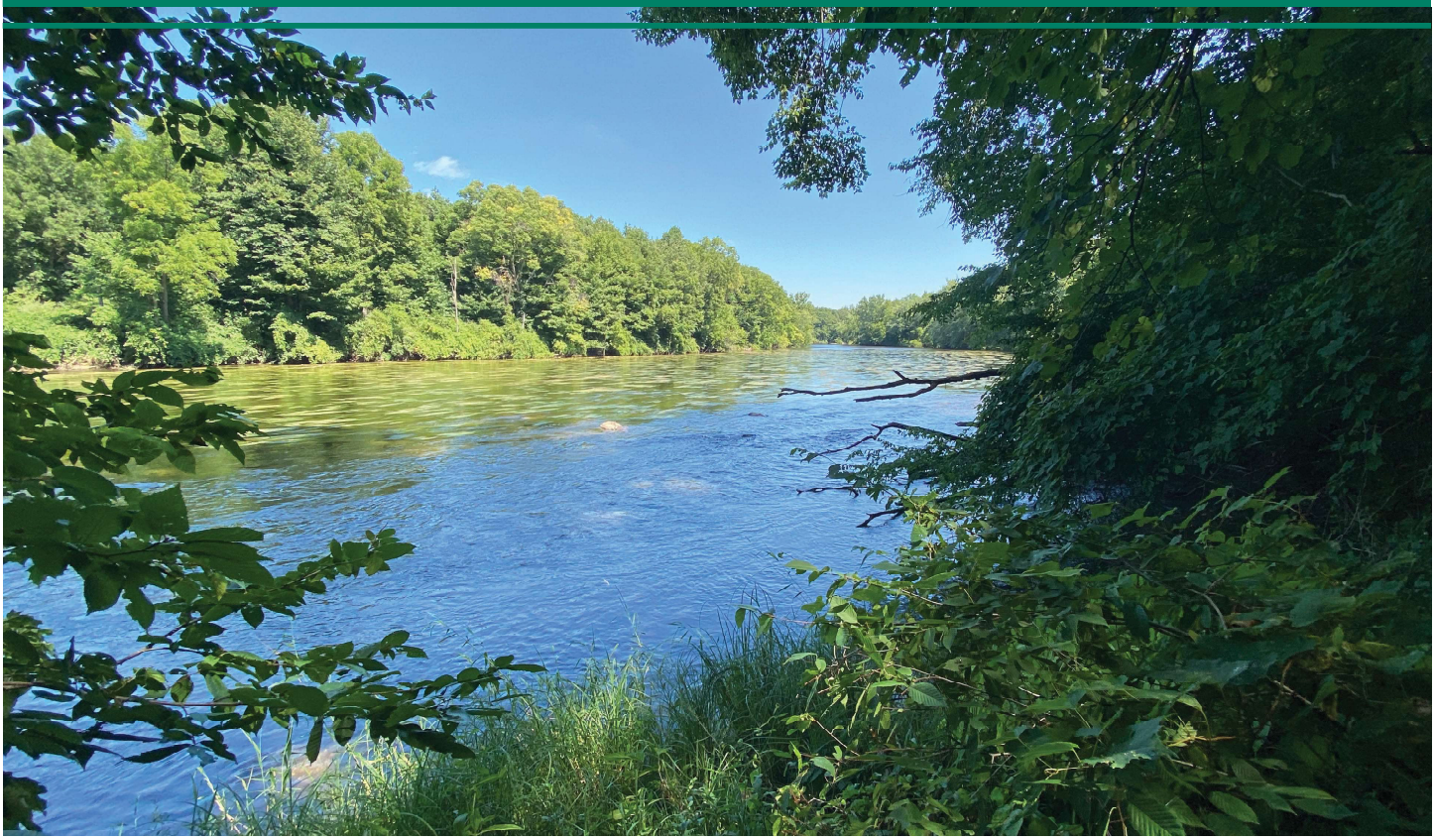
Natural Features Inventory and Management Recommendations for Portland State Game Area



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Prepared For:
Michigan Department of Natural Resources
Wildlife Division

July 2022

MNFI Report Number 2022–18

Michigan Natural Features Inventory
MICHIGAN STATE UNIVERSITY | Extension

Suggested Citation:
Lincoln, J.M., P.J. Badra, A.P. Kortenhoven, Y.M. Lee, A.A. Cole-Wick, L. Rowe, C. Ross, R. Rogers, and J.G. Cohen. 2022. Natural Features Inventory and Management Recommendations for Portland State Game Area. Michigan Natural Features Inventory, Report Number 2022-18, Lansing, MI. 109 pp.

Cover Photo: A view of the Grand River. Photo by Jesse M. Lincoln.

Acknowledgements

This project was supported by the Michigan Department of Natural Resources Wildlife Division. Funding for this project was through the Federal Aid in Wildlife Restoration Act program grant W-153-M (Habitat and Species Management with Technical Guidance) in cooperation with the U.S. Fish and Wildlife Service, Wildlife and Sport Fish Restoration Program. We express our gratitude to the numerous DNR staff that helped administer and guide this project including Michael Donovan, Mark Sargent, Amy Derosier, Dan Kennedy, Ann LeClaire, Steve Chadwick, John Niewoonder, James Miller, Donna Dreffs, Rich Ring, Jesse Bramer, Brian Maki, Nick Dohm, Nathan Poley, and Rachel Leightner.

