 am EDT. The areas were surveyed by slowly moving through suitable habitat and periodically playing conspecific calls. We broadcast calls of American bittern, least bittern, king rail, sora (*Porzana carolina*, SGCN), and Virginia rail (*Rallus limicola*, SGCN). Bird species presence/absence and relative abundance were recorded at each survey site. We documented any rare species observed on standard MNFI Rare Species forms and recorded spatial locations using a GPS unit. The number of individuals seen or heard and the extent and quality of the habitat were noted. We established new or updated existing EOs in MNFI's Biotics database. A list of non-target bird species was also recorded at each stop.

Reptiles and Amphibians

The following species of amphibians and reptiles (i.e., herptiles) were targeted for surveys in Barry SGA in 2013: Blanchard's cricket frog (*Acris blanchardi*, state threatened), Blanding's turtle (*Emydoidea blandingii*, state special concern), eastern box turtle (*Terrapene carolina carolina*, state special concern), spotted turtle (*Clemmys guttata*, state threatened), and eastern massasauga (*Sisturus catenatus*, state special concern and federal candidate). We also documented amphibian and reptile species identified

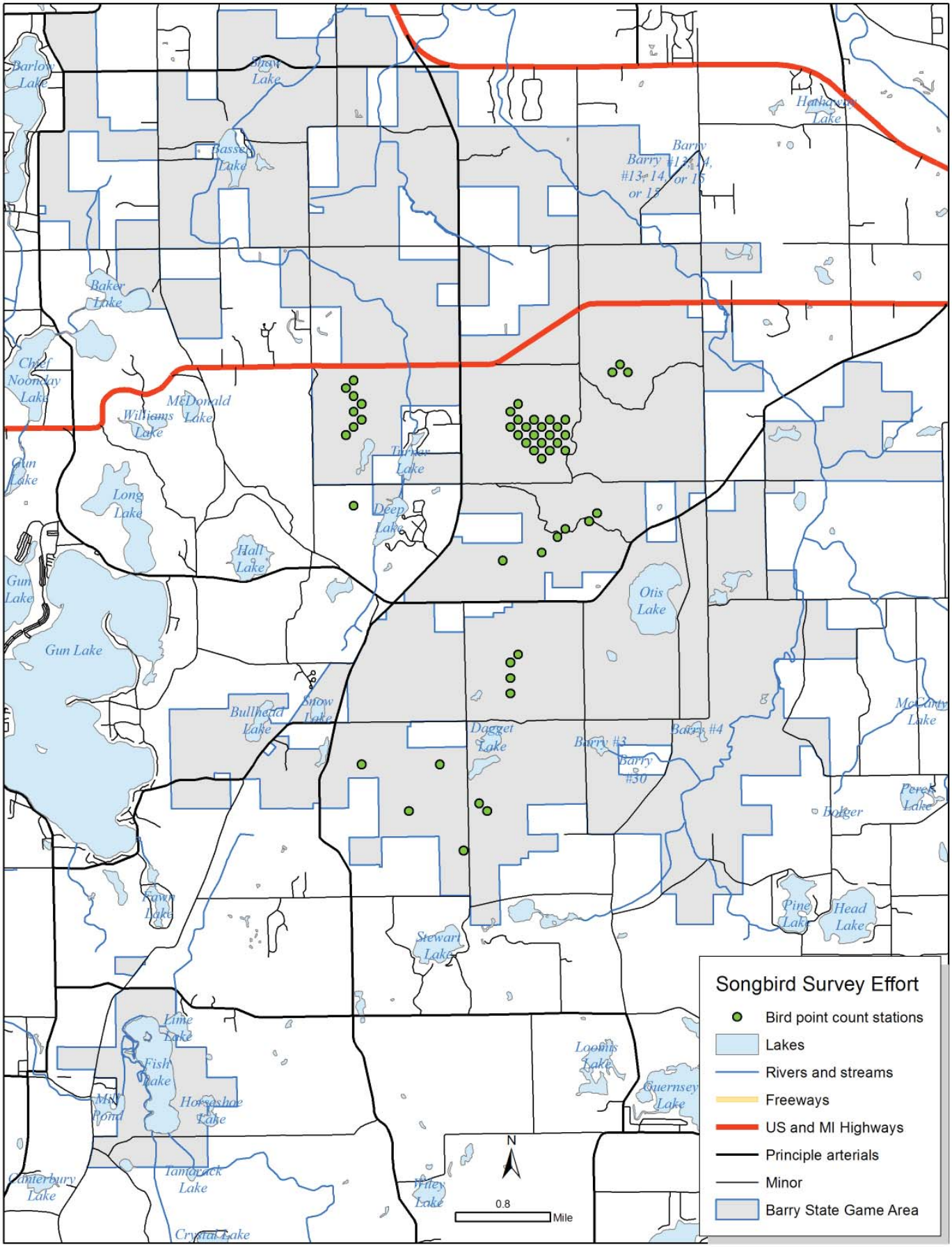


Figure 6. Locations of forest songbird point counts conducted in Barry State Game Area in 2013.

as SGCN in Michigan's Wildlife Action Plan (Eagle et al. 2005) during surveys for target species (Appendix 2). Visual encounter or meander surveys, basking turtle surveys, and breeding frog call surveys were conducted for the target species. Surveys focused on identifying new occurrences or additional locations for existing occurrences. Some previously documented sites also were surveyed to reconfirm the occurrence of target species, particularly those at which the species had not been observed within the last 10 to 20 years.

Visual encounter or meander surveys were conducted from May 19th through September 21st, 2013 using a standard method for surveying amphibians and reptiles (Campbell and Christman 1982, Corn and Bury 1990, Crump and Scott 1994). These surveys had potential for detecting all targeted rare turtles and snakes. Visual encounter surveys were conducted at 16 sites in Barry SGA, focusing on areas with suitable habitats for targeted species (Figure 7). Survey locations were visited one to four times during the field season. Visual encounter surveys were conducted during daylight hours and under appropriate weather conditions when targeted species were expected to be active and/or visible. These surveys consisted of one to two surveyors walking slowly through areas with suitable habitat for survey targets, overturning cover (e.g., logs, rocks, etc.), inspecting retreats, and looking for basking, resting, and/or active individuals on the surface or under cover. Visual encounter surveys were conducted in or along the edge of open wetlands, waterbodies (e.g., pools, ponds, streams, and rivers), upland and lowland deciduous or mixed forest stands, and open uplands adjacent to wetlands or waterbodies.

Basking turtle surveys were conducted during the same time period as visual encounter surveys, primarily to search for Blanding's turtles. We conducted basking surveys at six of the herp survey sites containing open wetlands or waterbodies that appeared to provide suitable habitat for Blanding's turtles (Figure 7). Basking turtle surveys consisted of slowly walking around the edge or shore of the wetlands or waterbodies and scanning the habitat with binoculars to look for turtles partially submerged in the water or basking on logs, woody debris, islands, or other structures. We also used these surveys to look for snakes basking in the wetlands or waterbodies.

Breeding frog call surveys were conducted for Blanchard's cricket frog from June 20th through June 21st, 2013. These surveys were done at 21 sites throughout Barry SGA. These sites were comprised of small lakes and surrounding open wetlands (Figure 7). We conducted frog call surveys in the evening or at night (17:30 – 01:00 EDT) by listening for breeding calls of cricket frogs from the edge of the lakes and wetlands at boat launch sites or along roads. Species, call index values, location, time, and weather conditions were recorded during surveys. Call indices were defined in the following manner: 1 = individuals can be counted, space between calls (1-5 individuals); 2 = individual calls can be distinguished but some overlapping calls (6-12 individuals); and 3 = full chorus, calls are constant, continuous and overlapping (unable to count individuals) (Michigan Department of Natural Resources 2002).

Survey data forms (Appendix 3) were completed for all surveys, and survey locations were recorded with a GPS or IPAQ unit. We noted all rare and common reptiles and amphibians and other animals 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. We completed MNFI special animal survey forms when rare reptile or amphibian species were encountered and recorded spatial locations with a GPS or IPAQ unit. Photos of rare species also were taken for supporting documentation, whenever possible.

Insects

Barry SGA contains records for multiple rare insect species (Table 5). We focused our survey effort at fens within the game area with documented occurrences or potential to support additional rare species. Survey methods consisted of sweep netting, visual meander surveys, and nighttime blacklighting.

Tree Crickets

Two species of rare tree crickets, tamarack tree cricket (*Oecanthus laricis*, state special concern) and pine tree cricket (*O. pini*, state special concern), occur in Michigan. Barry SGA contains suitable habitat for both species. We conducted surveys at wetlands with either tamarack (*Larix laricina*) or white pine (*Pinus strobus*) on July 30th, 2013 and August 29th, 2013 in the Otis Lake Bog (EO ID 15901) and Shaw Lake Fen (prairie fen, EO ID 12498). Surveys for these rare crickets were done by sweeping the lower branches of tamaracks and white pines with a sweep net attached to an extension pole. We examined the contents to identify and count any rare tree crickets that were captured.

Butterflies and Moths

We conducted surveys for two rare butterfly species: swamp metalmark (*Calephelis mutica*, state special concern) and Dukes' skipper (*Euphyes dukesi*, state threatened). Surveys were conducted by walking through suitable wetland habitat during appropriate weather conditions (e.g., no rain or strong winds) and visually observing adult butterflies in flight, perched on vegetation, or nectaring on flowers. Species that looked similar to the

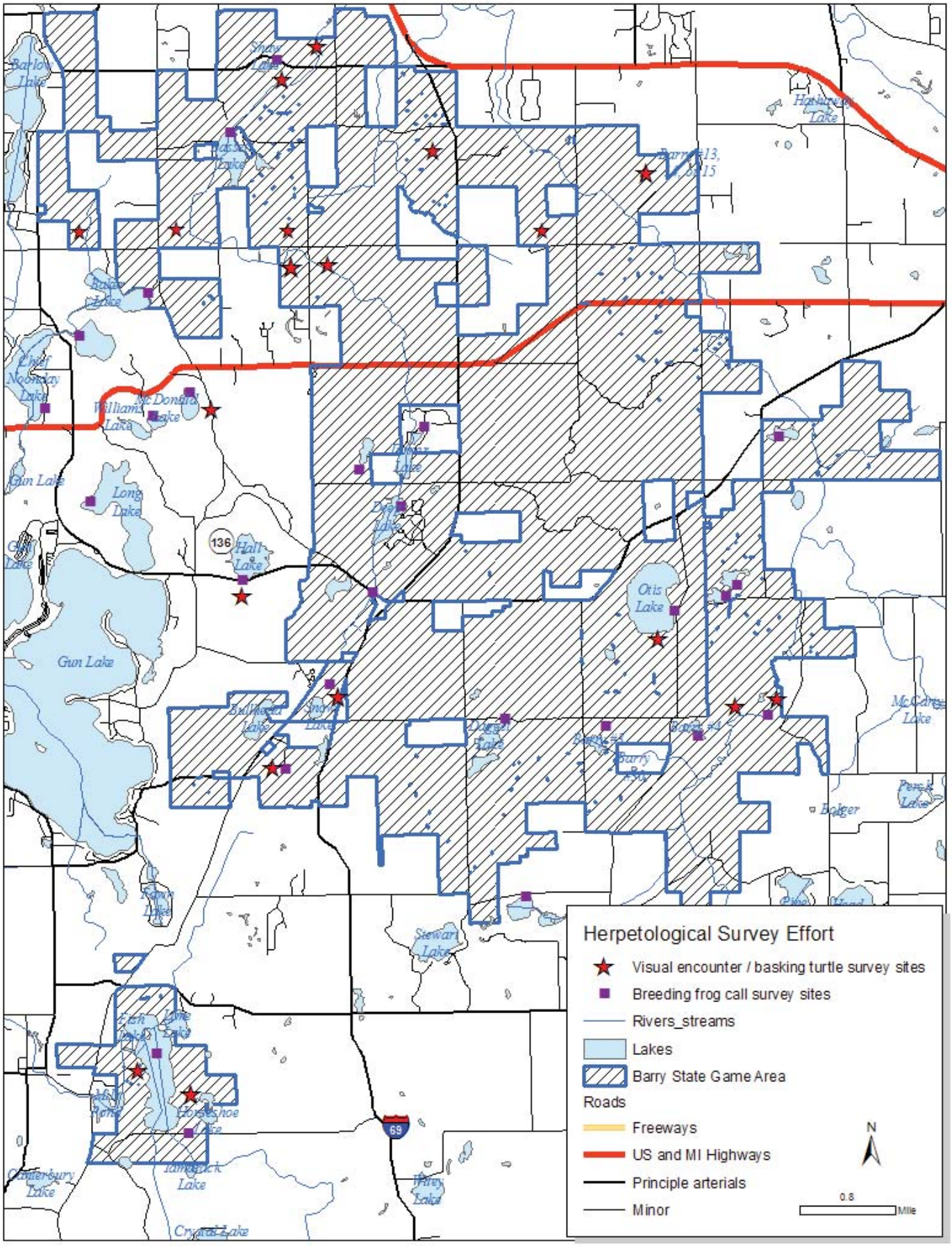


Figure 7. Locations of reptile and amphibian surveys conducted in and nearby Barry State Game Area in 2013.

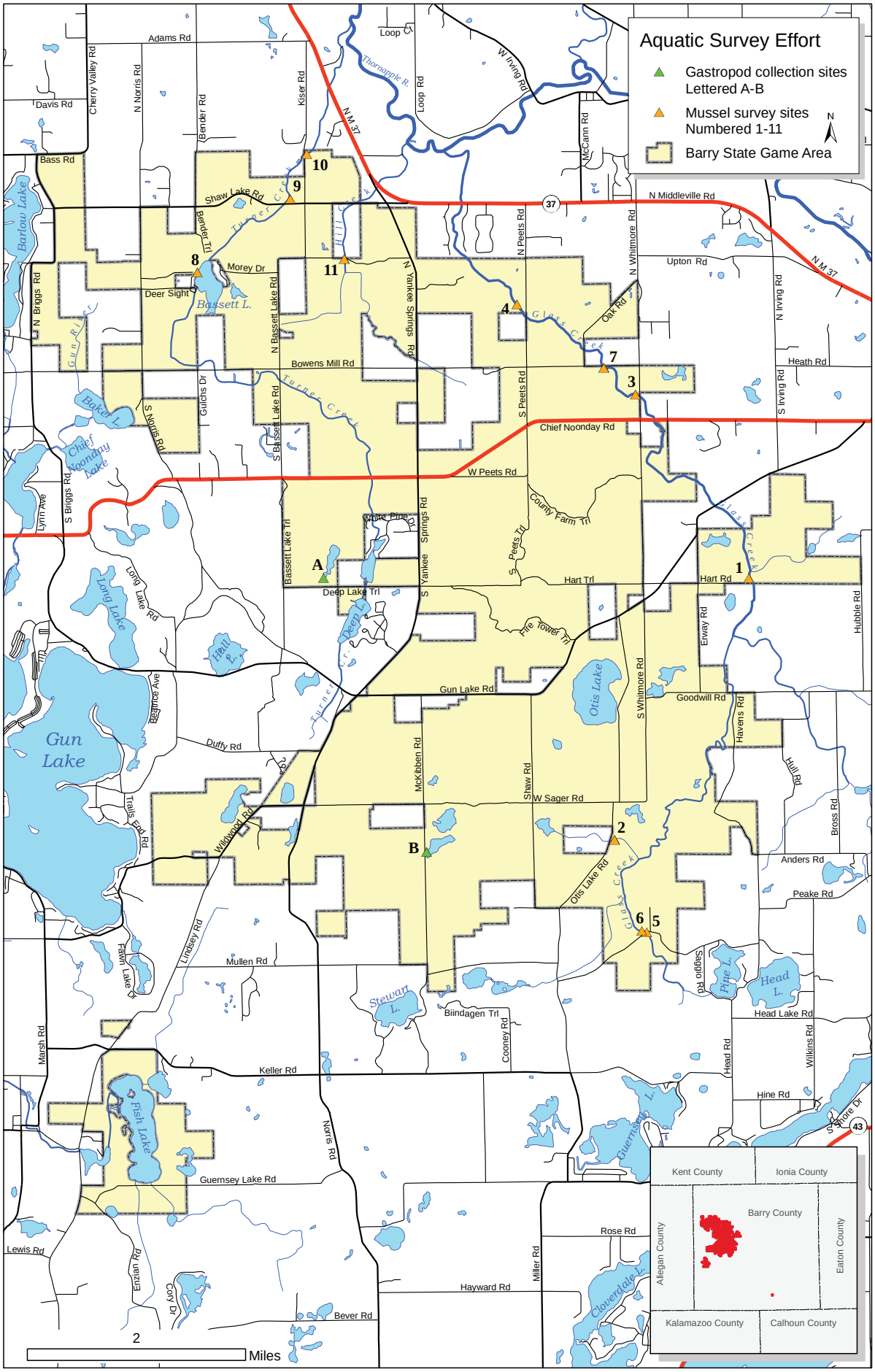


Figure 8. Locations of aquatic surveys conducted in Barry State Game Area in 2013.

target species were captured with an aerial net, identified in hand, and then released. We conducted rare butterfly surveys at Shaw Lake Fen (prairie fen, EO ID 12498) and at Bassett Lake Meadow (southern wet meadow, EO ID 18984) on July 22nd and July 30th, 2013, respectively. Both locations supported scattered patches of swamp thistle (*Cirsium muticum*), the host plant for swamp metalmark. The Bassett Lake Meadow southern wet meadow also contains scattered, shaded patches of lake sedge (*Carex lacustris*), the host plant of Dukes' skipper. At each survey site, we compiled lists of all butterfly species observed.

We conducted surveys for the following four rare moth species: blazing star borer (*Papaipema beeriana*, state special concern), maritime sunflower borer (*P. maritima*, state special concern), golden borer (*P. cerina*, state special concern), and regal fern borer (*P. speciosissima*, state special concern). Moth surveys were done utilizing blacklighting, which consisted of standard mercury-vapor and UV lights powered by a portable generator. We used a 2 m x 2 m metal conduit frame to support a white sheet used as a collecting surface. This frame was situated in a central location within larval host plant populations to maximize the likelihood of collecting adults. These locations were recorded using a hand-held GPS unit and *Papaipema* moth survey forms were completed for each site. We conducted blacklighting at two locations within Barry SGA that contain host plants of the targeted moths. The first site was located in Shaw Lake Fen (prairie fen, EO ID 12498) within a population of marsh blazing star (*Liatris spicata*), a host plant of *P. beeriana*. We sampled Shaw Lake Fen for four hours (20:00 – 24:00 EDT) on October 1st, 2013. The second location was in the southern portion of Turner Creek Wetlands (prairie fen, EO ID 278), a site that contains a small population of marsh blazing star. Turner Creek Wetlands was surveyed from 19:45 to 23:50 EDT on October 2nd, 2013.

Mussels

Glass Creek, Turner Creek, and Hill Creek flow through Barry SGA and are part of the Thornapple River Watershed. Each creek flows into the Thornapple River within a couple miles of exiting Barry SGA, which in turn flows into the Grand River near Ada, Michigan. Based on pre-1960s occurrence records from the University of Michigan Museum of Zoology, the Thornapple watershed historically supported populations of at least 17 unionid mussel species, and the lower Grand River watershed supported at least 31 species. Unionid mussel diversity tends to increase as river size increases. This pattern may be due to greater availability of a larger number of fish host species, food resources, and historical patterns of migration since the retreat of the last glaciers. Some mussel species, however, are associated with headwaters and are typically found in small to medium river habitats. In September of 2013, we conducted surveys for unionid mussels at 11 sites in Glass Creek, a tributary of Glass Creek, Basset Lake, Basset Creek, and Hill Creek (Table 7 and Figure 8).

Unionid mussel surveys were performed to determine the presence/absence and relative abundance of each species at each site. We searched areas of fixed size (128 m^2) to standardize sampling effort among sites and allow estimation of unionid density. Typically 128 m^2 provides a good compromise between amount of search effort per site and the number of sites to be completed within the scope of a project. The search area extended from bank to bank to include a wide range of microhabitats. We used GPS units to record the spatial location of survey sites and incidental finds.

We located live unionids and shells using a combination of visual and tactile means. Glass-bottom buckets were used for visual searches. Tactile searches of the substrate were conducted when necessary to help ensure that buried unionids were not overlooked. Live individuals and shells were identified to species, and live mussels were planted back into the substrate anterior end down (siphon end up) in the immediate vicinity of where they were found. Presence/absence was recorded for the invasive zebra mussel (*Dreissena polymorpha*) and Asian clam (*Corbicula fluminea*). We also searched for gastropods near the water's edge of two wetlands and collected incidental finds at mussel survey sites. Gastropod shells were collected and identified in the lab.

Habitat data were taken to describe and document stream conditions at the time of the surveys. We characterized the substrate within each transect by estimating percent composition of each of the following six particle diameter size classes (Hynes 1970): boulder (>256 mm), cobble (256-64 mm), pebble (64-16 mm), gravel (16-2 mm), sand (2-0.0625 mm), and silt/clay (<0.0625 mm). Woody debris, aquatic vegetation, exposed solid clay substrate, and eroded banks were noted when observed. The percentage of the search area with pool, riffle, and run habitat, and a rough assessment of current speed were estimated visually (Table 11). We recorded conductivity and pH with an Oakton handheld meter. Alkalinity was measured with a LaMotte kit (model DR-A) and hardness was estimated with a Hach kit (Table 12).

Table 1. Newly documented and previously known natural community element occurrences for the Barry State Game Area. EO rank abbreviations are as follows: B, good estimated viability; BC, good or fair estimated viability; C, fair estimated viability; CD, fair or poor estimated viability; and D, poor estimated viability. * indicates the EO was newly documented in 2012 or was updated with information collected during inventory.

Site Name	Community Type	EO ID	EO Rank	Year First Observed	Year Last Observed	Global Rank	State Rank
Bowens Mill Bogs*	Bog	18971	C	2012	2012	G3G5	S4
Gun Lake Road Bogs*	Bog*	18972	C	2012	2012	G3G5	S4
Otis Lake Bog	Bog	15901	BC	2005	2005	G3G5	S4
Dagget Lake*	Coastal Plain Marsh	9832	BC	1970	2012	G2	S2
Bassett Lake Woods*	Dry Southern Forest	18976	BC	2012	2012	G4	S3
Gulch Road Forest*	Dry-mesic Northern Forest	18974	C	2012	2012	G4	S3
Turner Creek Forest*	Dry-mesic Northern Forest	18975	C	2012	2012	G4	S3
Dagget Lake Woods*	Dry-mesic Southern Forest	18968	C	2012	2012	G4	S3
Fish Lake Forest*	Dry-mesic Southern Forest	13347	BC	1989	2012	G4	S3
Gun Lake Road Woods*	Dry-mesic Southern Forest	18967	BC	2012	2012	G4	S3
Gun Lake Woods*	Dry-mesic Southern Forest	18973	B	2012	2012	G4	S3
Hart Road Woods*	Dry-mesic Southern Forest	18969	BC	2012	2012	G4	S3
Hill Creek Woods*	Dry-mesic Southern Forest	13346	BC	1989	2012	G4	S3
Norris Road East Woods*	Dry-mesic Southern Forest	13349	C	1989	2012	G4	S3
The Hills North*	Dry-mesic Southern Forest	16128	BC	2006	2012	G4	S3
The Hills South*	Dry-mesic Southern Forest	16129	C	2006	2012	G4	S3
Whitmore Road Woods*	Dry-mesic Southern Forest	18970	BC	2012	2012	G4	S3
Dagget Lake Wetlands*	Intermittent Wetland	18977	BC	2012	2012	G2	S3
Norris Road Wetland*	Intermittent Wetland	18966	C	2012	2012	G2	S3
Whitmore Road Wetland*	Intermittent Wetland	18978	C	2012	2012	G2	S3
Snow Lake Fen*	Poor Fen	18980	C	2012	2012	G3	S3
Bassett Creek Fen*	Prairie Fen	18981	C	2012	2012	G3	S2
Bowens Mill Fen	Prairie Fen	13555	C	2002	2003	G3	S2
Fish Lake Fen*	Prairie Fen	18992	D	2012	2012	G3	S2
Hill Creek Fen*	Prairie Fen	7579	BC	1989	2012	G3	S2
Horseshoe Lake Fen*	Prairie Fen	2829	BC	1989	2012	G3	S2
Shaw Lake Fen*	Prairie Fen	12498	C	1989	2012	G3	S2
Turner Creek Wetlands	Prairie Fen	278	BC	1974	2005	G3	S2
Wildwood Fen*	Prairie Fen	18982	CD	2012	2012	G3	S2
Turner Creek Swamp*	Rich Tamarack Swamp	18983	C	2012	2012	G4	S3
Bassett Lake Meadow*	Southern Wet Meadow	18984	C	2012	2012	G4?	S4
Havens Road Meadow*	Southern Wet Meadow	13355	C	1989	2012	G4?	S4
Oak Road Meadow*	Southern Wet Meadow	18979	B	2012	2012	G4?	S4
Otis Lake Marsh*	Submergent Marsh	18985	B	2012	2012	GU	S4
Snow Lake Marsh*	Submergent Marsh	18986	B	2012	2012	GU	S4
Turner Creek Wetlands	Wet Prairie	2267	C	1974	2010	G3	S1
Turner Creek Wet Prairie*	Wet Prairie	18987	C	2012	2012	G3	S1
Turner Creek Wetlands	Wet-mesic Prairie	4771	C	1975	2010	G3	S1

Table 2. Newly documented and previosuly known rare plant element occurrences at Barry State Game Area. State status abbreviations are as follows: E, state endangered; T, state threatened; and SC, state special concern. EO rank abbreviations are as follows: A, excellent estimated viability; AB, excellent or good estimated viability; B, good estimated viability; BC, good or fair estimated viability; C, fair estimated viability; C?, possibly fair estimated viability; CD, fair or poor estimated viability; D, poor estimated viability; E, verified extant (viablity not assessed); and H, historical. * indicates the EO was newly documented in 2012 or was updated with information collected during inventory.

Common Name	Scientific Name	State Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Beaked agrimony	*Agrimonia rostellata*	T	6025	E	1971	1971
Leadplant	*Amorpha canescens*	SC	3168	CD	1975	1980
Leadplant	*Amorpha canescens*	SC	8995	D	1976	1980
Leadplant*	*Amorpha canescens*	SC	11347	AB	1986	2012
Leadplant	*Amorpha canescens*	SC	16471	BC	2006	2006
Tuberous Indian plantain	*Arnoglossum plantagineum*	SC	9542	CD	1977	2008
Tuberous Indian plantain	*Arnoglossum plantagineum*	SC	11889	AB	2002	2012
Tuberous Indian plantain	*Arnoglossum plantagineum*	SC	12307	BC	2000	2012
Tuberous Indian plantain	*Arnoglossum plantagineum*	SC	11668	B	1986	1986
Tuberous Indian plantain	*Arnoglossum plantagineum*	SC	1471	B	1986	2005
Purple milkweed	*Asclepias purpurascens*	T	16470	CD	2004	2006
Drummond's aster	*Aster drummondii*	T	16995	E	2002	2002
Horsetail spike rush	*Eleocharis equisetoides*	SC	5562	A	1960	2002
Black-fruited spike-rush*	*Eleocharis melanocarpa*	SC	5081	AB	1958	2012
Upland boneset*	*Eupatorium sessilifolium*	T	16133	BC	2006	2012
Umbrella-grass	*Fuirena pumila*	T	398	E	1976	1976
Dwarf-bulrush	*Hemicarpha micrantha*	SC	7820	D	1979	2006
Goldenseal	*Hydrastis canadensis*	T	621	H	2959	1959
Goldenseal*	*Hydrastis canadensis*	T	16884	A	2008	2012
Scirpus-like rush	*Juncus scirpoides*	T	4876	BC	1970	1970
False boneset*	*Kuhnia eupatorioides*	SC	18989	C?	2012	2012
False boneset	*Kuhnia eupatorioides*	SC	19124	D	2011	2011
Northern bayberry*	*Myrica pensylvanica*	T	16971	B	2003	2012
Ginseng*	*Panax quinquefolius*	T	16885	B	2008	2012
Ginseng*	*Panax quinquefolius*	T	18988	CD	2012	2012
Ginseng*	*Panax quinquefolius*	T	18990	CD	2012	2012
Ginseng*	*Panax quinquefolius*	T	18991	C	2012	2012
Spotted pondweed	*Potamogeton pulcher*	E	8421	E	1079	1985
Tall beakrush*	*Rhynchospora macrostachya*	SC	5256	C	1076	2012
Tall beakrush	*Rhynchospora macrostachya*	SC	7454	BC	1966	2002
Bald-rush	*Rhynchospora scirpoides*	T	9340	B	2002	2002
Bald-rush*	*Rhynchospora scirpoides*	T	16911	B	2006	2012

RESULTS

During the Integrated Inventory Project at Barry SGA, MNFI documented 45 new EOs and provided information for updating an additional 30 EOs (Tables 1-6). Data compiled on these EOs was entered into MNFI's Biotics database (MNFI 2014). In total, 29 SGCN were documented during the project including 14 different rare animal species (Table 8). The locations in Barry SGA of all natural community and rare species occurrences (both new and prior occurrences) are illustrated in Figures 9 through 13. 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 each natural community EO as well as site-specific threat assessments and management recommendations. The Rare Animal Survey Results section describes survey results for each grouping of rare animals: birds, reptiles and amphibians, insects, and mussels.

Natural Community Survey Results

During the summer of 2012, MNFI ecologists documented 23 new high-quality natural communities in the Barry SGA and also updated ten known high-quality community EOs. Five existing natural community EOs were not visited in 2012 because they had been surveyed just before the inception of this project. Barry SGA supports 38 high-quality natural community EOs (Table 1 and Figure 9). Twelve different natural community types are represented in the 33 element occurrences surveyed including: bog (2 EOs), coastal plain marsh (1 EO), dry southern forest (2 EOs), dry-mesic northern forest (2 EOs), dry-mesic southern forest (9 EOs), intermittent wetland (3 EOs), poor fen (1 EO), prairie fen (6 EOs), rich tamarack swamp (1 EO), southern wet meadow (3 EOs), submergent marsh (2 EOs), and wet prairie (1 EO). Table 1 lists the visited sites, their element occurrence ranks, their unique element occurrence identification number (EO ID), and the year first and last observed. As noted above, five additional natural community EOs within Barry were surveyed just prior to this project and were not revisited in 2012. These EOs include bog (1 EO), prairie fen (2 EO), wet prairie (1 EO), and wet-mesic prairie (1 EO).

During the IFMAP Stage 1 Inventory in 2010 and the natural community surveys in 2012, four new rare plant EOs were documented and information was gathered to allow ten previously documented rare plant EOs to be updated (Table 2). Newly documented rare plant species include three records for ginseng (*Panax quinquefolius*, state threatened) and one record for false boneset (*Kuhnia eupatorioides*, state special concern). Updates were processed for the following rare plant EOs: leadplant (*Amorpha canescens*, state special concern), tuberous Indian plantain (*Arnoglossum plantagineum*, state special concern), black-fruited spike-rush (*Eleocharis melanocarpa*, state special concern), upland boneset (*Eupatorium sessilifolium*, state threatened), goldenseal (*Hydrastis canadensis*, state threatened), northern bayberry (*Myrica pensylvanica*, state threatened), ginseng, tall beak-rush (*Rhynchospora macrostachya*, state special concern), and bald-rush (*Rhynchospora scirpoides*, state threatened). In total, 32 rare plant element occurrences of 18 different species have been recorded within Barry SGA (Table 2). The general location of these EOs is illustrated along with the natural community EOs in Figure 9. In addition, the following site descriptions for the natural community EOs include discussion of rare plant populations when they occur within the high-quality natural communities.

The following site summaries contain a detailed discussion for each of these 38 natural communities organized alphabetically by community type and then by element occurrence. A summary of priority management recommendations is provided for each natural community EO in Table 13. The beginning of each grouping of communities contains an overview of the natural community type, which was adapted from MNFI's natural community classification (Kost et al. 2007). In addition, an ecoregional distribution map is provided for each natural community type (Albert et al. 2008). For each site summary, the following information is provided:

a) site name
b) natural community type
c) state and global rank (see Appendix 1 for ranking criteria)
d) current element occurrence rank
e) size
f) locational information
g) digital photograph(s) (when available)
h) 1998 aerial photograph with polygon of site
i) detailed description
j) threat assessment
k) management recommendations

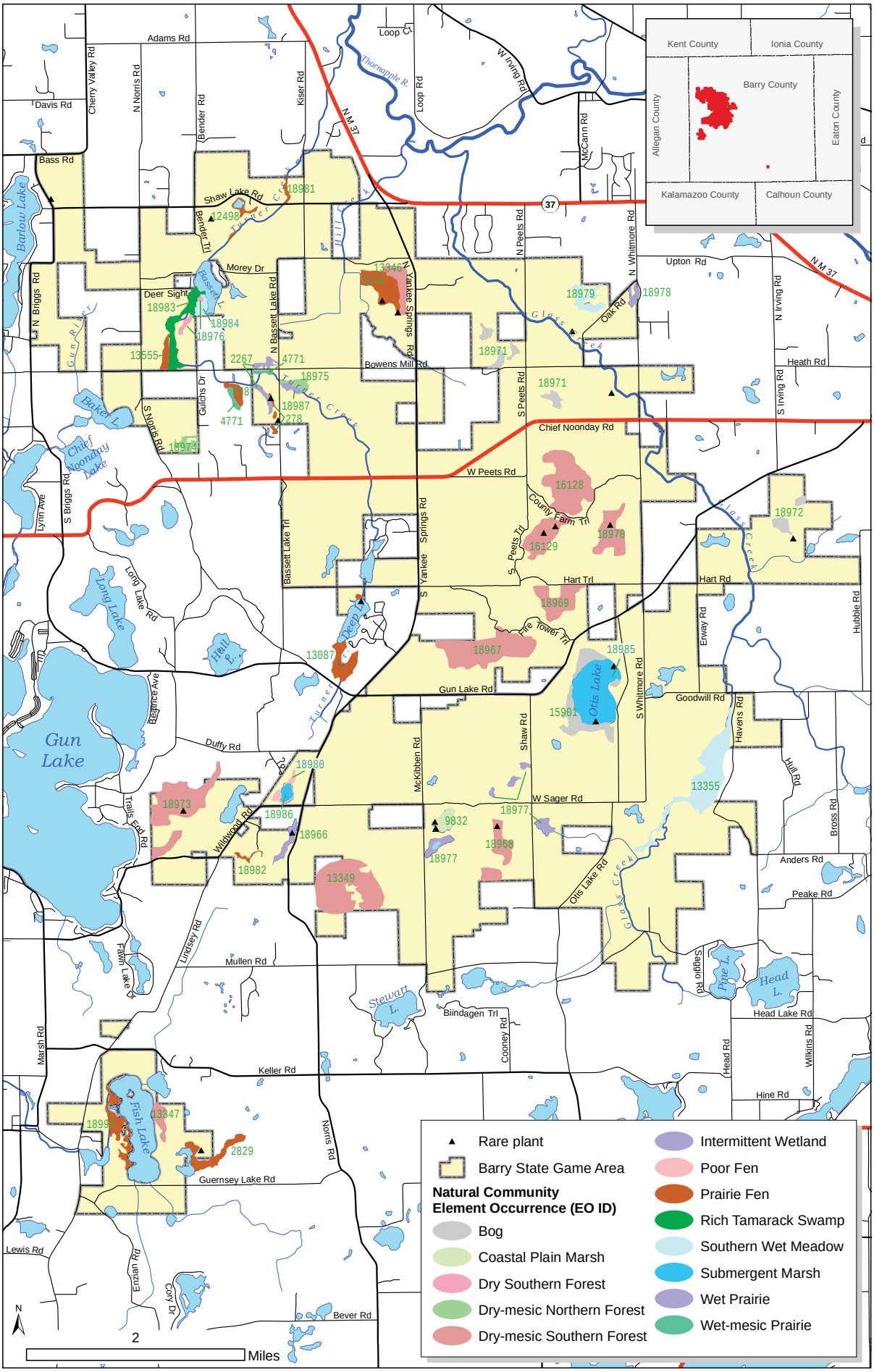
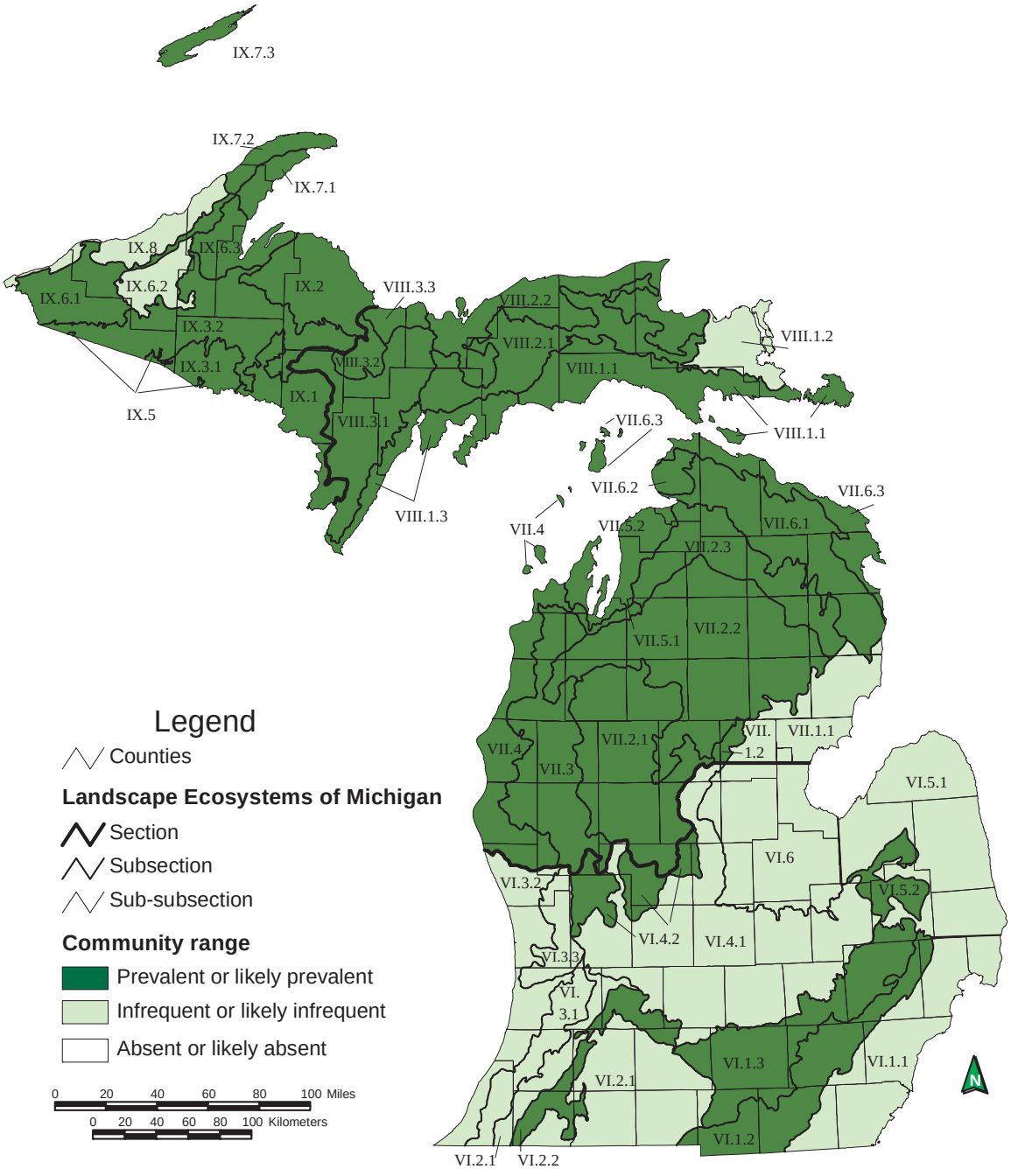


Figure 9. Natural community and rare plant element occurrences in Barry State Game Area.

BOG

Overview

Bog is a nutrient-poor peatland characterized by acidic, saturated peat and the prevalence of sphagnum mosses and ericaceous shrubs. Located in depressions in glacial outwash and sandy glacial lakeplains and in kettles on pitted outwash and moraines, bogs frequently occur as a floating mat on the margins of lakes and ponds. Fire occurs naturally during drought periods and can alter the hydrology, mat surface, and flora. Beaver-induced flooding also influences bogs (Kost et al. 2007).



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

1. Bowens Mill Bogs
Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and secure within the state
Element Occurrence Rank: C
Size: 35 acres
Location: Compartment 1, Stands 263, 274, and 275 and Compartment 4, Stand 43
Element Occurrence Identification Number: 18971

Site Description: The Bowen Mills Bogs EO is composed of four separate polygons that occupy kettle depressions within a ground moraine. The surrounding upland forest is characterized by dry-mesic southern forest and early-successional forest. These bogs formed through lake-filling or terrestrialization. The bogs are characterized by deep (> 1 meter) saturated to inundated acidic peats with well-developed fibric to sapric structure. The fibric peats on the sphagnum hummucks tend to be very strongly acidic (pH 4.0) while the hemic and sapric peats are very strongly acidic to strongly acidic (pH 4.5-5.5). Sphagnum hummocks and hollows provide microsite diversity by creating small-scale gradients in soil moisture and soil chemistry. In addition, numerous animal trails occur throughout the bog and provide inundated linear features that increase the bog's overall structural diversity.

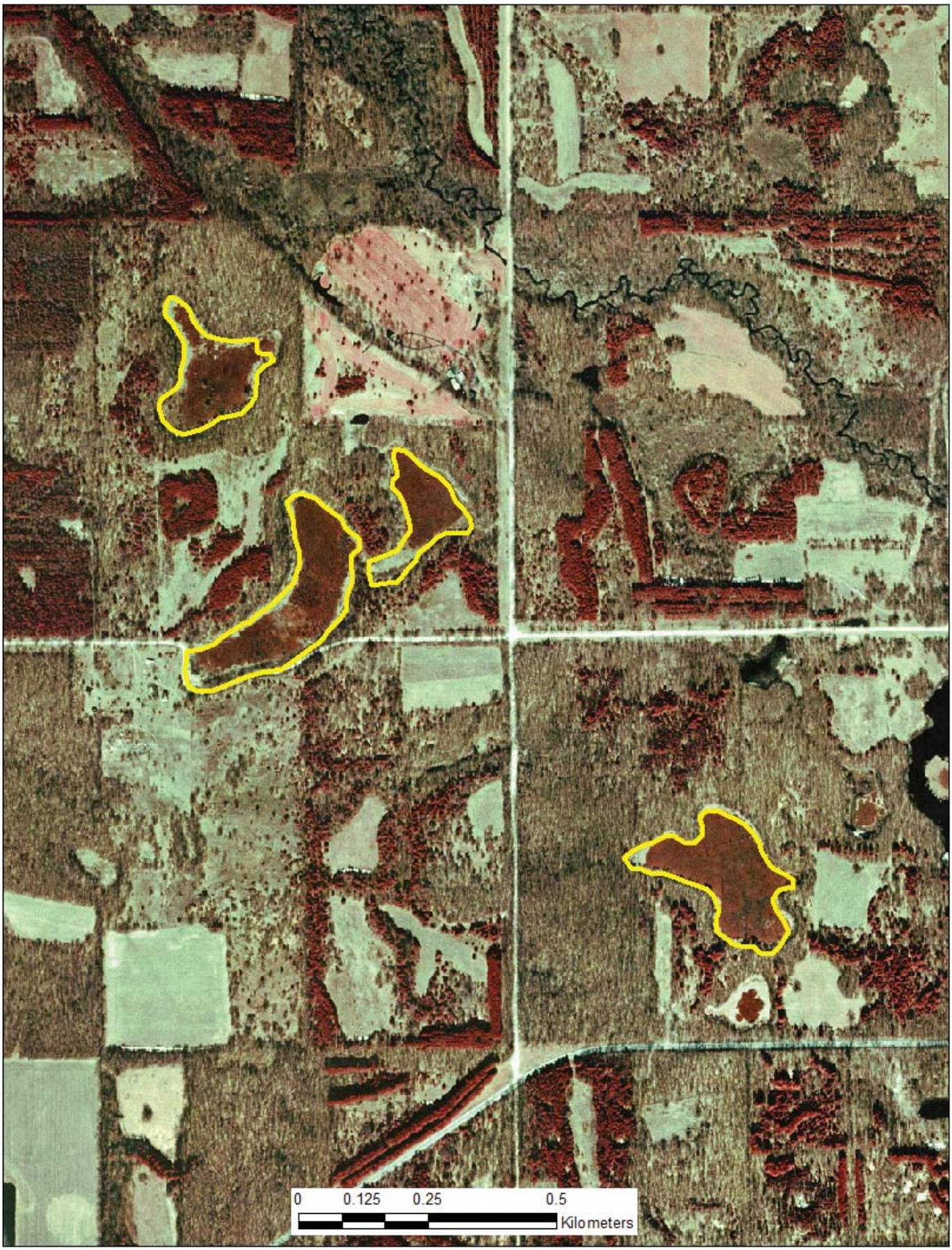
The Bowen Mills Bogs EO is characterized by a continuous carpet of sphagnum moss (*Sphagnum* spp.), a species-poor herbaceous layer, a dense low shrub layer, scattered patches of dense tall shrubs, and scattered and stunted trees. Characteristic species of the herbaceous layer include few-seed sedge (*Carex oligosperma*), tawny cotton-grass (*Eriophorum virginicum*), wool-grass (*Scirpus cyperinus*) (locally dominant), and water smartweed (*Persicaria amphibia*). Leatherleaf (*Chamaedaphne calyculata*) is dominant within the low shrub layer and the understory is locally dominated by highbush blueberry (*Vaccinium corymbosum*) with additional tall shrubs including winterberry (*Ilex verticillata*), black chokeberry (*Aronia prunifolia*), and bog birch (*Betula pumila*). Scattered and stunted trees include red maple (*Acer rubrum*), tamarack (*Larix laricina*), red pine (*Pinus resinosa*), white pine (*Pinus strobus*), and Scotch pine (*Pinus sylvestris*). The bogs are ringed by moats with more than a meter of water and submergent vegetation including wool-grass, tussock sedge (*Carex stricta*), and heart's-ease (*Persicaria maculosa*); emergent vegetation including lake sedge (*Carex lacustris*), three-way sedge (*Dulichium arundinaceum*), blue-joint grass (*Calamagrostis canadensis*), and pitcher-plant (*Sarracenia purpurea*); and a floating mat with three-way sedge, few-seed sedge, leatherleaf, royal fern (*Osmunda regalis*), and northern bugle weed (*Lycopus uniflorus*). Tall shrubs and stunted trees scattered along the margin of the moats include red maple, highbush blueberry, winterberry, Scotch pine, and tamarack. Fifty-one native, vascular plant species were noted within this bog during the 2012 surveys.

In 2002, tamarack tree cricket (*Oecanthus laricis*, state special concern) was observed in the bog polygon intersected by Bowens Mill Road.

Threats: Species composition and vegetative structure of the bog are largely driven by natural processes though non-native pines are seeding into the bogs from the adjacent pine plantations. In addition, fire suppression throughout the general landscape may have altered the fire regime of the bogs and a road to the south of the largest bog polygon has likely locally altered the hydrology and species composition.

Management Recommendations: The main management recommendations are to retain an intact buffer of natural communities surrounding the wetland to minimize the threat of hydrological alteration and to remove the non-native pines from the bog. Burning the bogs with the surrounding upland forest is also recommended. Monitoring should be implemented following prescribed fire and invasive species control efforts.

Bowens Mill Bogs. Photos by Michael A. Kost.



1998 aerial photograph of Bowens Mill Bogs.

2. Gun Lake Road Bogs
Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and secure within the state
Element Occurrence Rank: C
Size: 16 acres
Location: Compartment 4, Stands 144 and 145
Element Occurrence Identification Number: 18972

Site Description: The Gun Lake Road Bogs EO is composed of two separate polygons that occupy kettle depressions on coarse-textured end moraine. The surrounding upland forest is characterized by dry-mesic southern forest, pine plantations, and early-successional forest. These bogs formed through lake-filling or terrestrialization. The bogs are characterized by deep (> 1 meter) saturated to inundated acidic peats with well-developed fibric to sapric structure. The fibric peats on the sphagnum hummucks tend to be strongly acidic (pH 4.5). Sphagnum hummocks and hollows provide microsite diversity by creating small-scale gradients in soil moisture and soil chemistry. In addition, numerous animal trails occur throughout the bog and provide inundated linear features that increase the bog's overall structural diversity.

The Gun Lake Road Bogs EO is characterized by a floating mat with a nearly continuous carpet of sphagnum moss (*Sphagnum* spp.), a species-poor herbaceous layer, a dense low shrub layer, scattered patches of dense tall shrubs, and scattered and stunted tamarack (*Larix laricina*). Characteristic species of the herbaceous layer include few-seed sedge (*Carex oligosperma*), Virginia chain-fern (*Woodwardia virginica*) (locally dominant), wool-grass (*Scirpus cyperinus*), cotton-grasses (*Eriophorum* spp.), and pitcher-plant (*Sarracenia purpurea*). Within the low shrub layer, leatherleaf (*Chamaedaphne calyculata*), large cranberry (*Vaccinium macrocarpon*), bog-rosemary (*Andromeda glaucophylla*), and whorled loosestrife (*Decodon verticillata*) are locally dominant. Tall shrubs include winterberry (*Ilex verticillata*), black chokeberry (*Aronia prunifolia*), and poison sumac (*Toxicodendron vernix*). The bog is ringed by a moat with up to two meters of water and vegetation including yellow pond-lily (*Nuphar advena*), beggar-ticks (*Bidens* spp.), whorled loosestrife, buttonbush (*Cephalanthus occidentalis*), winterberry, and black gum (*Nyssa sylvatica*). Twenty native, vascular plant species were noted within this bog during the 2012 surveys.

Threats: Species composition and vegetative structure of the bog are largely driven by natural processes. However, fire suppression throughout the general landscape may have altered the fire regime of the bog.

Management Recommendations: The main management recommendations are to retain an intact buffer of natural communities surrounding the wetland to minimize the threat of hydrological alteration. Additional recommendations include burning the bogs with the surrounding upland forest and monitoring for invasive species and following prescribed fire.

1998 aerial photograph of Gun Lake Road Bogs.

3. Otis Lake Bog
Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and secure within the state
Element Occurrence Rank: BC
Size: 71 acres
Location: Compartment 3, Stands 92 and 97
Element Occurrence Identification Number: 15901

Site Description: Otis Lake Bog consists of three separate bog mats occurring along the margins of Otis Lake, a large, shallow kettle depression lake occurring in coarse-textured end moraine. These bog mats occur along the northern, southern, and east-central shores of the lake. The bog is characterized by acidic peats (pH 4.5) of variable depth. Closer to the lake margin, the fibric peats are 50 to 80 cm and overlie water. Peats are shallower closer to the inland margin and overlie wet, acidic sands.

The bog mats are characterized by a continuous carpet of sphagnum moss (*Sphagnum* spp.), a species-poor herbaceous layer, a dense low shrub layer, dense tall shrubs concentrated along the margins, and scattered and stunted tamarack (*Larix laricina*) and white pine (*Pinus strobus*) along the margins. Characteristic species of the herbaceous layer are cotton-grasses (*Eriophorum* spp.), sundews (*Drosera* spp.), rose pogonia (*Pogonia ophioglossoides*), and pitcher-plant (*Sarracenia purpurea*). Dominant low shrubs include leatherleaf (*Chamaedaphne calyculata*) and whorled loosestrife (*Decodon verticillata*). The inland margin of the bog is characterized by a dense almost impenetrable thicket of highbush blueberry (*Vaccinium corymbosum*) along with black chokeberry (*Aronia prunifolia*) and mountain holly (*Ilex mucronata*). The Otis Lake Bog occurs adjacent to high-quality submergent marsh (Otis Lake Marsh, EO ID 18985) that occupies Otis Lake.

Numerous rare species are associated with Otis Lake including breeding common loon (*Gavia immer*, state threatened) and osprey (*Pandion haliaetus*, state special concern), both observed in 2013. In addition a new record for pine tree cricket (*Oecanthus pini*, state special concern) was documented in the bog mat along the northern shore of Otis Lake and a known breeding population of Blanchard's cricket frog (*Acris blanchardi*, state threatened) was confirmed for Otis Lake in 2013. In addition, the forest surrounding Otis Lake supports a breeding population of cerulean warbler (*Dendroica cerulea*, state threatened).

