Natural Features Inventory and Management Recommendations for Lost Nation State Game Area

Prepared by:
Joshua G. Cohen, Peter J. Badra, Yu Man Lee, Jesse M. Lincoln,
Michael J. Monfils, and Helen D. Enander

Michigan Natural Features Inventory
P.O. Box 13036
Lansing, MI 48901-3036

For:
Michigan Department of Natural Resources

March 31, 2015

Report Number 2015-05

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Suggested Citation:
Cohen J.G., P.J. Badra, H.D. Enander, Y. Lee, J.M. Lincoln, and M.J. Monfils. 2015. Natural Features Inventory and Management Recommendations for Lost Nation State Game Area. Michigan Natural Features Inventory Report Number 2015-05, Lansing, MI. 118 pp.

Cover Photo: Southern hardwood swamp in Lost Nation State Game Area. Photo by Joshua G. Cohen.

EXECUTIVE SUMMARY

Lost Nation State Game Area (SGA) is a large block of semi-continuous public land in southeast Lower Michigan, consisting of approximately 2,375 acres of Hillsdale County. Lost Nation SGA is important ecologically because it provides critical habitat for a myriad of game and non-game species and supports over 1,900 acres of forest including close to 200 acres of high-quality forest. Because the landscape surrounding Lost Nation 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 and species dependent on mature forest ecosystems. In addition, the numerous and diverse high-quality wetlands, vernal pools, lakes, and streams within the game area support a wide array of rare insects, herptiles, avian, mammalian, plant, and 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 Lost Nation SGA as part of the Integrated Inventory Project for the Michigan Department of Natural Resources Wildlife Division. Surveys resulted in 20 new element occurrences (EOs) and provided information for updating an additional seven EOs. In all, 28 species of greatest conservation need (SGCN) and 15 rare animal species have been recorded in Lost Nation SGA with 20 SGCN and seven rare animal species documented during the course of this project. In total, 36 EOs have been documented in Lost Nation SGA including 16 animal EOs, 7 plant EOs, and 13 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). Lost Nation SGA supports 13 high-quality natural community EOs that include eight different natural community types. During the summers of 2012 and 2013, MNFI ecologists documented 12 new high-quality natural communities and also updated one known high-quality community EO. A total of eight different natural community types were surveyed in 2012 and 2013 including: bog (1 EO), cave (1 EO), dry-mesic southern forest (3 EOs), inundated shrub swamp (1 EO), mesic southern forest (2 EOs), prairie fen (3 EOs), southern hardwood swamp (1 EO), and submergent marsh (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 the natural community EOs also include discussion of rare plant populations documented within the high-quality natural communities. During the course of this project, we documented six new rare plant EOs for black-haw (*Viburnum prunifolium*, state special concern).

In 2014, 81 potential vernal pools were identified and mapped from aerial photo interpretation, and 20 vernal pools were surveyed and verified in the field. These survey and mapping results provide baseline information on vernal pool status, distribution, and ecology in the Lost Nation SGA, which will help natural resource planners and managers develop and implement appropriate management of these wetlands.

Surveys for rare avian species included point-counts for forest songbirds and red-shouldered hawks (*Buteo lineatus*, state threatened). We conducted morning surveys for rare songbirds at 21 point-count locations within forest. These surveys resulted in updated records for the three rare bird species that occur in Lost Nation SGA: Louisiana waterthrush (*Parkesia motacilla*, state threatened), hooded warbler (*Setophaga citrina*, state special concern), and cerulean warbler (*Setophaga cerulea*, state threatened), a focal species of the DNR's Wildlife Action Plan. Point-count surveys resulted in the documentation of 41 bird species including nine SGCN: black-billed cuckoo (*Coccyzus erythropthalmus*), yellow-billed cuckoo (*Coccyzus americanu*s), Acadian flycatcher (*Empidonax virescens*), wood thrush (*Hylocichla mustelina*), northern parula (*Setophaga americana*), cerulean warbler, Louisiana waterthrush, hooded warbler, and eastern towhee (*Pipilo erythrophthalmus*). A total of three rare bird species have been documented in the game area with all three being recorded during the 2014 breeding season.

We conducted visual encounter or meander surveys, basking surveys, dipnetting, aquatic funnel trapping, and breeding frog call surveys for rare amphibians and reptiles. Surveys and incidental observations by MNFI staff resulted in two new herptile EOs for Blanchard's cricket frog (*Acris blanchardi*, state threatened) and one updated record for Blanding's turtle (*Emydoidea blandingii*, state special concern). Breeding call surveys documented two new EOs of Blanchard's cricket frog. Visual encounter and basking surveys in 2014 documented Blanding's turtles. Herptile surveys resulted in the

documentation of four additional SGCN: blue-spotted salamander (*Ambystoma laterale*), spotted salamander (*Ambystoma maculatum*), northern leopard frog (*Lithobates pipiens*), and western chorus frog (*Pseudacris triseriata*). Visual encounter and basking surveys in 2014 were not able to reconfirm the occurrence of the copperbelly water (*Nerodia erythrogaster neglecta*, state endangered and federally threatened), in Lost Nation SGA. A total of seven amphibian and reptile SGCN have been documented in the Lost Nation SGA, with six being recorded during this project. In addition, three rare herptile species have been documented in the game area with two rare herptile species being recorded since 2014 by MNFI staff.

Four insect EOs of four different state special concern insect species are known from Lost Nation SGA including tamarack tree cricket (*Oecanthus laricis*), swamp metalmark (*Calephelis mutica*), Kansas prairie leafhopper (*Dorydiella kansana*), and wild indigo duskywing (*Erynnis baptisiae*). These four species are all currently listed as SGCN and tamarack tree cricket is a focal species of the DNR's Wildlife Action Plan.

Two rare bat species have been recorded within the Lost Nation SGA, Indiana bat (*Myotis sodalis*, state and federally endangered) and northern long-eared bat (*Myotis septentrionalis*, proposed to be listed as state threatened and federally endangered). Both bat species are SGCN and focal species of the DNR's Wildlife Action Plan.

We performed surveys for unionid mussels at five sites in the East Branch of the St. Joseph River (Maumee). Of the 22 mussel species known to occur in the St. Joseph River (Maumee) 10 were found in this survey including two rare mussels and four SGCN. Results included documenting one new EO for lilliput (*Toxolasma parvum*, state endangered) and updating two slippershell (*Alasmidonta viridis*, state threatened) EOs with four new locations for the species within the game area. In addition to slippershell and lilliput, round pigtoe (*Pleurobema sintoxia*, state special concern) has also been documented within the game area. Aquatic surveys in 2014 also documented three additional SGCN: cylindrical papershell (*Anodontoides ferussacianus*), creek heelsplitter (*Lasmigona compressa*), and big water crayfish (*Cambarus robustus*). Lost Nation SGA supports three rare aquatic species and a total of six aquatic SGCN.

Primary management recommendations for the Lost Nation SGA include 1) invasive species control focused in high-quality natural areas (especially wetland ecosystems), 2) the maintenance of the canopy closure of mature forest ecosystems, 3) the reduction of fragmentation and promotion of connectivity across the game area but focused in the vicinity of wetlands, riparian areas, and high-quality natural communities, 4) 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, 5) the protection of the cave, which is the sole documented cave in Lower Michigan; 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

Funding for this project was provided by the Michigan Department of Natural Resources (DNR) Wildlife Division (WD). We express our sincere gratitude to the numerous DNR staff that helped administer and guide this project including Michael Donovan, Patrick Lederle, Ann LeClaire-Mitchell, Steve Beyer, Christine Hanaburgh, Mark MacKay, Kristin Bissell, Tim Payne, and Jesse Bramer. In addition to the authors, this report relies on data collected by many present and former Michigan Natural Features Inventory (MNFI) field scientists, especially: Mike Kost, Mike Penskar, Ryan O'Connor, Aaron Kortenhoven, Mike Sanders, Jeff Lee, and Bradford Slaughter. For their support and assistance throughout this project, we thank our MNFI colleagues, especially Rebecca Rogers, Ed Schools, Kraig Korroch, Sue Ridge, Nancy Toben, Brian Klatt, and Dave Cuthrell. We gratefully acknowledge the editorial assistance provided by Dave Cuthrell, and Brian Klatt.

Mesic southern forest, Lost Nation State Game Area. Photo by Joshua G. Cohen.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

INTRODUCTION

Lost Nation State Game Area (SGA) is a large block of semi-continuous public land in southeast Lower Michigan, consisting of approximately 2,375 acres of Hillsdale County. Lost Nation SGA is important ecologically because it provides critical habitat for a myriad of game and non-game species and supports over approximately 1,900 acres of forest. Because the landscape surrounding Lost Nation 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, vernal pools, lakes, and streams within the game area support a wide array of rare insects, herptiles, avian, mammalian, 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. Within Hillsdale County, natural cover constitutes just 32% of the county. In comparison, natural cover constitutes approximately 92% of Lost Nation SGA. Prior to this project, numerous rare species and a high-quality natural community had been documented in Lost Nation SGA (Tables 1-6). Before 2011, 16 element occurrences (EOs) had been documented for Lost Nation SGA composed of 15 rare species occurrences and a high-quality natural community. Of those rare species occurrences, one was a rare plant, three were aquatic EOs, four were insect EOs, two were herptile EOs, three were bird EOs, and two were bat EOs. Fourteen species were represented by these occurrences and one natural community type (Tables 1-6).

From 2012 to 2014, 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 Lost Nation 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 Lost Nation SGA, summarizes the findings of MNFI's surveys of Lost Nation 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. Lost Nation SGA lies within the Washtenaw subsection (Subsection VI.1), and within one sub-subsection, the Ann Arbor Moraines (Sub-subsection VI.1.2) (Figure 2).

Washtenaw

The Washtenaw subsection is located in southeastern Lower Michigan and is characterized by glacial lakeplain, ground moraine, end moraine, and outwash plain. This subsection is characterized by the longest growing season in the state. The growing season ranges from approximately 130 days inland to 180 days along Lake Erie and Lake St. Clair in the east (Eichenlaub et al. 1990). Total annual precipitation averages between 28 and 36 inches, and total snowfall averages 30 to 50 inches. Surface glacial deposits, which are as thick as 300 feet near the inland margin of the subsection and locally less than 5 feet near the Lake Erie shoreline, are underlain by Pennsylvanian, Mississippian, Devonian, and Silurian marine and nearshore bedrock, including sandstone, shale, coal, marine limestone and dolomite, and gypsum and other evaporites (Dorr and Eschman 1970, Milstein 1987). Prevalent soils include sands, sandy loams, and loamy sands. Loams with clayey soils occur locally in areas of lakeplain. Prevalent vegetation types within this region historically included beech-sugar maple forest, oak savanna, swamp forest, wet prairie, and coastal marshes. The subsection has some of the most intensive urban, industrial, and agricultural land use in the state and much of the prairie, savanna, and coastal marshes have been eliminated or degraded. Remaining natural cover within this subsection is primarily fire suppressed oak-dominated forest (Albert 1995).

Ann Arbor Moraines

The Ann Arbor Moraines (VI.1.2) is a long, narrow band (120 miles long and 20 to 24 miles wide) of fine- and medium-textured end moraines and ground moraines bordered by flat lakeplain on the east and sandy outwash, end moraine, and ice-contact features to the west (Figure 3). The loamy ground moraines and end moraines occur as narrow parallel bands. Over 80% of the broad ground moraines are flat to gently rolling, with slopes in the 0 to

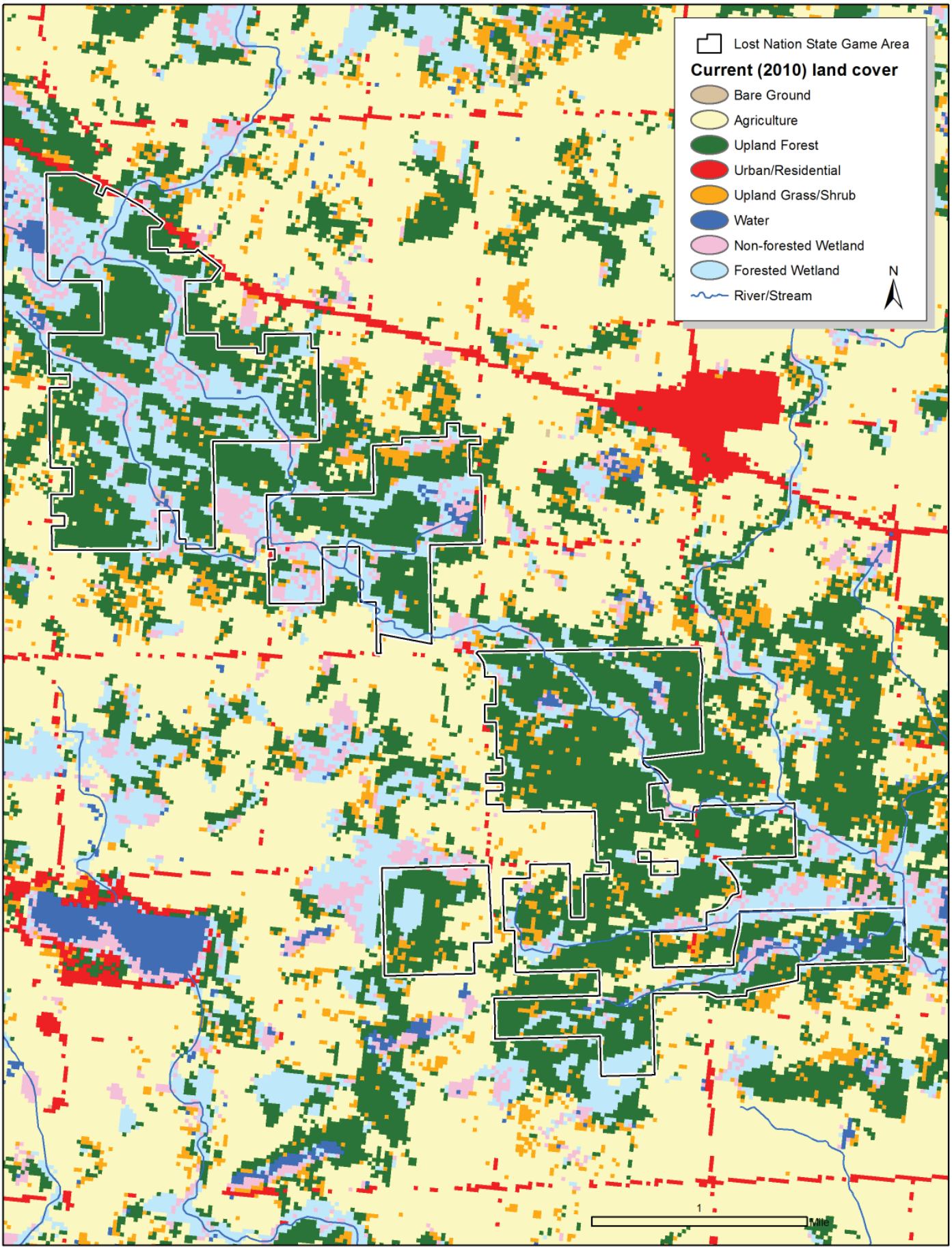


Figure 1. Current land cover of Lost Nation State Game Area.

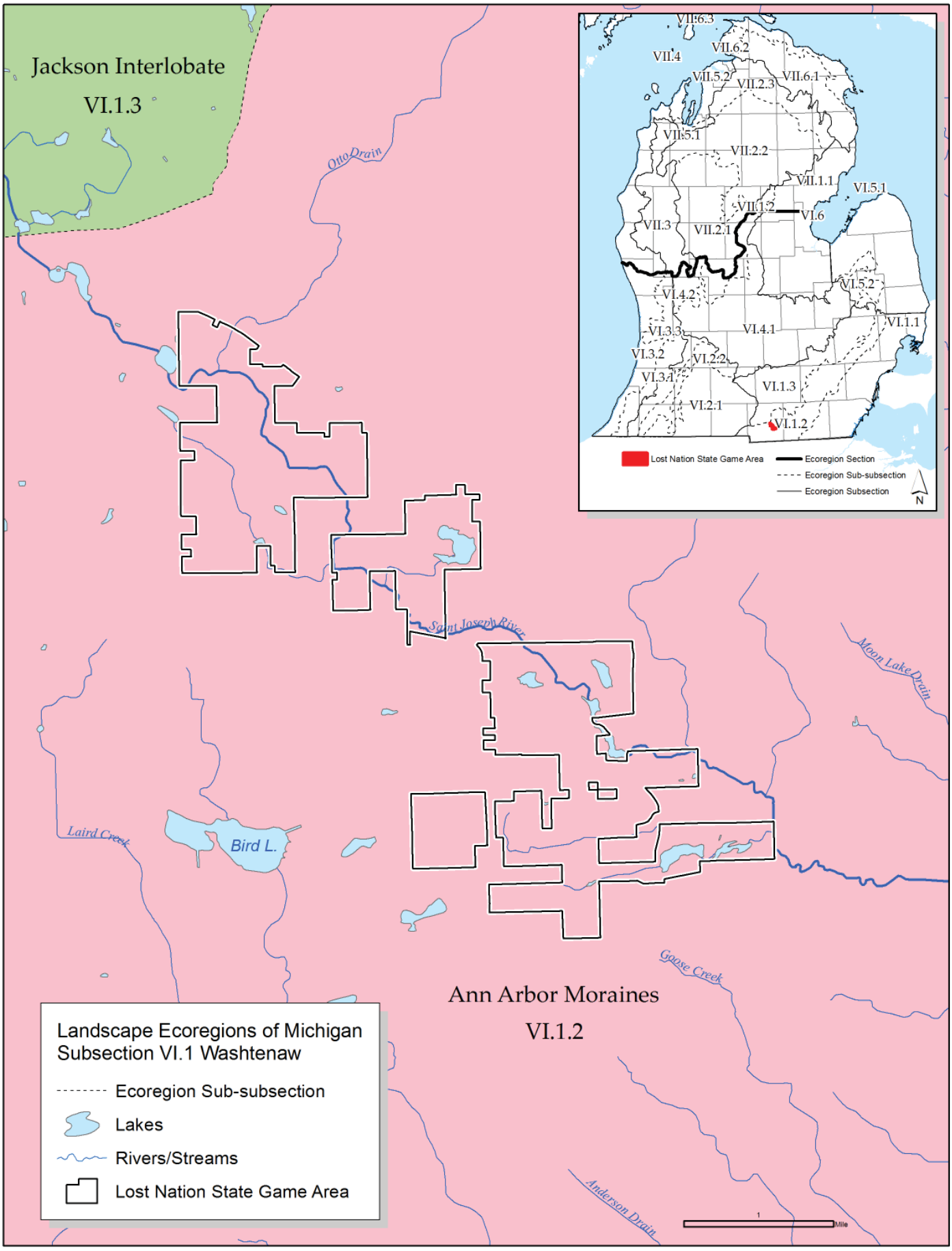


Figure 2. Ecoregions of Lost Nation State Game Area (Albert 1995)

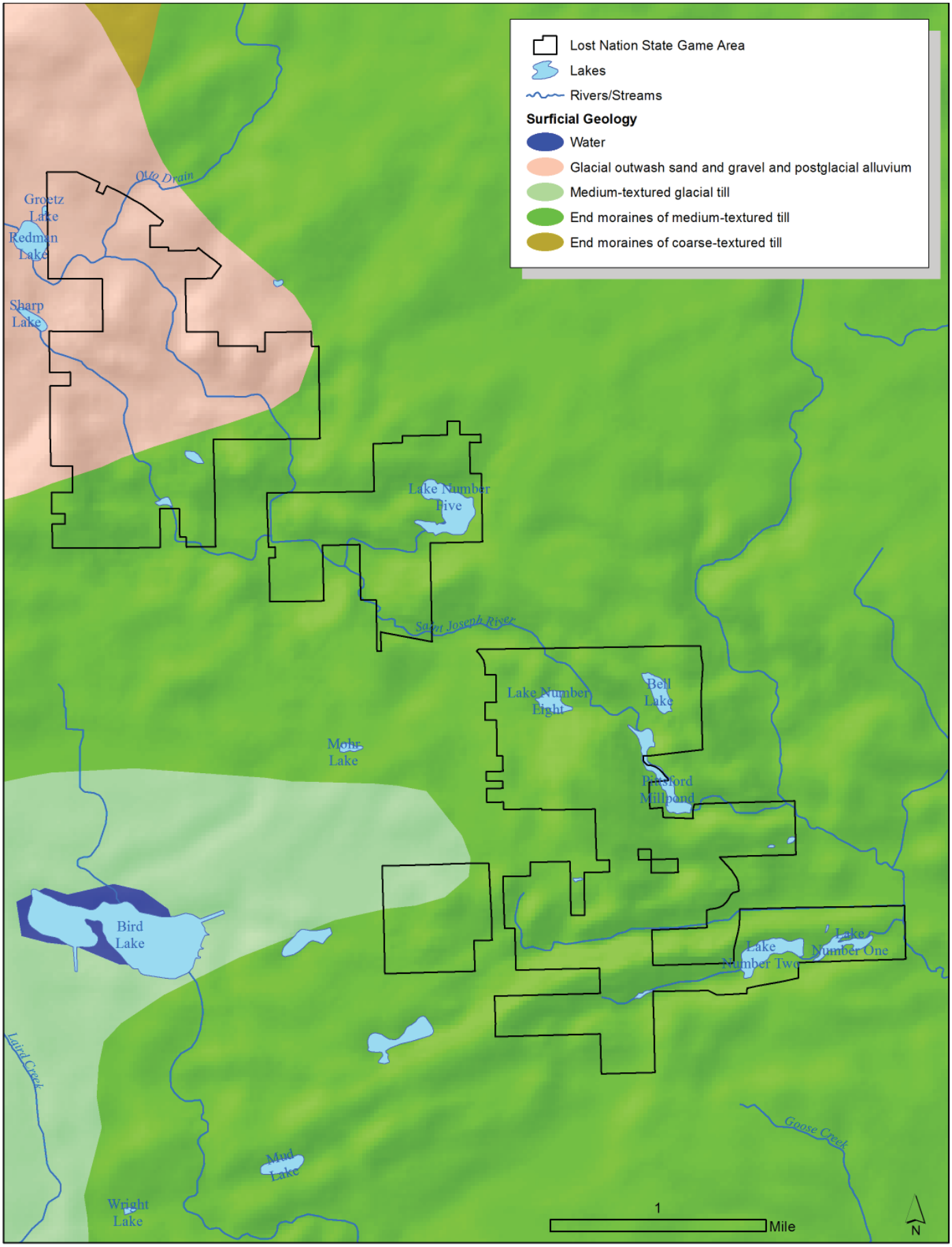


Figure 3. Surficial geology and relief of Lost Nation State Game Area (Farrand and Bell 1982, USGS 2009).

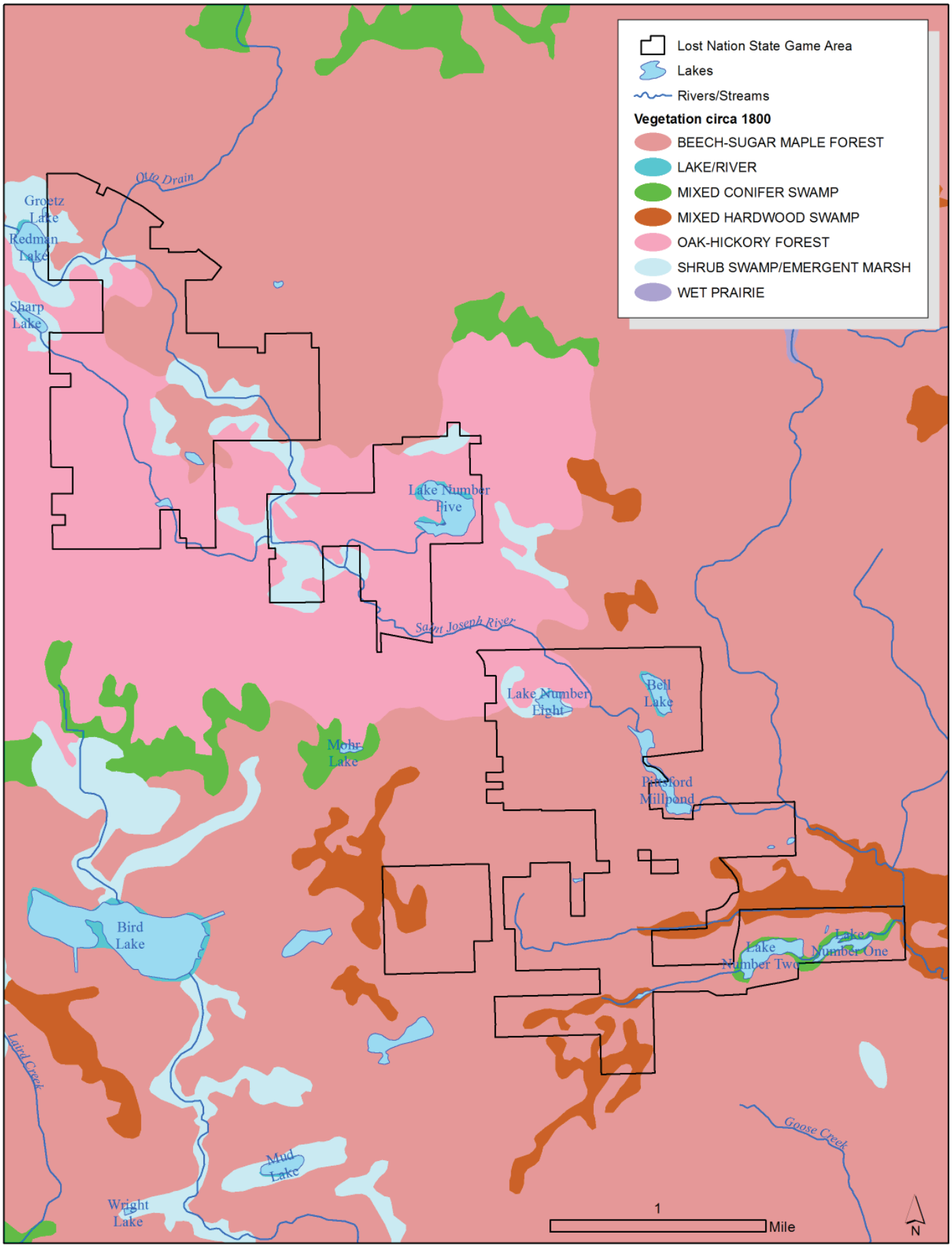


Figure 4. Circa 1800 vegetation of Lost Nation State Game Area (Comer et al. 1995).

6% slope class. Individual hills of the ground moraine are several miles in area, but are seldom higher than 80 feet. The topography of the end moraines is more rolling, with slopes in the 7 to 15% slope class; less than 1% of the end moraines have slopes greater than 15%. End moraine ridges can be distinct ridges one to several miles across and several miles long, or they can be broken into several smaller ridges separated by glacial outwash channels and postglacial drainages. Most of the end moraine ridges are 30 to 80 feet high; the highest ridges, about 170 feet high, are located at the northern edge of the sub-subsection. Few lakes occur within this region but there are numerous streams and headwater streams and several major rivers (i.e., the Huron River and Raisin River) and vernal pools are abundant within the forested ecosystems. The East Branch of the St. Joseph River is the primary waterway of Lost Nation SGA. This stream is part of the Maumee River watershed, which flows into Lake Erie. Soils are primarily loams and sandy loams with fine-textured soils, mainly silt loams and clay loam, occurring along the eastern margin of the sub-subsection. Poorly drained mineral soils are common on lower slopes of ground moraines and organic soils are restricted to outwash channels.

Historically areas of well-drained moraine with medium-textured loams and sandy loams supported oak and oak-hickory forests. Drier ridge tops supported dry southern forest and oak woodland locally. Oak savannas occurred within the sub-subsection along the western edge where fires from sub-subsection VI.1.3 where carried by westerly winds. Localized patches of beech-sugar maple forest were restricted to moraines with fine-textured silt loams and clay loams. These mesic southern forests occurred on well drained, irregular end moraines at the northeastern portion of the sub-subsection and on relatively flat and wet areas of ground moraine in the southeastern end of the sub-subsection. Swamp forests, which included southern hardwood swamp and to a lesser extent hardwood-conifer swamp, were common along the lower slope positions on both ground and end moraines. Localized areas of floodplain forest occur along the rivers and larger streams. Poorly drained outwash channels supported open wetlands including southern wet meadow, wet prairie, shrub swamp, and prairie fen. Agricultural use of lands within the Ann Arbor Moraines has been extensive. Almost all of the ground moraines have been farmed with most of the land having been cleared for agriculture by the mid-nineteenth century. Areas that remain forested include the steeper upland ridges and lowlands with poor drainage conditions. Oak-hickory forest is the most prevalent current forest type and typically persists in small woodlots, usually less than 40 acres in size (Albert 1995).

Circa 1800s Vegetation and Cultural History

Interpretations of the General Land Office (GLO) surveyor notes by MNFI ecologists indicated that the Lost Nation 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 Lost Nation SGA. Areas of steep end moraine, rolling ground moraine, and ice-contact ridges supported beech-sugar maple forest (Beech, Sugar Maple, Basswood) and oak-hickory forest (White Oak, Black Oak, Hickory), the two most prevalent cover types within the game area (covering 58% and 28% of the game area at the time of the GLO survey, respectively).

Abundant tree species recorded in this area by the GLO surveyors in the uplands classified as beech-sugar maple forest included beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), white oak (*Quercus alba*), ironwood (*Ostrya virginiana*), basswood (*Tilia americana*), and red oak (*Quercus rubra*). Less frequently recorded trees were tulip tree (*Lireodendron tulipifera*), white ash (*Fraxinus americana*), and American elm (*Ulmus americana*). The southern half of the game area and the northwestern portion of the northern half of the game area were mapped as beech-sugar maple forest (Figure 4). Within the areas classified as beech-sugar maple forest, recorded diameters of trees ranged widely from 10 to 121 cm (4-48 in) with an average of 41 cm (16 in, N = 97).

Within the uplands classified as oak-hickory forest, abundant tree species recorded by the GLO surveyors included white oak, red oak, hickory (*Carya* spp.), and beech. Less frequently recorded trees were black cherry (*Prunus serotina*), white ash, and American elm. The southwestern half of the northern portion of the game area was mapped as oak-hickory forest (Figure 4). Within the areas classified as oak-hickory forest, recorded diameters of trees ranged widely from 15 to 142 cm (6-56 in) with an average of 42 cm (16in, N = 37).

Within the southern portion of the game area, the GLO surveyors noted a large area of windthrow and wildfire with regenerating forest and “naughty briars and vines”. Trees within this disturbed forest were much smaller and included many shade-intolerant and mid-tolerant species including elm, black cherry, basswood, ash, red oak, paper birch (*Betula papyrifera*), and aspen (*Populus* spp.). Diameters of trees within this area of windthrow and wildfire ranged widely from 7 to 27 cm (3-11in) with an average of 16 cm (6 in, N = 19).

Circa 1800, wetlands were scattered throughout the game area, concentrated along the margins of the small

lakes and streams, in poorly drained portions of outwash plain and outwash channels, and along lower slopes of moraines (Figure 4). Prevalent circa 1800 wetland cover types included Shrub Swamp/Emergent Marsh (6% of the game area), Mixed Hardwood Swamp (4%), and Mixed Conifer Swamp (2%). In addition, 2% of the game area was classified as Lake or Pond and submergent wetland types such as submergent marsh likely occupied portions of these 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 does not allow for current ecologists to more specifically 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, bog, southern wet meadow, emergent marsh, and intermittent wetland.

The Circa 1800 vegetation in Lost Nation SGA and throughout Hillsdale County was likely influenced by Native Americans. In the 1800s Potawatomi Indians inhabited this region and Hopwell Indian mounds throughout the area suggest centuries of prior use. It is thought that a tribe of Potawatomi Indians lead by Chief Baw Beese took refuge in the steep terrain and dense forests of the area when they were forced from their villages by settlers. Around 1840 this tribe was removed by the federal government from Michigan and the name "Lost Nation" ascribed to the area is thought to be a tribute this peaceful tribe or to those indigenous peoples that preceded them and were buried in the mounds throughout the area. In the mid-1850s, the infamous outlaw Sile Doty also exploited the wilderness in Hillsdale County. Doty is purported to have used a cave within the Lost Nation SGA to hide stolen horses. It is rumored that after capturing Doty, the authorities destroyed the cave (Rood 1952).

Current Land Cover

The land cover within the Lost Nation SGA has changed significantly since 1800 due to logging, agriculture, deer herbivory, fire suppression, and hydrologic alteration. The mosaic of aerial photographs from 1938 (Figure 5) shows how logging and the expansion of agriculture heavily impacted the Lost Nation 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 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 unfavorable slope, drainage, and/or soil conditions. Many of these former agricultural areas have reverted to early-successional forest.

Current land cover in Lost Nation SGA is dominated by deciduous forest (75% of the game area) (Figure 1). This forest is primarily composed of beech-sugar maple forest (mesic southern forest), oak-hickory forest (dry-mesic southern forest), and early-successional forest. The majority of these forested systems within Lost Nation SGA are early-successional forest with over 92% of the total forested acreage being less than 100 years old and only 8% being over 100 years old or classified as uneven-aged. IFMAP stand types delineated in Lost Nation SGA that fall within the broad class of deciduous forest include Mixed Upland Deciduous (40%), Northern Hardwoods (24%), Oak Types (8%), and Other Upland Deciduous (3%). These forests occur throughout the game area and are especially prevalent on moderate to steep end moraine, rolling ground moraine, and ice-contact ridges. Early-successional forests have established on lands that were logged and/or farmed. High levels of invasive shrub species occur within the understory of the early-successional forests. In addition, many of the oak and oak-hickory forest types are fire suppressed and have a significant component of mesophytic competition in the understory. As a result of competition and high levels of deer herbivory, oak regeneration is sparse throughout the understory of these forests.

A small portion of the game area (approximately 4%) is composed of open uplands that include managed agricultural crops (<1%), and abandoned agricultural fields dominated by old-field herbaceous species (3%) or upland shrubs (1%).

Lakes and wetlands remain an important component of the game area with lakes accounting for approximately 2% of the area, open wetlands accounting for 6%, shrub wetlands accounting for approximately 9%, and forested wetlands accounting for 4% of the area. Open wetland types delineated in Lost Nation SGA by IFMAP stage 1 inventory include Emergent Wetland, Floating Aquatic, and Mixed Non-Forested Wetland. Shrub wetland and forested wetland types include Lowland Shrub and Lowland Deciduous Forest, respectively. Wetlands throughout Lost Nation SGA have been impacted by hydrologic alteration (e.g., ditching and dredging), grazing, marsh haying, invasive species encroachment, and fire suppression.

Despite the considerable loss of natural habitat due to conversion to agriculture and logging and degradation of remaining natural habitat due to deer herbivory, grazing,

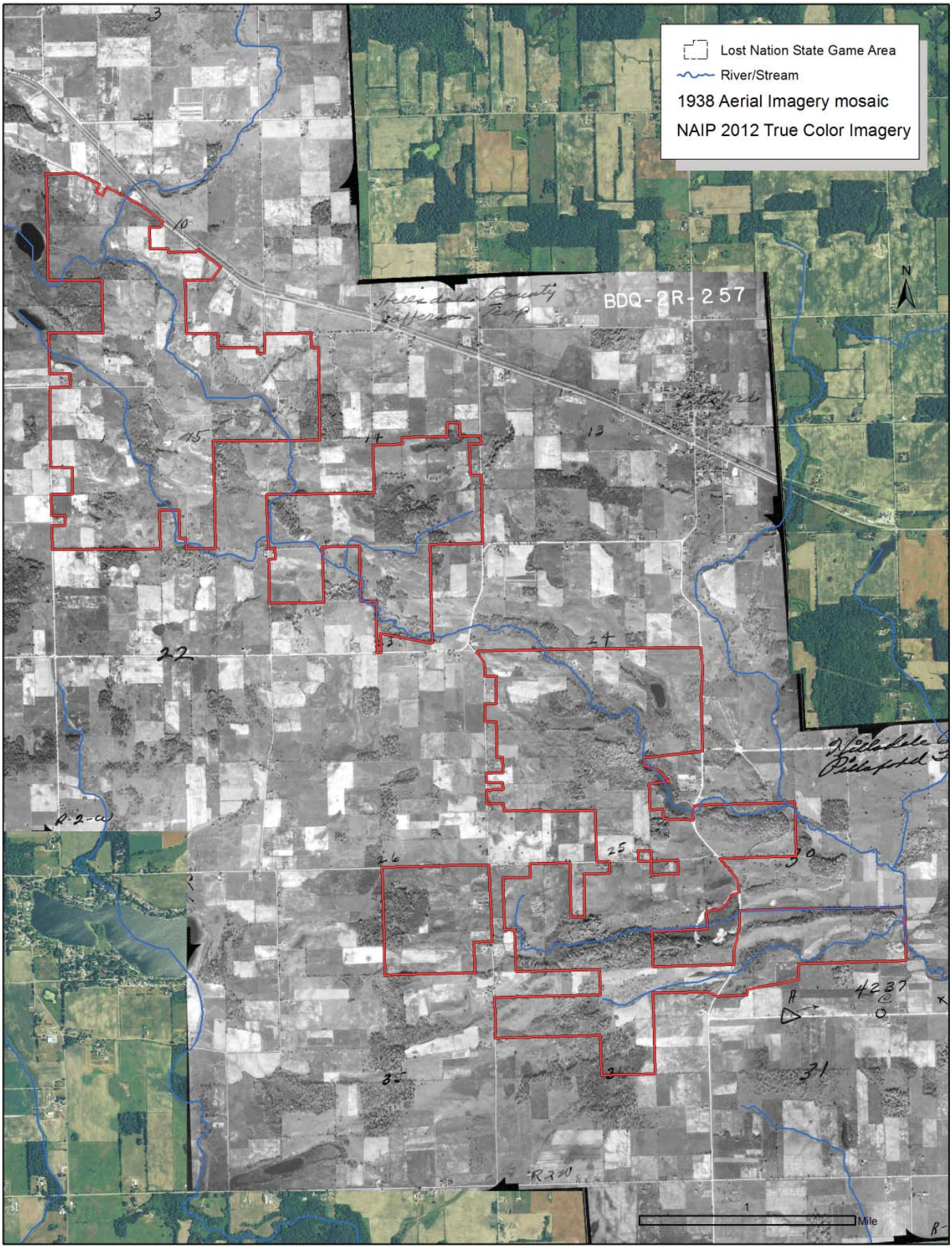


Figure 5. Mosaic of 1938 aerial photographs of Lost Nation State Game Area (MNFI 2014).

hydrologic alteration, invasive species encroachment, and fire suppression, a significant portion of Lost Nation SGA supports high-quality natural communities. In addition, compared to the surrounding fragmented landscape, Lost Nation SGA is characterized by a significant portion of natural cover. As noted above, 92% of the game area is natural cover. In comparison, 34% of the Washtenaw subsection (VI.1) and 31% of the Ann Arbor Moraines sub-subsection (VI.1.2) are natural cover. Prior to the 2012 survey effort, one natural community element occurrences (EO), a prairie fen, was documented within Lost Nation SGA (Table 1). Surveys in 2012 and 2013 identified an additional twelve natural community EOs. These EOs represent eight different natural community types including bog (1 EO), cave (1 EO), dry-mesic southern forest (3 EOs), inundated shrub swamp (1 EO), mesic southern forest (2 EOs), prairie fen (2 EOs), southern hardwood swamp (1 EO), and submergent marsh (1 EO) (Table 1). These natural community EOs will be described in detail within the Natural Community Results section. Documented high-quality natural communities constitute over 12% of Lost Nation SGA.

Praire fens within Lost Nation SGA provide critical habitat for numerous rare species. Photo by Jesse M. Lincoln.

Current land cover in Lost Nation SGA is dominated by deciduous forest (75% of the game area) with significant stretches characterized by mature beech-sugar maple forest or mesic southern forest. Photo by Joshua G. Cohen.

METHODS

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

Natural Community Survey Methods

A natural community is defined as an assemblage of interacting plants, animals, and other organisms that repeatedly occurs under similar environmental conditions across the landscape and is predominantly structured by natural processes rather than modern anthropogenic disturbances (Cohen et al. 2014a). Protecting and managing representative natural communities is critical to biodiversity conservation, since native organisms are best adapted to environmental and biotic forces with which they have survived and evolved over the millennia (Kost et al. 2007). According to MNFI's natural community classification, there are 77 natural community types in Michigan (Kost et al. 2007, Cohen et al. 2014a). 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 June to July of 2013) 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 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 2015). 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 following **Natural Community Surveys Results** section.