This report relies on data collected by many former Michigan Natural Features Inventory field scientists, especially Dennis Albert, Michael Kost, Ryan O'Conner, Mike Penskar, and Bradford Slaughter. Maps for this report were prepared by our GIS team of Becca Rogers, Courtney Ross, and Helen Endander. For their support and assistance throughout this project, we thank our MNFI colleagues, Mike Monfils, Michael Sanders, Ashley Adkins, Phyllis Higman, Rachel Hackett, Tyler Bassett, Kraig Korroch, Sarah Carter, Scott Warner, Elizabeth Haber, Clay Wilton, and Brian Klatt. AmeriCorps volunteer Charlotte Brennan assisted with aquatics field surveys and Ben Huston assisted with natural community surveys.

MNFI entomologist Ashley Cole-Wick surveying for rare dragonflies in the Grand River.
Photo by Peter J. Badra.

Executive Summary

The Portland State Game Area (SGA) is a block of semi-contiguous public land in southwest Michigan, consisting of 2,623 acres in Ionia and Clinton Counties. Portland SGA is important ecologically because it provides critical habitat for a myriad of game and non-game species and supports 1,275 acres of upland forest along the Grand River riparian corridor. The Grand River and steep forested slopes along its course are prominent features of Portland SGA and the forests within the game area support a diversity of insect, herptile, avian, mammalian, plant, mussel, and fish species.

Michigan Natural Features Inventory (MNFI) conducted Stage 1 Michigan Forest Inventory (MiFI) in 2015. Surveys for high-quality natural communities were conducted in 2019 and 2020 and surveys for rare animals were conducted in 2020 and 2021 as part of the Integrated Inventory Project. This project is part of a long-term effort by MNFI to document areas of high conservation significance on state lands and provide information to the Michigan Department of Natural Resources, Wildlife Division regarding sustainable management of these important areas.

MNFI scientists documented 5 new natural community Element Occurrences (EOs), 44 new rare animal EOs, 9 new rare plant EOs, and provided information for updating 10 existing EOs. In total, 71 EOs and 10 Species of Greatest Conservation Need (SGCN) have been documented in Portland SGA including 49 animal EOs, 22 plant EOs, and 5 natural community EOs.

No natural communities had been documented from Portland SGA prior to the MiFI surveys. Based on initial MiFI data from 2015, MNFI ecologists identified and documented 5 new natural communities, including mesic southern forest and southern shrub-carr. Together, these represent 5.7% of the game area and harbor populations of rare plants and songbirds.

Aquatic surveys were performed at 15 sites in the Grand River within Portland SGA. A total of 14 unionid mussel species were found including 6 rare species: elktoe (*Alasmidonta marginata*, State Special Concern), slippershell (*Alasmidonta viridis*, State Threatened), purple wartyback (*Cyclonaias tuberculata*, State Threatened), flutedshell (*Lasmigona costata*, State Special Concern), round pigtoe (*Pleurobema sintoxia*, State Special Concern), and ellipse (*Venustaconcha ellipsiformis*, State Special Concern).

Surveys for rare avian species included point-counts for raptors and forest songbirds. Hooded warblers (*Setophaga citrina*, State Special Concern) were recorded at 3 survey points and were incorporated into and existing EO. Cerulean warblers (*Setophaga cerulea*, State Threatened) had been documented in the game area prior to 2019 surveys and were documented again in 2019 updating an existing EO. A new EO for red-headed woodpecker (*Melanerpes erythrocephalus*, State Special Concern) was documented in the game area. Rare raptor surveys within the game area documented no nesting raptors.

Four types of rare insect surveys were conducted at Portland SGA targeting butterflies and spittlebugs; odonates; regal fern borer; and bumblebees. We documented a total of 141 occurrences of 7 bumble bee species, including new records of black and gold bumblebee (*Bombus auricomus*, State Special Concern). No other rare insects were documented.

MNFI scientists conducted visual encounter surveys for rare amphibians and reptiles. One eastern box turtle (*Terrapene carolina carolina*, State Special Concern) was found during this project.

Portland SGA supports 1,275 acres of forest, including 104 acres of mesic southern forest along the Grand River. These forests are critical for stabilizing the steep slopes and maintaining water quality of the river. Extensive blocks of forest once characterized the landscape but are now reduced to small and isolated woodlots. These forests provide a variety of ecosystem services, including sediment

trapping, removal of contaminants from water through physical and biological processes, carbon storage, groundwater recharge, erosion control, water temperature regulation, and protection of small feeder streams that run into the Grand River. These services work cummulatively to protect the water quality of the Grand River and Lake Michigan. By extension, these services benefit fisheries that rely on the health of these water bodies and the local economies surrounding aquatic and terrestrial recreation.