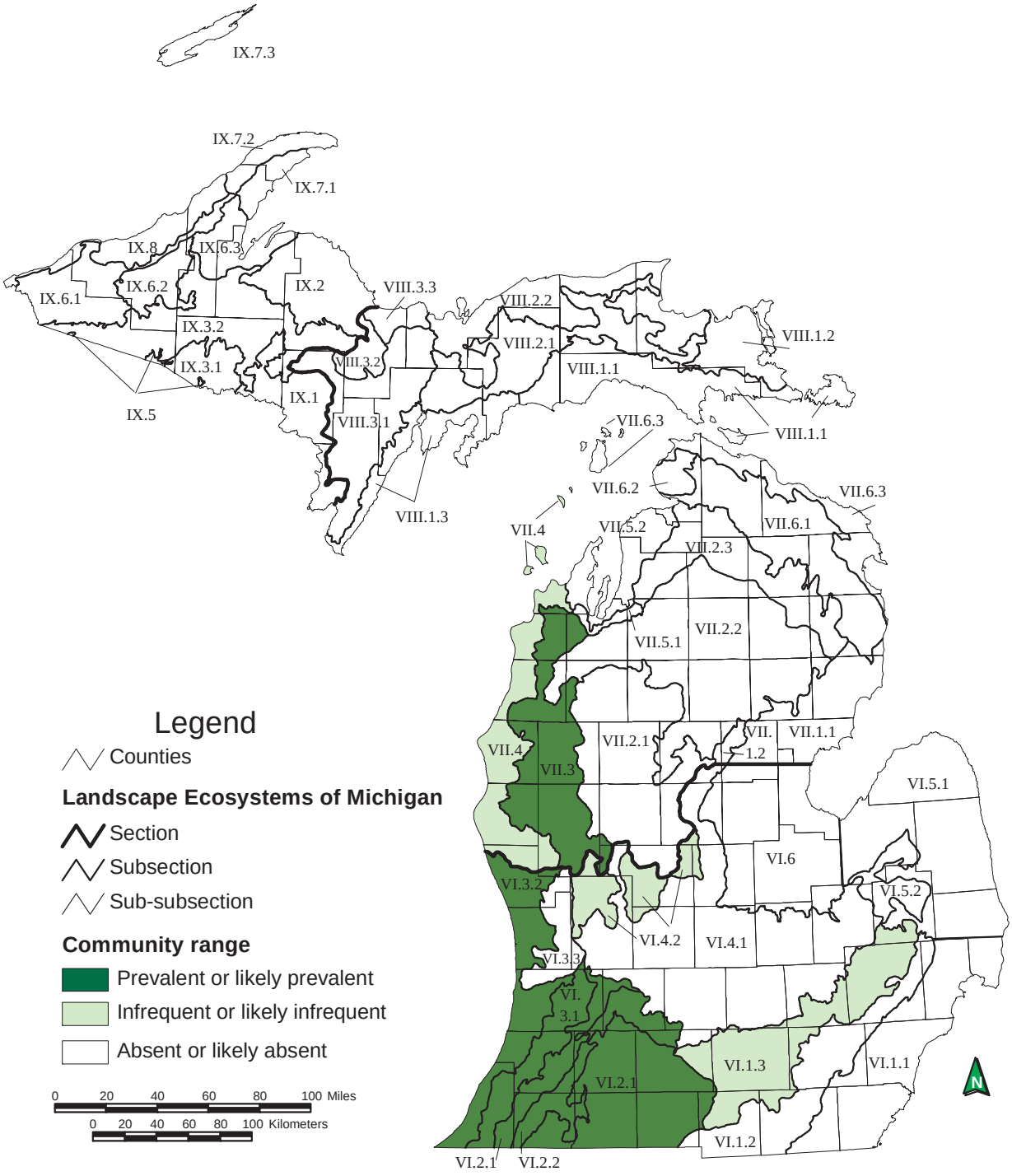
Threats: Species composition and vegetative structure of the bog are largely driven by natural processes. However, fire suppression throughout the general landscape may have altered the fire regime of the bog, which appears to be suffering from shrub encroachment.

Management Recommendations: The main management recommendation is to retain an intact buffer of natural communities surrounding the wetland to minimize the threat of hydrological alteration. Additional recommendations include burning the bog with the surrounding upland forest and monitoring for invasive species and following prescribed fire.

1998 aerial photograph of Otis Lake Bog.

COASTAL PLAIN MARSH

Overview: Coastal plain marsh is a graminoid-, shrub-, and herb-dominated wetland that contains numerous plant species disjunct from their primary ranges in the Atlantic and Gulf coastal plains. The community occurs primarily in the western Lower Peninsula along the shorelines of inland lakes and in depressions in sandy pitted outwash plains, outwash channels, and lakeplains. Coastal plain marsh is characterized by fluctuating water levels that can vary significantly both seasonally and interannually. The sandy soils underlying coastal plain marshes are strongly to very strongly acidic and nutrient-poor and are sometimes covered by a layer of peat or sandy peat. Fluctuating water levels and occasional fires maintain species composition and open conditions. (Kost et al. 2007).



Map 2. Distribution of coastal plain marsh in Michigan (Albert et al. 2008).

4. Dagget Lake
Natural Community Type: Coastal Plain Marsh
Rank: G2 S2, imperiled throughout range
Element Occurrence Rank: BC
Size: 19 acres
Location: Compartment 6, Stand 65
Element Occurrence Identification Number: 9832

Site Description: The Dagget Lake coastal plain marsh occurs along the shores of Dagget Lake, a softwater seepage lake that occupies an ice-block depression in a coarse-textured end moraine. The coastal plain marsh is best developed along the eastern and western shores of the lake and is characterized by seasonally and interannually fluctuating water levels. The soils are acidic sands (pH 4.8-5.6) with moderate organics.

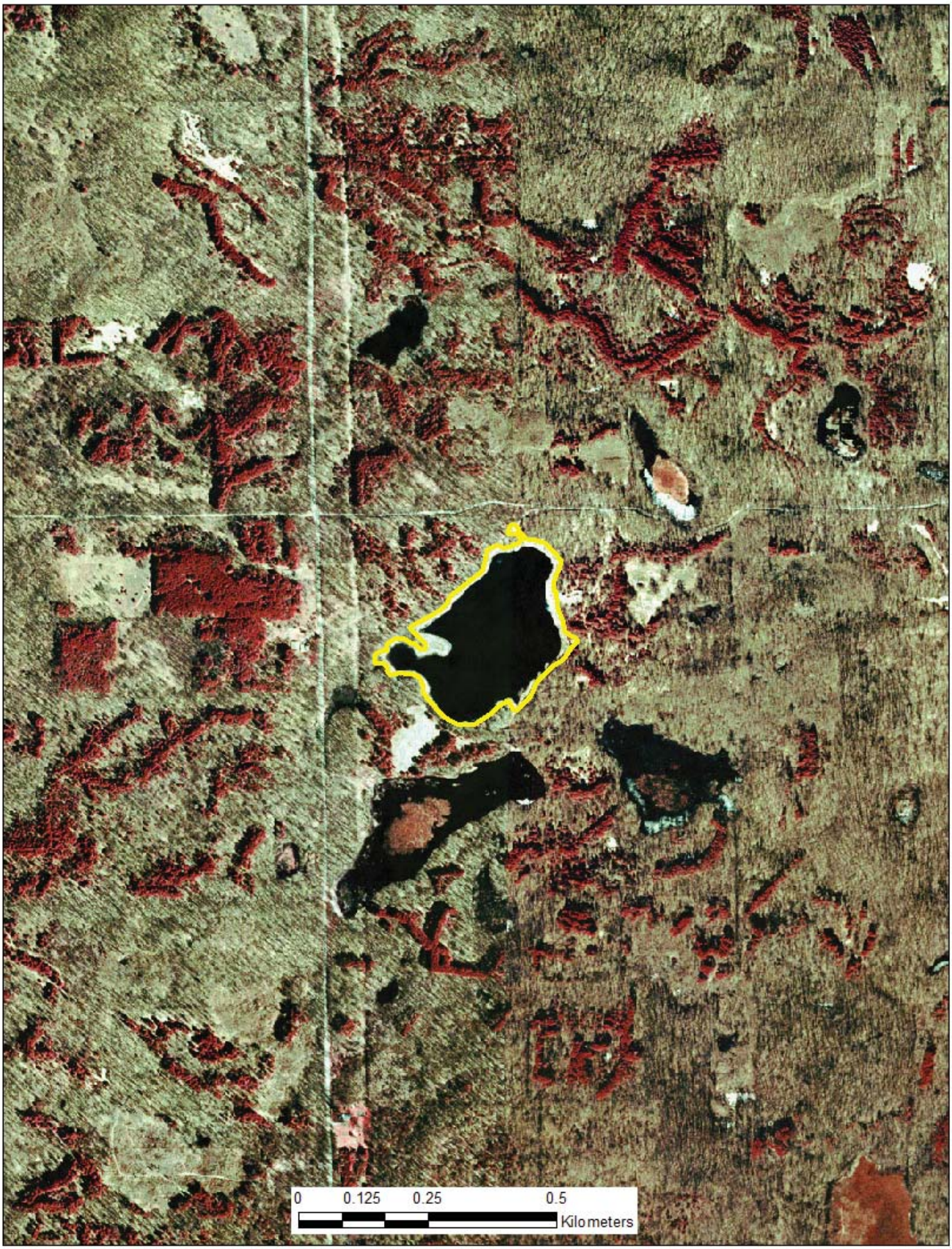
Areas of shallow water are characterized by sweet-scented waterlily (*Nymphaea odorata*), yellow pond-lilies (*Nuphar* spp.), and pipewort (*Eriocaulon aquaticum*). A three- to five-meter band of emergent graminoids rings the shallow water zone and is dominated by blue-joint (*Calamagrostis canadensis*), spike-rushes (*Eleocharis* spp.), and brownish beak-rush (*Rhynchospora capitellata*). Characteristic species include Canadian rush (*Juncus canadensis*), common boneset (*Eupatorium perfoliatum*), wild blue flag (*Iris versicolor*), slender goldentop (*Euthamia caroliniana*), northern bugle weed (*Lycopus uniflorus*), tooth-cup (*Rotala ramosior*), and wool-grass (*Scirpus cyperinus*). In addition, six rare coastal plain disjuncts occur within this emergent zone: black-fruited spike-rush (*Eleocharis melanocarpa*, state special concern), round-headed rush (*Juncus scirpoides*, state threatened), dwarf bulrush (*Lipocarpha micrantha*, state special concern), tall beak-rush (*Rhynchospora macrostachya*, state special concern), bald-rush (*Rhynchospora scirpoides*, state threatened), and umbrella-grass (*Fuirena pumila*, state threatened). Scattered shrubs occur along the margin of the marsh including willows (*Salix* spp.), buttonbush (*Cephalanthus occidentalis*), meadowsweet (*Spiraea alba*), steeplebush (*S. tomentosa*), swamp rose (*Rosa palustris*), and highbush blueberry (*Vaccinium corymbosum*). Scattered trees along the wetland margin include red maple (*Acer rubrum*) and trembling aspen (*Populus tremuloides*).

Blanchard's cricket frog (*Acris crepitans blanchardi,* state threatened) was last documented utilizing this wetland in 1986 and surveys in 2013 did not document any.

Threats: The main threat to the coastal plain marsh is fire suppression and associated tree and shrub encroachment. Shrub and tree encroachment is occurring locally along the western shore of the wetland. In the past, purple loosestrife (*Lythrum salicaria*) has been reported from this site but surveys in 2012 did not record any loosestrife.

Management Recommendations: The main management recommendation is to utilize prescribed fire to control shrub and tree encroachment. In addition, monitoring for invasive species should be implemented and invasive species should be controlled if found. Finally, an intact buffer of natural communities surrounding the wetland should be retained to minimize the threat of hydrological alteration.

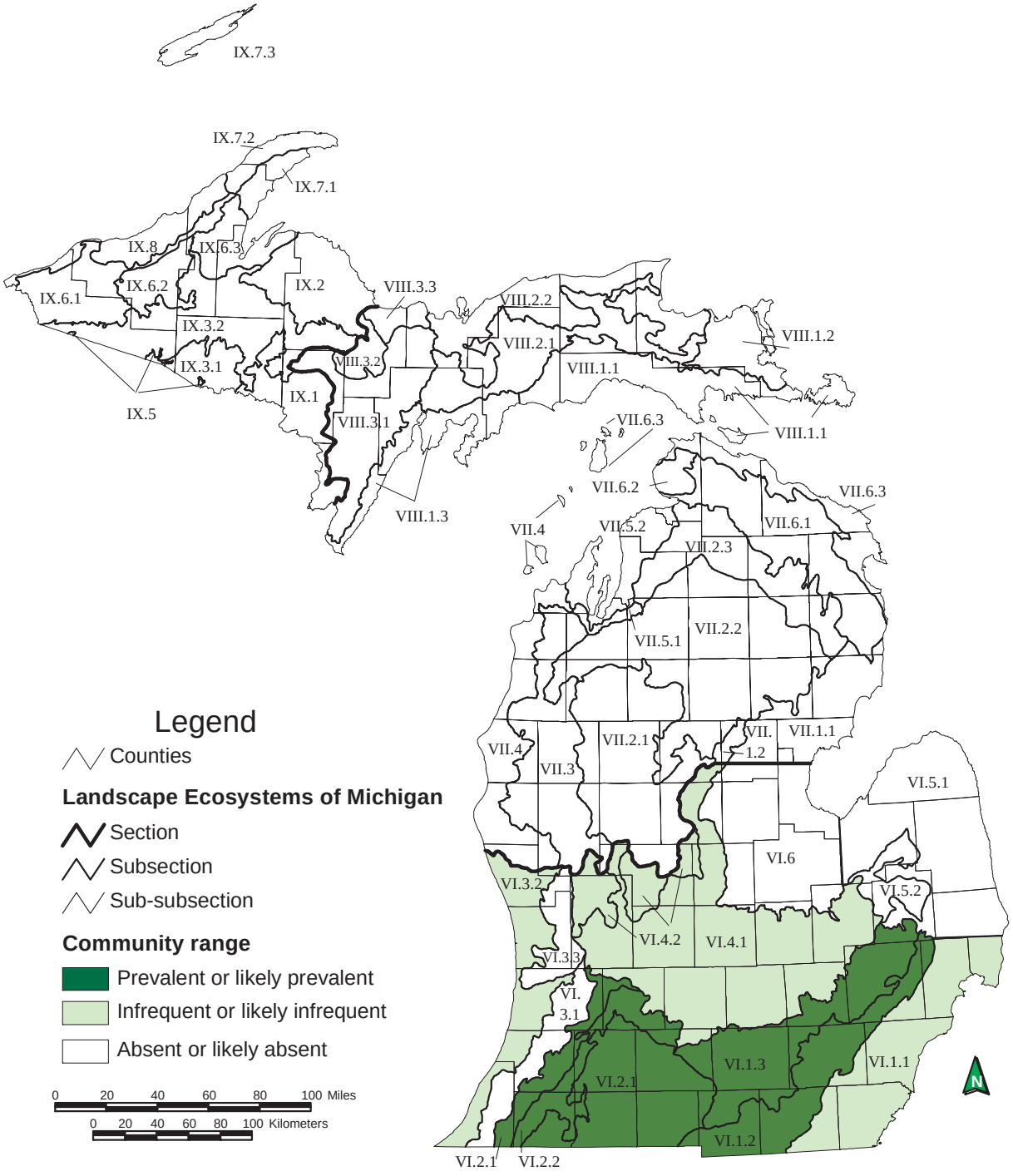
Dagget Lake coastal plain marsh. Photos by Michael A. Kost.



1998 aerial photograph of Dagget Lake coastal plain marsh.

DRY SOUTHERN FOREST

Overview: Dry southern forest is a fire-dependent, oak-dominated forest type on dry sites lying mostly south of the climatic tension zone in southern Lower Michigan. Frequent fires maintain semi-open conditions, promoting oak regeneration and ground and shrub layer diversity. The community occurs principally on glacial outwash, and less frequently on sand dunes, sandy glacial lakeplains, and coarse-textured moraines. Dry southern forest typically occurs in conjunction with other fire-dependent upland and wetland communities such as dry-mesic southern forest, oak barrens, dry sand prairie, coastal plain marsh, southern wet meadow, and prairie fen. The soils of dry southern forest are infertile, well-drained sand, loamy sand, or sandy loam with medium to strongly acid pH and low water-retaining capacity (Kost et al. 2007).



Map 3. Distribution of dry southern forest in Michigan (Albert et al. 2008).

5. Bassett Lake Woods
Natural Community Type: Dry Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 7 acres
Location: Compartment 1, Stands 99 and 110
Element Occurrence Identification Number: 18976

Site Description: Bassett Lake Woods is a small, maturing dry southern forest occurring on an esker and a kame within an outwash plain. The soils are medium-textured, well-drained, gravelly sandy loam that is circumneutral (pH 7.0). Diameters of canopy oaks range from 40 to 60 cm. A 60 cm white oak (*Quercus alba*) was cored and estimated to be 156 years old. The forest is characterized by large-diameter canopy oaks and moderate volumes of coarse woody debris resulting from gap-phase dynamics. The dry southern forest occurs adjacent to high-quality southern wet meadow (Bassett Lake Meadow, EO ID 18984) and rich tamarack swamp (Turner Creek Swamp, EO ID 18983) on the southwest side of Bassett Lake.

The closed canopy (70-80%) is dominated by oaks with black oak (*Q. velutina*), white oak, red oak (*Q. rubra*), and black cherry (*Prunus serotina*). The subcanopy is composed of scattered red maple (*Acer rubrum*), black cherry, black oak, serviceberries (*Amelanchier* spp.), witch-hazel (*Hamamelis virginiana*), and sassafras (*Sassafras albidum*). The ground cover is characterized by Pennsylvania sedge (*Carex pensylvanica*), bluestem goldenrod (*Solidago caesia*), yellow wild licorice (*Galium lanceoloatum*), round-leaved hepatica (*Hepatica americana*), arrow-leaved aster (*Symphyotrichum urophyllum*), large-leaved aster (*Eurybia macrophylla*), and long-awned wood grass (*Brachyelytrum erectum*). The prevalence of red maple and black cherry in the subcanopy as well as in the understory indicates that the site has experienced many decades of fire suppression. Invasives are sparse but in some areas autumn olive (*Elaeagnus umbellata*) and morrow honeysuckle (*Lonicera morrowii*) are locally abundant. Oak regeneration is sparse to absent, likely due to fire suppression, competition from invasives, and deer browse pressure.

Threats: Species composition, vegetative structure, and successional trajectories are strongly influenced by fire suppression, invasive species, and deer herbivory. Oak regeneration is sparse, likely due to fire suppression and mesophytic invasion (e.g., red maple), competition from invasives, and deer browse pressure. Invasives are scattered throughout this forest but in some areas, autumn olive (*Elaeagnus umbellata*) and morrow honeysuckle (*Lonicera morrowii*) are locally abundant. Within forests surrounding this site, invasive shrubs are prevalent within the understory and are impacting successional processes.

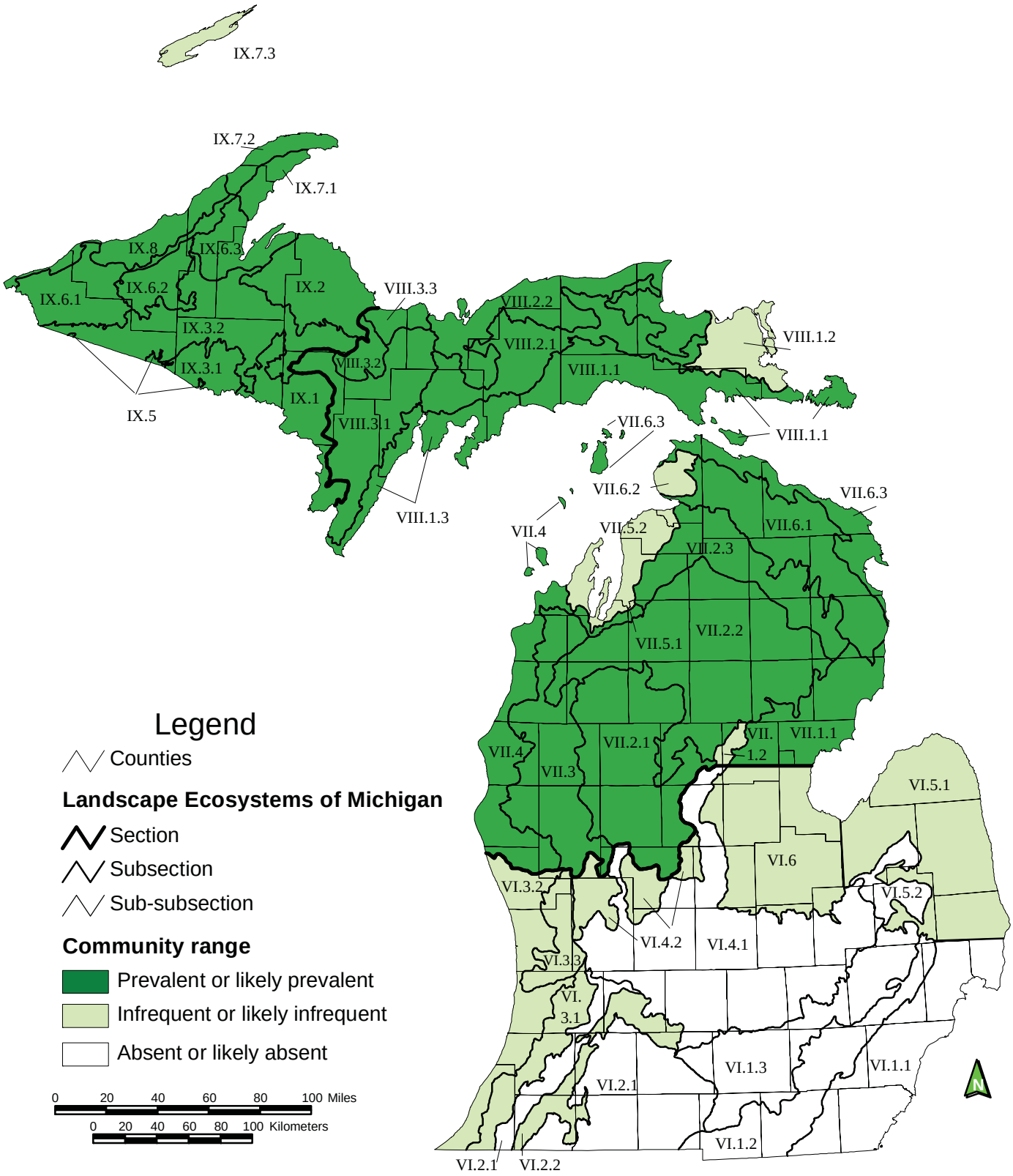
Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor to maintain open understory conditions, reduce invasive species and native mesophytic species, especially red maple, and promote oak regeneration. Prescribed burning of this dry southern forest should be coordinated with the burning of the adjacent southern wet meadow. The seasonality of burns should be varied to include growing season and fall burns as well as spring burns. Restricting prescribed fire to early spring can result in understory dominance by fire-tolerant woody species that can sprout following early season burns. Subcanopy and understory red maple (*Acer rubrum*) could be girdled if repeated fires do not control this mesophytic invader. In addition, cutting and herbiciding invasive shrubs will also complement the use of fire to control invasive shrubs. Reducing invasive species in the surrounding landscape and allowing surrounding early-successional forest to mature will reduce the seed source of invasive species adjacent to this high-quality area. Once invasive and mesophytic woody species have been controlled within the site, the frequency of burning should be carefully evaluated and could be reduced to once every 5 to 10 years. Monitoring should be implemented to allow for assessment of whether management is reducing invasive and native mesophytic species populations and fostering oak regeneration. If oak is not regenerating after ten years, resource managers should evaluate whether additional steps need to be taken, such as, planting of acorns or oak saplings, reduction of deer densities, and/or creation of canopy gaps. Monitoring deer densities and deer herbivory will allow for the assessment of whether deer herbivory threatens to jeopardize floristic structure and composition.

Bassett Lake Woods dry southern forest. Photos by Michael A. Kost.

1998 aerial photograph of Bassett Lake Woods dry southern forest.

DRY-MESIC NORTHERN FOREST

Overview: Dry-mesic northern forest is a pine or pine-hardwood forest type of generally dry-mesic sites located mostly north of the transition zone. Dry-mesic northern forest is characterized by acidic, coarse- to medium-textured sand or loamy sand and occurs principally on sandy glacial outwash, sandy glacial lakeplains, and less often on inland dune ridges, coarse-textured moraines, and thin glacial drift over bedrock. The community historically originated in the wake of catastrophic fire and was maintained by frequent, low-intensity ground fires (Kost et al. 2007).



Map 4. Distribution of dry-mesic northern forest in Michigan (Albert et al. 2008).

6. Gulch Road Forest
Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 14 acres
Location: Compartment 2, Stand 18
Element Occurrence Identification Number: 18974

Site Description: Gulch Road Forest is a maturing oak-pine forest that occurs on a sandy rise within an outwash plain north of Turner Creek. The soils of the dry-mesic northern forest are coarse-textured, acidic (pH 4.5) sandy loam. Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, fire suppression, invasive species, and deer herbivory. Scattered windthrow has generated small canopy gaps and a moderate volume of coarse woody debris of variable size and decomposition classes. Diameters of the canopy cohort typically range from 40 to 70 cm. A 56 cm black oak (*Quercus velutina*) was cored and estimated to be over 147 years old. Gulch Road Forest and Turner Creek Forest are the first two dry-mesic northern forest EOs documented in the Kalamazoo Interlobate (VI.2) and the Cassopolis Ice-Contact Ridges (VI.2.2).

The closed canopy is dominated by white oak (*Q. alba*) and white pine (*Pinus strobus*) with black oak (*Q. velutina*), red maple (*Acer rubrum*), and black cherry (*Prunus serotina*) as canopy associates. Scattered supercanopy white pines occur within the forest. The subcanopy is composed of red maple, white pine, sassafras (*Sassafras albidum*), and black cherry. The prevalence of red maple and black cherry in the subcanopy as well as in the understory indicates that the site has experienced many decades of fire suppression. White pine and red maple are abundant in the understory and low shrub layer. The shrub layer and ground cover are sparse to patchy and occur primarily within light gaps caused by windthrow. The ground cover, sparse due to deer browse and fire suppression, is dominated by Pennsylvania sedge (*Carex pensylvanica*). Autumn olive (*Elaeagnus umbellata*) was noted along the eastern margin of the forest. Fifteen native, vascular plant species were noted within this forest during the 2012 surveys.

Threats: Invasive species, heavy deer browse, and fire suppression threaten the long-term viability of this community and limit the capacity of oak to regenerate. In addition, high levels of invasive species occur in the adjacent degraded forests and provide a seed source for continued invasive species incursions.

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor. Implementation of prescribed fire is best done in the context of landscape-scale fire. Subcanopy and understory red maple and black cherry could be girdled or mechanically felled if repeated fires do not control these mesophytic species. In addition, cutting and herbiciding invasive shrubs along the margin of the forest and also in adjacent forested stands will also complement the use of fire to control invasive shrubs. Control of invasive plant populations within the surrounding landscape will require a major, long-term effort. Reducing local deer browse pressure is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak and pine regeneration and response of the forest to fire management.

Gulch Road Forest dry-mesic northern forest. Photo by Michael A. Kost.

1998 aerial photograph of Gulch Road Forest dry-mesic northern forest.

7. Turner Creek Forest
Natural Community Type: Dry-mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 11 acres
Location: Compartment 2, Stand 33
Element Occurrence Identification Number: 18975

Site Description: Turner Forest is a maturing oak-pine forest that occurs on a sandy rise within an outwash plain. The soils of the dry-mesic northern forest are coarse-textured, acidic (pH 4.5-5.0) sandy loam. Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, fire suppression, invasive species, and deer herbivory. Scattered windthrow has generated small canopy gaps and a moderate volume of coarse woody debris of variable size and decomposition classes. Turner Creek Forest occurs just north of a high-quality wet prairie (Turner Creek Wet Prairie, EO ID 18987). Diameters of the canopy cohort typically range from 38 to 76 cm. A 56 cm black oak (*Quercus velutina*) was cored and estimated to be over 149 years old. Turner Creek Forest and Gulch Road Forest are the first two dry-mesic northern forest EOs documented in the Kalamazoo Interlobate (VI.2) and the Cassopolis Ice-Contact Ridges (VI.2.2).

The closed canopy is dominated by large white oak (*Q. alba*) and white pine (*Pinus strobus*) with black oak, red maple (*Acer rubrum*), and black cherry (*Prunus serotina*) as canopy associates. Scattered supercanopy white pines occur within the forest. The subcanopy is composed of red maple, white pine, sassafras (*Sassafras albidum*), white oak, and black cherry. Common understory species include white pine, red maple, black cherry, and hazelnut (*Corylus americana*). The prevalence of red maple and black cherry in the subcanopy as well as in the understory indicates that the site has experienced many decades of fire suppression. Oak regeneration is locally prevalent where there are light gaps. The low shrub layer is patchy and characterized by hazelnut, low sweet blueberry (*Vaccinium angustifolium*), prickly gooseberry (*Ribes cynosbati*), and pasture rose (*Rosa carolina*). Vines are uncommon within the forest and include Virginia creeper (*Parthenocissus quinquefolia*) and poison-ivy (*Toxicodendron radicans*). The ground cover is sparse to patchy and is characterized by Pennsylvania sedge (*Carex pensylvanica*), bracken fern (*Pteridium aquilinum*), hairy sweet cicely (*Osmorhiza claytonii*), pointed-leaf tick-trefoil (*Hylodesmum glutinosum*), and naked-flower tick-trefoil (*Hylodesmum nudiflorum*). Invasive species are locally abundant along the margins of the forest and include multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), morrow honeysuckle (*Lonicera morrowii*), and garlic mustard (*Alliara petiolata*). Thirty-six native, vascular plant species were noted within this forest during the 2012 surveys.

Threats: Invasive species, heavy deer browse, and fire suppression threaten the long-term viability of this community and limit the capacity of oak to regenerate. In addition, high levels of invasive species occur in the adjacent degraded forests and provide a seed source for continued invasive species incursions.

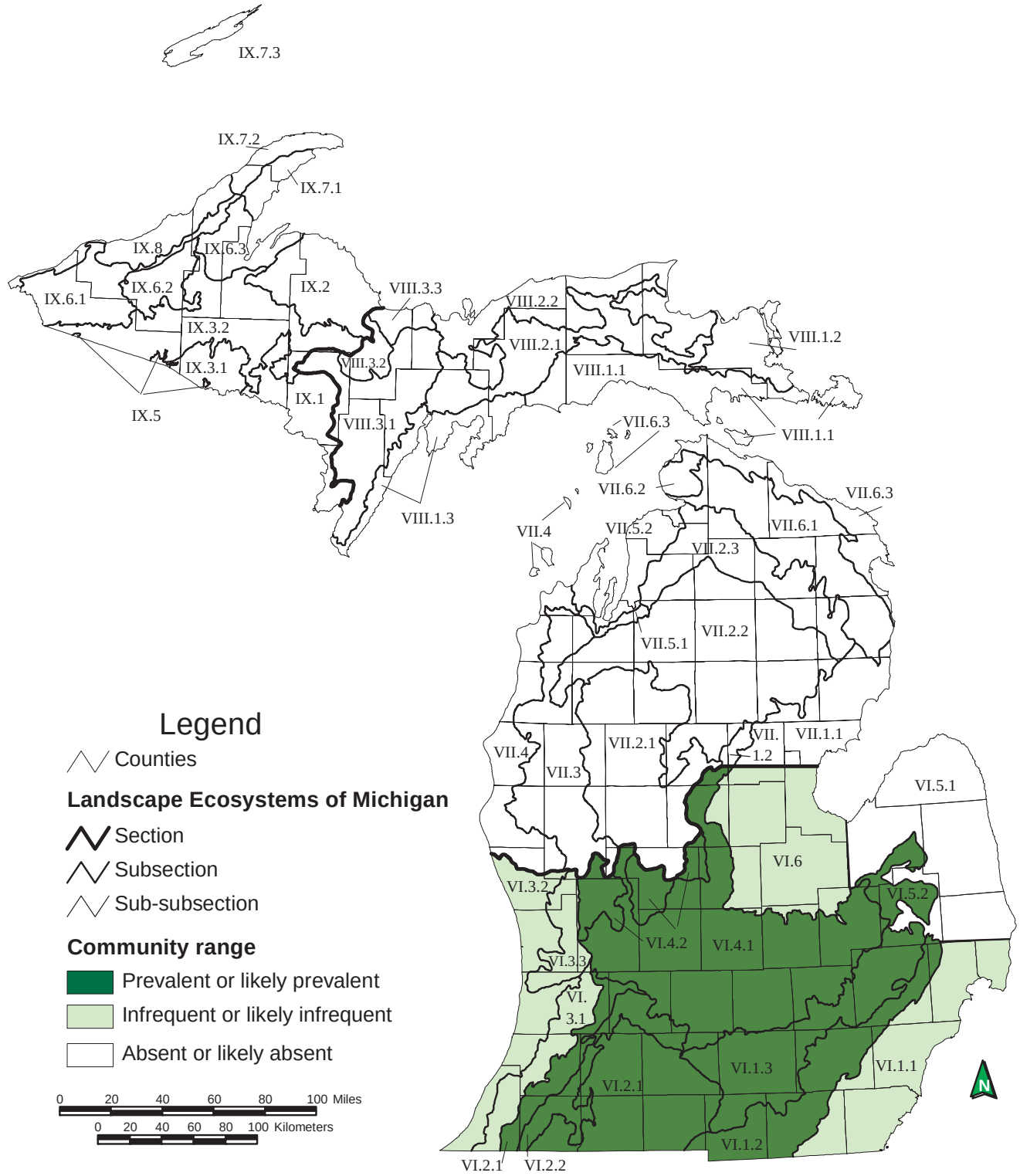
Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor. Implementation of prescribed fire is best done in the context of landscape-scale fire. This forest should be burned in concert with Turner Creek Wet Prairie to the south. Subcanopy and understory red maple and black cherry could be girdled or mechanically felled if repeated fires do not control these mesophytic invaders. In addition, cutting and herbiciding invasive shrubs along the margin of the forest and also in adjacent forested stands will also complement the use of fire to control invasive shrubs. Control of invasive plant populations within the surrounding landscape will require a major, long-term effort. Reducing local deer browse pressure is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak and pine regeneration and response of the forest to fire management.

Turner Creek Forest dry-mesic northern forest. Photos by Michael A. Kost.

1998 aerial photograph of Turner Creek Forest dry-mesic northern forest.

DRY-MESIC SOUTHERN FOREST

Overview: Dry-mesic southern forest is a fire-dependent, oak or oak-hickory forest type on generally dry-mesic sites found south of the climatic tension zone in southern Lower Michigan. This natural community occurs principally on glacial outwash, coarse-textured moraines, sandy glacial lakeplains, kettle-kame topography, and sand dunes. Soils are typically sandy loam or loam and slightly acid to neutral in pH. Frequent fires maintain semi-open conditions, promoting oak regeneration and ground and shrub layer diversity (Kost et al. 2007).



Map 5. Distribution of dry-mesic southern forest in Michigan (Albert et al. 2008).

8. Dagget Lake Woods
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 43 acres
Location: Compartment 6, Stands 90, 91, and 106
Element Occurrence Identification Number: 18968

Site Description: Dagget Lake Woods is a second-growth oak forest that occurs on rolling end moraine of variable aspect. The soils are acidic (pH 5.5) sandy loam. The forest is characterized by large-diameter canopy oaks and moderate volumes of coarse woody debris and small canopy gaps resulting from gap-phase dynamics. Diameters of the canopy cohort range from 50 to 75 cm with some larger oaks reaching 90 cm. A 62 cm white oak (*Quercus alba*) was cored and estimated to be 163 years old and a 60 cm pignut hickory (*Carya glabra*) was cored and estimated to be 160 years old. Several vernal pools occur within this forest.

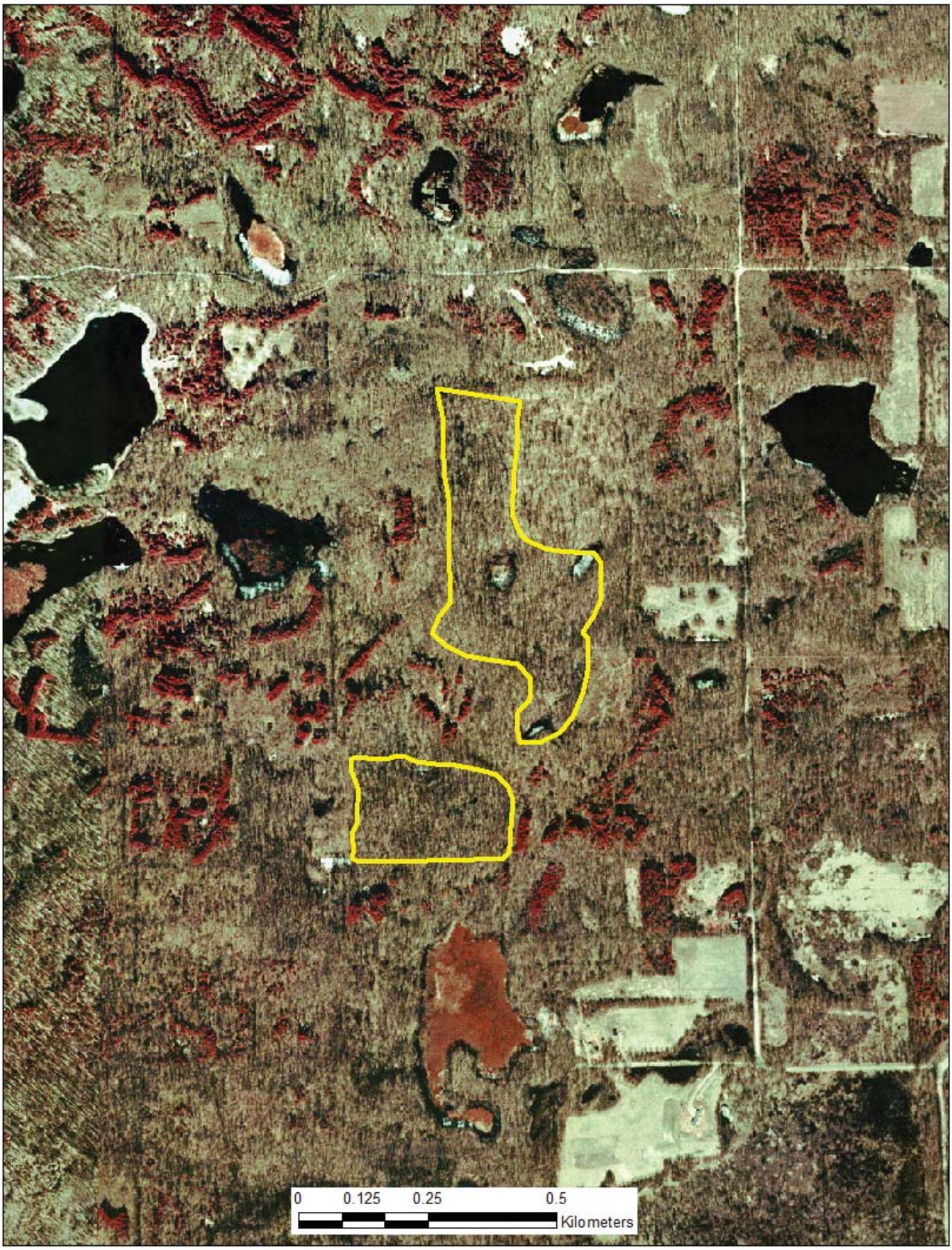
The closed canopy (85-95%) is dominated by large-diameter mid-tolerant oaks and hickories including red oak (*Quercus rubra*), white oak, black oak (*Q. velutina*), and pignut hickory. Canopy associates include red maple (*Acer rubrum*), white ash (*Fraxinus americana*), and black cherry (*Prunus serotina*). The subcanopy is composed of red maple, black cherry, and sassafras (*Sassafras albidum*). The prevalence of red maple and black cherry in the subcanopy and understory indicates that the site has experienced many decades of fire suppression. Other species prevalent in the patchy understory are witch-hazel (*Hamamelis virginiana*), serviceberries (*Amelanchier* spp.), white ash, and flowering dogwood (*Cornus florida*). Invasives are locally abundant in the understory and ground cover, especially near the forest edges, and include multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), Japanese barberry (*Berberis thunbergii*), hedge-parsley (*Torilis japonica*), and garlic mustard (*Alliara petiolata*). Within the understory layer, oak regeneration is sparse to absent, likely due to competition from invasives, fire suppression, and deer herbivory. The patchy low shrub layer is characterized by blackberries (*Rubus* spp.), gooseberries (*Ribes* spp.), maple-leaved arrow-wood (*Viburnum acerifolium*), and white ash. Vines are prevalent throughout the forest and include summer grape (*Vitis aestivalis*), Virginia creeper (*Parthenocissus quinquefolia*), and poison-ivy (*Toxicodendron radicans*). The ground cover is characterized by Pennsylvania sedge (*Carex pensylvanica*), may apple (*Podophyllum peltatum*), wild sarsaparilla (*Aralia nudicaulis*), wild geranium (*Geranium maculatum*), pointed-leaf tick-trefoil (*Hylodesmum glutinosum*), and naked-flower tick-trefoil (*Hylodesmum nudiflorum*). In addition, ginseng (*Panax quinquefolius*, state threatened) occurs within this forest. Seventy-eight native, vascular plant species were noted within this forest during the 2012 surveys.

Hooded warbler (*Setophaga citrina*, state special concern) have been documented using this forest complex.

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, past logging, fire suppression, invasive species, and deer herbivory. Signs of old anthropogenic disturbance were noted at the margins of the forest including scattered cut stumps, an old fence, and rock piles. Oak regeneration is sparse to absent, likely due to fire suppression and mesophytic invasion, competition from invasives and mesophytic species, and deer browse pressure. Many of the canopy white ash have been killed by emerald ash borer. As noted above, invasives are locally abundant in the understory. In addition, high levels of invasive species occur in the adjacent degraded forests and provide a seed source for continued invasive species incursions.

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor. Implementation of prescribed fire is best done in the context of landscape-scale fire. Subcanopy and understory red maple, sassafras, and black cherry could be girdled or mechanically felled if repeated fires do not control these mesophytic species. In addition, cutting and herbiciding concentrations of invasive shrubs in the site and also in adjacent forested stands will also complement the use of fire to control invasive shrubs. Concentrations of garlic mustard can also be pulled by hand. Control of invasive plant populations within the surrounding landscape will require a major, long-term effort. Reducing local deer browse pressure is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak regeneration and response of the forest to fire management. Within this site, care should be taken to protect the population of ginseng. Ginseng is a rare plant species that is sensitive to soil and canopy disturbance and competition from invasive species. In addition, maintaining this forest as a closed-canopy system will also benefit the breeding population of hooded warbler within this forest.

Dagget Lake Woods dry-mesic southern forest with ginseng below. Photos by Michael A. Kost.



1998 aerial photograph of Dagget Lake Woods dry-mesic southern forest.

9. Fish Lake East Woods
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 18 acres
Location: Compartment 7, Stand 24
Element Occurrence Identification Number: 13347

Site Description: Fish Lake East Woods is an upland island that occurs on the east side of Fish Lake in an outwash plain. The forest is surrounded by marsh and shrub-carr to the north and south and swamp to the east. Soils of the dry-mesic southern forest are acidic (pH 5.5-6.5) sandy loam. Diameters of the canopy cohort typically range from 50 to 70 cm with some larger oaks (*Quercus* spp.) and tulip tree (*Lireodendron tulipifera*) reaching 70 to 100 cm. A 38 cm tulip tree was cored and estimated to be over 88 years old. Scattered windthrow has generated small canopy gaps and a moderate volume of coarse woody debris. The northern portion of the forest burned in 2009.

The canopy is dominated by large diameter red oak (*Quercus rubra*) with diverse canopy associates including white oak (*Q. alba*), tulip tree, white ash (*Fraxinus americana*), basswood (*Tilia americana*), black oak (*Q. velutina*), and beech (*Fagus grandifolia*). The largest trees occur within the southern and central portion of the forest with the northern portion being scrubbier. Prevalent understory species include red maple (*Acer rubrum*) and flowering dogwood (*Cornus florida*) along with ironwood (*Ostrya virginiana*), and spicebush (*Lindera benzoin*). In addition, autumn olive (*Elaeagnus umbellata*) is locally abundant in the understory and multiflora rose (*Rosa multiflora*) is uncommon. The ground cover is dominated by Pennsylvania sedge (*Carex pensylvanica*) with associates including long-awned wood grass (*Brachyelytrum erectum*), bottlebrush grass (*Elymus hystrix*), hog-peanut (*Amphicarpaea bracteata*), pointed-leaf tick-trefoil (*Hylodesmum glutinosum*), and naked-flower tick-trefoil (*H. nudiflorum*).

Threats: Species composition, vegetative structure, and successional trajectories are strongly influenced by gap dynamics, fire suppression, invasive species, and likely deer herbivory. As noted above, invasives are scattered in the understory and include autumn olive (locally abundant) and multiflora rose (uncommon).

Management Recommendations: Management should focus on reducing infestations of invasive species through mechanical treatments, herbicide, and/or prescribed fire. Prescribed fire should be utilized to control invasive species and red maple. Implementation of prescribed fire is best done in the context of landscape-scale fire. Girdling of red maple should also be considered if fire does not set this meshophytic species back. Monitoring should be implemented for efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak regeneration and response of the forest to fire.

1998 aerial photograph of Fish Lake East Woods dry-mesic southern forest.

10. Gun Lake Road Woods
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 127 acres
Location: Compartment 3, Stand 62
Element Occurrence Identification Number: 18967

Site Description: Gun Lake Road Woods is a maturing second-growth oak forest that occurs on hilly terrain of end moraine of variable aspect. The soils are acidic (pH 5.5) sandy loam with abundant glacial erratics. The forest is characterized by large-diameter canopy oaks and hickories, a moderate volume of coarse woody debris, and small canopy gaps resulting from gap-phase dynamics. Diameters of the canopy cohort range from 50 to 75 cm. A canopy black oak (*Quercus velutina*) was cored and estimated to be 117 years old. Several vernal pools occur within this forest.

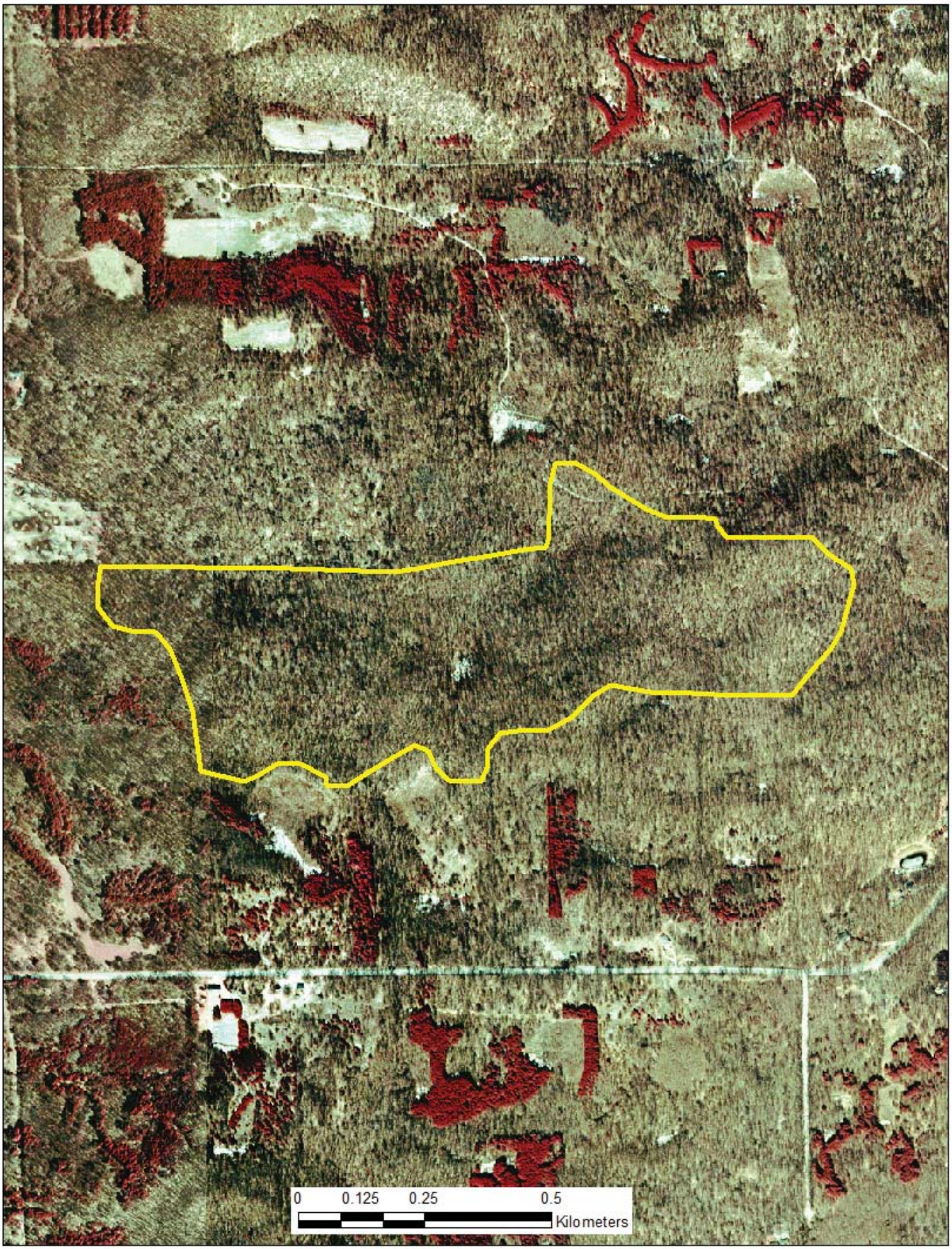
The closed canopy is dominated by large-diameter mid-tolerant oaks and hickories including white oak (*Q. alba*), black oak (*Q. velutina*), and pignut hickory (*Carya glabra*). These species are especially prevalent on ridge tops and south facing slopes. Red oak (*Q. rubra*) dominates the canopy on mid to lower slopes and also on north-facing slopes. Black cherry (*Prunus serotina*) is a common canopy associate throughout. The subcanopy is sparse and composed of red maple (*Acer rubrum*), flowering dogwood (*Cornus florida*), pignut hickory, sassafras (*Sassafras albidum*), and black cherry. The prevalence of red maple and black cherry in the subcanopy and understory indicates that the site has experienced many decades of fire suppression. Oak regeneration is uncommon, likely due to competition from invasive shrubs, fire suppression, and deer browse pressure. Invasive plants are uncommon to locally abundant and include multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), morrow honeysuckle (*Lonicera morrowii*), winged euonymus (*Euonymus alatus*), hedge-parsley (*Torilis japonica*), and garlic mustard (*Alliara petiolata*). The low shrub layer is sparse to patchy with characteristic species including blackberries (*Rubus* spp.), gooseberries (*Ribes* spp.), maple-leaved arrow-wood (*Viburnum acerifolium*), and white ash (*Fraxinus americana*). Vines are prevalent throughout the forest and include summer grape (*Vitis aestivalis*), Virginia creeper (*Parthenocissus quinquefolia*), and poison-ivy (*Toxicodendron radicans*). The ground cover is sparse and dominated by a few species including Pennsylvania sedge (*Carex pensylvanica*), may apple (*Podophyllum peltatum*), wild geranium (*Geranium maculatum*), wild sarsaparilla (*Aralia nudicaulis*), pointed-leaf tick-trefoil (*Hylodesmum glutinosum*), and naked-flower tick-trefoil (*H. nudiflorum*). In addition, upland boneset (*Eupatorium sessilifolium*, state threatened) was documented in the northeastern portion of this forest. Sixty-five native, vascular plant species were noted within this forest during the 2012 surveys.

This forest supports breeding populations of hooded warbler (*Setophaga citrina*, state special concern) and cerulean warbler (*Dendroica cerulea*, state threatened).

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, past logging, fire suppression, invasive species, and deer herbivory. As noted above, invasives are locally abundant in the understory. In addition, high levels of invasive species occur in the adjacent degraded forests and provide a seed source for continued invasive species incursions.