Vernal Pools Survey Methods

Vernal pools are small, generally isolated, temporary pools of water that form in shallow depressions in forested areas throughout Michigan (Thomas et al. 2010). These wetlands fill with water from rainfall, snowmelt, and/or groundwater between late fall and spring, and usually dry up by mid to late summer. The periodic drying of vernal pools prevents fish from establishing populations in these wetlands. Because vernal pools lack predatory fish populations, these wetlands provide critical breeding habitats for a host of forest-dwelling amphibians and invertebrates, including some species that are specialized for life in vernal pools and depend on these unique habitats for their survival. These include the blue-spotted salamander (*Ambystoma laterale*), spotted salamander (*Ambystoma maculatum*), wood frog (*Rana sylvatica*), and fairy shrimp (*Eubranchipus* spp.) (Colburn 2004, Calhoun and deMaynadier 2008). Vernal pools also provide habitat for a number of other animal and plant species including endangered, threatened, or rare species in Michigan, such as the state special concern Blanding's turtle (*Emydoidea blandingii*) and federally threatened and state endangered copperbelly water snake (*Nerodia erythrogaster neglecta*). Vernal pools also contribute other important ecosystem services including nutrient cycling, water storage and infiltration, groundwater recharge, and flood control (Colburn 2004, Calhoun and deMaynadier 2008). However, because vernal pools are small, isolated, and dry for part of the year, they can be difficult to identify in the field, and can be easily overlooked and unintentionally damaged or destroyed. They also are not well-protected under current federal and state wetland regulations, and limited information is available on their status, distribution, and ecology in the state.

Potential and verified vernal pools were identified and mapped in the Lost Nation SGA in 2014 using remote sensing and field sampling. The primary goal of this mapping and survey effort is to provide resource managers and planners with baseline information on vernal pool status and distribution within the game area. This baseline information is critical for developing and implementing appropriate management and protection of these unique wetlands. These wetlands also provide habitat for several rare amphibian and reptile species and species of greatest conservation need (SGCN) that were targeted for surveys in 2014. Vernal pools also were identified and mapped to identify potential sites for amphibian and reptile surveys in the game area.

Potential vernal pools were identified and mapped based on aerial photograph interpretation. Aerial photo interpretation is currently still the most effective method available for identifying and mapping vernal pools remotely (Calhoun and deMaynadier 2008). Aerial photograph interpretation was conducted in the spring of 2014 prior to field surveys to identify and map potential vernal pools (PVPs) within the game area. Aerial photograph interpretation consisted of using ESRI ArcGIS software to visually examine available aerial imagery and other available imagery of the game area on a computer screen. Aerial imagery that were examined to identify and map PVPs included color infrared, leaf-off aerial imagery from the spring of 1998, and natural color aerial imagery from the summer of 2005, 2010, and 2012 (NAIP 2005, NAIP 2010, and NAIP 2012 True Color). Additional high-resolution, leaf-off, natural color imagery and topographic maps of the game area also were examined. The aerial imagery and other data layers were available through Michigan State University's Remote Sensing and GIS (RSGIS) Center and the State of Michigan. We used a map scale of 1:5000 as a compromise between a high level of visible detail and spatial extent of the imagery displayed on the computer screen to detect PVPs. PVPs were digitized and mapped as polygons using ESRI ArcGIS software. PVPS were added to a statewide vernal pool geodatabase developed by MNFI to record and track data on the locations and characteristics of potential and verified vernal pools in the state. Each PVP polygon was assigned a unique identification number for reference, and some preliminary information about these polygons were included in the geodatabase.

A subset of the PVPs mapped in the game area was surveyed from May 20th through July 23rd, 2014 to verify, map, and collect data on vernal pools in the field. Most PVPs were surveyed only once, but several pools were visited two times during the sampling period. Surveyors verified if PVPs represented actual vernal pools in the field, or if the PVPs were other types of wetlands or other habitats. The status of PVPs visited in the field was documented using one of the following five designations: 1) verified as a vernal pool and is active/present; 2) verified as a vernal pool and is no longer active/has been destroyed; 3) visited in the field but status still uncertain/insufficient information; 4) visited in the field and is not a vernal pool/some other wetland type; and 5) visited in the field and is not a vernal pool/no water present. Vernal pools verified in the field were mapped using a GPS unit. Additional vernal pools that were encountered during field sampling and had not been remotely mapped as PVPs also were recorded and mapped. Basic information about the physical characteristics, general condition, surrounding habitat, vegetative structure, and presence of vernal pool indicator species (i.e., fairy shrimp, wood frog egg masses and tadpoles, and/or blue-spotted and spotted salamander egg masses and larvae) and other animals in the pools were recorded in the field using a standardized vernal pool monitoring data form (Appendix 1). Vernal pools verified in the field were classified into the following six general vernal pool types based on vegetation within the

pools: open pools, sparsely vegetated pools, shrubby pools, forested pools, marsh pools, and other (e.g., half open and half shrubby). Definitions of vernal pool types are provided in Appendix 2. Vernal pools and other wetlands and habitats identified in the field were photographed for documentation and verification. Field sampling results and data were incorporated in the statewide vernal pool geodatabase.

Rare Animal Survey Methods

We identified rare animal target species for surveys using historical distribution within Michigan, past occurrences in or near Lost Nation 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 stand 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; Amy Derosier, personal communication, March 2015).

Bird Surveys

Given the presence of large tracts of mature forest and results of previous surveys, we focused our surveys in the game area on red-shouldered hawk (*Buteo lineatus*, state threatened, DNR featured species) and rare songbird species. Contiguous forest stands at least 4 ha (10 acres) in area were considered potential habitat for these target species. We generated a 250 m X 250 m grid of possible survey points that was overlaid over the potential survey stands. Those points falling within the potential survey stands were used for conducting red-shouldered hawk and songbird surveys. Points were assigned unique identification numbers and uploaded to a GPS unit for field location. Thirty points were identified for Lost Nation SGA stands (Figure 6). In addition to surveying for red-shouldered hawk and rare songbirds, point-count sampling was used to gather baseline information about the forest bird community, including relative abundance and species richness.

We conducted three minute red-shouldered hawk surveys at systematically located point count stations (Figure 6; Mosher et al. 1990, Anderson 2007, Bruggeman et al. 2011). Each three minute point count consisted of two minutes of broadcasts and one minute of silent listening. Surveys were conducted on April 11th, 2014. At each station the following data were recorded: whether or not a red-shouldered hawk was detected, all other raptor sightings or vocalizations, other bird observations, and other rare animal species detections or potential habitats. If a red-shouldered hawk was observed, the vicinity surrounding the point was searched for potential nests. While walking and driving between station locations, we also visually inspected trees for stick nests.

Forest bird surveys focused on detecting the following species: cerulean warbler (*Setophaga cerulea*, state threatened), hooded warbler (*Setophaga citrina*, state special concern), and Louisiana waterthrush (*Parkesia motacilla*, state threatened). Forest songbird point counts were conducted at the same 30 systematically located points used for red-shouldered hawk surveys (Figure 6). 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 June 2nd and 3rd, 2014 between sunrise and four hours after sunrise. In addition to documenting observations of the three rare species, we gathered data on all birds seen or heard during each ten minute point count. We recorded the species and number of individuals observed during three independent periods (2 min, 3 min, and 5 min) for a total of ten minutes 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 of the bird from the observer to facilitate future distance analyses and refinement of density and population estimates. At each point-count station, we noted if the site appeared suitable for cerulean warbler, hooded warbler, and Louisiana waterthrush and recorded any invasive plant species seen.

Reptile and Amphibian Surveys

The following species of amphibians and reptiles (i.e., herptiles) were targeted for surveys in Lost Nation SGA in 2014: 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), copperbelly water snake (*Nerodia erythrogaster neglecta*, state endangered and federally threatened), eastern massasauga (*Sisturus catenatus*, state special concern and federal candidate), and smallmouth salamander (*Ambystoma texanum*, state endangered). During surveys for target species, we also looked for and/or documented other rare amphibian and reptile species as well as species identified as SGCN in Michigan's Wildlife Action Plan (Eagle et al. 2005; Amy Derosier, personal communication, March 2015) (Appendix 3). Visual

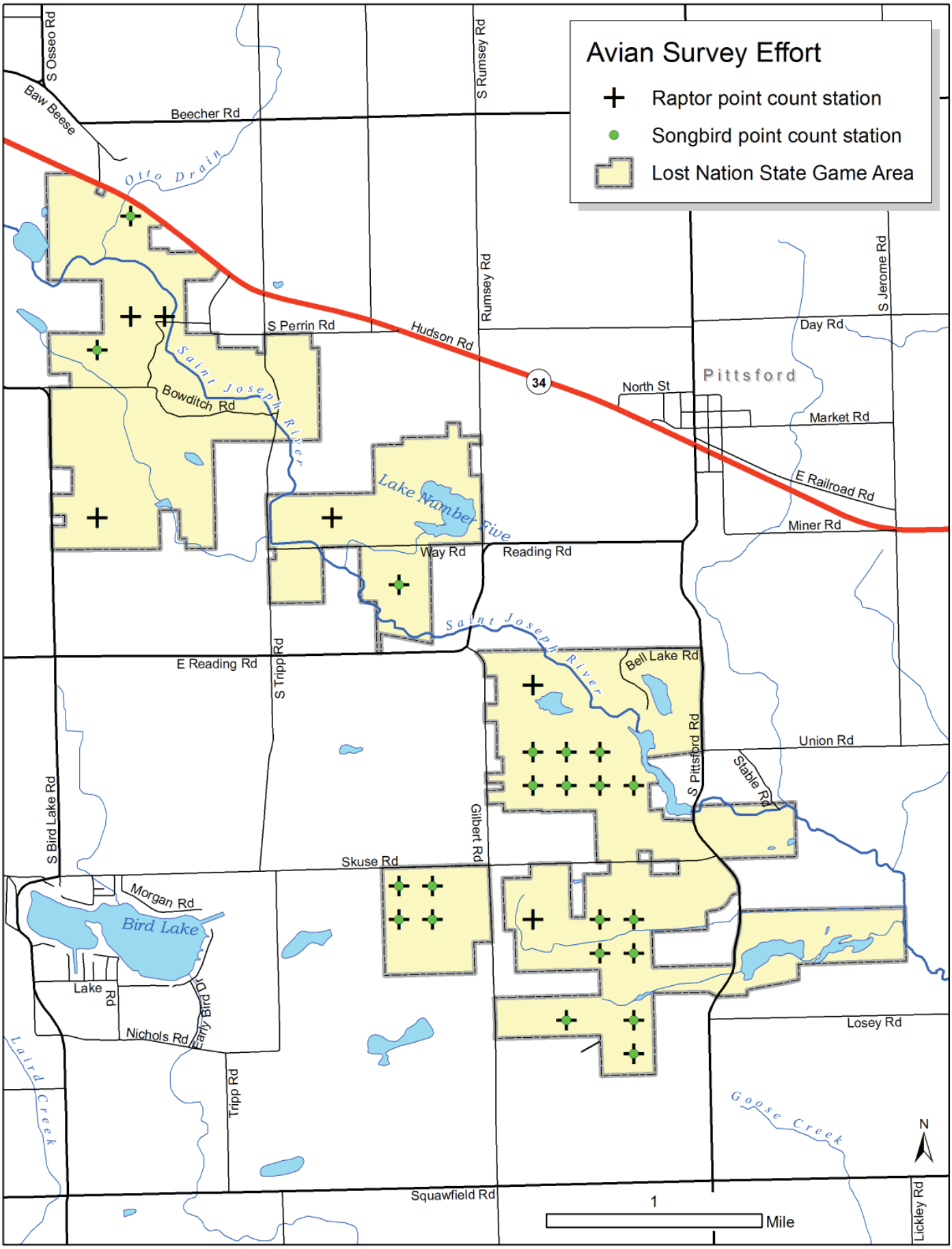


Figure 6. Locations of forest songbird and raptor point counts conducted in Lost Nation State Game Area in 2014.

encounter surveys, basking surveys, auditory or breeding frog call surveys, dipnetting, and aquatic funnel trapping 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 from which the species had not been reported within the last ten to twenty years. Rare amphibian and reptile species encountered incidentally during other MNFI surveys in 2014 also were recorded.

Visual encounter surveys were conducted from May 20th through July 23rd, 2014 using a standard method for surveying amphibians and reptiles (Campbell and Christman 1982, Corn and Bury 1990, Crump and Scott 1994). An additional visual encounter survey was conducted on October 27th, 2014. Visual encounter surveys were conducted in or along the edge of open wetlands, waterbodies (e.g., vernal pools, permanent ponds, lakes, streams, and rivers), upland and lowland deciduous or mixed forest stands, and/or open uplands adjacent to wetlands or waterbodies. These surveys were conducted at 37 sites in Lost Nation SGA, focusing on areas with suitable habitats for targeted species (Figure 7). These surveys had potential for detecting all targeted rare turtles and snakes. Survey sites included 17 previously mapped wetland and upland forest stands (identified through stage 1 IFMAP inventory) as well as 20 vernal pools that had not been mapped in the game area prior to this project. Survey sites were visited one to two 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 (i.e., between 60-80oF, wind less than 15 mph, no or light precipitation). 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.

Basking surveys were conducted from May 20th to June 6th, 2014, primarily to search for copperbelly water snakes and Blanding's turtles. We conducted basking surveys at ten survey sites containing open and/or shrubby wetlands or waterbodies that appeared to provide suitable habitat for copperbelly water snakes and/or Blanding's turtles (Figure 7). Basking 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 and snakes partially submerged in the water or basking on logs, woody debris, islands, or other structures.

Auditory surveys for breeding frog calls were conducted for the Blanchard's cricket frog on June 28th, 2014. These surveys were completed at 19 sites throughout Lost Nation SGA and on adjacent private lands. These sites were comprised of permanent lakes and ponds and surrounding open wetlands located near roads (Figure 7). We conducted frog call surveys along roads in the evening or at night (17:30 – 01:00 EDT) by listening for breeding calls of cricket frogs emanating from the nearby wetlands or bodies of water. 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 DNR 2002).

Dipnetting was conducted in vernal pools from May 20th to July 23rd, 2014 in a total of 20 sites to survey for larvae of the smallmouth salamander and other salamander SGCN and/or target species, including the blue-spotted salamander (*Ambystoma laterale*), spotted salamander (*Ambystoma maculatum*), and eastern tiger salamander (*Ambystoma tigrinum*) (Figure 7). These species primarily breed in vernal pools (Harding 1997). Dipnetting consisted of using a small aquarium net to take multiple sweeps through the water column and along the substrate and cover objects (e.g., woody debris, emergent or submergent vegetation) in the pools to try to capture larvae of target species and other amphibians. Amphibian larvae were identified to the lowest taxonomic level possible, recorded, photographed, and released at the capture site. Photographs were taken of the amphibian larvae captured for species verification and documentation.

Aquatic funnel trapping was conducted July 22nd to July 23rd, 2014 to survey for smallmouth salamanders and other salamander SGCN, including the spotted salamander, blue-spotted salamander, and eastern tiger salamander. Aquatic funnel trapping was conducted at only one site (Compartment 3, stand 5) in Lost Nation SGA (Figure 7). This site is a sparsely vegetated and forested vernal pool located in an upland deciduous forest (Compartment 3, stand 3). Commercially available modified minnow traps were used for aquatic funnel traps. These traps were about 46 cm long x 25 cm wide (i.e., 18 in long x 12 in wide) and consisted of a collapsible, spring loaded, metal or wire frame covered with 3 mm mesh nylon webbing with funnels with 5 cm (2 in) openings extending inward at both ends. Traps were placed in the water so that the funnel openings at the ends of each trap were completely submerged in the water but the top of the trap was above the surface of the water to provide an air pocket for animals

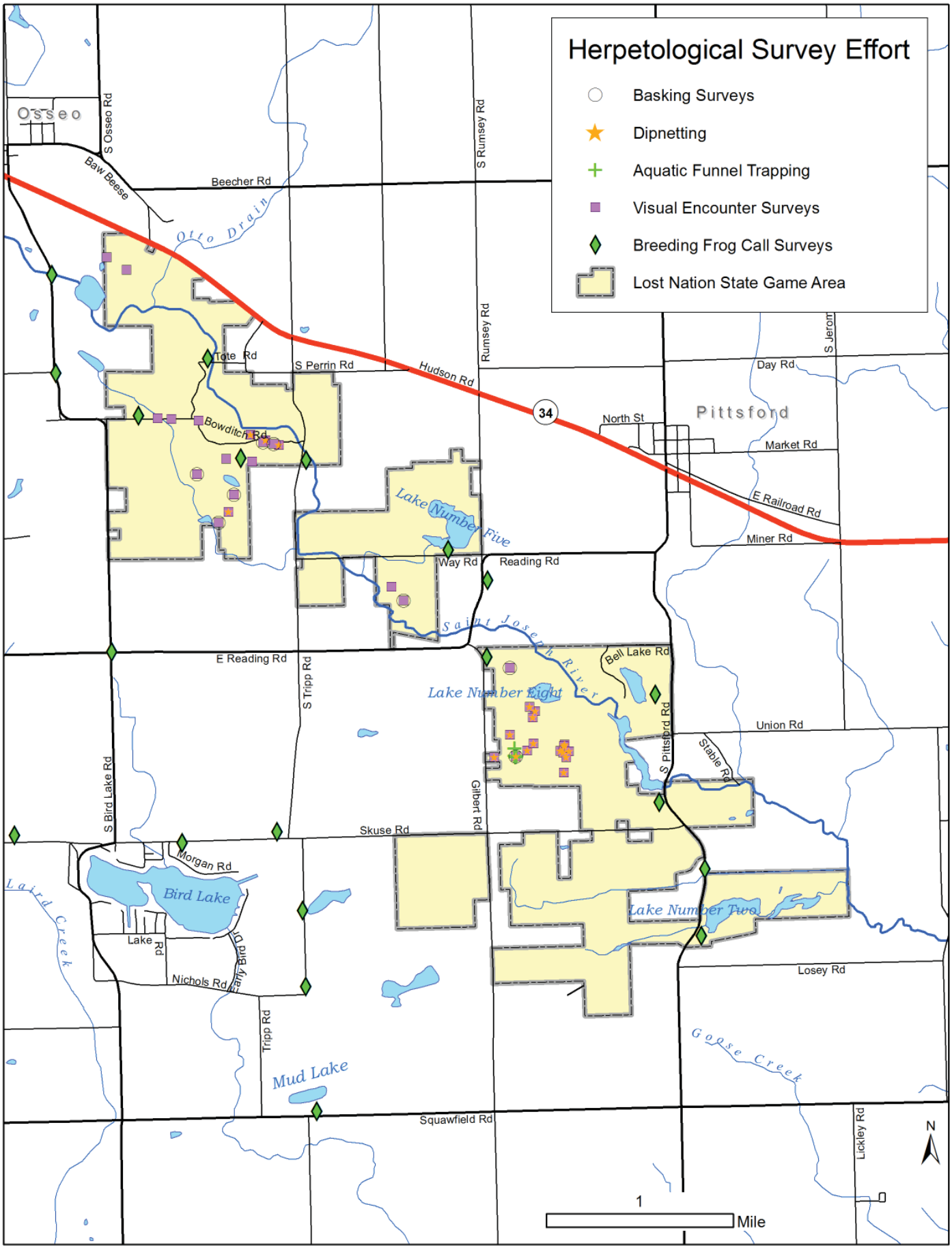


Figure 7. Locations of reptile and amphibian surveys conducted in and nearby Lost Nation State Game Area in 2014.

captured in the trap. A total of six traps were set in the wetland during the day. These traps were left overnight in the wetland, and checked and removed the following day. This resulted in a total of six trap nights. Amphibian adults and larvae captured in the traps were identified to the extent possible, recorded, photographed, and released. Photographs were taken of the amphibian adults and/or larvae captured in the traps for species verification and documentation.

Survey data forms (Appendix 4) were completed for all herp surveys, and survey locations were recorded with a GPS or Ashtech 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 Ashtech unit. Whenever possible, photographs of rare species were taken for supporting documentation.

Mussel Surveys

The East Branch of the St. Joseph River is the primary waterway of Lost Nation SGA. This stream is part of the Maumee River watershed, which flows into Lake Erie. The East Branch of the St. Joseph River flows southeast through Lost Nation SGA (Figure 8), continuing over the Michigan-Ohio boarder where it meets the West Branch of the St. Joseph. The main stem of the St. Joseph River joins the St. Mary's River and Maumee River in Fort Wayne, Indiana. The Maumee River takes an abrupt turn east to flow through Toledo and into Lake Erie. The St. Joseph River (Maumee) watershed historically supported populations of at least 22 unionid mussel species (Appendix 5). 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.

Aquatic funnel trap set within a vernal pool in Lost Nation State Game Area. Photo by Yu Man Lee.

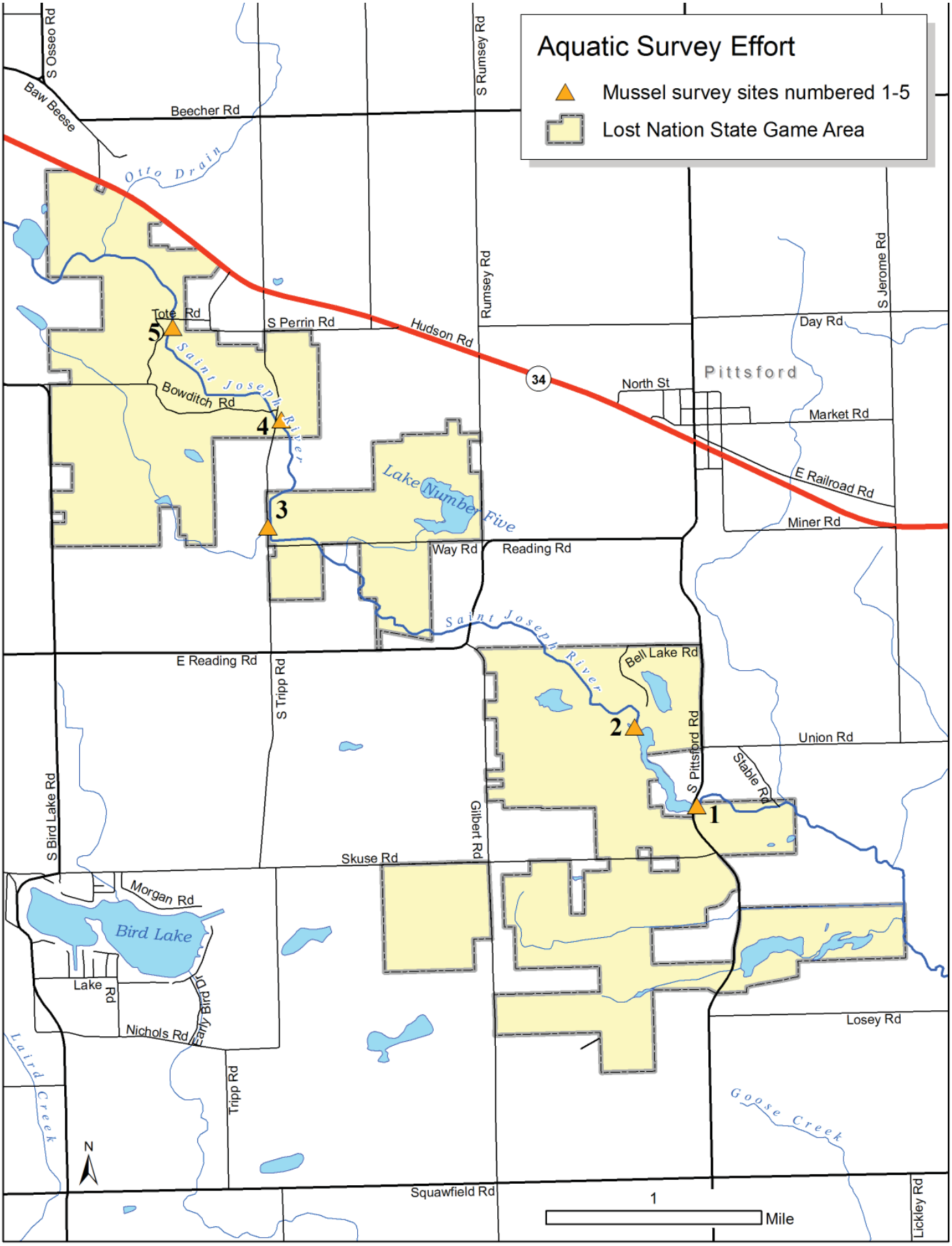


Figure 8. Locations of aquatic surveys conducted in Lost Nation State Game Area in 2014.

An assessment for potential unionid mussel habitat and for public access to potential aquatic survey sites within Lost Nation SGA was made in the field on August 6, 2014. Though there are a few very small tributaries of the East Branch of the St. Joseph River flowing through the game area, these were deemed to be too small to support unionid mussels, or had no flowing water at all at that time. Five sites within the East Branch of the St. Joseph River were surveyed for unionid mussels between August 7 and September 19, 2014 (Table 7 and Figure 8).

Aquatic surveys were performed to determine the presence/absence and abundance of unionid mussel species at each site, as well as document stream water chemistry and physical habitat characteristics. Additional taxa including aquatic snails (Gastropoda), crayfish, fingernail clams, and fish were also recorded as incidental finds. Surveys took place in wadeable habitats (less than approximately 70 cm deep). The search area at each site was measured to standardize sampling effort among sites and allow unionid density estimates to be made. The search area extended from bank to bank in order to include a wide range of microhabitats. Live unionids and shells were located with a combination of visual and tactile means. Glass bottom buckets were used to facilitate visual detection. Tactile searches through the substrate were made to help ensure that buried individuals were being detected, including smaller sized unionid mussels.

Live individuals were identified to species and placed back into the substrate anterior end down (siphon end up) in the immediate vicinity of where they were found. Shells were also identified to species. The number of individuals was determined for each unionid mussel species at each site. Presence/absence was recorded for the invasive, non-native zebra mussel (*Dreissena polymorpha*) and Asian clam (*Corbicula fluminea*). Gastropod shells were collected by hand and brought back to the lab for identification. Latitude and longitude of survey sites were recorded with handheld Garmin GPS units (Table 7).

Habitat data were taken to describe and document stream conditions at the time of the surveys. The substrate within each search area was characterized by estimating percent composition of each of the following six particle size classes (diameter): 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) (Hynes 1970). 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 characterization of current speed were estimated visually. Conductivity and pH were recorded with an Oakton handheld meter. Alkalinity was measured with a LaMotte kit (model DR-A) and hardness was measured with a Hach kit.

The East Branch of the St. Joseph River flows throughout Lost Nation State Game Area. Photo by Joshua G. Cohen

RESULTS

During the Integrated Inventory Project at Lost Nation SGA, MNFI documented 20 new EOs and provided information for updating an additional seven EOs (Tables 1-6). Data compiled on these EOs was entered into MNFI's Biotics database (MNFI 2015). In total, 20 SGCN were documented during the project including seven different rare animal species (Table 8). The locations in Lost Nation SGA of all natural community and rare species occurrences (both new and prior occurrences) are illustrated in Figures 9 through 13. In addition, MNFI scientists mapped the location of 20 vernal pools within the game area (Figure 11). The Results section is divided into three sections, a Natural Community Survey Results section, a Vernal Pools 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 Vernal Pools Results section describes survey results for the vernal pools surveys. The Rare Animal Survey Results section describes survey results for each grouping of rare animals: birds, reptiles and amphibians, and mussels.

Natural Community Survey Results

During the summers of 2012 and 2013, MNFI ecologists documented 12 new high-quality natural communities in the Lost Nation SGA and also updated one known high-quality community EO. Lost Nation SGA supports 13 high-quality natural community EOs (Table 1 and Figure 9). 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. Eight different natural community types are represented in the 13 element occurrences surveyed including: bog (1 EO), cave (1 EO), dry-mesic southern forest (3 EOs), inundated shrub swamp (1 EO), mesic southern forest (2 EOs), prairie fen (3 EOs), southern hardwood swamp (1 EO), and submergent marsh (1 EO).

During the IFMAP Stage 1 Inventory in 2012 and the natural community surveys in 2013, six EOs for the rare plant black-haw (*Viburnum prunifolium*, state special concern) were documented (Table 2). In addition to black haw, an existing EO of white lady slipper (*Cypripedium candidum*) has been documented within the Lost Nation Fen prairie fen (EO ID 2833). The general location of these rare plant EOs is illustrated along with the locations of 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 13 natural community EOs organized alphabetically by community type and then by element occurrence site name. A summary of priority management recommendations is provided for each natural community EO in Table 14. 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, Cohen et al. 2014a). 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 6 for ranking criteria)

d) current element occurrence rank

e) size

f) locational information

g) digital photograph(s)

h) detailed description

i) threat assessment

j) management recommendations

Shadyside Woods dry-mesic southern forest. Photo by Joshua G. Cohen.

Table 1. Newly documented and previously known natural community element occurrences for the Lost Nation State Game Area. EO rank abbreviations are as follows: BC, good or fair estimated viability; C, fair estimated viability; CD, fair or poor estimated viability; and D, poor estimated viability. * indicates that the EO was newly documented and ** indicates that the EO 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
Lost Nation Bog*	Bog	19893	C	2013	2013	G3G5	S4
Sile Doty Cave*	Cave	20175	CD	2012	2015	G4?	S1
Burst-Dam Woods*	Dry-mesic Southern Forest	19805	BC	2013	2013	G4	S3
Baw Beese Woods*	Dry-mesic Southern Forest	19888	C	2013	2013	G4	S3
Shadyside Woods*	Dry-mesic Southern Forest	19889	CD	2013	2013	G4	S3
Gilbert Road Buttonbush Swamp*	Inundated Shrub Swamp	19890	C	2013	2013	G4	S3
Pittsford Millpond Woods*	Mesic Southern Forest	19887	C	2013	2013	G2G3	S3
Sile Doty Woods*	Mesic Southern Forest	19886	C	2013	2013	G2G3	S3
East Branch Fen*	Prairie Fen	19894	D	2013	2013	G3	S3
Lost Nation Fen**	Prairie Fen	2833	BC	1997	2013	G3	S3
Osseo Fen*	Prairie Fen	19813	C	2013	2013	G3	S3
Squawfield Swamp*	Southern Hardwood Swamp	19891	C	2013	2013	G3	S3
Bell Lake*	Submergent Marsh	19892	C	2013	2013	GU	S4

Table 2. Newly documented and previosuly known rare plant element occurrences at Lost Nation State Game Area. State status abbreviations are as follows: T, state threatened; and SC, state special concern. EO rank abbreviations are as follows: AB, excellent or good estimated viability; BC, good or fair estimated viability; C, fair estimated viability; and E, verified extant (viablity not assessed). * indicates the EO was newly documented in 2012 or 2013.

Common Name	Scientific Name	State Status	EO ID	EO Rank	Year First Observed	Year Last Observed
White lady slipper	*Cypripedium candidum*	T	6605	BC	2002	2004
Black haw*	*Viburnum prunifolium*	SC	19816	AB	2012	2013
Black haw*	*Viburnum prunifolium*	SC	20122	C	2012	2013
Black haw*	*Viburnum prunifolium*	SC	20156	E	2013	2013
Black haw*	*Viburnum prunifolium*	SC	20157	E	2013	2013
Black haw*	*Viburnum prunifolium*	SC	20158	E	2013	2013
Black haw*	*Viburnum prunifolium*	SC	20159	E	2013	2103

Black haw (*Viburnum prunifolium*) occurs in dry-mesic southern forest throughout Lost Nation State Game Area. Photo by Joshua G. Cohen.

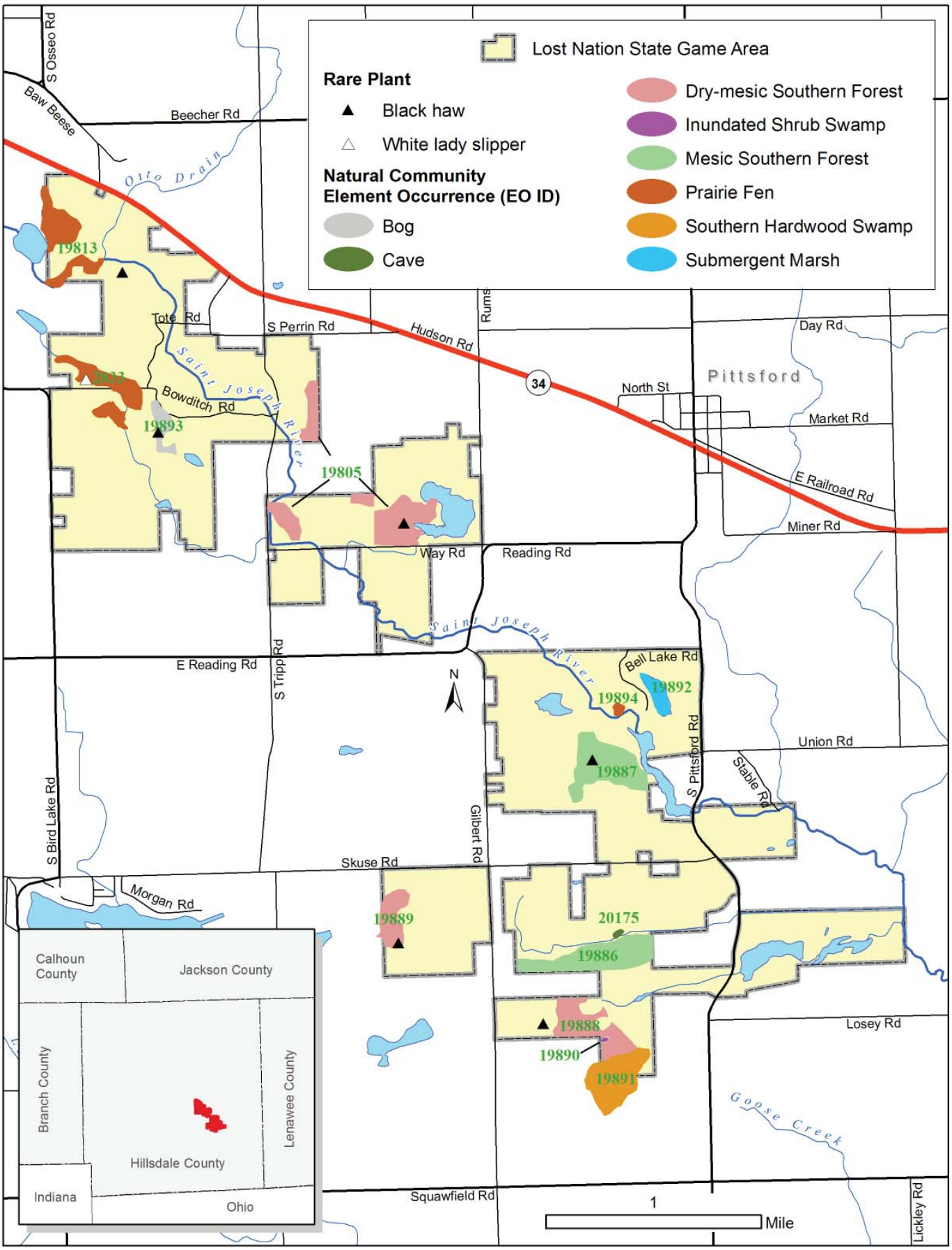
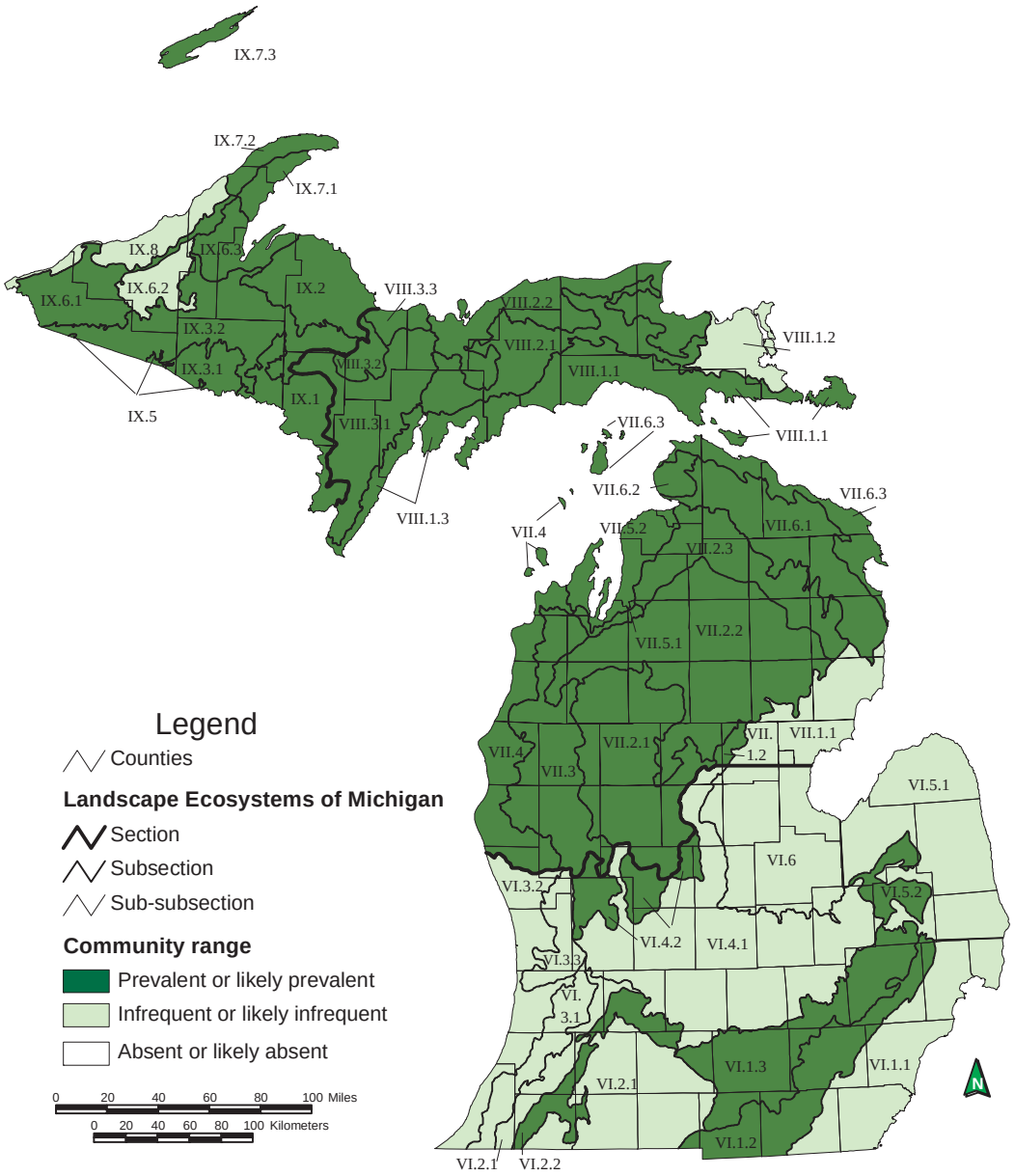


Figure 9. Natural community and rare plant element occurrences in Lost Nation State Game Area.

BOG

Overview: Bog is a nutrient-poor peatland characterized by a continuous carpet of sphagnum moss, a species-poor herbaceous layer, low ericaceous, evergreen shrubs, and widely scattered and stunted conifers. Though much more prevalent in the north, bogs occur throughout Michigan in kettle depressions within pitted outwash plains and moraines and in shallow depressions on glacial outwash plains and glacial lakeplains. Bogs often develop on the margins of lakes and slowly colonize the lake basin. Soils are extremely acidic to very strongly acidic, saturated peat. Natural processes that influence species composition and community structure include peat accumulation, insect outbreaks, flooding by beaver, windthrow, and occasional fires. Bogs are dominated by sphagnum mosses (*Sphagnum* spp.), few-seed sedge (*Carex oligosperma*), ericaceous shrubs such as leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), bog laurel (*Kalmia polifolia*), low sweet blueberry (*Vaccinium angustifolium*), highbush blueberry (*V. corymbosum*), large cranberry (*V. macrocarpon*), and small cranberry (*V. oxycoccos*), and scattered trees, especially conifers such as black spruce (*Picea mariana*), tamarack (*Larix laricina*), and pines (*Pinus* spp.). Insectivorous plants are characteristic of bogs and include round-leaved sundew (*Drosera rotundifolia*), pitcher-plant (*Sarracenia purpurea*), and bog bladderwort (*Utricularia geminiscapa*) (Kost et al. 2007, Cohen et al. 2014a).



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

1. Lost Nation Bog
Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and secure within the state
Element Occurrence Rank: C
Size: 9.5 acres
Location: Compartment 1, Stand 28
Element Occurrence Identification Number: 19893

Site Description: This small bog occupies a kettle depression on a ground moraine and is surrounded by dry-mesic southern forest and early-successional forest. The bog formed through lake-filling. Soils are 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 4.2-4.4) while the hemic/sapric peats are strongly acidic (pH 4.5). Well-developed sphagnum hummock and hollow microtopography provide microsite diversity by creating small-scale gradients in soil moisture and soil chemistry. Structural diversity of the bog is further increased by scattered clumps of tall shrubs, the moat that rings the bog, and the numerous animal trails that provide inundated linear features. The southern portion of the wetland depression that supports the bog is characterized by submergent marsh and southern shrub-carr with yellow pond-lily (*Nuphar advena*), three-way sedge (*Dulichium arundinaceum*), and whorled loosestrife (*Decodon verticillatus*) prevalent.