Portland SGA supports a high concentration of rare plants. It will be increasingly important to consider the game area in the context of regional conservation goals and the prevention of extirpation of rare species. We recommend that management efforts to maintain ecological integrity be focused in natural communities to provide maximum benefit for the numerous rare species documented in the area while simultaneously maintaining ecosystem services. We also recommend developing a comprehensive approach to treating severe infestations of invasive species in the game area.

In order of importance, we provide the following management recommendations to protect native biodiversity and ecosystem integrity: 1) establish corridors of natural cover to minimize forest fragmentation along the river and connect the most important natural communities containing populations of rare plants; 2) immediately develop a comprehensive approach to treating invasive species within the conservation corridor; 3) develop plans to apply prescribed fire; 4) investigate improving aquatic connectivity along the Grand River; 5) reduce deer browse pressure; and 6) monitor these activities to facilitate adaptive management.

Fire pink (*Silene virginiana*, State Threatened) is one of several rare plants found at Portland State Game Area. The only remaining population of fire pink in Michigan occurs in this game area. The game area serves as an important refuge for native biodiversity. Photo by Aaron P. Kortenhoven.

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Introduction

The Portland State Game Area (SGA) is a large block of semi-contiguous public land in the central Lower Peninsula of Michigan, consisting of 2,623 acres in Ionia and Clinton Counties (Figures 1 and 2). It is owned and managed by the Wildlife Division of Michigan's Department of Natural Resources (DNR). Portland SGA is important ecologically because it provides critical habitat for a myriad of game and non-game species and supports 1,275 acres of deciduous upland forest occurring in the riparian corridor of the Grand River. The river and forested riparian corridor are prominent features of Portland SGA. The Grand River watershed is the second largest watershed in Michigan, draining an area of 5,572 square miles, and is one of Michigan's most species-rich river systems in terms of native unionid mussels. Named "Owashtanong" or "Far-Flowing Water" by the Ottawa, the Grand River is Michigan's longest river, running 252 miles from its headwaters in Hillsdale County north to Lansing and west to where it flows into Lake Michigan in Grand Haven. The Grand River watershed has been significantly impacted by development and agriculture, highlighting the significance of the game area and the riparian systems therein.

Michigan Natural Features Inventory (MNFI) is Michigan's natural heritage program and maintains a geospatial database of populations of rare and declining species and benchmark natural communities. MNFI and the Department of Natural Resources Wildlife Division have been collaborating since 2009 to provide comprehensive ecological evaluation of state lands through a "Integrated Inventory" project which is also funded through the Pittman-Robertson Act. In 2015 MNFI conducted habitat cover type mapping in Portland SGA as part of the Michigan Forest Inventory (MiFI) process. Surveys for high-quality natural communities were conducted in 2015 and 2020 and rare animal surveys were conducted in 2020 and 2021.