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor. Implementation of prescribed fire is best done in the context of landscape-scale fire. Subcanopy and understory red maple, sassafras, and black cherry could be girdled or mechanically felled if repeated fires do not control these mesophytic invaders. In addition, cutting and herbiciding concentrations of invasive shrubs within the site and also in adjacent forested stands will also complement the use of fire to control invasive shrubs. Concentrations of garlic mustard can also be pulled by hand. Control of invasive plant populations within the surrounding landscape will require a major, long-term effort. Reducing local deer browse pressure is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak regeneration and response of the forest to fire management. Within this site, care should be taken to protect the population of upland boneset. Upland boneset is a rare plant species that is sensitive to soil and canopy disturbance and competition from invasive species. In addition, maintaining this forest as a closed-canopy system will also benefit the breeding populations of hooded warbler and cerulean warbler documented within this forest.

Gun Lake Road Woods dry-mesic southern forest with upland boneset below. Photos by Michael A. Kost.



1998 aerial photograph of Gun Lake Road Woods dry-mesic southern forest.

11. Gun Lake Woods
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Size: 119 acres
Location: Compartment 6, Stands 3 and 7
Element Occurrence Identification Number: 18973

Site Description: Gun Lake Woods is a diverse oak-hickory forest on steep sloping hillsides that occurs on rolling topography of end moraine with variable aspect. Soils of the dry-mesic southern forest are coarse-textured, acidic (pH 6.5) sandy loam with abundant glacial erratics. Diameters of the canopy cohort typically range from 25 to 75 cm with some larger oaks reaching 100 cm and one tulip tree (*Liriodendron tulipifera*) was measured to be 125 cm. A 56 cm beech (*Fagus grandifolia*) was cored and estimated to be 120 years old and a 53 cm red oak (*Quercus rubra*) was cored and estimated to be 103 years old. Scattered windthrow has generated small canopy gaps and a moderate volume of coarse woody debris. Several vernal pools occur within this forest.

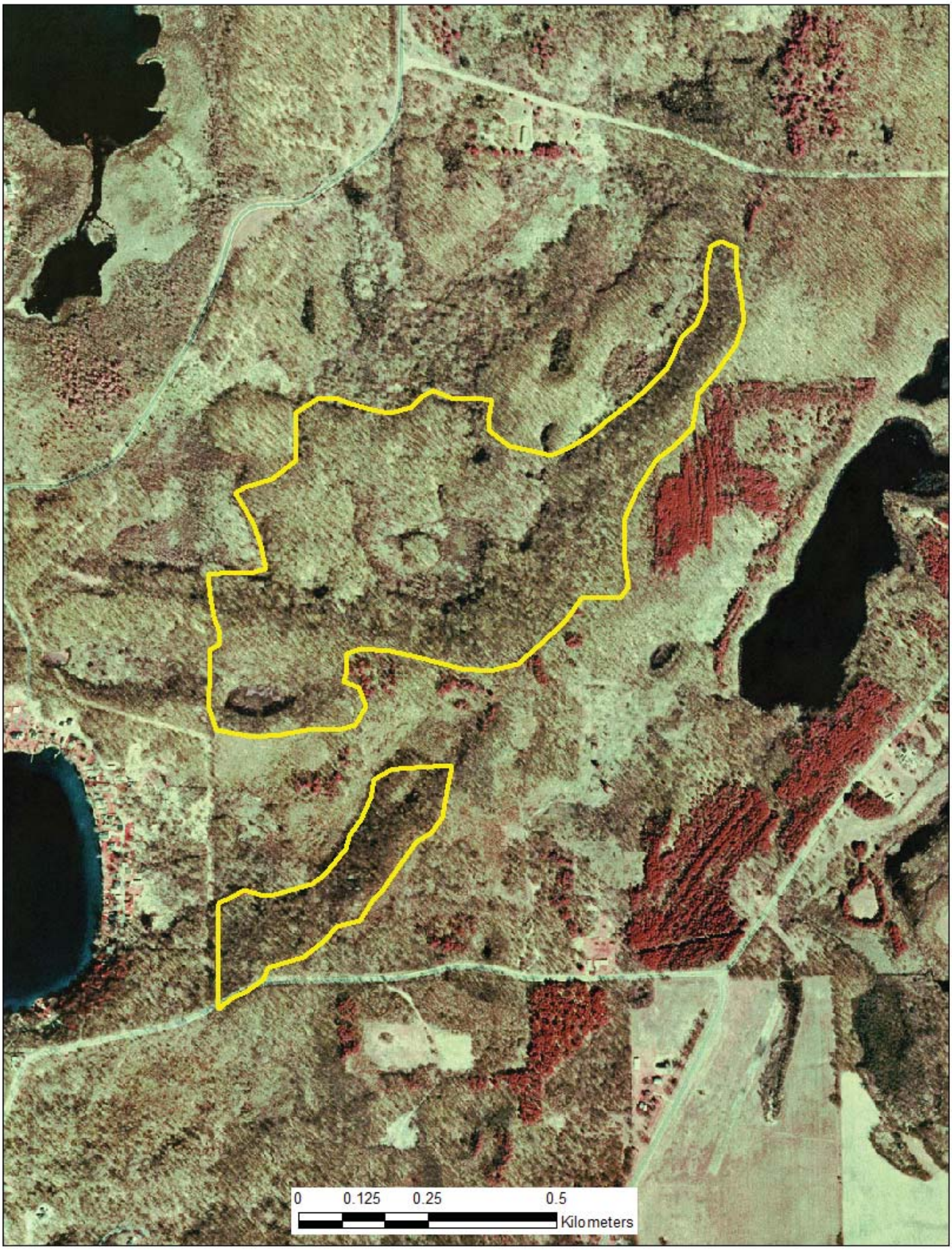
The closed canopy is dominated by very large maturing oaks and hickories with red oak, white oak (*Q. alba*), pignut hickory (*Carya glabra*), bitternut hickory (*C. cordiformis*), and black oak (*Q. velutina*). Canopy associates include red maple (*Acer rubrum*), white ash (*Fraxinus americana*), basswood (*Tilia americana*), tulip tree, beech, and black cherry (*Prunus serotina*). The subcanopy is composed of red maple, ironwood (*Ostrya virginiana*), flowering dogwood (*Cornus florida*), hickories, tulip tree, sassafras (*Sassafras albidum*), and black cherry. The prevalence of red maple and black cherry in the subcanopy as well as in the understory indicates that the site has experienced many decades of fire suppression. Other species prevalent in the patchy understory are witch-hazel (*Hamamelis virginiana*) and white ash. Invasive plants are locally abundant and include multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), morrow honeysuckle (*Lonicera morrowii*), winged euonymus (*Euonymus alatus*), Japanese barberry (*Berberis thunbergii*), and garlic mustard (*Alliara petiolata*). Oak regeneration is sparse to absent, likely due to competition from invasives, fire suppression, and deer browse pressure. The low shrub layer is patchy with characteristic species including blackberries (*Rubus* spp.), gooseberries (*Ribes* spp.), maple-leaved arrow-wood (*Viburnum acerifolium*), and white ash. Vines are prevalent throughout the forest and include summer grape (*Vitis aestivalis*), Virginia creeper (*Parthenocissus quinquefolia*), and poison-ivy (*Toxicodendron radicans*). The ground cover is sparse and dominated by a few species including Pennsylvania sedge (*Carex pensylvanica*), may apple (*Podophyllum peltatum*), wild geranium (*Geranium maculatum*), wild sarsaparilla (*Aralia nudicaulis*), pointed-leaf tick-trefoil (*Hylodesmum glutinosum*), and naked-flower tick-trefoil (*H. nudiflorum*). In addition, ginseng (*Panax quinquefolius*, state threatened) occurs within this forest. Ninety-six native, vascular plant species were noted within this forest during the 2012 surveys.

This forest supports breeding populations of cerulean warbler (*Dendroica cerulea*, state threatened).

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, past logging, fire suppression, invasive species, and deer herbivory. Signs of old anthropogenic disturbance were noted at the margins of the forest including scattered cut stumps, an old fence, and rock piles. Oak regeneration is sparse to absent, likely due to fire suppression and mesophytic invasion, competition from invasives and mesophytic species, and deer browse pressure. Many of the canopy white ash have been killed by emerald ash borer. As noted above, invasives are locally abundant in the understory. In addition, high levels of invasive species occur in the adjacent degraded forests and provide a seed source for continued invasive species incursions.

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor. Implementation of prescribed fire is best done in the context of landscape-scale fire. Subcanopy and understory red maple, sassafras, and black cherry could be girdled or mechanically felled if repeated fires do not control these mesophytic species. In addition, cutting and herbiciding concentrations of invasive shrubs in the site and also in adjacent forested stands will also complement the use of fire to control invasive shrubs. Concentrations of garlic mustard can also be pulled by hand. Control of invasive plant populations within the surrounding landscape will require a major, long-term effort. Reducing local deer browse pressure is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak regeneration and response of the forest to fire management. Within this site, care should be taken to protect the population of ginseng. Ginseng is a rare plant species that is sensitive to soil and canopy disturbance and competition from invasive species. In addition, maintaining this forest as a closed-canopy system will also benefit the breeding population of cerulean warbler documented within this forest.

Gun Lake Woods dry-mesic southern forest. Photos by Michael A. Kost.



1998 aerial photograph of Gun Lake Woods dry-mesic southern forest.

12. Hart Road Woods
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 54 acres
Location: Compartment 3, Stand 62
Element Occurrence Identification Number: 18969

Site Description: Hart Road Woods is an oak-hickory forest that occurs on a rolling end moraine of variable aspect. Soils of the dry-mesic southern forest are coarse- to medium-textured, acidic (pH 5.5) sandy loam. Diameters of the canopy cohort typically range from 40 to 60 cm with some larger oaks reaching 70 to 100 cm. A black oak (*Quercus velutina*) was cored and estimated to be over 117 years old. Scattered windthrow has generated small canopy gaps and a moderate volume of coarse woody debris. Several vernal pools occur within this forest.

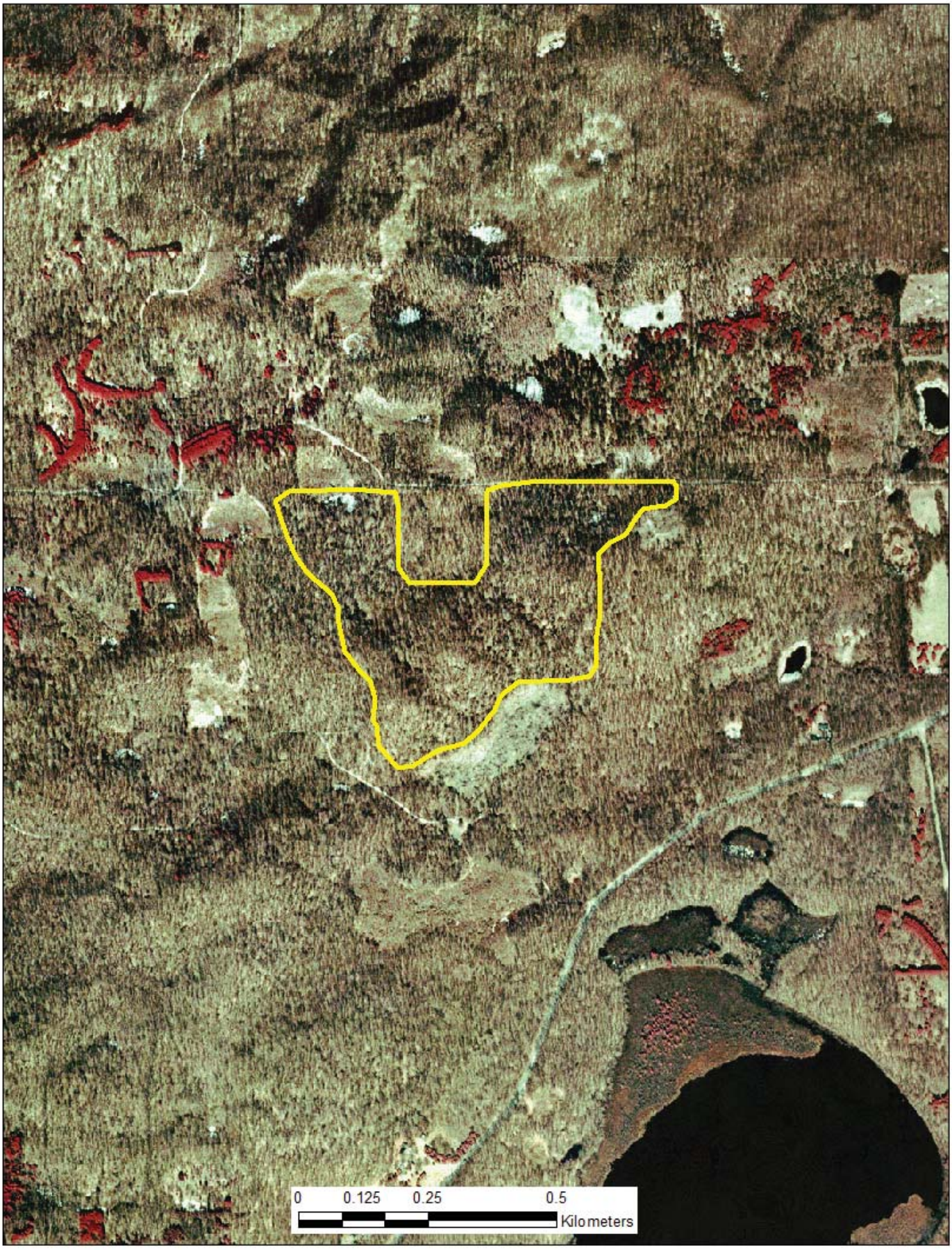
The closed canopy is dominated by maturing oaks and hickories with red oak (*Q. rubra*), white oak (*Q. alba*), black oak, and pignut hickory (*Carya glabra*) with canopy associates including red maple (*Acer rubrum*) and black cherry (*Prunus serotina*). The subcanopy is composed of red maple, flowering dogwood (*Cornus florida*), sassafras (*Sassafras albidum*), and black cherry. The prevalence of red maple and black cherry in the subcanopy as well as in the understory indicates that much of the site has experienced many decades of fire suppression. However, portions of the site have recently burned. Other species prevalent in the understory are witch-hazel (*Hamamelis virginiana*), juneberry (*Amelanchier arborea*), maple-leaved arrow-wood (*Viburnum acerifolium*), flowering dogwood, and the invasives multiflora rose (*Rosa multiflora*) and autumn olive (*Elaeagnus umbellata*). The low shrub layer is sparse to patchy with characteristic species including blackberries (*Rubus* spp.), gooseberries (*Ribes* spp.), and maple-leaved arrow-wood (*Viburnum acerifolium*). Vines are prevalent throughout the forest and include summer grape (*Vitis aestivalis*), Virginia creeper (*Parthenocissus quinquefolia*), and poison-ivy (*Toxicodendron radicans*). The ground cover is characterized by Pennsylvania sedge (*Carex pensylvanica*), pointed-leaf tick-trefoil (*Hylodesmum glutinosum*), bluestem goldenrod (*Solidago caesia*), long-awned wood grass (*Brachyelytrum erectum*), woodland sunflower (*Helianthus divaricatus*), and bottlebrush grass (*Elymus hystrix*). In addition, upland boneset (*Eupatorium sessilifolium*, state threatened) was documented in the southern portion of this forest.

This forest supports a breeding population of cerulean warbler (*Dendroica cerulea*, state threatened).

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, past logging and grazing history, fire suppression, invasive species, and deer herbivory. Signs of old anthropogenic disturbance were noted throughout the forest including scattered cut stumps, an old fence, and rock piles. Oak regeneration is sparse, likely due to fire suppression and mesophytic invasion, competition from invasives and mesophytic species, and deer browse pressure. Invasives are scattered in the understory and ground cover and include multiflora rose, autumn olive, garlic mustard (*Alliaria petiolata*), and morrow honeysuckle (*Lonicera morrowii*).

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor. Subcanopy and understory red maple and black cherry could be girdled if repeated fires do not control these mesophytic species. In addition, cutting and herbiciding invasive shrubs will also complement the use of fire to control invasive shrubs. Concentrations of garlic mustard can also be pulled by hand. Control of invasive plant populations within the surrounding landscape will require a major, long-term effort. Reducing local deer browse pressure is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak regeneration and response of the forest to fire management. Within this site, care should be taken to protect the population of upland boneset. Upland boneset is a rare plant species that is sensitive to soil and canopy disturbance and competition from invasive species. In addition, maintaining this forest as a closed-canopy system will also benefit the breeding population of cerulean warbler documented within this forest.

Hart Road Woods dry-mesic southern forest. Photo by Michael A. Kost.



1998 aerial photograph of Hart Road Woods dry-mesic southern forest.

13. Hill Creek Woods
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 31 acres
Location: Compartment 1, Stand 236
Element Occurrence Identification Number: 13346

Site Description: Hill Creek Woods is an even-aged oak-hickory forest found along a ridgetop within an outwash plain. The topography ranges from rolling to steep and the sandy soils are acidic (pH 5.0). Diameters of the canopy cohort typically range from 30 to 40 cm. A 38 cm black oak (*Quercus velutina*) was cored and estimated to be 86 years old. Scattered windthrow has generated small canopy gaps and a moderate volume of coarse woody debris. The dry-mesic southern forest occurs just east of a high-quality prairie fen (Hill Creek Fen, EO ID 7579).

The canopy is dominated by white oak (*Q. alba*) and black oak with canopy associates including basswood (*Tilia americana*), sassafras (*Sassafras albidum*), and black cherry (*Prunus serotina*). Oak regeneration is common in the understory along with witch-hazel (*Hamamelis virginiana*), choke cherry (*Prunus virginiana*), and hazelnut (*Corylus americana*). In addition, autumn olive (*Elaeagnus umbellata*) is locally abundant in the understory. The herbaceous layer is dominated by Pennsylvania sedge (*Carex pensylvanica*). Characteristic ground cover species include whorled loosestrife (*Lysimachia quadriflora*), wintergreen (*Gaultheria procumbens*), Virginia creeper (*Parthenocissus quinquefolia*), hairy bedstraw (*Galium pilosum*), and tick-trefoils (*Hylodesmum* spp.).

Threats: Species composition, vegetative structure, and successional trajectories are strongly influenced by gap dynamics, fire suppression, invasive species, and likely deer herbivory. As noted above, autumn olive is locally abundant in the understory.

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor. The dry-mesic southern forest should be burned in concert with the adjacent high-quality prairie fen. In addition, cutting and herbiciding invasive shrubs will also complement the use of fire to control invasive shrubs. Reducing local deer browse pressure is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak regeneration and response of the forest to fire management.

Hill Creek Woods dry-mesic southern forest. Photo by Michael A. Kost.

1998 aerial photograph of Hill Creek Woods dry-mesic southern forest.

14. Norris Road East Woods
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 149 acres
Location: Compartment 6, Stand 50
Element Occurrence Identification Number: 13349

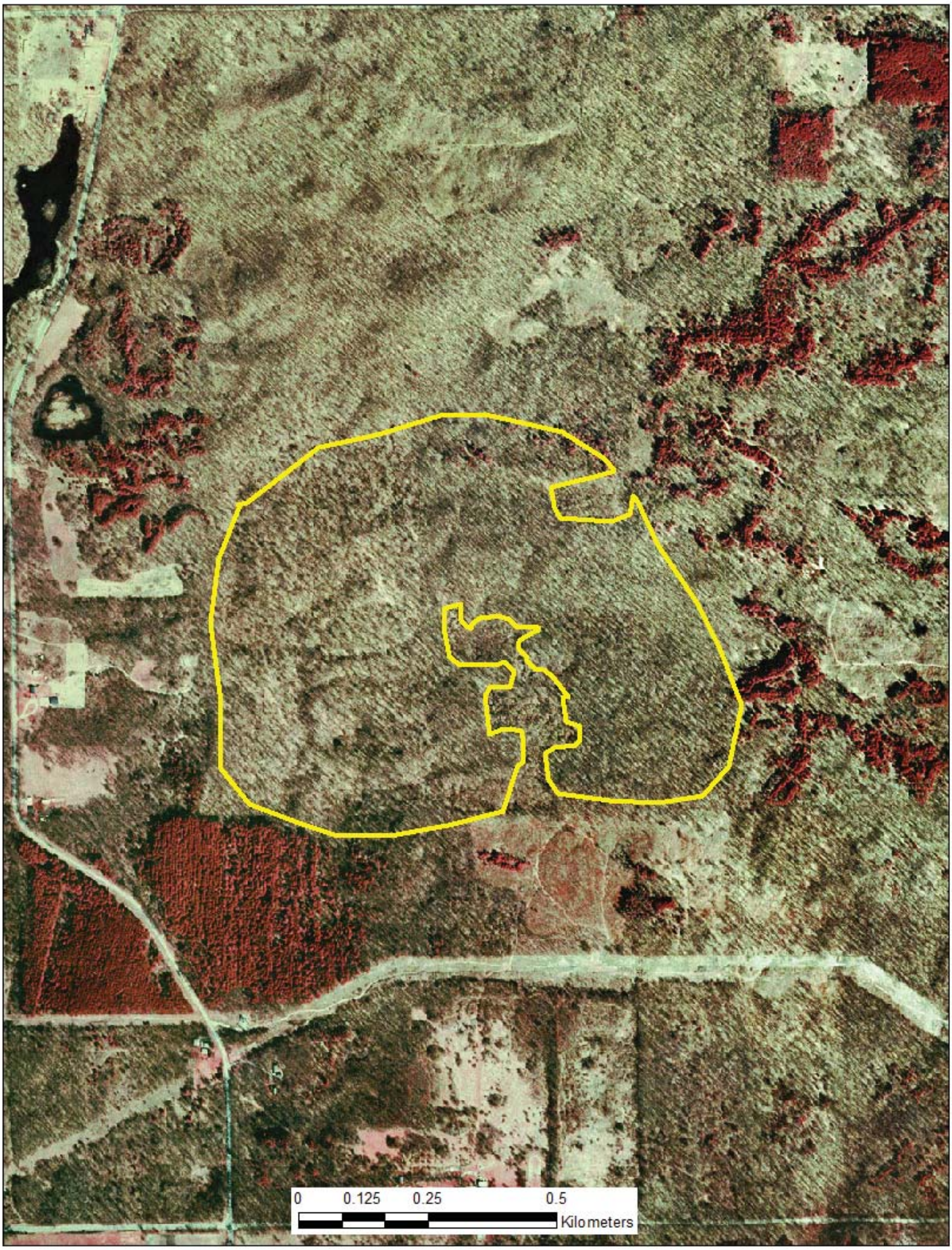
Site Description: Norris Road East Woods is a mature oak forest that occurs on rugged coarse-textured end moraine of variable aspect. The soils are acidic (pH 5.5), gravelly, loamy sand. Diameters of the canopy cohort range from 40 to 60 cm with some larger oaks reaching 70 to 80 cm. A 35 cm red oak (*Quercus rubra*) was cored and estimated to be over 77 years old. Scattered windthrow has generated small canopy gaps and a moderate volume of coarse woody debris of diverse size and decay classes. Several vernal pools occur within this forest.

The canopy is dominated by large-diameter oaks including red oak, white oak (*Q. alba*), and black oak (*Q. velutina*). Canopy associates include red maple (*Acer rubrum*) and pignut hickory (*Carya glabra*). Red maple is prevalent in the understory along with black cherry (*Prunus serotina*), oaks, sassafras (*Sassafras albidum*), and flowering dogwood (*Cornus florida*). Invasives are locally abundant in the understory and ground cover and include multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), Japanese barberry (*Berberis thunbergii*), and garlic mustard (*Alliara petiolata*). The ground cover is characterized by Pennsylvania sedge (*Carex pensylvanica*), bracken fern (*Pteridium aquilinum*), hairy sweet cicely (*Osmorhiza claytonii*), round-leaved hepatica (*Hepatica americana*), jumpseed (*Persicaria virginiana*), pointed-leaf tick-trefoil (*Hylodesmum glutinosum*), and naked-flower tick-trefoil (*H. nudiflorum*). Hooded warbler (*Setophaga citrina*, state special concern) have been documented using this forest complex.

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, fire suppression, invasive species, and deer herbivory. Oak regeneration is sparse, likely due to fire suppression and mesophytic invasion, competition from invasives and mesophytic species, and deer browse pressure. As noted above, invasives are locally abundant in the understory and ground cover and include multiflora rose, autumn olive, Japanese barberry, and garlic mustard. Stands adjacent to this site have been recently logged.

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor. Subcanopy and understory red maple and black cherry could be girdled if repeated fires do not control these mesophytic species. In addition, cutting and herbiciding invasive shrubs will also complement the use of fire to control invasive shrubs. Concentrations of garlic mustard can also be pulled by hand. Control of invasive plant populations within the surrounding landscape will require a major, long-term effort. Reducing local deer browse pressure is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak regeneration and response of the forest to fire management and nearby timber management. Maintaining this forest as a closed-canopy system will benefit the breeding population of hooded warbler documented within this forest.

Norris Road East Woods dry-mesic southern forest. Photo by Michael A. Kost.



1998 aerial photograph of Norris Road East Woods dry-mesic southern forest.

15. The Hills (North)
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 118 acres
Location: Compartment 4, Stands 86, 88, and 106
Element Occurrence Identification Number: 16128

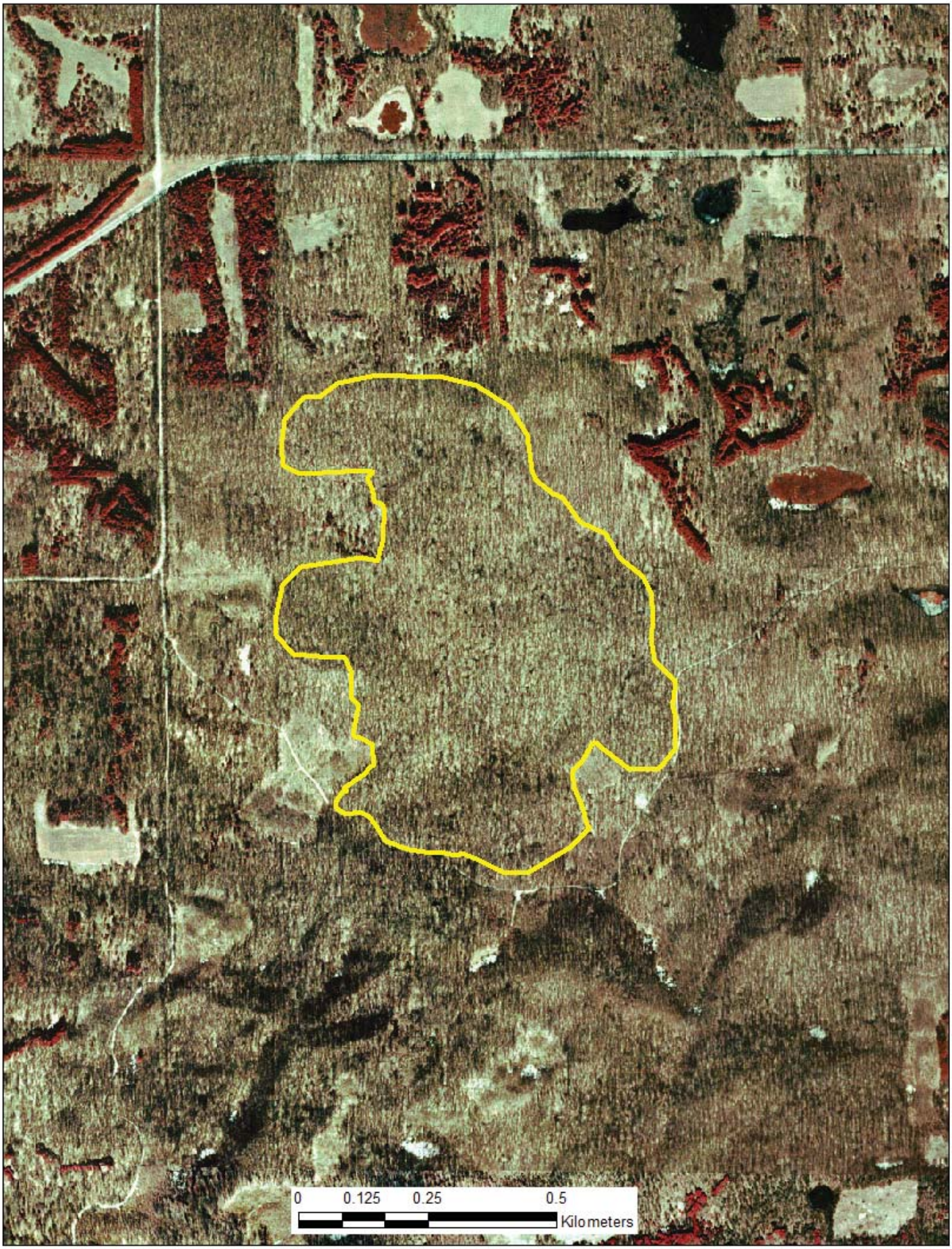
Site Description: The Hills (North) is a mature oak forest that occurs on moderately rolling coarse-textured end moraine of variable aspect. The soils are acidic (pH 5.5) sandy loams and loams over sands. Diameters of the canopy cohort range from 30 to 60 cm with some larger oaks reaching 60 to 90 cm. A 50 cm red oak (*Quercus rubra*) was cored and estimated to be 98 years old. Several vernal pools occur within this forest.

The canopy is dominated by large-diameter oaks including white oak (*Q. alba*) and black oak (*Q. velutina*). Canopy structure ranges from partially closed to relatively open (60-75% canopy closure). Canopy associates include red oak, pignut hickory (*Carya glabra*), and red maple (*Acer rubrum*). Red maple is common in the subcanopy along with sassafras (*Sassafras albidum*). The understory is sparse with flowering dogwood (*Cornus florida*) and localized white oak and black oak regeneration occurring on hilltops and south-facing slopes. The low shrub layer is patchy with huckleberry (*Gaylussacia baccata*) prevalent. The ground cover is dominated by Pennsylvania sedge (*Carex pensylvanica*) and bracken fern (*Pteridium aquilinum*) with associates including Virginia creeper (*Parthenocissus quinquefolia*) and wild sarsaparilla (*Aralia nudicaulis*). This forest supports a breeding population of cerulean warbler (*Dendroica cerulea*, state threatened).

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, past selective logging, fire suppression, invasive species, and deer herbivory. Signs of old anthropogenic disturbance were noted throughout the forest including scattered cut stumps. Oak regeneration is localized and sparse, likely due to fire suppression and mesophytic invasion, competition from invasives and mesophytic species, and deer browse pressure. Local infestations of multiflora rose (*Rosa multiflora*) and garlic mustard (*Alliara petiolata*) occur within the forest.

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor. Subcanopy and understory red maple and sassafras could be girdled if repeated fires do not control these mesophytic species. In addition, cutting and herbiciding invasive shrubs will also complement the use of fire to control invasive shrubs. Concentrations of garlic mustard can also be pulled by hand. Control of invasive plant populations within the surrounding landscape will require a major, long-term effort. Reducing local deer browse pressure is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak regeneration and response of the forest to fire management. Maintaining this forest as a closed-canopy system will benefit the breeding population of cerulean warbler documented within this forest.

The Hills (North) dry-mesic southern forest. Photo by Michael A. Kost.



1998 aerial photograph of The Hills (North) dry-mesic southern forest.

16. The Hills (South)
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 54 acres
Location: Compartment 4, Stands 99, 106, 111
Element Occurrence Identification Number: 16129

Site Description: The Hills (South) is a maturing oak forest that occurs on moderately rolling to steep coarse-textured end moraine of variable aspect. The forest includes dry-mesic ridgetops and deep, mesic ravines. The soils are acidic (pH 5.5) sandy loams. Diameters of the canopy cohort range from 25 to 45 cm. A 45 cm red oak (*Quercus rubra*) was cored and estimated to be 73 years old. Several vernal pools occur within this forest.

This forest is characterized by very high species richness due to exceptionally well-developed topography. The canopy along the ridgetops is dominated by black oak (*Quercus velutina*), white oak (*Q. alba*), and pignut hickory (*Carya glabra*). Mesic slopes of the ravines are characterized by large-diameter red oak (*Q. rubra*), basswood (*Tilia americana*), and red maple (*Acer rubrum*). Red maple is common in the subcanopy and understory throughout the forest, along with sassafras (*Sassafras albidum*), flowering dogwood (*Cornus florida*), and pignut hickory. Additional understory species include serviceberries (*Amelanchier* spp.), witch-hazel (*Hamamelis virginiana*), hazelnut (*Corylus americana*), and prickly ash (*Zanthoxylum americanum*). The low shrub layer is diverse with common species including blackberries (*Rubus* spp.), maple-leaved arrow-wood (*Viburnum acerifolium*), common juniper (*Juniperus communis*), and huckleberry (*Gaylussacia baccata*).

Ground layer dominance patterns vary based on slope and aspect. Drier areas are characterized by Pennsylvania sedge (*Carex pensylvanica*), woodland sunflower (*Helianthus divaricatus*), pointed-leaf tick-trefoil (*Hylodesmum glutinosum*), naked-flower tick-trefoil (*H. nudiflorum*), hog-peanut (*Amphicarpaea bracteata*), upland boneset (*Eupatorium sessilifolium*, state threatened), bluestem goldenrod (*Solidago caesia*), long-awned wood grass (*Brachyelytrum erectum*), lopseed (*Phryma leptostachya*), large-leaved aster (*Eurybia macrophylla*), Virginia creeper (*Parthenocissus quinquefolia*), sassafras seedlings, and black oak seedlings. Prevalent ground cover species along mesic slopes include wild sarsaparilla (*Aralia nudicaulis*), Virginia creeper, false spikenard (*Maianthemum racemosum*), horse-balm (*Collinsonia canadensis*), common trillium (*Trillium grandiflorum*), large-flowered bellwort (*Uvularia grandiflora*), maidenhair fern (*Adiantum pedatum*), Christmas fern (*Polystichum acrostichoides*), and lady fern (*Athyrium filix-femina*). In addition, mesic slopes support scattered patches of goldenseal (*Hydrastis canadensis*, state threatened) and ginseng (*Panax quinquefolius*, state threatened). The following invasive plants occur along roads and occasionally within the forest interior: multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), hedge-parsley (*Torilis japonica*), and garlic mustard (*Alliara petiolata*)

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, past logging, fire suppression, invasive species, and deer herbivory. Red maple occurs as a canopy associate along mesic slopes but is dominant throughout the forest understory. Oak regeneration is sparse, likely due to fire suppression and mesophytic invasion (e.g., red maple), competition from invasives, and deer browse pressure. As noted above, invasives are locally abundant in the understory and ground cover. In addition, high levels of invasive species occur in the adjacent degraded forests and provide a seed source for continued invasive species incursions.

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor. Subcanopy and understory red maple could be girdled if repeated fires do not control this mesophytic species. In addition, cutting and herbiciding invasive shrubs will also complement the use of fire to control invasive shrubs. Concentrations of garlic mustard can also be pulled by hand. Control of invasive plant populations within the surrounding landscape will require a major, long-term effort. Reducing local deer browse pressure is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak regeneration and response of the forest to fire management. Within this site, care should be taken to protect the populations of upland boneset, goldenseal, and ginseng. These rare plant species are sensitive to soil and canopy disturbance and competition from invasive species.

The Hills (South) dry-mesic southern forest. Photos by Bradford S. Slaughter.

1998 aerial photograph of The Hills (South) dry-mesic southern forest.

17. Whitmore Road Woods
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 53 acres
Location: Compartment 4, Stands 88 and 105
Element Occurrence Identification Number: 18970

Site Description: Whitmore Road Woods is an oak-hickory forest that occurs on a rolling end moraine of variable aspect. Soils of the dry-mesic southern forest are acidic (pH 5.5) sandy loam. Diameters of the canopy cohort typically range from 40 to 55 cm with some larger oaks reaching 70 cm. A 40 cm red oak (*Quercus rubra*) was cored and estimated to be 83 years old. Scattered windthrow has generated small canopy gaps and a moderate volume of coarse woody debris. Several vernal pools occur within this forest.

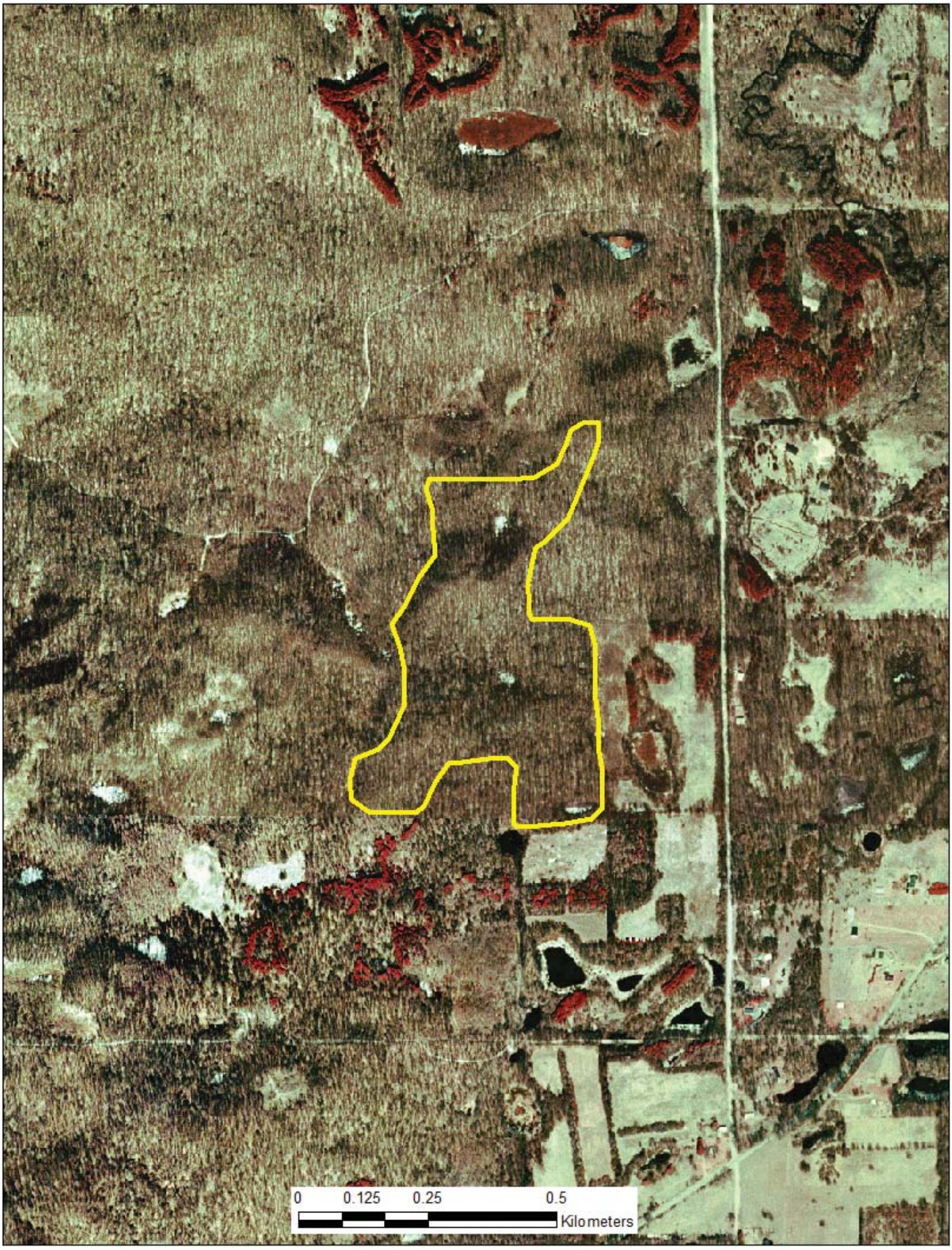
The closed canopy is dominated by maturing oaks and hickories with red oak, white oak (*Q. alba*), black oak (*Q. velutina*), and pignut hickory (*Carya glabra*) with black cherry (*Prunus serotina*) occurring as a common canopy associate. The subcanopy is composed of red maple (*Acer rubrum*), flowering dogwood (*Cornus florida*), sassafras (*Sassafras albidum*), pignut hickory, oaks, and black cherry. The prevalence of red maple and black cherry in the subcanopy as well as in the understory indicates that the site has experienced many decades of fire suppression. Other species prevalent in the patchy understory are serviceberries (*Amelanchier* spp.), basswood (*Tilia americana*), and hawthorns (*Crataegus* spp.). Invasive plants are locally abundant and include multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), hedge-parsley (*Torilis japonica*), and garlic mustard (*Alliara petiolata*). Oak regeneration is rare, likely due to competition from invasives, fire suppression, and deer browse pressure. The low shrub layer is sparse with characteristic species including blackberries (*Rubus* spp.), gooseberries (*Ribes* spp.), and multiflora rose. Vines are prevalent throughout the forest and include summer grape (*Vitis aestivalis*), Virginia creeper (*Parthenocissus quinquefolia*), and poison-ivy (*Toxicodendron radicans*). The ground cover is characterized by Pennsylvania sedge (*Carex pensylvanica*), wild sarsaparilla (*Aralia nudicaulis*), naked-flower tick-trefoil (*Hylodesmum nudiflorum*), pointed-leaf tick-trefoil (*H. glutinosum*), bluestem goldenrod (*Solidago caesia*), long-awned wood grass (*Brachyelytrum erectum*), and bottlebrush grass (*Elymus hystrix*). In addition, upland boneset (*Eupatorium sessilifolium*, state threatened) occurs within this forest. Seventy-one native, vascular plant species were noted within this forest during the 2012 surveys.

Hooded warblers (*Setophaga citrina*, state special concern) have been documented using this forest complex.

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, past logging, fire suppression, invasive species, and deer herbivory. Signs of old anthropogenic disturbance were noted at the margins of the forest including scattered cut stumps, an old fence, and rock piles. Oak regeneration is sparse to absent, likely due to fire suppression and mesophytic invasion, competition from invasives and mesophytic species, and deer browse pressure. As noted above, invasives are locally abundant in the understory and ground cover. In addition, high levels of invasive species occur in the adjacent degraded forests and provide a seed source for continued invasive species incursions.

Management Recommendations: The primary management need is the reintroduction of fire as a prevalent disturbance factor. Subcanopy and understory red maple and black cherry could be girdled if repeated fires do not control these mesophytic species. In addition, cutting and herbiciding invasive shrubs will also complement the use of fire to control invasive shrubs. Concentrations of garlic mustard can also be pulled by hand. Control of invasive plant populations within the surrounding landscape will require a major, long-term effort. Reducing local deer browse pressure is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak regeneration and response of the forest to fire management. Within this site, care should be taken to protect the population of upland boneset. Upland boneset is a rare plant species that is sensitive to soil and canopy disturbance and competition from invasive species. In addition, maintaining this forest as a closed-canopy system will also benefit the breeding population of hooded warbler documented within this forest.

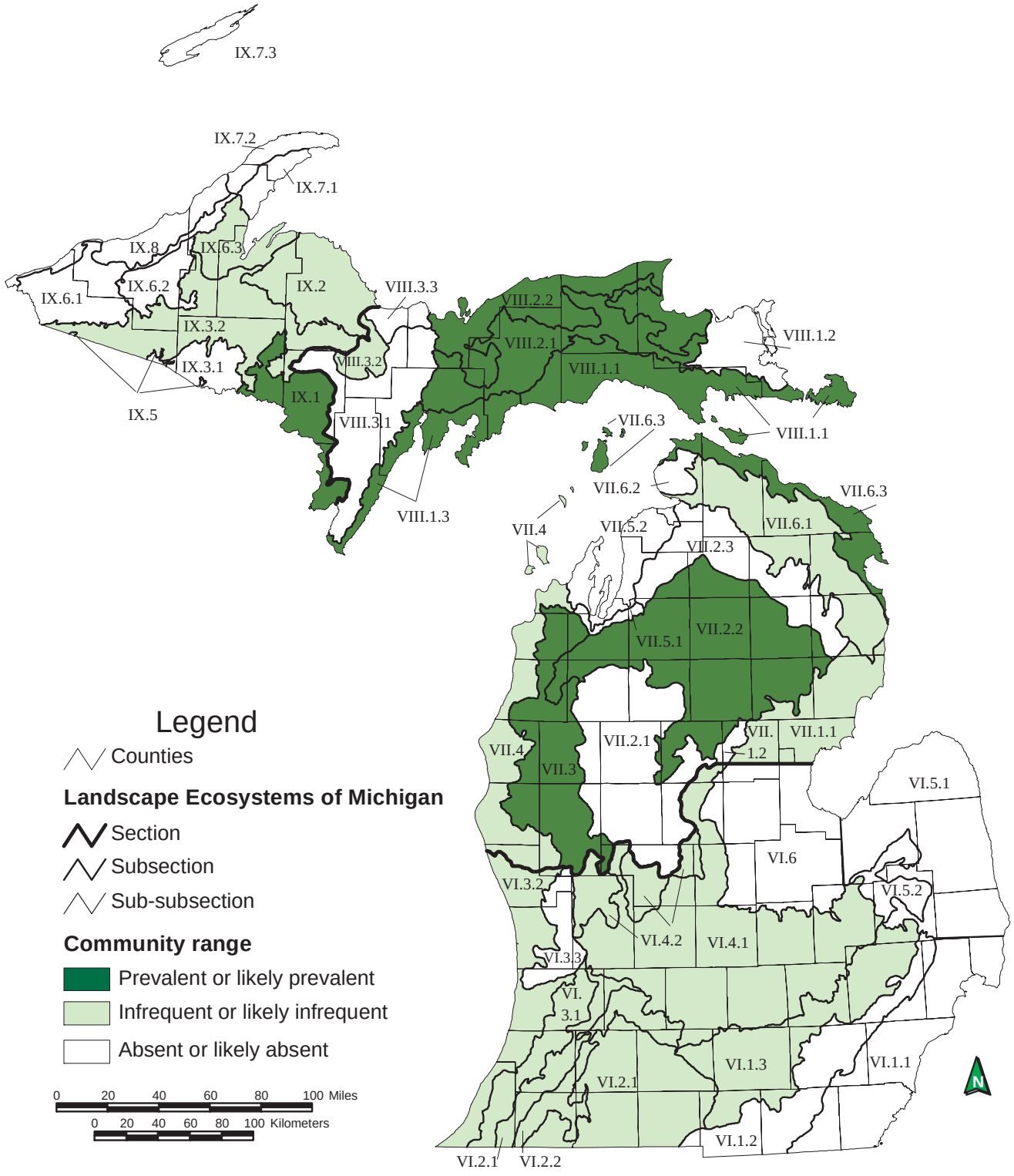
Whitmore Road Woods dry-mesic southern forest. Photos by Michael A. Kost.



1998 aerial photograph of Whitmore Road Woods dry-mesic southern forest.

INTERMITTENT WETLAND

Overview: Intermittent wetland is a graminoid- and herb-dominated wetland found along lakeshores or in depressions and characterized by fluctuating water levels, both seasonally and from year to year. Intermittent wetlands exhibit traits of both peatlands and marshes, with characteristic vegetation including sedges (*Carex* spp.), rushes (*Juncus* spp.), sphagnum mosses, and ericaceous shrubs. The community occurs statewide (Kost et al. 2007).



Map 6. Distribution of intermittent wetland in Michigan (Albert et al. 2008).

18. Dagget Lake Wetlands
Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Size: 30 acres
Location: Compartment 3, Stands 83, 88, and 89 and Compartment 6, Stands 63, 64, and 107
Element Occurrence Identification Number: 18977

Site Description: This intermittent wetland occurs on a flat, poorly drained ice-block depression within a coarse-textured end moraine. Dagget Lake Wetlands is composed of five separate intermittent wetland polygons. Along the open mud flats, the organic soil depth varies from 15 cm to 1 m of sapric peat over acidic (pH 5.5) sand. The water table fluctuates seasonally and annually creating diverse ecological zonation. The water table increases in depth as one passes from the center of the wetland toward the upland margin.

The wetlands are ringed by a shrub-dominated margin with buttonbush (*Cephalanthus occidentalis*), which occurs adjacent to a 10 meter-wide band of submergent moat with yellow pond-lily (*Nuphar advena*) and smartweed (*Persicaria amphibia*). The central portion of the wetlands is characterized by extensive mud flats with scattered patches of emergent vegetation. The patches of emergent vegetation are characterized by three-way sedge (*Dulichium arundinaceum*), marsh fern (*Thelypteris palustris*), cut grass (*Leersia oryzoides*), spike-rushes (*Eleocharis* spp.), common boneset (*Eupatorium perfoliatum*), and St. John's-wort (*Hypericum* sp.). Along the ecotone of the intermittent wetlands and the uplands are scattered trees including red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), white oak (*Quercus alba*), and black oak (*Q. velutina*). Twenty-eight native, vascular plant species were noted within this forest during the 2012 surveys.

Threats: Species composition and vegetative structure are influenced by natural processes. Fire suppression in the landscape in general may have reduced the fire-return interval of the wetland complex. Potential threats include invasive species and off-road vehicle damage. Off-road vehicle damage was noted nearby along Camp 10 Lake Road.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across this wetland). Maintaining a buffer of natural communities surrounding the intermittent wetland will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. Reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species and off-road vehicle damage should be implemented. Maintaining barriers at the end of Camp 10 Lake Road will help minimize potential anthropogenic threats to this site.

Dagget Lake Wetlands. Photo by Michael A. Kost.

1998 aerial photograph of Dagget Lake Wetlands.

19. Norris Road Wetland
Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 13 acres
Location: Compartment 6, Stands 36, 37, and 38
Element Occurrence Identification Number: 18966

Site Description: This intermittent wetland occurs on a flat, poorly drained ice-block depression within a coarse-textured end moraine. The organic soils are peats of variable depth overlying acidic sands. The water table fluctuates seasonally and annually creating diverse ecological zonation including a shrub-carr margin, an emergent zone, seasonally inundated mud flats with stranded aquatic plants, and a bog mat in the southern and central portions of the wetland. The water table increases in depth as one passes from the center of the wetland toward the upland margin. Seasonally, water levels tend to be highest during the winter and spring and lowest in late summer and fall. Fluctuations of water level allow for temporal variability of the accumulation and decomposition of organic matter.

The wetland is ringed by a shrub-dominated margin with highbush blueberry (*Vaccinium corymbosum*) and winterberry (*Ilex verticillata*) and scattered red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), and oaks (*Quercus* spp.). The emergent zone is dominated by graminoids including few-seed sedge (*Carex oligosperma*) and bur-reeds (*Sparganium* spp.) along with lance-leaved violet (*Viola lanceolata*). The mud flats are dominated by floating vegetation that gets stranded during draw-down periods. Two bog-like zones occur in the southern two-thirds of the wetland and are dominated by sphagnum moss (*Sphagnum* spp.) and leatherleaf (*Chamaedaphne calyculata*). Two rare plants occur within the intermittent wetland: bald-rush (*Rhynchospora scirpoides*, state threatened) and spotted pondweed (*Potamogeton pulcher*, state endangered). Reed canary grass (*Phalaris arundinacea*) occurs locally within this wetland. Thirty-four native, vascular plant species were noted within this wetland during the 2012 surveys.

Threats: Species composition and vegetative structure are influenced by natural processes. Fire suppression in the landscape in general may have reduced the fire-return interval of the wetland complex. The wetland borders Norris Road and likely receives direct salt spray during the winter. As noted above, reed canary grass is localized within this wetland.

Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across this wetland). Maintaining a buffer of natural communities surrounding the intermittent wetland will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. Reducing invasive species infestations within the wetland and in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species should be implemented.

Norris Road Wetland. Photo by Michael A. Kost.

1998 aerial photograph of Norris Road Wetlands.

20. Whitmore Road Wetland
Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 9 acres
Location: Compartment 4, Stand 33
Element Occurrence Identification Number: 18978

Site Description: This intermittent wetland occurs within a flat, poorly drained ice-block depression in a coarse-textured end moraine. The organic soils are peats of variable depth overlying acidic sands. The water table fluctuates seasonally and annually creating diverse ecological zonation including a shrub-carr margin, a graminoid-dominated emergent zone, and open water and mud flats dominated by floating aquatic vegetation. The water table increases in depth as one passes from the center of the wetland toward the upland margin. Seasonally, water levels tend to be highest during the winter and spring and lowest in late summer and fall. Fluctuations of water level allow for temporal variability of the accumulation and decomposition of organic matter.

The wetland is ringed by a shrub-dominated margin with highbush blueberry (*Vaccinium corymbosum*) and winterberry (*Ilex verticillata*) with scattered red maple (*Acer rubrum*) and oaks (*Quercus* spp.) along the ecotone between the wetland and the upland. Vegetation is sparse throughout the remainder of the wetland (< 25% coverage). The emergent zone is dominated by grasses, spike-rushes (*Eleocharis* spp.), wiregrass sedge (*Carex lasiocarpa*), lance-leaved violet (*Viola lanceolata*), smartweed (*Persicaria amphibia*), and St. John's-wort (*Hypericum* sp.). The core of this wetland is characterized by a matrix of water and mud flats that are likely inundated during wetter years. Throughout the mud flats are patches of yellow pond-lily (*Nuphar advena*) and pondweeds (*Potamogeton* spp.) that occur floating in pools of water or stranded in areas of draw down. Shrubs occur scattered within the wetland and include buttonbush (*Cephalanthus occidentalis*), winterberry, and meadowsweet (*Spiraea alba*). Reed canary grass (*Phalaris arundinacea*) occurs locally along the margins of the wetland. Twenty-five native, vascular plant species were noted within this wetland during the 2012 surveys.