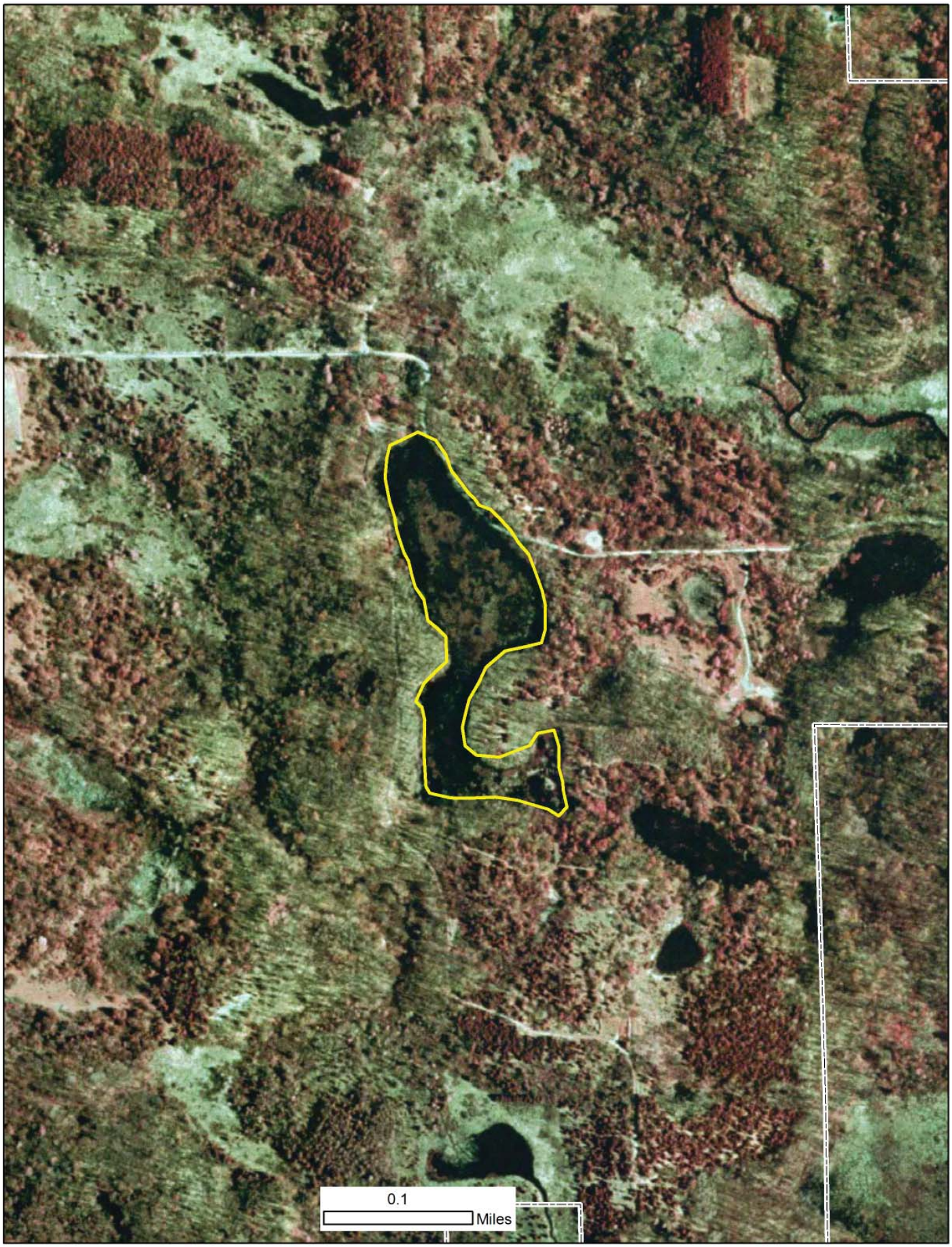
The Lost Nation Bog is characterized by a continuous carpet of sphagnum moss, a species-poor herbaceous layer, a dense low shrub layer, scattered patches of dense tall shrubs, widely scattered and stunted trees, patches of floating mats, and a moat dominated by tall shrubs and submergent vegetation. Characteristic species of the herbaceous layer include few-seed sedge (*Carex oligosperma*), three-way sedge, and Virginia chain-fern (*Woodwardia virginica*) with yellow pond-lily occurring in pools and in the moat. Leatherleaf (*Chamaedaphne calyculata*) dominates the low shrub layer with associates including highbush blueberry (*Vaccinium corymbosum*) and black chokeberry (*Aronia prunifolia*). Buttonbush (*Cephalanthus occidentalis*) and whorled loosestrife are locally dominant in the moat. The understory is dominated by highbush blueberry with additional tall shrubs including winterberry (*Ilex verticillata*), black chokeberry, buttonbush, poison sumac (*Toxicodendron vernix*), meadowsweet (*Spiraea alba*), and sapling red maple (*Acer rubrum*). The understory is patchy with scattered clumps of dense highbush blueberry. Scattered and stunted trees include red maple and yellow birch (*Betula alleghaniensis*). The bog is ringed by a moat with up to one meter of water and submergent vegetation including yellow pond lily and emergent vegetation including three-way sedge, blue-joint (*Calamagrostis canadensis*), fowl manna grass (*Glyceria striata*), whorled loosestrife, winterberry, and buttonbush.

An historical record for copperbelly water snake (*Nerodia erythrogaster neglecta*) was documented to the south of this bog and the bog has suitable habitat for this species.

Threats: Species composition and vegetative structure of the bog are largely driven by natural processes. An old road borders the bog to the northeast and has likely altered the hydrology locally. In addition, fire suppression throughout the general landscape may have altered the fire regime. Purple loosestrife (Lythrum salicaria) is locally common within 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 and to control the purple loosestrife. The bog should be allowed to burn if prescribed fire or wildfires enter the wetland basin. Monitoring should be implemented following invasive species control efforts and fire events.

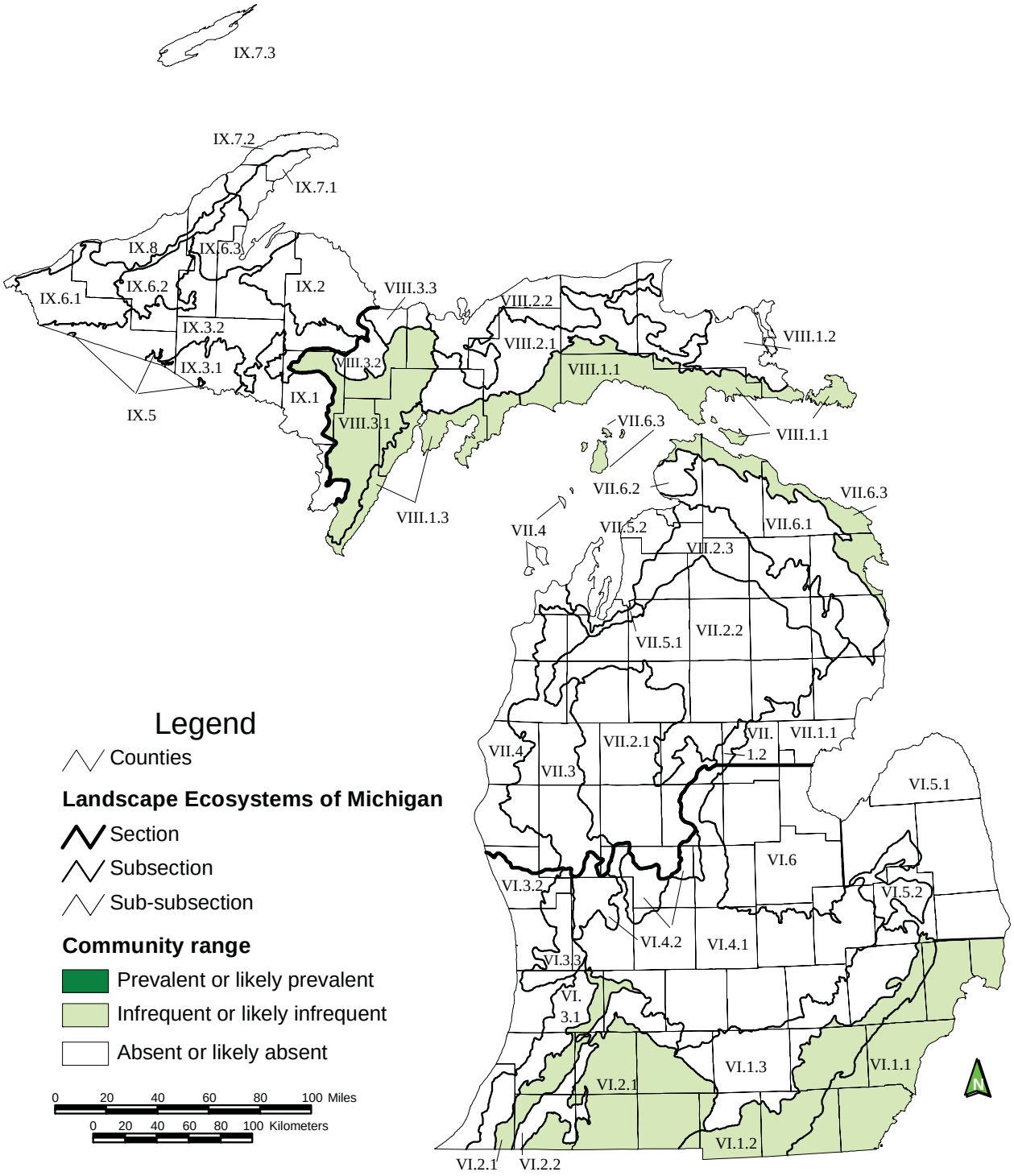
Lost Nation Bog. Photos by Joshua G. Cohen.



1998 aerial photograph of Lost Nation Bog.

CAVE

Overview: Cave is a naturally occurring cavity beneath the earth's surface, often with an opening to the surface. The community is characterized by little or no light, no primary producers, and biotic communities of one or two trophic levels that import energy from outside the system. In Michigan, naturally occurring caves include three karst features found in the eastern Upper Peninsula and one sandstone cave found in the southeast Lower Peninsula. Caves are subterranean depressions in the landscape that form following the dissolution and collapse of subsurface limestone, dolomite, or gypsum or the erosion of sediment and sandstone following carving by moving water (Kost et al. 2007, Cohen et al. 2014a).



Map 2. Distribution of cave in Michigan (Albert et al. 2008).

2. Sile Doty Cave
Natural Community Type: Cave
Rank: G4? S1, vulnerable to secure globally and secure within the state
Element Occurrence Rank: C
Size: 0.9 acres
Location: Compartment 3, Stand 35
Element Occurrence Identification Number: 20175

Site Description: This small sandstone cave occurs along the lower margin of a steep, south-facing morainal slope above a small outwash channel with a groundwater fed stream. Sandstone caves form following erosion of sediments and sandstone by moving water. It is likely that this cave formed through water erosion over hundreds of years. The cave includes two distinct caverns or rooms and has three entrances. The cave ranges from one to 1.5 meters (3 to 5 ft) tall and is approximately two by four meters (6 by 12 ft). Sands within the cave are fine- to medium-textured and are alkaline (pH 8.0). At the time of survey in late March, sections of the cave floor were covered by a sheet of ice. It appeared that a portion of the cave had collapsed. Historically, a larger cave also occurred in the vicinity but was destroyed to prevent the local brigand Sile Doty from using it to hide stolen horses in the mid-1800s. This cave occurs just north of Sile Doty Woods mesic southern forest (EO ID 19886).

Threats: Numerous anthropogenic disturbances were noted within and around the cave. People have been entering the cave and chipping away the sandstone. A plastic tarp was buried in the ground above one of the cave entrances in an unsuccessful attempt to block off the entrance. As noted above, cave within the area may have been destroyed to prevent illicit activity.

Management Recommendations: This cave represents the sole element occurrence of cave within the southern Lower Peninsula. The main management recommendation is to maintain closed canopy forest surrounding the cave and avoid the use of timber harvesting equipment near the cave to prevent the cave from collapsing. Educational signage could be erected to inform the public about caves and discourage anthropogenic abuse. Monitoring should be implemented to determine if the cave is functioning as a hibernaculum for bats.

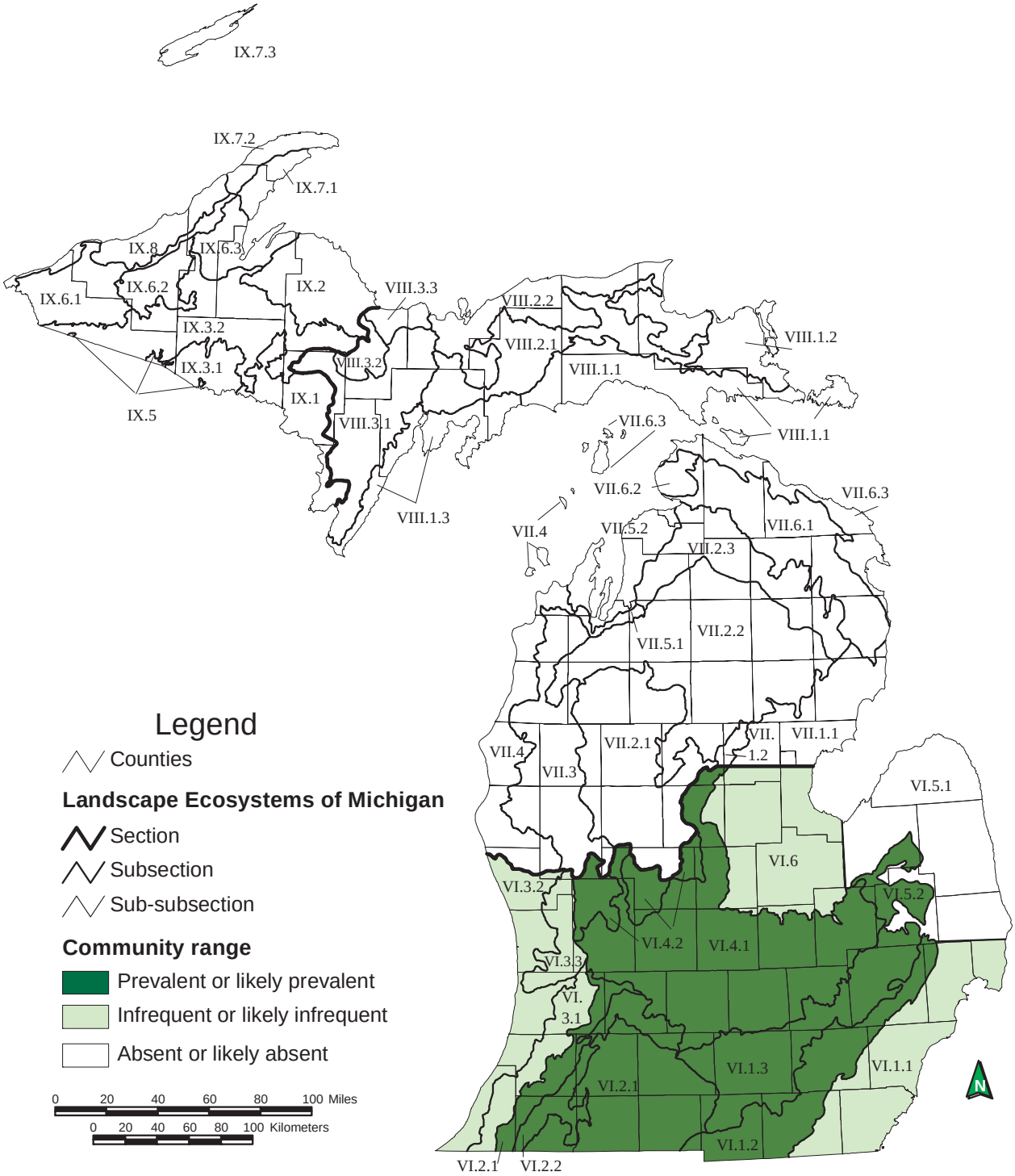
Sile Doty Cave. Photo by Joshua G. Cohen.

Sile Doty Cave. Photos by Joshua G. Cohen.

1998 aerial photograph of Sile Doty Cave.

DRY-MESIC SOUTHERN FOREST

Overview: Dry-mesic southern forest is an oak-dominated, fire-dependent forest that occurs in the southern Lower Peninsula on glacial outwash plains, coarse-textured moraines, sandy lakeplains, kettle-kame topography, and sand dunes. The community is found on slightly acidic to circumneutral sandy loams or loams. Historically, frequent fires maintained semi-open conditions and promoted oak regeneration and plant diversity. Windthrow and insect outbreaks and pathogens associated with oak decline also influence species composition and community structure. Dry-mesic southern forest is dominated by oaks or oaks and hickories, particularly white oak (*Quercus alba*), black oak (*Q. velutina*), red oak (*Q. rubra*), pignut hickory (*Carya glabra*), and shagbark hickory (*C. ovata*) (Kost et al. 2007, Cohen et al. 2014a).



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

3. Burst-Dam Woods
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 55 acres
Location: Compartment 1, Stand 49; Compartment 2 stands 2, 12, and 16
Element Occurrence Identification Number: 19805

Site Description: This dry-mesic southern forest occurs on somewhat steep to very steep ground moraine with variable aspects and glacial erratics throughout. The soils are medium-textured, slightly acidic (pH 6.0-6.5), loamy sand. The forest is characterized by mature and maturing, large trees, and moderate volumes of coarse woody debris. Diameters of the canopy cohort range from 40 to 70 cm (15 to 28 in) with some larger trees reaching 100 cm (39 in). A white oak (*Quercus alba*) was cored and estimated to be 149 years old and a red oak (*Q. rubra*) was cored and estimated to be 125 years old. Numerous vernal pools occur within this forest.

This forest is comprised of 4 portions. The southeastern block is the largest, most diverse, and most intact, however, some areas of logging have occurred at the margins. The southwestern block is smaller, has the largest trees, and has a history of cattle grazing with compacted soil and areas of very little ground cover and erosion on the steepest slopes. The northwestern block is the second largest block of this EO and has large mature trees. The northeastern block is very small but has large, mature trees and is separated from the southeastern block by a narrow, linear wetland along a small creek. The North Country Trail runs through both southern blocks of this EO.

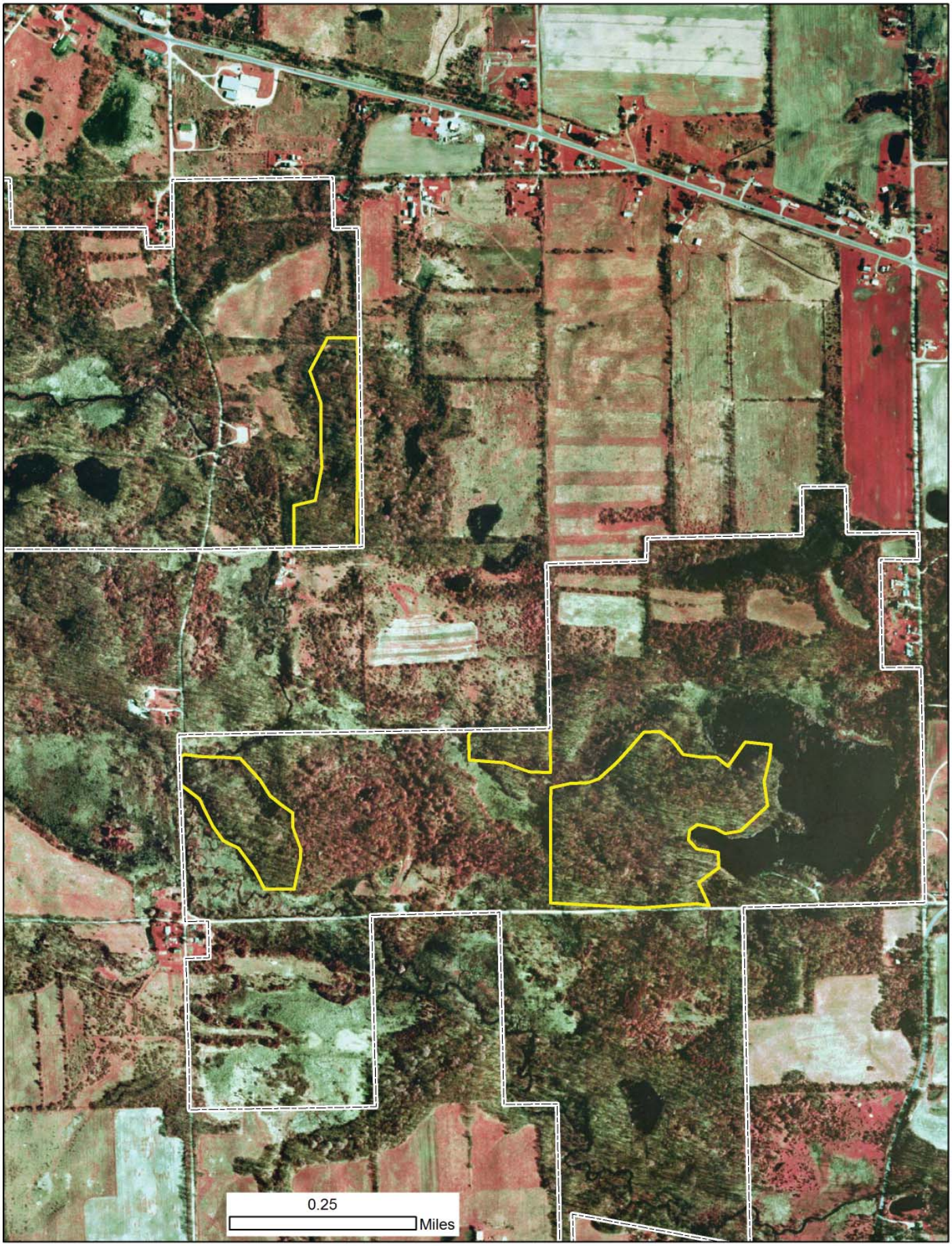
The closed canopy is dominated by mixed oaks and hickories: primarily red oak (*Quercus rubra*), white oak (*Q. alba*), black oak (*Q. velutina*), and shagbark hickory (*Carya ovata*). Other canopy codominants are bitternut hickory (*C.* cordiformis), pignut hickory (*C. glabra*), beech (*Fagus grandifolia*), black cherry (*Prunus serotina*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), and tulip poplar (*Lireodendron tulipifera*). Slope and aspect influence species composition and structure. Steeper slopes support drier species and flatter areas with vernal pools are characterized by more mesic species, especially along the margins of the vernal pools. The subcanopy and tall shrub layer are characterized by ironwood (*Ostrya virginiana*), red maple, sugar maple, white ash (*Fraxinus americana*), American elm (*Ulmus americana*), hickories, beech, flowering dogwood (*Cornus florida*), sassafras (*Sassafras albidum*), and black cherry. Fire suppression is leading to the understory dominance of red maple, white ash, American elm, and black cherry. Invasives are sparse to locally abundant in the understory and ground cover and include multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), and garlic mustard (*Alliaria petiolata*). The low shrub layer is primarily occupied by maple-leaved viburnum (*Viburnum acerifolium*) and prickly gooseberry (*Ribes cynosbati*) with black-haw (*Viburnum prunifolium*, state special concern), red elderberry (*Sambucus racemosa*), multiflora rose, and tree seedlings throughout. Black haw (EO ID 19816) is present within the southeastern block of this forest. Vines are prevalent throughout the forest and include Virginia creeper (*Parthenocissus quinquefolia*), grapes (*Vitis* spp.), poison-ivy (*Toxicodendron radicans*), and greenbriars (*Smilax* spp.). The ground cover is very lush in places and is characterized by sedges (*Carex* spp.), wild sarsaparilla (*Aralia nudicaulis*), wild geranium (*Geranium maculatum*), naked-flower tick-trefoil (*Hylodesmum nudiflorum*), long-awned wood grass (*Brachyelytrum erectum*), lopseed (*Phryma leptostachya*), bluestem goldenrod (*Solidago caesia*), white avens (*Geum canadense*), common trillium (*Trillium grandiflorum*), and downy Solomon seal (*Polygonatum pubescens*).

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by historic land use, logging history, deer herbivory, fire suppression, invasive species, and grazing. In particular, deer herbivory and fire suppression are fundamentally shifting the species composition of this forest and there is no evidence of reproduction for many species. Oak regeneration is low, likely due to fire suppression, mesophytic invasion, competition from invasives, and deer browse pressure. Invasives are scattered in the understory and ground cover and include multiflora rose, autumn olive, black locust (Robinia pseudoacacia), and garlic mustard. Slightly higher densities of multiflora rose and autumn olive seem to be associated with canopy gaps. 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 needs are the reintroduction of fire as a prevalent disturbance factor and the control of invasive species. 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 within the site and also in adjacent forested stands will 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 densities 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 diverse array of species that depend on the vernal pools nested within the forest.

Burst-Dam Woods dry-mesic southern forest. Photo by Jesse M. Lincoln.



1998 aerial photograph of Burst-Dam Woods dry-mesic southern forest.

4. Baw Beese Woods
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 31 acres
Location: Compartment 3, Stand 47
Element Occurrence Identification Number: 19888

Site Description: This dry-mesic southern forest occurs on gently sloping to moderate ground moraine with scattered kettle depressions and variable aspect. The forest is maturing with moderate to large coarse woody debris including snags and downed logs of long-lived species of varying size and decay classes. An 81.5 cm (32 in) red oak (*Quercus rubra*) snag was observed. Species composition, vegetative structure, and successional trajectory are driven by gap-phase dynamics and are also influenced by past selective logging and current fire suppression and deer browse pressure. Several canopy trees were aged: a 67.7 cm (27 in) white oak (*Q. alba*) was estimated to be over 170 years old and a 61.3 cm (24 in) white oak was estimated to be 180 years old. The soils of the dry-mesic southern forest are fine- to medium-textured glacial till characterized as sandy loam and sandy clay loam with surficial soils tending to be slightly more acidic than soils lower in the horizon (pH 5.0-5.5 compared to pH 5.5-6.0). Compared to the mesic southern forest to the north, the soils of the dry-mesic southern forest are finer-textured, more acidic, and less gravelly. A high-quality inundated shrub swamp (Gilbert Road Buttonbush Swamp EO ID 19890) occurs within one of the kettle depressions within the dry-mesic southern forest. An inclusion of high-quality mesic southern forest with red oak and sugar maple (*Acer saccharum*) occurs along a north-facing slope along the northern edge of this EO just south of the adjacent pond.

The closed canopy is dominated by white oak, red oak, and black oak (*Q. velutina*) with canopy associates including hickories (*Carya* spp.). Diameters of the canopy cohort typically range from 50 to 70 cm (20 to 28 in) with some scattered 70 to 100 cm (28 to 39 in) oaks. Canopy composition is variable depending on aspect and slope. The subcanopy is composed of scattered maples (*Acer* spp.), ironwood (*Ostrya virginiana*), hickories, and flowering dogwood (*Cornus florida*). The understory is characterized by witch-hazel (*Hamamelis virginiana*), serviceberries (*Amelanchier* spp.), maples (*Acer* spp.), and flowering dogwood. Seedling white ash (*Fraxinus americana*) are common in the low shrub layer along with maple-leaved (*Viburnum acerifolium*), witch hazel, gooseberries (*Ribes* spp.), and blackberries (*Rubus* spp.). The rare shrub black-haw (*Viburnum prunifolium*, state special concern) was documented within this forest and also just west of the forest (EO ID 20158). The ground cover is diverse with characteristic species including sedges (*Carex* spp.), bluestem goldenrod (*Solidago caesia*), Canada mayflower (*Maianthemum canadense*), Virginia creeper (*Parthenocissus quinquefolia*), wild geranium (*Geranium maculatum*), May apple (*Podophyllum peltatum*), purple meadow-rue (*Thalictrum dasycarpum*), sharp-lobed hepatica (*Hepatica acutiloba*), common trillium (*Trillium grandiflorum*), violets (*Viola* spp.), tick-trefoils (*Desmodium* spp. and *Hylodesmum* spp.), and poison-ivy (*Toxicodendron radicans*).

This forest and the adjacent Squawfield Swamp southern hardwood swamp (EO ID 19891) support a breeding population of Louisiana waterthrush (*Parkesia motacilla*, state special concern) (EO ID 13377).

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, fire suppression, deer herbivory, and past selective logging. Oak regeneration is sparse to absent, likely due to fire suppression, mesophytic invasion, and deer browse pressure. The prevalence of understory and subcanopy maples indicates that the forest is fire suppressed.

Management: The primary management needs are to maintain the closed canopy conditions, allow the forest to continue to mature, and reintroduce fire as a prevalent disturbance factor. In addition, reducing local deer densities will reduce deer browse pressure on the understory and ground cover. Monitoring should be implemented to gauge the impact of deer herbivory and evaluate oak regeneration and non-native plant populations. Maintaining this forest as a closed-canopy system will benefit the breeding population of Louisiana waterthrush documented within this forest.

Baw Beese Woods dry-mesic southern forest. Photos by Joshua G. Cohen.

1998 aerial photograph of Baw Beese Woods dry-mesic southern forest.

5. Shadyside Woods
Natural Community Type: Dry-Mesic Southern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: CD
Size: 17 acres
Location: Compartment 3, Stand 62
Element Occurrence Identification Number: 19889

Site Description: This dry-mesic southern forest occurs on gently sloping to moderate ground moraine with scattered kettle depressions and variable aspect. The forest is maturing with low levels of coarse woody debris. A 74.2 cm (29 in) white oak (Quercus alba) was cored and estimated to be over 140 years old. Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, fire suppression, deer herbivory, invasive species, and past selective logging. Oak regeneration is sparse to absent, likely due to fire suppression, mesophytic invasion and competition, and deer browse pressure. The soils of the dry-mesic southern forest are medium-textured glacial till characterized as sandy loam with some inclusions of sandy clay loam. The soils are acidic (pH 5.5-6.0) with a shallow oak leaf litter over the A horizon. Many of the canopy oaks have been heavily browsed by caterpillars.

The closed canopy is dominated by white oak, red oak (*Q. rubra*), and black oak (*Q. velutina*) with canopy associates including hickories (*Carya* spp.). Diameters of the canopy cohort typically range from 50 to 70 cm (20 to 28 in) with some scattered 70 to 80 cm (20 to 31 in) oaks. The subcanopy is composed of scattered sugar maple (*Acer saccharum*), ironwood (*Ostrya virginiana*), and beech (*Fagus grandifolia*). The understory is dominated by sugar maple advanced regeneration. Additional understory species include witch-hazel (*Hamamelis virginiana*), cherries (*Prunus* spp.), and serviceberries (*Amelanchier* spp.). Seedling sugar maple and white ash (*Fraxinus americana*) are common in the low shrub layer along with maple-leaved (*Viburnum acerifolium*), witch hazel, gooseberries (*Ribes* spp.), blackberries (*Rubus* spp.), and black-haw (*Viburnum prunifolium*, state special concern), which also occurs to the north (EO ID 20157). The ground cover is diverse with characteristic species including sedges (*Carex* spp.), bluestem goldenrod (*Solidago caesia*), Virginia creeper (*Parthenocissus quinquefolia*), enchanter's-nightshade (*Circaea canadensis*), wild geranium (*Geranium maculatum*), black snakeroot (*Sanicula odorata*), May apple (*Podophyllum peltatum*), riverbank grape (*Vitis riparia*), violets (*Viola* spp.), and white lettuce (*Prenanthes alba*).

This forest supports a breeding population of hooded warbler (*Setophaga citrina*, state special concern) (EO ID 13379).

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, fire suppression, deer herbivory, invasive species, and past selective logging. Oak regeneration is sparse to absent, likely due to fire suppression, mesophytic invasion and competition, and deer browse pressure. The prevalence of understory and subcanopy sugar maple indicates that the forest is fire suppressed and without management will convert to mesic southern forest over time. Invasive species noted within the forest include multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), autumn olive (*Elaeagnus umbellata*), and garlic mustard (*Alliaria petiolata*), and are most concentrated along the edges of the occurrence. In addition, high levels of invasive species occur in the adjacent degraded forests and provide a seed source for continued invasive species incursions.

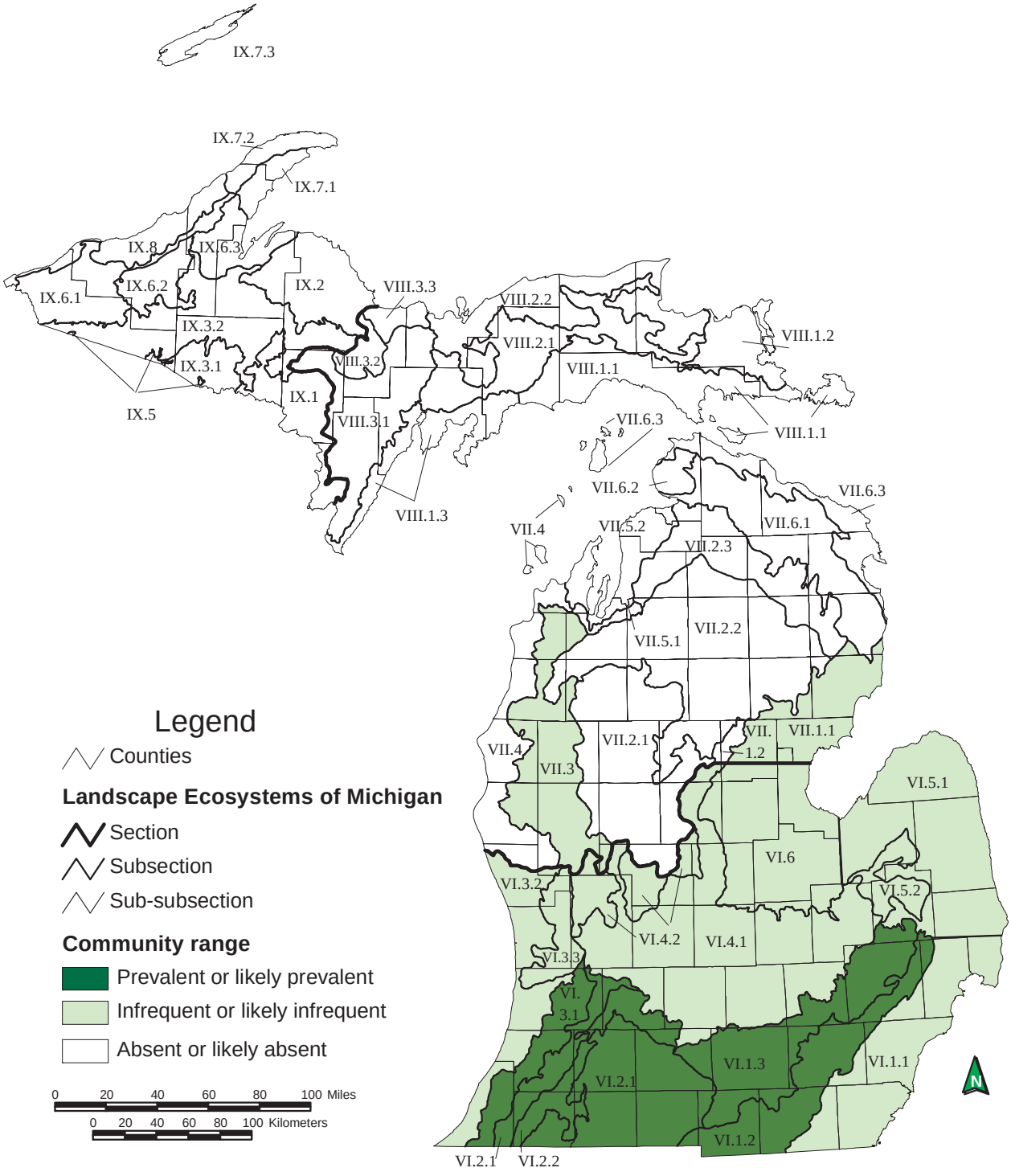
Management Recommendations: The primary management needs are to maintain the closed canopy conditions, allow the forest to continue to mature, reintroduce fire as a prevalent disturbance factor, and control invasive species. Implementation of prescribed fire is best done in the context of landscape-scale fire. Subcanopy and understory maples 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 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 densities 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 hooded warbler documented within this forest.

Shadyside Woods dry-mesic southern forest. Photos by Joshua G. Cohen.

1998 aerial photograph of Shadyside Woods dry-mesic southern forest.

INUNDATED SHRUB SWAMP

Overview: Inundated shrub swamp is a shrub-dominated wetland that occurs in small kettles and depressions throughout the southern Lower Peninsula. The community typically develops on shallow, saturated or inundated mucks over a variety of mineral soils from sands to silty or sandy clays. Water depth varies seasonally and from year to year. Natural processes that influence species composition and community structure include water level fluctuations and prolonged flooding. Inundated shrub swamp is dominated by buttonbush (*Cephalanthus occidentalis*). The community is often surrounded by a shallow moat of open water covered by small duckweed (*Lemna minor*) and ringed by a band of wetland trees. Herbaceous cover varies with depth and duration of inundation (Kost et al. 2007, Cohen et al. 2014a).



Map 4. Distribution of inundated shrub swamp in Michigan (Albert et al. 2008).

6. Gilbert Road Buttonbush Swamp
Natural Community Type: Inundated Shrub Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 0.4 acres
Location: Compartment 3, Stand 47
Element Occurrence Identification Number: 19890

Site Description: This inundated shrub swamp occurs in a kettle depression nested within a high-quality dry-mesic southern forest (Baw Beese Woods dry-mesic southern forest, EO ID 19888) on rolling ground moraine. Soils of the inundated shrub swamp are shallow, circumneutral (pH 7.0) mucks over circumneutral (pH 7.0) clay. Water depths are variable depending on the year and the season. In mid-June, the water levels were observed to range from 20 to 50 cm (8 to 20 in). Within the wetland, water pools for prolonged periods of time due to the impermeable clay layer in the soil profile. Water enters the depressions primarily through precipitation but also from groundwater seepage from the adjacent forested slopes. The flooded conditions limit tree establishment and growth. The base of buttonbush (*Cephalanthus occidentalis*), tree boles, and coarse woody debris that has fallen into the depressions from the surrounding uplands and swamp margins provide critical substrate for plant establishment and important habitat for herptiles and other animals.

The inundated shrub swamp is dominated by buttonbush. Buttonbush ranges in height from one to three meters. Water covers over 100% of the depression and buttonbush cover is between 50 to 65%. The margins of the kettle depressions support a sparse overstory of red maple (*Acer rubrum*), American elm (*Ulmus americana*), and swamp white oak (*Quercus bicolor*) (including a 96 cm or 38 in tree). The herbaceous layer is sparse due to frequent and prolonged flooding and the limitation of sites for plant establishment and growth. Characteristic ground cover species include false nettle (*Boehmeria cylindrica*) and nodding bur-marigold (*Bidens cernua*).

Threats: Species composition, vegetative structure, and successional trajectory are influenced by natural processes. No current threats were observed during the survey.

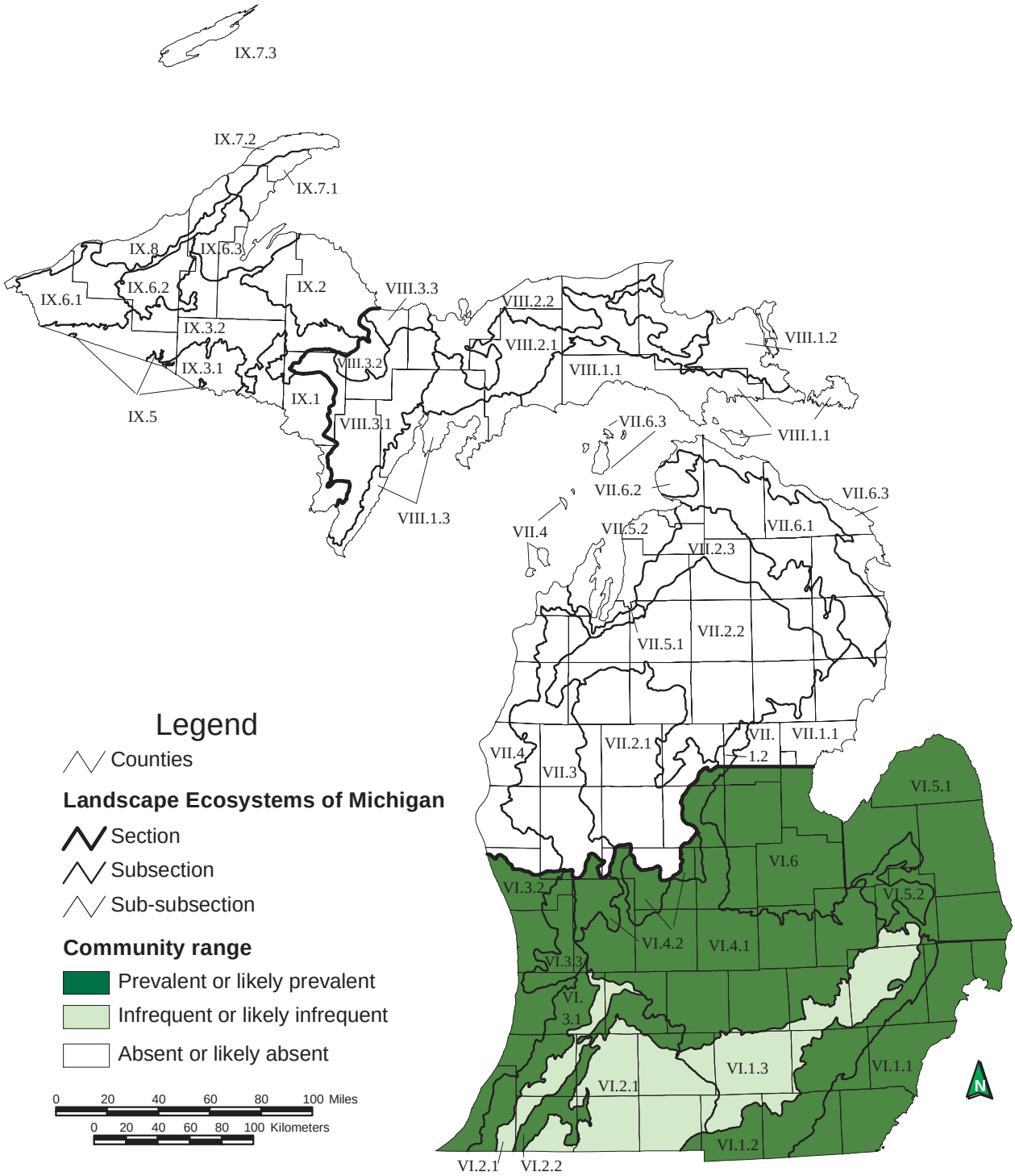
Management Recommendations: The primary management needs are to maintain a forested buffer surrounding the inundated shrub swamp to preserve the wetland's hydrology and to implement monitoring for invasive species.