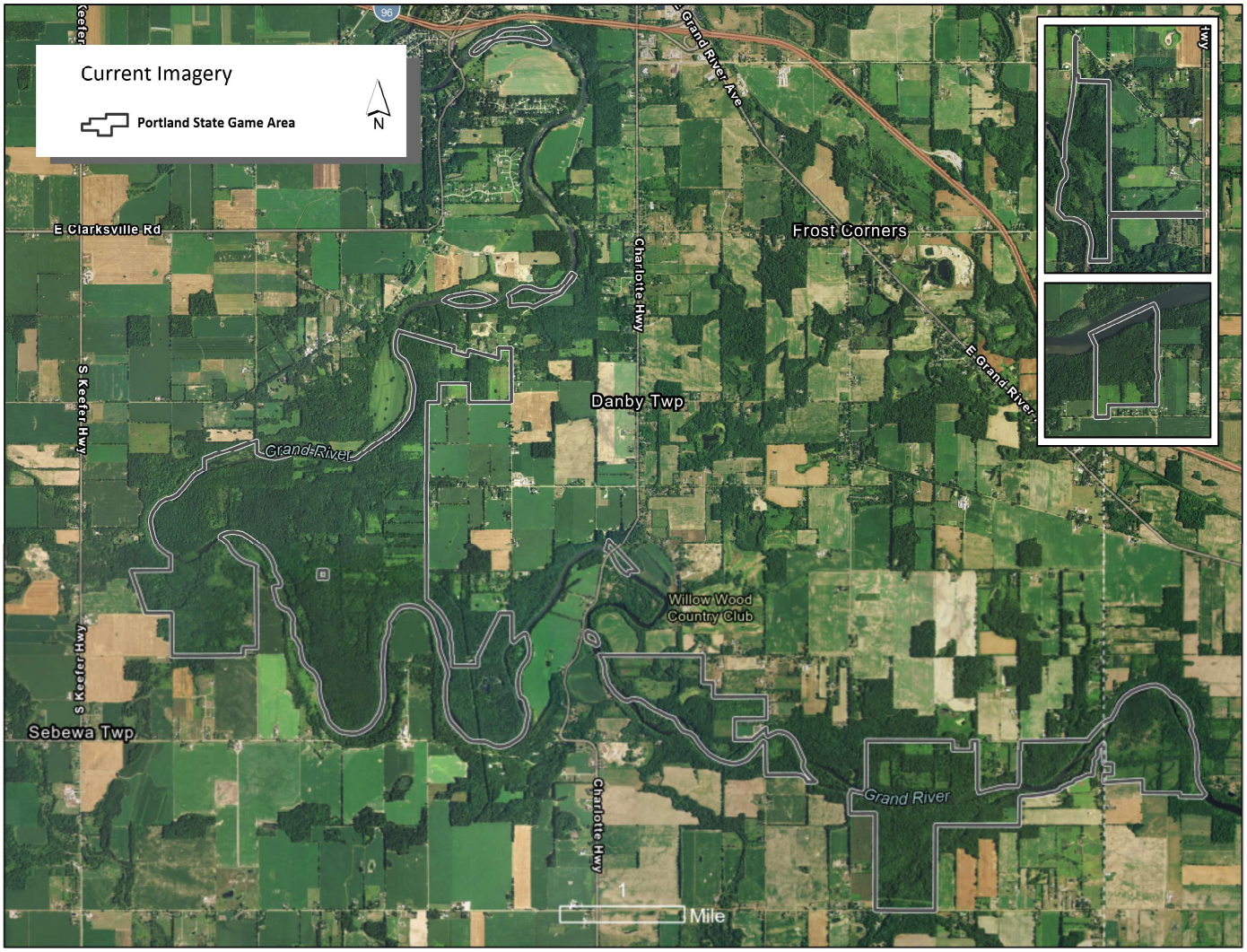


Figure 1. Imagery of Portland State Game Area (ESRI 2016). The game area occurs along the Grand River in Ionia and Clinton Counties. There are numerous islands within the Grand River and two disjunct parcels that occur north of the city of Portland.

Portland State Game Area was acquired to support recreation and provide habitat for numerous game species. Photo by Aaron P. Kortenhoven.

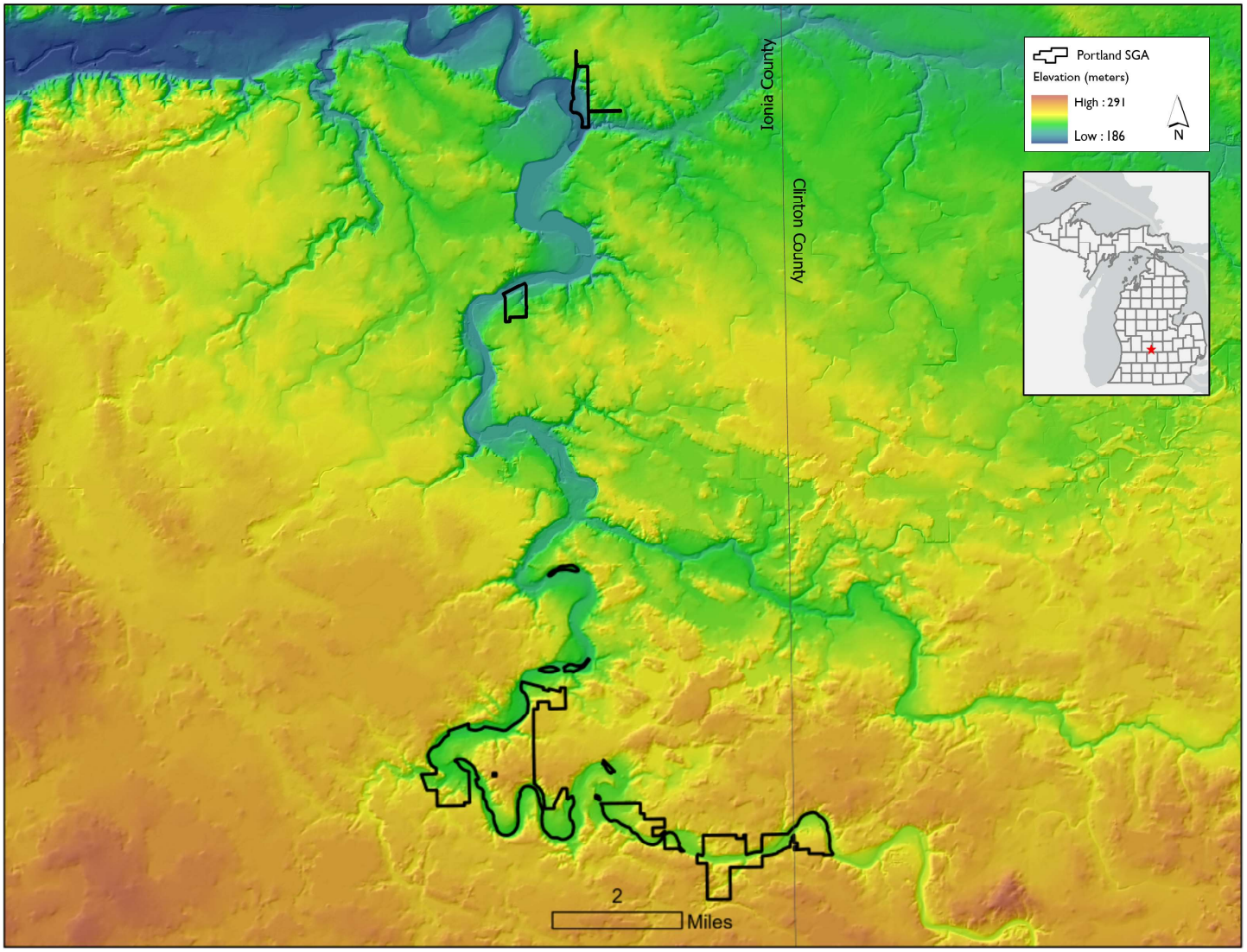


Figure 2. A digital elevation map of the Portland State Game Area.