Threats: Species composition and vegetative structure are influenced by natural processes. Fire suppression in the landscape in general may have reduced the fire-return interval of the wetland complex. Potential threats include invasive species. As noted above, reed canary grass occurs along the margins of the wetland.

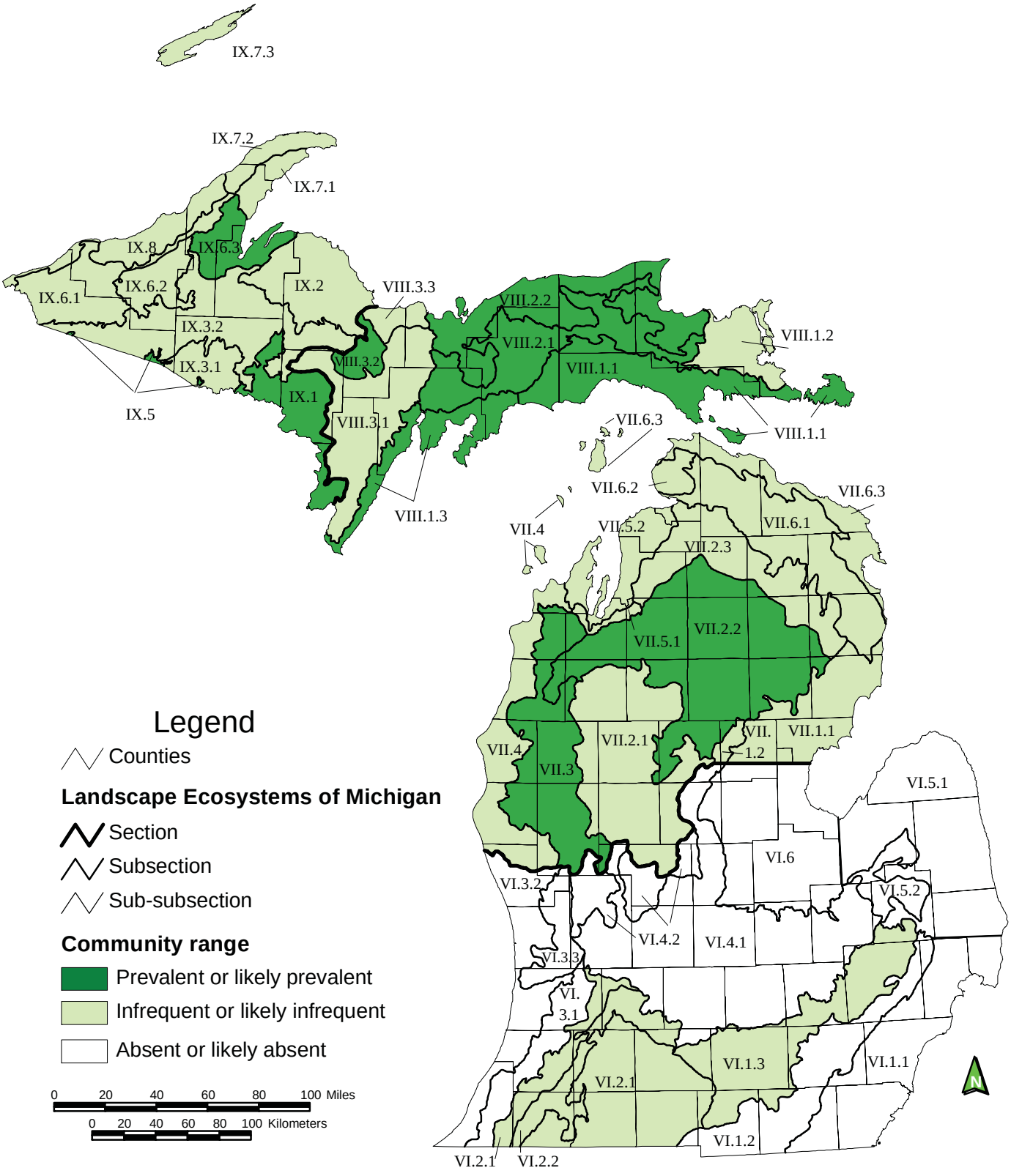
Management Recommendations: The primary management recommendation is to allow natural processes to operate unhindered (i.e., allow wildfires to burn across this wetland). Maintaining a buffer of natural communities surrounding the intermittent wetland will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. Control efforts to eliminate reed canary grass within this wetland should be implemented. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species should be implemented.

Whitmore Road Wetland. Photo by Michael A. Kost.

1998 aerial photograph of Whitmore Road Wetland.

POOR FEN

Overview: Poor fen is a wetland dominated by sedges, shrubs, and stunted conifers, and moderately influenced by groundwater. The community occurs within kettle depressions in outwash plains and moraines, and in mild depressions on glacial outwash plains and glacial lakeplain primarily in the Upper Peninsula and northern Lower Peninsula and rarely in the southern Lower Peninsula. Poor fen typically develops on slightly acidic to strongly acidic peat. Natural processes that influence species composition and community structure include groundwater seepage and lateral flow, peat accumulation, flooding by beaver, insect outbreaks, and occasional fires. (Kost et al. 2007).



Map 7. Distribution of poor fen in Michigan (Albert et al. 2008).

21. Snow Lake Fen
Natural Community Type: Poor Fen
Rank: G3G5 S3, vulnerable to secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 10 acres
Location: Compartment 3, Stand 37
Element Occurrence Identification Number: 18980

Site Description: This poor fen occurs within an ice-block depression within a coarse-textured end moraine system east of Gun Lake. The slightly acidic (pH 5.5-6.5) soils are deep (> 1 meter) sapric peat over hemic peat. Species composition, vegetative structure, and successional trajectory are influenced by seasonal water-level fluctuation. Water levels in poor fens fluctuate seasonally, reaching their peak in spring and lows in late summer, but typically remain at or near the soil's surface throughout the year. High-quality submergent marsh (Snow Lake Marsh, EO ID 18986) occurs adjacent to the poor fen. Snow Lake Fen is the first poor fen to be documented in the Kalamazoo Interlobate (V1.2).

This poor fen is dominated by a diverse, thick cover of sedges, grasses, and forbs occurring on sphagnum mats between pools of open water with floating vegetation and scattered shrubs and stunted trees. Dominant sedges and graminoids include wiregrass sedge (*Carex lasiocarpa*), twig-rush (*Cladium mariscoides*), Canadian rush (*Juncus canadensis*), white beak-rush (*Rhynchospora alba*), and bluejoint grass (*Calamagrostis canadensis*). Characteristic forbs include common boneset (*Eupatorium perfoliatum*), pitcher-plant (*Sarracenia purpurea*), rush aster (*Symphyotrichum boreale*), and wild blue flag (*Iris versicolor*). In addition, marsh fern (*Thelypteris palustris*) is common. Two rare plants occur within this wetland: bald-rush (*Rhynchospora scirpoides*, state threatened) and tall beak-rush (*Rhynchospora macrostachya*, state special concern). Scattered low shrubs include shrubby cinquefoil (*Dasiphora fruticosa*) and large cranberry (*Vaccinium macrocarpon*). The understory layer is patchy with willows (*Salix* spp.), highbush blueberry (*Vaccinium corymbosum*), winterberry (*Ilex verticillata*), buttonbush (*Cephalanthus occidentalis*), swamp rose (*Rosa palustris*), poison sumac (*Toxicodendron vernix*), tamarack (*Larix laricina*), and white pine (*Pinus strobus*). Trees occur sporadically within the fen and include tamarack, red maple (*Acer rubrum*), white pine, trembling aspen (*Populus tremuloides*), and black ash (*Fraxinus nigra*). Areas of open water near Snow Lake support submergent vegetation and are dominated by pondweed (*Potamogeton nodosus*), bladderworts (*Utricularia* spp.), and yellow pond-lily (*Nuphar advena*). The invasive narrow-leaved cat-tail (*Typha angustifolia*) is locally abundant along the margin of the fen. Forty native, vascular plant species were noted within this wetland during the 2012 surveys.

A known breeding population of Blanchard's cricket frog (*Acris blanchardi*, state threatened) was confirmed for Snow Lake in 2013.

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by fire suppression which is leading to encroachment by shrubs and small trees. In addition, the invasive narrow-leaved cat-tail is localized along the margin of the fen.

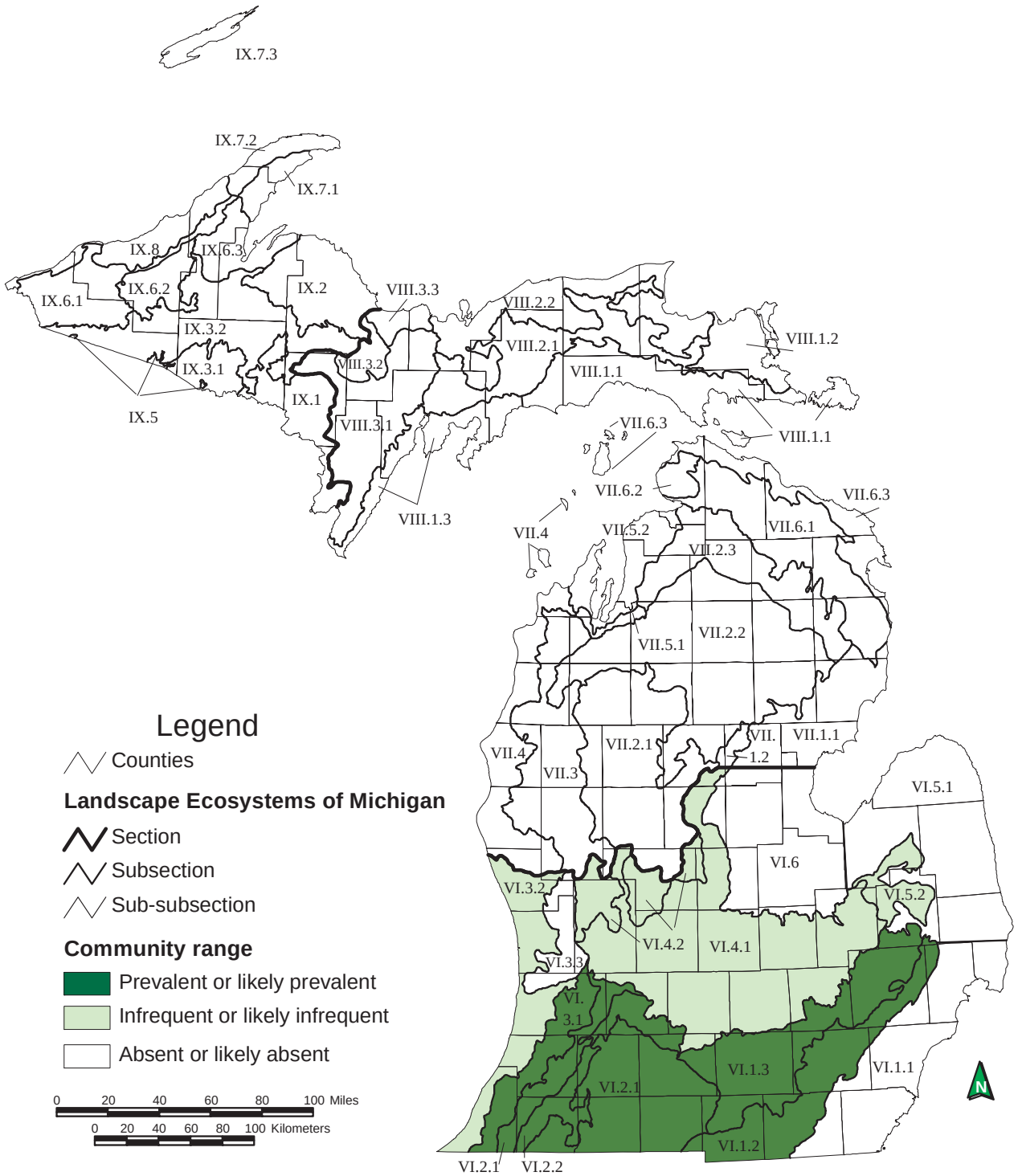
Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment. It is imperative that controlled burning be restricted from areas where narrow-leaved cat-tail occurs to prevent the further spread of this fire-tolerant species. Clusters of narrow-leaved cat-tail can be controlled through herbicide spot treatment. Selection of herbicide to apply to the cat-tails and seasonality of application should be carefully considered because a rare amphibian, Blanchard's cricket frog (*Acris crepitans blanchardi,* state threatened), is known to utilize this wetland. Maintaining a buffer of natural communities surrounding the poor fen will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species should be implemented. Keen attention should be paid to whether or not narrow-leaved cat-tail has infiltrated other portions of this fen since this species can spread rapidly following the use of prescribed fire. If additional populations of narrow-leaved cat-tail are discovered, fire should be restricted from these areas until the cat-tail has been controlled through alternative means (i.e., herbicide treatment).

Snow Lake Fen. Photos by Michael A. Kost.

1998 aerial photograph of Snow Lake Fen.

PRAIRIE FEN

Overview: Prairie fen is a wetland community dominated by sedges, grasses, and other graminoids that occurs on moderately alkaline organic soil and marl south of the climatic tension zone in southern Lower Michigan. Prairie fens occur predominantly within poorly drained outwash channels and outwash plains in the interlobate regions of southern Lower Michigan. This area is comprised of coarse-textured end moraines and ice-contact features (eskers and kames) that are bordered by glacial outwash. Prairie fen occurs on saturated organic soil and marl. Prairie fens occur where cold, calcareous, groundwater-fed springs reach the surface. The flow rate and volume of groundwater through a fen strongly influence vegetation patterning; thus, the community typically contains multiple, distinct zones of vegetation, some of which contain prairie grasses and forbs (Kost et al. 2007).



Map 8. Distribution of prairie fen in Michigan (Albert et al. 2008).

22. Bassett Creek Fen
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 4.6 acres
Location: Compartment 1, Stands 129
Element Occurrence Identification Number: 18981

Site Description: This small fen occurs along Bassett Creek, which passes through a coarse-textured end moraine. The fen is characterized by sloping peat mounds and groundwater seepage. The groundwater, rich in mineral content, generates minerotrophic conditions. Within the fen, the organic soils are deep, alkaline (pH 7.6), sapric peats with scattered sphagnum hummocks present. Sphagnum hummock development and sedge tussocks generate micro-scale heterogeneity by creating fine-scale gradients of soil moisture and chemistry.

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 southern shrub-carr along the wetland margins, southern wet meadow, prairie fen in areas of sloping peat, and emergent marsh in beaver ponds, streams, and along the lake margin. The fen is graminoid-dominated with wiregrass sedge (*Carex lasiocarpa*), Buxbaum's sedge (*C. buxbaumii*), hardstem bulrush (*Schoenoplectus acutus*), softstem bulrush (*S. tabernaemontani*), and fringed brome (*Bromus ciliatus*). Characteristic forbs include bog goldenrod (*Solidago uliginosa*) and common boneset (*Eupatorium perfoliatum*). Shrubby cinquefoil (*Dasiphora fruticosa*) is prevalent in the low shrub layer. The tall shrub layer is characterized by tamarack (*Larix laricina*), poison sumac (*Toxicodendron vernix*), silky dogwood (*Cornus amomum*), willows (*Salix* spp.), and red maple (*Acer rubrum*). The scattered overstory (35% canopy coverage) is dominated by tamarack with occasional red maple. Glossy buckthorn (*Frangula alnus*) and reed canary grass (*Phalaris arundinacea*) occur scattered throughout the fen. Thirty-seven native, vascular plant species were noted within this prairie fen during the 2012 surveys.

Bassett Creek, which passes through the fen, supports a population of ellipse (*Venustaconcha ellipsiformis*, state special concern mussel).

Threats: The primary threat to this prairie fen is posed by fire suppression and shrub encroachment of native species as well as non-native invasive species. Invasive species are common in the adjacent uplands and in nearby wetlands. As noted above, glossy buckthorn and reed canary grass are scattered within the fen. The following invasives occur in nearby wetlands: narrow-leaved cat-tail (*Typha angustifolia*), reed canary grass, and reed (*Phragmites australis*). In addition, the hydrology of the fen has likely been impacted by the nearby road and a power line corridor intersects the fen.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment. Clusters of glossy buckthorn can also be controlled through cutting and herbiciding the cut stumps. 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. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species should be implemented. Keen attention should be paid to whether or not narrow-leaved cat-tail has infiltrated the fen since this species can spread rapidly following the use of prescribed fire. If populations of narrow-leaved cat-tail are discovered, fire should be restricted from these areas until the cat-tail has been controlled through alternative means (i.e., herbicide treatment). Stewardship of this high-quality prairie fen will help protect the integrity of the ellipse (*Venustaconcha ellipsiformis*, state special concern) population found within Bassett Creek.

Bassett Creek Fen. Photos by Michael A. Kost.

1998 aerial photograph of Bassett Creek Fen.

23. Bowens Mill Fen
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 11 acres
Location: Compartment 1, Stands 124
Element Occurrence Identification Number: 13555

Site Description: Bowens Mill Fen occurs on the lower slope of a small moraine in an outwash channel of Turner Creek. The fen is characterized by groundwater influence and diverse ecological zonation. The groundwater, rich in mineral content, generates minerotrophic conditions. Within the fen, the organic soils are deep (> 1 meter), alkaline (pH 8.0) marl and peat. The peats are mucky with lots of woody debris throughout the peat profile and marl occurring near the surface locally. A headwater stream passes through the fen. The prairie fen occurs adjacent to high-quality rich tamarack swamp (Turner Creek Swamp, EO ID 18983), which occurs just east of the prairie fen.

Zones within the fen include fen meadows dominated by wiregrass sedge (*Carex lasiocarpa*) and sedge (*C. sterilis*), marly areas, tamarack (*Larix laricina*) savanna, and southern shrub-carr. Common shrubs within the fen include poison sumac (*Toxicodendron vernix*), silky dogwood (*Cornus amomum*), red-osier dogwood (*C. sericea*), bog birch (*Betula pumila*), alder-leaved buckthorn (*Rhamnus alnifolia*), and shrubby cinquefoil (*Dasiphora fruticosa*). An eastern box turtle (*Terrapene carolina carolina*, state special concern) was documented within Bowens Mill Fen in 2013 and box turtles have also been observed in the vicinity of the fen. In addition, tamarack tree cricket (*Oecanthus laricis*, state special concern) and a rare leafhopper (*Dorydiella kansana*, state special concern) have been documented within the fen.

Threats: This fen contains numerous vegetative zones but is fire suppressed and is impacted by shrub encroachment, invasive species, nutrient loading, a power line corridor, and stream channelization. Narrow-leaved cat-tail (*Typha angustifolia*) and reed canary grass (*Phalaris arundinacea*) are invading the western edge of the fen, likely due to fire suppression and nutrient loading from the adjacent agricultural field. In addition, glossy buckthorn (*Frangula alnus*) occurs within the tamarack-dominated portions of the wetland.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment. Because eastern box turtle and rare insects have been documented at this site, if prescribed fire is implemented, rotating non-fire refugia should be established within the fen. It is imperative that controlled burning 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. In addition to use of prescribed fire, clusters of buckthorn should be cut and herbicided. 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. Restoring agricultural fields to the west of the fen to native cover is encouraged. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species should be implemented. Keen attention should be paid to whether or not narrow-leaved cat-tail has infiltrated additional areas of the fen since this species can spread rapidly following the use of prescribed fire. If additional populations of narrow-leaved cat-tail are discovered, fire should be restricted from these areas until the cat-tail has been controlled through alternative means (i.e., herbicide treatment).

Bowens Mill Fen. Photo by Yu Man Lee.

1998 aerial photograph of Bowens Mill Fen.

24. Fish Lake Fen
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: D
Size: 37 acres
Location: Compartment 7, Stands 20
Element Occurrence Identification Number: 18992

Site Description: The Fish Lake Fen occurs on the margins of a kettle depression lake within a coarse-textured end moraine. The fen is characterized by groundwater influence and diverse ecological zonation. The groundwater, rich in mineral content, generates minerotrophic conditions. Within the fen, the organic soils are alkaline peats with scattered sphagnum hummocks present. Sphagnum hummock development and sedge tussocks generate micro-scale heterogeneity by creating fine-scale gradients of soil moisture and chemistry. Zones within the fen include shrubby fen, fen meadow, and emergent marsh along the edge of the lake.

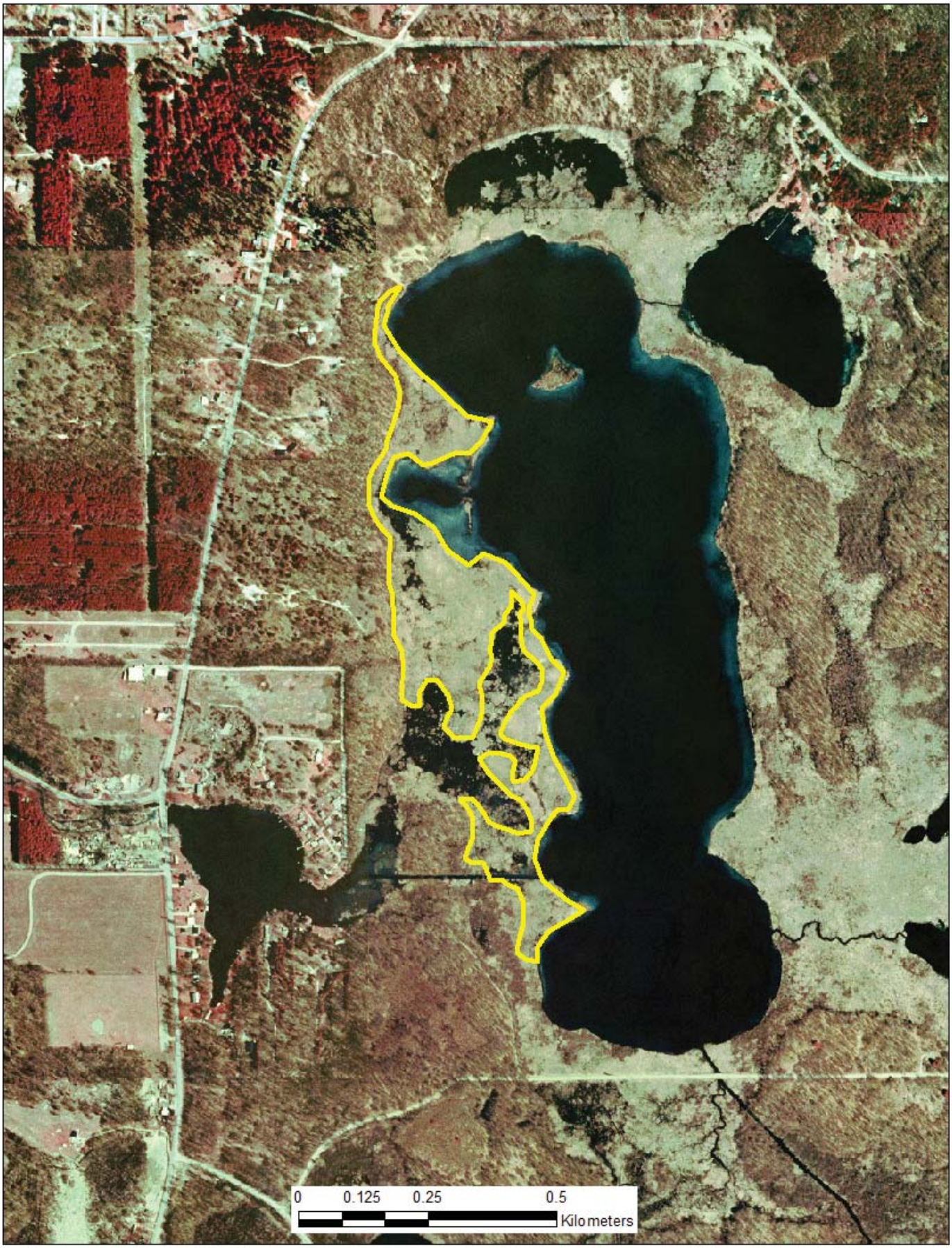
The fen is diverse due to structural heterogeneity resulting from fine-scale gradients in hydrology and soil chemistry and moisture. The fen is graminoid-dominated with wiregrass sedge (*Carex lasiocarpa*), water sedge (*C. aquatilis*), bristly-stalked sedge (*C. leptalea*), twig-rush (*Cladium mariscoides*), and cat-tails (*Typha* spp.). Significant portions of the fen are dominated by hybrid cat-tail (*Typha* x*glauca*) and narrow-leaved cat-tail (*T. angustifolia*). Marsh fern (*Thelypteris palustris*) is also prevalent within the ground cover and shrubby cinquefoil (*Dasiphora fruticosa*) is common in the low shrub layer. Tall shrubs within the shrubby fen zone and scattered in the fen meadow include poison sumac (*Toxicodendron vernix*), silky dogwood (*Cornus amomum*), gray dogwood (*C. foemina*), red-osier dogwood (*C. sericea*), highbush blueberry (*Vaccinium corymbosum*), slender willow (*Salix petiolaris*), and pussy willow (*S. discolor*). Scattered trees within the fen include red maple (*Acer rubrum*) and American elm (*Ulmus americana*). Forty-five native, vascular plant species were noted within this prairie fen during the 2012 surveys.

Rare animal species associated with Fish Lake and its associated wetlands include Blanchard's cricket frog (*Acris crepitans blanchardi,* state threatened), spotted turtle (*Clemmys guttata*, state threatened), eastern massasauga (*Sisturus catenatus*, state special concern and federal candidate), Blanding's turtle (*Emydoidea blandingii*, state special concern), marsh wren (*Cistothorus palustris*, state special concern), and pugnose shiner (*Notropis anogenus*, state endangered). In 2013, Blanding's turtle, Blanchard's cricket frog, and marsh wren were documented using Fish Lake and/or its associated wetlands.

Threats: Fire suppression, invasion by cat-tails, and alterations to the fen hydrology (primarily from the road and past ditching throughout) have altered the community trajectory and are shifting the structure from a diverse wetland to a monotypic stand of invasive cat-tails. Invasive species are common in the adjacent uplands and in nearby wetlands. The following invasives occur in nearby wetlands: narrow-leaved cat-tail, reed canary grass (*Phalaris arundinacea*), and reed (*Phragmites australis*). In addition, the hydrology of the fen has likely been impacted by the nearby road.

Management Recommendations: The primary management recommendation is to control the invasive cat-tails through herbicide treatment. Once the cat-tails have been controlled, then prescribed fire should be implemented to maintain open prairie fen conditions and reduce woody encroachment. Prescribed fire should be allowed to carry into surrounding upland forest to the west of the fen. It is imperative that controlled burning be restricted from areas where narrow-leaved cat-tail occurs to prevent the further spread of this fire-tolerant species. Because numerous rare species have been documented at this site, if prescribed fire is implemented, rotating non-fire refugia should be established within the fen. To avoid negative impacts to rare 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. Reducing invasive species in the surrounding landscape, especially in nearby wetlands, and allowing surrounding early-successional forest to mature will reduce the seed source of invasive species adjacent to this fen.

Fish Lake Fen. Photos by Michael A. Kost.



1998 aerial photograph of Fish Lake Fen.

25. Hill Creek Fen (Great Fen)
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Size: 51 acres
Location: Compartment 1, Stands 226 and 237
Element Occurrence Identification Number: 7579

Site Description: Hill Creek Fen is a large, flat, lakebed marl fen that occurs on poorly drained outwash. The fen is characterized by groundwater influence and diverse ecological zonation. The groundwater, rich in mineral content, generates minerotrophic conditions. Within the fen, the organic soils are alkaline marl and peat with scattered sphagnum hummocks and rises present. A small one acre rich tamarack swamp inclusion occurs near the center of the fen. Standing water (2-10 cm deep) occurs in the marl flats in the early growing season. A high-quality dry-mesic southern forest (Hill Creek Woods, EO 13346) occurs just east of the prairie fen.

The fen is dominated by wiregrass sedge (*Carex lasiocarpa*), beaked spike-rush (*Eleocharis rostellata*), Buxbaum's sedge (*C. buxbaumii*), hardstem bulrush (*Schoenoplectus acutus*), twig-rush (*Cladium mariscoides*), and scattered shrubby cinquefoil (*Dasiphora fruticosa*). Small peat rises within the fen contain stunted tamarack (*Larix laricina*), swamp gooseberry (*Ribes hirtellum*), alder-leaved buckthorn (*Rhamnus alnifolia*), and glossy buckthorn (*Frangula alnus*). Rare plants found within this fen include tuberous Indian plantain (*Arnoglossum plantagineum*, state special concern) and northern bayberry (*Myrica pensylvanica*, state threatened). Invasive species found within the fen include glossy buckthorn, reed canary grass (*Phalaris arundinacea*) and reed (*Phragmites australis*).

Numerous rare animal species have been documented in the Hill Creek Fen including eastern box turtle (*Terrapene carolina carolina*, state special concern), spotted turtle (*Clemmys guttata*, state threatened), eastern massasauga (*Sisturus catenatus*, state special concern and federal candidate), blazing star borer (*Papaipema beeriana*, state special concern), tamarack tree cricket (*Oecanthus laricis*, state special concern), and Henslow's sparrow (*Ammodramus henslowii*, state endangered).

Threats: The primary threat to this prairie fen is posed by fire suppression and shrub encroachment of native species as well as non-native invasive species. Glossy buckthorn is locally dominant within the fen and within the inclusion of rich tamarack swamp that occurs within the fen. In addition reed and reed canary grass are locally abundant. Trembling aspen is encroaching into the margins of the prairie fen. Invasive species are common in the adjacent uplands and in nearby wetlands. Historically the fen was hayed and grazed but appears to have recovered from these historical disturbances.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment. In addition to use of prescribed fire, clusters of buckthorn should be cut and herbicided. Because numerous rare species have been documented at this site, if prescribed fire is implemented, rotating non-fire refugia should be established within the fen. To avoid negative impacts to rare 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. The high-quality dry-mesic southern forest along the eastern side of the fen should be burned in concert with the fen. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species should be implemented. Keen attention should be paid to whether or not narrow-leaved cat-tail has infiltrated the fen since this species can spread rapidly following the use of prescribed fire. If populations of narrow-leaved cat-tail are discovered, fire should be restricted from these areas until the cat-tail has been controlled through alternative means (i.e., herbicide treatment).

Hill Creek Fen with northern bayberry below. Photos by Michael A. Kost.

1998 aerial photograph of Hill Creek Fen.

26. Horseshoe Lake Fen
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Size: 32 acres
Location: Compartment 7, Stands 35
Element Occurrence Identification Number: 2829

Site Description: Horseshoe Lake Fen is a large, diverse prairie fen that occurs to the east of Horseshoe Lake in an area of poorly drained outwash. The fen is characterized by groundwater influence and diverse ecological zonation that include open marl flats, low peat rises within the marl flats, and sloping fen that plateaus in a tufa-lined marl pool. The groundwater, rich in mineral content, generates minerotrophic conditions. Within the fen, the organic soils are alkaline marl and peat. This is a long, narrow fen that occurs at the base of a south-facing slope. A swift flowing and rock-bottomed creek passes through the fen. Rich tamarack swamp occurs to the south of the fen.

Marl flats within the fen are dominated by beaked spike-rush (*Eleocharis rostellata*) with tuberous Indian plantain (*Arnoglossum plantagineum*, state special concern) and white camas (*Anticlea elegans*) common. Peat rises within the marl flats are characterized by stunted tamarack (*Larix laricina*). Areas of fen meadow are dominated by tussock sedge (*Carex stricta*) with showy coneflower (*Rudbeckia fulgida*) and showy lady-slipper (*Cypripedium reginae*) prevalent. The invasive hybrid cat-tail (*Typha* x*glauca*) now dominates the eastern and northeastern lakeshore. Glossy buckthorn (*Frangula alnus*) occurs scattered throughout the fen.

Numerous rare animal species have been documented in the Horseshoe Lake Fen or in the immediate vicinity and include eastern box turtle (*Terrapene carolina carolina*, state special concern), eastern massasauga (*Sisturus catenatus*, state special concern and federal candidate), gray ratsnake (*Pantherophis spiloides*, state special concern), spotted turtle (*Clemmys guttata*, state threatened), Blanding's turtle (*Emydoidea blandingii*, state special concern), and tamarack tree cricket (*Oecanthus laricis*, state special concern).

Threats: The primary threats to this prairie fen are posed by fire suppression and shrub encroachment and invasion by hybrid cat-tail (*Typha* x*glauca*). The size of the overall fen is decreasing due to shrub encroachment and spread of hybrid cat-tail along the eastern and northeastern shore of Horseshoe Lake. As noted above, glossy buckthorn occurs scattered throughout the fen.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment and control invasive species. Because numerous rare species have been documented at this site, 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 should be cut and herbicided. To avoid negative impacts to rare 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. Restoring the adjacent uplands to oak barrens and savanna should be considered to increase water infiltration and encourage prairie grasses and forbs that can colonize the prairie fen. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species should be implemented. Keen attention should be paid to whether or not narrow-leaved cat-tail has infiltrated the fen since this species can spread rapidly following the use of prescribed fire. If populations of narrow-leaved cat-tail are discovered, fire should be restricted from these areas until the cat-tail has been controlled through alternative means (i.e., herbicide treatment).

1998 aerial photograph of Horseshoe Lake Fen prairie fen.

27. Shaw Lake Fen
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 8 acres
Location: Compartment 1, Stands 82 and 97
Element Occurrence Identification Number: 12498

Site Description: Shaw Lake Fen is a large, diverse prairie fen that occurs along Bassett Creek to the south of Shaw Lake and along the shore of Shaw Lake in an area of poorly drained outwash. The fen is characterized by groundwater influence and diverse ecological zonation that includes open marl flats and low peat rises within the marl flats. The groundwater, rich in mineral content, generates minerotrophic conditions. Within the fen, the organic soils are alkaline (pH 7.6) peat and marl.

The fen is dominated by wiregrass sedge (*Carex lasiocarpa*) and beaked spike-rush (*Eleocharis rostellata*). Other common species include hardstem bulrush (*Schoenoplectus acutus*), twig-rush (*Cladium mariscoides*), softstem bulrush (*S. tabernaemontani*), Indian grass (*Sorghastrum nutans*), grass-of-Parnassus (*Parnassia glauca*), marsh blazing-star (*Liatris spicata*), Kalm's lobelia (*Lobelia kalmii*), and purple false foxglove (*Agalinis purpurea*). Tall and low shrubs occur scattered throughout the fen, especially along peat rises, sphagnum hummocks, and along the margins of the fen. Understory and low shrub species include tamarack (*Larix laricina*), shrubby cinquefoil (*Dasiphora fruticosa*), swamp rose (*Rosa palustris*), alder-leaved buckthorn (*Rhamnus alnifolia*), glossy buckthorn (*R. frangula*), poison sumac (*Toxicodendron vernix*), silky dogwood (*Cornus amomum*), pussy willow (*Salix discolor*), and bog birch (*Betula pumila*). Scattered trees occur along the margins of the fen and include tamarack, red maple (*Acer rubrum*), and red-cedar (*Juniperus virginiana*). Invasives occur throughout the fen and include glossy buckthorn, purple loosestrife (*Lythrum salicaria*), hybrid cat-tail (*Typha xglauca*), multiflora rose (*Rosa multiflora*), reed (*Phragmites australis*), and autumn olive (*Elaeagnus umbellata*).

Numerous rare animal species have been documented in the Shaw Lake Fen including eastern box turtle (*Terrapene carolina carolina*, state special concern), eastern massasauga (*Sisturus catenatus*, state special concern and federal candidate), spotted turtle (*Clemmys guttata*, state threatened), Blanchard's cricket frog (*Acris blanchardi*, state threatened), Newman's brocade (*Meropleon ambifusca*, state special concern), regal fern borer (*Papaipema speciosissima*, state special concern), angular spittlebugs (*Lepyronia angulifera*, state special concern), and tamarack tree cricket (*Oecanthus laricis*, state special concern). Angular spittlebug, tamarack tree cricket and regal fern borer were all observed at Shaw Lake Fen in 2013.

Threats: The primary threats to this prairie fen are posed by fire suppression and shrub encroachment and invasion by non-native species. The fen was historically larger but a significant portion of the wetland complex was ditched and dredged for waterfowl management. As noted above, invasives occur throughout the fen and include glossy buckthorn, purple loosestrife, hybrid cat-tail, multiflora rose, reed, and autumn olive.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment and control invasive species. Because numerous rare species have been documented at this site, 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, multiflora rose, and autumn olive should be cut and herbicided. To avoid negative impacts to rare 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. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species should be implemented. Keen attention should be paid to whether or not narrow-leaved cat-tail has infiltrated the fen since this species can spread rapidly following the use of prescribed fire. If populations of narrow-leaved cat-tail are discovered, fire should be restricted from these areas until the cat-tail has been controlled through alternative means (i.e., herbicide treatment).

Shaw Lake Fen. Photos by Michael A. Kost.

1998 aerial photograph of Shaw Lake Fen.

28. Turner Creek Wetlands
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Size: 12 acres
Location: Compartment 2, Stands 25
Element Occurrence Identification Number: 278

Site Description: Turner Creek Fen is a fen complex that occurs as four fen polygons along a tributary of Turner Creek within poorly drained outwash. These fens occur in association with several high-quality natural communities that include wet prairie (Turner Creek Wetlands, EO ID 2267) and wet-mesic prairie (Turner Creek Wetlands, EO ID 4771). The fen is characterized by groundwater influence and diverse ecological zonation that includes fen meadows, marl flats, and southern shrub-carr. The groundwater, rich in mineral content, generates minerotrophic conditions. Within the fen, the organic soils are saturated, alkaline (pH 7.0-7.4) peats.

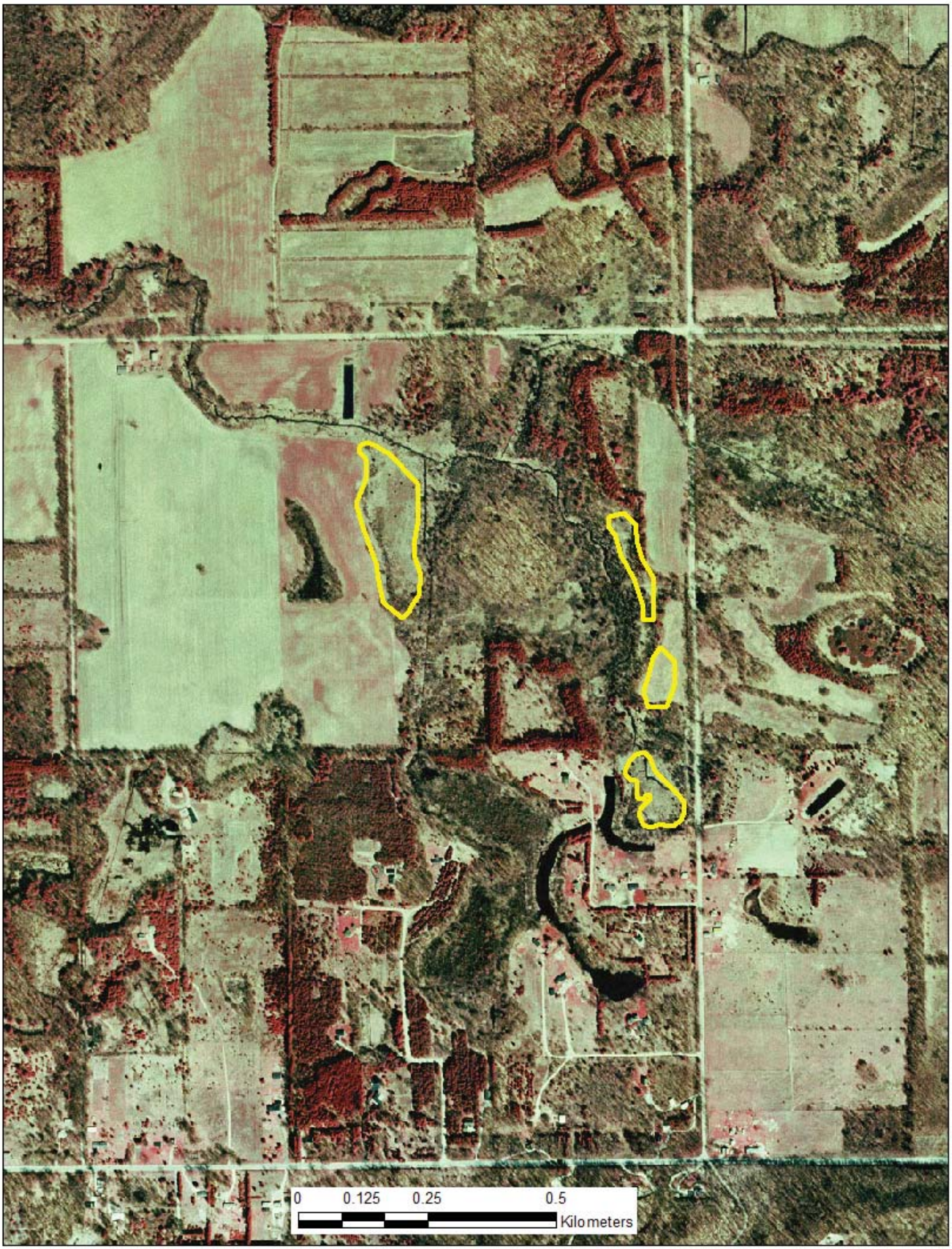
Two of the four fens are dominated by grasses while the other two polygons are dominated by sedges (*Carex* spp.). Dominant grasses include big bluestem (*Andropogon gerardii*) and little bluestem (*Schizachyrium scoparium*). Margins of the fen are characterized by a scattered canopy of tamarack (*Larix laricina*), and in places, the fen transitions to southern shrub-carr or rich tamarack swamp. Rare plants found within this fen include tuberous Indian plantain (*Arnoglossum plantagineum*, state special concern) and purple milkweed (*Asclepias purpurascens*, state threatened).

The wetland complex associated with Turner Creek and the prairie fen have been utilized in the past by Mitchell's satyr butterfly (*Neonympha mitchellii mitchellii*, state and federally endangered). Mitchell's satyr was last observed using this site in 2012 but was not documented by surveyors in 2013. Additional rare species documented within this fen include eastern box turtle (*Terrapene carolina carolina*, state special concern), eastern massasauga (*Sisturus catenatus*, state special concern and federal candidate), tamarack tree cricket (*Oecanthus laricis*, state special concern), angular spittlebugs (*Lepyronia angulifera*, state special concern), and red-legged spittlebug (*Prosapia ignipectus*, state special concern). Angular spittlebug was observed in the Turner Creek Wetlands in 2013.

Threats: The primary threats to this prairie fen are posed by fire suppression and native shrub and invasive species encroachment. Beaver damming along the stream on the nearby private property has likely caused the establishment and spread of cat-tails (*Typha* spp.) into portions of the fen. In addition, autumn olive (*Elaeagnus umbellata*) is common to abundant and reed canary grass (*Phalaris arundinacea*), reed (*Phragmites australis*), and invasive honeysuckles (*Lonicera* spp.) occur occasionally within the fen. Off-road vehicle damage was noted locally in the southern fen polygon.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment and control invasive species. Because this site may still harbor Mitchell's satyr and other rare, fire-sensitive species, if prescribed fire is implemented, rotating non-fire refugia should be established within the wetland complex. To avoid negative impacts to rare 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. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for Mitchell's satyr and invasive species should be implemented. Keen attention should be paid to whether or not narrow-leaved cat-tail (*Typha angustifolia*) has infiltrated the fen since this species can spread rapidly following the use of prescribed fire. If populations of narrow-leaved cat-tail are discovered, fire should be restricted from these areas until the cat-tail has been controlled through alternative means (i.e., herbicide treatment). Portions of the fen occur on adjacent private land. Pursuit of acquisition of adjacent private lands or discussion of compatible management with private landowners is recommended.

Turner Creek Wetlands prairie fen. Photos by Michael A. Kost.



1998 aerial photograph of Turner Creek Wetland prairie fen.

29. Wildwood Fen
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: CD
Size: 4.4 acres
Location: Compartment 6, Stands 27
Element Occurrence Identification Number: 18982

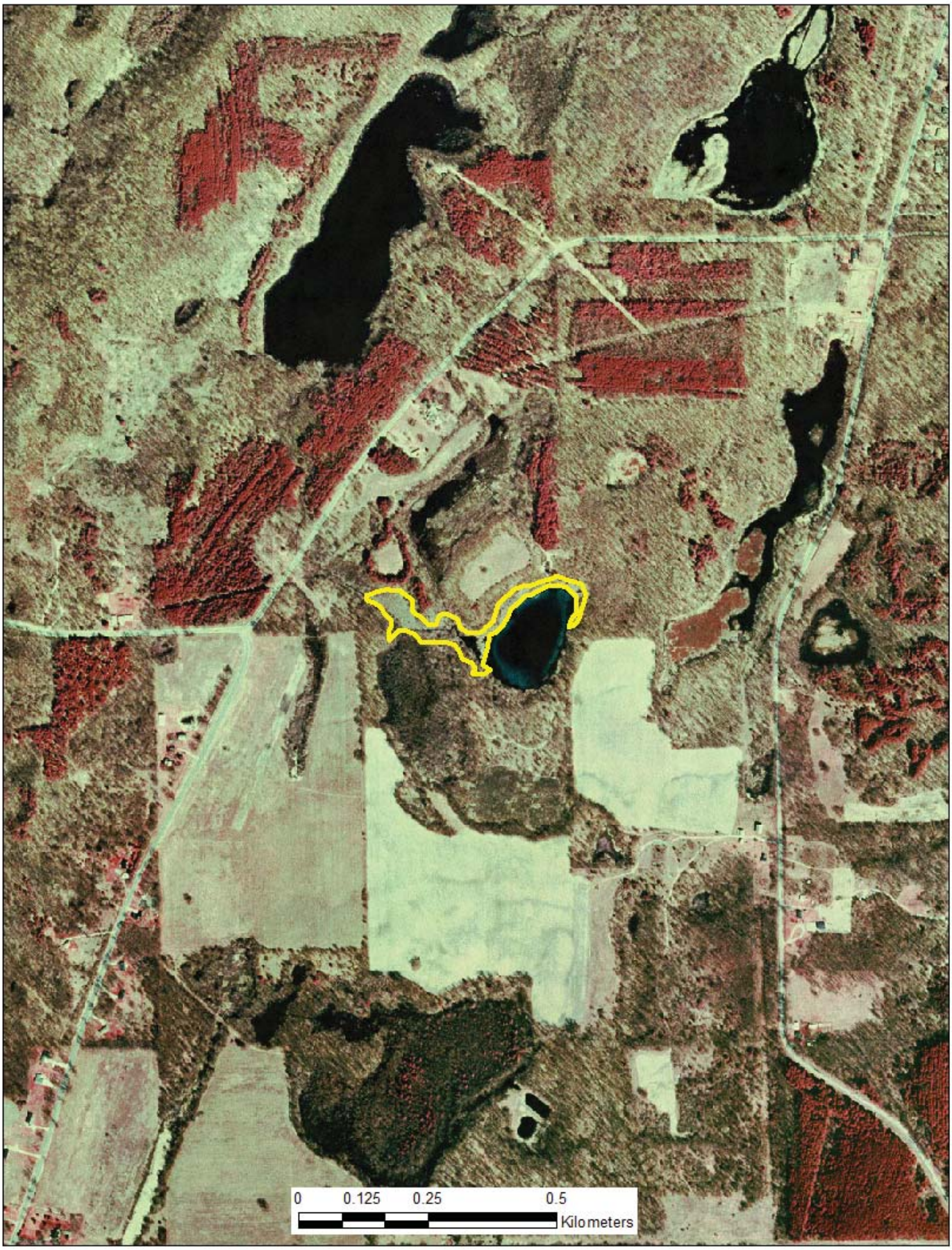
Site Description: Wildwood Fen occurs along the margins of a kettle depression lake within a coarse-textured end moraine. The fen is surrounded by degraded dry-mesic southern forest, degraded pine plantations and early-successional forest. This graminoid-dominated fen is characterized by groundwater influence and distinct ecological zonation. The groundwater, rich in mineral content, generates minerotrophic conditions. Within the fen, the organic soils are alkaline (pH 7.8) peats and marl with scattered sphagnum hummocks present. Sphagnum hummock development and sedge tussocks generate micro-scale heterogeneity by creating fine-scale gradients of soil moisture and chemistry. Zones within the fen include shrubby fen, fen meadow, marl flats, and emergent marsh along the edge of the lake.

The fen is dominated by wiregrass sedge (*Carex lasiocarpa*), beaked spike-rush (*Eleocharis rostellata*), and twig-rush (*Cladium mariscoides*). Prevalent graminoid associates include tussock sedge (*C. stricta*) and hardstem bulrush (*Schoenoplectus acutus*) and the forb Kalm's lobelia (*Lobelia kalmii*) is also common. The tall shrub layer is sparse near the lake but increases toward the inland margin of the fen. Characteristic understory species include tamarack (*Larix laricina*), poison sumac (*Toxicodendron vernix*), silky dogwood (*Cornus amomum*), gray dogwood (*C. foemina*), slender willow (*Salix petiolaris*), and bog birch (*Betula pumila*). Scattered trees occur along the margins of the fen and include tamarack, red maple (*Acer rubrum*), and American elm (*Ulmus americana*). Invasives occur throughout the fen, especially in areas of shrubby fen, and include narrow-leaved cat-tail (*Typha angustifolia*) and hybrid cat-tail (*T.* x*glauca*). Forty-three native, vascular plant species were noted within this prairie fen during the 2012 surveys.

Threats: The primary threat to this prairie fen is posed by fire suppression and shrub encroachment of native species as well as non-native invasive species. Invasive cat-tails occur locally within the fen. Invasive species are also common in the adjacent uplands and in nearby wetlands. The following invasives occur in nearby wetlands: narrow-leaved cat-tail, reed canary grass (*Phalaris arundinacea*), and reed (*Phragmites australis*). In addition, the hydrology of the fen has likely been impacted by the nearby road.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment. It is imperative that controlled burning 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. 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. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species should be implemented. Keen attention should be paid to whether or not additional narrow-leaved cat-tail has infiltrated the fen since this species can spread rapidly following the use of prescribed fire. If new populations of narrow-leaved cat-tail are discovered, fire should be restricted from these areas until the cat-tail has been controlled through alternative means (i.e., herbicide treatment).