Gilbert Road Buttonbush Swamp. Photo by Joshua G. Cohen.

1998 aerial photograph of Gilbert Road Buttonbush Swamp.

MESIC SOUTHERN FOREST

Overview: Mesic southern forest is a hardwood forest found throughout the southern Lower Peninsula on a wide variety of landforms. The community is most prevalent on gently rolling ground moraine but also occurs on flat glacial outwash plains and lakeplains, kettle-kame topography, and sand dunes. Soils vary widely but are typically well-drained loams with high water-holding capacity and high nutrient content. Frequent, small-scale windthrow events (i.e., gap-phase dynamics) promote species diversity and allow for the regeneration of shade-tolerant canopy species. Historically, mesic southern forest occurred as a matrix system, dominating vast areas of level to rolling, loamy uplands of southern Lower Michigan. These forests were multi-generational, with old-growth conditions lasting many centuries. Mesic southern forest is dominated by American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) (Kost et al. 2007, Cohen et al. 2014a).



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

7. Pittsford Millpond Woods
Natural Community Type: Mesic Southern Forest
Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: C
Size: 42 acres
Location: Compartment 3, Stand 14
Element Occurrence Identification Number: 19887

Site Description: This mesic southern forest occurs on rolling ground moraine of variable aspect with gentle to moderate topography and numerous bowls and vernal pools throughout. The forest is maturing with moderate volumes of coarse woody debris. Vernal pools and glacial erratics occur throughout the forest. The vernal pools are of varying size with some still holding water in mid-June and others drawn down. Species composition, vegetative structure, and successional trajectory are driven by gap-phase dynamics and are also influenced by past selective logging and grazing. The mesic southern forest is diverse both structurally and floristically. Several canopy trees were aged: a 67.3 cm (26 in) sugar maple (*Acer saccharum*) was estimated to be 150 to 200 years old, a 66.4 cm (26 in) red oak (*Quercus rubra*) was estimated to be 117 years old, a 80.2 cm (32 in) red oak was estimated to be 100 years old, a 92 cm (36 in) red oak was estimated to be 110 years old, and a 62.3 cm (25 in) white oak (*Quercus alba*) was estimated to be 112 years old. The soils of the mesic southern forest are fine- to medium-textured glacial till characterized as slightly acidic (pH 6.5-6.8) sandy loam. The A horizon was estimated to be 12 cm (5 in) deep. Soils in one of the vernal pools were characterized by shallow, slightly acidic (10 cm or 4 in, pH 6.5) peats over slightly acidic clay (pH 6.5).

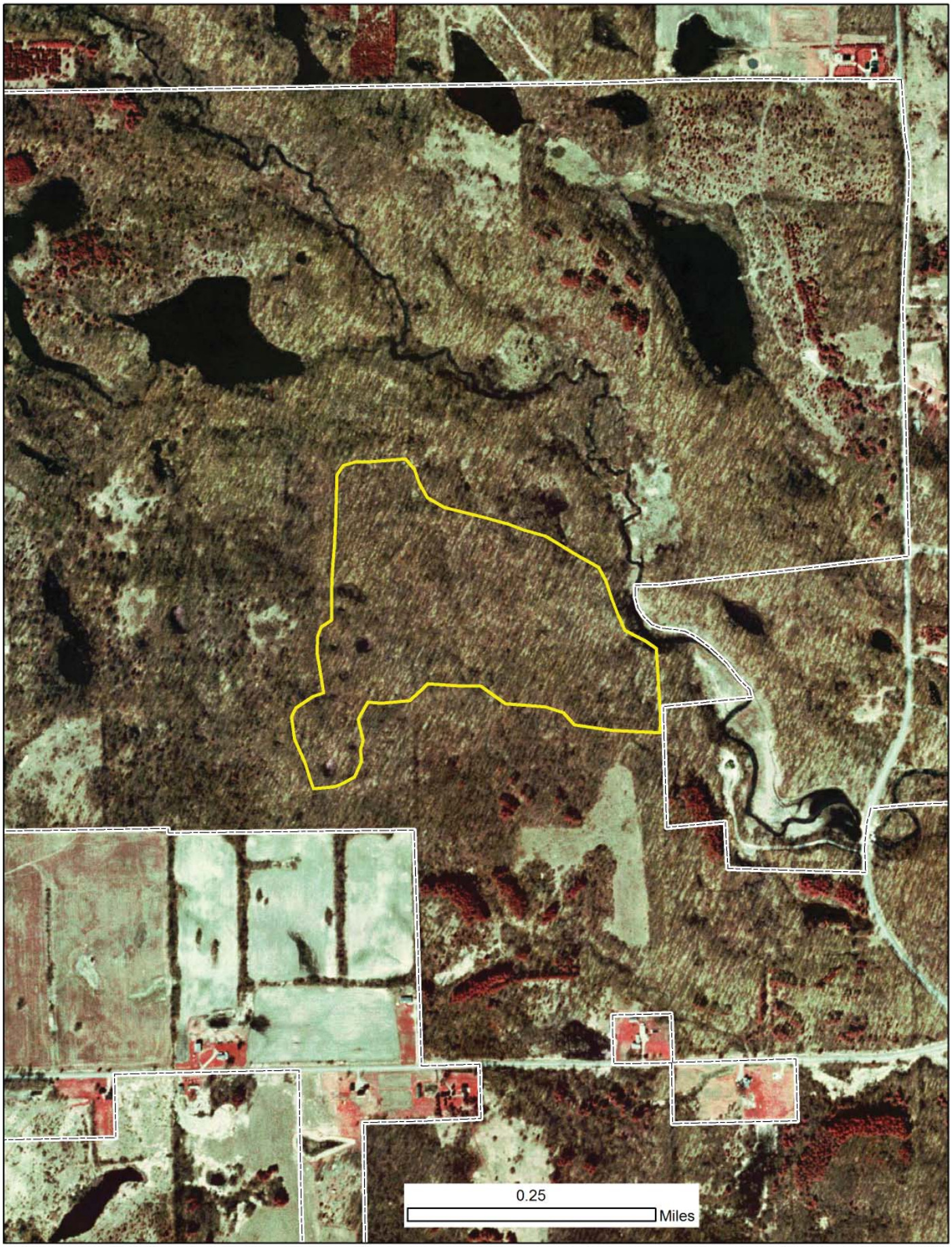
The closed canopy is dominated by sugar maple, white oak, and red oak with canopy associates including basswood (*Tilia americana*), hickories (*Carya* spp.), beech (*Fagus grandifolia*), black maple (*Acer nigrum*), and black walnut (*Juglans nigra*). Canopy composition is variable depending on slope, aspect, and local soil conditions. Diameters of the canopy cohort typically range from 50 to 80 cm (20 to 31 in) with some scattered 80 to 100 cm (31 to 39 in) oaks and sugar maple. The mesic soils provide excellent growing conditions with many canopy trees reaching 27 to 30 m (90 to 100 ft). White ash (*Fraxinus americana*) snags occur scattered throughout, killed by emerald ash borer. The subcanopy is composed of scattered maples (*Acer* spp.), ironwood (*Ostrya virginiana*), hickories, basswood, and beech. Shade-tolerant regeneration is also prevalent in the understory with numerous sugar maple saplings. Understory associates include witch-hazel (*Hamamelis virginiana*), ironwood, and maple-leaved viburnum (*Viburnum acerifolium*). Seedling sugar maple and white ash are common in the low shrub layer along with gooseberries (*Ribes* spp.), blackberries (*Rubus* spp.), and black-haw (*Viburnum prunifolium*, state special concern), which also occurs to the east of the forest (EO ID 20156). The ground cover is diverse with characteristic species including blue cohosh (*Caulophyllum thalictroides*), wild geranium (*Geranium maculatum*), hairy sweet cicely (*Osmorhiza claytonii*), sharp-lobed hepatica (*Hepatica acutiloba*), bloodroot (*Sanguinaria canadensis*), goldenrods (*Solidago* spp.), and sugar maple seedlings. Additional common species include large-flowered bellwort (*Uvularia grandiflora*), black snakeroot (*Sanicula odorata*), sedges (*Carex* spp.), and waterleafs (*Hydrophyllum* spp.). Vines are common within the forest and include riverbank grape (*Vitis riparia*), Virginia creeper (*Parthenocissus quinquefolia*), and poison-ivy (*Toxicodendron radicans*).

This forest supports breeding populations of hooded warbler (*Setophaga citrina*, state special concern) (EO ID 13379) and cerulean warbler (*Setophaga cerulea*, state threatened) (EO ID 13378).

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, past logging and grazing history, invasive species, and deer herbivory. The forest appears to have been selectively logged and was also likely grazed (fencing within the forest suggests that grazing was likely). Emerald ash borer has killed the canopy ash within this forest. Multiflora rose (*Rosa multiflora*) occurs locally. Deer browse was noted throughout and deer herbivory has likely impacted species composition and structure. Non-native earthworms were noted within the soil.

Management Recommendations: The primary management needs are to maintain the closed canopy conditions and allow the forest to continue to mature and control the invasive species. Invasive shrubs (i.e., multiflora rose) need to be cut and herbicided. Reducing local deer densities is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented for efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate regeneration. Maintaining this forest as a closed-canopy system will benefit the breeding populations of hooded warbler and cerulean warbler documented within this forest and the diverse array of species that depend on the vernal pools nested within the forest.

Pittsford Millpond Woods mesic southern forest. Photos by Joshua G. Cohen.



1998 aerial photograph of Pittsford Millpond Woods mesic southern forest.

8. Sile Doty Woods
Natural Community Type: Mesic Southern Forest
Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: C
Size: 42 acres
Location: Compartment 3, Stand 37
Element Occurrence Identification Number: 19886

Site Description: This mesic southern forest occurs on moderate to steep end moraine of variable aspect with numerous bowls and vernal pools throughout. The forest is maturing with moderate volumes of coarse woody debris including snags and downed logs of long-lived species of varying size and decay classes. The mesic southern forest is diverse both structurally and floristically. Species composition, vegetative structure, and successional trajectory are driven by gap-phase dynamics and are also influenced by past selective logging and grazing. Several canopy trees were aged: a 50 cm (19 in) black oak (*Quercus velutina*) was estimated to be over 160 years old and a 79.5 (31 in) cm red oak (*Q. rubra*) was estimated to be 150 to 160 years old. In addition to coarse woody debris, common windthrow events have also generated pit and mound topography that contributes to the forest's microtopography. The soils of the mesic southern forest are medium- to coarse-textured glacial till characterized as sandy loam and sandy clay loams with clays being more prevalent in the top layer of soil. As a result, acidity increases with soil depth. Surficial sandy clay loams tend to be slightly acidic to circumneutral (pH 6.8-7.0) with soils lower in the horizon (10 to 15 cm deep) being more acidic (pH 5.5-6.5). In addition, the soils are gravelly and scattered glacial erratics occur throughout the forest. A ground-water fed stream occurs along the base of this mesic southern forest. Just north of the forest and this stream, there is a small cave (Sile Doty Cave EO ID 20175) in Compartment 3, Stand 35. The cave is along the lower margin of a steep, south-facing slope above a small outwash channel. Apparently a larger cave also occurred in the vicinity but was destroyed to prevent the local infamous outlaw Sile Doty from using it to hide stolen horses in the mid-1800s.

The closed canopy of the mesic southern forest is dominated by red oak, sugar maple (*Acer saccharum*), and beech (*Fagus grandifolia*) with canopy associates including basswood (*Tilia americana*), tulip poplar (*Lireodendron tulipifera*), and white oak (*Quercus alba*). Canopy composition is variable depending on slope, aspect, and local soil conditions. Diameters of the canopy cohort typically range from 50 to 80 cm (20 to 31 in) with some scattered 80 to 100 cm (31 to 39 in) oaks and tulip poplar. The mesic soils provide excellent growing conditions with many canopy trees reaching 27 to 30 m (90 to 100 ft). White ash (*Fraxinus americana*) snags occur scattered throughout, killed by emerald ash borer. The subcanopy is composed of scattered sugar maple, ironwood (*Ostrya virginiana*), hickories (*Carya* spp.), and beech. Shade-tolerant regeneration is also prevalent in the understory with numerous saplings of sugar maple and beech (not as common as sugar maple). The understory is diverse and dense. Understory associates include witch-hazel (*Hamamelis virginiana*), musclewood (*Carpinus caroliniana*), ironwood, white ash, hickories, and maple-leaved (*Viburnum acerifolium*). Seedling sugar maple and white ash are common in the low shrub layer along with gooseberries (*Ribes* spp.), blackberries (*Rubus* spp.), and leatherwood (*Dirca palustris*). The ground cover is diverse with characteristic species including blue cohosh (*Caulophyllum thalictroides*), wild geranium (*Geranium maculatum*), hairy sweet cicely (*Osmorhiza claytonii*), sharp-lobed hepatica (*Hepatica acutiloba*), bloodroot (*Sanguinaria canadensis*), May apple (*Podophyllum peltatum*), sedges (*Carex* spp.), and false spikenard (*Maianthemum racemosum*). Additional common species include purple meadow-rue (*Thalictrum dasycarpum*), common trillium (*Trillium grandiflorum*), violets (*Viola* spp.), downy Solomon seal (*Polygonatum pubescens*), enchanter's-nightshade (*Circaea canadensis*), hairy sweet cicely (*Osmorhiza claytonii*), zigzag goldenrod (*Solidago flexicaulis*), maidenhair fern (*Adiantum pedatum*), doll's eyes (*Actaea pachypoda*), and large-leaved aster (*Eurybia macrophylla*). Vines are common within the forest and include riverbank grape (*Vitis riparia*), Virginia creeper (*Parthenocissus quinquefolia*), and poison-ivy (*Toxicodendron radicans*). Portions of the forest with north facing aspects tend to support more mesic species. Areas of seepage along the base of steep slopes support skunk-cabbage (*Symplocarpus foetidus*) and wood nettle (*Laportea canadensis*).

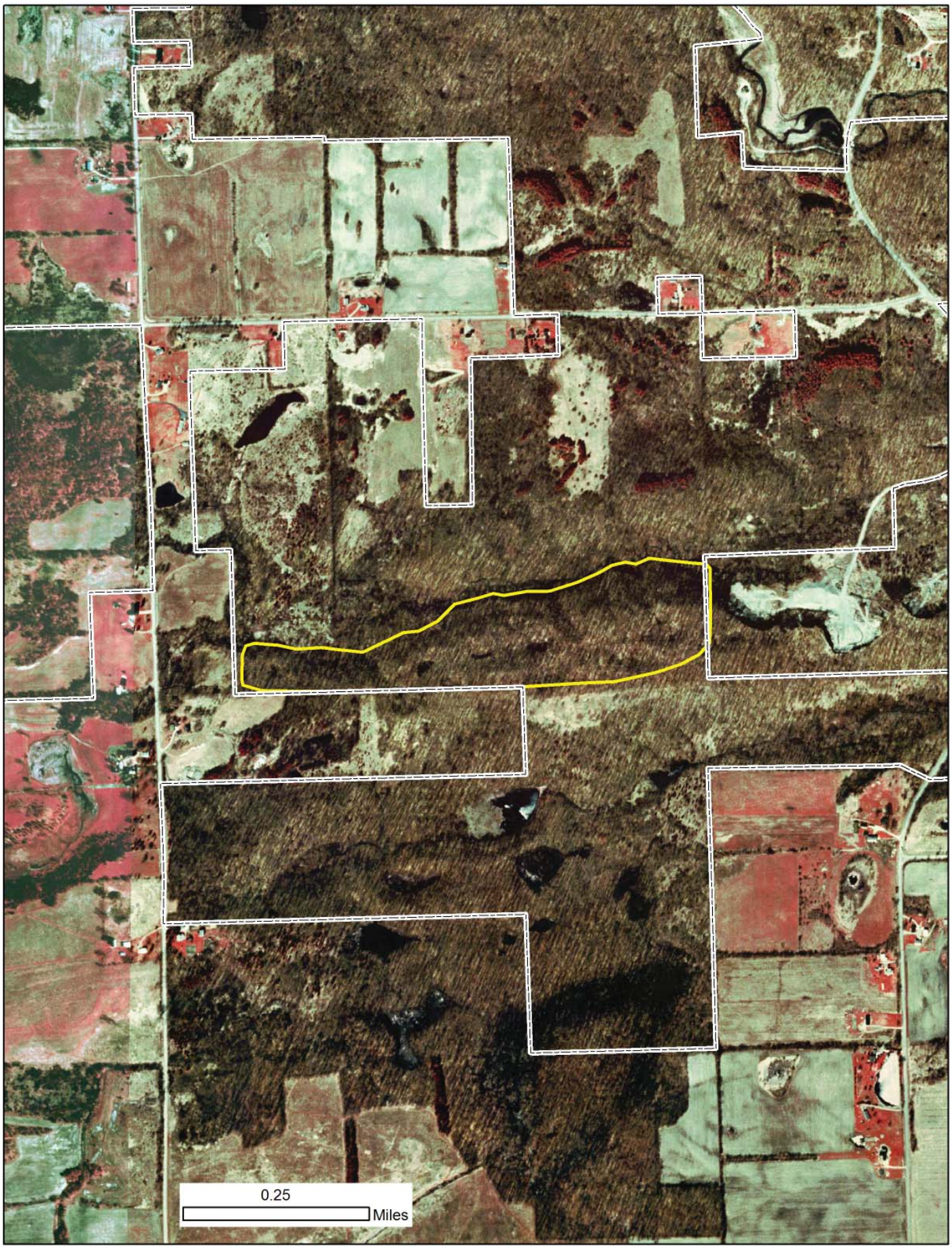
This forest supports a breeding population of hooded warbler (*Setophaga citrina*, state special concern) (EO ID 13379) and Louisiana waterthrush (*Parkesia motacilla*, state special concern) (EO ID 13377) occurs just north of the forest.

Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, past logging and grazing history, invasive species, and deer herbivory. The forest appears to have been selectively logged and was also likely grazed (fencing within the forest suggests that grazing was likely). Emerald ash borer has killed the

canopy ash within this forest. Garlic mustard (*Alliaria petiolata*) is locally common, especially along the hiking trail and multiflora rose (*Rosa multiflora*) and honeysuckles (*Lonicera* spp.) are occasional. Deer browse was noted throughout and deer herbivory has likely impacted species composition and structure.

Management Recommendations: The primary management needs are to maintain the closed canopy conditions and allow the forest to continue to mature and control the invasive species. Garlic mustard can be controlled through hand-pulling while invasive shrubs (multiflora rose and honeysuckles) need to be cut and herbicided. Reducing local deer densities is recommended in order to dampen deer browse pressure on the understory and ground cover. Monitoring should be implemented for efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate regeneration. Maintaining this forest as a closed-canopy system will benefit the breeding populations of hooded warbler and Louisiana waterthrush documented within or nearby this forest and the diverse array of species that depend on the vernal pools nested within the forest.

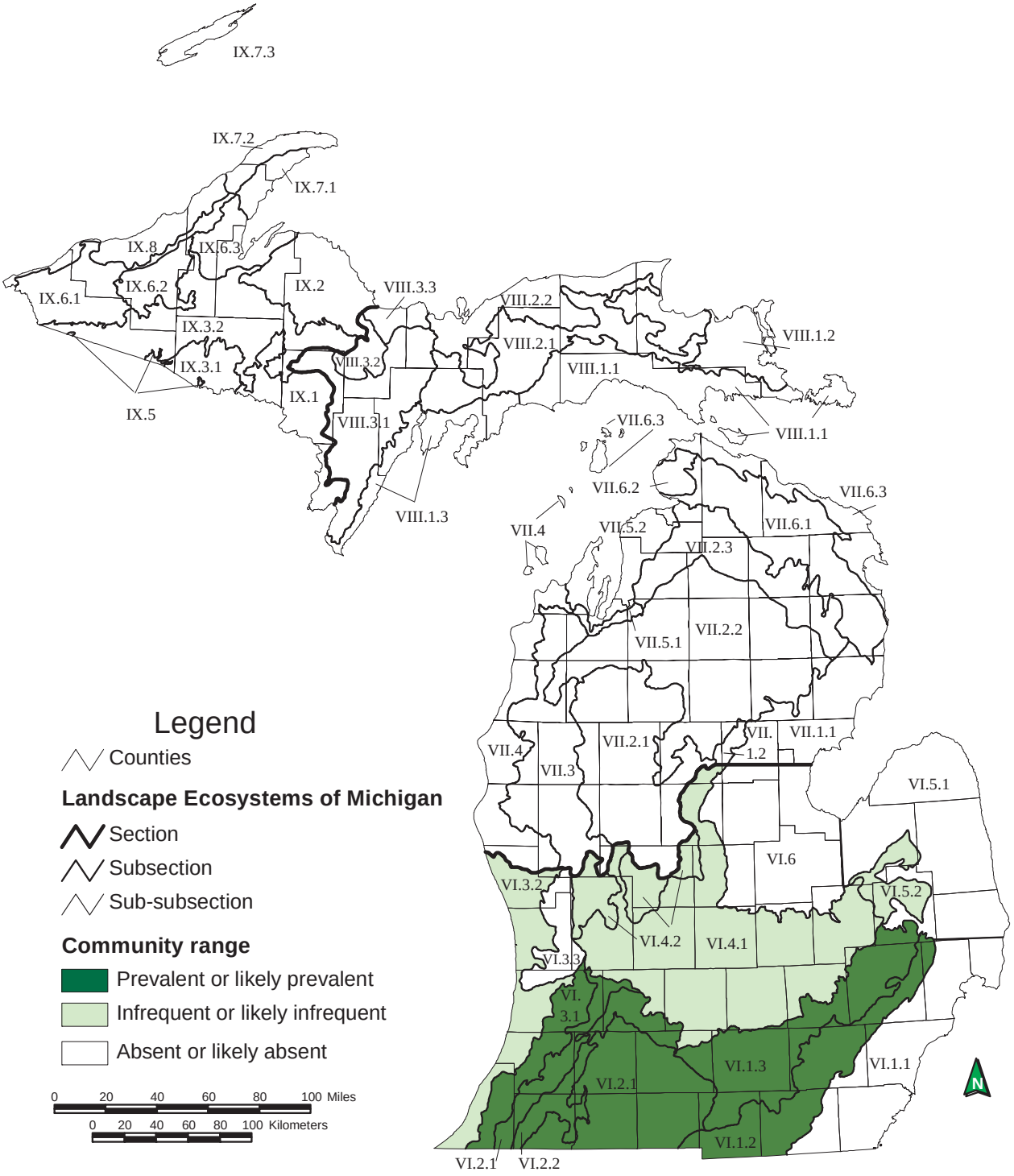
Sile Doty Woods mesic southern forest. Photo by Joshua G. Cohen.



1998 aerial photograph of Sile Doty Woods mesic southern forest.

PRAIRIE FEN

Overview: Prairie fen is a ground-water influenced wetland community dominated by graminoids, forbs, and shrubs. The community occurs in glacial outwash plains and outwash channels on moderately alkaline peat and marl in the southern Lower Peninsula. Prairie fen is often associated with headwater streams and cold, calcareous, groundwater-fed springs at the margins of steep end moraine ridges. Natural processes that determine species composition and community structure include calcareous groundwater seepage and lateral flow, fire, insect outbreaks, and flooding by beaver. Variation in the flow rate and groundwater volume influences vegetation patterning and results in distinct zones of vegetation, some of which support a diversity of calciphilic plants. Prairie fen is 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 (Kost et al. 2007, Cohen et al. 2014a).



Map 6. Distribution of prairie fen in Michigan (Albert et al. 2008).

9. East Branch Fen
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: D
Size: 1.8 acres
Location: Compartment 3, Stand 10
Element Occurrence Identification Number: 19894

Site Description: This small fen occurs along the East Branch of the Saint Joseph River, 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.

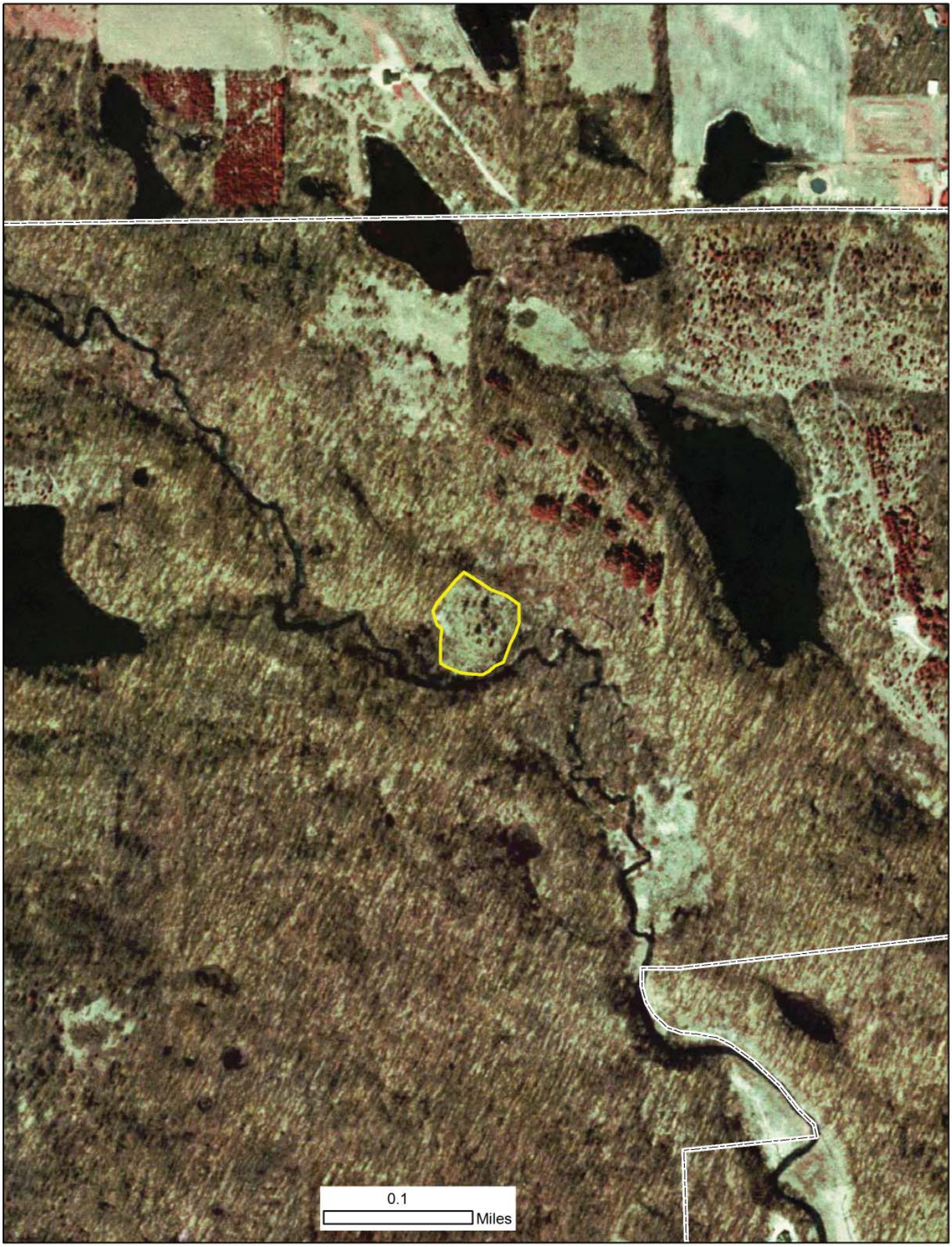
East Branch Fen is a small and shrinking prairie fen that occupies a seepage area along slopes above the East Branch of the Saint Joseph River. Species composition, vegetative structure, and successional trajectory are influenced by groundwater seepage and fire suppression. Fire suppression has led to woody encroachment. A 25.8 cm (10 in) tamarack (*Larix laricina*) was cored and estimated to be over 47 years old. The prairie fen occurs in a wetland complex along the stream that includes southern wet meadow and southern-shrub carr. The soils of the prairie fen are deep (> 1 meter), saturated, alkaline (pH 7.8) peat influenced by cold groundwater seepage. Groundwater rich in mineral content influences the underlying hydrology which generates minerotrophic conditions. Sedge tussocks increase the microheterogeneity of the site and increase the species diversity.

The fen is primarily characterized as shrub fen with pockets of graminoid fen. The herbaceous layer is dominated by tussock sedge (*Carex stricta*), blue-joint (*Calamagrostis canadensis*), marsh fern (*Thelypteris palustris*), common mountain mint (*Pycnanthemum virginianum*), swamp goldenrod (*Solidago patula*), common boneset (*Eupatorium perfoliatum*), and joe-pye-weed (*Eutrochium maculatum*). Additional characteristic ground cover species include skunk-cabbage (*Symplocarpus foetidus*), common water horehound (*Lycopus americanus*), northern bugle weed (*L. uniflorus*), swamp thistle (*Cirsium muticum*), dwarf raspberry (*Rubus pubescens*), fowl manna grass (*Glyceria striata*), purple avens (*Geum rivale*), and marsh pea (*Lathyrus palustris*). The invasive purple loosestrife (*Lythrum salicaria*) was noted within the fen. The low shrub layer is characterized by shrubby cinquefoil (*Dasiphora fruticosa*), alder-leaved buckthorn (*Rhamnus alnifolia*), and swamp gooseberry (*Ribes hirtellum*). Due to fire suppression the fen is being invaded by woody species. Prevalent tall shrubs within the fen include bog birch (*Betula pumila*), swamp rose (*Rosa palustris*), dogwoods (*Cornus* spp.), poison sumac (*Toxicodendron vernix*), willows (*Salix* spp.), spicebush (*Lindera benzoin*), and ninebark (*Physocarpus opulifolius*). Trees invading the fen include tamarack and tulip poplar (*Lireodendron tulipifera*).

Threats: The species composition, vegetative structure, and successional trajectory of the fen are influenced by groundwater seepage and fire suppression. The primary threat to this prairie fen is posed by fire suppression and shrub encroachment of native species and non-native species as well. Invasive species are common in the adjacent uplands and in nearby wetlands. As noted above, purple loosestrife was noted locally within the fen.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment. In addition efforts should be made to control the purple loosestrife. 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.

East Branch Fen. Photos by Joshua G. Cohen.



1998 aerial photograph of East Branch Fen.

10. Lost Nation Fen
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: BC
Size: 28 acres
Location: Compartment 1, Stands 21
Element Occurrence Identification Number: 2833

Site Description: The Lost Nation Fen occurs on sloping peat along headwater streams within outwash north of a moraine. Species composition, vegetative structure, and successional trajectory are influenced by groundwater seepage, fire suppression, and invasive species. Fire suppression has led to woody encroachment. A 9.5 cm (4 in) red-cedar (*Juniperus virginiana*) was cored and estimated to be over 40 years old. The prairie fen occurs in a wetland complex that includes southern wet meadow, southern shrub-carr, and emergent marsh. The soils of the prairie fen are deep (> 1 meter), saturated, alkaline (pH 7.5-8.0), hemic and sapric peats influenced by cold groundwater seepage. Groundwater rich in mineral content influences the underlying hydrology of the fen which generates minerotrophic conditions. Sedge tussocks and sphagnum hummocks increase the microheterogeneity and increase the species diversity of the fen. Numerous braids of headwater streams (many disappearing) and springs occur throughout the fen. The fen is characterized by a diverse and active insect fauna.

The fen includes zones of graminoid fen as well as shrub fen along the wetland margins. The herbaceous layer is dominated by sedges (*Carex stricta*, *C. sterilis*, and *C. exilis*), blue-joint (*Calamagrostis canadensis*), marsh fern (*Thelypteris palustris*), common mountain mint (*Pycnanthemum virginianum*), and goldenrods (*Solidago* spp.). Additional characteristic species include rush aster (*Symphyotrichum boreale*), common boneset (*Eupatorium perfoliatum*), purple meadow-rue (*Thalictrum dasycarpum*), black-eyed Susan (*Rudbeckia fulgida*), marsh pea (*Lathyrus palustris*), skunk-cabbage (*Symplocarpus foetidus*), swamp milkweed (*Asclepias incarnata*), wild mint (*Mentha canadensis*), northern bugle weed (*Lycopus uniflorus*), golden alexanders (*Zizia aurea*), white camas (*Anticlea elegans*), fringed brome (*Bromus ciliatus*), and purple avens (*Geum rivale*). White lady-slipper (*Cypripedium candidum*, state threatened) (EO ID 6605) has been documented within the fen. The invasives purple loosestrife (*Lythrum salicaria*) and European bittersweet (*Solanum dulcamara*) were noted within the fen. The low shrub layer is characterized by shrubby cinquefoil (*Dasiphora fruticosa*), alder-leaved buckthorn (*Rhamnus alnifolia*), swamp gooseberry (*Ribes hirtellum*), and ninebark (*Physocarpus opulifolius*). Due to fire suppression the fen is being invaded by woody species. Prevalent tall shrubs within the fen include bog birch (*Betula pumila*), dogwoods (*Cornus* spp.), poison sumac (*Toxicodendron vernix*), willows (*Salix* spp.), spicebush (*Lindera benzoin*), meadowsweet (*Spiraea alba*), nannyberry (*Viburnum lentago*), and ninebark. Invasive shrubs found within the fen include glossy buckthorn (*Frangula alnus*), common buckthorn (*Rhamnus cathartica*), multiflora rose (*Rosa multiflora*), and autumn olive (*Elaeagnus umbellata*). Scattered trees within the fen include red-cedar (*Juniperus virginiana*), tamarack (*Larix laricina*), trembling aspen (*Populus tremuloides*), tulip tree (*Lireodendron tulipifera*), and American elm (*Ulmus americana*).

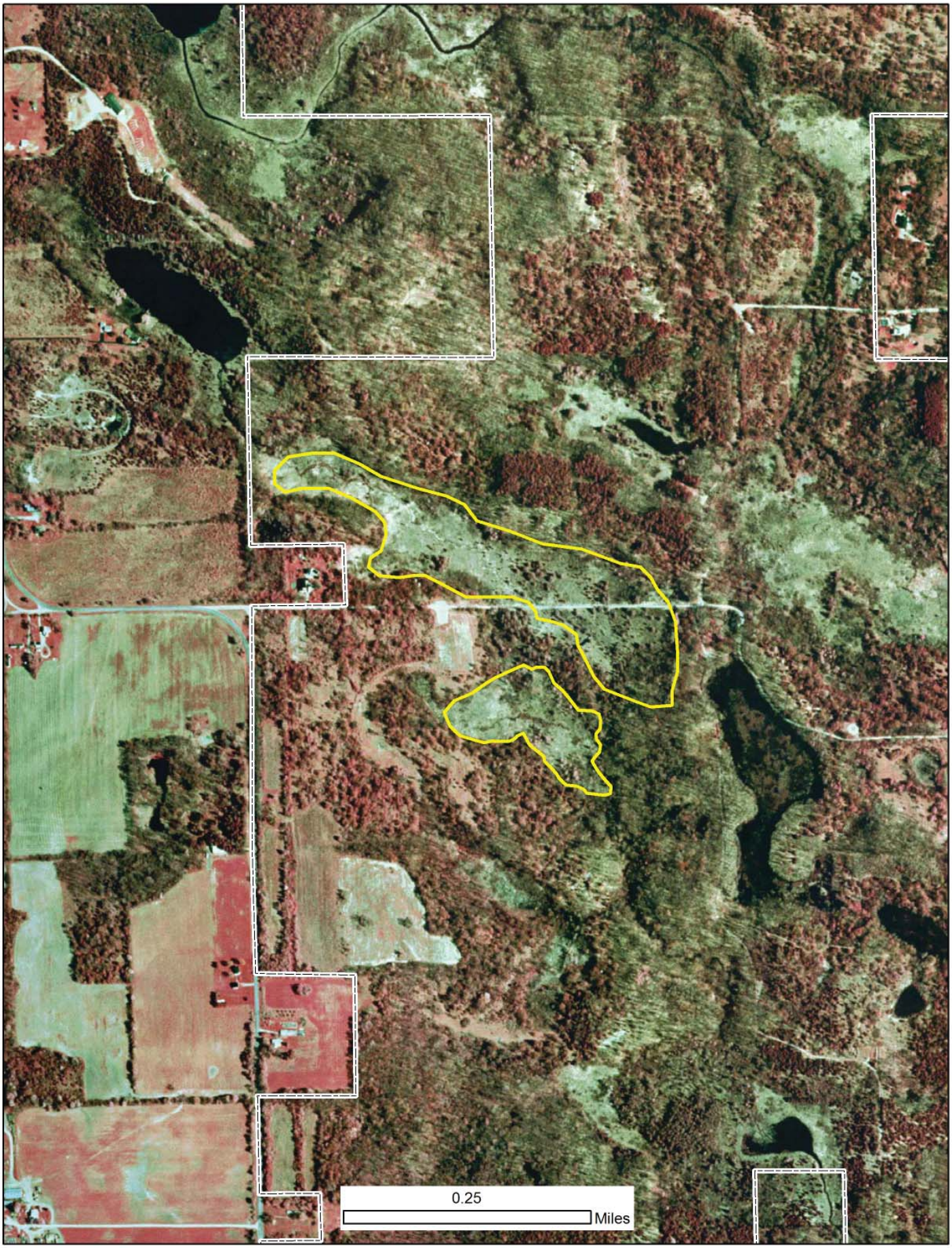
An historical record for wild indigo duskywing (*Erynnis baptisiae*, state special concern, EO ID 12688) was recorded for the section that includes this prairie fen. In addition, tamarack tree cricket (*Oecanthus laricis*, state special concern, EO ID 9053), swamp metalmark (*Calephelis mutica*, state special concern, EO ID 7366), and a rare leafhopper (*Dorydiella kansana*, state special concern, EO ID 17404) have been documented within the fen.

Threats: Species composition, vegetative structure, and successional trajectory are influenced by groundwater seepage, fire suppression, and invasive species. Fire suppression has led to woody encroachment. As noted above, invasive plants found within the fen include glossy buckthorn, common buckthorn, multiflora rose, autumn olive, purple loosestrife, and European bittersweet.

Management Recommendations: The primary management recommendation is to employ prescribed fire to reduce tree and shrub encroachment. Allowing fire to extend into adjacent uplands will also benefit the fen as there are potentially adjacent upland areas where prairie species persist in the seedbank or understory, particularly in the degraded forest and pine plantation to the north (Compartment 1, Stands 19 and 20) as well as the oak forest to the east and south (Compartment 1, Stand 31). Because rare insects have been documented at this prairie fen, if prescribed fire is implemented, rotating non-fire refugia should be established within the fen. In addition to use of prescribed fire, clusters

of buckthorn, autumn olive, tulip tree, red maple, and multiflora rose 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. 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 (*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). Lost Nation Fen has been identified as a potential Focal Area for management for the tamarack tree cricket (Cohen et al. 2014b).

Lost Nation Fen. Photo by Joshua G. Cohen.



1998 aerial photograph of Lost Nation Fen.