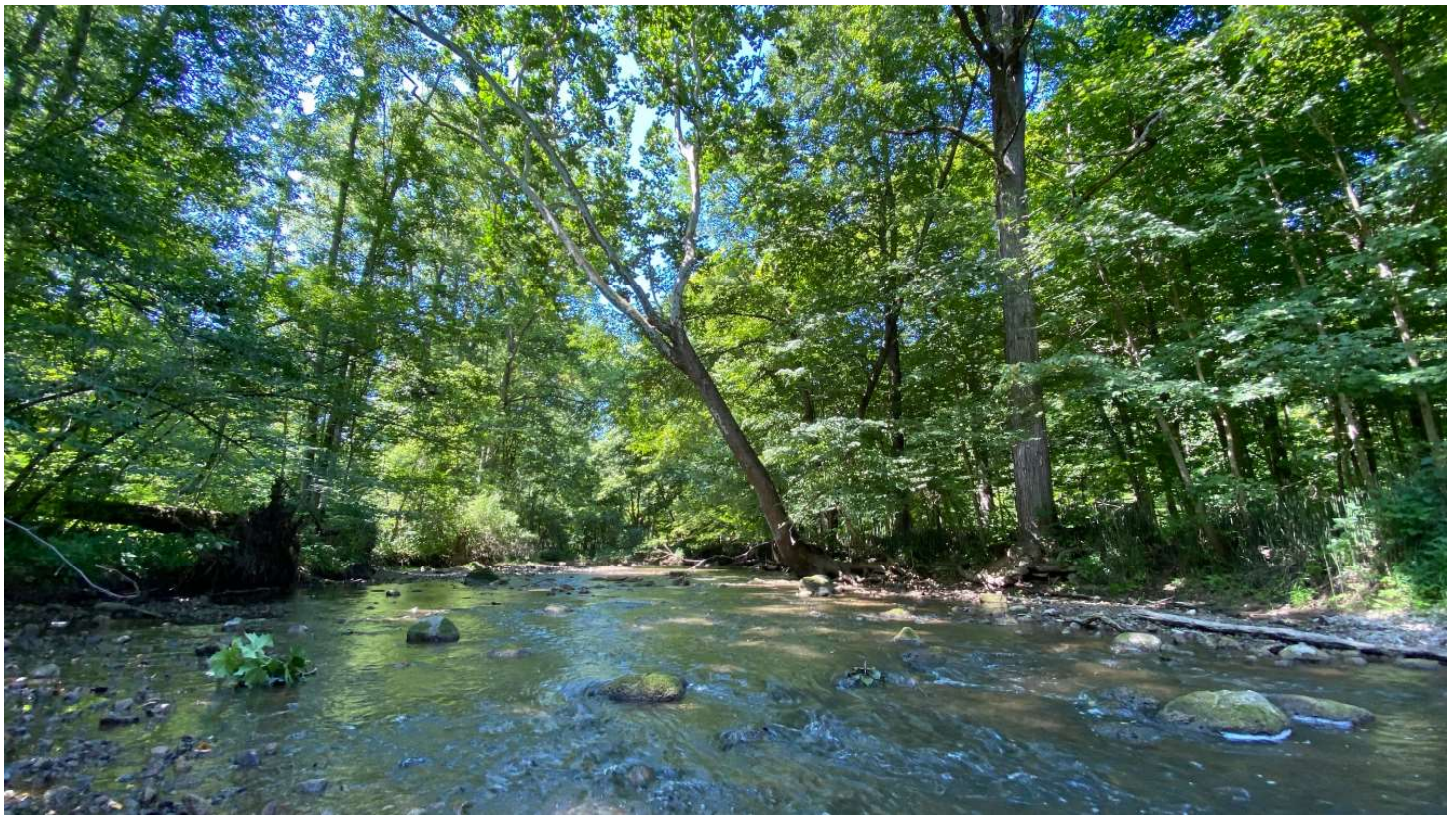
This project is part of a long-term effort by MNFI to document areas of high conservation significance on state lands and provide the Michigan DNR Wildlife Division with information to inform the sustainable management of these areas. This project addresses MNFI's mission to guide the conservation of Michigan's biodiversity for current and future generations by providing the highest quality scientific expertise and information and the DNR Wildlife Division's complementary mission to enhance, restore and conserve the State's wildlife resources, natural communities, and ecosystems for the benefit of Michigan's citizens, visitors, and future generations.

The primary goal of this survey effort is to provide resource managers and planners with standardized, baseline information on each natural community and rare species occurrence and identify the most critical places on state lands for biodiversity stewardship. This baseline information is vital for informing landscape-level biodiversity planning efforts; prioritizing protection, management, and restoration objectives; facilitating site-level decisions about biodiversity stewardship; and monitoring the success of management and restoration.