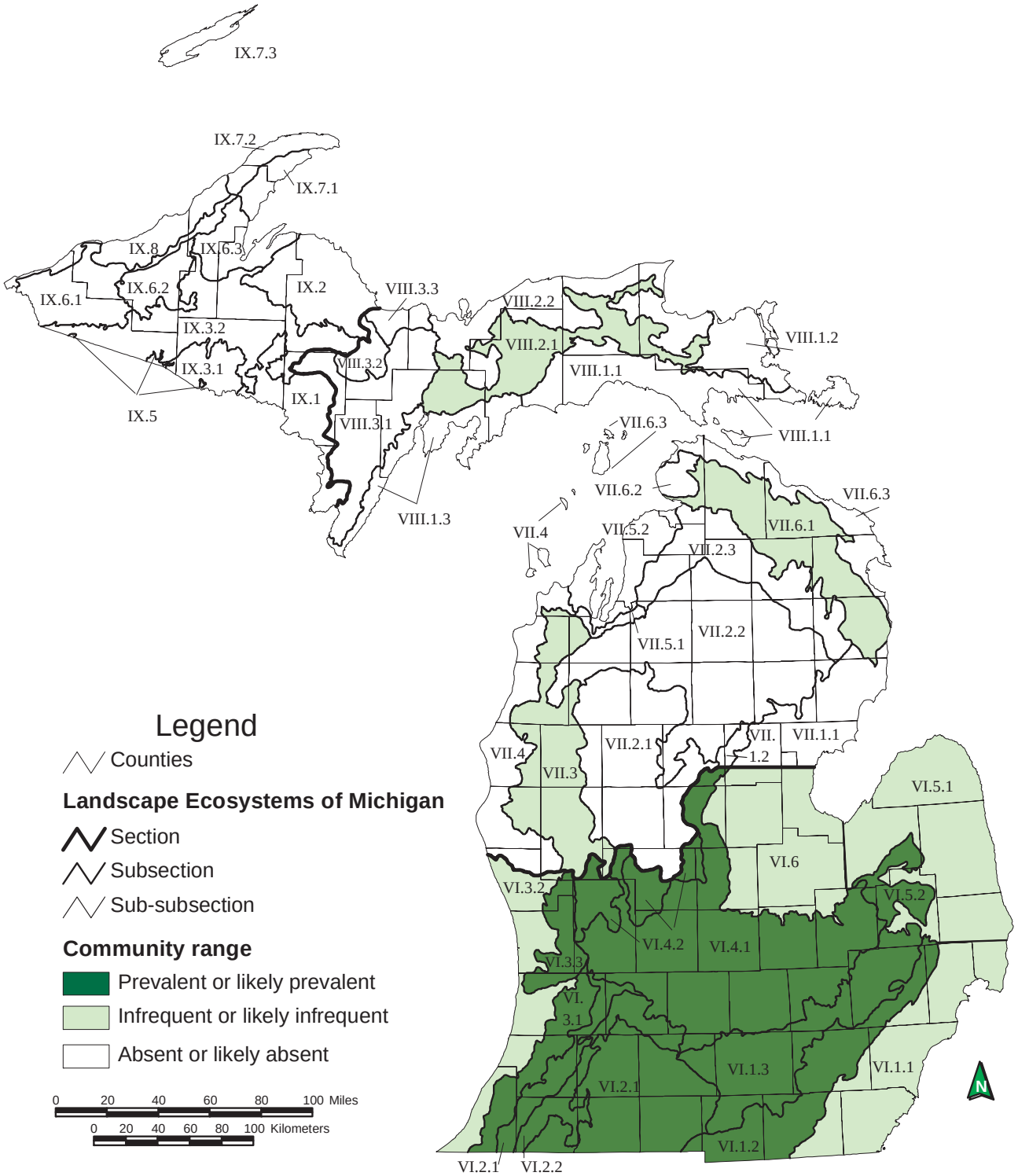
Wildwood Fen. Photo by Michael A. Kost.



1998 aerial photograph of Wildwood Fen.

RICH TAMARACK SWAMP

Overview: Rich tamarack swamp is a groundwater-influenced, minerotrophic, forested wetland dominated by tamarack (*Larix laricina*) that occurs on deep organic soils predominantly south of the climatic tension zone in southern Lower Michigan. Rich tamarack swamp occurs in outwash channels, outwash plains, and kettle depressions. Rich tamarack swamp typically occurs in association with headwater streams and adjacent to inland lakes. The organic soils underlying rich tamarack swamp are typically comprised of deep peat containing large amounts of woody debris and occasionally layers of sedge-dominated peat. Windthrow, insect outbreak, beaver flooding, and fire are all important forms of natural disturbance for rich tamarack swamp (Kost et al. 2007).



Map 9. Distribution of rich tamarack swamp in Michigan (Albert et al. 2008).

30. Turner Creek Swamp
Natural Community Type: Rich Tamarack Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 43 acres
Location: Compartment 1, Stand 109
Element Occurrence Identification Number: 18983

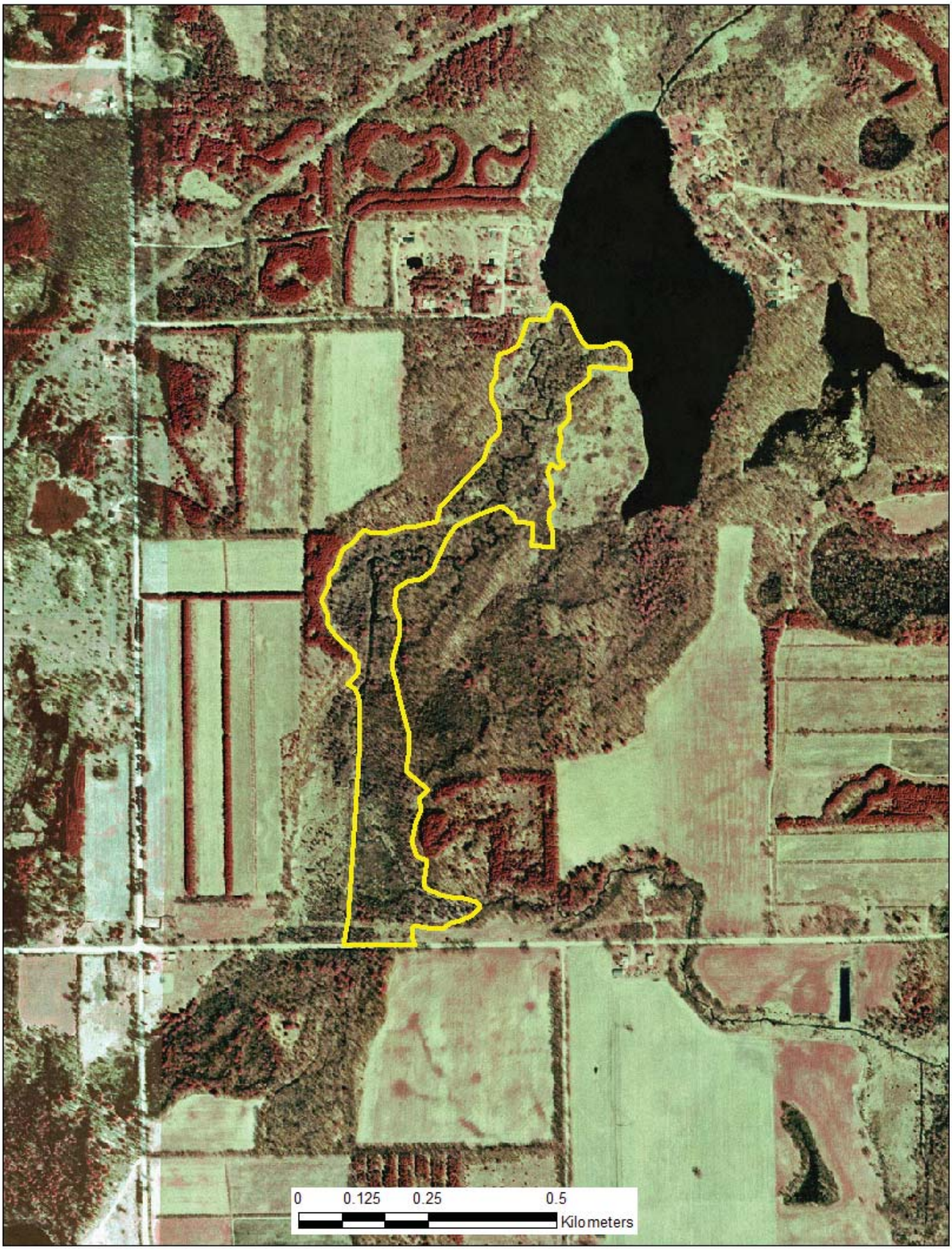
Site Description: This rich tamarack swamp occurs along Turner Creek in a poorly drained outwash plain. The rich tamarack swamp intergrades with southern-shrub carr. The alkaline (pH 7.4) organic soils are characterized by sapric peats over sedge peats. The rich tamarack swamp occurs adjacent to high-quality dry southern forest (Bassett Lake Woods, EO ID 18976), prairie fen (Bowens Mill Fen, EO ID 13555), and southern wet meadow (Bassett Lake Meadow, EO ID 18984).

The rich tamarack swamp is characterized by canopy closure of approximately 30% with tamarack (*Larix laricina*) dominant and canopy associates including red maple (*Acer rubrum*), American elm (*Ulmus americana*), swamp white oak (*Quercus bicolor*), yellow birch (*Betula alleghaniensis*), black ash (*Fraxinus nigra*), and white pine (*Pinus strobus*). The tall shrub layer is dense and diverse with characteristic species including poison sumac (*Toxicodendron vernix*), spicebush (*Lindera benzoin*), silky dogwood (*Cornus amomum*), gray dogwood (*C. foemina*), red-osier dogwood (*C. sericea*), winterberry (*Ilex verticillata*), tag alder (*Alnus incana*), and bog birch (*Betula pumila*). The invasive shrub multiflora rose (*Rosa multiflora*) is also common within the tall shrub layer. Whorled loosestrife (*Decodon verticillata*) is common in the low shrub layer. The ground cover is diverse with common species including false nettle (*Boehmeria cylindrica*), jewelweed (*Impatiens capensis*), tussock sedge (*Carex stricta*), calico aster (*Symphyotrichum lateriflorum*), swamp aster (*S. puniceum*), golden ragwort (*Packera aurea*), nodding bur-marigold (*Bidens cernua*), swamp milkweed (*Asclepias incarnata*), bristly-stalked sedge (*C. leptalea*), and lake sedge (*C. lacustris*). The invasive narrow-leaved cat-tail (*Typha angustifolia*) occurs within the swamp. Eighty-six native, vascular plant species were noted within this rich tamarack swamp during the 2012 surveys.

Threats: The species composition, vegetative structure, and successional trajectory of the rich tamarack swamp are influenced by groundwater seepage, fire suppression, deer herbivory, and invasive species. Fire suppression is beginning to lead to woody encroachment. Invasives include multiflora rose and narrow-leaved cat-tail. Invasive species are common in the adjacent uplands and in nearby wetlands. Run-off from fertilizer from nearby agricultural fields may also be impacting the nutrient dynamics of the swamp and leading to a localized increase in cat-tails along the western edge of the swamp. The hydrology of the swamp is likely impacted by Bowens Mill Road, which occurs along the southern margin of the swamp

Management Recommendations: The primary management recommendation is to control invasive species and monitor the control efforts. Landscape fires should be allowed to burn the rich tamarack swamp and adjacent uplands. In addition, maintaining natural communities surrounding the rich tamarack swamp will buffer the wetland and help preserve its hydrology, reduce the landscape-level seed source of invasive species, and mitigate the potential impact of run-off from nearby agricultural fields. The culvert passing under Bowens Mill Road should be monitored to make sure that it is functioning.

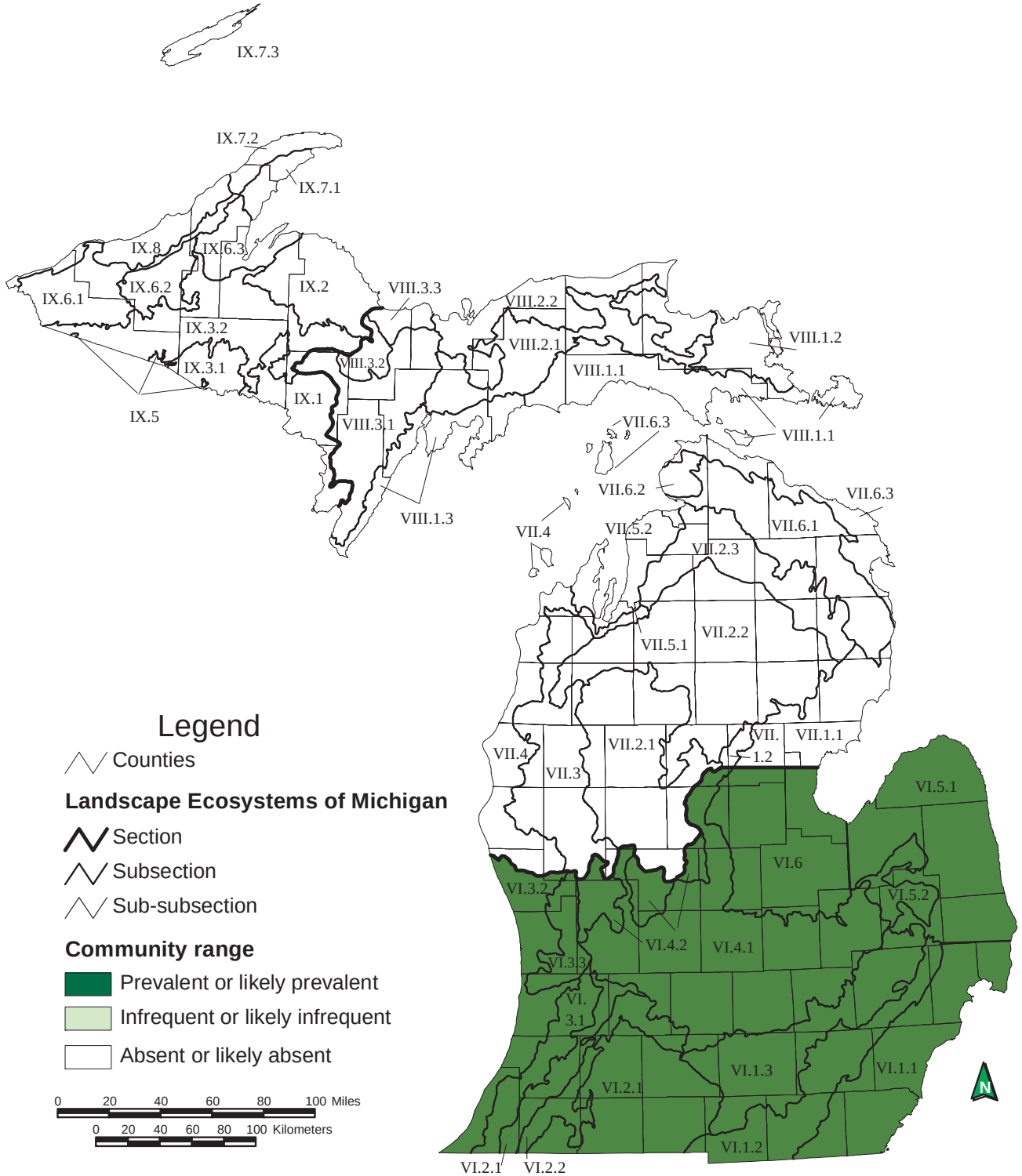
Turner Creek Swamp. Photo by Michael A. Kost.



1998 aerial photograph of Turner Creek Swamp.

SOUTHERN WET MEADOW

Overview: Southern wet meadow is an open, groundwater-influenced (minerotrophic), sedge-dominated wetland that occurs in central and southern Lower Michigan. Southern wet meadow occurs on glacial lakebeds, lakeplains, and in depressions on glacial outwash and moraines. The community frequently occurs along the margins of lakes and streams, where seasonal flooding or beaver-induced flooding is common. Soils are typically neutral to strongly alkaline organic soils (i.e., sapric to hemic peat), but saturated mineral soil may also support the community. Open conditions are maintained by seasonal flooding, beaver-induced flooding, and fire. Sedges in the genus *Carex*, in particular tussock sedge (*Carex stricta*), dominate the community (Kost et al. 2007).



Map 10. Distribution of southern wet meadow in Michigan (Albert et al. 2008).

31. Bassett Lake Meadow
Natural Community Type: Southern Wet Meadow (re-classified from Prairie Fen)
Rank: G4? S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 10 acres
Location: Compartment 1, Stand 108
Element Occurrence Identification Number: 18984

Site Description: Bassett Lake Meadow occurs adjacent to Bassett Lake and Turner Creek in a poorly drained outwash plain. Species composition, vegetative structure, and successional trajectory are influenced by season water-level fluctuation. Water levels fluctuate seasonally, reaching their peak in spring and lows in late summer, but typically remain at or near the soil's surface throughout the year. The structure of this southern wet meadow is largely influenced by tussock sedge (*Carex stricta*), which forms large tussocks on which many additional species successfully establish above the zone of seasonal inundation. Animal tracks throughout the southern wet meadow create inundated linear features within the southern wet meadow. The soils of the southern wet meadow are saturated to inundated hemic to sapric peats that are circumneutral (pH 7.0) and of variable depth (20 cm to 80 cm). The southern wet meadow occurs adjacent to high-quality dry southern forest (Bassett Lake Woods, EO ID 18976) and rich tamarack swamp (Turner Creek Swamp, EO ID 18983).

The southern wet meadow is dominated by tussock sedge, which forms prevalent tussocks. Graminoid associates include blue-joint grass (*Calamagrostis canadensis*) and lake sedge (*Carex lacustris*). The invasives narrow-leaved cat-tail (*Typha angustifolia*), hybrid cat-tail (*T.* x*glauca*), and reed canary grass (*Phalaris arundinacea*) are locally abundant. Characteristic forbs are joe-pye-weed (*Eutrochium maculatum*), common boneset (*Eupatorium perfoliatum*), swamp goldenrod (*Solidago patula*), Canada goldenrod (*S. canadensis*), smooth swamp aster (*Symphyotrichum firmum*), and wild blue flag (*Iris versicolor*). Prevalent ferns in the herbaceous layer include marsh fern (*Thelypteris palustris*) and sensitive fern (*Onoclea sensibilis*). Shrubs are scattered within the wet meadow and include poison sumac (*Toxicodendron vernix*), silky dogwood (*Cornus amomum*), gray dogwood (*C. foemina*), red-osier dogwood (*C. sericea*), tag alder (*Alnus incana*), slender willow (*Salix petiolaris*), and pussy willow (*S. discolor*). Infrequent trees occur sporadically on the margins of the wet meadow and include red maple (*Acer rubrum*), American elm (*Ulmus americana*), and tamarack (*Larix laricina*). Twenty-eight native, vascular plant species were noted within this rich tamarack swamp during the 2012 surveys.

Threats: This southern wet meadow is threatened by fire suppression and the subsequent encroachment of woody species, both native and non-native. Areas of southern shrub-carr occur along the west side of the southern wet meadow and along the lakeshore. Invasive shrubs are prevalent within these inclusions of southern shrub-carr and include multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*) and invasive honeysuckles (*Lonicera* spp.). In addition to these invasive shrubs, invasive graminoids common in the southern wet meadow include narrow-leaved cat-tail, hybrid cat-tail, and reed canary grass.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment. It is imperative that controlled burning 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. In addition to using prescribed fire, cutting and herbiciding of invasive shrubs may be necessary. Maintaining a buffer of natural communities surrounding the southern wet meadow will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species should be implemented. Keen attention should be paid to whether or not additional populations of narrow-leaved cat-tail have infiltrated the meadow since this species can spread rapidly following the use of prescribed fire. If new populations of narrow-leaved cat-tail are discovered, fire should be restricted from these areas until the cat-tail has been controlled through alternative means (i.e., herbicide treatment).

Basset Lake Meadow. Photos by Michael A. Kost.

1998 aerial photograph of Bassett Lake Meadow.

32. Havens Road Meadow
Natural Community Type: Southern Wet Meadow
Rank: G4? S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 124 acres
Location: Compartment 4, Stands 198, 201, 204, and 218 and Compartment 5, Stands 12, 13, 15, and 22
Element Occurrence Identification Number: 13355

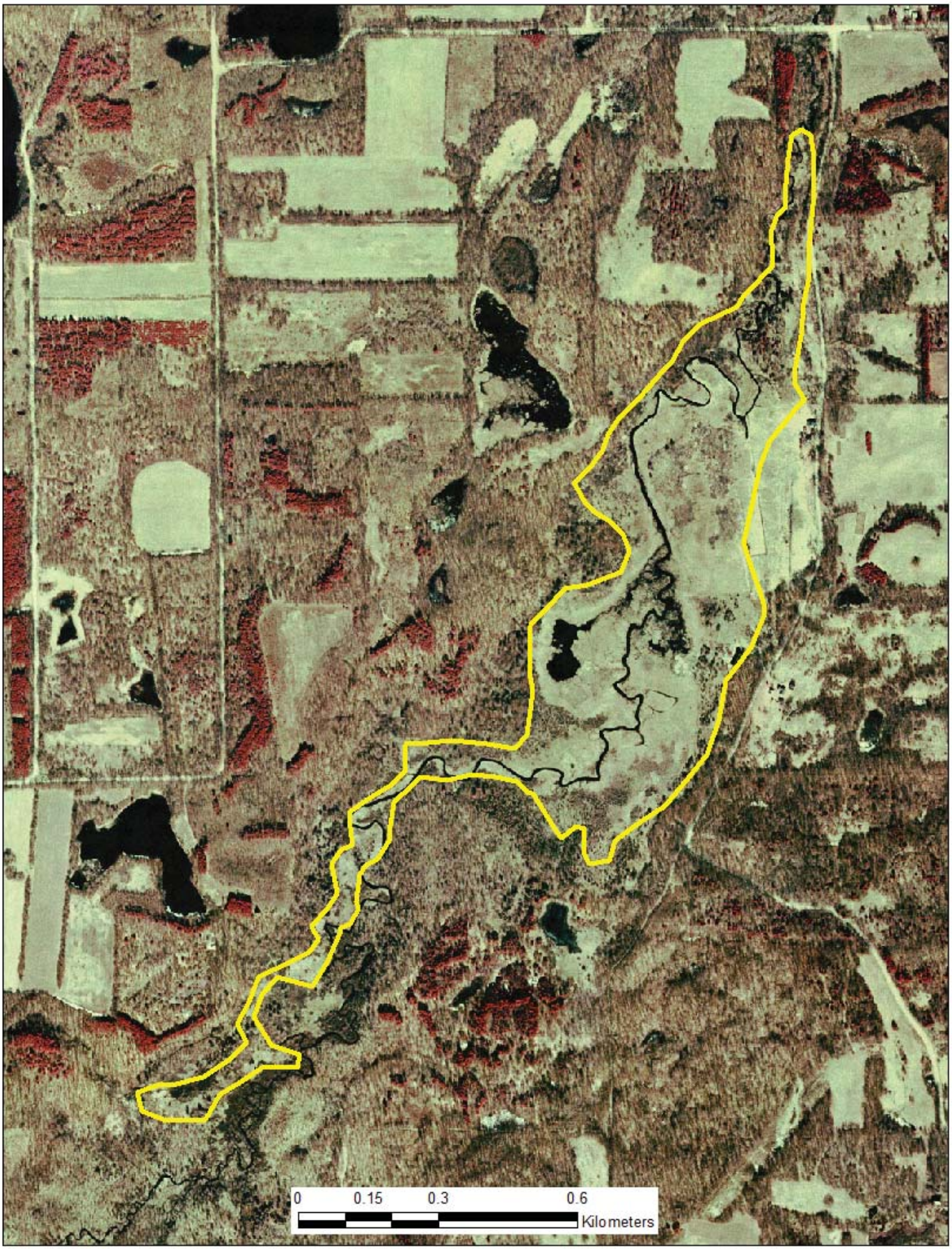
Site Description: Havens Road Meadow occurs within a poorly drained outwash channel that passes through a coarse-textured end moraine. This large meadow extends for half a mile along Glass Creek as a quarter mile wide basin and then thins abruptly in the southwest portion of the site but continues as a narrow streamside zone for another half mile. Within the outwash channel, the southern wet meadow occurs in association with southern shrub-carr and rich tamarack swamp. The meadow is characterized by saturated organic soils.

The southern wet meadow is dominated by sedges (*Carex* spp.) with water sedge (*C. aquatilis*) being dominant. Additional prevalent species include common boneset (*Eupatorium perfoliatum*), softstem bulrush (*Schoenoplectus tabernaemontani*), round-leaved sundew (*Drosera rotundifolia*), marsh-marigold (*Caltha palustris*), marsh pea (*Lathyrus palustris*), and water dock (*Rumex verticillata*). The invasive hybrid cat-tail (*Typha* x*glauca*) dominates large portions of the wetland along Glass Creek. Scattered shrub and stunted trees occur within the meadow, especially along the margins and closer to the stream, and include shrubby cinquefoil (*Dasiphora fruticosa*), alder-leaved buckthorn (*Rhamnus alnifolia*), bog birch (*Betula pumila*), and tamarack (*Larix laricina*)

Rare animal species associated with Havens Road Meadow and nearby wetlands include spotted turtle (*Clemmys guttata*, state threatened), eastern massasauga (*Sisturus catenatus*, state special concern and federal candidate), Blanding's turtle (*Emydoidea blandingii*, state special concern), and eastern box turtle (*Terrapene carolina carolina*, state special concern). Eastern box turtle and eastern massasauga were documented in the vicinity of this wetland in 2013.

Threats: This southern wet meadow is threatened by fire suppression and the subsequent encroachment of woody species both native and non-native. As noted above, the invasive hybrid cat-tail dominates large portions of the wetland along Glass Creek.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment and control hybrid cat-tail. Because numerous rare species have been documented at this site, if prescribed fire is implemented, rotating non-fire refugia should be established within the meadow. To avoid negative impacts to rare 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 wetland vegetation when treating invasives with chemicals. Maintaining a buffer of natural communities surrounding the southern wet meadow will help ensure the stability of the wetland's hydrologic regime and limit the possibility for invasive species encroachment. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for invasive species and Mitchell's satyr should be implemented. Keen attention should be paid to whether or not populations of narrow-leaved cat-tail have infiltrated the meadow since this species can spread rapidly following the use of prescribed fire. If populations of narrow-leaved cat-tail are discovered, fire should be restricted from these areas until the cat-tail has been controlled through alternative means (i.e., herbicide treatment).



1998 aerial photograph of Havens Road Meadow.

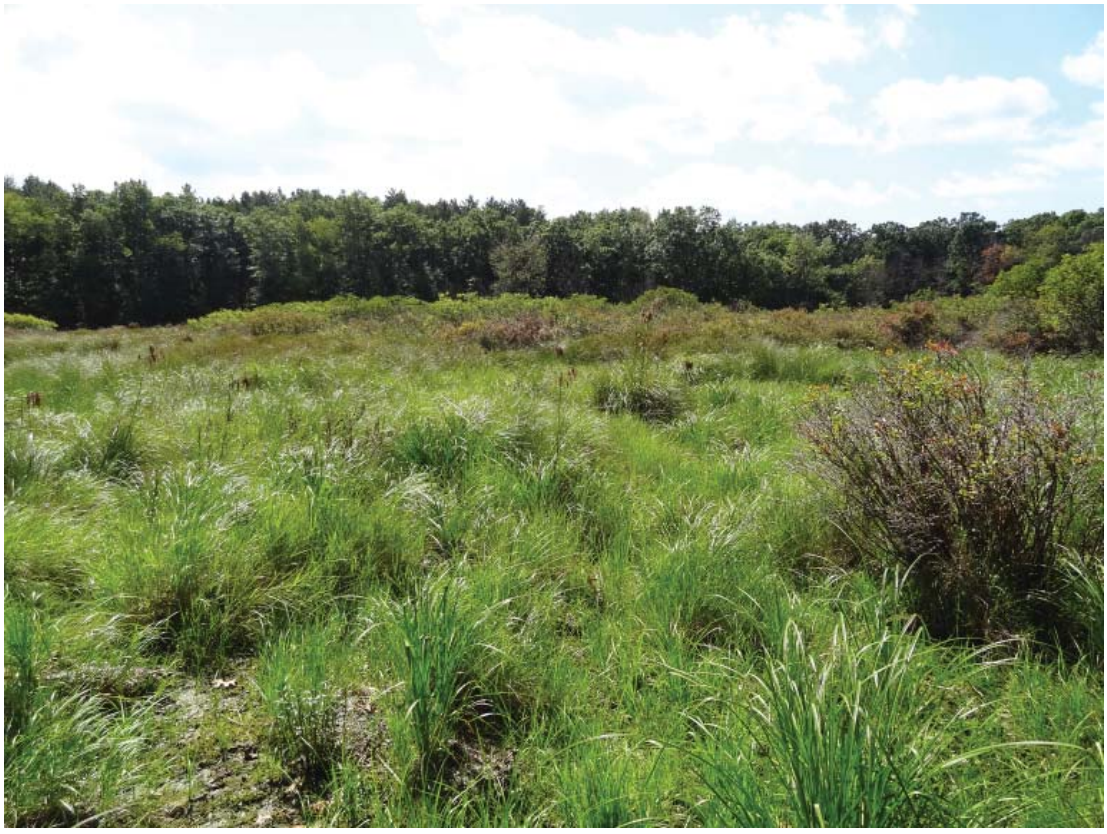
33. Oak Road Meadow
Natural Community Type: Southern Wet Meadow
Rank: G4? S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Size: 28 acres
Location: Compartment 4, Stand 12
Element Occurrence Identification Number: 18979

Site Description: This wet meadow occurs within an ice-block depression in a coarse-textured end moraine. It is characterized by annual and seasonal water fluctuations and various vegetation zones including open water, mud flats, wet meadow, sphagnum mats, and a shrub-carr margin. Species composition, vegetative structure, and successional trajectory are influenced by season water-level fluctuation. Water levels in the southern wet meadow fluctuate seasonally, reaching their peak in spring and lows in late summer, but typically remain at or near the soil's surface throughout the year. The soils are deep (> 1 meter), inundated, acidic (pH 5.5) mucks.

The central portion of the southern wet meadow is dominated by emergent graminoids including three-way sedge (*Dulichium arundinaceum*), blue-joint grass (*Calamagrostis canadensis*), and wool-grass (*Scirpus cyperinus*) with water smartweed (*Persicaria amphibia*) also prevalent. The mud flats are characterized by floating vegetation. The margin of the wetland supports a shrub zone characterized by highbush blueberry (*Vaccinium corymbosum*) and winterberry (*Ilex verticillata*) along with scattered trees including black gum (*Nyssa sylvatica*) and oaks (*Quercus* spp.). In the southern two-thirds of the wetland are two bog-like zones or sphagnum mats that are dominated by sphagnum moss (*Sphagnum* spp.), leatherleaf (*Chamaedaphne calyculata*), blue-joint grass, and wool-grass. Highbush blueberry and black chokeberry (*Aronia prunifolia*) occur scattered on these sphagnum mats. Seventeen native, vascular plant species were noted within this southern wet meadow during the 2012 surveys.

Threats: The species composition, vegetative structure, and successional trajectory of the southern wet meadow are influenced by groundwater seepage and fire suppression. Invasive species are common in the adjacent uplands and in nearby wetlands.

Management Recommendations: The primary management recommendation is to control invasive species and monitor the control efforts. Landscape fires should be allowed to burn the southern wet meadow and adjacent uplands. In addition, maintaining natural communities surrounding the wet meadow will buffer the wetland and help preserve its hydrology and reduce the landscape-level seed source of invasive species.

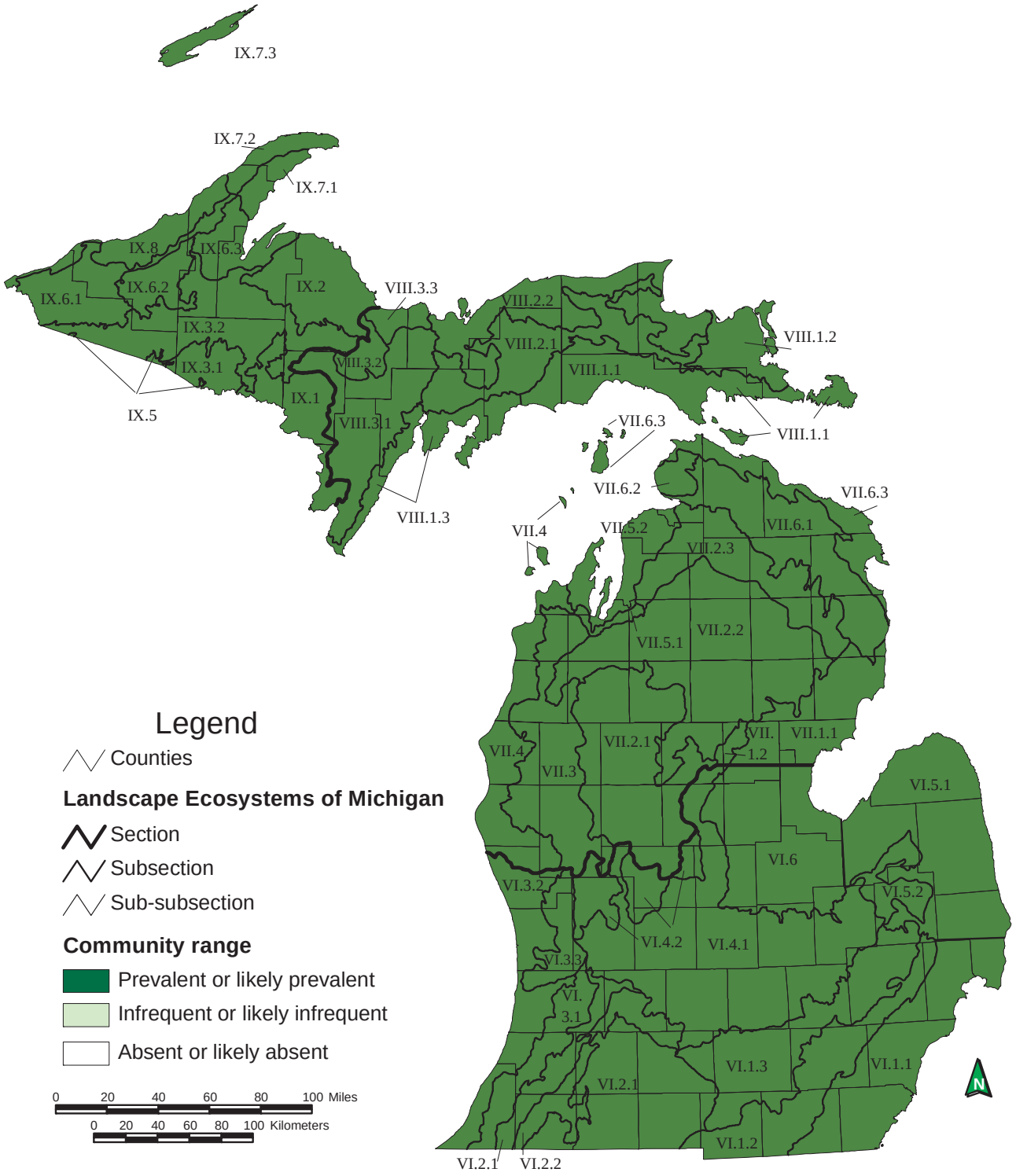


Oak Road Meadow. Photo by Michael A. Kost.

1998 aerial photograph of Oak Road Meadow.

SUBMERGENT MARSH

Overview: Submergent marsh is an herbaceous plant community that occurs in deep to sometimes shallow water in lakes and streams throughout Michigan. Soils are characterized by loosely consolidated organics of variable depth that range from acid to alkaline and accumulate over all types of mineral soil, even bedrock. Submergent vegetation is composed of both rooted and non-rooted submergent plants, rooted floating-leaved plants, and non-rooted floating plants. Common submergent plants include common waterweed (*Elodea canadensis*), water star-grass (*Heteranthera dubia*), milfoils (*Myriophyllum* spp.), naiads (*Najas* spp.), pondweeds (*Potamogeton* spp.), stoneworts (*Chara* spp. and *Nitella* spp.), coontail (*Ceratophyllum demersum*), bladderworts (*Utricularia* spp.), and water-celery (*Vallisneria americana*) (Kost et al. 2007).



Map 11. Distribution of submergent marsh in Michigan (Albert et al. 2008).

34. Otis Lake Marsh
Natural Community Type: Submergent Marsh
Rank: GU S4, globally unrankable and secure within the state
Element Occurrence Rank: AB
Size: 128 acres
Location: Compartment 3, Stand 100
Element Occurrence Identification Number: 18985

Site Description: Otis Lake Marsh and Otis Lake occur within an ice-block depression in a coarse-textured end moraine. The submergent marsh is characterized by annual and seasonal water fluctuations and various vegetation zones including open water, mud flats dominated by floating aquatic vegetation and emergent graminoids, and a shrub-carr margin. The soils of the marsh are characterized as 50 to 70 cm of unconsolidated organics over slightly acidic (pH 6.5) sand. The marsh is surrounded by a high-quality bog (Otis Lake Bog, EO ID 15901) and two high-quality dry-mesic southern forests occur to the northeast across Gun Lake Rd (Gun Lake Road Woods EO ID 18967 and Hart Road Woods, EO ID 18969).

The core of this wetland is characterized by a matrix of water and mud flats that are likely inundated during wetter years. Prevalent species in this zone include yellow pond-lily (*Nuphar advena*), sweet-scented waterlily (*Nymphaea odorata*), water-shield (*Brasenia schreberi*), three-way sedge (*Dulichium arundinaceum*), pickerel-weed (*Pontederia cordata*), pondweed (*Potamogeton nodosus*), spike-rushes (*Eleocharis* spp.), hardstem bulrush (*Schoenoplectus acutus*), threesquare (*S. pungens*), and water-pennywort (*Hydrocotyle umbellata*). Two rare species occur along the margins of the marsh, tall beak-rush (*Rhynchospora macrostachya*, state special concern) and horsetail spike-rush (*Eleocharis equisetoides*, state special concern). Scattered trees occur along the margin of the wetland and include red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), white oak (*Quercus alba*), and tamarack (*Larix laricina*) with buttonbush (*Cephalanthus occidentalis*) and autumn olive (*Elaeagnus umbellata*) occurring in the understory beneath. Eighteen native, vascular plant species were noted within this marsh during the 2012 surveys.

Numerous rare species are associated with Otis Lake including breeding common loon (*Gavia immer*, state threatened) and osprey (*Pandion haliaetus*, state special concern), both observed in 2013. In addition a new record for pine tree cricket (*Oecanthus pini*, state special concern) was documented in the bog mat along the northern shore of Otis Lake and a known breeding population of Blanchard's cricket frog (*Acris blanchardi*, state threatened) was confirmed for Otis Lake in 2013. In addition, the forest surrounding Otis Lake supports a breeding population of cerulean warbler (*Dendroica cerulea*, state threatened).

Threats: This is a large submergent marsh within a degraded landscape that displays well-developed ecological zonation, moderate species diversity, and little evidence of anthropogenic disturbance. The species composition and structure of this submergent marsh are influenced by natural processes. As noted above, autumn olive is scattered in the understory along the margin of the wetland. The hydrology of the marsh is likely locally impacted by the road that passes by the wetland along the southeastern margin.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the wetland to minimize the threat of hydrological alteration, and monitor for invasive plants and illegal off-road vehicle use. The autumn olive along the margin of the wetland should be cut and herbicided.

Otis Lake Marsh. Photos by Michael A. Kost.

1998 aerial photograph of Otis Lake Marsh.

35. Snow Lake Marsh
Natural Community Type: Submergent Marsh
Rank: GU S4, globally unrankable and secure within the state
Element Occurrence Rank: B
Size: 9 acres
Location: Compartment 3, Stand 38
Element Occurrence Identification Number: 18986

Site Description: Snow Lake Marsh occupies the basin of Snow Lake, which is an ice-block depression within a coarse-textured end moraine. The submergent marsh is bordered by high-quality poor fen (Snow Lake Fen, EO ID 18980) and degraded uplands. The soils of the marsh are characterized as 20 to 50 cm of unconsolidated, circumneutral (pH 7.0) organics over circumneutral (pH 7.0) sands. The submergent marsh occurs throughout Snow Lake in water typically greater than 50 cm deep. Emergent marsh and poor fen occur along the margins of Snow Lake and emergent marsh is prevalent in shallower waters (20-50 cm).

The submergent marsh in Snow Lake is characterized by dense beds of floating aquatic vegetation including yellow pond-lily (*Nuphar advena*), sweet-scented waterlily (*Nymphaea odorata*), water-shield (*Brasenia schreberi*), pickerel-weed (*Pontederia cordata*), and pondweeds (*Potamogeton* spp.). Areas of emergent marsh along the margin of the submergent marsh are dominated by softstem bulrush (*Schoenoplectus tabernaemontani*). The invasives narrow-leaved cat-tail (*Typha angustifolia*) and hybrid cat-tail (*T.* x*glauca*) are localized within these emergent zones. Scattered shrubs within the emergent zone include buttonbush (*Cephalanthus occidentalis*) and meadowsweet (*Spiraea alba*). Scattered trees occur along the margin of the wetland and include red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), trembling aspen (*Populus tremuloides*), and black ash (*Fraxinus nigra*). Twelve native, vascular plant species were noted within this marsh during the 2012 surveys. A known breeding population of Blanchard's cricket frog (*Acris blanchardi*, state threatened) was confirmed for Snow Lake in 2013.

Threats: The species composition and structure of this submergent marsh are influenced by natural processes. As noted above, invasive cat-tails occur locally within the emergent zone bordering the submergent marsh.

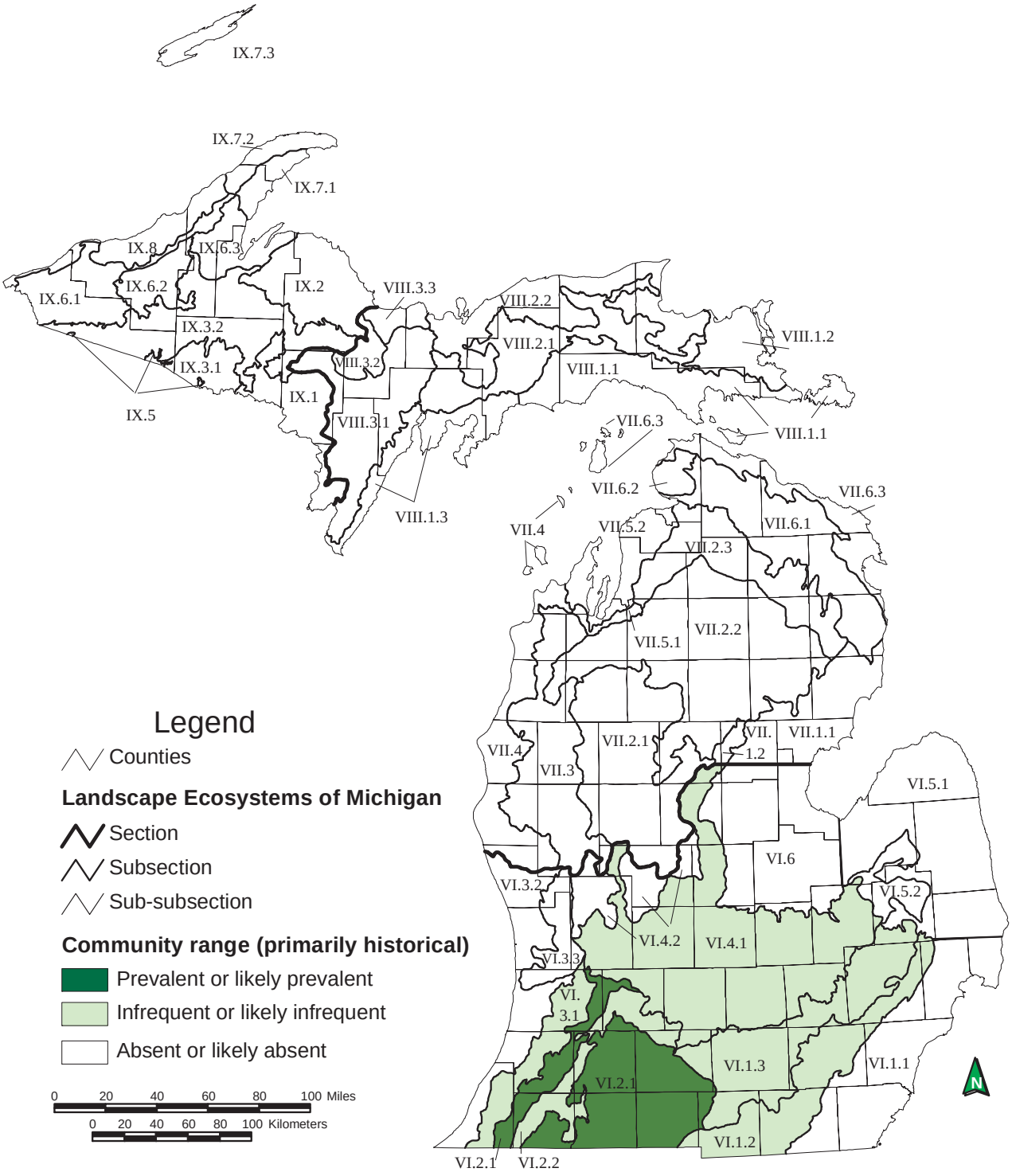
Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered and to retain an intact buffer of natural communities surrounding the wetland to minimize the threat of hydrological alteration. Invasive cat-tails should be controlled and monitoring for invasives should be implemented. Selection of herbicide to apply to the cat-tails and seasonality of application should be carefully considered because a rare amphibian, Blanchard's cricket frog (*Acris crepitans blanchardi,* state threatened), is known to utilize this wetland.

Snow Lake Marsh. Photo by Michael A. Kost.

1998 aerial photograph of Snow Lake Marsh.

WET PRAIRIE

Overview: Wet prairie is a native lowland grassland occurring on level, saturated and/or seasonally inundated stream and river floodplains, lake margins, and isolated depressions in the southern Lower Peninsula. The community is typically found on outwash plains and outwash channels near moraines, and usually occurs on circumneutral loams or silt loams with high organic content. Natural processes that influence species composition and community structure include fluctuating water levels, flooding by beaver, and fire. Dominant plant species include blue-joint (*Calamagrostis canadensis*) and cordgrass (*Spartina pectinata*), with sedges (*Carex* spp.) often important subdominants. Today, wet prairie is nearly extirpated from Michigan due to changes in land use and colonization by shrubs and trees (Kost et al. 2007).



Map 12. Distribution of wet prairie in Michigan (Albert et al. 2008).

36. Turner Creek Wetlands
Natural Community Type: Wet Prairie
Rank: G3 S1, globally vulnerable and critically imperiled within the state
Element Occurrence Rank: C
Size: 17 acres
Location: Compartment 1, Stand 199 and Compartment 2, Stand 25
Element Occurrence Identification Number: 2267

Site Description: This wet prairie consists of two distinct polygons that occur along a tributary of Turner Creek within poorly drained outwash. The site occurs in association with several high-quality natural communities that include prairie fen (Turner Creek Wetlands, EO ID 278) and wet-mesic prairie (Turner Creek Wetlands, EO ID 4771). The soils of the wet prairie are saturated to inundated hemic peat overlying sands. Species composition, vegetative structure, and successional trajectory are influenced by seasonal water-level fluctuation. The wet prairie is seasonally inundated with the fluctuating water levels reaching their peak in spring and lows in late summer, but typically remain at or near the soil's surface throughout the year. Sedge hummocks within the wet prairie occur above the high water table.

The wet prairie is characterized by sedges and grasses with dominant species including tussock sedge (*Carex stricta*), bluejoint grass (*Calamagrostis canadensis*), and cordgrass (*Spartina pectinata*). Characteristic forbs include joe-pye-weed (*Eutrochium maculatum*), swamp goldenrod (*Solidago patula*), swamp aster (*Symphyotrichum puniceum*), and late goldenrod (*S. gigantea*). Marsh fern (*Thelypteris palustris*) is also abundant in the ground cover and scattered shrubs include shrubby cinquefoil (*Dasiphora fruticosa*) and gray dogwood (*Cornus foemina*).

The wetland complex associated with Turner Creek has been utilized in the past by Mitchell's satyr butterfly (*Neonympha mitchellii mitchellii*, state and federally endangered). Mitchell's satyr was last observed using this site in 2012 but was not documented by surveyors in 2013. Additional rare species documented within this wet prairie and in the vicinity include eastern box turtle (*Terrapene carolina carolina*, state special concern), eastern massasauga (*Sisturus catenatus*, state special concern and federal candidate), tamarack tree cricket (*Oecanthus laricis*, state special concern), angular spittlebugs (*Lepyronia angulifera*, state special concern), and red-legged spittlebug (*Prosapia ignipectus*, state special concern). Angular spittlebug was observed in the Turner Creek Wetlands in 2013.

Threats: The primary threats to this prairie fen are posed by fire suppression and native shrub and invasive species encroachment. Invasive species recorded within this wet prairie include morrow honeysuckle (*Lonicera morrowii*), reed canary grass (*Phalaris arundinacea*), and reed (*Phragmites australis*). The hydrology of this wet prairie may be locally impacted by the adjacent road and roadside ditch.

Management Recommendations: The primary management recommendation is to continue utilizing prescribed fire to reduce tree and shrub encroachment and control invasive species. Because this site may still harbor Mitchell's satyr and other rare species, rotating non-fire refugia should be established within the wetland complex. To avoid negative impacts to rare 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 wetland vegetation when treating invasives with chemicals. Maintaining a buffer of natural communities surrounding the wet prairie will help ensure the stability of the wetland's hydrologic regime. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for Mitchell's satyr and invasive species should be implemented.

1998 aerial photograph of Turner Creek Wetlands wet prairie.

37. Turner Creek Wet Prairie
Natural Community Type: Wet Prairie
Rank: G3 S1, globally vulnerable and critically imperiled within the state
Element Occurrence Rank: C
Size: 6 acres
Location: Compartment 2, Stand 31
Element Occurrence Identification Number: 18987

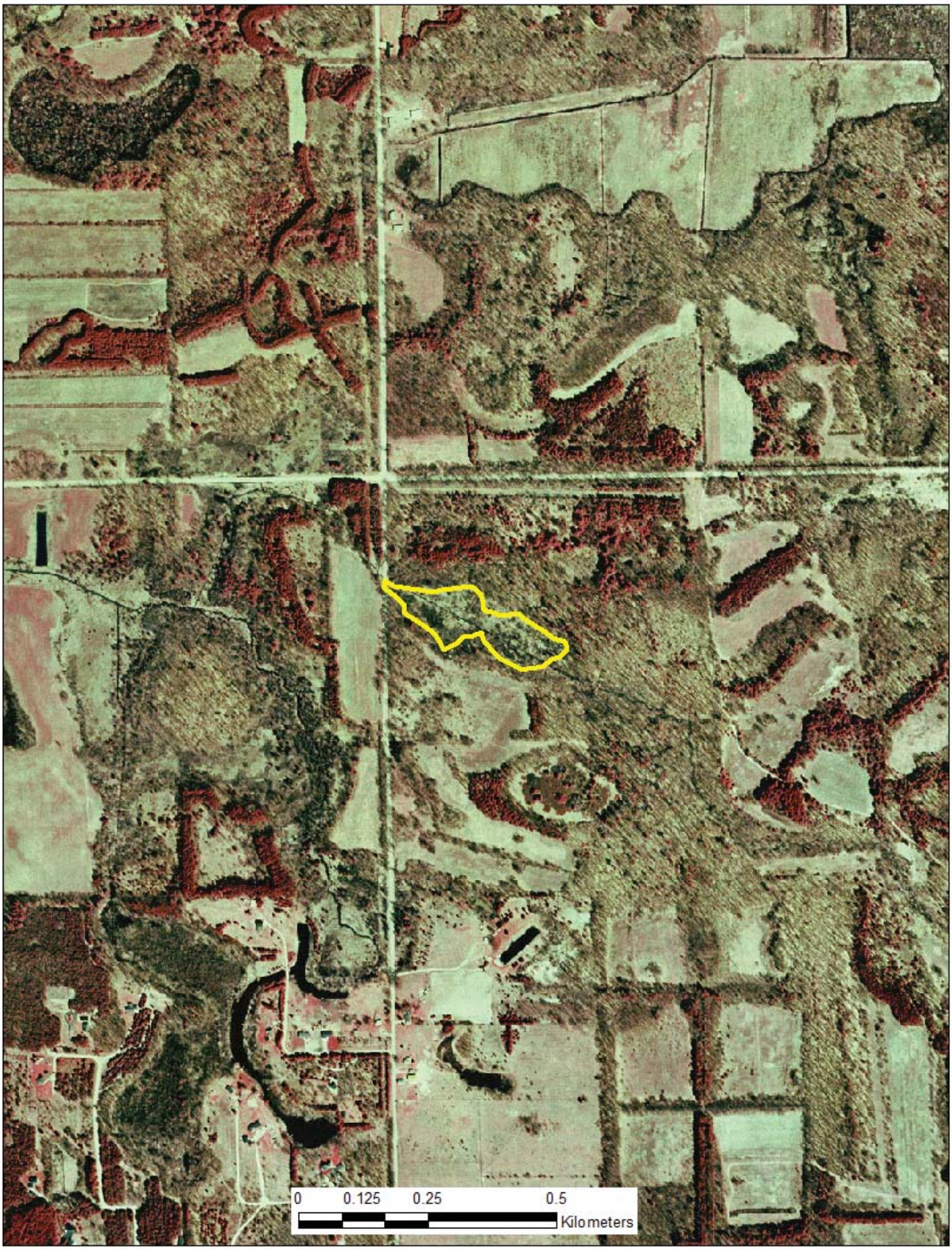
Site Description: This wet prairie occurs within a broad outwash plain adjacent to Turner Creek. Turner Creek is a small creek with a sandy bottom that runs throughout this site in a nearly straight line. The soils of the wet prairie are slightly acidic (pH 6.5) sandy clay loam to 30 cm over peat mixed with mineral soils to 60 cm and marl with shells at 60 to 90 cm deep. Species composition, vegetative structure, and successional trajectory are influenced by seasonal water-level fluctuation. Water levels in wet prairies fluctuate seasonally, reaching their peak in spring and lows in late summer, but typically remain at or near the soil's surface throughout the year. Turner Creek Wet Prairie occurs just south of a high-quality dry-mesic northern forest (Turner Creek Forest, EO ID 18975).