11. Osseo Fen
Natural Community Type: Prairie Fen
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 29 acres
Location: Compartment 1, Stands 3, 4, and 7
Element Occurrence Identification Number: 19813

Site Description: Osseo Fen is a large, diverse prairie fen occurring at the margins of a small unnamed lake that is near the headwaters of the St. Joseph River. This fen occurs within a poorly drained outwash channel to the west of a moraine. This prairie fen is part of a larger wetland complex that includes rich tamarack swamp, southern wet meadow, southern shrub-carr, emergent marsh, and submergent marsh. The open wetland complex is characterized by zones of open water, floating aquatic vegetation, emergent marsh, marl flats, sphagnum hummocks, sedge meadow, shrub-carr, and graminoid areas with sparse shrub cover and a high diversity of forbs. Shrub fen occurs along the upper margin and fen meadow occurs in areas of sloping peat. One marl pool occurs within the marl flats. The soils of the prairie fen are deep (> 1 meter), saturated to inundated, alkaline (pH 8.0-8.5) peats that range from fibric to hemic to sapric and occur locally over marl and are influenced by cold groundwater seepage. Moisture and alkalinity increase with peat depth with fibric peats on the sphagnum hummocks being slightly acidic. A ditched creek flows through the wetland complex. Groundwater rich in mineral content influences the underlying hydrology, which generates minerotrophic conditions. Patches of sphagnum mounds and localized sedge tussocks in wet portions of the fen increase the site's microheterogeneity and increase the overall species diversity. Ant mounds occur throughout the site. Ants mix and aerate the soil. Animal trails through the fen provide inundated linear features. The fen is highly diverse due to structural heterogeneity resulting from fine-scale gradients in hydrology. Air photo interpretation indicates that the fen appears to continue to the south onto private property

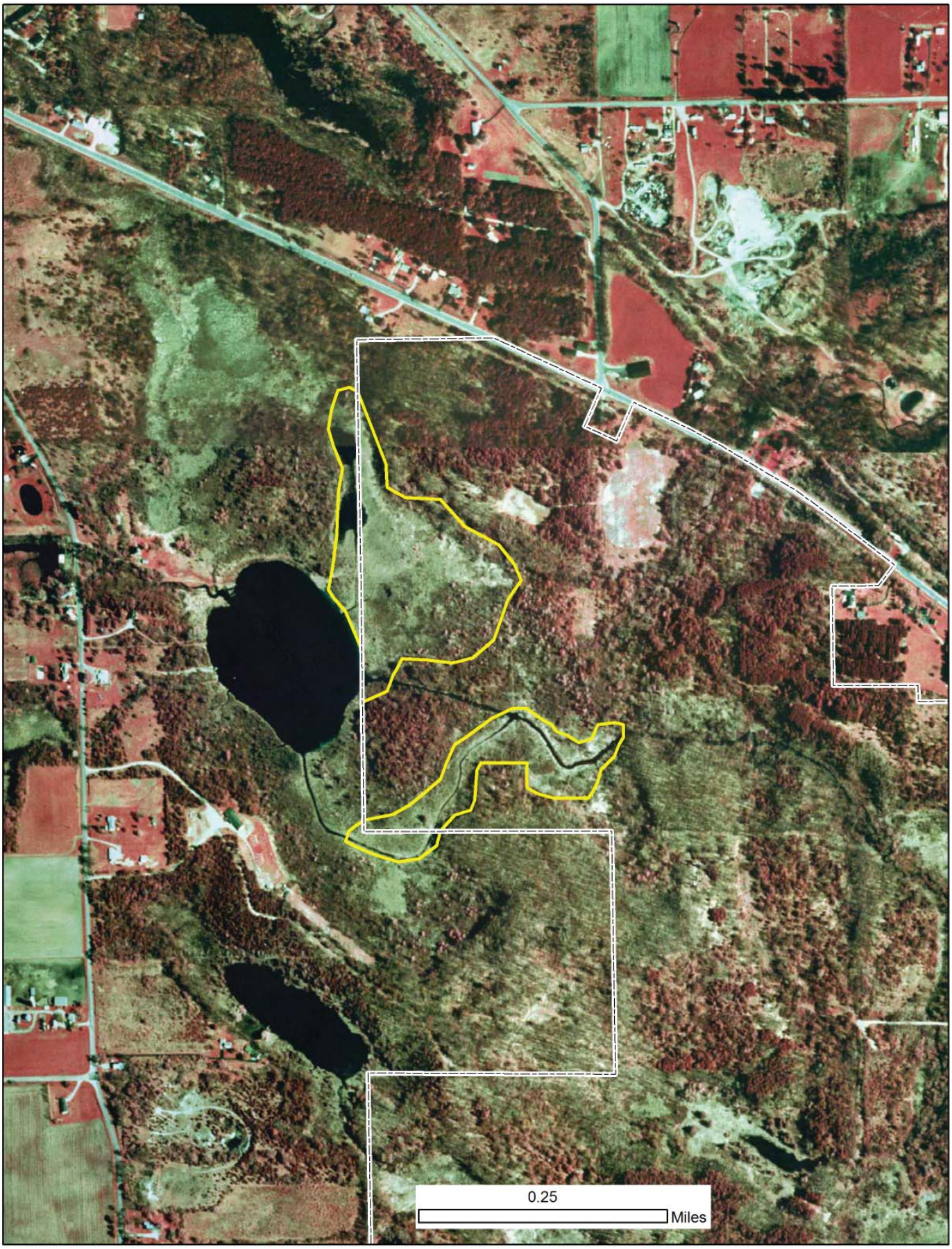
The marl flats of the prairie fen are dominated by beaked spike-rush (*Eleocharis rostellata*), hardstem bulrush (*Schoenoplectus acutus*), wiregrass sedge (*Carex lasiocarpa*), dioecious sedge (*C. sterilis*), northeastern sedge (*C. cryptolepis*), horned bladderwort (*Utricularia cornuta*), and beak-rush (*Rhynchospora capillacea*). Areas of fen meadow and shrub fen are very diverse with dominant herbaceous species including sedges (*Carex stricta*, *C. sterilis*, and *C. lasiocarpa*), goldenrods (*Solidago* spp.), marsh fern (*Thelypteris palustris*), common boneset (*Eupatorium perfoliatum*), swamp milkweed (*Asclepias incarnata*), common mountain mint (*Pycnanthemum virginianum*), golden alexanders (*Zizia aurea*), joe-pye-weed (*Eutrochium maculatum*), common cat-tail (*Typha latifolia*), bog valerian (*Valeriana uliginosa*), and blue-joint (*Calamagrostis canadensis*). Purple loosestrife (*Lythrum salicaria*) is locally common in areas of fen meadow but appears to be succumbing to herbivory by an introduced weevil. Clumps of the invasive narrow-leaved cat-tail (*Typha angustifolia*) occur within portions of the wet meadow zone and are expanding, particularly in the northeastern portion of the fen. The low shrub layer is characterized by shrubby cinquefoil (*Dasiphora fruticosa*), alder-leaved buckthorn (*Rhamnus alnifolia*), and bog birch (*Betula pumila*). The tall shrub layer is patchy to dense with ninebark (*Physocarpus opulifolius*), black chokeberry (*Aronia prunifolia*), bog birch, dogwoods (*Cornus* spp.), willows (*Salix* spp.), and tamarack (*Larix laricina*). The invasive glossy buckthorn (*Frangula alnus*) occurs locally in areas of shrub fen, especially along the upland margin. Shrubs are becoming dominant and dramatically reducing herbaceous diversity, particularly in the southern portions of this complex. Scattered overstory species include tamarack, red-cedar (*Juniperus virginiana*), trembling aspen (*Populus tremuloides*), red maple (*Acer rubrum*), swamp white oak (*Quercus bicolor*), and American elm (*Ulmus americana*).

Threats: Species composition, vegetative structure, and successional trajectory are influenced by groundwater seepage, fire suppression, historical alterations to the wetland hydrology, and competition from invasive species. Neighbors along the northern shore of the lake also appear to be taking off-road vehicles into the fen. Fire suppression has led to woody encroachment and build-up of leaf litter. Areas of shrub fen and fen meadow are quickly decreasing due to fire suppression and woody encroachment by glossy buckthorn (*Frangula alnus*), red maple (*Acer rubrum*), trembling aspen (*Populus tremuloides*), and native shrubs. Invasives are localized but increasing in dominance and include narrow-leaved cat-tail (*Typha angustifolia*) (at margins of sedge meadow), purple loosestrife (*Lythrum salicaria*) (locally common in fen meadow), and glossy buckthorn (infringing from the upper margin and locally common in areas of shrub fen). Deer browse was noted throughout the fen. All of the streams within the fen have been ditched. Portions of the lake within the wetland complex were likely dredged and possibly mined for marl. These alterations probably occurred in the early part of the 20th century and there has likely been little change to the hydrology since. Some of the material removed during the ditching

activities is piled along the stream that drains from the lake to the east. Aerial imagery from 1938 indicates that this wetland was extensively hayed. Finally, uplands surrounding the fen are degraded dry-mesic southern forest with a heavy invasive species component.

Management Recommendations: The primary management recommendation is to control the invasive cat-tails through herbicide treatment. Once the narrow-leaved cat-tail has 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, particularly Compartment 1, Stands 1, 6, 10, and 11. 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. In addition to use of prescribed fire, cutting and herbiciding should be employed to control glossy buckthorn. Targeted buckthorn and shrub removal will be ongoing and should initially be conducted throughout the southern portion of Stand 4. This management activity is most effective in mid-winter when cut stumps are receptive to herbicide and the ground is frozen. A small bridge for foot traffic may need to be erected in the southwest portion of Stand 7 to facilitate stewardship activities. Management of the purple loosestrife population should be continued using biocontrol agents. To avoid negative impacts to potential 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. Monitoring for invasive species should be implemented. Air photo interpretation indicates that portions of the fen occur on adjacent private land that was not surveyed. Pursuit of acquisition of adjacent private lands supporting prairie fen or discussion of compatible management with private landowners is recommended.

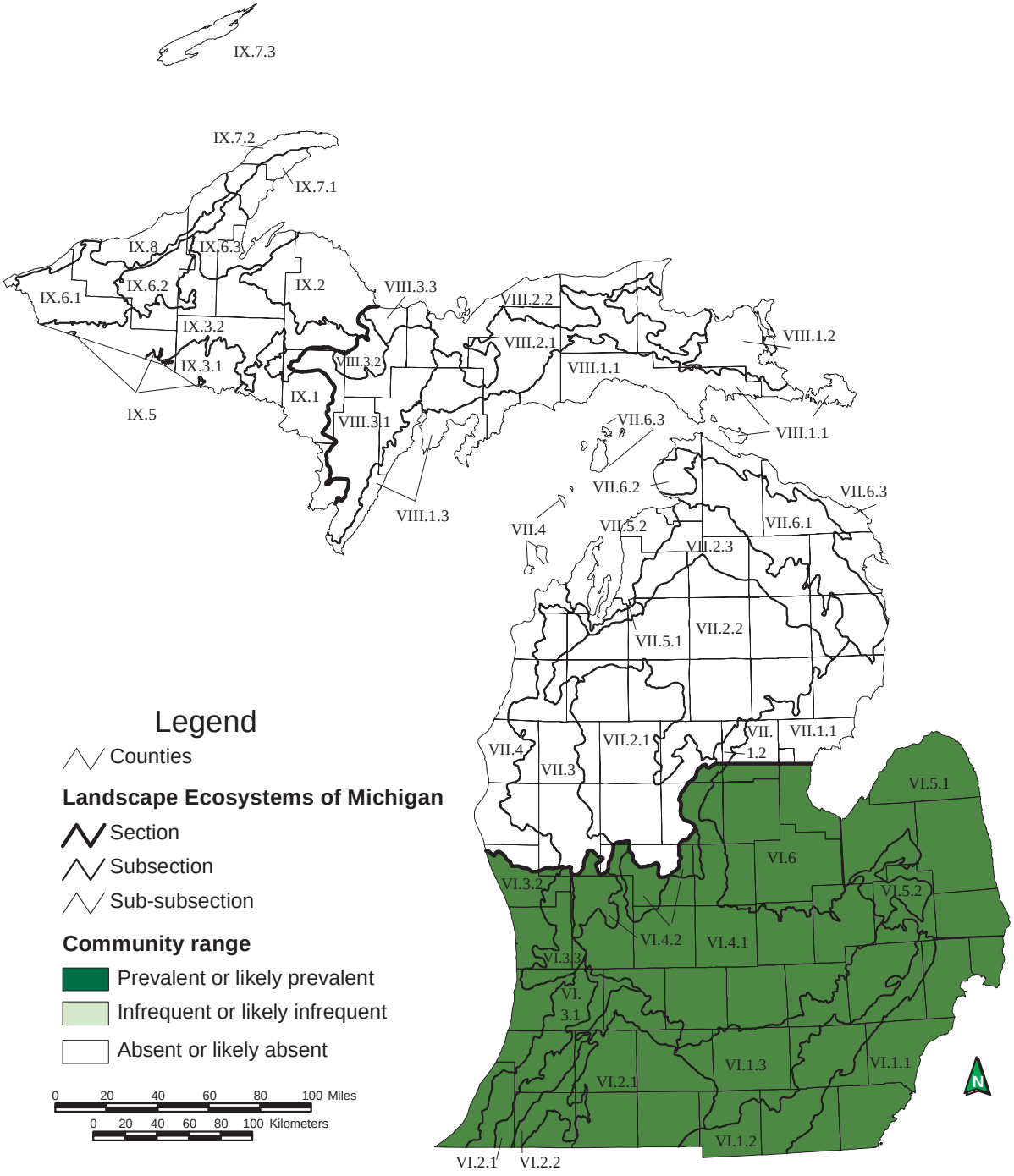
Osseo Fen. Photo by Jesse M. Lincoln.



1998 aerial photograph of Osseo Fen.

SOUTHERN HARDWOOD SWAMP

Overview: Southern hardwood swamp is a groundwater-influenced forested wetland dominated by a mixture of lowland hardwoods that occurs in the southern Lower Peninsula. Southern hardwood swamp occupies shallow depressions and small stream drainages on a variety of landforms. On lakeplains and within depressions on fine- to medium-textured moraines, an underlying impermeable clay lens is often present and allows for prolonged seasonal flooding. The community occurs on a variety of mineral and organic soils that range from acidic to alkaline but are generally circumneutral. Natural processes that influence species composition and community structure include seasonal flooding, flooding by beaver, and windthrow. Canopy dominants include silver maple (*Acer saccharinum*), red maple (*A. rubrum*), swamp white oak (*Quercus bicolor*), and historically, green ash (*Fraxinus pennsylvanica*), black ash (*F. nigra*), and American elm (*Ulmus americana*), which are now largely restricted to the understory due to canopy die-off caused by the inadvertently introduced emerald ash borer (*Agrilus planipennis*) and Dutch elm disease (Kost et al. 2007, Cohen et al. 2014a).



Map 7. Distribution of southern hardwood swamp in Michigan (Albert et al. 2008).

12. Squawfield Swamp
Natural Community Type: Southern Hardwood Swamp
Rank: G3 S3, vulnerable throughout range
Element Occurrence Rank: C
Size: 35 acres
Location: Compartment 3, Stand 52
Element Occurrence Identification Number: 19891

Site Description: This maturing southern hardwood swamp occurs on a flat, poorly drained depression within a morainal landscape. The swamp is seasonally flooded in the spring and as the water recedes, some of the larger pits from windthrows hold water during the growing season. Numerous windthrows within the swamp create light gaps and pit and mound topography and contribute to a moderate coarse woody debris load. Downed logs within the swamp provide substrate for vegetation to establish and grow. Pit and mound topography from windthrow generates hummock and hollow microtopography that generates small-scale gradients in soil moisture and chemistry and increases species diversity. The soils are inundated to saturated, slightly acidic to circumneutral (pH 6.0-7.0) peats of variable depth (50 cm in one location) that overlie slightly acidic (pH 6.0-6.5) sandy clay. A 74 cm (29 in) silver maple (*Acer saccharinum*) was cored and estimated to be 62 years old, a 67.2 cm (26 in) swamp white oak (*Quercus bicolor*) was cored and estimated to be 71 years old, a 68.9 cm (27 in) silver maple was cored and estimated to be 72 years old, and a 66.6 cm (26 in) swamp white oak was cored and estimated to be over 100 years old.

Squawfield Swamp is dominated by silver maple and red maple (*Acer rubrum*) with swamp white oak and yellow birch (*Betula alleghaniensis*) locally dominant. Canopy trees typically range in diameter from 40 to 60 cm (16 to 24 in) with some large swamp white oak and silver maple reaching 70 to 100 cm (28 to 39 in). Prevalent subcanopy species include American elm (*Ulmus americana*), silver maple, red maple, and ashes (*Fraxinus* spp.). The understory is characterized by maples, American elm, ashes, and prickly ash (*Zanthoxylum americanum*). Common species of the low shrub layer are gooseberries (*Ribes* spp.), raspberries (*Rubus* spp.), American elm, and spicebush (*Lindera benzoin*). The ground cover is diverse with characteristic species including wood nettle (*Laportea canadensis*), sensitive fern (*Onoclea sensibilis*), false nettle (*Boehmeria cylindrica*), northern bugle weed (*Lycopus uniflorus*), sedges (*Carex* spp.), lady fern (*Athyrium filix-femina*), white avens (*Geum canadense*), mad-dog skullcap (*Scutellaria lateriflora*), calico aster (*Symphyotrichum lateriflorum*), enchanter's-nightshade (*Circaea canadensis*), turtlehead (*Chelone glabra*), black snakeroot (*Sanicula odorata*), jewelweed (*Impatiens capensis*), riverbank grape (*Vitis riparia*), New York fern (*Thelypteris noveboracensis*), water hemlock (*Cicuta bulbifera*), water smartweed (*Persicaria amphibia*), and fowl manna grass (*Glyceria striata*).

This swamp supports breeding populations of Louisiana waterthrush (*Parkesia motacilla*, state special concern) (EO ID 13377), which also occur to the north of the swamp in Baw Beese Woods dry-mesic southern forest (EO ID 19888).

Threats: Threats to the swamp include invasive species encroachment and high levels of deer herbivory. Deer browse was noted as prevalent within the swamp. In addition, canopy ash throughout the swamp has been killed by the Emerald Ash Borer.

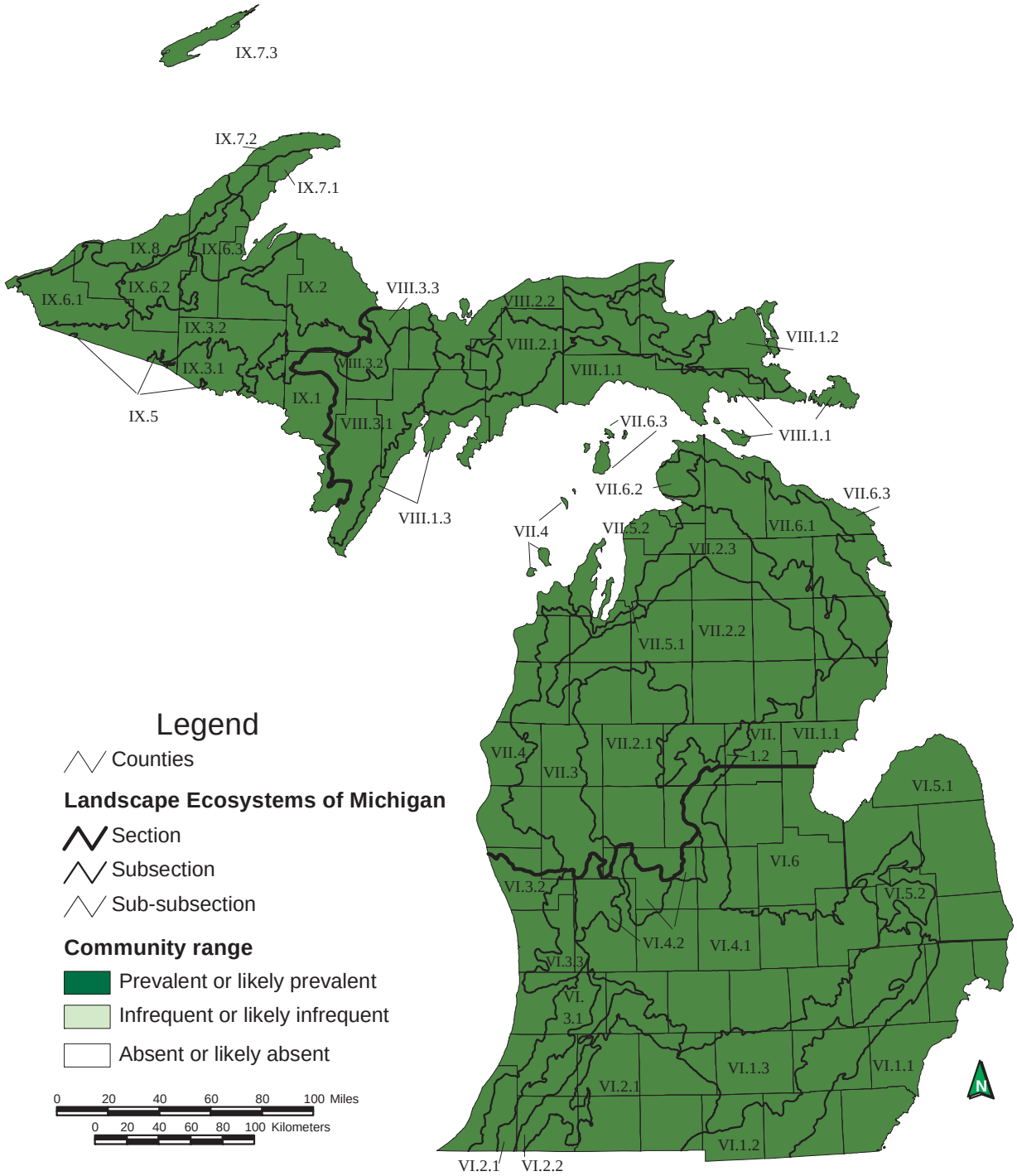
Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, monitor for invasive species and deer browse, and to retain an intact buffer of natural communities surrounding the southern hardwood swamp. Maintaining this swamp as a closed-canopy system will benefit the breeding populations of Louisiana waterthrush documented within this site.

Sqauwfield Swamp southern hardwood swamp. Photos by Joshua G. Cohen.

1998 aerial photograph of Squawfield Swamp southern hardwood swamp.

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, acidic to alkaline organic deposits of variable depth that accumulate over all types of mineral soil and bedrock. Natural processes that influence species composition and community structure include fluctuating water levels, storm waves, currents, and flooding by beaver. Vegetation is comprised of both rooted and non-rooted plants that occur completely beneath the water surface (i.e., submergent plants), rooted floating-leaved plants, and non-rooted floating plants. Characteristic plants include sweet-scented waterlily (*Nymphaea odorata*), yellow pond-lilies (*Nuphar variegata* and *N. advena*), bladderworts (*Utricularia* spp.), pondweeds (*Potamogeton* spp.), water-shield (*Brasenia schreberi*), duckweeds (*Lemna* spp.), and water meal (*Wolffia* spp.) (Kost et al. 2007, Cohen et al. 2014a).



Map 8. Distribution of submergent marsh in Michigan (Albert et al. 2008).

13. Bell Lake
Natural Community Type: Submergent Marsh
Rank: GU S4, globally unrankable and secure within the state
Element Occurrence Rank: C
Size: 8.5 acres
Location: Compartment 3, Stands 15 and 16
Element Occurrence Identification Number: 19892

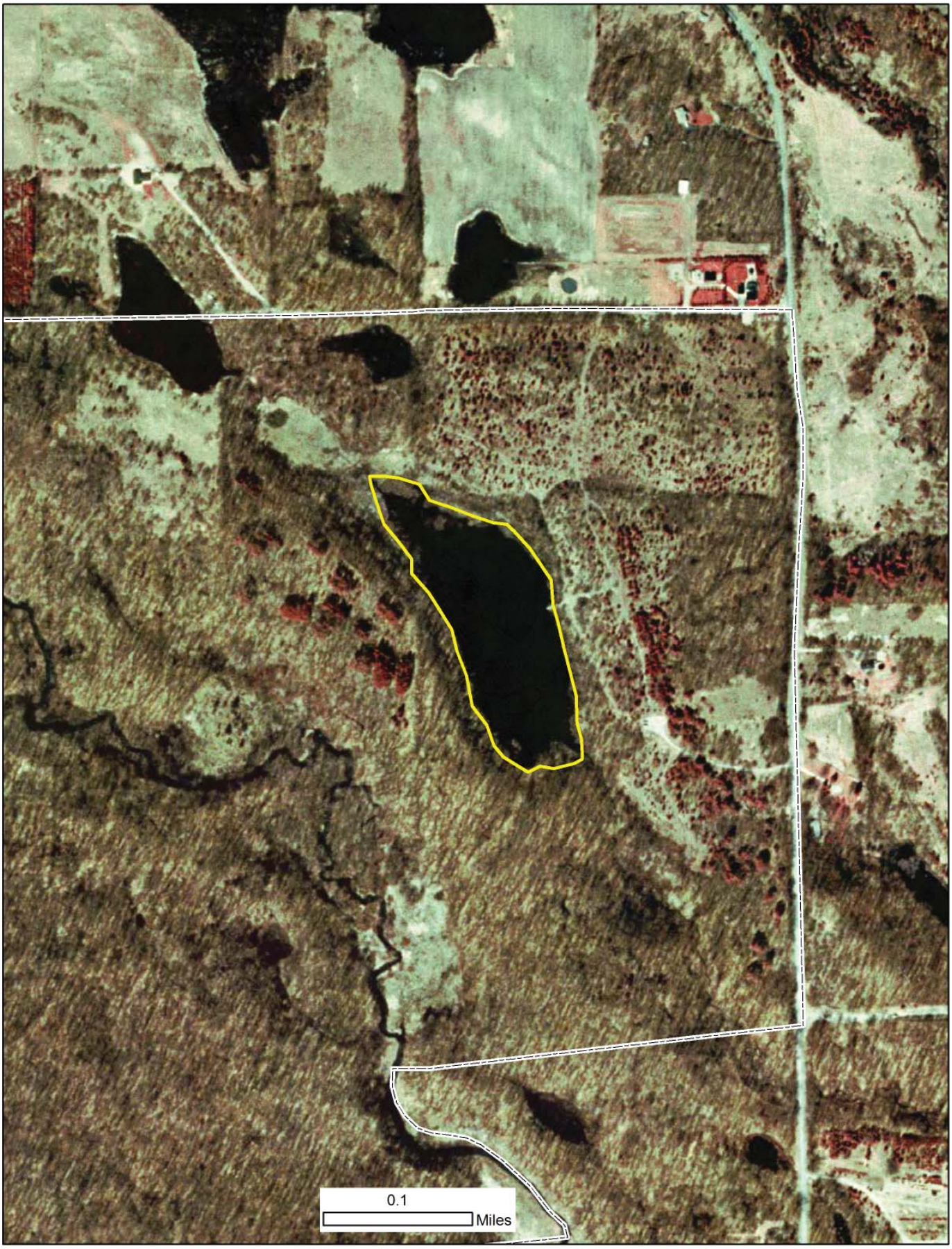
Site Description: Bell Lake submergent marsh is found in a large pond that occupies a kettle depression in a morainal landscape. A beaver dam occurs along the southern margin of the pond and has contributed to flooding on the periphery of the pond and the subsequent death of canopy trees along the margin and the expansion of the submergent marsh. Flood-killed trees include green ash (*Fraxinus pennsylvanica*) and American elm (*Ulmus americana*). Beaver felled trees and a beaver lodge were also noted. Water-level fluctuations create conditions important for plant regeneration. Establishment of submergent plants is also affected by substrate changes initiated by fish nests and waterfowl feeding; these openings and depressions generated by fauna create substrate and light heterogeneity that facilitate plant colonization. Storm waves and currents are important for distributing seeds and asexual propagules, as well as altering sediment conditions. The submergent marsh occurs on loosely consolidated, slightly acidic to alkaline (pH 6.9-7.1) mucks of variable depth (up to 70 cm) overlying gravelly sand.

The submergent marsh is characterized by scattered submergent vegetation including yellow pond-lilies (*Nuphar variegata* and *N. advena*), sweet-scented waterlily (*Nymphaea odorata*), pondweeds (*Potamogeton* spp.), small duckweed (*Lemna minor*), and bladderworts (*Utricularia* spp.). Scattered emergent vegetation include three-way sedge (*Dulichium arundinaceum*), arrow-arum (*Peltandra virginica*), bur-reed (*Sparganium* sp.), northern bugle weed (*Lycopus uniflorus*), beggar-ticks (*Bidens* spp.), and willows (*Salix* spp.) along the pond margins.

Threats: The species composition and structure of this submergent marsh are influenced by natural processes including beaver flooding. No threats to the submergent marsh were documented during the survey.

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.


Bell Lake submergent marsh. Photo by Joshua G. Cohen.



1998 aerial photograph of Bell Lake submergent marsh.

Vernal Pools Survey Results

A total of 81 potential vernal pools (PVPs) were identified and mapped in Lost Nation SGA through aerial photograph interpretation (Figure 14, See Page 89). These were distributed across the game area with 20 PVPs mapped in the southern half of Compartment 1, nine PVPs mapped in Compartment 2, and 52 PVPs mapped in Compartment 3. A number of PVPs were located within several natural community EOs in the game area including Burst-Dam Woods dry-mesic southern forest (EO ID 19805), Baw Beese Woods dry-mesic southern forest (EO ID 19888), Pittsford Millpond Woods mesic southern forest (EO ID 19887), Sile Doty Woods mesic southern forest (EO ID 19886), and Squawfield Swamp southern hardwood swamp (EO ID 19891).

A total of 20 vernal pools were surveyed and verified in the field during 2014 surveys (Figure 11, See Page 73). Of these, nineteen were mapped as PVPs from aerial photo interpretation, and one new pool was discovered and mapped in the field. All of the vernal pools surveyed in the field were surrounded by upland deciduous forest within 30 meters (100 ft) of the pools. Fourteen of the vernal pools were classified as open vernal pools with little to no vegetation growing in the pools. Three vernal pools were classified as shrubby vernal pools. Two vernal pools were classified as forested pools, and one vernal pool was classified as other because it was half forested and half sparsely vegetated. The water level in most of the vernal pools surveyed between May 20th and June 6th was full or mostly full (i.e., 75-100% of the pool basin filled with water), but one pool was only partially full (i.e., 50-74% full) and six pools were dry or mostly dry (i.e., 0-24% full). Of the four vernal pools surveyed on July 22nd, one was partially full, one was less than half full (i.e., 25-49% full), and two were dry/mostly dry. Most of the vernal pools surveyed were isolated basins or depressions and not connected to other wetlands or water bodies.

Surveys for rare amphibian and reptile species and other SGCN were conducted at all 20 vernal pools identified in the field. Visual encounter surveys and dipnetting surveys for amphibians and reptiles were conducted at all of the pools. Aquatic funnel or minnow trapping for larval amphibians was conducted at one vernal pool in Compartment 3 west of Pittsford Millpond Woods mesic southern forest (EO ID 19887). Vernal pool indicator species were observed in four of the 20 vernal pools surveyed. These included observations of blue-spotted salamander larvae in three pools, spotted salamander larvae in one pool, *Ambystomatid* salamander larvae in another pool, and recent wood frog metamorphs in one pool. Other amphibian and reptile species observed in the vernal pools included green frogs (*Lithobates clamitans*), gray treefrogs (*Hyla versicolor/Hyla chrysoscelis*), painted turtles (*Chrysemys picta*), Blanding's turtle (*Emydoidea blandingii*), and northern water snake (*Nerodia sipedon sipedon*). Additional information about amphibians and reptiles that were documented in vernal pools in 2014 is provided in the amphibian and reptile results section that follows. In addition to herps, a number of invertebrates also were found in the pools. These included fingernail clams (Veneroida: Sphaeriidae), clam shrimp (Laevicaudata and/or Spinicaudata), water fleas (Cladocera), caddisfly larvae (Trichoptera), leeches (Clitellata: Hirudinida), phantom midges (Chaoboridae), spiral snails (Gastropoda), mosquito larvae (Diptera), water mites (Acari), blood worms (Polychaeta: Glyceridae), water striders (Hemiptera: Gerridae), water boatmen (Corixidae), millipedes (Diplopoda), spiders (Arachnida: Araneae), and aquatic beetles (Coleoptera). A beaver (*Castor canadensis*) was observed swimming in one of the vernal pools.

Vernal pool. Photo by Joshua G. Cohen.

Vernal pools occur throughout Lost Nation State Game Area and provide critical habitat for herptile and invertebrate species. Photos by Yu Man Lee.

Rare Animal Survey Results

Birds

We completed red-shouldered hawk surveys at 27 points within the game area (Figure 6). Although potential habitat appeared to be present at many of the points, we did not observe any red-shouldered hawks. Red-tailed hawk (*Buteo jamaicensis*) was the only raptor species recorded during the surveys and was detected at three of the 27 points surveyed. We also recorded an incidental observation of Louisiana waterthrush.

Forest songbird surveys were conducted at 21 points within forest stands (Figure 6). We recorded observations at new locations for all three rare songbird species (cerulean warbler, hooded warbler, and Louisiana waterthrush) targeted during point counts. All three of these species were previously documented within the game area and data collected during these surveys was incorporated into existing element occurrences (Table 3). Cerulean warbler was the most common of the three rare species observed, with five individuals being detected at five survey points (Figure 10). New cerulean warbler observations occurred at three general locations: 1) north of Skuse Road and south of the East Branch St. Joseph River near and within Pittsford Millpond Woods mesic southern forest (EO ID 19887); 2) south of Skuse Road and west of Gilbert Road to the west of Shadyside Woods dry-mesic southern forest (EO ID 19889); and 3) south of Way Road and west and north of Reading Road. We documented three hooded warblers at three locations (Figure 10). Two of the new hooded warbler locations were north of Skuse Road and south of the East Branch St. Joseph River/Pittsford Millpond, one of which was within Pittsford Millpond Woods mesic southern forest (EO ID 19887). The third new hooded warbler observation occurred south of Skuse Road and west of Gilbert Road near the edge of Shadyside Woods dry-mesic southern forest (EO ID 19889). Two Louisiana waterthrushes were recorded at two separate points. Both of the new Louisiana waterthrush observations we located south of Skuse Road, east of Gilbert Road, and west of Pittsford Road (Figure 10). One of the observations was within two community element occurrences: Squawfield Swamp southern hardwood swamp (EO ID 19891) and Baw Beese Woods dry-mesic southern forest (EO ID 19888). We documented the second Louisiana waterthrush just north of Sile Doty Woods mesic southern forest (EO ID 19886).

We recorded a total of 41 bird species during point counts within Lost Nation SGA (Appendix 7), with several of these species having special conservation status (Table 8 and Appendix 8). Three species, wood duck (*Aix sponsa*), pileated woodpecker (*Dryocopus pileatus*), and wood thrush (*Hylocichla mustelina*), are considered featured species for habitat management by Wildlife Division of the Michigan DNR. Nine bird species documented in the game area are considered SGCN (Eagle et al. 2005; Amy Derosier, personal communication, March 2015): black-billed cuckoo (*Coccyzus erythropthalmus*), yellow-billed cuckoo (*Coccyzus americanus*), Acadian flycatcher (*Empidonax virescens*), wood thrush, northern parula (*Setophaga americana*), cerulean warbler, Louisiana waterthrush, hooded warbler, and eastern towhee (*Pipilo erythrophthalmus*). In addition, we observed four species (veery [*Catharus fuscescens*], wood thrush, cerulean warbler, and Louisiana waterthrush) that are identified as focal species for conservation efforts in the Landbird Habitat Conservation Strategy (Potter et al. 2007) of the Upper Mississippi River and Great Lakes Region Joint Venture. Cerulean warbler is a focal species of the DNR's Wildlife Action Plan (Amy Derosier, personal communication, March 2015).

Table 3. Previosuly known rare bird and bat element occurrences at Lost Nation State Game Area. State and federal status abbreviations are as follows: E, state or federally endangered; T, state threatened; and SC, state special concern. EO rank abbreviations are as follows: C, fair estimated viability; CD, fair or poor estimated viability; E, verified extant (viablity not assessed); and H, historical. * indicates the EO was updated with information collected during 2014 inventory. ** indicates that the listing status is currently proposed.

Common Name	Scientific Name	State Status	Federal Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Northern long-eared bat	*Myotis septentrionalis*	T**	E**	20009	E	2001	2001
Indiana bat	*Myotis sodalis*	E	E	832	H	1978	1978
Louisiana waterthrush*	*Parkesia motacilla*	T		13377	CD	2003	2014
Cerulean warbler*	*Setophaga cerulea*	T		13378	C	2003	2014
Hooded warbler*	*Setophaga citrina*	SC		13379	CD	2003	2014

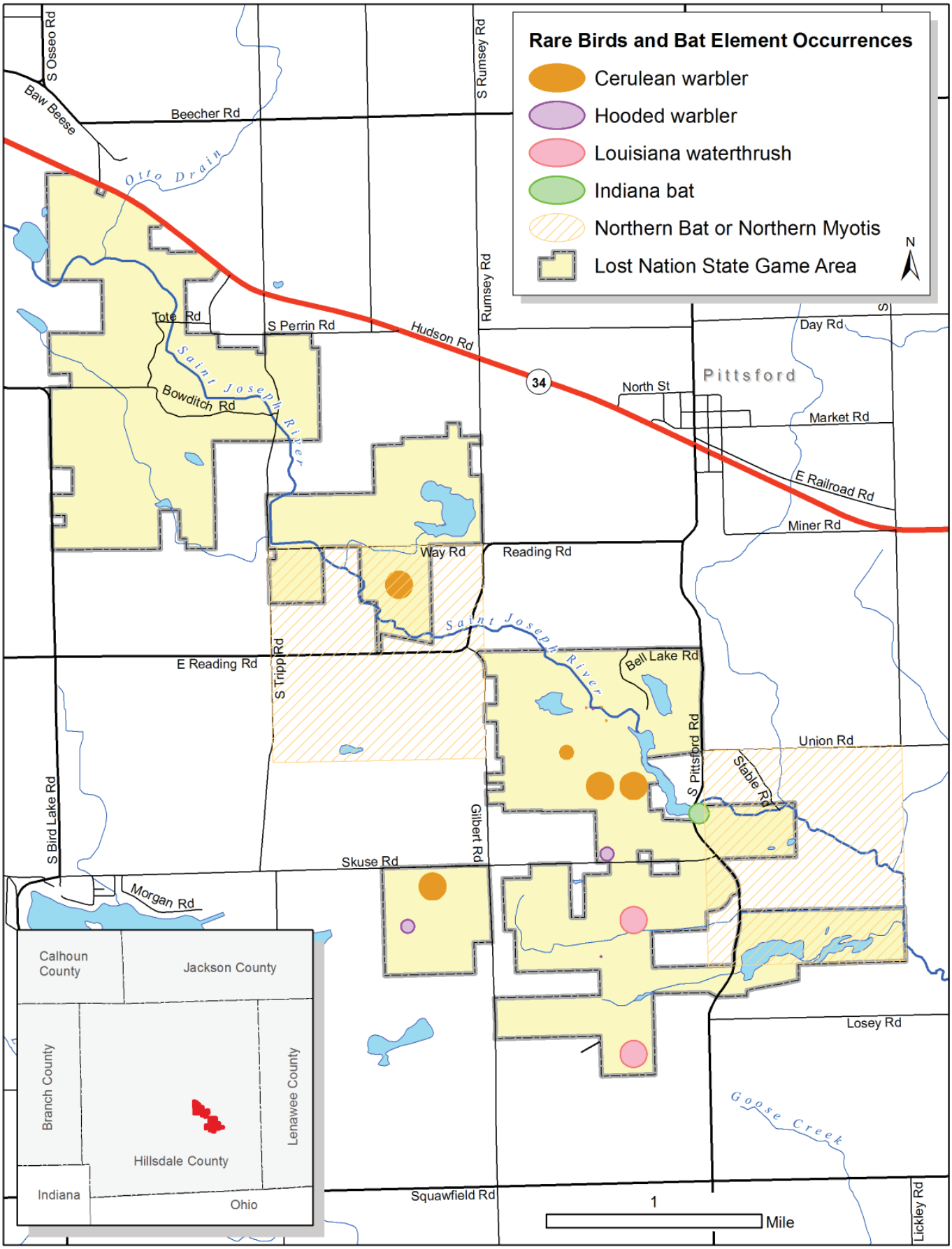


Figure 10. Rare bird and bat element occurrences within Lost Nation State Game Area.

Reptiles and Amphibians

Amphibian and reptile surveys in Lost Nation SGA in 2014 documented observations of two rare species, the Blanchard's cricket frog and Blanding's turtle (Table 4). Rare species observations in 2014 resulted in two new element occurrences (EOs) of the Blanchard's cricket frog and updated a previously documented EO of the Blanding's turtle in the Lost Nation SGA and surrounding private land (Table 4). Amphibian and reptile surveys in 2014 also documented observations of four additional current SGCN, the spotted salamander, blue-spotted salamander, northern leopard frog (*Lithobates pipiens*), and western chorus frog (*Pseudacris triseriata*) (Table 8). The blue-spotted salamander and western chorus frog have been proposed by the Michigan DNR to be removed from the revised list of SGCN (Amy Derosier, personal communication, March 2015).

Auditory or breeding frog call surveys within and around the Lost Nation SGA in 2014 identified two new EOs of Blanchard's cricket frogs. One occurrence is located at Lake Number Two in the southeast unit of the game area (Figure 11). The second occurrence consists of Mud Lake and two other small lakes on private land along Tripp Road west and south of Lost Nation's southwest unit. Cricket frogs were not documented at 15 other sites that were surveyed in or near the game area in 2014. This species had not been documented in or adjacent to the game area prior to the 2014 surveys. Element occurrence specifications developed by NatureServe for the hylid/treefrog group, of which the Blanchard's cricket frog is a member, specify that EOs should be separated by 5 km or more of suitable habitat, 1 km or more of unsuitable habitat, and/or barriers (i.e., busy major highway such that frogs rarely if ever cross successfully; intensive urban development dominated by buildings and pavement and lacking suitable vegetated frog refuges) (Hammerson 2004). The two sites where Blanchard's cricket frogs were documented are about 3 to 3.5 km apart but they are separated by over 1 km of unsuitable habitat (i.e., active agricultural land and upland forest). As a result, the two documented sites for this species were designated as two separate EOs (Table 4 and Figure 11) (MNFI 2015).