This report provides an overview of the landscape and historical context of Portland SGA, summarizes the findings of MNFI's surveys for high-quality natural communities and rare animal species, and identifies stewardship priorities within the game area. Because the landscape surrounding Portland SGA has extensive agricultural and rural development, the large area of natural cover within the game area serves as an important reservoir of biodiversity for the local region. Portland SGA supports numerous rare plant, avian, mussel, reptile, and insect species. During the natural features inventory of this game area, MNFI scientists documented or updated 3 element occurrences of 3 rare bird species, 1 rare herptile, 1 rare insect, 39 rare mussels of 6 different species, and 5 high-quality natural communities representing 2 natural community types. In addition, 22 occurrences of 19 different rare plant species have been documented in the game area; 9 of these rare plant element occurrences were opportunistically documented during the course of this project. Management recommendations are provided for rare species, specific natural communities, and the game area in general.

Some of the rare species in Portland SGA. Top, snow trillium (*Trillium nivale*, State Threatened) grows along the river in several locations. Photo by Aaron P. Kortenhoven. Middle, three purple wartybacks (*Cyclonaias tuberculata*, State Threatened) and a round pigtoe (*Pleurobema sintoxia*, State Special Concern) (bottom right) documented during aquatic surveys. Age at death can be estimated by counting annular rings visible on the outside of the shells. These purple wartybacks were 30+ years old and the round pigtoe was 20+ years old. Photo by Peter J. Badra. Left, a cerulean warbler (*Setophaga cerulea*, State Threatened) was documented from forests in the game area. Photo by Aaron P. Kortenhoven.

Bald eagles have been documented within the game area for years. While eagles were consistently in the area, it was not clear that they were using the nest located within the game area during 2021. Photo by Aaron P. Kortenhoven.



Sebewa Creek is one of several streams that course through Portland SGA. Photo by Jesse M. Lincoln.

Landscape and Historical Context

Ecoregions

Michigan has been subdivided into ecoregions based on climate, glacial features, physiography, soils, and characteristic ecosystems (Albert 1995). This classification system provides a framework for understanding the distribution patterns of species, natural communities, natural disturbance regimes, and anthropogenic activities. The classification is structured with three levels, from broad landscape regions called Sections, down to smaller Subsections and Sub-Subsections. Portland SGA occurs in southern lower Michigan in Section VI within the Lansing Sub-subsection (VI.4.1) of the Ionia Subsection (VI.4) (Albert 1995) (Figure 3).

The Lansing Sub-Subsection is dominated by a broad till plain or ground moraine with rich, loamy soils that have been largely converted to agriculture. The gently sloping ground moraine that characterizes this Sub-Subsection is broken by several outwash channels and also by numerous end moraine ridges, many of which are a little steeper than the surrounding ground-moraine topography (Figure 4). Three large rivers, the Grand, Maple, and Thornapple flow across the broad till plain with the Grand River flowing through Portland SGA. The Grand River crosses the Sub-Subsection and occupies a major glacial outwash channel that is 150 to 200 feet lower than the surrounding till plain. The Grand River outwash channel was formed by periodic flood events caused by melting of glaciers.

The portion of the Grand River that flows through the Portland SGA is winding with minimal floodplain forest development. Both the higher topographic relief and fine-textured parent material of moraines encourage the development of narrow river valleys with restricted floodplains and a reduced duration of flooding (Baker and Barnes 1998). The high topographic relief, relatively steep slope gradients, and fine-textured soil of morainal landscapes found within the game area restrict lateral channel migration, resulting in narrow, sinuous floodplains that are frequently dissected by a series of higher terraces. Because channel migration is restricted, the micro-topography of low ridges and swales that characterizes the first bottom of many floodplains is lacking.