The wet prairie is dominated by sedges and grasses with tussock sedge (*Carex stricta*) and blue-joint grass (*Calamagrostis canadensis*) dominant. In areas dominated by tussock sedge, tussocks are prevalent. Graminoid associates include cordgrass (*Spartina pectinata*), wood reedgrass (*Cinna arundinacea*), fowl manna grass (*Glyceria striata*), fringed brome (*Bromus ciliatus*), cut grass (*Leersia oryzoides*), wool-grass (*Scirpus cyperinus*), and Canada wild rye (*Elymus canadensis*). Characteristic forbs are joe-pye-weed (*Eutrochium maculatum*), common boneset (*Eupatorium perfoliatum*), goldenrods (*Solidago* spp.), calico aster (*Symphyotrichum lateriflorum*), common mountain mint (*Pycnanthemum virginianum*), Missouri ironweed (*Vernonia missurica*), and wild senna (*Senna hebecarpa*). Marsh fern (*Thelypteris palustris*) is also locally abundant within the ground cover. This wet prairie is also impacted by fire suppression which is leading to local dominance by shrubs and small trees and the suppression of grasses and forbs. Scattered low shrubs include shrubby cinquefoil (*Dasiphora fruticosa*), swamp rose (*Rosa palustris*), meadowsweet (*Spiraea alba*), winterberry (*Ilex verticillata*), and dogwoods (*Cornus* spp.). The tall shrub layer is patchy with willows (*Salix* spp.), dogwoods (*Cornus* spp.), and poison sumac (*Toxicodendron vernix*). Scattered trees include red maple (*Acer rubrum*), American elm (*Ulmus americana*), trembling aspen (*Populus tremuloides*), and pin oak (*Quercus palustris*). Invasives are locally abundant and include multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), and reed canary grass (*Phalaris arundinacea*). Sixty native, vascular plant species were noted within this rich tamarack swamp during the 2012 surveys.

Threats: Species composition, vegetative structure, and successional trajectory are influenced by seasonal water-level fluctuation, fire suppression, and competition from invasive species. The wet prairie is currently dominated by a diverse, thick cover of sedges, grasses, and forbs; however, with continued fire suppression, this wet prairie will likely soon become dominated by woody trees and shrubs. In addition, the hydrology of the wetland complex has been minimally impacted by the road crossing that occurs downstream. Turner Creek may have been straightened during the early part of the 20th century but lasting impacts are minimal. As noted above, invasives are locally abundant and include multiflora rose, autumn olive, and reed canary grass.

Management Recommendations: Prescribed fire should be employed to control shrub encroachment and reduce invasive species. The wet prairie should be burned in concert with the high-quality dry-mesic northern forest that occurs to the north. Cutting and herbiciding of autumn olive and multiflora rose are warranted. Monitoring should be employed to allow for assessment of whether management is reducing invasive species populations. In addition, maintaining a buffer of natural communities surrounding the wet prairie will buffer the wetland and help preserve its hydrology.

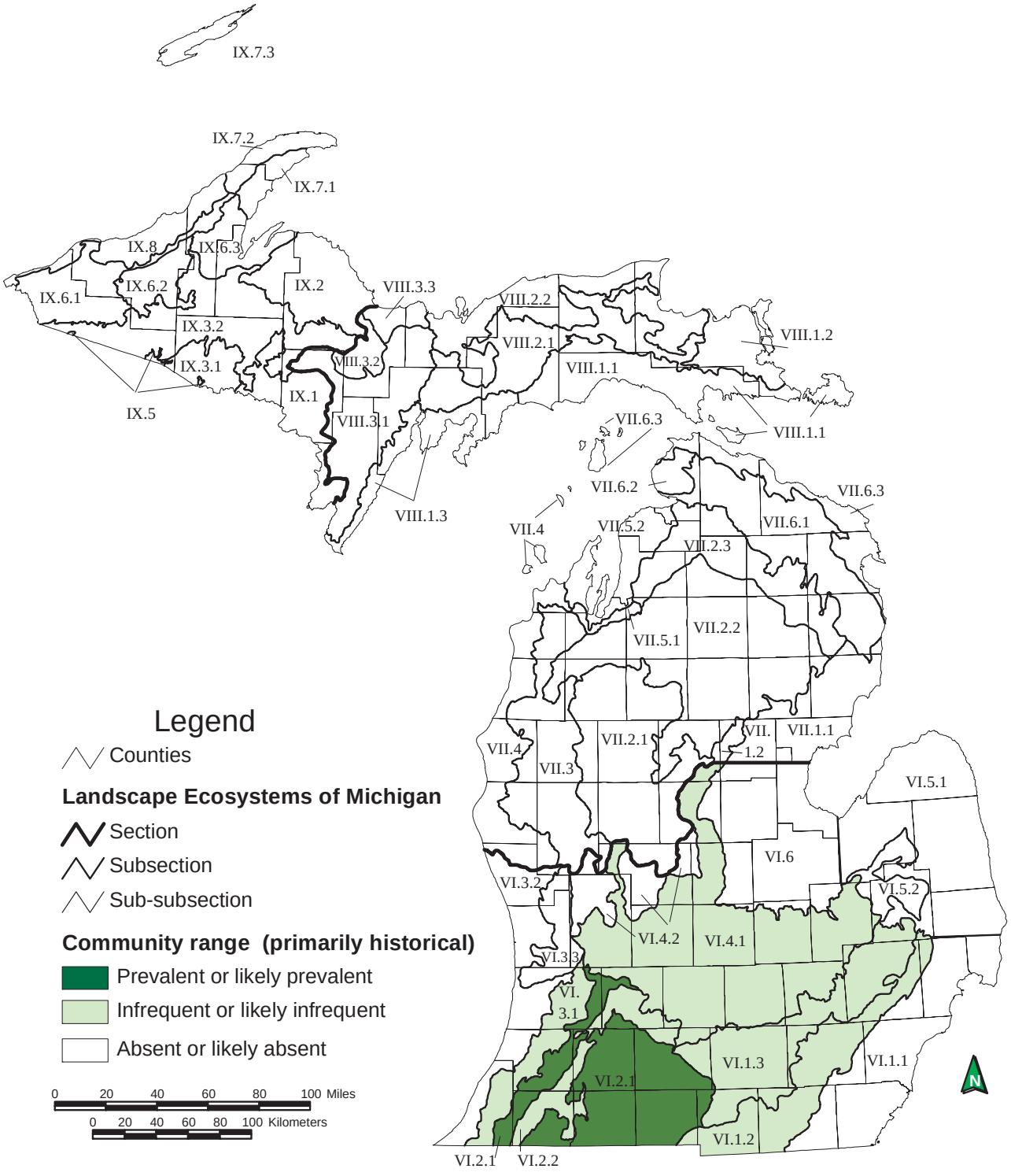
Turner Creek Wet Prairie. Photos by Michael A. Kost.



1998 aerial photograph of Turner Creek Wet Prairie

WET-MESIC PRAIRIE

Overview: Wet-mesic prairie is a native lowland grassland occurring on moist, occasionally inundated stream and river floodplains, lake margins, and isolated depressions in the southern Lower Peninsula. The community is typically found on glacial outwash plains and outwash channels near moraines. Wet-mesic prairie occurs primarily on circumneutral loams or silt loams with variable organic content, but soils can also include sand, sandy clay loam, sandy loam, and shallow muck overlying mineral soil. Natural processes that influence species composition and community structure include fluctuating water levels, fire, and flooding by beaver. Dominant or subdominant plant species include big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), blue-joint (*Calamagrostis canadensis*), cordgrass (*Spartina pectinata*), and sedges (*Carex* spp.). Today, wet-mesic prairie is nearly extirpated from Michigan due to changes in land use and colonization by shrubs and trees (Kost et al. 2007).



Map 13. Distribution of wet-mesic prairie in Michigan (Albert et al. 2008).

38. Turner Creek Wetlands
Natural Community Type: Wet-Mesic Prairie
Rank: G3 S1, globally vulnerable and critically imperiled within the state
Element Occurrence Rank: C
Size: 3.3 acres
Location: Compartment 2, Stand 25
Element Occurrence Identification Number: 4771

Site Description: This wet-mesic prairie consists of two distinct polygons that occur along a tributary of Turner Creek within poorly drained outwash. The site occurs in association with several high-quality natural communities that include prairie fen (Turner Creek Wetlands, EO ID 278) and wet prairie (Turner Creek Wetlands, EO ID 2267). The soils of the wet-mesic prairie are saturated to moist, alkaline (pH 7.0) mucks mixed with sands. Species composition, vegetative structure, and successional trajectory are influenced by seasonal water-level fluctuation.

The wet-mesic prairie is characterized by sedges and grasses with dominant species including big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), cordgrass (*Spartina pectinata*), and sedges (*Carex* spp.). Characteristic forbs include tall sunflower (*Helianthus giganteus*), flat-topped white aster (*Doellingeria umbellata*), tall coreopsis (*Coreopsis tripteris*), flowering spurge (*Euphorbia corollata*), Michigan lily (*Lilium michiganense*), golden alexanders (*Zizia aurea*), Culver's root (*Veronicastrum virginicum*), southern blue flag (*Iris virginica*), and prairie phlox (*Phlox pilosa*). Hazelnut (*Corylus americana*) occurs scattered throughout the site.

The wetland complex associated with Turner Creek has been utilized in the past by Mitchell's satyr butterfly (*Neonympha mitchellii mitchellii*, state and federally endangered). Mitchell's satyr was last observed using this site in 2012 but was not documented by surveyors in 2013.

Threats: The primary threats to this wet-mesic prairie are posed by hydrologic alteration, fire suppression, and native shrub and invasive species encroachment. The hydrology of this wet-mesic prairie may be locally impacted by the adjacent road and roadside ditch and channelized stream that drains this area. Portions of this site may have also been historically grazed.

Management Recommendations: The primary management recommendation is to utilize prescribed fire to reduce tree and shrub encroachment and control invasive species. Because this site may still harbor Mitchell's satyr, non-fire refugia should be established within the wetland complex. To avoid negative impacts to Mitchell's satyr, the manual 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 wet-mesic prairie vegetation when treating invasives with chemicals. Maintaining a buffer of natural communities surrounding the wet-mesic prairie will help ensure the stability of the wetland's hydrologic regime. In addition, reducing invasive species infestations in the surrounding uplands and wetlands is also recommended. Monitoring for Mitchell's satyr and invasive species should be implemented.

1998 aerial photograph of Turner Creek Wetlands wet-mesic prairie.

Rare Animal Survey Results

Birds

We conducted morning surveys for rare songbirds at 49 point-count locations within Barry SGA from June 12th through June 18th, 2013 (Figure 6). Two rare species, cerulean warbler and hooded warbler, were observed at several locations within the game area (Table 4). Hooded warbler was the most common rare species observed, with 18 individuals detected at 13 point-count stations. At least four male cerulean warblers were heard singing at four survey points. The two rare species have been recorded at many locations within the game area in forested areas south of M-179 (Chief Noonday Road) (Figure 10). In 2011, Michigan Audubon conducted surveys for cerulean warblers in Barry SGA and observed 80 individuals and banded 25 birds (MNFI 2014).

While conducting surveys for rare songbirds, we also recorded all other bird species observed. Forty-four bird species were detected during surveys. In addition to cerulean warbler and hooded warbler, eight other SGCN and four species used by the DNR Wildlife Division as featured species for habitat management were documented (Table 8 and Appendix 4). Acadian flycatcher (*Empidonax virescens*), eastern wood-pewee (*Contopus virens*), ovenbird (*Seirus aurocapilla*), and red-eyed vireo (*Vireo olivaceus*) were the most common species detected, being observed at over 60% of the survey points. American robin (*Turdus migratorius*), blue jay (*Cyanocitta cristata*), rose-breasted grosbeak (*Pheucticus ludovicianus*), scarlet tanager (*Piranga olivacea*), tufted titmouse (*Baeolophus bicolor*), and veery (*Catharus fuscescens*) were also common and recorded on between one third and one half of the point-count stations. Three SGCN, Acadian flycatcher, hooded warbler, and wood thrush (*Hylocichla mustelina*), were regularly observed (≥25% of stations). The remaining seven SGCN, black-billed cuckoo (*Coccyzus erythropthalmus*), cerulean warbler, eastern towhee (*Pipilo erythropthalmus*), northern flicker (*Colaptes auratus*), red-headed woodpecker (*Melanerpes erythrocephalus*), worm-eating warbler (*Helmitheros vermivorum*), and yellow-billed cuckoo (*Coccyzus americanus*), were only observed sporadically (Appendix 4). Wood thrush was the most common DNR featured species that we detected. The other three featured species, pileated woodpecker (*Dryocopus pileatus*), red-headed woodpecker, and wild turkey (*Meleagris gallopavo*), were detected at less than 10% of the points.

We conducted surveys for rare wetland birds in wetlands associated with Otis and Fish Lakes and at a site on Glass Creek with a previous unconfirmed observation of common gallinule. Common loon was observed on Otis Lake, which was a reconfirmation of a known occurrence. A pair of adult loons was heard calling and seen with two fledglings. We documented a new occurrence of osprey (*Pandion haliaetus*, state special concern) on Otis Lake. A pair of osprey was observed copulating on a stick nest on the nesting platform within the lake. Several marsh wrens were recorded at five locations in marsh along the western shore of Fish Lake, which constituted a new EO for the species. Loon, osprey, and marsh wren are all SGCN. We did not reconfirm the presence of king rail at the Fish Lake site (EO ID 3352) and no other rare wetland bird species were detected. We observed Virginia rail, a SGCN, in emergent wetlands adjacent to Fish Lake.

Table 3. Newly documented and previosuly known rare bird element occurrences at Barry State Game Area. State status abbreviations are as follows: E, state endangered; T, and state threatened; SC, state special concern. EO rank abbreviations are as follows: A?, possibly excellent estimated viability; D, poor estimated viability; E, verified extant (viablity not assessed); F, failed to find; and H, historical. * indicates the EO was newly documented in 2013 or was updated with information collected during inventory.

Common Name	Scientific Name	State Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Henslow's sparrow	*Ammodramus henslowii*	E	15797	D	2005	2005
Henslow's sparrow	*Ammodramus henslowii*	E	16107	D	2002	2006
Marsh wren*	*Cistothorus palustris*	SC	19697	E	2013	2013
Cerulean warbler*	*Dendroica cerulea*	T	18411	E	2006	2013
Common loon*	*Gavia immer*	T	880	A?	1986	2013
Bald eagle	*Haliaeetus leucocephalus*	SC	14231	F	2000	2000
Osprey*	*Pandian haliaetus*	SC	19698	E	2013	2013
King rail	*Rallus elegans*	E	3352	H	1974	1983
Hooded warbler*	*Setophaga citrina*	SC	18412	E	2010	2013

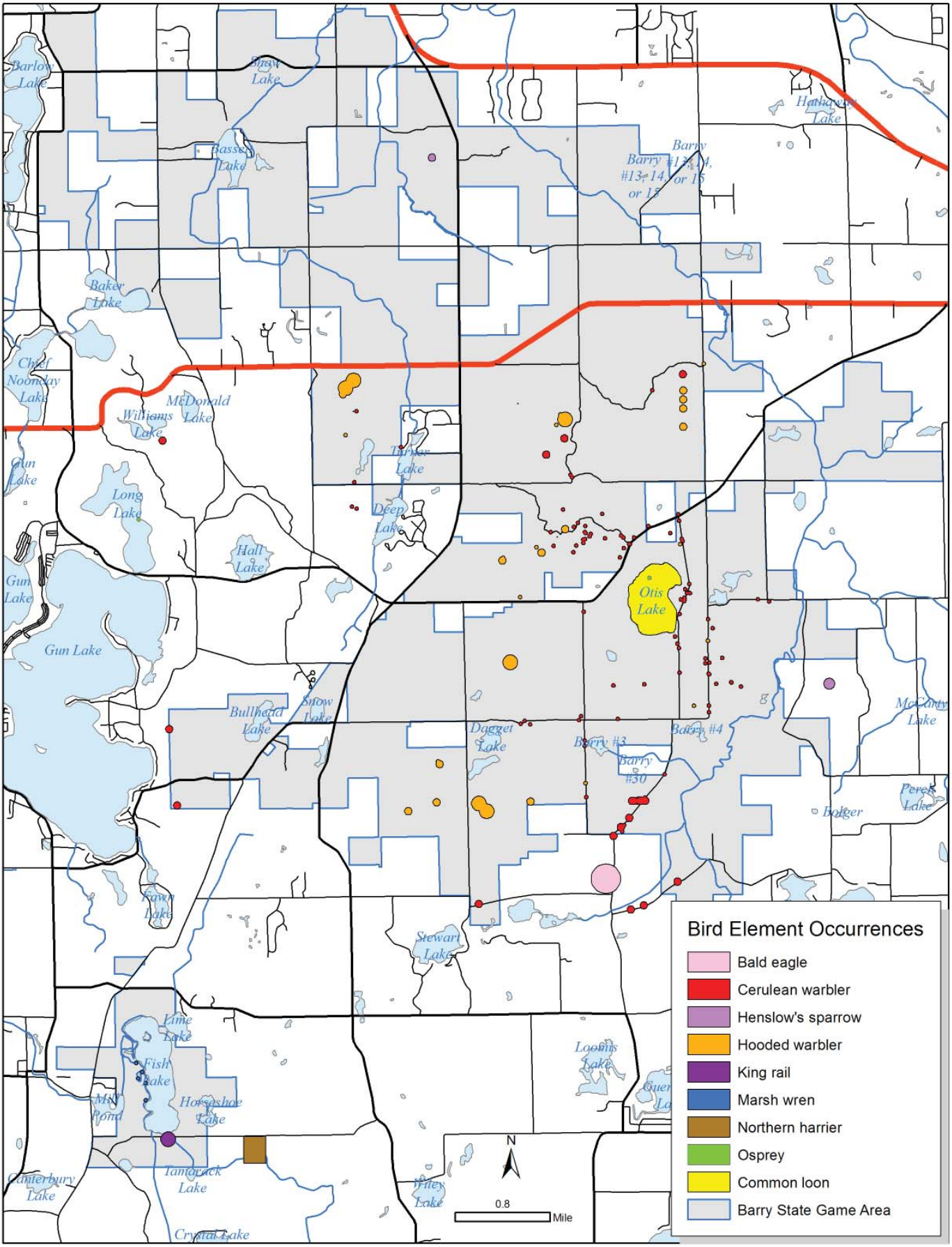


Figure 10. Rare bird element occurrences within Barry State Game Area.

Reptiles and Amphibians

Amphibian and reptile surveys in Barry SGA in 2013 documented observations of three of the five rare species that were targeted, the Blanchard's cricket frog, eastern box turtle, and eastern massasauga. Several incidental observations of eastern box turtles and Blanding's turtles also were documented during the IFMAP Stage 1 inventory conducted by MNFI in 2010. Rare species observations in 2010 and 2013 updated previously documented EOs of the Blanchard's cricket frog, eastern box turtle, eastern massasauga, and Blanding's turtle in Barry SGA (Table 4). In 2013, we also documented observations of several SGCN identified in Michigan's Wildlife Action Plan (Eagle et al. 2005), including pickerel frog (*Lithobates palustris*), northern leopard frog (*Lithobates pipiens*), eastern hog-nosed snake (*Heterodon platirhinos*), and blue racer (*Coluber constrictor foxii*) (Table 8).

Breeding frog call surveys in the Barry SGA in 2013 reconfirmed three previously documented EOs of Blanchard's cricket frog in Otis Lake, Snow Lake, and Fish Lake (Figure 11). We heard one to three cricket frogs calling at Fish Lake on May 19th and at Otis Lake and Snow Lake on June 21st. These observations represent significant updates, because cricket frogs were last documented at Fish Lake and Otis Lake in 1997 and 2003, respectively. Cricket frogs were not reconfirmed at several previously documented sites in or near Barry SGA, including Shaw Lake, Dagget Lake, and a small lake east of Stewart Lake just outside of the south end of the game area (Figure 11). Cricket frogs were last documented at these sites over 20 to 25 years ago (Table 4). We also did not detect cricket frogs at 20 additional sites with potential habitat that were surveyed in or near the Barry SGA in 2013 (Figure 7).

Visual encounter surveys in 2013 documented eastern box turtles at three different sites. We found one adult female box turtle on July 1st along the edge of Haven Road Meadow (southern wet meadow, EO ID 13355) on the east side of Glass Creek about a mile south of W. Goodwill Road (Figure 11). Another adult female box turtle was observed on July 11th in McDonald Lake Fen (prairie fen, EO ID 15920) on the southeast side of McDonald Lake in Yankee Springs State Recreation Area (SRA) (Figure 11). This was a new locality for eastern box turtle based on known occurrences in the Biotics database. We found an adult male box turtle on September 21st in Bowens Mill Fen (prairie fen, EO ID 13555) (Figure 11). Box turtles were last reported from this site in 2002 (MNFI 2014). We were unable to reconfirm box turtles at six previously documented sites (i.e., Shaw Lake Fen, Hill Creek Fen, Hall Lake Fen, Fish Lake Fen, Briggs Road Wetland along creek flowing into Baker Lake west of Bowens Mill Fen, and N. Peets Road/Bowens Mill Bogs) during 2013 surveys (Figure 11). However, box turtles were reported from Horseshoe Lake Fen in 2013 (Mehne pers. comm.) (Figure 11).

In addition to box turtles found during targeted surveys in 2013, MNFI staff found seven box turtles incidentally in the summer of 2010 during Stage 1 IFMAP inventory of Barry SGA. Three box turtles were observed at two locations at the south end of the game area in Compartment 6. Two box turtles were found in a mixed upland deciduous forest stand about 1 km south of Barry #3 Lake, and one turtle was found along the edge of an oak forest and aspen stand about 1.5 km south of Dagget Lake (Figure 11). These were new locations for box turtles based on known EOs in the Biotics database and are significant in that box turtles were last documented in the vicinity in 1989 (MNFI 2014). Four box turtles were found toward the north end of the game area in Compartment 2 (Figure 11). Two turtles were observed in upland oak forest just south of the Turner Creek Wet Prairie (EO ID 18987) (Figure 11). One turtle was observed in or adjacent to the prairie fen (EO ID 278) that is part of Turner Creek Wetlands (Figure 11). One turtle was found in an upland oak forest stand (stand 67) south of Chief Noonday Road and west of S. Bassett Lake Trail (Figure 11).

The box turtle observations documented in 2010 and 2013 were associated with or near EOs or sites at which the species had been previously documented based on earlier MNFI surveys and other surveys and reports. Initially, these observations represented updates of five previously documented box turtle occurrences (MNFI 2014). However, EO specifications for the eastern box turtle developed by NatureServe specify that sites separated by 5 km or more of suitable habitat, 1 km or more of unsuitable habitat, and/or barriers (e.g., busy highway; highway with obstructions; untraversable topography; a major river, lake, pond, or deep marsh; and urbanized area dominated by buildings and pavement) should constitute separate EOs, and sites that do not meet these specifications should be part of the same EO (Hammerson 2004). Upon further review of the five updated box turtle EOs and other previously documented EOs in the Barry SGA and vicinity, we determined that all these EOs constitute one large EO. As a result, we combined the EOs previously documented in Barry SGA and surrounding lands into one EO comprised of 21 sub-EOs or individual sites at which box turtles were documented. Of these 21 sub-EOs, 12 occur within the game area (Figure 11; MNFI 2014). Box turtle observations in 2010 and 2013 updated six of the sub-EOs within Barry SGA and one sub-EO in Yankee Springs SRA adjacent to the game area (i.e., McDonald Lake Fen; MNFI 2014). Negative survey results from 2013 updated three sub-EOs in the game area and one sub-EO in the adjacent SRA (i.e., Hall Lake Fen; Table 4).

Eastern box turtle. Photo by Yu Man Lee.

Visual encounter surveys in 2013 resulted in one eastern massasauga observation. We found the individual in the Havens Road Meadow (southern wet meadow, EO ID 13355) on the east side of Glass Creek located west of Havens Road and about 1 mi south of W. Goodwill Road (Figure 11). Eastern massasaugas were previously documented farther north in the wet meadow along Glass Creek in 2003 and 2004 (Figure 11; MNFI 2014). Based on the 2013 massasauga observation, we updated and expanded the extent of the known occurrence along Glass Creek. However, in 2013 we were not able to find or reconfirm massasaugas at the following sites: Shaw Lake Fen, Hill Creek Fen, McDonald Lake Fen, Hall Lake Fen, Bowens Mill Fen, Briggs Road Wetland along creek flowing into Baker Lake west of Bowens Mill Fen, Turner Creek Wetlands, and Fish Lake Fen(Figure 11). Although we did not detect massasaugas along Fish Lake or Horseshoe Lake, two were reported in or adjacent to Horseshoe Lake Fen in 2013 (Mehne personal communication).

We re-examined Massasauga EOs in Barry SGA and in the vicinity based on updated information on the species' distribution in the area, updated information on the species' ecology, and EO specifications for this species developed by NatureServe. These specifications state that 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 do not meet these specifications should be part of the same EO. Recent studies on massasauga movements and home ranges also 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, Kingsbury pers. comm.). We determined that the 13 sites at which massasaugas were documented in Barry SGA and in the vicinity constitute five EOs, of which four are located within the game area

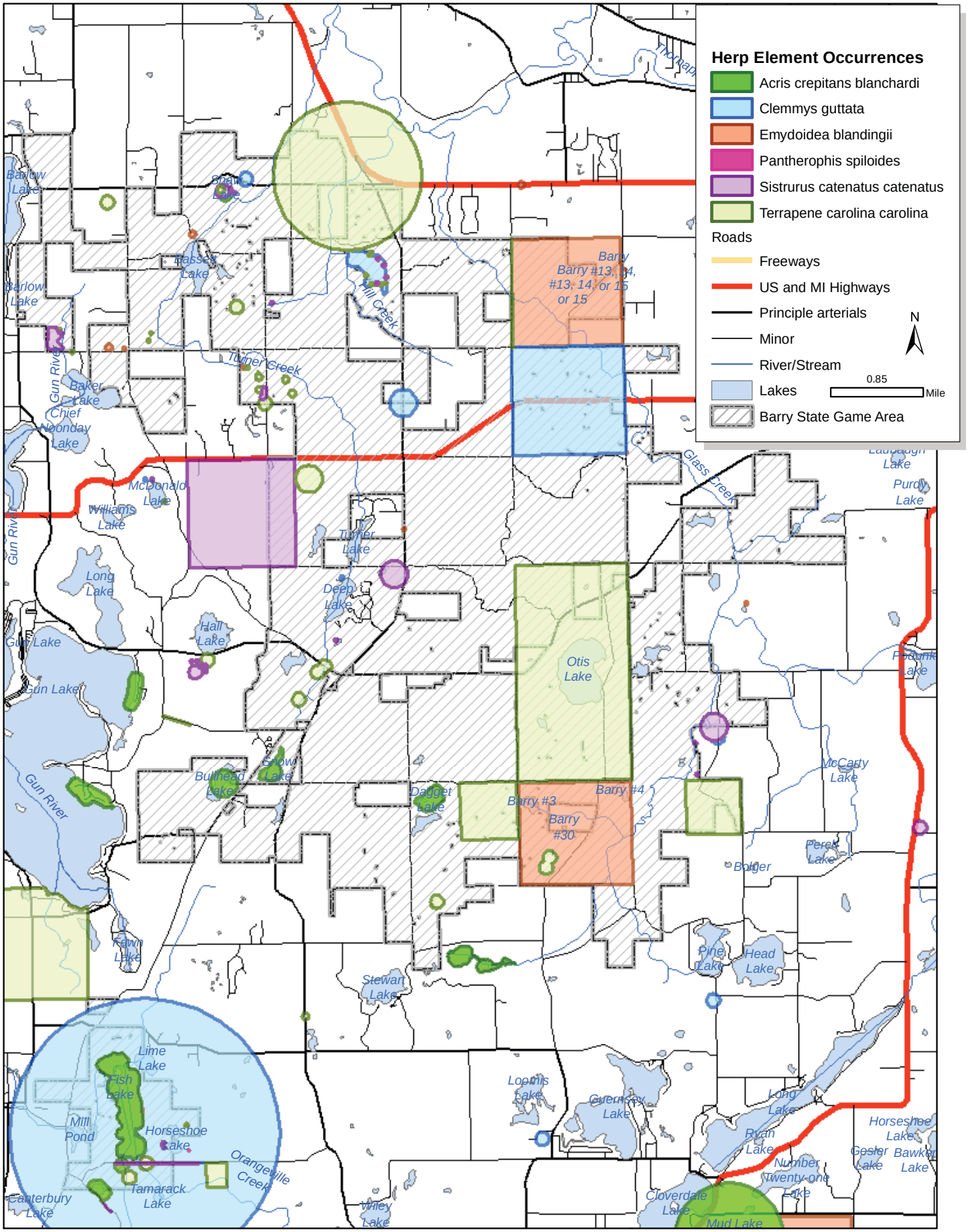


Figure 11. Rare amphibian and reptile element occurrences within Barry State Game Area.

Table 4. Previosuly known rare amphibian and reptile element occurrences at Barry State Game Area. State and federal status abbreviations are as follows: T, state threatened; SC, state special concern; and C, federal candidate for listing. EO rank abbreviations are as follows: A, excellent estimated viability; AB, excellent or good estimated viability; AC, excellent, good, or fair estimated viability; B, good estimated viability; BC, good or fair estimated viability; F, failed to find; and H, historical. * indicates the EO was updated with information collected during inventory. ** indicates EOs that include one or more sub-EOs or locations. Element occurrence ranks, first observed dates, and last observed dates for these EOs were based on all the sub-EOs within that EO. For example, the first observed date was the first year any one of the sub-EOs in that EO was documented. The EO ranks for these EOs listed in this table represent estimated viability for the entire EO encompassing all the sub-EOs (locations) and not just the parent EO.

Common Name	Scientific Name	State Status	Federal Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Blanding's turtle*	*Emydoidea blandingii*	SC	---	11101**	AB	1996	2013
Spotted turtle	*Clemmys guttata*	T	---	3679	AB	1961	2012
Spotted turtle	*Clemmys guttata*	T	---	373	AB	1968	2013
Spotted turtle	*Clemmys guttata*	T	---	19162**	B	1980	2006
Spotted turtle	*Clemmys guttata*	T	---	19412	AC	2004	2004
Spotted turtle	*Clemmys guttata*	T	---	19413	BC	2004	2004
Eastern box turtle*	*Terrapene carolina carolina*	SC	---	5639**	A	1951	2013
Eastern massasauga	*Sistrurus catenatus*	SC	C	12751**	AB	1960	2006
Eastern massasauga	*Sistrurus catenatus*	SC	C	17111**	BC	2002	2013
Eastern massasauga*	*Sistrurus catenatus*	SC	C	17113	BC	2003	2013
Eastern massasauga	*Sistrurus catenatus*	SC	C	19835**	BC	1990s	2004
Gray ratsnake	*Pantherophis spiloides*	SC	---	14085	AC	2002	2013
Blanchard's cricket frog	*Acris blanchardi*	T	---	4294	F	1986	1986
Blanchard's cricket frog*	*Acris blanchardi*	T	---	593	AB	1986	2013
Blanchard's cricket frog*	*Acris blanchardi*	T	---	10097**	AB	1986	2013
Blanchard's cricket frog	*Acris blanchardi*	T	---	3876	H	1990	1990
Blanchard's cricket frog*	*Acris blanchardi*	T	---	13936**	AB	1968	2013

and one in the adjacent Yankee Springs SRA (Table 4 and Figure 11). Previously, these sites comprised three EOs (MNFI 2014). Three of the revised massasauga EOs contain several sub-EOs (i.e., sites where massasauga was documented). We updated two of the EOs occurring in the game area based on the 2013 massasauga observations (Table 4).

Although Blanding's turtles were not documented during targeted herp surveys in 2013, MNFI staff found them incidentally during other rare animal surveys in 2013 and during IFMAP Stage 1 inventory in Barry SGA in 2010. One adult Blanding's turtle was found just north of Bassett Lake in 2010, which was a new location for this species (Figure 11). Another adult Blanding's turtle was observed on Bowens Mill Road just west of Norton Road in 2010 (Figure 11). In 2013, a Blanding's turtle was found in the middle of Whitmore Road heading south just west of Glass Creek and south of Chief Noonday Road, and one was observed swimming in shallow water (1-2 ft deep) along the shoreline on the east side of Fish Lake (Figure 11). Four Blanding's turtles also were reported from Horseshoe Lake in 2013 (Mehne personal communication). In 2013, we did not reconfirm Blanding's turtles at two previously documented sites, Hill Creek Fen, and Turner Creek Wetlands (wet prairie, EO ID 2267). Prior to surveys in 2010 and 2013, Blanding's turtles had been documented from five EOs comprised of nine sites within Barry SGA and the surrounding area. However, EO specifications developed by NatureServe for this species specify that EOs should be separated by 10 km or more along continuous riverine-riparian corridors, 10 km or more for mosaics of aquatic-wetland and undeveloped upland habitat, and/or barriers (i.e., busy highway, highway with obstructions, untraversable topography, or densely urbanized area lacking aquatic or wetland habitat) (Hammerson and Hall 2004). Based on data collected in 2010 and 2013 and EO specifications, we combined the known sites for this species into one EO comprised of eight sub-EOs within and around the Barry SGA (Table 4 and Figure 11; MNFI 2014).

During visual encounter surveys in 2013, we were not able to detect spotted turtles at four previously documented sites or new sites in Barry SGA. Spotted turtles were previously documented at Shaw Lake Fen (prairie fen, EO ID 12498), Hill Creek Fen (prairie fen, EO ID 7579), Fish Lake Fen (prairie fen, EO ID 18992), and nearby McDonald Lake Fen (prairie fen, EO ID 15920) (Yankee Springs SRA) (Figure 11; MNFI 2014). Although we did not observe spotted turtle at these locations, suitable habitat was still present. Two spotted turtles were reported in or near Horseshoe Lake Fen in 2013 (Mehne personal

communication). Based on EO specifications developed by NatureServe for the spotted turtle, which specify that EOs should be separated by 3 km of suitable habitat, 2 km of unsuitable habitat, and/or barrier(s) (Hammerson 2005), we combined three of the spotted turtle EOs in the Barry SGA into one EO (EO ID 19162) with two sub-EOs (Table 4). This resulted in a total of five spotted turtle EOs currently documented within Barry SGA and the surrounding area (Table 4).

Additionally, two gray ratsnakes (*Pantherophis spiloides*, state special concern, formerly black ratsnake) were observed on a private property along Horseshoe Lake in 2013 by a landowner who is knowledgeable about reptiles and amphibians (Mehne personal communication). These observations reconfirm the only known EO of gray ratsnake documented in Barry SGA. Gray ratsnakes were last observed in this area in 2002 (Table 4 and Figure 11). This occurrence is significant, not only because it is the only EO of this species within the game area, but it is also the only known EO of this species in Barry County and one of only 27 EOs of this species in the state (MNFI 2014).

Visual encounter and breeding frog call surveys in 2013 also documented observations of other amphibian and reptile species in Barry SGA and in surrounding state land. We documented four additional amphibian and reptile species identified as SGCN in Michigan's Wildlife Action Plan (pickerel frog, northern leopard frog, eastern hog-nosed snake, and blue racer) (Table 8 and Appendix 2). Pickerel frog and eastern hog-nosed snake were found in Bowens Mill Fen (EO ID 13555). We observed northern leopard frog and blue racer in Hill Creek Fen (EO ID 7579). Ten additional, more common amphibian and reptile species also were documented during herp surveys in Barry SGA in 2013 (Appendix 2). These species were the eastern American toad (*Anaxyrus americanus americanus*), spring peeper (*Pseudacris crucifer*), gray treefrog (*Hyla versicolor/Hyla chrysoscelis*), American bullfrog (*Lithobates catesbeianus*), green frog (*Lithobates clamitans*), wood frog (*Lithobates sylvaticus*), eastern musk turtle (*Sternotherus odoratus*), northern water snake (*Nerodia sipedon sipedon*), eastern garter snake (*Thamnophis sirtalis sirtalis*), and northern ribbon snake (*Thamnophis sauritus septentrionalis*).

Table 5. Newly documented and previosuly known rare insect element occurrences at Barry State Game Area. State and federal status abbreviations are as follows: E, state endangered; T, state threatened; SC, state special concern; and LE, federal endangered. EO rank abbreviations are as follows: A, excellent estimated viability; A?, possibly excellent estimated viability; AB, excellent or good estimated viability; AC, excellent, good, or fair estimated viability; BC, good or fair estimated viability; D, poor estimated viability; E, verified extant (viability not assessed); and H, historical. * indicates the EO was newly documented in 2013 or was updated with information collected during inventory.

Common Name	Scientific Name	State Status	Federal Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Three-staff underwing	*Catocala amestris*	E		9889	A	1985	1990
Leafhopper	*Dorydiella kansana*	SC		16947	E	2007	2007
Persius dusky wing	*Erynnis persius persius*	T		5191	E	1990	1990
Persius dusky wing	*Erynnis persius persius*	T		9247	H	1968	1971
Persius dusky wing	*Erynnis persius persius*	T		13364	E	2002	2002
Barrens buckmoth	*Hemileuca maia*	SC		7974	H	1968	1968
Ottoe skipper	*Hesperia ottoe*	T		1656	H	1966	1966
Ottoe skipper	*Hesperia ottoe*	T		8180	H	1986	1989
Ottoe skipper	*Hesperia ottoe*	T		11397	H	1967	1982
Small heterocampa	*Heterocampa subrotata*	SC		431	E	1987	1996
Angular spittlebug*	*Lepyronia angulifera*	SC		188	AB	1987	2013
Angular spittlebug	*Lepyronia angulifera*	SC		3620	H	1965	1965
Angular spittlebug*	*Lepyronia angulifera*	SC		2991	BC	2000	2013
Newman's brocade	*Meropleon ambifusca*	SC		1175	AB	1985	1994
Mitchell's satyr	*Neonympha mitchellii mitchellii*	E	LE	4669	D	1986	2012
Tamarack tree cricket	*Oecanthus laricis*	SC		579	E	1999	1999
Tamarack tree cricket	*Oecanthus laricis*	SC		635	E	2002	2002
Tamarack tree cricket	*Oecanthus laricis*	SC		2789	E	2002	2002
Tamarack tree cricket*	*Oecanthus laricis*	SC		6991	A?	1999	2013
Tamarack tree cricket	*Oecanthus laricis*	SC		7721	A?	2002	2005
Tamarack tree cricket	*Oecanthus laricis*	SC		10919	E	2002	2002
Pine tree cricket*	*Oecanthus pini*	SC		19700	E	2013	2013
Blazing star borer	*Papaipema beeriana*	SC		15659	BC	2005	2005
Regal fern borer*	*Papaipema speciosissima*	SC		19699	E	2013	2013
Red-legged spittlebug	*Prosapia ignipectus*	SC		17184	AC	2007	2007
Sprague's pygarctia	*Pygarctia spraguei*	SC		2627	H	1977	1977
Spartina moth	*Spartiniphaga inops*	SC		205	E	1986	1997

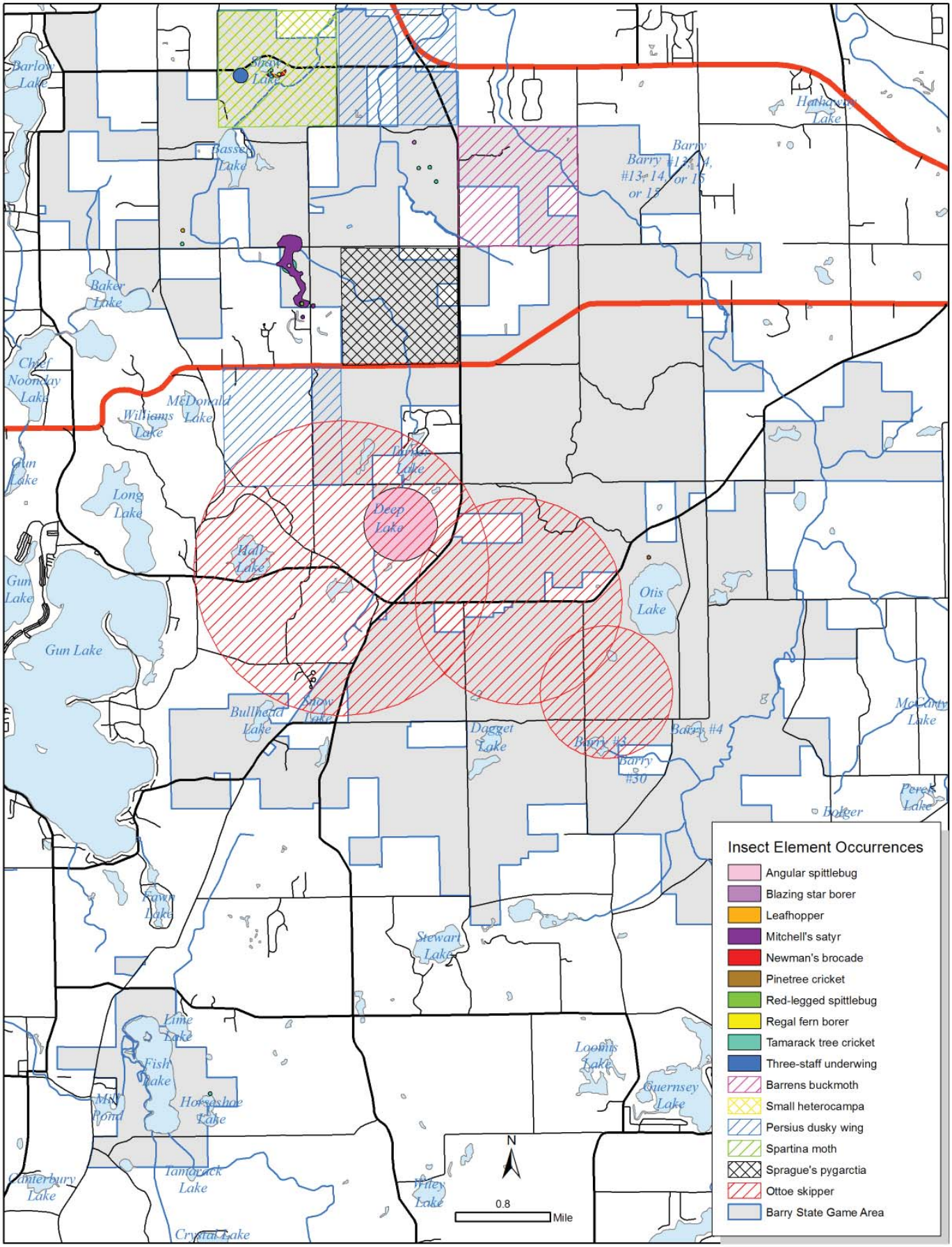


Figure 12. Rare insect element occurrences within Barry State Game Area.

Insects

Sweep net samples were collected from tamarack and white pine trees in wetlands near Shaw Lake (Shake Lake Fen, EO ID 12498) and Otis Lake (Otis Lake Bog, EO ID 15901). We collected one tamarack tree cricket from a tamarack in Shaw Lake Fen. This observation was reconfirmation of an EO first documented in 1999 (Table 5). We did not detect tamarack tree crickets at any of the other sites sampled. One pine tree cricket was collected in Otis Lake Bog in a polygon just north of Otis Lake, which represented a new EO for the species (Figure 12).

We conducted surveys for rare butterflies and moths at several sites in Barry SGA. We did not observe swamp metalmark or Duke's skipper during surveys conducted at Shaw Lake Fen and at Bassett Lake Meadow (southern wet meadow, EO ID 18984) on the southwest side of the lake. Blacklighting surveys were done during the fall of 2013 at Shaw Lake Fen and in the prairie fen along Turner Creek (EO ID 278). We collected one regal fern borer at Shaw Lake Fen, which represented a new EO for the species (Figure 12). We did not detect any of the other rare *Papaipema* moths targeted (blazing star borer, maritime sunflower borer, and golden borer) at the sites sampled. While conducting blacklight surveys for rare moths, we observed four angular spittlebugs (*Lepyronia angulifera*, state special concern) at Shaw Lake Fen and one at the wetlands associated with Turner Creek (prairie fen, EO ID 278). These observations reconfirmed known occurrences for the species at both sites.

Mussels

Surveys for unionid mussels were performed at 11 sites in Glass Creek, a tributary of Glass Creek, Basset Lake, Basset Creek, and Hill Creek (Table 7). Seven of the 46 mussel species known to occur in Michigan were found in this survey (Appendix 5). We found the state threatened slippershell (*Alasmidonta viridis*) at one site in Bassett Creek and two sites in Glass Creek. One species of special concern, the ellipse (*Venustaconcha ellipsiformis*), was found at two sites in Bassett Creek and one in Glass Creek. These records resulted in four new EOs including two slippershell EOs and two ellipse EOs (Table 6). Both species occurred at Sites 7 and 10 (Table 7 and Figure 13). Site 10 in Bassett Creek supported the most significant mussel populations, with live individuals of six species detected (Table 9). In addition, two SGCN mussels were documented: cylindrical papershell (*Anodontoides ferussacianus*) and creek heelsplitter (*Lasmigona compressa*) (Tables 8 and 9).

We detected several species incidentally while conducting surveys for unionid mussels (Table 10). Native aquatic snails (Gastropoda) and fingernail clams (Sphaeriidae) were found at nearly every survey site. Two species of crayfish were observed in Glass and Bassett Creeks. The virile crayfish (*Orconectes virilis*) is one of the most common and widespread crayfish species throughout Michigan and the central U.S. and was very abundant in both creeks. We found big water crayfish (*Cambarus robustus*) at only one site in Glass Creek (Photo M2); it is less common and currently has a state rank of S2? (imperiled with

Regal fern borer and angular spittlebug were documented during blacklightning survey at Shaw Lake Fen. Photo by David L. Cuthrell.

Table 6. Newly documented and previosuly known aquatic species element occurrences at Barry State Game Area. State status abbreviations are as follows: E, state endangered; T, state threatened; and SC, state special concern. EO rank abbreviations are as follows: E, verified extant (viability not assessed) and H, historical. * indicates the EO was newly documented in 2013.

Common Name	Scientific Name	State Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Slippershell*	*Alasmidonta viridis*	T	19795	E	2013	2013
Slippershell*	*Alasmidonta viridis*	T	19797	E	2013	2013
Watercress snail	*Fontigens nickliniana*	SC	16677	H	1990	1990
Pugnose shiner	*Notropis anogenus*	E	7014	H	1974	1976
Pugnose shiner	*Notropis anogenus*	E	12565	H	1946	1946
Ellipse*	*Venustaconcha ellipsiformis*	SC	19796	E	2013	2013
Ellipse*	*Venustaconcha ellipsiformis*	SC	19798	E	2013	2013

Table 7. Locations of mussel survey sites and two gastropod collection sites within Barry State Game Area, Summer 2013.

Site #	Waterbody	Access	Latitude (N)	Longitude (W)
1	Glass Creek	Hart Rd.	42.62489	-85.38759
2	Glass Creek Tributary	Otis Lake Rd.	42.59026	-85.41207
3	Glass Creek	Whitmore Rd.	42.64940	-85.40767
4	Glass Creek	Peets Rd.	42.66147	-85.42887
5	Glass Creek	Little Pine Lake Rd.	42.57799	-85.40637
6	Glass Creek	Little Pine Lake Rd.	42.57818	-85.40728
7	Glass Creek	Bowens Mill Rd.	42.65298	-85.41334
8	Bassett Lake	Fishing Site off Norris Rd.	42.66602	-85.48638
9	Bassett Creek	Shaw Lake Rd.	42.67568	-85.46958
10	Bassett Creek	Kiser Rd.	42.68163	-85.46654
11	Hill Creek	Upton Rd.	42.66765	-85.45993
A*	unnamed wetland	Hart Rd.	42.62531	-85.46401
B*	unnamed wetland	McKibben Rd.	42.58882	-85.44584

* Gastropod only collection site

some uncertainty). Several fish were identified, including rainbow darter (*Etheostoma caeruleum*), blackside darter (*Percian maculata*), Johnny darter (*E. nigrum*), and western blacknose dace (*Rhinichthys obtusus*; Photo M3). All of these fish species are ranked S5 (demonstrably secure) in Michigan, except for rainbow darter which is S4 (apparently secure). Two lampreys were flushed up from the stream bottom at Site 10 in Bassett Creek. They were about eight inches in length, but identification was not possible as they were viewed only briefly. They may have been one of the native species, such as chestnut (*Ichthyomyzon castaneus*), northern brook (*I. fossor*), or American brook lamprey (*Lethenteron appendix*). The non-native, Asian clam (*Corbicula fluminea*), was found at the Bassett Lake survey site, but no zebra mussels (*Dreissena polymorpha*) were observed during surveys.

We described the general stream and water chemistry characteristics of our mussel survey sites (Tables 11 and 12). Water chemistry data were taken at all sites except for Site 6 in Glass Creek, which was not sampled because it was located only about 100 m downstream of Site 5. Water clarity was high and visibility very good at all sites at the time of surveys. However, because some live mussels were found to be completely buried within the stream substrate, primarily tactile methods of detection were used.

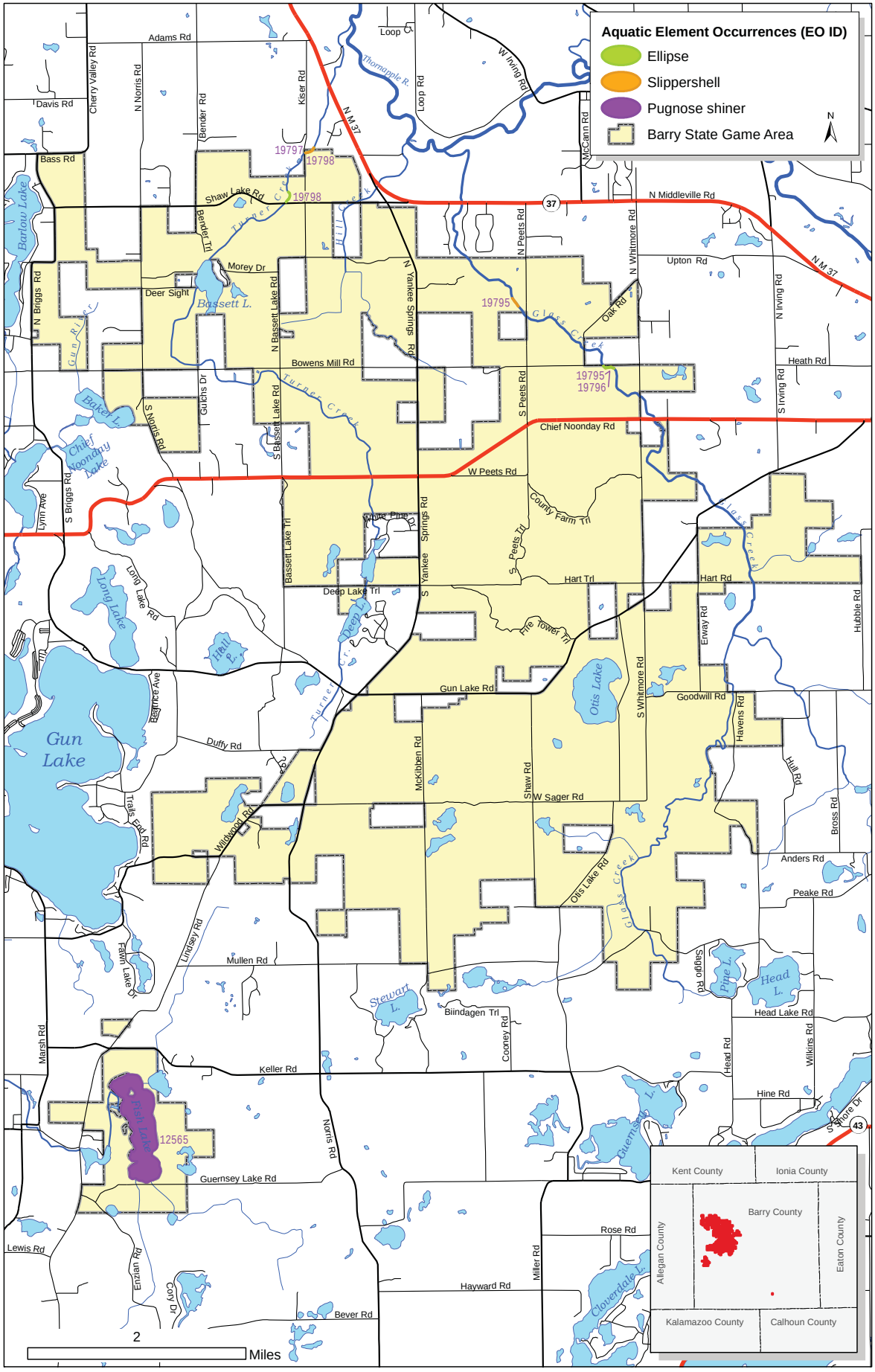


Figure 13. Rare aquatic element occurrences within Barry State Game Area.