Visual encounter and basking surveys in 2014 documented Blanding's turtles at two newly documented sites in Lost Nation SGA. One adult Blanding's turtle was found on May 22nd on land about two meters from the shore of a small open wetland/pond (Compartment 1, south of stand 40) surrounded by dry-mesic southern forest north of Way Road in the northwest unit of the game area (Figure 11). A second adult Blanding's turtle was observed on June 6th basking on a log in a forested vernal pool (Compartment 3, Stand 5) located east of Gilbert Road between Lake Number Eight and Skuse Road (Figure 11). This site is located about 800 m (0.5 mi) south of the small pond in which Blanding's turtles had been observed in 2003. The pond is east of Gilbert Road in the northwest corner of the southeast unit of the game area (Compartment 3, Stand 1) and the observation of Blanding's turtles here in 2003 represents the original source for the existing EO of this species in the game area (MNFI 2015). Two additional Blanding's turtles were incidentally observed basking on a log in this pond on April 11th, 2014 during point count surveys for red-shouldered hawks. Element occurrence specifications for the Blanding's turtle developed by NatureServe 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). As a result, the two newly documented sites for this species were incorporated into the existing EO for this species (Table 4) (MNFI 2015).

Visual encounter and basking surveys in 2014 were not able to reconfirm the occurrence of the copperbelly water snake in Lost Nation SGA. This species was first and last documented at Lost Nation SGA in 1982 in a wetland along the southern edge of the northwest unit along Way Road between S. Bird Lake Road and S. Tripp Road (Figure 11). Visual encounter and basking surveys in 2014 focused on shallow wetlands and waterbodies and adjacent forests in the northwest unit of the game area in the vicinity of this observation, and in the southeast unit. Although copperbellies were not observed, suitable habitat for the species appeared to be available throughout the game area.

Visual encounter surveys in 2014 also were not able to document the occurrence of eastern massasaugas, spotted turtles, and eastern box turtles. These species have not been reported from Lost Nation SGA before, but suitable habitats for these species do occur in the game area. Osseo Fen prairie fen (EO ID 19813) and Lost Nation Fen prairie fen (EO ID 2833) were surveyed in 2014 (Figures 7 and 9) and contain suitable habitat for all three species. The shallow wetlands/waterbodies and adjacent forests that were surveyed for copperbelly water snakes and Blanding's turtles in all three units of the game area also appeared to provide suitable habitat for eastern box turtles.

Dipnetting and aquatic funnel trapping surveys in 2014 were not able to document smallmouth salamanders in Lost Nation SGA. Suitable habitat for this species occurs throughout the game area though, particularly in the southern half of the northwest unit and in the southeast unit. Dipnetting and aquatic funnel trapping surveys documented

blue-spotted salamander larvae in one vernal pool north of Way Road between Bird Lake and Tripp Roads in T07S R02W Section 15 in the northwest unit, and two vernal pools east of Gilbert Road in T07S R02W Section 25 in the southeast unit (Figure 7). A spotted salamander larva also was found in one of the vernal pools surveyed east of Gilbert Road in Section 25 (Figure 7). Ambystomatid or mole salamander larvae were found on May 22nd in a second vernal pool in Section 15 in the northwest unit of the game area (Figure 7), but they were too small to identify to species at the time. These larvae could have been smallmouth, blue-spotted, and/or spotted salamander larvae. We had intended to conduct dipnetting and aquatic funnel trapping surveys at this pool later in the field season but the pool had dried up when we returned in July.

Amphibian and reptile surveys in 2014 also documented observations of other herp species in the Lost Nation SGA. These included observations of two additional amphibian SGCN, the northern leopard frog and western chorus frog (Appendix 3). An adult northern leopard frog was observed on May 20th on the trail/old two-track that goes through the Lost Nation Fen prairie fen (EO ID 2833). Western chorus frog tadpoles were observed in a vernal pool in the north half of the southeast unit of the game area in T07S R02W Section 25. Nine additional amphibian and reptile species were documented during herp surveys in Lost Nation SGA in 2014 (Appendix 3). These include the eastern American toad (*Anaxyrus americanus americanus*), gray treefrog (*Hyla versicolor/Hyla chrysoscelis*), American bullfrog (*Lithobates catesbeianus*), green frog (*Lithobates clamitans*), wood frog (*Lithobates sylvaticus*), northern water snake (*Nerodia sipedon sipedon*), northern ribbon snake (*Thamnophis sauritus septentrionalis*), painted turtle (*Chrysemys picta*), and snapping turtle (*Chelydra serpentina*).

Blanding's turtle basking on a log in a vernal pool. Photo by Yu Man Lee.

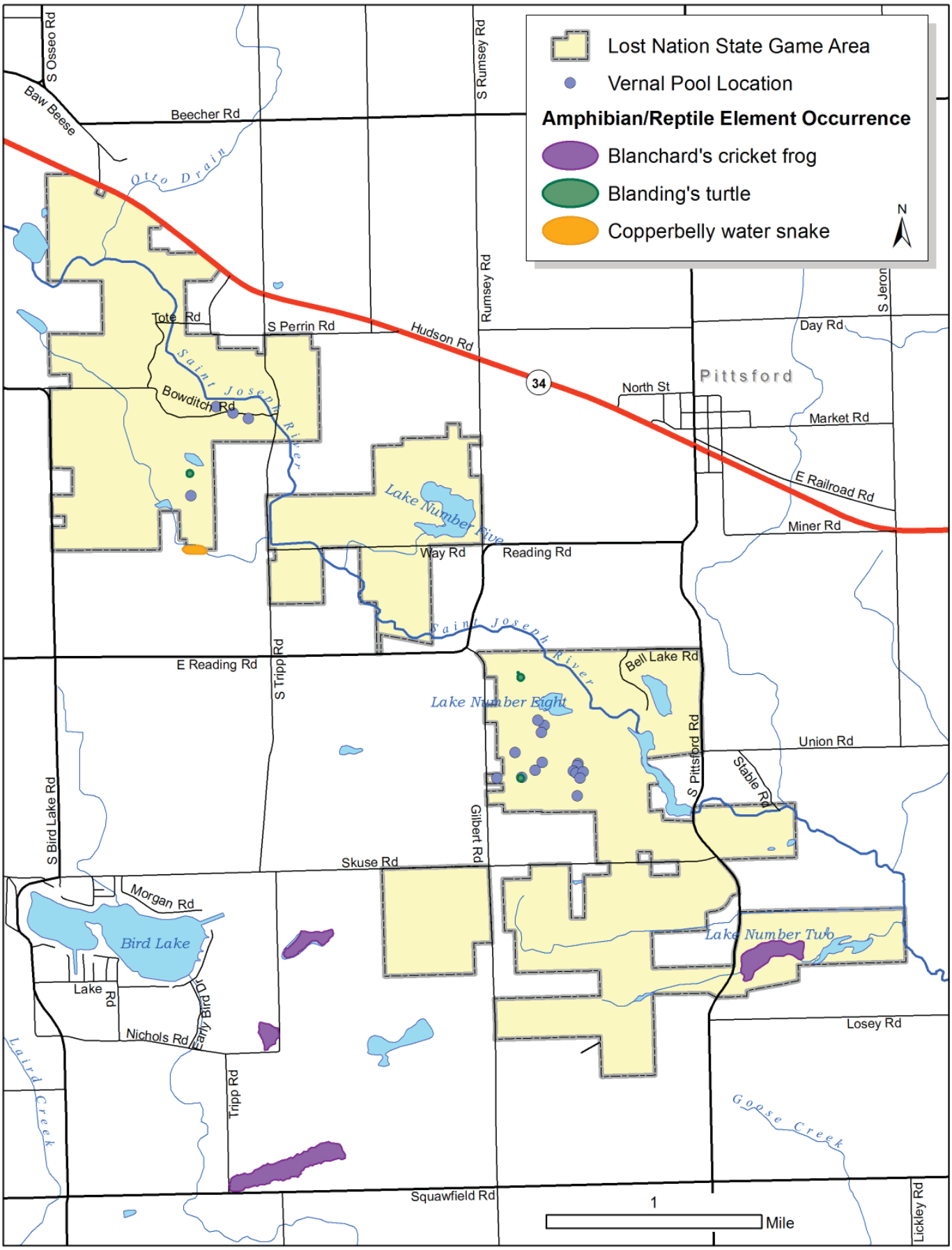


Figure 11. Rare amphibian and reptile element occurrences and verified vernal pools within and nearby Lost Nation State Game Area.

Table 4. Newly documented and previosuly known rare amphibian and reptile element occurrences at Lost Nation State Game Area. State and federal status abbreviations are as follows: E, state endangered; T, state or federally threatened; and SC, state special concern. EO rank abbreviations are as follows: B, good estimated viability; BC, good or fair estimated viability; and H, historical. * indicates the EO was newly documented in 2014 or updated with information collected during inventory.

Common Name	Scientific Name	State Status	Federal Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Blanchard's cricket frog*	*Acris blanchardi*	T		19975	BC	2014	2014
Blanding's turtle*	*Emydoidea blandingii*	SC		13376	B	2003	2014
Copperbelly water snake	*Nerodia erythrogaster neglecta*	E	T	10447	H	1982	1982

Table 5. Previosuly known rare insect element occurrences at Lost Nation State Game Area. State abbreviation of SC indicates state special concern. EO rank abbreviations are as follows: AB, excellent or good estimated viability; CD, fair or poor estimated viability; F, failed to find; and H, historical.

Common Name	Scientific Name	State Status	Federal Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Swamp metalmark	*Calephelis mutica*	SC		7366	F	1989	2005
Kansas prairie leafhopper	*Dorydiella kansana*	SC		17404	AB	2010	2010
Wild indigo duskywing	*Erynnis baptisiae*	SC		12688	H	1993	1993
Tamarack tree cricket	*Oecanthus laricis*	SC		9053	CD	2000	2000

The East Branch of the Saint Joseph River (Maumee) supports numerous mussels including the state endangered lilliput (*Toxolasma parvum*) and the state threatened slippershell (*Alasmidonta viridis*). Photo by Peter J. Badra.

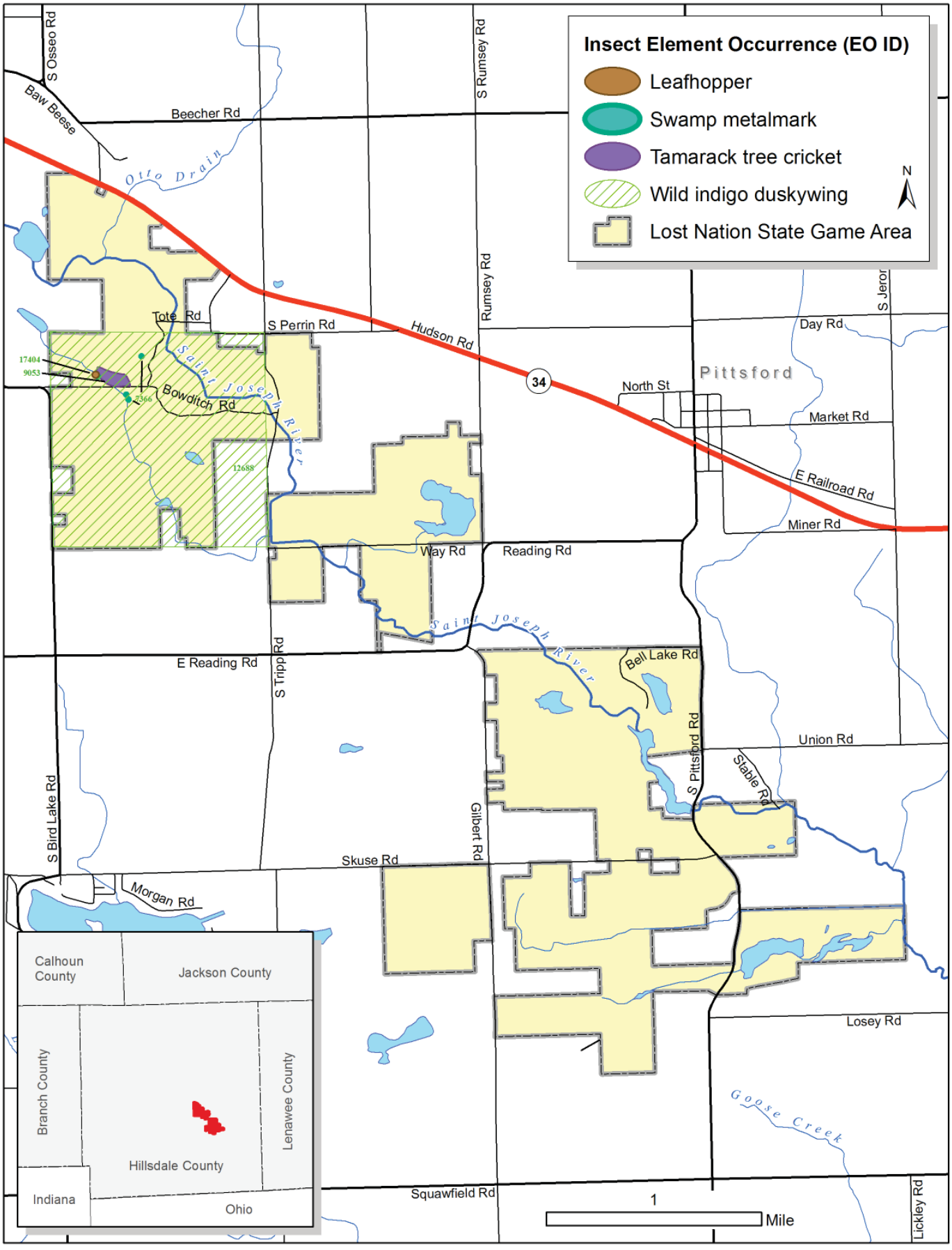


Figure 12. Rare insect element occurrences within Lost Nation State Game Area.

Mussels and Aquatic Species

A total of five sites in the East Branch of the St. Joseph River (Maumee) were surveyed (Figure 8). Several other sites were visited, but were not surveyed due to a lack of potential unionid mussel habitat or lack of access (e.g., private land). Locations of sites are given in Table 7 and numbers of each species found at each site are given in Table 9. Of the 22 mussel species known to occur in the St. Joseph River (Maumee), ten were found in this survey (Appendix 5) including four SGCN (Table 8).

Shells of the state endangered lilliput (*Toxolasma parvum*) were found at Site 1 in the East Branch of the St. Joseph River near the Pittsford Road crossing (Figures 8 and 13) (Table 6). This species was previously not documented in the St. Joseph River (Maumee) within Michigan's boarders. The state threatened slippershell (*Alasmidonta viridis*) was found at all five survey sites including live individuals at Sites 1, 4, and 5 (Figures 8 and 13). Four of these sites constitute newly documented locations for this species. Of the five sites surveyed, Site 4 off of Tripp Road had the highest number of live slippershells, highest density of live mussels, and greatest number of species represented by live individuals (Table 9). Site 1 had the greatest number of species represented by live individuals or shells, and had both slippershell and lilliput. Two additional SGCN mussels were documented during the surveys. Cylindrical papershell (*Anodontoides ferussacianus*) was documented at Site 4, and creek heelsplitter (*Lasmigona compressa*) was documented at Site 1 (Table 9).

Aquatic snails (Gastropoda) were found at all five sites, and fingernail clams (Sphaeriidae) at four sites. Two species of crayfish and three fish species were noted as incidental finds (Table 10). None of the six snail species found are listed species or species of special concern. The virile crayfish (*Orconectes virilis*) was abundant at Sites 3, 4, and 5 (Figure 8). Only one individual of the big water crayfish (*Cambarus robustus*) was found. Big water crayfish is a proposed SGCN. Johnny darter (*Etheostoma nigrum*) were spotted at four out of the five survey sites and were quite abundant. Mottled sculpin (*Cottus bairdii*) were especially abundant at Site 3 (Figure 8). Both of these fish species are known to act as hosts for slippershell, and Johnny darter is also a known host for lilliput. No zebra mussels or Asian clams were observed during the surveys.

Stream substrate within Lost Nation SGA was generally favorable for unionid mussels, being a mix of pebble, gravel, sand, and silt, with the addition of cobble at two sites (Table 11). Stream morphology included pool, riffle, and run components at Sites 1, 2, and 3 (Table 12), characteristics often associated with high-quality stream systems (Rankin 2006). Excessive erosion was seen at Site 3 along the side of S. Tripp Road, and Site 5 at the Tote Road Bridge. Water clarity was high and visibility very good at all sites at the time of surveys. However, since some live mussels were found to be completely buried within the stream substrate, primarily tactile methods of detection were used. Fish cover, in the form of large woody debris and overhanging vegetation, was abundant. Physical and chemical habitat measures are provided in Tables 12 and 13 and addressed in the following aquatic discussion section.

A mottled sculpin (*Cottus bairdii*) from mussel survey Site 3 in the East Branch of the St. Joseph River (Maumee drainage). Mottled sculpin is one of three known host fish species of the state threatened slippershell. Photo by Peter J. Badra.

Table 6. Newly documented and previosuly known rare mussel element occurrences at Lost Nation 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 2014 or updated with information collected during inventory.

Common Name	Scientific Name	State Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Slippershell*	*Alasmidonta viridis*	T	17784	H	1931	1931
Slippershell*	*Alasmidonta viridis*	T	19128	E	1998	2014
Round pigtoe	*Pleurobema sintoxia*	SC	19129	E	1998	1998
Lilliput*	*Toxolasma parvus*	E	20117	E	2014	2014

Table 7. Locations of mussel survey sites within Lost Nation State Game Area, Summer 2014.

Site #	Waterbody	Access	Latitude (N)	Longitude (W)
1	East Branch St. Joseph River	S. Pittsford Rd.	41.83639	84.47688
2	East Branch St. Joseph River	Hiked W. from S. Pittsford Rd. Parking Lot	41.84177	84.48235
3	East Branch St. Joseph River	S. Tripp Rd.	41.85567	84.51497
4	East Branch St. Joseph River	S. Tripp Rd.	41.86285	84.51357
5	East Branch St. Joseph River	Tote Rd.	41.86918	84.52322

Table 8. Rare species, Species of Greatest Conservation Need (SGCN), DNR featured species, and DNR focal species documented at Lost Nation State Game Area. State and federal status abbreviations are as follows: E, state or federally endangered; T, state or federally threatened; SC, state special concern. ** indicates that the listing status is currently proposed.

Common Name	Scientific Name	State Status	Federal Status	SGCN	DNR Featured Species	DNR Focal Species	Year Last Observed
AQUATIC SPECIES							
Slippershell	*Alasmidonta viridis*	T		X			2014
Cylindrical papershell	*Anodontoides ferussacianus*			X			2014
Big water crayfish	*Cambarus robustus*			X			2014
Creek heelsplitter	*Lasmigona compressa*			X			2014
Round pigtoe	*Pleurobema sintoxia*	SC		X			1998
Lilliput	*Toxolasma parvum*	E		X			2014
BIRDS							
Yellow-billed cuckoo	*Coccyzus americanus*			X			2014
Black-billed cuckoo	*Coccyzus erythroprthalmus*			X			2014
Acadian flycatcher	*Empidonax virescens*			X			2014
Wood thrush	*Hylocichla mustelina*			X			2014
Louisiana waterthrush	*Parkesia motacilla*	T		X			2014
Eastern towhee	*Pipilo erythrophthalmus*			X			2014
Northern parula	*Setophaga americana*			X			2014
Cerulean warbler	*Setophaga cerulea*	T		X		X	2014
Hooded warbler	*Setophaga citrina*	SC		X			2014
HERPTILES							
Blanchard's cricket frog	*Acris blanchardi*	T		X			2014
Blue-spotted salamander	*Ambystoma laterale*			X			2014
Spotted salamander	*Ambystoma maculatum*			X			2014
Blanding's turtle	*Emydoidea blandingii*	SC		X			2014
Northern leopard frog	*Lithobates pipiens*			X			2014
Copperbelly water snake	*Nerodia erythrogaster neglecta*	E	T	X			1982
Western chorus frog	*Pseudacris triseriata*			X			2014
INSECTS							
Swamp metalmark	*Calephelis mutica*	SC		X			1989
Kansas prairie leafhopper	*Dorydiella kansana*	SC		X			2010
Wild indigo duskywing	*Erynnis baptisiae*	SC		X			1993
Tamarack tree cricket	*Oecanthus laricis*	SC		X		X	2000
MAMMALS							
Northern long-eared bat	*Myotis septentrionalis*	T**	E**	X		X	2001
Indiana bat	*Myotis sodalis*	E	E	X		X	1978

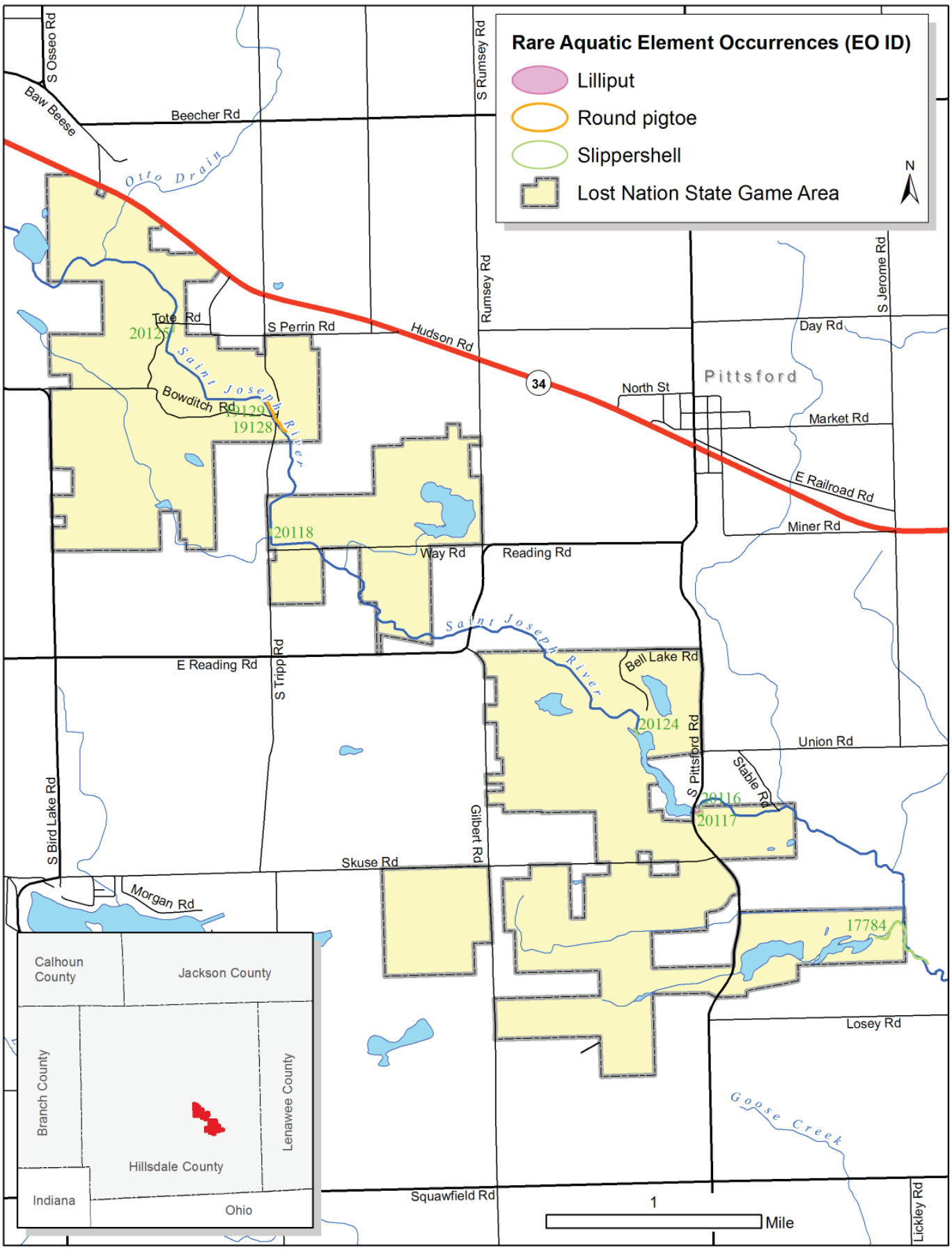


Figure 13. Rare mussel element occurrences within Lost Nation State Game Area.

Lilliput (*Toxolasma parvum*) shells found at Site 1 in the East Branch of the St. Joseph River (Maumee). This is the first record of this state endangered mussel from the St. Joseph River in Michigan, and one of only six recent (post-1989) occurrences in the state. Photo by Peter J. Badra.

Slippershell (*Alasmidonta viridis*) from mussel survey Site 5 in the East Branch of the St. Joseph River (Maumee). The small individual on the left is approximately two years old (2.4 cm in length), indicating recent reproduction of this state threatened species. Photo by Peter J. Badra.

Table 9. Numbers of unionid mussels (#), relative abundance (RA), and density (D = individuals/m2) by site number during surveys conducted in Lost Nation State Game Area in 2014. The number of unionid shells (S) found is given in parentheses. Status in Michigan is listed in parentheses after the scientific name (E = state endangered; T = state threatened).

		1			2			3			4			5		
Species	Common name	#	RA	D	#	RA	D	#	RA	D	#	RA	D	#	RA	D
Slippershell	*Alasmidonta viridis* (T)	1*	0.02	0.01	S(10)			S(4)			7	0.16	0.17	2	0.06	0.04
Threeridge	*Amblema plicata*	51	0.86	0.40												
Cylindrical papershell	*Anodontoides ferussacianus*										2	0.04	0.05			
Spike	*Elliptio dilatata*	7	0.12	0.05	S			35	0.92	0.35	13	0.29	0.31	16	0.52	0.33
Wabash pigtoe	*Fusconaia flava*	1	0.02	0.01				3	0.08	0.03	25	0.56	0.60	12	0.39	0.25
Fatmucket	*Lampsilis siliquoidea*	S			S			S			7	0.16	0.17	3	0.10	0.06
Creek heelsplitter	*Lasmigona compressa*	S														
Giant floater	*Pyganodon grandis*	S														
Strange floater	*Strophitus undulatus*				S			1	0.03	0.01						
Lilliput	*Toxolasma parvum* (E)	S(7)														
	Total # individuals and density	59		0.46	0		0.00	39		0.39	45		1.07	31		0.65
	# species live	4			4			3			5			4		
	# species live or shell	8			4			5			5			4		
	Area searched (m^2)	128			128			99			42			48		
Asian clam	*Corbicula fluminea*															
Zebra mussel	*Dreissena polymorpha*															

* In addition to one live individual, 30 *A. viridis* shells were also found at Site 1.

A spike (*Elliptio dilatata*) embedded in high-quality stream substrate at Site 5 in the East Branch of the St. Joseph River (Maumee). The incurrent and excurrent siphon openings can be seen at the center of the photo. Two small fingernail clams (Sphaeriidae) are located on either side of the spike. This mixture of pebble, gravel, sand, and relatively low amount of silt is suitable for most unionid mussel species. Photo by Peter J. Badra.

Spike (*Elliptio dilatata*) from mussel survey Site 5 in the East Branch of the St. Joseph River (Maumee). The small individual on the tape is two to three years old, indicating successful reproduction of this species within the past three years. Photo by Peter J. Badra.

Table 10. Species observed incidentally by site number during mussel surveys conducted in Lost Nation State Game Area in 2014. An "X" indicates at least one individual of the taxa was detected at a site.

Common Name	Species/Taxa	1	2	3	4	5
Snails	Gastropoda	X	X	X	X	X
Pointed campeloma	*Campeloma decisium*	X	X	X	X	
Flexed gyro	*Gyraulus deflectus*	X		X	X	
Two-ridge rams-horn	*Helisoma anceps*	X				X
Pewter physa	*Physella acuta*	X				
Marsh pondsnail	*Stagnicola elodes*	X				
Striped whitelip	*Webbhelix multilineata* (terrestrial)			X		
Fingernail clams	Sphaeriidae	X	X		X	X
Mottled sculpin	*Cottus bairdii*			X	X	X
Johnny darter	*Etheostoma nigrum*		X	X	X	X
Northern hogsucker	*Hypentelium nigricans*	X	X			
Big water crayfish	*Cambarus robustus*				X	
Virile crayfish	*Orconectes virilis*			X	X	X

Table 11. Substrate characterization by mussel survey sites in Lost Nation State Game Area during 2014.

	Substrate Classes (Proportion)					
Site #	Boulder	Cobble	Pebble	Gravel	Sand	Silt
1		25	25	15	15	20
2			10	30	30	30
3		5	10	40	30	15
4			10	20	50	20
5			10	30	40	20

Table 12. Physical habitat characteristics and measures taken at mussel survey sites in Lost Nation State Game Area during 2014.

Site #	Current speed*	Aquatic vegetation?	Woody debris?	Eroded banks?	%Pool	%Riffle	%Run
1	med./fast	N	Y	N	20	40	40
2	slow/med.	Y	Y	N	40	40	20
3	slow/med.	Y	Y	Y (along side of road)	33	33	33
4	slow	N	Y	Y (slight)	10		90
5	slow	Y	Y	Y (at bridge)			100

*slow = approx. 0.2m/second; medium = approx. 1m/second; fast = approx. 2m/second

Table 13. Water temperature and chemistry measures collected at mussel survey sites in Lost Nation State Game Area in 2014.

Site #	pH	Conductivity (µS)	Alkalinity (mg/l CaCO3)	Hardness (mg/l)	Water temp. (C)
1	7.76	554	184	320	22.3
2	8.21	568	160	440	18.9
3	7.76	554	176	240	21.9
4	7.64	551	192	380	17.4
5	7.04	548	192	380	18.6

For each site, the substrate, physical habitat, and water temperature and chemistry were characterized. Photo by Peter J. Badra.

DISCUSSION

Natural Community Discussion and Recommendations
In addition to the specific management recommendations provided in the above Natural Community Survey Results section, we provide the following general management recommendations for your consideration. We encourage invasive species control focused in high-quality natural areas, 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, the use of landscape-scale prescribed fire, 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 Lost Nation 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 mature dry-mesic forested stands in Lost Nation SGA is likely due to the interaction of competition from invasive shrubs, deer herbivory, and fire suppression. Lastly, non-native invasive species often have no natural predators and spread aggressively through rapid sexual and asexual reproduction.

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*), common buckthorn (*Rhamnus cathartica*), multiflora rose (*Rosa multiflora*), hybrid cat-tail (*Typha* x*glauca*), and narrow-leaved cat-tail (*T. angustifolia*). Additionally, new invasive species that were not seen in Lost Nation 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 Lost Nation 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 in southern Michigan has been found to locally increase invasive species populations with areas of recent logging being associated with local dominance of garlic mustard (Michele Richards, personal communication, July 2010). 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 Lost Nation SGA. As noted within the above discussion of Osseo Fen prairie fen (EO ID 19813), 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.

Forest Biodiversity and Fragmentation
The Lost Nation SGA supports approximately 1,900 acres of forest and close to 200 acres of high-quality dry-mesic southern forest and mesic southern forest. Because the landscape surrounding Lost Nation 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 documentation of numerous vernal pools within these forests and the recording during point-count surveys of forty-one species of birds of which nine are SGCN and three are DNR featured species (Table 8 and Appendix 7).

Although Lost Nation 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 drastic (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 can contributes to the increase of forest connectivity and decrease in forest fragmentation. We recommend that efforts to reduce fragmentation and promote connectivity be concentrated in the vicinity of existing high-quality natural communities and adjacent to riparian corridors and wetlands.

Fire as an Ecological Process

Much of the land within Lost Nation SGA historically supported fire-dependent ecosystems such as dry-mesic southern forest, 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). 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 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). In addition, due to fire suppression, closed-canopy dry-mesic southern forests within Lost Nation 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 dry-mesic 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, and hickories. In addition, 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 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 and dry-mesic southern forest) 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 impact the same species year after year, and over time, can lower floristic diversity (Howe 1994, Copeland et al. 2002). For example, forbs that flower in early spring often overwinter as a green rosette or may have buds very close to the soil surface and in the litter layer. Repeated burns in early spring can be detrimental to these species. Historically, fires burned in a variety of seasons, including spring, during the growing season, and fall (Howe 1994, Copeland et al. 2002, Petersen and Drewa 2006). Many of the natural communities found at Lost Nation SGA, including prairie fen and dry-mesic southern forest, 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 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 Lost Nation 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.

Closed-canopy forest in Lost Nation State Game Area provides critical habitat for interior-forest obligates and species dependent on the numerous vernal pools nested within the forest. Photo by Joshua G. Cohen.

Fire suppression within fire-dependent dry-mesic southern forests across Lost Nation State Game Area is resulting in strong regeneration of thin-barked, shade-tolerant or mesophytic trees and shrubs and contributing to the regeneration failure of oaks. Photo by Joshua G. Cohen.

Table 14. Summary of management recommendations for natural community element occurrences for the Lost Nation State Game Area.

Site Name	Community Type	Management Recommendations
Lost Nation Bog	Bog	• Maintain intact buffer of natural communities surrounding bog • Control purple loosestrife • Monitor for invasives
Sile Doty Cave	Cave	• Maintain closed canopy forest surrounding cave • Avoid operating mechanical equipment in the vicinity of cave entrances • Erect education signange • Monitor for hibernating bats
Burst-Dam 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 red maple, sassafras, and black cherry • Monitor following fire and for invasives, oak regeneration, and deer herbivory
Baw Beese Woods	Dry-mesic Southern Forest	• Maintain closed canopy • Apply prescribed fire to reduce invasive species and native mesophytic species • Monitor following fire and for invasives, oak regeneration, and deer herbivory
Shadyside 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 red maple • Monitor following fire and for invasives, oak regeneration, and deer herbivory
Gilbert Road Buttonbush Swamp	Inundated Shrub Swamp	• Maintain intact buffer of natural communities surrounding wetland to protect hydrology • Monitor for invasive species
Pittsford Millpond Woods	Mesic Southern Forest	• Maintain closed canopy • Cut and herbicide invasive shrubs, especially multiflora rose • Monitor to evaluate invasives, understory and herbaceous composition, and deer herbivory
Sile Doty Woods	Mesic Southern Forest	• Maintain closed canopy • Cut and herbicide invasive shrubs • Hand pull garlic mustard • Protect populations of showy orchis and goldenseal • Monitor to evaluate invasives, understory and herbaceous composition, and deer herbivory
East Branch Fen	Prairie Fen	• Apply prescribed fire to reduce tree and shrub encroachment • Control purple loosestrife • Maintain intact buffer of natural communities surrounding fen to protect hydrology • Monitor for invasive species
Lost Nation Fen	Prairie Fen	• Apply prescribed fire to reduce tree and shrub encroachment • Cut and herbicide clusters of buckthorn, autumn olive, multiflora rose, tulip tree, and tred maple • Allow prescribed fire to carry into surrounding uplands • Establish rotating non-fire refugia to protect rare insect species • Maintain intact buffer of natural communities surrounding fen to protect hydrology • Monitor for invasive species, especially narrow-leaved cat-tail
Osseo 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 • Cut and herbicide glossy buckthorn and control purple loosestrife with biocontrol • Maintain intact buffer of natural communities surrounding fen to protect hydrology • Monitor for invasive species • Pursue acquisition of adjacent private lands or discuss compatible management with landowner
Squawfield Swamp	Southern Hardwood Swamp	• Maintain closed canopy • Maintain intact buffer of natural communities surrounding swamp to protect hydrology • Monitor for invasive species
Bell Lake	Submergent Marsh	• Maintain intact buffer of natural communities surrounding swamp to protect hydrology • Monitor for invasive species

Control of invasive species and prescribed fire are stewardship priorities for the game area fens. Photo by Joshua G. Cohen.

Setting Stewardship Priorities

This report provides site-based assessments of 13 natural community EOs that occur in Lost Nation 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 Lost Nation SGA. Because the list of stewardship needs for the game area (Table 14) 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 Lost Nation 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. As a forested island within a sea of agricultural fragmentation, Lost Nation SGA provides critical habitat for forest-interior dependent species. Stewardship efforts should be focused in the highest quality and largest dry-mesic southern forest and mesic southern forest EOs. In addition, we also recommend that stewardship efforts be focused on rare wetland communities that harbor high levels of biodiversity and provide habitat for numerous rare species, namely prairie fens. We also recommend that management efforts focus on sites located along riparian corridors and complexes that include wetland and upland ecosystems, so that management efforts impact the upland and wetland interface. Finally, efforts to protect the cave should be made since this is the only recorded cave in southern Lower Michigan and one of only four documented caves in the state.

Sites that meet these criteria include Lost Nation Fen* (prairie fen, EO ID 2833), Sile Doty Cave* (cave, EO ID 20175), Sile Doty Woods* (mesic southern forest, EO ID 19886), Baw Beese Woods* (dry-mesic southern forest, EO ID 19888), Pittsford Millpond Woods* (mesic southern forest, EO ID 19887), Burst-Dam Woods (dry-mesic southern forest, EO ID 19805), Osseo Fen (prairie fen, EO ID 19813), and Squawfield Swamp (EO ID 19891) (Table 15). The highest priority sites within this subset of natural community EOs are highlighted by an asterisk. Lost Nation Fen has been identified as a potential Focal Area for management for the tamarack tree cricket (Cohen et al. 2014b).

Monitoring

We recommend that monitoring be implemented at Lost Nation 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 in understories of fire-prone forests, and fostering regeneration of oak saplings in fire-dependent forested 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.

Table 15. Stewardship priorities for Lost Nation 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
Sile Doty Cave*	Cave	20175	CD	2012	2015	G4?	S1
Burst-Dam Woods	Dry-mesic Southern Forest	19805	BC	2013	2103	G4	S3
Baw Beese Woods*	Dry-mesic Southern Forest	19888	C	2013	2013	G4	S3
Pittsford Millpond Woods*	Mesic Southern Forest	19887	C	2013	2013	G2G3	S3
Sile Doty Woods*	Mesic Southern Forest	19886	C	2013	2013	G2G3	S3
Lost Nation Fen*	Prairie Fen	2833	BC	1997	2013	G3	S3
Osseo Fen	Prairie Fen	19813	C	2013	2013	G3	S3
Squawfield Swamp	Southern Hardwood Swamp	19891	C	2013	2013	G3	S3

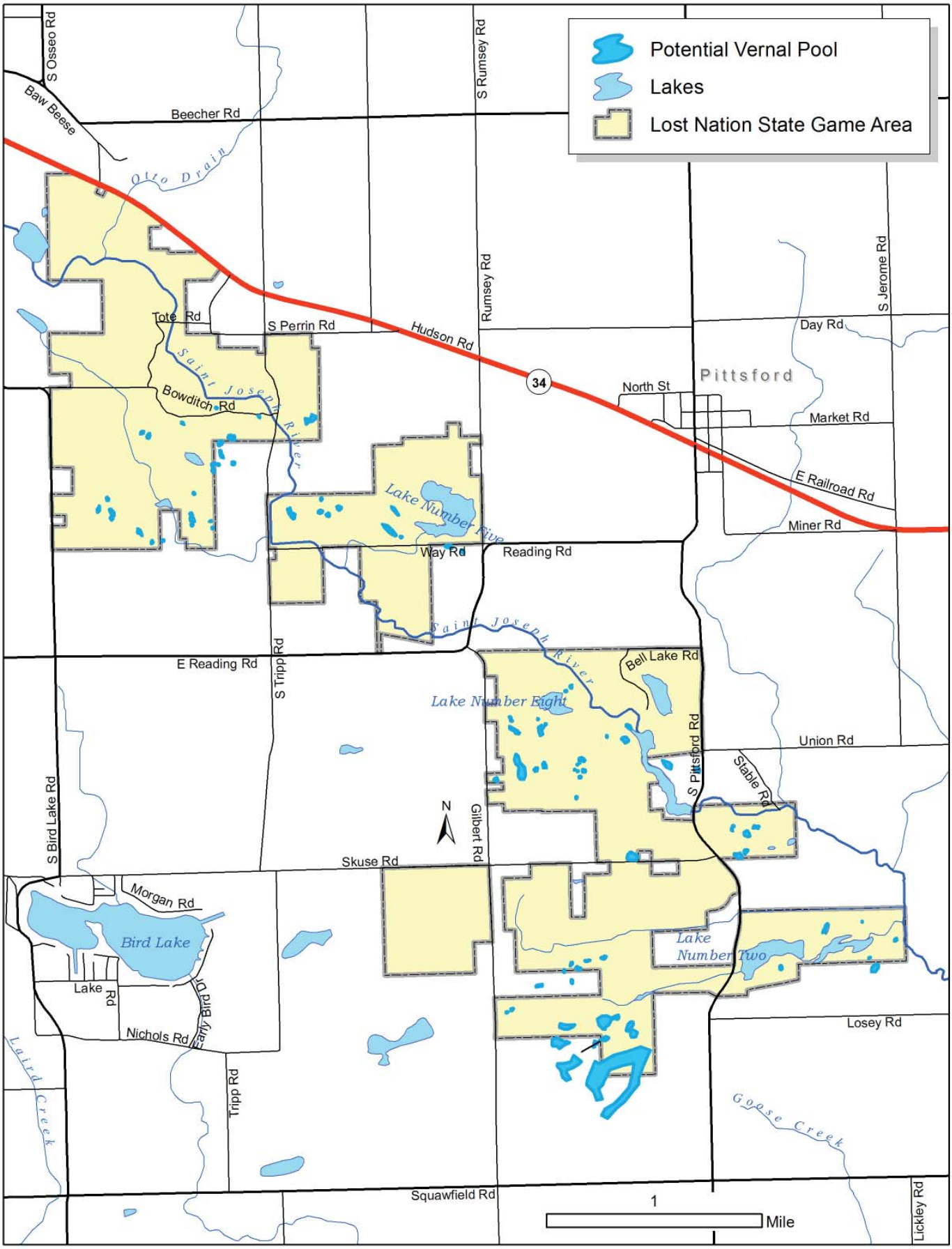


Figure 14. A total of 81 potential vernal pools were identified and mapped from aerial photo interpretation within Lost Nation State Game Area.