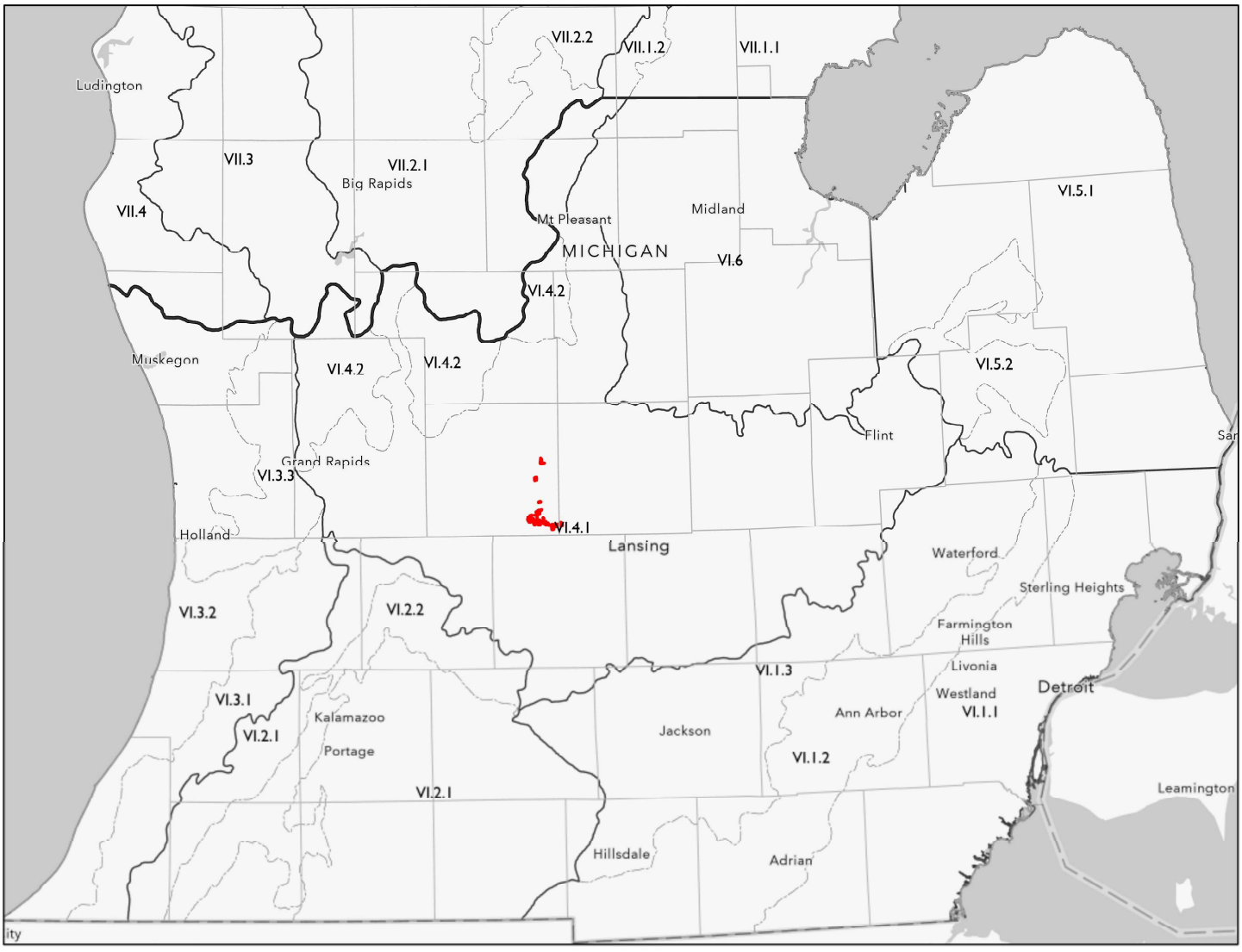


Figure 3. Ecoregions of southern Michigan (Albert 1995).

Within the game area, the Grand River is flanked by relatively large areas of natural cover. Photo by Jesse M. Lincoln.