Table 8. Rare species, Species of Greatest Conservation Need (SGCN), and DNR featured species documented in Barry State Game Area. State and federal status abbreviations are as follows: E, state endangered; T, state threatened; SC, state special concern; and LE, federal endangered.

Common Name	Scientific Name	State Status	Federal Status	SGCN	DNR Featured Species	Year Last Observed
AQUATIC SPECIES						
Slippershell	*Alasmidonta viridis*	T		X		2013
Cylindrical papershell	*Anodontoides ferussacianus*			X		2013
Watercress snail	*Fontigens nickliniana*	SC		X		1990
Creek heelsplitter	*Lasmigona compressa*			X		2013
Pugnose shiner	*Notropis anogenus*	E		X		1976
Ellipse	*Venustaconcha ellipsiformis*	SC		X		2013
BIRDS						
Henslow's sparrow	*Ammodramus henslowii*	E		X		2006
Marsh wren	*Cistothorus palustris*	SC		X		2013
Yellow-billed cuckoo	*Coccyzus americanus*			X		2013
Black-billed cuckoo	*Coccyzus erythroprthalmus*			X		2013
Northern flicker	*Colaptes auratus*			X		2013
Cerulean warbler	*Dendroica cerulea*	T		X		2013
Wild turkey	*Meleagris gallopavo*				X	2013
Acadian flycatcher	*Empidonax virescens*			X		2013
Common loon	*Gavia immer*	T		X		2013
Bald eagle	*Haliaeetus leucocephalus*	SC		X		2000
Worm-eating warbler	*Helmitheros vermivorum*			X		2013
Wood thrush	*Hylocichla mustelina*			X	X	2013
Pileated woodpecker	*Dryocopus pileatus*				X	2013
Red-headed woodpecker	*Melanerpes erythrocephalus*			X	X	2013
Osprey	*Pandian haliaetus*	SC		X	X	2013
Eastern towhee	*Pipilo erythropthalmus*			X		2013
King rail	*Rallus elegans*	E		X		1983
Virginia rail	*Rallus limicola*			X		2013
Hooded warbler	*Setophaga citrina*	SC		X		2013
INSECTS						
Three-staff underwing	*Catocala amestris*	E		X		1990
Leafhopper	*Dorydiella kansana*	SC		X		2007
Persius dusky wing	*Erynnis persius persius*	T		X		2002
Barrens buckmoth	*Hemileuca maia*	SC		X		1968
Ottoe skipper	*Hesperia ottoe*	T		X		1989
Small heterocampa	*Heterocampa subrotata*	SC		X		1996
Angular spittlebug	*Lepyronia angulifera*	SC		X		2013
Newman's brocade	*Meropleon ambifusca*	SC		X		1994
Mitchell's satyr	*Neonympha mitchellii mitchellii*	E	LE	X	X	2012
Tamarack tree cricket	*Oecanthus laricis*	SC		X		2013
Pine tree cricket	*Oecanthus pini*	SC		X		2013
Blazing star borer	*Papaipema beeriana*	SC		X		2005
Regal fern borer	*Papaipema speciosissima*	SC		X		2013
Red-legged spittlebug	*Prosapia ignipectus*	SC		X		2007
Sprague's pygarctia	*Pygarctia spraguei*	SC		X		1977
Spartina moth	*Spartiniphaga inops*	SC		X		1997
HERPTILES						
Blanchard's cricket frog	*Acris blanchardi*	T		X		2013
Blanding's turtle	*Emydoidea blandingii*	SC		X		2013
Spotted turtle	*Clemmys guttata*	T		X		2013
Blue racer	*Coluber constrictor foxii*			X		2013
Eastern hog-nosed snake	*Heterodon platirhinos*			X		2013
Pickerel frog	*Lithobates palustris*			X		2013
Northern leopard frog	*Lithobates pipiens*			X		2013
Eastern box turtle	*Terrapene carolina carolina*	SC		X		2013
Eastern massasauga	*Sistrurus catenatus*	SC	C	X	X	2013
Gray ratsnake	*Pantherophis spiloides*	SC		X		2013
Western chorus frog	*Pseudacris triseriata*			X		pre-2013

Table 9. Numbers of unionid mussels (#), relative abundance (RA), and density (D = individuals/m2) by site number during surveys conducted in Barry State Game Area in 2013. The number of unionid shells (S) found is given in parentheses and the presence of the non-native Asian clam is denoted with an "x". Status in Michigan is listed in parentheses after the scientific name (T = state threatened; SC = state special concern).

		Glass Creek																	
		1			2			3			4			5			6		
Common Name	**Species**	**#**	**RA**	**D**	**#**	**RA**	**D**	**#**	**RA**	**D**	**#**	**RA**	**D**	**#**	**RA**	**D**	**#**	**RA**	**D**
Slippershell	*Alasmidonta viridis* (T)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cylindrical papershell	*Anodontoides ferussacianus*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Spike	*Elliptio dilatata*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Wabash pigtoe	*Fusconaia flava*	S(1)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Creek heelsplitter	*Lasmigona compressa*	1	1.00	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Strange floater	*Strophitus undulatus*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Ellipse	*Venustaconcha ellipsiformis* (SC)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Asian clam	*Corbicula fluminea*	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Total # and density	1	---	0.01	0	---	---	0	---	---	0	---	---	0	---	---	0	---	---
	# species live	1	---	---	0	---	---	0	---	---	0	---	---	0	---	---	0	---	---
	# species live or shell	2	---	---	0	---	---	0	---	---	2	---	---	0	---	---	0	---	---
	Area searched (m^2)	128	---	---	75	---	---	128	---	---	128	---	---	128	---	---	128	---	---

		Glass Creek			Bassett Lake			Bassett Creek						Hill Creek		
		7			8			9			10			11		
Common Name	**Species**	**#**	**RA**	**D**	**#**	**RA**	**D**	**#**	**RA**	**D**	**#**	**RA**	**D**	**#**	**RA**	**D**
Slippershell	*Alasmidonta viridis* (T)	---	---	---	---	---	---	---	---	---	3	0.13	0.05	---	---	---
Cylindrical papershell	*Anodontoides ferussacianus*	---	---	---	---	---	---	---	---	---	2	0.09	0.03	---	---	---
Spike	*Elliptio dilatata*	S(1)	---	---	---	---	---		---	---	1	---	---	---	---	---
Wabash pigtoe	*Fusconaia flava*		---	---	---	---	---	1*	---	---	6	---	---	---	---	---
Creek heelsplitter	*Lasmigona compressa*	S(1)	---	---	---	---	---		---	---		---	---	---	---	---
Strange floater	*Strophitus undulatus*	---	---	---	---	---	---	S(1)*	---	---	7	---	---	---	---	---
Ellipse	*Venustaconcha ellipsiformis* (SC)	S(1)	---	---	---	---	---	S(1)	---	---	4	---	---	---	---	---
Asian clams	*Corbicula fluminea*	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---
	Total # and density	0	---	---	0	---	---	1	---	---	23	---	---	0	---	---
	# species live	0	---	---	0	---	---	1	---	---	6	---	---	0	---	---
	# species live or shell	4	---	---	0	---	---	3	---	---	6	---	---	0	---	---
	Area searched (m^2)	128	---	---	135	---	---	128	---	---	64	---	---	128	---	---

***** Found outside measured search area.

Slippershell (*Alasmidonta viridis*, state threatened) found at Site 10 in Bassett Creek during mussel surveys conducted in Barry State Game Area in 2013. Photo by Peter J. Badra.

Big water crayfish (*Cambarus robustus*) found at Site 3 in Glass Creek during mussel surveys conducted at Barry State Game Area in 2013. Photo by Peter J. Badra.

Blacknose dace (*Rhinichthys maculata*) found at Site 10 in Bassett Creek during mussel surveys conducted at Barry State Game Area in 2013. Photo by Peter J. Badra.

Table 10. Species observed incidentally by site number during mussel and gastropod surveys conducted in Barry State Game Area in 2013. The number of individuals is provided when available and an "X" indicates at least one individual of the taxa was detected at a site.

		Glass Creek							Bassett Lake	Bassett Creek		Hill Creek	Unnamed wetland	Unnamed wetland
Common Name	**Species/Taxa**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**A**	**B**
Aquatic snails	Gastropoda	X	X	X	X	X		X	X	X	X	X	X	X
	Amnicola limosa								11					
	Campeloma decisium	2	1	2	3	7		2		3	2			
	Elimia livescens							5						
	Helisoma anceps								8	1	2	1		
	Fossaria dalli											2		
	Fossaria obrussa					1			3					4
	Physella acuta								2		1	3		
	Physella gyrina								5					11
	Planorbella campanulata				1				4			1		
	Planorbella trivolvis					3					1	3	16	13
	Promentus umbilicatellus													25
	Valvata carinata								3					
	Viviparus georgianus								2					
Fingernail clams	Sphaeriidae	X	X	X	X	X	X	X	X	X	X	X	X	X
Johnny darter	*Etheostoma nigrum*			X	X			X			X			
Rainbow darter	*Etheostoma caeruleum*	X				X								
Bluegill	*Lepomis macrochirus*								X					
Largemouth bass	*Micropterus salmoides*								X					
Blackside darter	*Percina maculata*			X										
Lamprey*	Petromyzontidae										2			
W. blacknose dace	*Rhinichthys obtusus*					X	X				X			
Water scorpion	Nepidae: *Ranatra* sp.								X					
Big water crayfish	*Cambarus robustus*			X										
Virile crayfish	*Orconectes virilis*	X		X	X	X	X	X		X	X			

*Saw only briefly, possibly one of the native chestnut, northern brook, or American brook lamprey species.

Table 11. Physical habitat characteristics and measures taken at mussel survey sites in Barry State Game Area during 2013.

		General Conditions					Stream Flow Classes (proportion)			Substrate Classes (proportion)					
Site #	**Waterbody**	**Estimated current speed (m/s)**	**Aquatic vegetation?**	**Woody debris?**	**Eroded banks?**	**Signs of dredging?**	**Pool**	**Riffle**	**Run**	**Boulder**	**Cobble**	**Pebble**	**Gravel**	**Sand**	**Silt**
1	Glass Creek	0.33	No	Yes	No	No	---	10	90	---	---	20	20	40	20
2	Glass Creek Trib.	0.25-1.00	No	Yes	Yes	No	33	33	34	---	---	25	40	15	20
3	Glass Creek	0.50	No	Yes	Yes	No	20	10	70	3	2	25	25	25	20
4	Glass Creek	0.25	No	Yes	Yes	No	5	---	95	---	5	20	20	30	25
5	Glass Creek	0.25	Yes	Yes	No	No	20	10	70	2	8	10	10	50	20
6	Glass Creek	1.00	No	Yes	No[1]	No	10	90	---	15	25	20	20	15	5
7	Glass Creek	0.40	No	Yes	No	No	15	---	85	2	3	10	20	45	20
8	Bassett Lake	0	Yes	Yes	No	No	100	---	---	---	---	10[2]	10[2]	40	40
9	Bassett Creek	0.50	Yes	Yes	No	No	20	60	20	---	---	10	45	25	20
10	Bassett Creek	0.33	Yes	Yes	No	No	5	---	95	---	---	---	10	60	30
11	Hill Creek	0.33	Yes	Yes	Yes	Yes	---	---	100	---	---	---	---	40	60

[1]Banks at culvert were eroded, but not elsewhere.
[2]Pebble and gravel introduced from boat ramp.

Table 12. Water temperature and chemistry measures collected at mussel survey sites in Barry State Game Area in 2013.

Site #	Waterbody	pH	Conductivity (µS)	Alkalinity (mg/l)	Hardness (mg/l)	Water temp. (C)
1	Glass Creek	7.67	442	296	188	16.8
2	Glass Creek Tributary	7.67	359	176	154	14.6
3	Glass Creek	7.68	458	372	205	14.3
4	Glass Creek	8.42	453	388	222	14.7
5	Glass Creek	7.99	440	268	205	15.9
6	Glass Creek[1]	---	---	---	---	---
7	Glass Creek	7.87	457	292	205	15.6
8	Bassett Lake	7.98	345	188	222	21.2
9	Bassett Creek	8.12	359	204	205	19.6
10	Bassett Creek	7.46	375	220	188	19.1
11	Hill Creek	7.83	448	240	188	17.3

[1]Site was not sampled due to its close proximity (<200 m) to Site 5.

Bassett Creek, Barry State Game Area. Photo by Michael A. Kost.

DISCUSSION

Natural Community Discussion and Recommendations

In addition to the specific management recommendations provided in the above Natural Community Survey Results section and summarized in Table 13, we provide the following general management recommendations for your consideration. We encourage invasive species control focused in high-quality natural areas, the use of landscape-scale prescribed fire, the opportunistic restoration of oak savanna ecosystems, the maintenance of the canopy closure of high-quality forest, the reduction of fragmentation across the game area but focused in the vicinity of high-quality natural communities and along riparian corridors, 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 Barry SGA. By out-competing and replacing native species, invasive species can change floristic composition of natural communities, alter vegetation 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). The lack of oak regeneration in the understory of the majority of the forested stands in Barry SGA is likely due to 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.

Glossy buckthorn invading prairie fen. Photo by Michael A. Kost.

Table 13. Summary of management recommendations for natural community element occurrences for the Barry State Game Area.

Site Name	Community Type	Management Recommendations
Bowens Mill Bogs	Bog	• Maintain intact buffer of natural communities surrounding bog • Burn bog with surrounding uplands • Remove non-native pines and monitor for invasives
Gun Lake Road Bogs	Bog	• Maintain intact buffer of natural communities surrounding bog • Burn bog with surrounding uplands • Monitor for invasives
Otis Lake Bog	Bog	• Maintain intact buffer of natural communities surrounding bog • Burn bog with surrounding uplands • Monitor for invasives
Dagget Lake	Coastal Plain Marsh	• Apply prescribed fire to reduce tree and shrub cover • Control and monitor invasives • Maintain intact buffer of natural communities surround coastal plain marsh
Bassett Lake Woods	Dry Southern Forest	• Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Monitor for invasives and following fire
Gulch Road Forest	Dry-mesic Northern Forest	• Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Girdle or cut subcanopy and understory red maple and black cherry • Monitor for invasives and following fire
Turner Creek Forest	Dry-mesic Northern Forest	• Apply prescribed fire to reduce invasive species and native mesophytic species • Burn in concert with adjacent wet prairie • Cut and herbicide invasive shrubs • Girdle or cut subcanopy and understory red maple and black cherry • Monitor for invasives and following fire
Dagget Lake Woods	Dry-mesic Southern Forest	• Maintain closed canopy • Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Hand pull garlic mustard • Girdle or cut subcanopy and understory mesophytic species • Monitor following fire and for invasives, oak regeneration, and deer herbivory
Fish Lake Forest	Dry-mesic Southern Forest	• Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Hand pull garlic mustard • Girdle or cut subcanopy and understory red maple • Monitor following fire and for invasives, oak regeneration, and deer herbivory
Gun Lake Road Woods	Dry-mesic Southern Forest	• Maintain closed canopy • Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Hand pull concentrations of garlic mustard • Girdle or cut subcanopy and understory mesophytic species • Monitor following fire and for invasives, oak regeneration, and deer herbivory
Gun Lake Woods	Dry-mesic Southern Forest	• Maintain closed canopy • Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Hand pull concentrations of garlic mustard • Girdle or cut subcanopy and understory mesophytic species • Monitor following fire and for invasives, oak regeneration, and deer herbivory
Hart Road Woods	Dry-mesic Southern Forest	• Maintain closed canopy • Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Hand pull concentrations of garlic mustard • Girdle or cut subcanopy and understory red maple and black cherry • Monitor following fire and for invasives, oak regeneration, and deer herbivory
Hill Creek Woods	Dry-mesic Southern Forest	• Burn forest in concert with adjacent prairie fen • Apply prescribed fire to reduce invasive species and native mesophytic species. • Cut and herbicide invasive shrubs • Monitor following fire and for invasives, oak regeneration, and deer herbivory
Norris Road East Woods	Dry-mesic Southern Forest	• Maintain closed canopy • Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Hand pull concentrations of garlic mustard • Girdle or cut subcanopy and understory red maple and black cherry • Monitor following fire and for invasives, oak regeneration, and deer herbivory

Table 13 (continued). Summary of management recommendations for natural community element occurrences for the Barry State Game Area.

Site Name	Community Type	Management Recommendations
The Hills North	Dry-mesic Southern Forest	• Maintain closed canopy • Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Hand pull concentrations of garlic mustard • Girdle or cut subcanopy and understory red maple and sassafras • Monitor following fire and for invasives, oak regeneration, and deer herbivory
The Hills South	Dry-mesic Southern Forest	• Maintain closed canopy • Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Hand pull concentrations of garlic mustard • Girdle or cut subcanopy and understory red maple • Monitor following fire and for invasives, oak regeneration, and deer herbivory
Whitmore Road Woods	Dry-mesic Southern Forest	• Maintain closed canopy • Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Hand pull concentrations of garlic mustard • Girdle or cut subcanopy and understory red maple and black cherry • Monitor following fire and for invasives, oak regeneration, and deer herbivory
Dagget Lake Wetlands	Intermittent Wetland	• Maintain intact buffer of natural communities surrounding intermittent wetland • Allow wildfires to carry across wetland • Monitor for invasives and off-road vehicle damage. • Control invasives in surrounding uplands
Norris Road Wetland	Intermittent Wetland	• Maintain intact buffer of natural communities surrounding intermittent wetland • Allow wildfires to carry across wetland • Control invasives within wetland and in surrounding uplands • Monitor for invasive species
Whitmore Road Wetland	Intermittent Wetland	• Maintain intact buffer of natural communities surrounding intermittent wetland • Allow wildfires to carry across wetland • Control invasives within wetland and in surrounding uplands • Monitor for invasive species
Snow Lake Fen	Poor Fen	• Maintain intact buffer of natural communities surrounding poor fen • Eliminate narrow-leaved cat-tail population through herbicide spot treatment before burning • Apply prescribed fire to reduce tree and shrub encroachment • Monitor for invasive species
Bassett Creek Fen	Prairie Fen	• Apply prescribed fire to reduce tree and shrub encroachment • Cut and herbicide glossy buckthorn • Maintain intact buffer of natural communities surrounding fen to protect hydrology • Monitor for invasive species
Bowens Mill Fen	Prairie Fen	• Control clusters of narrow-leaved cat-tail through herbicide spot treatment before burning • Apply prescribed fire to reduce tree and shrub encroachment • Establish rotating non-fire refugia to protect rare species • Maintain intact buffer of natural communities surrounding fen to protect hydrology • Restore agricultural field to west of fen to native cover • Monitor for invasive species
Fish Lake Fen	Prairie Fen	• Control clusters of narrow-leaved cat-tail through herbicide spot treatment before burning • Apply prescribed fire to reduce tree and shrub encroachment • Allow prescribed fire to carry into surrounding uplands to west • Establish rotating non-fire refugia to protect rare species • Maintain intact buffer of natural communities surrounding fen to protect hydrology • Monitor for invasive species
Hill Creek Fen	Prairie Fen	• Apply prescribed fire to reduce tree and shrub encroachment • Burn dry-mesic southern forest along eastern side of fen in concert with fen • Establish rotating non-fire refugia to protect rare species • Cut and herbicide glossy buckthorn • Maintain intact buffer of natural communities surrounding fen to protect hydrology • Monitor for invasive species
Horseshoe Lake Fen	Prairie Fen	• Apply prescribed fire to reduce tree and shrub encroachment • Establish rotating non-fire refugia to protect rare species • Cut and herbicide glossy buckthorn • Maintain intact buffer of natural communities surrounding fen to protect hydrology • Monitor for invasive species

Table 13 (continued). Summary of management recommendations for natural community element occurrences for the Barry State Game Area.

Site Name	Community Type	Management Recommendations
Shaw Lake Fen	Prairie Fen	• Apply prescribed fire to reduce tree and shrub encroachment • Establish rotating non-fire refugia to protect rare species • Cut and herbicide glossy buckthorn, autumn olive, and multiflora rose • Maintain intact buffer of natural communities surrounding fen to protect hydrology • Monitor for invasive species
Turner Creek Wetlands	Prairie Fen	• Apply prescribed fire to reduce tree and shrub encroachment • Establish rotating non-fire refugia to protect rare species • Cut and herbicide glossy buckthorn, autumn olive, and multiflora rose • Reduce invasive species infestations in surrounding uplands and wetlands • Maintain intact buffer of natural communities surrounding fen to protect hydrology • Monitor for invasive species and for Mitchell's satyr • Pursue acquisition of adjacent private lands or discuss compatible management with landowner
Wildwood Fen	Prairie Fen	• Control clusters of narrow-leaved cat-tail through herbicide spot treatment before burning • Apply prescribed fire to reduce tree and shrub encroachment • Maintain intact buffer of natural communities surrounding fen to protect hydrology • Monitor for invasive species
Turner Creek Swamp	Rich Tamarack Swamp	• Control invasive species and monitor control effort • Allow fire to burn swamp • Maintain intact buffer of natural communities surrounding swamp • Monitor culvert passing under Bowens Mill Road
Bassett Lake Meadow	Southern Wet Meadow	• Control clusters of narrow-leaved cat-tail through herbicide spot treatment before burning • Apply prescribed fire to reduce tree and shrub encroachment • Cut and herbicide invasive shrubs • Maintain intact buffer of natural communities surrounding meadow to protect hydrology • Monitor for invasive species
Havens Road Meadow	Southern Wet Meadow	• Apply prescribed fire to reduce tree and shrub encroachment • Establish rotating non-fire refugia to protect rare species • Cut and herbicide invasive shrubs • Maintain intact buffer of natural communities surrounding meadow to protect hydrology • Monitor for invasive species
Oak Road Meadow	Southern Wet Meadow	• Control invasive species and monitor control effort • Allow fire to burn meadow • Maintain intact buffer of natural communities surrounding meadow
Otis Lake Marsh	Submergent Marsh	• Maintain intact buffer of natural communities surrounding marsh to protect hydrology • Monitor for invasive species and off-road vehicle activity • Cut and herbicide autumn olive along margin of wetland
Snow Lake Marsh	Submergent Marsh	• Maintain intact buffer of natural communities surrounding marsh to protect hydrology • Control narrow-leaved cat-tail and hybrid cat-tail • Monitor for invasive species
Turner Creek Wetlands	Wet Prairie	• Apply prescribed fire to reduce tree and shrub encroachment and control invasive species • Establish rotating non-fire refugia to protect rare species • Reduce invasive species infestations in surrounding uplands and wetlands • Maintain intact buffer of natural communities surrounding wet prairie to protect hydrology • Monitor for invasive species and for Mitchell's satyr
Turner Creek Wet Prairie	Wet Prairie	• Apply prescribed fire to reduce tree and shrub encroachment and control invasive species • Burn wet prairie in concert with adjacent high-quality dry-mesic northern forest • Cut and herbicide autumn olive and multiflora rose • Reduce invasive species infestations in surrounding uplands and wetlands • Maintain intact buffer of natural communities surrounding wet prairie to protect hydrology • Monitor for invasive species and rare species
Turner Creek Wetlands	Wet-mesic Prairie	• Apply prescribed fire to reduce tree and shrub encroachment and control invasive species • Establish rotating non-fire refugia to protect rare species • Reduce invasive species infestations in surrounding uplands and wetlands • Maintain intact buffer of natural communities surrounding wet prairie to protect hydrology • Monitor for invasive species and for Mitchell's satyr

Although numerous invasive species occur within the game area, the species likely to pose the greatest threats because of their ability to invade and quickly dominate intact natural areas in southern Lower Michigan include garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), autumn olive (*Elaeagnus umbellata*), Amur honeysuckle (*Lonicera maackii*), Morrow's honeysuckle (*Lonicera morrowii*), purple loosestrife (*Lythrum salicaria*), reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), glossy buckthorn (*Frangula alnus*), multiflora rose (*Rosa multiflora*), hedge-parsley (*Torilis japonica*), hybrid cat-tail (*Typha* x*glauca*), and narrow-leaved cat-tail (*T. angustifolia*). Additionally, new invasive species that were not seen in Barry SGA, such as Japanese knotweed (*Polygonum cuspidatum*), Oriental bittersweet (*Celastrus orbiculata*), and zebra mussel (*Dreissena polymorpha*) 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: http://www.imapinvasives.org/GIST/ESA/index

Invasive species management at Barry SGA should focus on controlling populations of pernicious invasive species within high-quality natural areas and also in the surrounding landscape. Prescribed fire can be employed as the primary mechanism for reducing invasive species at the landscape scale and targeted prescribed fire and spot treatment through cutting and/or herbicide application and biocontrol can be employed locally within priority high-quality natural community EOs. We encourage this multi-faceted approach and emphasize that improving the landscape context surrounding the high-quality natural areas is critical and that reducing background levels of invasive species will reduce the seed source for these invaders. Logging within nearby Fort Custer has been found to locally increase invasive species populations with areas of recent logging being associated with local dominance of garlic mustard (personal communication Michele Richards). Restricting future logging operations to winter months when the soils are frozen may limit the establishment and expansion of invasives, such as garlic mustard, that benefit from soil disturbance and can also reduce detrimental impacts to plant and animal species. We strongly encourage the implementation of monitoring within the high-quality natural communities 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 Barry SGA. As noted within the above discussion of many of the wetland sites, it is critical that prescribed fire be avoided in areas where narrow-leaved cat-tail occurs because this species tends to increase following fire. We recommend controlling populations of narrow-leaved cat-tail through foliar application of herbicide using a wick applicator.

Fire as an Ecological Process

Much of the land within Barry SGA historically supported fire-dependent ecosystems such as oak openings, oak barrens, dry-mesic southern forest, dry southern forest, wet prairie, prairie fen, and southern wet meadow. 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, open oak savanna and oak barrens have converted to closed-canopy forests dominated by shade-tolerant native and invasive species (Cohen 2001, Lee and Kost 2008). Fire-suppressed wetlands such as prairie fen, wet prairie, and southern wet meadow have converted to shrub-carr and swamp forests (Curtis 1959). The conversion of oak savanna ecosystems to closed-canopy forest and open wetland to shrub- or tree-dominated systems typically results in significant reductions in species and habitat diversity (Curtis 1959, McCune and Cottam 1985, McClain et al. 1993, Wilhelm 1991). Many of the rare species found within Barry SGA depend on these fire-dependent habitats. In addition, due to fire suppression closed-canopy forests within Barry SGA are experiencing strong regeneration of thin-barked, shade-tolerant or mesophytic trees, such as red maple, and invasive shrubs such as honeysuckles, multiflora rose, and autumn olive. Within 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 native shrubs, oaks, hickories, and conifers. Efforts to restore oak barrens and oak savanna within Barry SGA will depend on the implementation of frequent prescribed fire. Regular prescribed fire management within open wetlands can help reduce shrub and tree cover and invasive species and promote high species diversity.

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

Recently burned dry-mesic southern forest in Barry State Game Area. Photo by Michael A. Kost.

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).

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 1988). 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 amphibian and reptile species. 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 (<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 to one thousand acres in size). If resources for burning are limited, we recommend that prescribed fire be prioritized for high-quality, underrepresented, fire-dependent natural communities (e.g., prairie fen, wet prairie, wet-mesic prairie, and oak savanna) and habitat immediately adjacent to these systems. Fire-suppressed

sites should be burned using an initially aggressive fire-return interval.

We also recommend that the seasonality of burns be varied across the game area. 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 impacts 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). Many of the natural communities found at Barry SGA, including prairie fen, dry-mesic southern forest, and wet prairie, likely historically burned primarily in late summer and early fall. Varying the seasonality of prescribed burns to match the full range of historical variability better mimics the natural disturbance regime and leads to higher biodiversity (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 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 expand 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, black locust, and sumac (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 game area outweigh the costs and that ultimately, successful restoration of fire-dependent ecosystems at Barry SGA 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.

Oak Savanna Restoration

Although no high-quality oak barrens or oak openings were documented during the course of the surveys, numerous plant and animal species associated with oak savanna ecosystems persist in Barry SGA including numerous rare plant and insect species (Tables 2 and 5). Rare savanna and prairie insect species that have been documented within Barry SGA include Persius dusky wing (*Erynnis persius persius*, state special concern), Ottoe skipper (*Hesperia ottoe*, state threatened), barrens buckmoth (*Hemileuca maia*, state special concern), Sprague's pygarctia (*Pygarctia spraguei*, state special concern), three-staff underwing (*Catocala amestris*, state endangered), and blazing star borer (*Papaipema beeriana*, state special concern) (Table 5 and Figure 12). In addition, Henslow's sparrow (*Ammodramus henslowii*, state endangered), which depends on large grassland complexes, has been recorded in Barry SGA. Rare savanna and prairie plants recorded from Barry SGA include purple milkweed (*Asclepias purpurascens*, state threatened), false boneset (*Kuhnia eupatorioides*, state special concern), upland boneset (*Eupatorium sessilifolium*, state threatened), leadplant (*Amorpha canescens*, state special concern), and Drummond's aster (*Aster drummondii*, state threatened) (Table 2). The numerous rare reptiles that have been documented within Barry SGA, likely historically used oak savanna and prairie habitat for nesting, foraging, dispersal, mating, gestation, parturition, and/or overwintering.

The presence of these rare species of savanna and prairie ecosystems as well as more common indicators, such as wild lupine (*Lupinus perennis*) and large-diameter, open-grown oaks, can be used to help target potential sites for consideration for barrens restoration. Pursuing restoration of oak savanna remnants is recommended because these rare ecosystems support a high-level of biodiversity and numerous rare species. As noted above, savanna ecosystems in Barry SGA were historically concentrated in the northern portion of the game area on the Battle Creek Outwash Plain (Figures 2 and 4). Oak savanna restoration opportunities are most prevalent and realistic in Compartments 1, 2, and 4.

If suitable savanna remnants are located, the first management step will be the restoration of the oak savanna physiognomy through prescribed fire and/or selective cutting or girdling. Where canopy closure has degraded the savanna character, resource managers can selectively cut or girdle the majority of trees (White 1986), leaving between 10 and 60% canopy closure. Degraded savannas 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 but can be removed by mechanical thinning (Abella et al. 2001, Peterson and Reich 2001). Many of the shade-tolerant shrubs in the understory of oak savanna 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). 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. The incremental opening of the canopy, especially when followed by the implementation of prescribed fires, can result in the germination of savanna species dormant in seedbanks during fire suppression.

Fire is the single most significant factor in preserving oak savanna ecosystems. Once savanna conditions have been re-established, the reintroduction of annual fire is essential for the maintenance of open canopy conditions. 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). Burning at longer time intervals will allow for seedling establishment and the persistence of 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 remnants.

Resource managers in southwestern Michigan face a complex management dilemma. Following decades of fire suppression, oak savanna communities have converted to closed-canopy oak systems. Many of these dry southern and dry-mesic southern forests provide critical habitat for forest-dwelling species, such as neotropical migrant birds. Within Barry SGA these forested ecosystems provide nesting habitat for hooded warbler and cerulean warbler (*Dendroica cerulea*, state threatened). Conversion of these closed-canopy oak forests to oak savannas 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 leaves them susceptible to invasion by aggressive invasive and native plants (Solecki 1997). Conversion of oak forest to oak savanna 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 oak savanna systems. Savanna 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 oak savanna landscapes are likely to pay rich dividends (Leach and Givnish 1999).

Forest Biodiversity and Fragmentation

The Barry SGA supports over 10,000 acres of forest and close to 800 acres of high-quality forest, primarily dry-mesic southern forest. Because the landscape surrounding Barry SGA is dominated by agriculture and rural development (Figure 1), the large area of forest within the game area serves as an important island of biodiversity for the local region. Maintaining the forest canopy of mature forest systems will help ensure that high-quality habitat remains for the diverse array of plants and animals, including the many rare species and SGCN that utilize this forested island. The conservation significance of these forests is heightened by the presence of forty-four species of birds of which ten are SGCN and four are DNR featured species (Appendix 4).

Although Barry SGA is relatively unfragmented compared to the surrounding landscape, its past history of agricultural development and abandonment and logging activity has resulted in a significant amount of native habitat fragmentation within the game area. As native forests become increasingly fragmented ecosystems, their dynamics shift from being primarily internally driven to being externally and anthropogenically driven. The effects of forest fragmentation on native plants and animals and ecosystem processes are profound and alarming (Heilman et al. 2002). Fire regimes in fragmented landscapes are reduced because roads, agriculture, and development enhance modern forest fire suppression (Leahy and Pregitzer 2003). Forestry and wildlife management practices that focus on species- and stand-based management have directly and indirectly promoted landscape fragmentation and exacerbated edge effects through prescriptions that generate and maintain small discrete patches of habitats or stand types (Bresse et al. 2004). The small and insularized nature of forest fragments may make them too small to support the full array of species formerly found in the landscape (Rooney and Dress 1997). Local population extinctions within fragments are accelerated by reduced habitat and population size. Within fragmented forests, avian diversity is reduced by nest predation and nest parasitism and herptile diversity is reduced by the prevalence of mesopredators (e.g., raccoons, skunks, and opossums). Numerous neotropical migrant songbirds are dependent on interior forest habitat and are highly susceptible to nest parasitism and predation (Robinson et al. 1995, Heske et al. 2001, Heilman et al. 2002). Native plant diversity within forested fragments is threatened by low seedling survivorship, infrequent seed dispersal, high levels of herbivory, and growing prevalence of invasive species and native weeds, which thrive along the increasing edges and disperse throughout fragmented landscapes along roads and trails (Brosofske et al. 2001, Heilman et al. 2002, Hewitt and Kellman 2004).

In general, dampening the effects of forest fragmentation can be realized by decreasing forest harvest levels, halting the creation of new wildlife openings within forested landscapes, closing redundant forest roads, and limiting the creation of new roads. In addition, conversion of wildlife openings and old agricultural fields to forest and other native habitats such as oak savanna also contributes to increase of forest connectivity and decrease in forest fragmentation. We recommend that efforts to reduce fragmentation be concentrated in the vicinity of existing high-quality natural communities and adjacent to riparian corridors.

Closed-canopy forest in Barry State Game Area provides critcal habitat for interior-forest obligates. Photo by Michael A. Kost.

Setting Stewardship Priorities

This report provides site-based assessments of 38 natural community EOs that occur on Barry SGA. Detailed site descriptions, threats, management needs, and restoration opportunities specific to each individual site have been discussed. The baseline information presented in the current report provides resource managers with an ecological foundation for prescribing site-level biodiversity stewardship, monitoring these management activities, and implementing landscape-level biodiversity planning to prioritize management efforts. Threats such as invasive species and fire suppression are common across Barry SGA. Because the list of stewardship needs for the game area (Table 13) may outweigh available resources, prioritizing activities is a pragmatic necessity. We provide the following framework for prioritizing stewardship efforts across all high-quality natural community EOs within Barry SGA in order to facilitate difficult decisions regarding the distribution of finite stewardship resources. In general, prioritization of stewardship within these natural community EOs should focus on the highest quality examples of the rarest natural community types. 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 Barry SGA, we recommend that stewardship efforts be focused on rare wetland communities that harbor high levels of biodiversity and provide habitat for numerous rare plant and animal species. Rare wetland communities that management efforts should focus on include prairie fen, wet prairie, wet-mesic prairie, and coastal plain marsh. We also recommend that management efforts focus on sites located along riparian corridors and complexes that support numerous high-quality natural communities, especially adjacent wetland and upland ecosystems, so that management efforts impact the upland and wetland interface. In addition, as a forested island within a sea of agricultural fragmentation, Barry SGA provides critical habitat for forest-interior dependent species. Stewardship efforts should also be focused in the highest quality and largest dry-mesic southern forest EOs.

Sites that meet these criteria include Dagget Lake* (coastal plain marsh, EO ID 9832), Turner Creek Forest (dry-mesic northern forest, EO ID 18975), Gun Lake Road Woods (dry-mesic southern forest, EO ID 18967), Gun Lake Woods* (dry-mesic southern forest, EO 18973), Hill Creek Woods* (dry-mesic southern forest, EO ID 13346), The Hills (North) (dry-mesic southern forest, EO ID 16128), Bowens Mill Fen* (prairie fen, EO ID 13555), Hill Creek Fen* (prairie fen, EO ID 7579), Horseshoe Lake Fen (prairie fen, EO ID 2829), Shaw Lake Fen (prairie fen, EO ID 12498), Turner Creek Swamp (rich tamarack swamp, EO ID 18983), Basset Lake Meadow* (southern wet meadow, EO ID 18984), Havens Road Meadow (southern wet meadow, EO ID 13355), Turner Creek Wetlands* (prairie fen, wet prairie, and wet-mesic prairie, EO IDs 278, 2267, and 4771), and Turner Creek Wet Prairie* (EO ID 18987) (Table 14). The highest priority sites within this subset of natural community EOs are highlighted by an asterisk.

Table 14. Stewardship priorities for Barry State Game Area natural community element occurrences with the highest priorities highlighted with asterisks.

Site Name	Community Type	EO ID	EO Rank	Year First Observed	Year Last Observed	Global Rank	State Rank
Dagget Lake*	Coastal Plain Marsh	9832	BC	1970	2012	G2	S2
Turner Creek Forest	Dry-mesic Northern Forest	18975	C	2012	2012	G4	S3
Gun Lake Road Woods	Dry-mesic Southern Forest	18967	BC	2012	2012	G4	S3
Gun Lake Woods*	Dry-mesic Southern Forest	18973	B	2012	2012	G4	S3
Hill Creek Woods*	Dry-mesic Southern Forest	13346	BC	1989	2012	G4	S3
Norris Road East Woods	Dry-mesic Southern Forest	13349	C	1989	2012	G4	S3
The Hills North	Dry-mesic Southern Forest	16128	BC	2006	2012	G4	S3
Bowens Mill Fen*	Prairie Fen	13555	C	2002	2003	G3	S2
Hill Creek Fen*	Prairie Fen	7579	BC	1989	2012	G3	S2
Horseshoe Lake Fen*	Prairie Fen	2829	BC	1989	2012	G3	S2
Shaw Lake Fen*	Prairie Fen	12498	C	1989	2012	G3	S2
Turner Creek Wetlands*	Prairie Fen	278	BC	1974	2012	G3	S2
Turner Creek Swamp	Rich Tamarack Swamp	18983	C	2012	2012	G4	S3
Bassett Lake Meadow*	Southern Wet Meadow	18984	C	2012	2012	G4?	S4
Havens Road Meadow	Southern Wet Meadow	13355	C	1989	2012	G4?	S4
Turner Creek Wetlands*	Wet Prairie	2267	BC	1974	2010	G3	S1
Turner Creek Wet Prairie*	Wet Prairie	18987	C	2012	2012	G3	S1
Turner Creek Wetlands*	Wet-mesic Prairie	4771	C	1975	2010	G3	S1

Monitoring

We recommend that monitoring be implemented at Barry SGA, concentrated within the high-quality natural communities 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 open communities such as prairie fen and wet prairie and in understories of fire-prone forests, and fostering regeneration of oak saplings in fire-dependent ecosystems. Assessing the impacts of prescribed fire on herptile and rare insect populations should be a critical 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

Birds

Forest Songbirds

We observed two rare songbird species, cerulean warbler and hooded warbler, during surveys conducted in Barry SGA in 2013. Both species were documented in the game area previously and were last observed in 2011. These species are known to occur in landscapes consisting of large blocks of mature deciduous forest. Management of Barry SGA and the adjacent Yankee Springs SRA has maintained large areas of forest within a landscape that is largely dominated by agricultural land, residential development, and small fragments of forest. The large areas of forest in Barry SGA and Yankee Springs SRA are providing breeding habitat for cerulean and hooded warblers, as well as other Neotropical migrant songbirds. We documented 44 species using forested tracts of the game area (Appendix 4). Recorded bird species included several SGCN and four species (red-headed woodpecker, veery, wood thrush, and cerulean warbler) identified as focal species in the Landbird Habitat Conservation Strategy (Potter et al. 2007) for the Upper Mississippi River and Great Lakes Region Joint Venture.

Although cerulean and hooded warblers are at the northern edges of their breeding ranges in Michigan, they can be locally common breeders in forested landscapes in the southern Lower Peninsula. Cerulean warbler is considered an area-sensitive species and typically occupies forest tracts that are 3,000 ha (over 7,400 acres) or larger within the core of its breeding range (Hamel 2000). Hamel (1992) noted that the needs of cerulean warbler may be compatible with low-intensity timber management (e.g., single-tree selective removal) that mimics natural forest gap-phase dynamics. Such low-intensity management may also be compatible with hooded warbler breeding habitat. Hooded warblers nest in small trees or shrubs in the understory of mature deciduous forest (Dunn and Garrett 1997), and we observed them in areas of dense young trees and shrubs associated with blowdowns.

The maintenance and expansion of mature forest blocks within the game area would benefit cerulean and hooded warblers and other forest-interior species, such as Acadian flycatcher and wood thrush. Activities that reduce the cover of mature forest or increase fragmentation could reduce the value of Barry SGA to forest-interior nesting songbirds. We observed brown-headed cowbirds (*Molothrus ater*) at 8% of the point-count stations surveyed in the game area. Cowbirds thrive in fragmented landscapes and reduce the reproductive success of forest-breeding songbirds through nest parasitism. Efforts to reduce forest fragmentation could decrease nest parasitism by brown-headed cowbirds on rare and declining forest songbirds.

We recommend conducting songbird point counts periodically to monitor use of the game area by the rare species we observed. 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 species. Because rare species often are not detected even when present, additional surveys would also help determine if rare songbirds (e.g., Louisiana waterthrush) are present at sites where the habitat appeared suitable, but they were not observed.

Wetland Birds

Emergent wetlands in Barry SGA, such as marshes, wet meadows, and fens, have potential to support rare and declining marsh bird species. We documented marsh wren, common loon, and osprey using wetland and aquatic ecosystems at Fish and Otis Lakes. Marsh birds are difficult species to detect, so wetlands at these sites could support several rare species and SGCN not observed during surveys, such as pied-billed grebe (*Podilymbus podiceps*), American, bittern, least bittern, sora, common gallinule, American coot (*Fulica americana*), and Wilson's snipe (*Gallinago delicata*). We recommend periodic surveys using conspecific broadcasts (see Conway 2011) to track occupancy of known rare species and detect new species not previously documented in potential habitat.

Wetlands in the game area have been degraded by shrub encroachment and invasive species expansion, which has likely reduced their suitability for marsh birds. We recommend management (e.g., burning, mowing, hand

cutting, and herbicide application) to reduce shrub cover in previously open wetlands to maintain habitat for wetland birds and plant diversity, especially at sites with glossy buckthorn (*Frangula alnus*). Wetlands in Barry SGA should also be monitored for invasive common reed (*Phragmites australis*) populations. Common reed has been shown to influence use by marsh birds in the Great Lakes region (Meyer et al. 2010), as well as drastically alter plant diversity and ecosystem functioning. We suggest sites containing invasive, non-native common reed be managed according to the guidelines developed for wetlands in the Great Lakes region in *A Guide to the Control and Management of Invasive Phragmites* (Avers et al. undated). Maintaining upland buffers surrounding wetlands and aquatic systems would help maintain the hydrologic regime of wetlands and reduce sediment and nutrient inputs. Increased nutrient levels can encourage the development of monocultures of broad-leaved emergent plants (Wisheu and Keddy 1992) and degrade the quality of riparian systems.

Other Bird Species

We did not conduct specific surveys for grassland birds, but large southern wet meadow and prairie fen wetlands and upland grasslands in the game area could support rare grassland birds, such as Henslow's sparrow (*Ammodramus henslowii*, state endangered) and northern harrier (*Circus cyaneus*, state special concern). Grasshopper sparrow (*A. savannarum*, state special concern), dickcissel (*Spiza americana*, state special concern), western meadowlark (*Sturnella neglecta*, state special concern), and several other SGCN, including bobolink (*Dolichonyx oryzivorus*) and eastern meadowlark (*Sturnella magna*), could also occur in upland grasslands. Henslow's sparrow (EO ID 15797) was documented at Hill Creek Fen in 2005 and nearby at Michigan Audubon's Otis Sanctuary (EO ID 16107) in 2006 (Figure 10), as well as other locations outside the game area. Northern harrier was documented (EO ID 2901) in wetlands on private land near Fish Lake in 1980. Periodic management (e.g., burning, mowing) to set back succession and minimize encroachment of woody vegetation in open wetlands and upland grasslands could maintain potential habitat for grassland birds. We recommend management at sites occupied by rare grassland birds be conducted outside the nesting season (May – August).

Reptiles and Amphibians

Barry SGA and adjacent public and private lands represent a "hotspot" of amphibian and reptile biodiversity in southern Michigan. Of the 43 amphibian and reptile species that have potential to occur in the Barry SGA and surrounding area, at least 24 species were documented in or around the state game area during surveys conducted by MNFI and others during and/or prior to 2013 (Appendix 2). These species included six listed or rare amphibian and reptile species, five SGCN, and 13 common species (Appendix 2). Additionally, most of the rare species found in Barry SGA were documented at multiple sites (Table 4, Figure 11). Many of these occurrences have persisted for a number of years (e.g., over 10-60 years), and are estimated to have excellent to good viability in the foreseeable future (i.e., at least the next 20-30 years) (Table 4; MNFI 2014).

A likely reason that a large number of rare and common amphibian and reptile species have been found in and around Barry SGA and are considered to have excellent to good viability is the availability of large complexes of suitable wetland and adjacent upland habitats in the game area and on adjacent public and private lands. Many of the amphibian and reptile species found in Barry SGA are associated with or utilize open wetlands, such as prairie fens, wet meadows, wet/wet-mesic prairies, bogs, and/or emergent marshes. Several of the rare species and SGCN known to occur or with potential to occur within the game area are associated with these habitats, including eastern massasauga, spotted turtle, Blanding's turtle, eastern box turtle, Blanchard's cricket frog, western chorus frog (Pseudacris triseriata), pickerel frog, northern leopard frog, Kirtland's snake, eastern hog-nosed snake, and smooth green snake (Opheodrys vernalis) (Appendix 2; Ernst et al. 1994, Harding 1997, Hyde 1999, Lee 1999, Lee 2000, Lee and Legge 2000, Lee et al. 2000, Ernst and Ernst 2003, Barton and Lee 2010). Forested wetlands, such as tamarack swamps, and other wetlands, including submergent marsh, intermittent wetland, coastal plain marsh, and poor fen, also provide habitat for some of these species. There are several sites within Barry SGA that provide open wetlands for these species, including areas in and around Bassett Creek Fen, Shaw Lake Fen, Bassett Lake Meadow, Bowens Mill Fen, Briggs Road Wetland along a creek flowing into Baker Lake west of Bowens Mill Fen, Turner Creek Swamp, Turner Creek Wetlands, Turner Creek Wet Prairie, Hill Creek Fen, Snow Lake Fen, Otis Lake Bog, Dagget Lake Wetlands, Havens Road Meadow, Fish Lake Fen, and Horseshoe Lake Fen. Some of the open wetlands or wetland-upland complexes are particularly noteworthy based on occurrences of multiple rare herp species and the condition/extent of habitat, including complexes near Shaw Lake Fen, Bassett Lake Meadow, Bowens Mill Fen, Turner Creek Swamp, Turner Creek Wetlands, Hill Creek Fen, Havens Road Meadow, Fish Lake Fen, Horseshoe Lake Fen, Otis Lake Bog, and Dagget Lake Wetlands.

Many of the rare and/or declining herp species that have been found in Barry SGA also use open and/or forested uplands adjacent to wetlands. Eastern massasaugas utilize open and forested uplands, ranging from prairies, savannas, barrens, and old fields to 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 also overwinter in upland habitats adjacent to wetlands or in the transition zone between wetlands and uplands (Bissell 2006, Smith 2009). As Michigan's only truly terrestrial turtle, the eastern box turtle typically occurs in upland forests near wetlands or water, and overwinters in upland forests under the soil surface (Tinkle et al. 1979, Harding 1997, Hyde 1999). Spotted turtles and Blanding's turtles will use upland forests adjacent to wetlands for basking, aestivating, and dispersing (Rowe and Moll 1991, Ernst et al. 1994, Harding 1997, Lee 2000, Joyal et al. 2001, NatureServe 2014). Spotted turtles, Blanding's turtles, and eastern box turtles utilize open uplands for nesting, foraging, dispersal, and mating (Ward et al. 1976, Ernst et al. 1994, Harding 1997, Hyde 1999, Lee 1999, Lee 2000). Eastern hog-nosed snakes, blue racers, and smooth green snakes (*Opheodrys vernalis*) also use open uplands and open deciduous, coniferous, and mixed forests (Harding 1997, Ernst and Ernst 2003). The gray ratsnake primarily occurs in forests, including deciduous or mixed forests (e.g., dry to mesic southern forests), but also utilizes adjacent open or shrubby habitats, such as old fields, prairies, and edges of swamps, marshes, and bogs (Fitch 1963, McAllister 1995, Harding 1997, Ernst and Ernst 2003, Lee 2008).

Amphibian and reptile species within the game area face many threats to their long-term persistence. Disruption of natural ecological processes, hydrological alterations, vegetative succession, invasive species, residential and agricultural development, and roads have resulted in the loss, degradation, and fragmentation of habitat for many herp species in and around Barry SGA. Maintaining viable populations of rare and common herp species will require maintaining and restoring large complexes of open wetland and adjacent uplands both open and forested. Management efforts that maintain, restore, and expand habitat complexes comprised of diverse open wetlands and connected open and forested uplands in multiple locations within the game area would help ensure sufficient habitat is available to maintain viable populations of herp species. The following are priority sites for habitat management for amphibian and reptile populations within Barry SGA: 1) wetland-upland complex along Bassett Creek and Turner Creek from north of Shaw Lake Road to south of Snow Lake, including Bassett Creek Fen, Shaw Lake Fen, Bassett Lake Meadow, Turner Creek Swamp, Bowens Mill Fen, Turner Creek Wetlands, Yankee Springs Fen, McKibben Fen, Horsetail Bog, Snow Lake Fen; 2) Hill Creek Fen and adjacent uplands; 3) Havens Road Meadow; 4) wetland-upland complexes around and between Otis Lake Bog and Dagget Lake Wetlands; and 5) wetland-upland complex around and between Fish Lake Fen and Horseshoe Lake Fen. Some of the open wetlands at these sites have become wetter and/or have increased shrub density from fire suppression. As a result, these wetlands are less suitable for some amphibian and reptile species (e.g., eastern massasauga) and would benefit from habitat management and restoration. For example, the following locations would particularly benefit from habitat management: 1) Turner Creek Wetlands; 2) Briggs Road Wetland along creek flowing into Baker Lake west of Bowens Mill Fen; and 3) Horseshoe Lake Fen. Invasive species (e.g., glossy buckthorn, purple loosestrife, reed, autumn olive, multiflora rose, and honeysuckles) are becoming more prevalent throughout these wetland complexes and should be controlled before populations expand.

It also is important to maintain sufficient suitable upland habitats adjacent to wetlands for rare and common amphibians and reptiles in Barry SGA. Uplands that have or could be used by herp species for nesting, gestation, parturition, and/or overwintering should be identified and managed appropriately, because they are required for critical and sensitive aspects of herp species life history. Suitable upland habitats, particularly open uplands, adjacent to wetlands may be limiting or lacking in some areas. For example, the uplands around Bowens Mill Fen, Bassett Lake Meadow, Turner Creek Swamp, and Turner Creek Wetlands primarily consist of agricultural fields. Suitable upland habitat for herp nesting, gestation, and/or parturition may be limited or of poor quality at this site. Suitable upland habitats, particularly open uplands, could be created or restored at sites if limited.