Vernal Pools Discussion and Management Recommendations

Despite their small size and temporary nature, vernal pools can be incredibly diverse and productive wetlands. Due to increased awareness of the ecological significance of vernal pools, there has been growing interest in identifying, mapping, monitoring, and protecting these small but ecologically critical wetlands in Michigan. In 2014, 81 potential vernal pools were identified and mapped from aerial photo interpretation (Figure 14), and 20 vernal pools were surveyed and verified in the field in Lost Nation SGA (Figure 11). These survey and mapping results provide baseline information on vernal pool status, distribution, and ecology in the game area, which will help natural resource planners and managers develop and implement appropriate management of these wetlands. However, Lee et al. (2014) documented a 27% commission error rate (false positives) and a 12% omission error rate (false negatives) for mapping vernal pools from aerial photograph interpretation in several study areas in southeast Michigan. It is likely that some of the potential vernal pools mapped in the game area are not vernal pools, and that there are additional vernal pools in the field that were not mapped as potential vernal pools. Thus, additional surveys are warranted to verify and map vernal pools in the field to obtain more accurate information on the status and distribution of vernal pools in the game area.

Ideally, vernal pool surveys should consist of multiple visits to each pool within a year and across several years (e.g., 2-3 years). Vernal pools should be surveyed at least two to three times within a year if possible, consisting of one to two visits in early spring to collect data when the pools are full and survey for vernal pool indicator species, and one visit in late summer or early fall to verify pool drying. Multiple visits to each pool within a year and across several years are recommended because vernal pool hydrology and ecology can vary significantly within a year and between years. For example, fairy shrimp are mainly found in flooded vernal pools in early spring until mid to late May, or when water temperatures reach 68 °F to 72 °F (20 °C to 22 °C), which can vary in terms of the timing depending on local weather conditions in the spring (Colburn 2004). Fairy shrimp also may not be observed every year in a given pool (Colburn 2004, Calhoun and deMaynadier 2008). Vernal pool hydrology (e.g., hydroperiod or how long a pool holds water) also can vary significantly from year to year depending on annual weather conditions (i.e., shorter hydroperiod during drier years, longer hydroperiod in wetter years). It is important to note that most of the vernal pools that were surveyed in 2014 were visited only once in the spring due to limited time and resources. Additional surveys of these pools within a year, particularly in late summer or early fall, and across several years are needed to verify drying and obtain more complete and accurate information on their status, ecology, and faunal composition.

Recommendations for the conservation and management of vernal pools include the following. In order to protect vernal pools it is important to accurately identify and map them. It is important to become familiar with the characteristics of vernal pools and learn to identify them during all times of year because vernal pools are small, highly variable, and can be difficult to detect during certain times of the year. Activities that disturb soils or tree canopies in and near vernal pools should be avoided or minimized, particularly during critical time periods for most amphibians (i.e., March through July) (Thomas et al. 2010). Equipment use and canopy alteration can impact water quality and quantity and shift vegetation, resulting in changes to microhabitat that can pose serious problems for many amphibians (Semlitsch et al. 1988; deMaynadier and Hunter 1995, 1998, 1999; Waldick et al. 1999). The State of Michigan's sustainable soil and water quality practices for forest lands recommend no disturbance to the vernal pool depression, limiting use of heavy equipment within 30 meters (100 ft) or at least one tree length of the pool to avoid creating deep ruts, and maintaining at least 70% canopy closure within the 30-meter (100 ft or 1.4 ac) buffer (Michigan DNR and Michigan DEQ 2009). Maintaining a larger buffer (e.g., 31-122 m or 100-400 ft or up to 13 ac) with at least 50% canopy cover around vernal pools and implementing management practices that protect the forest floor and provide woody debris would maintain suitable habitat for vernal pool-dependent amphibians and invertebrates (Calhoun and deMaynadier 2008). Construction of roads and landings and applications of chemicals (e.g., herbicides and/or pesticides) should be avoided within the 30-meter buffer around a vernal pool, and minimized within the larger buffer (Calhoun and deMaynadier 2008). Natural cover, wetland areas, and drainage connections should be maintained as much as possible between groups of vernal pools and between vernal pools and other wetlands, so that animals may continue to disperse between scattered vernal pools and wetlands (Calhoun and deMaynadier 2008). It also is important to note that vernal pools are highly diverse and variable across the landscape. For example, vernal pool indicator or obligate species occur in some vernal pools and not others. Additional information about the ecology of individual vernal pools in the game area would help inform the development and implementation of appropriate and more site-specific management of vernal pools within the game area.

Rare Animal Discussion and Management Recommendations

Birds

Lost Nation SGA is characterized by large blocks of forest within a landscape consisting of agricultural land, residential development, and small forest fragments. These large blocks of forest are providing valuable nesting habitat for rare songbird species and other Neotropical migrant songbirds. We observed three rare songbird species (cerulean warbler, Louisiana waterthrush, and hooded warbler) during point count surveys, and all of these species are known to occur in landscapes dominated by mature deciduous forest. Although Michigan represents the northern edge of the breeding range for all three of these rare species, cerulean and hooded warblers can be locally common breeders in forested landscapes of the southern Lower Peninsula. We documented 41 avian species using forested tracts of the game area (Appendix 7). Recorded bird species included three MI DNR featured species, nine SGCN, and four species (veery, wood thrush, cerulean warbler, and Louisiana waterthrush) 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. In addition, cerulean warbler has been identified as a Focal Species of the DNR's Wildlife Action Plan (Amy Derosier, personal communication, March 2015).

Forest management at Lost Nation SGA should consider the habitat needs of the rare songbird species we observed. Cerulean warbler is considered an area-sensitive species and, within the core of its breeding range, typically occupies forest tracts that are 3,000 ha or larger (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 gaps. 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 regularly observed them in areas of dense young trees and shrubs associated with blowdowns. Louisiana waterthrush typically uses mature forest adjacent to small (e.g., first-order) fast-flowing streams within large blocks of deciduous forest (Eaton 1958, Dunn and Garrett 1997). We recommend managing for mature stands of riparian and adjacent upland forest at locations where Louisiana waterthrushes were observed.

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 Lost Nation SGA to forest-interior nesting songbirds. We observed brown-headed cowbirds (Molothrus ater) at 43% 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 occur at sites where the habitat appeared suitable, but they were not observed.

Reptiles and Amphibians

Amphibian and reptile surveys in Lost Nation SGA in 2014 documented a total of 15 different species (Appendix 3). These include two listed or rare species, four additional SGCN, and nine common species. Surveys were not able to document five other amphibian and reptile species targeted for surveys in 2014 including the federally threatened and state endangered copperbelly water snake, which was historically documented in the game area. However, suitable habitats for these species appear to still be available in Lost Nation SGA. Thus, potential exists for these species to occur within or adjacent to the game area. Additional surveys for these species should be conducted in the future to determine if they occur in the game area.

The new Blanchard's cricket frog occurrences that were documented within Lost Nation SGA and on adjacent private lands in 2014 are significant given the status of this species and limited number of known extant sites in the state, particularly in southeast Michigan. Historically, Blanchard's cricket frogs were common throughout southern Michigan, but this species has declined dramatically, particularly in southeast Michigan with less than 20 known extant sites documented in southeast Michigan since 1985 (Lee et al. 2000, MNFI 2015). The new occurrences in Lost Nation SGA also are significant in that there are only three other known extant occurrences of this species in Hillsdale County (MNFI 2015). Blanchard's cricket frogs inhabit the open edges of permanent ponds, lakes, floodings, bogs, seeps, and slow-moving streams and rivers. They also will utilize shallow, temporary pools near larger, permanent waterbodies. Cricket frogs prefer open or partially vegetated mud flats, muddy or sandy shorelines, and mats of emergent aquatic vegetation in shallow

water. Quiet, permanent water is essential for this species (Harding 1997). Cricket frogs also are the most aquatic of North American treefrogs, rarely leaving the vicinity of water after the breeding season except during rainy or wet conditions (Oldham and Campbell 1986). In addition to habitat loss, water pollution, vegetative succession, stocking of previously fishless lakes and ponds with fish, and competition and predation from bullfrogs are additional threats to this species in Michigan (Minton 1972, Oldham and Campbell 1986, Harding and Holman 1992, Thurow 1994, Lee et al. 2000).

Because Blanchard's cricket frogs have been recently documented from only a small number of sites in southeast Michigan, protection of known extant populations of this species is critical. Maintaining open or partially vegetated shoreline and shallow water areas along permanent waterbodies where this species occurs is critical for maintaining suitable habitat for this species. Maintaining suitable habitat between occupied sites and other areas with suitable habitat for the species would provide connectivity and help facilitate genetic exchange among sites and dispersal to new areas. The use of agricultural or residential chemicals in areas with cricket frog populations may pose a threat to this species. Avoiding or limiting the use of these chemicals in areas where runoff would impact occupied sites would likely benefit the species. Maintaining buffers of natural vegetation between occupied habitat and agricultural fields or developed areas would help reduce the input of chemical runoff into cricket frog habitat. Fish introductions into extant cricket frog sites should be avoided (Lee et al. 2000). Potential exists for this species to occur in additional areas within Lost Nation SGA and surrounding private lands. Additional surveys for this species should be conducted within and around the game area.

Surveys in 2014 updated and expanded a known occurrence of Blanding's turtles in Lost Nation SGA. Prior to 2014, the species had been documented in 2003 from one pond in Compartment 3. Surveys in 2014 reconfirmed the species' occurrence at two ponds in Compartment 3 and documented the species at a new site in Compartment 1. This Blanding's turtle occurrence has been ranked as having good viability or probability of persistence into the foreseeable future (i.e., at least 20-30 years, EO rank B) because of the extent and contiguous nature of available habitat within the game area, the protected status of this site, and the long-lived nature of this species. Although there are a fairly large number of Blanding's turtle occurrences statewide, there are only five other known extant occurrences of this species in Hillsdale County. This occurrence in Lost Nation SGA is significant and important to conserve from a local perspective given the highly fragmented and developed landscape in the surrounding area and county.

The most critical conservation need for the Blanding's turtle is the protection and management of landscape complexes of suitable wetland and adjacent upland habitats (Lee 1999, NatureServe 2015). Blanding's turtles inhabit clean, shallow waters with abundant aquatic vegetation and soft, muddy bottoms over firm substrates (Ernst et al. 1994). This species utilizes a variety of temporary and permanent wetlands and waterbodies including ponds, marshes, swamps, bogs, wet prairies, fens, river backwaters, embayments, sloughs, slow-moving rivers, protected coves, and lake shallows and inlets (Kofron and Schreiber 1985, Ernst et al. 1994, Harding 1997). It is important to protect clusters of small wetlands (<0.4 ha or 1 ac) within habitat complexes for this species since it has been found to frequently use multiple small wetlands (Joyal et al. 2001). Blanding's turtles also require open and forested upland habitats for locating mates, nesting, basking, aestivating, and dispersing (Rowe and Moll 1991, Harding 1997, Joyal et al. 2001, NatureServe 2015). They prefer to nest in open, sunny areas with moist but well-drained sandy or loamy soil. It is important to maintain sufficient suitable overwintering and nesting sites within habitat complexes (Joyal et al. 2001). Blanding's turtles also make frequent movements and may travel considerable distances over land to locate mates, nest sites, and aestivation sites (Harding 1997, Joyal et al. 2001, NatureServe 2015). Therefore, maintaining or restoring connectivity between suitable wetland and upland habitats within landscape complexes is essential for this species.

Minimizing mortality or loss of adult and juvenile Blanding's turtles also is important for maintaining viable populations of this species. The Blanding's turtle is a long-lived species characterized by delayed sexual maturity and low annual recruitment, and requires high annual adult and juvenile survivorship [>93% adult survivorship and over 72% juvenile (ages 1-13) survivorship] to maintain stable populations (Congdon et al. 1993). Even small increases in adult and subadult or juvenile mortality (e.g., <10% increase in annual mortality of mature females or only 2-3% increase in annual mortality overall) could lead to population declines (Brooks et al. 1991, Congdon et al. 1993 and 1994). Nest predation, road mortality, and illegal collection can impact adult and/or juvenile survival and threaten the viability of Blanding's turtle populations. Some of these threats may occur in Lost Nation SGA. Habitat fragmentation 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). Predator control and protection of nest sites may be

necessary to maintain a viable population of this species within the game area. Road mortality can pose a substantial threat to Blanding's turtles, particularly because of the species' tendency to make frequent and long distance migrations over land (Joyal et al. 2001). Road mortality of Blanding's turtles was not observed during surveys in 2014, but should be monitored. Fencing (e.g., silt fencing) could be installed along roads where turtle road mortality is an issue. The Blanding's turtle also is vulnerable to collection for personal collection, commercial pet trade, and/or consumption (e.g., Asian turtle markets) (Harding 1997). Research and monitoring are needed to determine whether these threats are facing the Blanding's turtle populations and other turtle populations in Lost Nation SGA. Additional management and monitoring may be needed to address these threats and monitor the impact and effectiveness of management efforts.

In addition to rare herp species, a number of frog and salamander species were found in Lost Nation SGA during 2014 surveys. Herptile surveys documented four additional current SGCN, the spotted salamander, blue-spotted salamander, northern leopard frog, and western chorus frog (Table 8). Frogs and salamanders are important components of forest and wetland ecosystems. These species can represent significant biomass and important components of food chains (Burton and Likens 1975). Frogs and salamanders also can serve as important bioindicators of ecosystem health because of their amphibious life cycles and permeable skin and eggs. For example, the northern leopard frog, which was found near Lost Nation Fen prairie fen (EO ID 2833), may be particularly sensitive to certain pesticides and is intolerant of acidification of their breeding habitats (Harding 1997). Many of the frogs and salamanders were found in forested and open canopy vernal pools and adjacent forested habitats in the game area. Spotted and blue-spotted salamanders and many other salamanders and frogs require vernal pools for breeding, but only inhabit these pools for a few days to a couple of weeks per year. They spend the majority of their time in the upland forest surrounding the breeding pools, and readily travel about 125 meter (400 ft) or more from the breeding pools (Semlitsch 1998). Spotted and blue-spotted salamanders are considered to be forest management–sensitive species, and require relatively undisturbed upland forests with temporary woodland ponds of pH > 4.5 (Wilbur 1977, DeGraaf and Rudis 1983, Downs 1989a and 1989b, Van Buskirk and Smith 1991, deMaynadier and Hunter 1998, Petranka 1998, Knox 1999). Guerry and Hunter (2002) found that spotted salamanders and blue-spotted hybrid salamanders are more likely to occur in breeding ponds that are in more forested landscapes and are within or adjacent to forests. Homan et al. (2004) also found that spotted salamanders and wood frogs appear to have critical habitat thresholds in which species occupancy or probability of occurrence declines significantly below a certain level of suitable habitat, which was about 30% forest cover. Ambystomatid salamanders, such as the spotted and blue-spotted, also return to same ponds to breed (Semlitsch et al. 1993). The main threats to spotted and blue-spotted salamanders are habitat loss and degradation, land use, and acidification of breeding ponds.

Based on the ecology and habitat needs of spotted and blue-spotted salamanders and other pool-breeding amphibians, the following forest management recommendations have been developed for these species. Activities that disturb soils or tree canopies in and near vernal pools should be avoided or minimized, particularly during critical time periods for most amphibians (i.e., March through July) (Thomas et al. 2010). The State's sustainable soil and water quality practices for forest lands recommend no disturbance to the vernal pool depression, limiting use of heavy equipment within 30 meters (100 ft) or at least one tree length of the pool to avoid creating deep ruts, and maintaining at least 70% canopy closure within the 30-meter (100 ft) buffer (Michigan DNR and Michigan DEQ 2009). Because many of the pool-breeding salamanders and frogs travel 125 meters (400 ft) or more from the breeding pools into the surrounding forest (Semlitsch 1998), extending the buffer zone at least to 125 meters or greater [e.g., 140 to 180 meters (450-600 ft)] around the pools would enhance conservation of pool-breeding salamanders and frogs (Semlitsch 1998, Calhoun and deMaynadier 2004, Massachusetts Natural Heritage and Endangered Species Program 2007).

Finally, additional surveys and monitoring are needed to determine the status and distribution of other rare herp species and SGCN that have been documented or have potential to occur at Lost Nation SGA. Because many herp species are cryptic and difficult to detect in the field, particularly if they are rare, additional surveys to document rare herp species in Lost Nation SGA should be conducted. We recommend additional surveys for the copperbelly water snake, eastern massasauga, spotted turtle, eastern box turtle, and smallmouth salamander. The copperbelly water snake was last documented in the game area in 1982 (MNFI 2015). In addition to the surveys in 2014, MNFI and other partners surveyed for copperbelly water snakes in Lost Nation SGA in 2001, 2003, and 2012. Suitable habitat for copperbellies is available in the game area, but repeated surveys over multiple years have not been able to reconfirm the species. If possible, survey and monitoring for this species should continue given the extreme rarity of this species in the state. Eastern massasaugas, spotted turtles, and eastern box turtles have not been documented in Lost Nation SGA, but suitable habitat for these

species is available, particularly in the prairie fens for all three species and in the mesic and dry-mesic southern forest stands for the eastern box turtle. Potential exists for the smallmouth salamander to occur in the vernal pools and surrounding upland and lowland forests. The Kirtland's snake (*Clonophis kirtlandii*) and gray ratsnake (*Pantherophis spiloides*) also have potential to occur in the game area, particularly in the prairie fen and upland forest stands, respectively. However, these species are very difficult to detect.

Insects

We did not conduct surveys for insects during this project because recent surveys for insects occurred in Lost Nation SGA in 2010. Four insect EOs of four different state special concern insect species are known from Lost Nation SGA including tamarack tree cricket (*Oecanthus laricis*), swamp metalmark (*Calephelis mutica*), Kansas prairie leafhopper (*Dorydiella kansana*), and wild indigo duskywing (*Erynnis baptisiae*) (Table 5 and Figure 12). These four species are all currently listed as SGCN and tamarack tree cricket is a focal species of the DNR's Wildlife Action Plan (Amy Derosier, personal communication, March 2015). Tamarack tree cricket, Kansas prairie leafhopper, and swamp metalmark have all been documented within the Lost Nation Fen prairie fen (EO ID 2833). In addition, an historical record for wild indigo duskywing occurs in the vicinity of this fen. Because wild indigo duskywing feeds on the non-native and pervasive crown vetch (Securigera varia), this species has been proposed to be removed from the revised list of SGCN (Amy Derosier, personal communication, March 2015). Kansas prairie leafhopper is associated with wetlands (e.g., prairie fen) containing nut-rushes (*Scleria* spp.) that serve as its host plant. The main host plant for swamp metalmark is swamp thistle (*Cirsium muticum*). As its name suggests, the tamarack tree cricket is found on tamaracks (*Larix laricina*) within wetland ecosystems, especially prairie fens. Tamarack tree cricket is restricted in distribution to southern Michigan.

Tamarack tree cricket, Kansas prairie leafhopper, and swamp metalmark 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 prairie fen throughout Lost Nation SGA should be monitored periodically for these, and other, rare insects.

Bats

Two rare bat species have been recorded within the Lost Nation SGA, Indiana bat (*Myotis sodalis*, state and federally endangered) and northern long-eared bat (*Myotis septentrionalis*, proposed to be listed as state threatened and federally endangered) (Table 3 and Figure 10). Both bat species are SGCN and focal species of the DNR's Wildlife Action Plan and will benefit from maintaining closed canopy forest within the game area. We recommend periodic monitoring for these two rare bats species within Lost Nation SGA. The small cave that occurs in Compartment 3, Stand 35 should be surveyed to determine if it is functioning as a hibernaculum for bats.

Indiana bat was mistnetted in 1978 along the East Branch of the St. Joseph River just west of the Pittsford Millpond along South Pittsford Road north of Skuse Road (Figure 10). Indiana bats roost and form maternity colonies under loose bark or in cavities of mature trees along riparian corridors. The bats are thought to prefer sun-exposed trees for maximum warmth at the northern limit of their range. The Indiana bat requires large blocks of mature floodplain forest or swamp hardwoods, including standing snags and other suitable living roost sites. A primary limiting factor in their summer range has been the deforestation of riparian habitats. Stream channelization, bank modification, and agricultural development along stream banks also have contributed to habitat destruction. Riparian habitat can be maintained by protecting mature, wooded areas, leaving large, dead trees standing, and maintaining wide vegetation buffer strips. Cutting of snags, canopy removal, and general land clearing activities along streams and rivers for development, agriculture, utility corridors, river or drain dredging and other purposes should be avoided. Maintaining large diameter trees to function as roosting locations in riparian areas is recommended.

A general record for northern long-eared bat was observed in the central portion of the game area in 2001 (Figure 10). This species is found in large blocks of mature forests where it forages along wooded hillsides and ridge lines and roosts underneath the bark of trees or in tree crevices or cavities. Wintering hibernacula include caves and mines. Within Lost Nation SGA, maintaining large blocks of mature forest with large diameter trees will benefit this species.

Mussel Element Occurrences, Aquatic SGCN, and Fish Species

The occurrence of the state endangered lilliput in Lost Nation SGA is one of only six documented in Michigan in recent times (post-1989) (MNFI 2015). An additional fourteen occurrences have been reported historically (pre-1960), primarily in the southeastern region of the state. This is the first record of lilliput from the St. Joseph River (Maumee) within Michigan. There are four historical records (pre-1980) of this species documented in the St. Joseph River near Pioneer and Montpelier, Ohio (Watters et al. 2009). The nearest post-1980 occurrence in the St. Joseph/Maumee River watershed is near Napoleon, Ohio in the Maumee River. The nearest occurrence in Michigan is a pre-1936 record in a tributary of the River Raisin approximately five miles west of Blissfield, Michigan. The nearest recent occurrence in Michigan was documented in the River Rouge near Plymouth in 2011. Both the Lost Nation and River Rouge occurrences consisted of empty shells only. The state conservation rank of lilliput in Michigan is S1 or "critically imperiled". Additional survey effort is needed to located live individuals, and better assess if a viable population still exists within the St. Joseph River (Maumee).

The state conservation rank for slippershell in Michigan is S2S3 or "imperiled-vulnerable". Although numerous records for slippershell exist in Michigan, most records for this species are of empty shells and/or are historical occurrences. At least ten post-1980 slippershell records are documented near Pioneer and Montpelier, Ohio within the St. Joseph River (Maumee). It is notable that live slippershell were found at three of the five survey sites within the Lost Nation SGA. Two previous EOs (one historical and one recent) existed for slippershell in and adjacent to the game area. The four new locations documented in this survey updated and expanded upon these previous records, and were entered into the Natural Heritage Database as sub-EOs to the previous EOs.

The dam located at the downstream end of the Pittsford Millpond near the Pittsford Road crossing lies between these two occurrences, and may be hindering migration and gene flow among mussel populations. The separation distance between the two updated occurrences is small enough that they would normally be considered one population; however, since they are separated by a dam they may actually be isolated from each other. An old dam and bridge structure located at Site 5 at Tote Road may also be hindering fish passage. Barriers to host fish movement are also barriers to unionid mussels (Watters 1996).

An old dam and bridge structure located at Site 5 at Tote Road may be hindering fish passage, and migration and gene flow of unionid mussels that utilize fish as hosts. Photo by Peter J. Badra.

An estimate of age can be made by counting the external annular rings of unionid mussels. Young mussels are difficult to detect because of their very small size and often go unseen in field surveys. The presence of young mussels in this survey, indicate recent reproduction of these species within Lost Nation SGA. These included a two year old slippershell at Site 5, a one to two year old spike (*Elliptio diliata*) at Site 3, a one to two year old spike and a two to three year old fatmucket (*Lamsilis siliquoidea*) at Site 4, and a two to three year old spike at Site 5 (Figure 8).

Both lilliput and slippershell are species of greatest conservation need (SGCN). Other SGCN found during aquatics surveys include creek heelsplitter (*Lasmigona compressa*), cylindrical papershell (*Anodontoides ferrusacianus*), and big water crayfish (*Cambarus robustus*), which is currently being considered as an addition to the SGCN list (Amy Derosier, personal communication, March 2015). Creek heelsplitter is considered a Regional Forester Sensitive Species by the USDA Forest Service. Its state conservation rank in Michigan is S3, "vulnerable". The cylindrical papershell is S3, "vulnerable", and it is not listed as state endangered or threatened, or as a species of special concern. Cylindrical papershell is being considered for removal from the SGCN list (Amy Derosier, personal communication, March 2015).

The range of the bigwater crayfish in Michigan is confined to the Lower Peninsula where it is not widely distributed, but occurs sporadically. It was recorded in the St. Joseph River in southern Hillsdale County in 1968. It is one of the larger sized crayfish in Michigan, and is often found in shallow excavations under flats stones rather than in the typical burrows of other cambarid species. Typical habitat is fast flowing, rocky, often tea-colored streams and rivers with little rooted aquatic vegetation (Lippson 1975). Maximum lifespan of this crayfish is three to four years. The virile crayfish (*Orconectes virilis*) is one of the most common and widespread crayfish throughout Michigan and the central U.S. Big water crayfish is less common and currently has a state conservation rank of S2? ("Imperiled" with some uncertainty). The American Fisheries Society considers it "currently stable" at the range-wide level (Taylor et al. 2007). Big water crayfish has been proposed as a species of special concern in Michigan due to a relatively low number of recently documented populations.

All fish species noted during the survey have a rank of S5 and are considered secure in Michigan. Johnny darter is one of the most common fish in Michigan and is tolerant of a wide range of habitat conditions throughout the state. Mottled sculpin is often associated with coldwater streams, and is common in Michigan except for within the Saginaw River watershed. Northern hogsucker (*Hypentelium nigricans*) is common in the southern two-thirds of the Lower Peninsula and an isolated area in the southern portion of the Upper Peninsula (Bailey et al. 2004).

Unionid Mussel/Host Fish Relationship and Implications for Management

Unionid mussels rely on fish hosts to reproduce. Eggs are fertilized within female mussels in the summer months and develop into larvae, called glochidia. These glochidia are brooded within marsupial gills of the female mussel until they are ready to be released. In some species the glochidia overwinter within the parent mussel (bradytictic), while in other species they are released in the fall (tachytictic). When they are released glochidia must attach to the gills or fins of a fish host in order to survive and develop into the adult mussel form. The fish host provides a stable environment for the glochidia to grow. Without the proper species of fish co-occurring with the unionid mussel population, glochidia do not survive and 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.

Some species of unionid mussels have lures that attract fish hosts when glochidia are ready to be released. The lures of species in the Lampsilis genus (e.g., fatmucket, *Lampsilis siliquoidea*) resemble minnows, complete with an eye spot and fringes that look like fins. The female mussel extends and moves the lure in an undulating motion. When the potential host fish bites the lure, glochidia are released and have a much better chance of attaching to their fish host. Dr. Chris Barnhart's website at http://unionid.missouristate.edu/ provides video footage of mussel lures in action.

Known hosts for lilliput are Johnny darter (*Etheostoma nigrum*), green sunfish (*Lepomis cyanellus*), warmouth (*Lepomis gulosus*), orangespotted sunfish (*Lepomis humilis*), bluegill (*Lepomis macrochirus*), and white crappie (*Pomoxis annularis*) (Watters et al. 2009). All of these occur in Michigan. Though warmouth and orangespotted sunfish have limited ranges in Michigan, they do occur in the southern-most part of the state (Bailey et al. 2004). Maximum lifespan of lilliput is around 12 years. Lilliput are bradytictic, with glochidia overwintering in the female mussel before being released the following spring or summer.

Known hosts for the slippershell are mottled sculpin, banded sculpin (*Cottus carolinae*), and Johnny darter.

Banded sculpin does not occur in Michigan. Maximum lifespan of slippershell is around 10 years. The slippershell is found almost exclusively in small streams and creeks, and has one of the strongest associations to headwater habitats of any freshwater mussel species. No fish host lure has been documented for slippershell. They are suspected to be bradytictic (Watters et al. 2009).

The creek heelsplitter is a generalist when it comes to its ability to utilize host fish. At least 20 fish species have been determined to be acceptable hosts, including common species that occur in southern Michigan. Hosts fish include black bullhead (*Ameiurus melas*), yellow bullhead (*Ameiurus natalis*), spotfin shiner (*Cyprinella spiloptera*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), and creek chub (*Semotilus atromaculatus*) (Bailey et al. 2004, Watters et al. 2009). Maximum lifespan for creek heelsplitter is up to 13 years. It is typically found in creeks and small streams with high water quality, in sand and cobble substrate. This species is bradytictic, with glochidia overwintering in the gills of the female. Creek heelsplitter is one of a few unionid mussels reported to be hermaphroditic (Ortman 1912, Watters et al. 2009).

Cylindrical papershell is a short-lived unionid known to utilize 14 different hosts to complete its life cycle, including some of the most common fish species in Michigan. These include white sucker (*Catostomus commersoni*), spotfin shiner (*Cyprinella spiloptera*), bluegill, common shiner (*Luxilus cornutus*), largemouth bass (*Micropterus salmoides*), bluntnose minnow (*Pimephales notatus*), and black crappie (*Pomoxis nigromaculatus*). Maximum lifespan of cylindrical papershell is seven to eight years. It is a bradytictic species found in headwater streams in a variety of substrates from cobble and pebble to mud and clay (Watters et al. 2009).

A potential management action that could improve the viability of populations of lilliput, slippershell, and other mussels within Lost Nation SGA is to improve connectivity of mussel populations. Removing barriers and improving fish passage with the St. Joseph River will also improve connectivity of mussel populations, allowing for migration to new habitats and transportation of mussels between populations. Gene flow among populations prevents inbreeding and genetic isolation of populations.

Rare Mussels in the St. Joseph River Watershed

In addition to lilliput and slippershell, several other rare mussel species have been documented in the St. Joseph (Maumee) watershed (Appendix 5). The West Branch of the St. Joseph River is the only stream in Michigan to support the federally endangered clubshell (*Pleurobema clava*). Though a relatively large population persists in the West Branch (Badra 2004), they have not been reported from the East Branch. One 1997 record for the federally endangered rayed bean (*Villosa fabalis*) was reported for the West Branch (MNFI 2015). None have been documented from the East Branch.

Round pigtoe (*Pleurobema sintoxia*) was reported from Lost Nation SGA at the location of Site 4 in 1998 (Figures 8 and 12). Another occurrence of round pigtoe was recorded approximately five miles south of Lost Nation SGA in 1948. The external shell morphology of this species can be very similar to Wabash pigtoe (*Fusconia flava*). This is especially the case in small river habitats where there are often forms that appear to be intermediate between the two species. However, this is due to similarity in shell morphology and not to hybridization. In this 2014 survey, 25 Wabash pigtoe were reported from Site 4 (Table 9). Six of these were somewhat intermediate in form but were determined to be Wabash pigtoe. The other nineteen had the typical form of Wabash pigtoe. Though no round pigtoe were found in this 2014 survey it is possible they still persist within the game area.

Water Quality and Stream Habitat

Conductivity measures taken at the time of surveys were within normal expected ranges (Table 13). Conductivity of rivers in the United States ranges between 50 and 1500µS. Streams supporting good fisheries typically measure between 150 and 500µS. 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, while 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 normal ranges (Table 13), indicating enough buffering capacity to help protect aquatic life from normal fluctuations in pH (160-192mg/l CaCO3). Alkalinity is a measure of how much calcium carbonate (mg/liter of CaCO3) 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.

The continued absence of zebra mussels in Lost Nation 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 on boats and trailers. Both larvae and adults can be introduced in this way. 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 the St. Joseph River that do not have 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. Commonly used fishing sites 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.

Due to cumulative downstream effects of non-point source impacts including erosion/siltation, impervious surface, and pollutants, the quality of large river habitats is dependent upon the quality of headwater habitats. The St. Joseph River within Lost Nation SGA is a relatively high-quality waterway that contributes to maintaining the quality of downstream habitats. Excessive siltation does not appear to be a large problem within Lost Nation SGA. The highest estimated percent of silt was 30% at Site 2, and 20% or less at the rest of the sites. The two dams/impoundments present in the river may be acting as silt traps, although excessive erosion was noted along the side of S. Tripp Road at Site 3, and at the Tote Road bridge at Site 5. Tributaries that flow through land with intense agricultural use may have a net negative impact on the rivers they feed into. The benefit that Lost Nation SGA provides through wide intact riparian buffers, relatively low levels of impervious surface (large amount of natural land cover), and low levels of other non-point and point source impacts extends beyond the East Brach of the St. Joseph River. Lost Nation SGA also contributes to the habitat quality of the lower reaches of the St. Joseph River and the Maumee River and the species these systems support.

A nation-wide assessment of threats to imperiled freshwater fauna identified altered sediment loads and nutrient inputs from agricultural nonpoint pollution, non-native species, and altered hydrologic regimes associated with impoundments as the three leading threats (Richter et al. 1997). The St. Joseph River within Lost Nation SGA is somewhat buffered from agricultural impacts by relatively wide riparian zones of natural vegetation cover, and has not yet been affected by zebra mussels. There is opportunity to return the hydrologic characteristics of the river to a more natural state by removing remnant dam structures.

Maintaining a buffer of natural cover along the East Branch of the St. Joseph River (Maumee) is recommended. Photo by Joshua G. Cohen

CONCLUSION

During the Integrated Inventory Project at Lost Nation SGA, MNFI documented 20 new element occurrences (EOs) and updated an additional seven EOs (Tables 1-6). A total of 36 EOs have been recorded within the game area. In total, 20 SGCN were documented during the project including seven rare animal species (Table 8). Surveys for exemplary natural communities resulted in 12 new high-quality natural communities and one high-quality natural community was updated (Table 1). Thirteen natural communities were surveyed in 2012 and 2013 including: bog (1 EO), cave (1 EO), dry-mesic southern forest (3 EOs), inundated shrub swamp (1 EO), mesic southern forest (2 EOs), prairie fen (3 EOs), southern hardwood swamp (1 EO), and submergent marsh (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, six EOs for the rare plant black-haw (*Viburnum prunifolium*, state special concern) were documented (Table 2). In addition to black haw, an existing EO of white lady-slipper (*Cypripedium candidum*, state threatened) occurs within the Lost Nation Fen prairie fen (EO ID 2833). The site descriptions for natural community EOs include discussion of rare plant populations when they occur within the high-quality natural communities.

Employing aerial photo interpretation, MNFI scientists identified and mapped 81 potential vernal pools in Lost Nation SGA. During the 2014 field season, 20 vernal pools were surveyed and verified. These survey and mapping results provide baseline information on vernal pool status, distribution, and ecology in the game area, which will facilitate the development and implementation of appropriate management of these wetlands.

Three rare bird species have been documented in the game area with all three rare bird species being recorded during the 2014 breeding season (Table 3). We updated EOs for Louisiana waterthrush (*Parkesia motacilla*, state threatened), cerulean warbler (*Setophaga cerulea*, state threatened), and hooded warbler (*Setophaga citrina*, state special concern). A total of nine avian SGCN were documented in Lost Nation SGA during the 2014 breeding season (Table 8).

During the course of the project, two new Blanchard's cricket frog (*Acris blanchardi*, state threatened) were documented and one Blanding's turtle EO was updated (Table 4). A total of seven amphibian and reptile SGCN have been documented in the Lost Nation SGA, with six being recorded during this project (Table 8).

Four insect EOs of four different state special concern insect species are known from Lost Nation SGA including tamarack tree cricket (*Oecanthus laricis*), swamp metalmark (*Calephelis mutica*), Kansas prairie leafhopper (*Dorydiella kansana*), and wild indigo duskywing (*Erynnis baptisiae*) (Table 5). These four species are all currently listed as SGCN.

Two rare bat species have been recorded within the Lost Nation SGA, Indiana bat (*Myotis sodalis*, state and federally endangered) and northern long-eared bat (*Myotis septentrionalis*, proposed to be listed as state threatened and federally endangered) (Table 3). Both bat species are SGCN and focal species and will benefit from maintaining closed canopy forest within the game area. We recommend periodic monitoring for these two rare bats species within Lost Nation SGA.

Surveys within Lost Nation SGA for unionid mussels resulted in one new EO for lilliput (*Toxolasma parvum*, state endangered) and updating two slippershell (*Alasmidonta viridis*, state threatened) EOs with four new locations for the species. In addition, aquatic surveys documented two additional SGCN mussels, cylindrical papershell (*Anodontoides ferussacianus*) and creek heelsplitter (*Lasmigona compressa*) and a proposed SGCN, big water crayfish (*Cambarus robustus*) (Tables 8 and 10). We did not detect invasive zebra mussels (*Dreissena polymorpha*) at any of the survey sites.

Primary management recommendations for the Lost Nation SGA include: 1) invasive species control focused in high-quality natural areas (especially wetland ecosystems); 2) the maintenance of the canopy closure of mature forest ecosystems; 3) the reduction of fragmentation and promotion of connectictivy across the game area but focused in the vicinity of high-quality natural communities, wetlands, and riparian areas; 4) 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; 5) protection of the cave; 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 Lost Nation 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*), common buckthorn (*Rhamnus cathartica*), multiflora rose (*Rosa multiflora*), hybrid cat-tail (*Typha* x*glauca*), and narrow-leaved cat-tail (*Typha angustifolia*). Invasive species management at Lost Nation 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. Although not detected during surveys of aquatic systems, zebra mussel (*Dreissena polymorpha*) poses a potential threat to the integrity of aquatic systems and aquatic species populations and periodic monitoring for this invasive should be implemented. Erecting education signs within the game area describing the threat of zebra mussels and how to limit their spread could help minimize future impacts.

Lost Nation SGA supports over 1,900 acres of forest and close to 200 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 also contributes to the 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.

Much of the land within Lost Nation SGA historically supported fire-dependent ecosystems, such as dry-mesic southern forest, 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, fire-suppressed wetlands such as prairie fen 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 wetland to shrub- or tree-dominated systems typically results in significant reductions in diversity at the species and habitat levels. Regular prescribed fire management within open wetlands can help reduce native woody cover and invasive species and also promote high species diversity. Many of the rare species documented in Lost Nation SGA and the surrounding area depend on these fire-dependent habitats. In addition, due to fire suppression, dry-mesic southern forests within Lost Nation SGA are experiencing strong regeneration of thin-barked, shade-tolerant mesophytic trees and invasive shrubs and failure of oak to regenerate. Within dry-mesic forested ecosystems, a sustained, landscape-scale, fire-management program would reduce the density of shade-tolerant understory and help facilitate increased recruitment of fire-adapted native species.

We recommend the implementation of prescribed fire at a landscape-scale and the creation of large burn units (e.g., several hundred 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 and dry-mesic southern forest) 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.

In general, prioritization of stewardship within Lost Nation 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 Lost Nation SGA, we recommend the following: 1) that canopy closure be maintained in the highest-quality and largest forest ecosystems and especially adjacent to the cave, vernal pools, and riparian areas; 2) that stewardship efforts be focused on the high-quality prairie fens that harbor high levels of biodiversity and provide habitat for numerous rare plant and animal species; and 3) that management efforts focus on sites along riparian corridors and in complexes that include wetland and upland ecosystems. Critical to any effective management strategy is the adaptive capacity to modify stewardship activities and priorities following monitoring.

LITERATURE CITED

Abrams, M.D., and L.C. Hulbert. 1987. Effect of topographic position and fire on species composition in tall grass prairie in northeast Kansas. American Midland Naturalist 117: 442-445.

Abrams, M.D., A.K. Knapp and L. C. Hulbert. 1986. A ten year record of aboveground biomass in a Kansas tallgrass prairie: Effects of fire and topographic position. American Journal of Botany 73: 1509-1515.

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

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

Anderson, D.E. 2007. Survey Techniques. In Raptor Research and Management Techniques, ed. D.M, Bird and K.L. Bildstein. Hancock House Publishers, Blaine, WA. Pp. 89-100.

Anderson, R.C., and J.E. Schwegman. 1991. Twenty years of vegetational change on a southern Illinois Barren. Natural Areas Journal 11(1): 100-107.

Axelrod, A.N., and F.D. Irving. 1978. Some effects of prescribed fire at Cedar Creek Natural History Area. Journal of the Minnesota Academy of Science 44: 9-11.

Badra, P.J. 2004. Monitoring of Clubshell (*Pleurobema clava*) Populations and Surveys for the Northern Riffleshell (*Epioblasma torulosa rangiana*) in Michigan. Michigan Natural Features Inventory report number 2004-17. For the U.S. Fish and Wildlife Service, Lansing, MI.

Bailey, R.M., W.C. Latta, and G.R. Smith. 2004. An atlas of Michigan fishes with keys and illustrations for their identification. Museum of Zoology, University of Michigan, Miscellaneous Publications No. 192. Ann Arbor.

Barnhart, M. C. 2008. Unio Gallery: http://unionid.missouristate.edu.

Bratton, S.P. 1982. The effects of exotic plant and animal species on nature preserves. Natural Areas Journal 2(3): 3-13.

Bresse, M.K., J. Le Moine, S. Mather, K.D. Brosofske, J. Chen, T.R. Crow, and J. Rademacher. 2004. Disturbance and landscape dynamics in the Chequamegon National Forest Wisconsin, USA, from 1972 to 2001. Landscape Ecology 19: 291-309.

Brooks, R.J., G.P. Brown, and D.A. Galbraith. 1991. Effects of a sudden increase in natural mortality of adults on a population of the common snapping turtle (*Chelydra serpentina*). Canadian Journal of Zoology 69: 1314-1320.

Brosofske, K.D., J. Chen, and T.R. Crow. 2001. Understory vegetation and site factors: Implications for a managed Wisconsin landscape. Forest Ecology and Management 146: 75-87.

Bruggeman, J.E., D.E. Andersen, and J.E. Woodford. 2011. Northern Goshawk monitoring in the western Great Lakes bioregion. Journal of Raptor Research, 45: 290-303.

Burton, T.M., and G.E. Likens. 1975. Salamander populations and biomass in the Hubbard Brook Experimental Forest, New Hampshire. Copiea 1975(3): 541-546.

Calhoun, A.J.K., and P. deMaynadier. 2004. Forestry habitat management guidelines for vernal pool wildlife. MCA Technical Paper No. 6, Metropolitan Conservation Alliance, Wildlife Conservation Society, Bronx, New York.

Calhoun, A.J., and P.G. deMaynadier. 2008. Science and Conservation of Vernal Pools in Northeastern North America. CRC Press, New York, NY. 363 pp.

Campbell, H.W., and S.P. Christman. 1982. Field techniques for herpetofaunal community analyses. Pages 193-200 in N.J. Scott, Jr., ed. Herpetological Communities, U.S. Department of Interior, Fish and Wildlife Service, Wildlife Research Report 13, Washington, D.C. 239 pp.

Cohen, J.G., D.L. Cuthrell, and H.D. Enander. 2014b. Development of a Preliminary Focal Area Network for the Wildlife Action Plan. Michigan Natural Features Inventory Report Number 2014-26, Lansing, MI. 25 pp.

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

Cohen, J.G., R.P. O'Connor, B.J. Barton, D.L. Cuthrell, P.J. Higman, and H.D. Enander. 2009. Fort Custer Vegetation and Natural Features Survey 2007-2008 Report. Michigan Natural Features Inventory, Report Number 2009-04, Lansing, MI. 46 pp plus 2 appendices.

Colburn, E.A. 2004. Vernal Pools: Natural History and Conservation. The McDonald and Woodward Publishing Company, Granville, Ohio. 426 pp.

Collins, S.L., and D.J. Gibson. 1990. Effects of fire on community structure in tallgrass and mixed grass prairie. Pp. 81-98 in S. L. Collins and L. L. Wallace (eds.), Fire in North American Tallgrass Prairies, University of Oklahoma Press, Norman, OK.

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

Congdon, J.D., A.E. Dunham, and R.C. Van Loben Sels. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): Implications for conservation and management of long-lived organisms. Conservation Biology 7: 826-833.

Congdon, J.D., A.E. Dunham, and R.C. Van Loben Sels. 1994. Demographics of common snapping turtles (*Chelydra serpentina*): Implications for conservation and management of long-lived organisms. American Zoologist 34: 397-408.

Copeland, T.E., W. Sluis, and H.F. Howe. 2002. Fire season and dominance in an Illinois tallgrass prairie restoration. Restoration Ecology 10: 315-323.

Corn, P.S., and R.B. Bury. 1990. Sampling methods for terrestrial amphibians and reptiles. U.S. Department of Agriculture, Forest Service, General Technical Report PNW-GTR-256. 34 pp.

Crump, M.L., and N.J. Scott. 1994. Visual encounter surveys. Pages 84-92 in W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster, eds. Measuring and Monitoring Biological Diversity. Standard Methods for Amphibians. Smithsonian Institution Press, Washington, D.C.

Curtis, J.T. 1959. Vegetation of Wisconsin: An Ordination of Plant Communities. University of Wisconsin Press, Madison, WI. 657 pp.

Daubenmire, R. 1968. Ecology of fire in grasslands. Advances in Ecological Research 5: 209-66.

DeGraaf, R.M., and D.D. Rudis. 1983. Amphibians and Reptiles of New England: Habitats and Natural History. University of Massachusetts Press, Amherst, Massachusetts. 96 pp.

deMaynadier, P.G., and M.L. Hunter, Jr. 1995. The relationship between forest management and amphibian ecology: A review of the North American literature. Environmental Review 3: 230-261.

deMaynadier, P.G., and M.L. Hunter, Jr. 1998. Effects of silvicultural edges on the distribution and abundance of amphibians in Maine. Conservation Biology 12: 340-352.

deMaynadier, P.G. and M.L. Hunter, Jr. 1999. Forest canopy closure and juvenile emigration by pool-breeding amphibians in Maine. Journal of Wildlife Management 63: 441-450.

Derosier, A. Personal communication. Wildlife Action Plan Coordinator. Wildlife Division, Michigan Department of Natural Resources. Lansing, MI.

Dorney, J.R. 1981. The impact of Native Americans on presettlement vegetation in Southeastern Wisconsin. Transactions of the Wisconsin Academy of Science, Arts, and Letters. 69: 26-36.

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

Downs, F.L. 1989a. *Ambystoma laterale* (Hallowell), blue-spotted salamander. Pp. 102-107. In Pfingsten, R.A. and F.L. Downs (eds.), Salamanders of Ohio. Ohio Biological Survey Bulletin, New Series, Volume 7, Number 2, Columbus, Ohio.

Downs, F.L. 1989b. *Ambystoma maculatum* (Shaw), spotted salamander. Pp. 108-125. In Pfingsten, R.A. and F.L. Downs (eds.), Salamanders of Ohio. Ohio Biological Survey Bulletin, New Series, Volume 7, Number 2, Columbus, Ohio.

Dunn, J., and K. Garrett. 1997. A field guide to warblers of North America. Houghton Mifflin, Boston, Massachusetts. 672 pp.

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. http://www.michigan.gov/dnrwildlifeactionplan

Eaton, S. W. 1958. A life history of the Louisiana Waterthrush. Wilson Bulletin 70: 211-236.

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

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institute Press, Washington, D.C. 578 pp.

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

Farrand, W.R. and Bell, D.L. 1982. Quaternary Geology of Southern Michigan. 1:500,000 scale. Department of Natural Resources, Geological Survey Division, Lansing, Michigan.

Gillis, P.L., and G.L. Mackie. 1994. Impact of the zebra mussel, *Dreissena polymorpha*, on populations of Unionidae (Bivalvia) in Lake St. Clair. Canadian Journal of Zoology 72: 1260-1271.

Glenn-Lewin, D.C., L.A. Johnson, T.W. Jurik, A. Akey, M. Leoschke, and T. Rosberg. 1990. Fire in central North American grasslands: Vegetative reproduction, seed germination, and seedling establishment. Pp. 28-45 In (S.L. Collins and L.L. Wallace, eds.) Fire in North American Tallgrass Prairies, University of Oklahoma Press, Norman, OK.

Grimm, E.C. 1984. Fire and other factors controlling the Big Woods vegetation of Minnesota in the mid-nineteenth century. Ecological Monographs 54 (3): 291-311.

Guerry, A.D., and M.L. Hunter, Jr. 2002. Amphibian distributions in a landscape of forests and agriculture: An examination of landscape composition and configuration. Conservation Biology 16(3): 745-754.

Hamel, P.B. 1992. Cerulean Warbler, (*Dendroica cerulea*). In Migratory nongame birds of management concern in the Northeast. U.S. Department of Interior, U.S. Fish and Wildlife Service. Pp. 385-400.

Hamel, P.B. 2000. Cerulean Warbler (*Dendroica cerulea*). Account 511 in A. Poole and F. Gill, editors. The birds of North America. The Birds of North America, Philadelphia, Pennsylvania.

Hammerson, G. 2004. Element occurrence specifications for Hylid Frogs (Treefrogs). NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: March 13, 2015).

Hammerson, G., and C.D. Hall. 2004. Element occurrence specifications for Blanding's turtle (*Emys blandingii*). NatureServe Biotics5 (Accessed: March 13, 2014).

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

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

Harty, F.M. 1986. Exotics and their ecological ramifications. Natural Areas Journal. 6(4): 20-26.

Heilman Jr., G.E., J.R. Strittholt, N.C. Slosser, and D.A. Dellasala. 2002. Forest fragmentation of the conterminous United States: Assessing forest intactness through road density and spatial characteristics. BioScience 52(5): 411-422.

Heske, E.J., S.K. Robinson, and J.D. Brawn. 2001. Nest predation and neotropical migrant songbirds: Piecing together the fragments. Wildlife Society Bulletin 29(1): 52-61.

Hewitt, N., and M. Kellman. 2004. Factors influencing tree colonization in fragmented forests: An experimental study of introduced seeds and seedlings. Forest Ecology and Management 191: 39-59.

Homan, R.N., B.S. Windmiller, and J.M. Reed. 2004. Critical thresholds associated with habitat loss for two vernal pool-breeding amphibians. Ecological Applications 14(5): 1547-1553.

Howe, H.F. 1994. Managing species diversity in tallgrass prairie: Assumptions and implications. Conservation Biology 8: 691-704.

Hulbert, L.C. 1969. Fire and litter effects in undisturbed bluestem prairie in Kansas. Ecology 50: 874-877.

Hynes, H.B.N. 1970. The Ecology of Running Waters. Liverpool University Press, Liverpool. 24 pp.

Joyal, L.A., M. McCollough, and M.L. Hunter Jr. 2001. Landscape ecology approaches to wetland species conservation: A case study of two turtle species in southern Maine. Conservation Biology 15(6): 1755-1762.

Knapp, A.K. 1984. Post-burn differences in solar radiation, leaf temperature and water stress influencing production in a lowland tallgrass prairie. American Journal of Botany 71: 220-227.

Knox, C.B. 1999. Blue-spotted salamander, *Ambystoma laterale*. Pp. 37-43. In Hunter, M.L., A.J.K. Calhoun, and M. McCollough (Eds.), Maine Amphibians and Reptiles. University of Maine Press, Orono, Maine.

Kofron, C.P., and A.A. Schreiber. 1985. Ecology of two endangered aquatic turtles in Missouri: *Kinosternon flavescens* and *Emydoidea blandingii*. Journal of Herpetology 19: 27-40.

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

Kost, M.A., and D. De Steven. 2000. Plant community responses to prescribed burning in Wisconsin sedge meadows. Natural Areas Journal 20: 36-45.

Laubhan, M.K. 1995. Effects of prescribed fire on moist-soil vegetation and macronutrients. Wetlands 15: 159-166.

Leach, M.K., and T.J. Givnish. 1996. Ecological determinants of species loss in remnant prairies. Science 273: 1555-1558

Leach, M.K., and T.J. Givnish. 1999. Gradients in the composition, structure, and diversity of remnant oak savannas in southern Wisconsin. Ecological Monographs 69(3): 353-374.

Leahy, M.J., and K.S. Pregitzer. 2003. A comparison of presettlement and present-day forests in northeastern Lower Michigan. American Midland Naturalist 149(1): 71-89.

Lee, Y. 1999. Special animal abstract for *Emydoidea blandingii* (Blanding's turtle). Michigan Natural Features Inventory, Lansing, Michigan. 4 pp.

Lee, Y., P.J. Badra, M. Battaglia, L.L. Bourgeau-Chavez, H.D. Enander, D.A. Hyde, B.J. Klatt, Z. Laubach, M.J. Monfils, M.R. Penskar, K. Scarbrough, and E.H. Schools. 2014. Developing an approach for identifying, mapping, and assessing vernal pools in Michigan. Michigan Natural Features Inventory Report No. 2014-07, Lansing, MI. 128 pp.

Lee, Y., D.A. Hyde, and J.T. Legge. 2000. Special animal abstract for *Acris crepitans blanchardi* (Blanchard's cricket frog). Updated 2009. Michigan Natural Features Inventory, Lansing, Michigan. 4 pp.

Lippson, R.L. 1975. The distribution of the crayfishes of Michigan with aspects of their life cycle and physiology. Dissertation. Michigan State University, East Lansing, MI.

Massachusetts Natural Heritage and Endangered Species Program. 2007. Massachusetts Forestry Conservation Management Practices for MESA-listed mole salamanders. Version 2007.1. Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, Westborough, Massachusetts, USA.

McClain, W.E., M.A. Jenkins, S.E. Jenkins, and J.E. Ebinger. 1993. Changes in the woody vegetation of A bur oak savanna remnant in central Illinois. Natural Areas Journal 13: 108-114.

McCune, B., and G. Cottam. 1985. The successional status of a southern Wisconsin oak woods. Ecology 66: 1270-1278.

Michigan Department of Natural Resources (Michigan DNR). 2002. Michigan Frog and Toad Survey Instructions. Michigan Department of Natural Resources, Wildlife Division, Lansing, Michigan. http://www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/frogs_instructions.pdf

Michigan Department of Natural Resources (Michigan DNR) and Michigan Department of Environmental Quality (Michigan DEQ). 2009. Sustainable Soil and Water Quality Practices on Forest Land. Revised Feb. 24, 2009. Lansing, Michigan. 79 pp.

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

Michigan Natural Features Inventory (MNFI). 2014. 1938 Aerial Photo Mosaic. Time period of content 06/14/1938. From aerial photos scanned at 600 d.p.i. by Michigan State University Aerial Imagery Archive. Photo Scale 1:20,000.

Michigan Natural Features Inventory (MNFI). 2015. Biotics database. Michigan Natural Features Inventory, Lansing, MI.

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

Minton, S.A. 1972. Amphibians and reptiles of Indiana. Indiana Academy of Science. Indianapolis, IN. Monograph No.3. Pp. 96-99.

Mosher, J.A., M.R. Fuller, and M. Kopeny. 1990. Surveying woodland hawks by broadcast of conspecific vocalizations. Journal of Field Ornithology 61: 453-461.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer (Accessed: March 13, 2015).

Oldham, M.J., and C.A. Campbell. 1986. Status report on Blanchard's cricket frog (*Acris crepitans blanchardi*) in Canada. Unpublished report to the Committee on the Status of Endangered Wildlife in Canada. 79 pp.

Ortman, A.E. 1912. Notes upon the families and genera of the najades. Annals of the Carnegie Museum 8: 22-365.

Panzer, R. 1998. Insect conservation within the severely fragmented eastern tallgrass prairie landscape. PhD thesis, University of Illinois, Champaign Urbana, IL.

Petersen, S.M., and P.B. Drewa. 2006. Did lightning initiated growing season fires characterize oak-dominated ecosystems of southern Ohio? Journal of the Torrey Botanical Society 133: 217-224.

Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C. 592 pp.

Potter, B.A., G.J. Soulliere, D.N. Ewert, M.G. Knutson, W.E. Thogmartin, J.S. Castrale, and M.J. Roell. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, Minnesota. 124 pp.

Ralph, C. J., J. R. Sauer, and S. Droege (eds.). 1995. Monitoring bird populations by point counts. General Technical Report PSW-GTR-149. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, California. 187 pp.

Rankin, E.T. 2006. Methods for assessing habitat in flowing waters: Using the Qualitative Habitat Evaluation Index (QHEI). Ohio EPA Technical Bulletin EAS/2006-06-1.

Reich, P.B., M.D. Abrams, D.S. Ellsworth, E.L. Kruger and T.J. Tabone. 1990. Fire affects ecophysiology and community dynamics of Central Wisconsin oak forest regeneration. Ecology 71: 2179-2190.

Reinartz, J.A. 1997. Controlling glossy buckthorn (*Rhamnus frangula* L.) with winter herbicide treatments of cut stumps. Natural Areas Journal 17(1): 38-41.

Richards, M. Personal communication. Natural Resources Specialist. Fort Custer Training Center, MI.

Richburg, J.A. 2005. Timing Treatments to the Phenology of Root Carbohydrate Reserves to Control Woody Invasive Plants. Doctoral Dissertation. University of Massachusetts, Amherst, MA. 54 pp.

Richter, B.D., D.P. Braun, M.A. Mendelson, and L.L. Master. 1997. Threats to imperiled freshwater fauna. Conservation Biology 11: 1081-1093.

Robinson, S.K., F.R. Thompson, T.M. Donovan, D.R. Whitehead, and J. Faarborg. 1995. Regional forest fragmentation and the nesting success of migratory birds. Science 267: 1987-1990.

Rood, D. 1952. The Legend of "Lost Nation". Inside Michigan 2(3): 19-21.

Rooney, T.P., and W.J. Dress. 1997. Patterns of plant diversity in overbrowsed primary and mature secondary hemlock-northern hardwood forest stands. Journal of the Torrey Botanical Society 124(1): 43-51.

Rowe, J.W., and E.O. Moll. 1991. A radiotelemetric study of activity and movements of the Blanding's turtle (*Emydoidea blandingii*) in northeastern Illinois. Journal of Herpetology 25: 178-185.

Schloesser, D.W., W.P. Kovalak, G.D. Longton, K.L. Ohnesorg, and R.D Smithee. 1998. Impact of zebra and quagga mussels (*Dreissena* spp.) on freshwater unionids (Bivalvia: Unionidae) in the Detroit River of the Great Lakes. American Midland Naturalist 140: 299-313.

Schmalzer, P.A., and C.R. Hinkle. 1992. Soil dynamics following fire in Juncus and Spartina marshes. Wetlands 12: 8-21.

Semlitsch, R.D. 1998. Biological delineation of terrestrial buffer zones for pond-breeding amphibians. Conservation Biology 12: 1113-1119.

Semlitsch, R.D., D.E. Scott, and J.H.K. Pechmann. 1988. Time and size at metamorphosis related to adult fitness in Ambystoma talpoideum. Ecology 69: 184-192.

Semlitsch, R.D., D.E. Scott, J.H.K. Pechmann, and J.W. Gibbons. 1993. Phenotypic variation in the arrival time of breeding salamanders: Individual repeatability and environmental influences. Journal of Animal Ecology 62: 334-340.

Siemann, E., J. Haarstad, and D. Tilman. 1997. Short-term and long-term effects of burning on oak savanna arthropods. American Midland Naturalist 137(2): 349-361.

Sparks, J.C., R.E. Masters, D.M. Engle, M.W. Palmer, and G.A. Bukenhofer. 1998. Effects of late growing-season and late dormant-season prescribed fire on herbaceous vegetation in restored pine-grassland communities. Journal of Vegetation Science 9: 133-142.

Taylor, C.A., G.A. Schuster, J.E. Cooper, R.J. DiStefano, A.G. Eversole, P. Hamr, H.H. Hobbs III, H.W. Robison, C.E. Skelton, and R.F. Thoma. 2007. A reassessment of the conservation status of crayfishes of the United States and Canada after 10+ years of increased awareness. Fisheries 32(8): 371-389.

Temple, S.A. 1987. Predation on turtle nests increases near ecological edges. Copeia 1987: 250-252.

Tester, J.R. 1989. Effects of fire frequency on oak savanna in east-central Minnesota. Bulletin of the Torrey Botanical Club 116(2): 134-144.

Thomas, S.A., Y. Lee, M.A. Kost, and D.A. Albert. 2010. Abstract for vernal pool. Michigan Natural Features Inventory, Lansing, Michigan. 23 pp.

Thurow, G. 1994. Suggested interim responses to the amphibian decline problem. Bulletin of the Chicago Herpetological Society 29: 265-268.

U.S. Geological Survey. 2009 Digital Elevation Model (DEM) for Michigan from the National Elevation Dataset (NED). 30 m raster dataset. http://ned.usgs.gov/

Van Buskirk, J., and D.C. Smith. 1991. Density-dependent population regulation in a salamander. Ecology 72: 1747-1756.

Viro, P.J. 1974. Effects of forest fire on soil. Pp. 7-45 in (T.T. Kozlowski and C.E. Ahlgren eds.) Fire and Ecosystems, Academic Press, New York, NY.

Waldick, R.C., B. Freedman, and R.J. Wassersug. 1999. The consequences for amphibians of the conversion of natural, mixed-species forests to conifer plantations in southern New Brunswick. The Canadian Field Naturalist 113: 408-418.

Warners, D. P. 1997. Plant diversity in sedge meadows: Effects of groundwater and fire. Ph.D. dissertation, University of Michigan, Ann Arbor, MI. 231 pp.

Watters, G.T. 1996. Small dams as barriers to freshwater mussels (Bivalvia, Unionoida) and their hosts. Biological Conservation 75: 79-85.

Watters, G.T., M.A. Hoggarth, and D.H. Stansbery. 2009. The Freshwater Mussels of Ohio. The Ohio State University Press, Columbus.

White, A.S. 1983. The effects of thirteen years of annual prescribed burning on a *Quercus ellipsoidalis* community in Minnesota. Ecology 64(5): 1081-1085.

White, A.S. 1986. Prescribed burning for oak savanna restoration in central Minnesota. Research Paper NC-266, U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, St. Paul, MN. 12 pp.

Wilbur, H.M. 1977. Propagule size, number, and dispersion pattern in *Ambystoma* and *Asclepias*. American Naturalist 111: 43-68.

Wilhelm, G.S. 1991. Implications of change in floristic composition of the Morton Arboretum's East Woods. Proceedings of the Oak Woods Management Workshop. Eastern Illinois University. Charleston, IL.

Appendix 1. Vernal Pool Monitoring Form.

Michigan Natural Features Inventory

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan Vernal Pools Project

Volunteer Vernal Pool Monitoring Form

http://mnfi.anr.msu.edu/vernalpools/ - Contact MNFI at (517) 284-6200

QC Date:
QC Initials:
Date Entered:

1a) Observer Information ☐ Visit 1 ☐ Visit 2 ☐ Visit 3 Time: from ☐AM ☐PM to ☐AM ☐PM

Name(s): Date:

1b) Property Information Ownership? ☐ Public ☐ Private Landowner/Manager Name:

Site name: Address:

Plot # City: State: Zip:

2a) Vernal Pool Location Was pool mapped as a Potential Vernal Pool (PVP)? ☐ Yes ☐ No

Pool ID #: New Pool ID #:

Township/Range/Section/1/4 info :

County:

Method for locating pool?

☐ GPS ☐ Topo Map ☐ Google Earth ☐ Air Photo

Enter coordinates in Decimal Degrees (e.g. Latitude: 44.764322 Longitude: -72.654222)

Latitude: Longitude:

For verification of PVP's location please enter names and coordinates for the nearest crossroads. Record as Decimal Degrees as shown above.

Latitude: Longitude:

Crossroad names:

2b) Brief Site Directions to Pool **

**** Written site directions to pool** (This should include: (1) description of a logical starting point; (2) the distance from the starting point to pool; (3) the direction of travel; and (4) distinctive landmarks and water bodies.): For example 'Enter Robinhood Park on the trailhead at Jordan Road. Follow the trail west approximately 1/2 mi. This is the first pool on your left, just behind a low stone wall.'

3a) Pool Type Is this a Vernal Pool? ☐ Yes ☐ No ☐ Not Sure Pool Photo Numbers:

☐ Open Pool ☐ Sparsely Vegetated Pool ☐ Shrubby Pool

☐ Forested Pool ☐ Marsh Pool ☐ Other (describe):

3b) Presence of Inlet or Outlet

Is this pool connected to or part of another water feature? ☐ culvert ☐ lake ☐ open/emergent/shrubby wetland

☐ No, pool is isolated ☐ Yes, pool is connected to: (check **ALL** that apply) ☐ stream ☐ ditch ☐ forested wetland ☐ vernal pool

If inlet/outlet is present, indicate type: ☐ permanent ☐ temporary ☐ do not know ☐ none

3c) Surrounding Habitat (within 100 feet of pool) (check **ALL** that apply)

☐ Upland Deciduous Forest ☐ Lowland Deciduous Forest
☐ Upland Coniferous Forest ☐ Lowland Coniferous Forest
☐ Upland Mixed Forest ☐ Lowland Mixed Forest
☐ Floodplain ☐ Grassland or open
☐ Emergent Wetland (marsh, bog)

Disturbances:

☐ Agriculture
☐ Road/driveway
☐ paved
☐ dirt/gravel
☐ Powerline right-of-way
☐ Light development (<25%)
☐ Intensive development (>25%)
☐ Minor logging (> or = 70% canopy remaining)
☐ Major logging (< or = 70% canopy remaining)
☐ Other:
☐ No disturbances

4a) Approximate Maximum Pool Depth

☐ Ankle-deep (<6") ☐ Hip-deep (2-3 ft)
☐ Shin-deep (6-12") ☐ Chest-deep (3-4 ft)
☐ Knee-deep (12-24") ☐ Deeper than 4 ft

4b) Water Level at Time of Survey (check one)

☐ Full/Nearly full 75-100% ☐ Less than half 25-49%
☐ Partially full 50-74% ☐ Dry/mostly dry 0-24%

4c) Water temperature (*F):

4d) Approximate Size of Pool (at maximum capacity - at widest and longest points)

Width: feet

Length: feet

Size determined by: ☐ Pacing ☐ Measuring ☐ Using GPS

4e) Substrate (when dry - check **ALL** that apply)

☐ Leaf litter ☐ Sand - Gravel ☐ Unknown
☐ Bedrock ☐ Muck - Peat ☐ Other:
☐ Loam ☐ Silt - Clay

Funding for this project was provided by the US Environmental Protection Agency along with the Michigan Department of Environmental Quality

Appendix 1. Vernal Pool Monitoring Form (continued).

4f) Vegetation in Pool

Are trees (trees = or > 4" in diameter) present in the basin? (check one)

☐ No ☐ Yes, within pool basin ☐ Yes, but only at the edge

# of trees only within the pool basin? ☐ live and/or ☐ dead/snags

% Cover within the pool (check one):

Floating vegetation: ☐ 0% ☐ 1 to 9% ☐ 10 to 25% ☐ 26 to 50% ☐ >50%

Emergent vegetation: ☐ 0% ☐ 1 to 9% ☐ 10 to 25% ☐ 26 to 50% ☐ >50%

Shrubs: ☐ 0% ☐ 1 to 9% ☐ 10 to 25% ☐ 26 to 50% ☐ >50%

4h) Cover (Any material in the pool that can provide egg attachment sites and offer concealment to adults and/or larvae; check all that apply):

☐ Shrubs ☐ Submergent vegetation

☐ Branches, twigs ☐ Logs or large woody debris

☐ Sphagnum moss ☐ Emergent vegetation (grasses, cattails)

☐ Algae ☐ Other:

☐ Leaf litter

Tree canopy over pool basin (when leaves are fully out): ☐ 0% ☐ 1 to 9% ☐ 10 to 25% ☐ 26 to 50% ☐ >50%

4g) Pool Disturbance (in pool, immediately adjacent or along shore of pool - check all that apply)

☐ Dumping - Refuse ☐ Filling ☐ Invasive Species Present

☐ Ditching - Draining ☐ Sediment ☐ Purple loosestrife ☐ Garlic mustard

☐ Agricultural runoff ☐ Vehicle ruts ☐ Reed canary grass ☐ Other:

☐ Cultivation - Livestock ☐ Presence of rock pile or other anthropogenic disturbance ☐ No disturbances

5) Indicator Species and Additional Species (if other species are observed please list below in blank fields under Fingernail Clams)

Provide a photograph of each indicator species (adults, juveniles/larvae, or egg masses) observed. **Photos of species observed are required.**

Species Observed	Adults	Tadpoles/Larvae	Egg Masses			Photo? Yes	Notes/Photo ID#
			Number	Estimated	Counted		
Wood Frog							
Spotted Salamander							
Blue-spotted Salamander							
Fairy Shrimp							
Fingernail Clams							

Were any of the following observed? (check **ALL** that apply)

☐ Fish: (indicate all lengths observed) ☐ ≤ 3" ☐ > 3" ☐ Green frogs: ☐ tadpoles ☐ adults

☐ Bullfrogs: ☐ tadpoles ☐ adults ☐ Other:

Comments:

Draw diagram of pool (include landmarks, location of indicated species, north arrow and area surveyed if entire pool was not surveyed):

Funding for this project was provided by the US Environmental Protection Agency along with the Michigan Department of Environmental Quality

Page 2 of 2

Appendix 2. Vernal Pool Types.

VERNAL POOL TYPES:

1) **Open Pool** – "Classic" vernal pool, rooted/live trees, shrubs and/or non-woody herbaceous or persistent emergent plants covering <10% of the ground within pool basin


2) **Sparsely Vegetated Pool** – Rooted/live trees, shrubs, and/or non-woody herbaceous or persistent emergent plants covering 10% to < 30% of the ground within pool basin


3) **Shrubby Pool** – Pool dominated by shrubs – Vegetation covers ≥ 30% of the ground with shrubs comprising ≥ 30% of the uppermost vegetation layer within pool basin.


Appendix 2. Vernal Pool Types (continued).

4) **Forested Pool** – Pool dominated by trees - Vegetation covers ≥ 30% of the ground with rooted/live trees comprising ≥ 30% of the uppermost vegetation layer in pool basin. For example, forested swamp pool, pool within larger forested swamp, floodplain pool.

5) **Marsh Pool** – Pool dominated by non-woody herbaceous or persistent emergent plants – Non-woody herbaceous and/or persistent emergent plants comprise 30 – 50% of the uppermost vegetation layer in pool basin. Trees and shrubs may be present but < 30% cover.

Appendix 3. List of amphibian and reptile species known to occur or with potential to occur in Lost Nation 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]	Rare Species Survey Targets 2014	Species Found During 2014 Surveys	Species Found During Surveys Prior to 2014	General Habitats[3,4]
Amphibian	Mudpuppy	*Necturus maculosus maculosus*			X				Permanent waters - rivers, reservoirs, inland lakes, Great Lakes bays and shallows
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**	X	X	X	Deciduous and coniferous forests from moist bottomlands to dry uplands; ponds that retain water into midsummer essential
Amphibian	Spotted Salamander	*Ambystoma maculatum*			X	X	X		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	Smallmouth Salamander	*Ambystoma texanum*		E	X	X			Forested floodplains, swamp forests, deciduous forests and associated wetlands . Also more open habitats such as prairies and farm fields. Require temporary, shallow bodies of water, which are usually fish-free, for breeding, including forested vernal ponds, oxbow ponds in floodplains, roadside ditches, borrow pits, flooded fields, prairie ponds, swamps, and occasionally slow headwater streams/pools. Outside the breeding season, adult and juveniles spend most of their lives on the forest floor under cover or underground.
Amphibian	Eastern Tiger Salamander **	*Ambystoma tigrinum*			X**	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
Amphibian	Blanchard's Cricket Frog	*Acris blanchardi*		T	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	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				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*					X		Permanent waterbodies including shallow, weedy Great Lakes inlets and bays; muddy ponds, lakes, sloughs and slow streams with dense aquatic vegetation
Reptile	Eastern Musk Turtle	*Sternotherus odoratus*							Permanent waterbodies - ponds, lakes, marshes, sloughs, rivers; highly aquatic

Appendix 3. List of amphibian and reptile species known to occur or with potential to occur in Lost Nation State Game Area. Each species' status at federal and state levels and within the game area is provided along with general habitat associations (continued).

Amphibian/ Reptile	Common Name[1,3]	Scientific Name[1]	US Status	State Status	WAP SGCN[2]	Rare Species Survey Targets 2014	Species Found During 2014 Surveys	Species Found During Surveys Prior to 2014	General Habitats[3,4]
Reptile	Spotted Turtle	*Clemmys guttata*		T	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			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	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*							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	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	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	Copperbelly Water Snake	*Nerodia erythrogaster neglecta*	LT	E	X	X		(X)	Wetlands, generally shallow wetlands, including shrub swamps; emergent wetlands; and temporary or permanent, palustrine open water wetland, usually associated with mature or second-growth forests but occasionally in more open situations; also forested swamps, woodland pools, and floodplain forests as well as small lakes, slow-moving rivers and streams, oxbows, and sloughs.
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	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.
Reptile	Brown Snake	*Storeria dekayi*							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 adjacent fields, pastures, road embankments, marshes and sphagnum bogs
Reptile	Eastern Garter Snake	*Thamnophis sirtalis sirtalis*							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

Appendix 3. List of amphibian and reptile species known to occur or with potential to occur in Lost Nation State Game Area. Each species' status at federal and state levels and within the game area is provided along with general habitat associations (continued).

Amphibian/ Reptile	Common Name[1,3]	Scientific Name[1]	US Status	State Status	WAP SGCN[2]	Rare Species Survey Targets 2014	Species Found During 2014 Surveys	Species Found During Surveys Prior to 2014	General Habitats[3,4]
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**				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				Dry sunny, open habitats with access to cover - old fields, hedgerows, shrub thickets, open forests, forest edges, also grassy lake borders and marshes
Reptile	Gray Ratsnake *	*Pantherophis spiloides*		SC	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			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:
U.S. Status: LE = Federally Endangered; LT = Federally Threatened; C = Federal Candidate
State Status: E = State Endangered; T = State Threatened; SC = State Special Concern
WAP SGCN - Wildlife Action Plan Species of Greatest Conservation Need
^ - Lost Nation SGA may be at the edge or just outside of known range for species in the state but close to species' range and potential exists for species to occur in Lost Nation SGA.
* - Rare species not targeted for surveys in 2014 due to low likelihood or probability of detecting the species given available methods and resources for surveys.
** - Species was a SGCN in 2014 but has been removed or proposed for removal as a SGCN by the Michigan DNR as of February 2015.

Appendix 4. 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 4. State Lands Inventory Special Animal Survey Form - Herps (continued)

V. LISTED ANIMAL OR PLANT SPECIES or COMMUNITY EOS _____

_____

_____

VI. ADDITIONAL ASSOCIATED SPECIES FOUND

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

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

Wind Codes (Beaufort wind scale):

0 = Calm (< 1 mph) smoke rises vertically

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

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

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

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

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

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

Precipitation Codes:

0 = None

1 = Mist

2 = Light rain or drizzle

3 = Heavy rain

4 = Snow/hail

Sky Codes:

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

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

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

3 = Mostly cloudy (50-75%)

4 = Overcast (75-100%)

5 = Fog or haze

Appendix 5. A checklist of Michigan's unionid mussel species found at sites surveyed in Lost Nation State Game Area in 2014. Also noted are species with historical (pre-1960) records from the larger Saint Joseph River (Maumee) Watershed. Historical records are from the University of Michigan Museum of Zoology Mollusk Collection.

		Lost Nation SGA 2014	Post-1989 records in St. Joseph (Maumee) Watershed	Pre-1960 records in St. Joseph (Maumee) Watershed	State status	Federal status
Actinonaias ligamentina	Mucket			X		
Alasmidonta marginata	Elktoe		X	X	SC	
Alasmidonta viridis	Slippershell	X	X	X	T	
Amblema plicata	Threeridge	X	X	X		
Anodontoides ferussacianus	Cylindrical papershell	X	X	X		
Cyclonaias tuberculata	Purple wartyback				T	
Elliptio complanata	Eastern elliptio					
Elliptio crassidens	Elephant-ear					
Elliptio dilatata	Spike	X	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	X		
Lampsilis fasciola	Wavy-rayed lampmussel		X	X	T	
Lampsilis siliquoidea	Fatmucket	X	X	X		
Lampsilis ventricosa	Pocketbook		X	X		
Lasmigona complanata	White heelsplitter					
Lasmigona compressa	Creek heelsplitter	X	X	X		
Lasmigona costata	Fluted-shell		X	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		X	X	E	E
Pleurobema sintoxia	Round pigtoe		X	X	SC	
Potamilus alatus	Pink heelsplitter					
Potamilus ohiensis	Pink papershell				T	
Ptychobranchus fasciolaris	Kidney-shell		X	X	SC	
Pyganodon grandis	Giant floater	X	X	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	X		
Toxolasma lividus	Purple lilliput		X		E	
Toxolasma parvum	Lilliput	X			E	
Truncilla donaciformis	Fawnsfoot				T	
Truncilla truncata	Deertoe				SC	
Utterbackia imbecillis	Paper pondshell		X	X	SC	
Venustaconcha ellipsiformis	Ellipse		X		SC	
Villosa fabalis	Rayed bean		X		E	E
Villosa iris	Rainbow		X	X	SC	

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 7. List of bird species detected during 21 point counts conducted in forested areas of Lost Nation State Game Area during 2014. State status (T = threatened, SC = special concern) and the proportion of points having detections are provided for each species. Bird species considered as Michigan DNR featured species, Michigan DNR focal species, species of greatest conservation need (SGCN), and focal species of the Upper Mississippi River and Great Lakes Region Joint Venture (JV) are indicated with an "X."

Common Name	Scientific Name	State Status	Featured Species	Focal Species	SGCN	JV Focal Species	Prop. of Points
Acadian flycatcher	*Empidonax virescens*				X		0.67
American crow	*Corvus brachyrhynchos*						0.29
American redstart	*Setophaga ruticilla*						0.29
American robin	*Turdus migratorius*						0.29
Black-billed cuckoo	*Coccyzus erythropthalmus*				X		0.05
Black-capped chickadee	*Poecile atricapillus*						0.10
Blue jay	*Cyanocitta cristata*						0.38
Blue-gray gnatcatcher	*Polioptila caerulea*						0.19
Blue-headed vireo	*Vireo solitarius*						0.10
Black-throated green warbler	*Setophaga virens*						0.10
Brown-headed cowbird	*Molothrus ater*						0.43
Cedar waxwing	*Bombycilla cedrorum*						0.19
Cerulean warbler	*Setophaga cerulea*	T		X	X	X	0.24
Common grackle	*Quiscalus quiscula*						0.05
Common yellowthroat	*Geothlypis trichas*						0.05
Eastern towhee	*Pipilo erythrophthalmus*				X		0.05
Eastern wood-pewee	*Contopus virens*						0.86
Great crested flycatcher	*Myiarchus crinitus*						0.38
Hairy woodpecker	*Picoides villosus*						0.10
Hooded warbler	*Setophaga citrina*	SC			X		0.05
Indigo bunting	*Passerina cyanea*						0.33
Louisiana waterthrush	*Seiurus motacilla*	T			X	X	0.10
Northern cardinal	*Cardinalis cardinalis*						0.57
Northern parula	*Setophaga americana*				X		0.05
Ovenbird	*Seiurus aurocapilla*						0.38
Pileated woodpecker	*Dryocopus pileatus*		X				0.14
Rose-breasted grosbeak	*Pheucticus ludovicianus*						0.05
Red-bellied woodpecker	*Melanerpes carolinus*						0.29
Red-eyed vireo	*Vireo olivaceus*						0.71
Red-winged blackbird	*Agelaius phoeniceus*						0.10
Ruby-throated hummingbird	*Archilochus colubris*						0.14
Sandhill crane	*Grus canadensis*						0.05
Scarlet tanager	*Piranga olivacea*						0.33
Tufted titmouse	*Baeolophus bicolor*						0.43
Veery	*Catharus fuscescens*					X	0.14
White-breasted nuthatch	*Sitta carolinensis*						0.19
Wood duck	*Aix sponsa*		X				0.05
Wood thrush	*Hylocichla mustelina*		X		X	X	0.33
Yellow warbler	*Setophaga petechia*						0.19
Yellow-billed cuckoo	*Coccyzus americanus*				X		0.29
Yellow-throated vireo	*Vireo flavifrons*						0.19

Appendix 8. List of bird species having special status that were detected at Lost Nation State Game Area during 2014 surveys and general habitat requirements.

Species	General Habitat Requirements	State Status[1]	Featured Species[2]	WAP SGCN[3]	JV Focal Species[4]
Wood Duck	Variety of swamps, marshes, streams, beaver ponds, and lakes. Nests in tree cavities of mature forests near wetlands or water bodies.		X		
Black-billed cuckoo	Shrubby uplands and wetlands, forest gaps, and edges of thickets.			X	
Yellow-billed Cuckoo	Gaps, clearings, or wetlands within deciduous forest containing dense growth of shrubs/young trees.			X	
Pileated woodpecker	Mature mesic deciduous forest with dead or dying trees. Lowland and mixed hardwood-conifer forests also used.		X		
Acadian flycatcher	Wet forests, such as floodplains, but also occurs in mesic forests			X	
Veery	Large tracts of moist forest, dense understory of deciduous trees/shrubs				X
Wood thrush	Large tracts of wet and mesic deciduous forest, sometimes dry forests		X	X	X
Northern parula	Boreal forest in northern parts of its range. Bottomland hardwoods in southern portion of its range.			X	
Cerulean warbler[5]	Mature mesic to wet deciduous forest. Bottomland hardwood and floodplain forests preferred over uplands.	T		X	X
Louisiana waterthrush	Fast-flowing streams within large blocks of mature deciduous forest with moderate to sparse understory.	T		X	X
Hooded warbler	Mature mesic or wet deciduous forest with dense understories of shrubs/small trees.	SC		X	
Eastern towhee	Variety of shrubby areas, including second-growth forest, openings or edges of mature forests, and old fields succeeding to forest.			X	

[1]Michigan listing status (T = state threatened, SC = state special concern).
[2]Identified as featured species for habitat management by MDNR Wildlife Division.
[3]Species of greatest conservation need in the Michigan Wildlife Action Plan (Eagle et al. 2005).
[4]Focal species in the Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy (Potter et al. 2007).
[5]Identified as focal species for habitat management by MDNR Wildlife Division.