Maintaining suitable microhabitats for amphibians and reptiles within sites also is critical. Amphibians and reptiles generally require particular microhabitat features within their environments to survive and persist. For example, 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. Massasaugas use sedge and grass hummocks, live and dead herbaceous vegetation, shrubs, muskrat and beaver lodges, burrows, and woody debris to thermoregulate (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 often give birth to live young 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

Herptiles, such as the eastern box turtle, rely on both upland and wetland habitat. Photo by Michael A. Kost.

dead and live trees and shrubs (Johnson and Menzies 1993, Moore 2004, Bissell 2006, Smith 2009). Spotted turtles need sedge, grass and/or Sphagnum moss hummocks, live and dead herbaceous vegetation, logs, shallow water, and burrows for basking, nesting, refugia or cover, foraging, aestivating, and overwintering (Ernst et al. 1994, Harding 1997, Lutz 2009). Blanding's turtles require logs or other woody debris or structures for basking (Ernst et al. 1994). Eastern box turtles utilize leaf litter, rotting vegetation, logs, and brush piles for protective cover (Conant and Collins 1998). These and other turtle species require open, sunny upland habitats for nesting, particularly areas with a southerly exposure, sandy or loamy soils, and little to no ground vegetation. Blanchard's cricket frogs and other frogs, salamanders, snakes, and turtles use aquatic, submergent, or emergent vegetation for protective cover, food, and/or attachment sites for egg masses. Habitat management efforts should strive to maintain or provide suitable microhabitats, such as cover objects, basking structures, and nesting habitat, for herp species.

High annual adult and/or juvenile survivorship is critical for maintaining stable populations of some of the herp species documented in Barry SGA, particularly long-lived species characterized by delayed sexual maturity, low annual recruitment, and high lifetime recruitment. For example, the Blanding's turtle requires high annual adult and juvenile survivorship [i.e., >93% for adults and >72% for juveniles (ages 1-13)] to maintain stable populations (Congdon et al. 1993). Because this species is so long-lived (e.g., 60+ years), populations can persist for many years even when population recruitment is limited or not occurring (Congdon and van Loben Sels 1991, Congdon et al. 1993). Long-term demographic studies or population viability analyses of various turtle species have reported that even small increases in adult and subadult or juvenile mortality (e.g., <10% increase in annual mortality of mature females or only 1-3% increase in annual mortality overall) could lead to population declines (Brooks et al. 1991, Congdon et al. 1993 and 1994, Erb 2011). 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 survival 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).

Management practices such as prescribed burning, mechanical vegetation control, and chemical control are important for maintaining and restoring wetland and upland habitats for amphibians and reptiles. However, these management practices also have potential to cause injury

or death to amphibians and reptiles. Adjusting the timing and/or manner in which these practices are conducted can reduce the potential for adversely impacting herp species. Conducting these management practices in early spring before herp species emerge, in the fall after species have entered their hibernacula, or after the species have left a particular area or habitat would minimize the potential for adversely impacting these species. For example, if female turtles or massasaugas are utilizing an upland area for nesting or gestation, conducting management activities prior to or after the turtle nesting season (i.e., primarily May-June) or after the gravid female massasaugas have given birth and left the area (i.e., after August) would minimize the potential harm to these species when they are particularly vulnerable. 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 reduce adverse impacts. Kingsbury and Gibson (2012) and Mifsud (2014) provide general habitat management guidelines and recommendations for amphibians and reptiles.

In addition to habitat loss, amphibian and reptile populations in the Barry SGA may be impacted by roads and road mortality, human disturbance or persecution, and illegal collection. These threats can significantly impact adult and/or juvenile survivorship and viability of some herp populations within the game area. 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.). Turtle mortality has been especially high along roads built through or near wetlands (Ashley and Robinson 1996, Wood and Herlands 1997, Haxton 2000). Although we did not observe road mortality during herp surveys in 2013, a number of the paved and gravel roads in the game area are adjacent to suitable wetland and upland habitats for amphibians and reptiles. Road mortality and the impact of roads on herp populations in Barry SGA should be monitored and further investigated. Where herp 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).

Amphibians and reptiles, particularly rare species, are vulnerable to collection for personal interest or recreation, commercial pet trade, and/or consumption (e.g., Asian turtle markets; Harding 1997). Additionally, some herp species, such as snakes and particularly massasaugas and look-alike snakes, are not well-understood or liked, and are intentionally or accidentally killed or injured by people. Because many of the herp sites in the Barry SGA are publicly accessible and heavily used for recreation, there is potential for collection, human disturbance, and persecution of some herp species. Sharing information about the locations of rare amphibian and reptile species only when necessary and monitoring herp populations and any suspicious activity at known sites will help reduce the potential for these threats to impact herp populations in the game area. Education and outreach efforts to raise awareness and understanding of the ecology, status, and conservation of amphibians and reptiles in Michigan and specifically in Barry SGA also would help reduce potential for persecution of these species.

Habitat fragmentation (e.g., due to roads, residential or agricultural development, and land management activities) can lead to increased populations of mesopredators such as raccoons, skunks, opossums, and foxes which can result in increased turtle nest predation and reduced or minimal population recruitment (Temple 1987). Research and monitoring are needed to determine whether nest predation and lack of recruitment are threatening turtle populations in Barry SGA. Predator control (e.g., trapping of mesopredators) and protection of nest sites are management strategies that can help reduce nest predation and increase recruitment, and may be necessary to maintain viable turtle populations within the game area. Restoring and enlarging habitat complexes, increasing connectivity, and reducing habitat fragmentation also would help address this issue.

In recent years, diseases and malformations have been affecting amphibians and reptiles in the U.S., and some of these have been documented or have potential to occur in herp populations in Michigan and Barry SGA. These include Chytridiomycosis, Ranavirus, and Snake Fungal Disease. Chytridiomycosis (Chytrid) is an emerging infectious disease of amphibians caused by an aquatic fungal pathogen (*Batrachochytrium dendrobatidis* [*Bd*]; Daszak et al. 2000). Over 350 amphibian species, mostly frogs and some salamanders, are known to have been infected by *Bd* (Fisher et al. 2009). This disease causes changes in the skin that are deadly to amphibians because they rely on their skin for the absorption of water and electrolytes (Minnesota DNR 2014). An amphibian that is sick with Chytridiomycosis can exhibit reddened or discolored skin, excessive shedding of skin, and abnormal postures or behaviors (Minnesota DNR 2014).

Ranavirus is a type of iridovirus (a DNA virus) that causes systemic infections in amphibians, reptiles, and fishes. This virus can cause a sudden onset of illness (disease) in animal populations. Symptoms include subtle to severe hemorrhages (bleeding) in the ventral (belly) skin, especially at the base of the hind limbs and around the vent opening; lethargy; erratic or weak swimming, often on their sides; and mild to severe fluid accumulation under the skin of the abdomen and hind limbs. Turtles infected with ranavirus show weakness, swollen eyelids, discharge from the nose and mouth, and the tongue and palate may show dull white or thick yellow plaques. Ranaviruses have been documented most frequently in mole salamanders (*Ambystoma* spp.), true frogs (*Lithobates* spp. and *Rana* spp.) and chorus frogs (*Pseudacris* spp.), and less frequently in adult newts (*Notophthalmus viridescens*), adult treefrogs (*Hyla* spp.), eastern box turtles, and true tortoises (USGS 2013a).

Snake fungal disease (SFD) is an emerging disease in certain populations of snakes in the eastern and Midwestern U.S (USGS 2013b). This disease was discovered in snakes (i.e., massasaugas) in Michigan in 2013. The disease is believed to be caused by a fungus, *Ophidiomyces* (formerly *Chrysosporium*) *ophiodiicola*, but this is not definitive at this time (USGS 2013b). Clinical signs of SFD include scabs or crusty scales, nodules, localized thickening or crusting of the skin; premature separation of the outermost layer of the skin from the underlying skin (abnormal shedding); white opaque cloudiness of the eyes (not associated with molting); and skin ulcers, nodules, and swelling of the head and face (USGS 2013b). Multiple species of snakes have been diagnosed with SFD, including the northern water snake, eastern racer (*Coluber constrictor*), rat snake (*Pantherophis obsoletus* species complex), timber rattlesnake (*Crotalus horridus*), eastern massasauga, and milk snake (*Lampropeltis triangulum*).

Chytridiomycosis, ranavirus, and SFD can have devastating impacts on individual animals and populations. Chytrid has caused the catastrophic decline or extinction of at least 200 species of frogs around the world, even in pristine, remote habitats (Skerratt et al. 2007). Ranavirus can cause high rates of mortality and massive die-offs of hundreds or thousands of amphibians in a short period of time (USGS 2013a). Although mortality has been associated with some cases of SFD (e.g., 100% mortality in massasaugas removed from the wild for treatment), population-level impacts of the disease are not yet widely known and are difficult to assess due to the cryptic and solitary nature of snakes, and a general lack of long-term monitoring data (USGS 2013b). These diseases have not been documented in Barry SGA, but targeted efforts to investigate the presence of these diseases in the game area could be conducted in the future. Any sick or dead amphibians and reptiles found exhibiting symptoms of these diseases should be reported, photographed and/or collected, and submitted to the Michigan DNR Wildlife Disease Lab and/or the USGS National Wildlife Health Center.

Additional surveys and monitoring are needed to assess the viability of known populations of rare herp species and also to identify other rare species within Barry SGA. Because many herp species are cryptic and difficult to detect in the field, especially if they are rare, additional surveys should be conducted for amphibian and reptile species of conservation interest that could occur in the game area. These include gray ratsnake, state endangered Kirtland's snake, state special concern queen snake (*Regina septemvittata*), and SGCN, such as the mudpuppy (*Necturus maculosus maculosus*), four-toed salamander (*Hemidactylium scutatum*), smooth green snake (*Opheodrys vernalis*), and northern ring-necked snake (*Diadophis punctatus edwardsii*). The habitats used by these species are summarized in Appendix 2. Future survey and monitoring efforts also should focus on reconfirming occurrences of rare species, particularly those that have not been detected within the last 20 years (see Table 4), and evaluating the status, distribution/extent, and population size or abundance of known occurrences.

In addition, we recommend that more surveys and monitoring of vernal pools and rare species and SGCN associated with these unique wetlands be done within Barry SGA. Spotted salamander (*Ambystoma maculatum*), blue-spotted salamander (*Ambystoma laterale*), eastern tiger salamander (*Ambystoma tigrinum*), four-toed salamander, Blanding's turtle, and spotted turtle are all known to use vernal pools. Vernal pools are small, shallow, temporarily flooded, and often isolated pools of water that are wet for only part of the year. Because vernal pools dry up, they provide fish-free environments that are critical breeding habitats for some frog, salamander, and invertebrate species, such as the wood frog, spotted salamander, blue-spotted salamander, fairy shrimp (Order Anostraca), and clam shrimp (Orders Laevicaudata, Brevicaudata, and Spinicaudata) Calhoun and deMaynadier 2004, Colburn 2004, Thomas et al. 2010). Vernal pools also provide habitat for many other wildlife species. Identification and protection of vernal pools are essential for maintaining healthy and diverse populations of amphibian and reptile species, as well as other wildlife. Protecting the surrounding upland forest and maintaining buffers around vernal pools are critical for maintaining habitat for herp species (Calhoun and deMaynadier 2004). For example, spotted salamanders, blue-spotted salamanders, and wood frogs disperse quite a distance from breeding ponds [e.g., 100 – 125+ m (328 – 400+ ft) for spotted and blue-spotted

salamanders and 1.2 km (0.75 mi) for Wood Frogs] (Semlitsch 1998).

The State of Michigan's manual on sustainable soil and water quality practices on forest land recommends not disturbing the vernal pool depression at all, avoiding deep ruts within a 100-foot buffer of the pool, generally only using heavy equipment within the buffer when the soil is dry or frozen, and maintaining at least 70% canopy closure in the area (MDNR and MDEQ 2009). Calhoun and deMaynadier (2004) provided habitat management guidelines for conserving vernal pool wildlife during forest harvesting activities and recommended maintaining closed or partial forest canopy, natural litter, and coarse woody debris, protecting the forest floor, avoiding the use of chemicals, and maintaining a 30 meter (100 ft) buffer or protection zone around vernal pools and a 30 to 122 meter (100-400 ft) amphibian habitat buffer or protection zone. Maintaining connectivity between vernal pools or clusters of vernal pools, particularly with different hydroperiods, also would be beneficial.

Insects

We conducted sweep net surveys for rare tree cricket species. Tamarack tree cricket has been documented at several sites within the game area and Yankee Springs SRA, and we reconfirmed the presence of the species at Shaw Lake Fen (EO ID 12498). We documented the first occurrence of pine tree cricket in the game area during our 2013 surveys at Otis Lake Bog (EO ID 15901). Additional sampling for pine tree cricket is warranted at Barry SGA at sites with potential habitat. We also recommend periodic sampling of known tamarack tree cricket sites to monitor site occupancy. Tamarack and white pine trees should be maintained at occupied sites, as should the functional integrity of the wetland and forest ecosystems in which they occur.

Blacklight surveys revealed one new occurrence of regal fern borer. Regal fern borer was also collected in 2000 in prairie fen south of Hall Lake in Yankee Springs SRA. Royal fern (*Osmunda regalis*) and cinnamon fern (*O. cinnamomea*) serve as larval hosts for the regal fern borer, so populations of these plants should be maintained in occupied sites. Although no other rare *Papaipema* moths were detected during our 2013 surveys, blazing star borer is known to occur in other parts of the game area and potential habitat is present for maritime sunflower borer and golden borer. Blazing star borer larvae feed on blazing star or snakeroot (*Liatris* spp.). Populations of host plants should be maintained in prairie fens within the game area, and care should be taken if prescribed fire is used as a management tool. Eggs of *Papaipema* moths are sensitive to fire, so we recommend that entire occupied sites not be burned in one season. Periodic burning could help set back shrub encroachment of sites inhabited by angular spittlebug, but burning of entire occupied sites is also not recommended for this species. Dividing occupied sites into smaller burn units would reduce the mortality risk to rare insect species and provide refugia for these fire-sensitive species. *Papaipema* moths are difficult to detect even when present. Because it may take multiple survey efforts to document these cryptic species, we recommend additional surveys for rare *Papaipema* moths at sites with populations of host plants.

Although we limited our 2013 surveys to the species described above, Barry SGA contains records of several rare insect species documented in a variety of wetland ecosystems, including prairie fen, southern wet meadow, and wet prairie (Table 5 and Figure 12). Mitchell's satyr (*Neonympha mitchellii mitchellii*, federally and state endangered) has been recorded in Turner Creek Wetlands (EO ID 2267 in prairie fen EO ID 278, wet prairie EO ID 2267, and wet-mesic prairie EO ID 4771) in Barry SGA and at Yankee Springs Fen (EO ID 13087) in Yankee Springs SRA. Satyr could also potentially occur in other prairie fen, southern wet meadow, and southern shrub-carr wetlands in the game area. Spartina moth (*Spartiniphaga inops*, state special concern) was documented from wetlands in the vicinity of Shaw Lake and was last observed in 1997. This species can occur in a variety of wetland types, including southern wet meadow, prairie fen, wet prairie, and wet-mesic prairie, containing its larval host plant, prairie cord-grass (*Spartina pectinata*). A historical record of Newman's brocade (*Meropleon ambifusca*, state special concern) is known from Turner Creek Wetlands and was last observed in 1994. This species is associated with fens, prairies, ephemeral wetlands, and forest openings. Kansas prairie leafhopper (*Dorydiella kansana*, state special concern) was collected at Bowens Mill Fen (EO ID 13555) in 2007. This leafhopper species is associated with wetlands (e.g., prairie fen) containing nut-rushes (*Scleria* spp.) that serve as its larval host plant. Red-legged spittlebug (*Prosapia ignipectus*, state special concern) was collected at the Turner Creek Wetlands site (prairie fen EO ID 278) in 2007. This species occurs in wetlands and prairies containing big bluestem (*Andropogon gerardii*) or little bluestem (*Schizachyrium scoparium*), on which nymphs (sub-adult life stages) are believed to feed. All of these species are sensitive to degradation of their habitats, such as altered hydrology (e.g., drainage, development of surrounding landscape), plant communities (e.g., invasive species), and disturbance regimes (e.g., fire suppression). Occupied sites should be protected by maintaining normal hydrologic conditions, protecting host plants, and providing adequate upland buffers to minimize sediment and nutrient inputs that can encourage invasive

species and monocultures. Periodic disturbance (e.g., burning) could benefit these species by controlling invasive plant species and minimizing the encroachment of woody vegetation. However, management of entire occupied sites during a given season should be avoided. We recommend such disturbances be implemented within multiple subunits on a rotational basis. High-quality wetlands throughout Barry SGA should be monitored periodically for these rare insects.

Small heterocampa (*Heterocampa subrotata*, state special concern) was last collected from wetlands in the Shaw Lake area in 1996. This species can occur in floodplain forests, southern hardwood swamps, and inundated shrub swamps that contain hackberry (*Celtis occidentalis*), its larval host plant. Populations of hackberry should be maintained and these sites should be surveyed for small heterocampa. The best method to survey for this species is to conduct blacklighting during the adult flight period (mid-May through mid-August).

Several other rare insect species known to occur in Barry SGA are primarily associated with barrens and prairie ecosystems. A historical three-staff underwing (*Catocala amestris*, state endangered) record was documented near Shaw Lake Fen and last observed in 1990. Three-staff underwing is associated with leadplant (*Amorpha canescens*, state special concern), which its larvae feed upon exclusively. Leadplant usually occurs in dry to mesic prairies and savannas, but most records in Michigan are from degraded prairies and rights-of-way. Persius dusky wing (*Erynnis persius persius*, state threatened) was previously documented at three locations within the game area: near Bassett Lake Road (last observed in 1971), near Shaw Lake Road (last observed in 1990), and near Bowens Mill Road (last observed in 2002). The species inhabits oak and oak-pine barrens and associated prairies, fields, trails, and utility rights-of-way. Adults lay eggs on wild blue lupine (*Lupinus perennis*) and will nectar on a variety of plant species, including blueberry (*Vaccinium* spp.), lupine, downy phlox (*Phlox pilosa*), wild plum (*Prunus americana*), and birdfoot violet (*Viola pedata*). Sprague's pygarctia (*Pygarctia spraguei*, state special concern) was documented in the game area near Yankee Springs Road, but this record is considered historical because it was last observed in 1977. This species could occur in openings within oak or oak-pine barrens, old fields, rights-of-way, and forest openings that contain its larval host plant flowering spurge (*Euphorbia corollata*). A historical barrens buckmoth (*Hemileuca maia*, state special concern) occurrence was recorded in the game area near Yankee Springs Road, but the species has not been reconfirmed at this location since 1968. Barrens buckmoth was also documented at Yankee Springs SRA within oak barrens associated with the McDonald Lake prairie fen (EO ID 15920). This occurrence was last reconfirmed in 1988. In Michigan, barrens buckmoth is associated with oak barrens, oak-pine barrens, and associated habitats, such as shrubby prairie fens, fields, and roadsides. Barrens buckmoths feed on a variety of species, including oaks (*Quercus* spp.), willows (*Salix* spp.), aspens (*Populus* spp.), *Spiraea* spp., and bog birch (*Betula pumila*). Three historical records of Ottoe skipper (*Hesperia ottoe*, state threatened) are known from the game area, but the species has not been documented in the area since 1982. Known sites for these rare insect species, as well as locations with potential habitat, should be surveyed periodically to track the status of populations within Barry SGA. Occupied sites should be protected by minimizing fragmentation and human disturbance (e.g., off-road vehicles, agriculture, and silviculture), monitoring for and controlling invasive plant species, and promoting fire management that mimics natural conditions. Populations of host and preferred food plants should also be maintained and monitored. We recommend that fire management at occupied sites be conducted on a rotational basis within several subunits to minimize the risk of mortality to populations. Restoring oak savanna ecosystems within Barry SGA could potentially benefit remnant populations of these rare species.

Mussels

The water bodies surveyed within Barry SGA supported 15% of the unionid mussel species known to occur in Michigan. We documented two rare species, slippershell (state threatened) and ellipse (state special concern), within the game area. The slippershell has one of the strongest associations to headwater habitats of any freshwater mussel species, being almost exclusively found in small streams and creeks. Most records for this species are of empty shells, so it is notable that three live individuals were found in Bassett Creek. Known hosts for the slippershell are mottled sculpin (*Cottus bairdii*), banded sculpin (*C. carolinae*), and Johnny darter. We documented Johnny darter at the same site as slippershell. Maximum lifespan for the slippershell is 10 years.

To protect unionid mussels, it is helpful to understand their life cycle. Unionid mussels rely on fish hosts to reproduce. The larvae, also known as glochidia, attach to the gills or fins of their host where they are provided a stable environment to transform to the adult form. Without the proper species of fish co-occurring with the unionid population, reproduction cannot occur. Some species of mussel are specialists and have only a few species of fish known to act as hosts, others are generalists and are known to utilize a dozen or more different host species. Glochidia are transported with their host fish until they transform into the adult form and drop off the fish. This allows unionid

mussels, which are otherwise mostly sedentary, to migrate to new habitats and exchange genes among populations.

The continued absence of zebra mussels in Barry SGA is crucial to maintaining populations of native unionid mussels. Zebra mussels have had dramatic negative effects on native unionid mussels and aquatic ecosystems in Michigan (Gillis and Mackie 1994, Schloesser et al. 1998). Zebra mussel larvae do not require a fish host to complete their life cycle. They are free swimming and are not normally able to migrate upstream in lotic habitats. The most common pathway for zebra mussel introduction is inadvertent transportation of larvae or adults on boats and trailers. Zebra mussel larvae are microscopic and can exist in small amounts of water that can be found in boats, boat trailers, and live wells. Bait buckets and waders are other possible pathways for introduction. For waterways like Glass and Bassett Creeks that have very little if any boat traffic, bait buckets and waders may be the most likely pathways. The risk of introduction can be reduced by promoting the washing and drying of boats, canoes, kayaks, waders, and any other gear that could transport zebra mussel larvae or adults before they are used in the watershed. Boat access and fishing sites like those at Bassett Lake are the most likely points of zebra mussel introduction. Signage describing the threat of zebra mussels and how to limit their spread could help minimize impacts and is recommended.

Conductivity measures taken at the time of surveys were within normal expected ranges. Conductivity of rivers in the United States ranges between 50 and 1500 µS. Streams supporting good fisheries typically measure between 150 and 500 µS. We recorded conductivity readings from 345 to 458 µS at our mussel survey sites (Table 12). Conductivity, a measure of the ability of water to carry an electrical current, is determined by the amount of inorganic dissolved substances including chloride, nitrate, sulfate, and phosphate (negatively charged ions), and sodium, magnesium, calcium, iron, and aluminum (positively charged ions). The geology of a given watershed is normally a strong factor in determining the amount of these substances present in river water. Streams that run through clay soils pick up materials in the clay that ionize in water resulting in higher conductivity, whereas streams that run through areas dominated by granite have lower conductivity because granite has an abundance of materials that do not ionize in water. Conductivity can be affected by point and non-point discharges into streams as well. Input of chlorides, phosphate, and nitrates can raise conductivity in rivers and lakes. Unusually high conductivity measures can be indicative of impacts such as excessive input of fertilizer or sewage overflows.

Alkalinity and hardness measures were also within the normal range, indicating enough buffering capacity to help protect aquatic life from normal fluctuations in pH (175-420mg/l $CaCO_3$) (Table 12). Alkalinity is a measure of how much calcium carbonate (mg/l of $CaCO_3$) is present in water and is one factor in determining how much acid can be added to water without causing a change in pH. In this way it buffers against rapid changes in pH. Hardness is a similar measure that accounts for other minerals such as magnesium and iron, in addition to calcium carbonate. Alkalinity is influenced by the surficial geology of the watershed. Streams flowing through areas with limestone tend to have high alkalinity.

In addition to slippershell, other rare mussel species have been documented in the Thornapple Watershed, including the purple wartyback (*Cyclonaias tuberculata*, state threatened) and three species of special concern, elktoe (*Alasmidonta marginata*), round pigtoe (*Pleurobema sintoxia*), and ellipse. The Grand River supports globally significant populations of the federally endangered snuffbox (*Epioblasma triquetra*). Though there is potential for it to also occur in the Thornapple River, systematic surveys have not been done and it has not been documented there to date.

Due to cumulative downstream effects of non-point source impacts including erosion/siltation, impervious surface, pollutants, etc., the quality of large river habitats is dependent upon the quality of headwater habitats. Glass Creek, Bassett Creek, and Hill Creek within Barry SGA are generally high quality waterways that contribute to maintaining the quality of downstream habitats. Other tributaries of the Thornapple River that pass through land with intense agricultural use may have a net negative impact on the rivers into which they flow. The benefit that Barry SGA provides through wide intact riparian buffers, relatively low levels of impervious surface (large amount of natural land cover), and lack of other non-point and point source impacts extends beyond Glass and Bassett Creeks. Barry SGA also contributes to the habitat quality of the wider Thornapple and Grand River watersheds and the species these systems support. Maintaining a buffer of native habitat adjacent to the riparian systems within Barry SGA, will help maintain the high-quality of the headwater streams and creeks and benefit the watersheds these creeks feed into.

CONCLUSION

During the Integrated Inventory Project at Barry SGA, MNFI documented 45 new element occurrences (EOs) and updated an additional 30 EOs (Tables 1-6). In total, 29 SGCN were documented during the project including 14 rare animal species (Table 8). In total, 130 EOs have been documented in Barry SGA including 60 animal EOs, 32 plant EOs, and 38 natural community EOs.

Surveys for exemplary natural communities resulted in 23 new high-quality natural communities and ten known high-quality communities were updated (Table 1). Twelve natural communities were surveyed in 2013 including: bog (2 EOs), coastal plain marsh (1 EO), dry southern forest (1 EO), dry-mesic northern forest (2 EOs), dry-mesic southern forest (10 EOs), intermittent wetland (3 EOs), poor fen (1 EO), prairie fen (6 EOs), rich tamarack swamp (1 EO), southern wet meadow (3 EOs), submergent marsh (2 EOs), and wet prairie (1 EO). We assessed the current ranking, classification, and delineation of these occurrences and detailed the vegetative structure and composition, ecological boundaries, landscape and abiotic context, threats, management needs, and restoration opportunities. For each natural community EO, a detailed site description, threats assessment, and management discussion is provided.

Over the course of the project, four new rare plant EOs were opportunistically documented and information was gathered to allow ten previously documented rare plant EOs to be updated (Table 2). Newly documented rare plant species include three records for ginseng (*Panax quinquefolius*, state threatened) and one record for false boneset (*Kuhnia eupatorioides*, state special concern). We processed updates for the following rare plant EOs: leadplant (*Amorpha canescens*, state special concern), tuberous Indian plantain (*Arnoglossum plantagineum*, state special concern), black-fruited spike-rush (*Eleocharis melanocarpa*, state special concern), upland boneset (*Eupatorium sessilifolium*, state threatened), goldenseal (*Hydrastis canadensis*, state threatened), northern bayberry (*Myrica pensylvanica*, state threatened), ginseng, tall beak-rush (*Rhynchospora macrostachya*, state special concern), and bald-rush (*Rhynchospora scirpoides*, state threatened). In total, 32 rare plant element occurrences of 18 different species have been recorded within Barry SGA. The site descriptions for natural community EOs include discussion of rare plant populations when they occur within the high-quality natural communities.

Eight rare bird species have been documented in the game area with five rare bird species being recorded during the 2013 breeding season (Table 3). We recorded new occurrences for osprey (*Pandion haliaetus*, state special concern) and marsh wren (*Cistothorus palustris*, state special concern) and updated EOs for common loon (*Gavia immer*, state threatened), cerulean warbler (*Dendroica cerulea*, state threatened) and hooded warbler (*Setophaga citrina*, state special concern). A total of 16 avian SGCN have been documented in Barry SGA, with 13 being recorded during the 2013 breeding season (Table 8). During the course of the project, six rare amphibian and reptile EOs were updated for the following five species: Blanchard's cricket frog (*Acris blanchardi*, state threatened), eastern box turtle (*Terrapene carolina carolina*, state special concern), eastern massasauga (*Sisturus catenatus*, state special concern and federal candidate), and Blanding's turtle (*Emydoidea blandingii*, state special concern) (Table 4). A total of 11 amphibian and reptile SGCN have been documented in the Barry SGA, with eight being recorded during this project (Table 8). We documented a total of 16 rare insects (all SGCN) in the Barry SGA, with four rare insect species being recorded during this project (Table 5). Insect surveys resulted in two new EOs and three updated records. We documented one new record for pine tree cricket (*Oecanthus pini*, state special concern) and updated an existing tamarack tree cricket (*Oecanthus laricis*, state special concern) record during sweep net surveys. Blacklighting surveys resulted in one new record for regal fern borer (*Papaipema speciosissima*, state special concern) and the update of two records for angular spittlebugs (*Lepyronia angulifera*, state special concern). Surveys for unionid mussels resulted in four EOs for slippershell (*Alasmidonta viridis*, state threatened) and ellipse (*Venustaconcha ellipsiformis*, state special concern), both SGCN, and documentation of two additional SGCN mussels, cylindrical papershell (*Anodontoides ferussacianus*) and creek heelsplitter (*Lasmigona compressa*) (Tables 6 and 8). We did not detect invasive zebra mussels (*Dreissena polymorpha*) at any of the survey sites.

Primary management recommendations for the Barry SGA include: 1) invasive species control focused in high-quality natural areas (especially wetland ecosystems), 2) the use of landscape-scale prescribed fire focused in high-quality natural communities and with rotating non-fire refugia where fire-sensitive rare species occur, 3) the opportunistic restoration of oak savanna ecosystems, 4) the maintenance of the canopy closure of mature forest ecosystems, 5) the reduction of fragmentation across the game area but focused in the vicinity of high-quality natural communities and riparian areas, 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 Barry SGA. Although numerous invasive species occur within the game area, the species likely to pose the greatest threats because of their ability to invade and quickly dominate intact natural areas include garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), autumn olive (*Elaeagnus umbellata*), Amur honeysuckle (*Lonicera maackii*), Morrow's honeysuckle (*Lonicera morrowii*), purple loosestrife (*Lythrum salicaria*), reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), glossy buckthorn (*Frangula alnus*), multiflora rose (*Rosa multiflora*), hedge-parsley (*Torilis japonica*), hybrid cat-tail (*Typha* x*glauca*), and narrow-leaved cat-tail (*Typha angustifolia*). Monitoring should be implemented for zebra mussel (*Dreissena polymorpha*). Invasive species management at Barry SGA should focus on controlling populations of pernicious invasive species within high-quality natural communities and also in the surrounding landscape. 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. The primary mechanisms for reducing invasive species are landscape-scale prescribed fire and targeted prescribed fire and spot treatment through cutting and/or herbicide application and biocontrol within priority high-quality natural community EOs.

Much of the land within Barry SGA historically supported fire-dependent ecosystems, such as oak openings, oak barrens, dry-mesic southern forest, dry southern forest, wet prairie, prairie fen, and southern wet meadow. 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, open oak savanna and oak barrens have converted to closed-canopy forests dominated by shade-tolerant native and invasive species and fire-suppressed wetlands such as prairie fen, wet prairie, and southern wet meadow are becoming degraded due to woody encroachment or have converted to shrub-carr and swamp forests. This conversion of fire-dependent open savanna ecosystems to closed-canopy forest and open wetland to shrub- or tree-dominated systems typically results in significant reductions in diversity at the species and habitat levels. Many of the rare species documented in Barry SGA and the surrounding area depend on these fire-dependent habitats. In addition, due to fire suppression, closed-canopy forests within Barry SGA are experiencing strong regeneration of thin-barked, shade-tolerant mesophytic trees and invasive shrubs and failure of oak to regenerate.

Within 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. Regular prescribed fire management within open wetlands can help reduce native woody cover and invasive species and also promote high species diversity. Efforts to restore oak barrens and oak savanna within Barry SGA will depend on the implementation of frequent prescribed fire. Savanna ecosystems in Barry SGA were historically concentrated in the northern portion of the game area on the Battle Creek Outwash Plain. Although no high-quality oak barrens or oak openings were documented during surveys, numerous plant and animal species associated with oak savanna ecosystems persist in Barry SGA, including numerous rare plants and rare insect species. Pursuing restoration of oak savanna remnants is recommended because these rare ecosystems support a high-level of biodiversity and numerous rare species.

We recommend the implementation of prescribed fire at a landscape-scale and the creation of large burn units (e.g., several hundred to one thousand acres in size). We recommend that prescribed fire be prioritized for high-quality, underrepresented, fire-dependent natural communities (e.g., prairie fen, wet prairie, wet-mesic prairie, and oak savanna) and immediately adjacent systems. Where rare invertebrates and 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

Barry SGA supports over 10,000 acres of forest and close to 800 acres of high-quality forest. The large area of forest within the game area serves as an important island of biodiversity for the local region, which is dominated by agricultural lands. Maintaining the canopy of mature forest and avoiding additional forest fragmentation will help ensure that high-quality habitat remains for the diverse array of plants and animals, including the many rare species and SGCN that utilize this forested island. Dampening the effects of forest fragmentation within this landscape can be realized by decreasing forest harvest levels, halting the creation of new wildlife openings within forested landscapes, closing redundant forest roads, and limiting the creation of new roads. In addition, conversion of wildlife openings and old agricultural fields to forest and other native habitats such as oak savanna also contributes to increase of forest and native habitat connectivity and decrease in forest fragmentation. We recommend that efforts to reduce fragmentation be concentrated in the vicinity of existing high-quality natural communities and along riparian corridors.

In general, prioritization of stewardship within Barry SGA should focus on the highest-quality examples of the rarest natural community types. Biodiversity is most easily and effectively protected by preventing high-quality sites from degrading. Within Barry SGA, we recommend the following: 1) that stewardship efforts be focused on rare wetland communities that harbor high levels of biodiversity and provide habitat for numerous rare plant and animal species; 2) that management efforts focus on sites along riparian corridors and complexes that support numerous high-quality natural communities, especially adjacent wetland and upland ecosystems; and 3) that canopy closure be maintained in the highest-quality and largest forest ecosystems. Critical to any effective management strategy is the adaptive capacity to modify stewardship activities and priorities following monitoring.

Restoration of prairie fen, wet prairie, and wet-mesic prairie associated with Turner Creek is a high priority. Photo by Michael A. Kost.

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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.

Appendix 2. List of amphibian and reptile species known to occur or with potential to occur in Barry State Game Area. Each species' status at federal and state levels and within the game area is provided along with general habitat associations.

						Status in Barry SGA			
Amphibian/ Reptile	**Common Name[1,3]**	**Scientific Name[1]**	**US Status**	**State Status**	**WAP SGCN[2]**	**Survey Target Species**	**Found in 2013**	**Found Prior to 2013**	**General Habitats[3,4]**
Amphibian	Mudpuppy	*Necturus maculosus maculosus*			X				Permanent waters - rivers, reservoirs, inland lakes, Great Lakes bays and shallows
Amphibian	Western Lesser Siren^	*Siren intermedia nettingi*		SC	X				Shallow, weedy ponds, lakes and lake inlets, ditches, and sluggish streams.
Amphibian	Eastern Newt / Central Newt	*Notophthalmus viridescens louisianensis*							Small, permanent ponds, temporary ponds, and shallows of large lakes, river sloughs and backwaters with abundant aquatic vegetation
Amphibian	Blue-spotted Salamander	*Ambystoma laterale*			X				Deciduous and coniferous forests from moist bottomlands to dry uplands; ponds that retain water into midsummer essential
Amphibian	Spotted Salamander	*Ambystoma maculatum*							Moist closed canopy deciduous or mixed forests, temporary/semi-permanent ponds within or adjacent to woods. Avoid cutover forests and those subject to flooding.
Amphibian	Marbled Salamander^	*Ambystoma opacum*		E	X				Various moist wooded habitats near swamps, floodplains, and vernal pools. Require vernal pools and other seasonally flooded habitats for breeding. Fossorial species - spend most of their lives underground except for breeding and egg-laying in the fall.
Amphibian	Eastern Tiger Salamander	*Ambystoma tigrinum*			X				Forests, marshes, and grasslands; breeding - permanent and semi-permanent ponds
Amphibian	Eastern Red-backed Salamander	*Plethodon cinereus*							Deciduous, coniferous, and mixed forests
Amphibian	Four-toed Salamander	*Hemidactylium scutatum*			X				Moist deciduous, coniferous, or mixed forests, usually in vicinity of spring-fed creeks, sphagnum seepages, bogs, or boggy ponds
Amphibian	Eastern American Toad	*Anaxyrus [Bufo] americanus americanus*					X	X	Open forests, forest edges, prairies, marshes, and meadows

Appendix 2. List of amphibian and reptile species known to occur or with potential to occur in Barry State Game Area. Each species' status at federal and state levels and within the game area is provided along with general habitat associations.

						Status in Barry SGA			
Amphibian/ Reptile	**Common Name[1,3]**	**Scientific Name[1]**	**US Status**	**State Status**	**WAP SGCN[2]**	**Survey Target Species**	**Found in 2013**	**Found Prior to 2013**	**General Habitats[3,4]**
Amphibian	Blanchard's cricket frog	*Acris blanchardi*		T	X	X	X	X	Open, muddy edges of permanent ponds, lakes, bogs, and slow-moving streams or rivers with abundant aquatic vegetation, including fens and wet or sedge meadows
Amphibian	Spring Peeper	*Pseudacris crucifer*					X	X	Temporary and permanent ponds, marshes, floodings, and ditches, as well as forests, old fields, shrubby areas
Amphibian	Western Chorus Frog	*Pseudacris triseriata*			X			X	Marshes, wet meadows, swales, and other open habitats, also mesic forests and swamp forests
Amphibian	Gray Treefrog	*Hyla versicolor/Hyla chrysoscelis*					X	X	Temporary ponds, swamps, floodings, shallow edges of permanent lakes, and sloughs, surrounded by forested or open habitats
Amphibian	American Bullfrog	*Lithobates [Rana] catesbeianus*					X	X	Permanent waterbodies - river backwaters, sloughs, lakes, farm ponds, impoundments, marshes, shallow Great Lakes bays; abundant emergent and submergent vegetation
Amphibian	Green Frog	*Lithobates [Rana] clamitans*					X	X	Ponds, lakes, swamps, sloughs, impoundments, and slow streams
Amphibian	Pickerel Frog	*Lithobates [Rana] palustris*			X		X	X	Bogs, fens, ponds, streams, springs, sloughs, and lake coves; cool clear waters, grassy stream banks
Amphibian	Northern Leopard Frog	*Lithobates [Rana] pipiens*			X		X	X	Open wetland habitats including marshes, bogs, lake and stream edges, and sedge meadows, and adjacent open uplands including hay fields, lawns; breed in shallow temporary ponds, stream backwaters, and marsh pools
Amphibian	Wood Frog	*Lithobates [Rana] sylvaticus*					X	X	Moist, forested habitats (deciduous, coniferous, and mixed); breeding - vernal ponds, floodings, forested swamps, and quiet stream backwaters
Reptile	Snapping Turtle	*Chelydra serpentina*							Permanent waterbodies including shallow, weedy Great Lakes inlets and bays; muddy ponds, lakes, sloughs and slow streams with dense aquatic vegetation

Appendix 2. List of amphibian and reptile species known to occur or with potential to occur in Barry State Game Area. Each species' status at federal and state levels and within the game area is provided along with general habitat associations.

						Status in Barry SGA			
Amphibian/ Reptile	**Common Name[1,3]**	**Scientific Name[1]**	**US Status**	**State Status**	**WAP SGCN[2]**	**Survey Target Species**	**Found in 2013**	**Found Prior to 2013**	**General Habitats[3,4]**
Reptile	Eastern Musk Turtle	*Sternotherus odoratus*					X	X	Permanent waterbodies - ponds, lakes, marshes, sloughs, rivers; highly aquatic
Reptile	spotted turtle	*Clemmys guttata*		T	X	X		X	Shallow ponds, wet meadows, tamarack swamps, bogs, fens, marshes, sphagnum seepages, slow streams; require clear shallow water with mud/muck bottom and ample aquatic and emergent vegetation
Reptile	eastern box turtle	*Terrapene carolina carolina*		SC	X	X	X	X	Deciduous or mixed forests, esp. with sandy soils, also adjacent old fields, pastures, dunes, marshes, and bog edges
Reptile	Blanding's Turtle	*Emydoidea blandingii*		SC	X	X		X	Shallow, weedy waters - ponds, marshes, forested and shrub swamps, wet meadows, lake inlets and coves, rivers backwaters, embayments, sloughs, vernal pools
Reptile	Northern Map Turtle	*Graptemys geographica*						X	Larger lakes, rivers, reservoirs, oxbow sloughs, open marshes, Great Lakes bays and inlets; also smaller lakes and streams and ponds
Reptile	Painted Turtle	*Chrysemys picta*						X	Quiet, slow-moving permanent water bodies with soft bottom substrates, abundant aquatic vegetation, and basking sites; temporarily occupy vernal ponds, imoundments, ditches and faster streams and rivers
Reptile	Eastern Spiny Softshell	*Apalone spinifera spinifera*							Rivers and larger streams, inland lakes, reservoirs, protected Great Lakes bays and river mouths; often with sandy or muddy bottoms, and open with little aquatic vegetation
Reptile	Five-lined Skink	*Plestiodon [Eumeces] fasciatus*							Moist but not wet, forested or partially forested habitats with ample cover and basking sites - stumps, logs, rock outcrops, wood or brush piles, sawdust piles, fallen bark; moist not wet habitats
Reptile	Kirtland's Snake*	*Clonophis kirtlandii*		E	X				Various moist habitats, including wet meadows/prairies, tamarack swamps, prairie fens, open swamp forests, and vacant city lots.

Appendix 2. List of amphibian and reptile species known to occur or with potential to occur in Barry State Game Area. Each species' status at federal and state levels and within the game area is provided along with general habitat associations.

Amphibian/ Reptile	Common Name[1,3]	Scientific Name[1]	US Status	State Status	WAP SGCN[2]	Status in Barry SGA: Survey Target Species	Status in Barry SGA: Found in 2013	Status in Barry SGA: Found Prior to 2013	General Habitats[3,4]
Reptile	Northern Water Snake	*Nerodia sipedon sipedon*					X	X	Permanent water bodies - rivers, streams sloughs, lakes, ponds, bogs, marshes, swamps, wet meadows, impoundments; also utilize shallow, small temporary ponds and wetlands including vernal pools and shrub swamps
Reptile	Queen Snake*	*Regina septemvittata*		SC	X				Warm, shallow, rocky-bottomed streams with abundance of crayfish; also edges of ponds, lakes, marshes, ditches and canals, open to mostly forested but totally shaded sites are avoided; often bask at water's edge or in overhanging shrubbery or tree branches.
Reptile	Brown Snake	*Storeria dekayi*						X	Variety of habitats from dense forests and shrubby habitatss to open prairies, meadows, and marshes; prefer areas with moist soils but also found on dry hillsides, pine forests, and railroad embankments
Reptile	Northern Red-bellied Snake	*Storeria occipitomaculata occipitomaculata*							Deciduous or mixed forests, and adacentj fields, pastures, road embankments, marshes and sphagnum bogs
Reptile	Eastern Garter Snake	*Thamnophis sirtalis sirtalis*					X	X	Almost any natural habitats - open and forested habitats and moist grassy places - edges of ponds, lakes, streams ditches,
Reptile	Northern Ribbon Snake	*Thamnophis sauritus septentrionalis*					X	X	Edges of lakes, ponds, streams, marshes, especially with grasses, sedges and low shrubs, open sunny areas/habitats
Reptile	Northern Ring-necked Snake	*Diadophis punctatus edwardsii*			X				Moist, shady forests and adjacent open habitats including old fields, grassy dunes; often found under leaf litter or cover or in burrows
Reptile	Eastern Hog-nosed Snake	*Heterodon platirhinos*			X		X	X	All types of terrestrial habitats - from open pine or deciduous forests to old fields, meadows, and pastures. Prefer sandy, well-drained soils.
Reptile	Blue Racer	*Coluber constrictor foxii*			X		X	X	Dry sunny, open habitats with access to cover - old fields, hedgerows, shrub thickets, open forests, forest edges, also grassy lake borders and marshes

Appendix 2. List of amphibian and reptile species known to occur or with potential to occur in Barry State Game Area. Each species' status at federal and state levels and within the game area is provided along with general habitat associations.

						Status in Barry SGA			
Amphibian/ Reptile	**Common Name[1,3]**	**Scientific Name[1]**	**US Status**	**State Status**	**WAP SGCN[2]**	**Survey Target Species**	**Found in 2013**	**Found Prior to 2013**	**General Habitats[3,4]**
Reptile	Gray Rat Snake*	*Pantherophis spiloides*		SC	X			X	In or near forests, and adjacent open habitats - shrubby fields, pastures, marsh and bog edges
Reptile	Eastern Milk Snake	*Lampropeltis triangulum triangulum*							Open forests, bogs, swamps, forest edges, marshes, lakeshores, old fields, and pastures
Reptile	Smooth Green Snake	*Opheodrys vernalis*			X				Moist grassy places including prairie remnants and savannahs, meadows, old fields, pastures, roadsides, marsh and lake edges, also open deciduous and pine forests
Reptile	eastern massasauga	*Sistrurus catenatus catenatus*	C	SC	X	X	X	X	Open and forested wetlands including shrub swamps, bogs, fens, marshes, wet or sedge meadows, moist prairie, and forested swamps, and adjacent open and forested upland habitats including prairies, old fields, meadows, shrub thickets, and deciduous, coniferous, and mixed forests.

Key to abbreviations:
C = federal candidate; E = state endangered; T = state threatened; SC = state special concern; and SGCN = species of greatest conservation need in Michigan Wildlife Action Plan.

^Barry SGA is outside of but close to known range for species, so potential exists for species to occur in Barry SGA. However, species has not been documented in Michigan for 30+ years.

*Rare species not targeted for surveys in 2013 due to low likelihood of detecting the species given available methods and resources for surveys.

Listed/rare amphibian and reptile species and/or SGCN targeted for surveys in Barry SGA in 2013 and documented during surveys in 2013 and/or prior to 2013.

Additional listed/rare amphibian and reptile species and/or SGCN that have been documented in Barry SGA during surveys in 2013 and/or prior to 2013.

Additional amphibian and reptile species that have been documented in the Barry SGA during MNFI surveys in 2013 and/or prior to 2013.

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[1]Crother, B. I. (ed.). 2012. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding. SSAR Herpetological Circular 39:1-92.

[2]Eagle, A.C., E.M. Hay-Chmielewski, K.T. Cleveland, A.L. Derosier, M.E. Herbert, and R.A. Rustem, eds. 2005. Michigan's Wildlife Action Plan. Michigan Department of Natural Resources, Lansing, Michigan. 1592 pp.

[3]Harding, J.H. 1997. Amphibians and Reptiles of the Great Lakes Region. The University of Michigan Press, Ann Arbor, MI. 378 pp.

[4]Harding, J.H. and J.A. Holman. 1992. Michigan Frogs, Toads, and Salamanders. Michigan State University, Cooperative Extension Service, East Lansing, MI. 144 pp.

Appendix 3. 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 _____

_____

Appendix 3. State Lands Inventory Special Animal Survey Form - Herps

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

Appendix 4. List of bird species detected during 49 point counts conducted in forested areas of Barry State Game Area during 2013. State status (E = endangered, T = threatened, and SC = special concern) and the proportion of points having observations are provided for each species. Bird species considered species of greatest conservation need (SGCN) and Michigan Department of Natural Resources featured species are indicated with an "X."

Common Name	Scientific Name	State Status	SGCN	Featured Species	Proportion of Points with Detections
Acadian flycatcher	*Empidonax virescens*		X		0.63
American crow	*Corvus brachyrhynchos*				0.14
American goldfinch	*Spinus tristis*				0.08
American redstart	*Setophaga ruticilla*				0.14
American robin	*Turdus migratorius*				0.35
Barred owl	*Strix varia*				0.06
Black-billed cuckoo	*Coccyzus erythropthalmus*		X		0.06
Black-capped chickadee	*Poecile atricapillus*				0.06
Blue grosbeak	*Passerina caerulea*				0.02
Blue jay	*Cyanocitta cristata*				0.33
Blue-headed vireo	*Vireo solitarius*				0.04
Black-throated green warbler	*Setophaga virens*				0.12
Brown-headed cowbird	*Molothrus ater*				0.08
Cedar waxwing	*Bombycilla cedrorum*				0.02
Cerulean warbler	*Setophaga cerulea*	T	X		0.08
Chipping sparrow	*Spizella passerina*				0.02
Downy woodpecker	*Picoides pubescens*				0.14
Eastern towhee	*Pipilo erythrophthalmus*		X		0.08
Eastern wood-pewee	*Contopus virens*				0.71
Great crested flycatcher	*Myiarchus crinitus*				0.20
Hairy woodpecker	*Picoides villosus*				0.10
Hermit thrush	*Catharus guttatus*				0.02
Hooded warbler	*Setophaga citrina*	SC	X		0.27
Indigo bunting	*Passerina cyanea*				0.02
Mourning dove	*Zenaida macroura*				0.04
Northern cardinal	*Cardinalis cardinalis*				0.10
Northern flicker	*Colaptes auratus*		X		0.02
Ovenbird	*Seiurus aurocapilla*				0.61
Pileated woodpecker	*Dryocopus pileatus*			X	0.06
Rose-breasted grosbeak	*Pheucticus ludovicianus*				0.47
Red-bellied woodpecker	*Melanerpes carolinus*				0.27
Red-eyed vireo	*Vireo olivaceus*				0.67
Red-headed woodpecker	*Melanerpes erythrocephalus*		X	X	0.04
Ruby throated hummingbird	*Archilochus colubris*				0.06
Scarlet tanager	*Piranga olivacea*				0.39
Tufted titmouse	*Baeolophus bicolor*				0.49
Turkey vulture	*Cathartes aura*				0.02
Veery	*Catharus fuscescens*				0.35
White-breasted nuthatch	*Sitta carolinensis*				0.22
Wild turkey	*Meleagris gallopavo*			X	0.02
Wood thrush	*Hylocichla mustelina*		X	X	0.25
Worm-eating warbler	*Helmitheros vermivorum*		X		0.02
Yellow-billed cuckoo	*Coccyzus americanus*		X		0.12
Yellow-throated vireo	*Vireo flavifrons*				0.16

Appendix 5. A checklist of Michigan's unionid mussel species found at sites surveyed in Barry State Game Area in 2013. Also noted are species with historical (pre-1960) records from the larger Thornapple River Watershed. Historical records are from the University of Michigan Museum of Zoology Mollusk Collection.

Scientific Name	Common Name	Barry SGA	Pre-1960 records in Thornapple Watershed	State status	Federal status
Actinonaias ligamentina	Mucket		X		
Alasmidonta marginata	Elktoe		X	SC	
Alasmidonta viridis	Slippershell	X	X	T	
Amblema plicata	Threeridge		X		
Anodontoides ferussacianus	Cylindrical papershell	X	X		
Cyclonaias tuberculata	Purple wartyback		X	T	
Elliptio complanata	Eastern elliptio				
Elliptio crassidens	Elephant-ear				
Elliptio dilatata	Spike	X	X		
Epioblasma obliquata perobliqua	White catspaw			E	E
Epioblasma torulosa rangiana	Northern riffleshell			E	E
Epioblasma triquetra	Snuffbox			E	E
Fusconaia flava	Wabash pigtoe	X	X		
Lampsilis fasciola	Wavy-rayed lampmussel			T	
Lampsilis siliquoidea	Fatmucket		X		
Lampsilis ventricosa	Pocketbook		X		
Lasmigona complanata	White heelsplitter				
Lasmigona compressa	Creek heelsplitter	X	X		
Lasmigona costata	Fluted-shell		X		
Leptodea fragilis	Fragile papershell				
Leptodea leptodon	Scaleshell			SC	E
Ligumia nasuta	Eastern pondmussel			E	
Ligumia recta	Black sandshell			E	
Obliquaria reflexa	Three-horned wartyback			E	
Obovaria olivaria	Hickorynut			E	
Obovaria subrotunda	Round hickorynut			E	
Pleurobema clava	Clubshell			E	E
Pleurobema sintoxia	Round pigtoe		X	SC	
Potamilus alatus	Pink heelsplitter				
Potamilus ohiensis	Pink papershell			T	
Ptychobranchus fasciolaris	Kidney-shell			SC	
Pyganodon grandis	Giant floater		X		
Pyganodon lacustris	Lake floater			SC	
Pyganodon subgibbosa	Lake floater			T	
Quadrula pustulosa	Pimpleback				
Quadrula quadrula	Mapleleaf				
Simpsonaias ambigua	Salamander mussel			E	
Strophitus undulatus	Strange floater	X	X		
Toxolasma lividus	Purple lilliput			E	
Toxolasma parvus	Lilliput			E	
Truncilla donaciformis	Fawnsfoot			T	

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Scientific Name	Common Name	Barry SGA	Pre-1960 records in Thornapple Watershed	State status	Federal status
Truncilla truncata	Deertoe			SC	
Utterbackia imbecillis	Paper pondshell			SC	
Venustaconcha ellipsiformis	Ellipse	X	X	SC	
Villosa fabalis	Rayed bean			E	E
Villosa iris	Rainbow		X	SC	