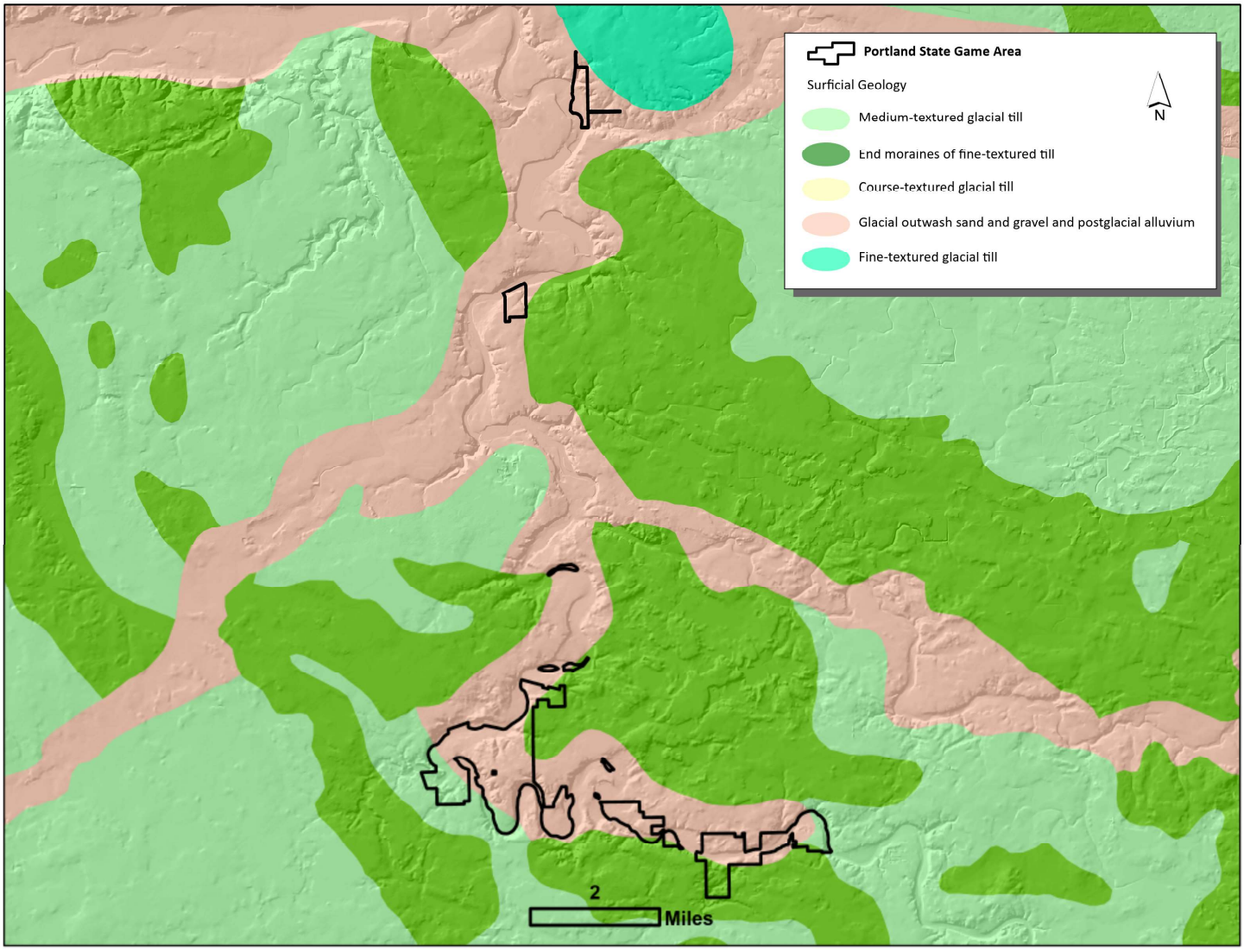


Figure 4. Surficial geology of the Portland State Game Area.

The frequency of over-the-bank flooding in morainal landscapes is generally less than that in outwash plains and lake plains. Instead, groundwater plays a stronger role, and constant soil saturation due to groundwater seepage locally supports large accumulations of organic soil (Baker and Barnes 1998). Two large streams pass through the game area and feed into the Grand River. These tributaries are Frayer Creek, which flows through the game area for approximately half a mile, and Sebewa Creek, which flows through approximately a mile of the game area.

Circa-1800 Vegetation

Interpretations of the General Land Office (GLO) surveyor notes by MNFI ecologists indicated that the Portland River SGA and surrounding area contained several distinct vegetation assemblages (Comer et al. 1995) (Figure 5). The GLO surveys in this area were conducted by Lucius Lyon in January of 1827. He recorded information on tree species composition, tree size, and general condition of the lands within and surrounding Portland SGA. The game area was predominantly forested in 1827, with an estimated 87% of the game area supporting forested ecosystems. The predominant cover types included Oak-Hickory Forest (61%) and Beech-Sugar Maple Forest (24%) with pockets of Mixed Hardwood Swamp (1%) and significant areas of Lake/River (13%) corresponding to the Grand River.

Beech-Sugar Maple Forest occurred on both ground and end moraines with Oak-Hickory Forest characterizing drier end moraine ridges and sandy ridges occurring on outwash deposits. We evaluated the notes of the land surveyors within the game area and the immediate vicinity of the game area to provide a summary of the composition and structure of the predominant circa-1800 covertypes. Within the Beech-Sugar Maple Forest, beech (*Fagus grandifolia;* 37%), sugar maple (*Acer saccharum*; 17%), American elm (*Ulmus americana;* 9%), white ash (*Fraxinus americana;* 8%), basswood (*Tilia americana;* 8%), and white oak (*Quercus alba*; 7%) were prevalent canopy dominants with red oak (*Quercus rubra*; 3%) and red maple (*Acer rubrum*; 1.5%) occurring locally as canopy associates. Within the areas classified as Beech-Sugar Maple Forest, recorded diameters of trees ranged widely from 12.7 to 121.9 cm (5 to 48 in) with an average of 37 cm (14.5 in; N = 629). Average tree diameters for the canopy dominants follow: beech 30.5 cm (12 in; N = 238); sugar maple 35.1 cm (13.8 in; N = 110); American elm 38.9 cm (15.3 in; N = 60); white ash 42.4 cm (16.7 in; N = 51); basswood 47 cm (18.5 in; N = 51); and white oak 54.8 cm (21.5 in; N = 49). Where the Beech-Sugar Maple Forest occurs along the Grand River, a diverse array of additional canopy and subcanopy associates were noted by the surveyors including bur oak (*Quercus macrocarpa*), ironwood (*Ostrya virginiana*), eastern red cedar (*Juniperus virginiana*), black walnut (*Juglans nigra*), butternut (*Juglans cinerea*), sassafras (*Sassafras albidum*), sycamore (*Platanus occidentalis*), and willows (*Salix* spp.).

White oak (*Quercus alba*; 58%) was the most prevalent canopy dominant within the Oak-Hickory Forest with canopy associates including black oak (*Quercus velutina*; 8%), American elm (*Ulmus americana;* 6%), hickories (*Carya* spp.; 4%), and white ash (*Fraxinus americana;* 4%). Within the areas classified as Oak-Hickory Forest, recorded diameters of trees ranged widely from 12.7 to 101.6 cm (5 to 40 in) with an average of 39.5 cm (15.5 in; N = 357). Average tree diameters for the most prevalent canopy trees follow: white oak 43.5 cm (17.1 in; N = 208); black oak 36.9 cm (14.5 in; N = 29); American elm 34.6 cm (13.6 in; N = 22); hickories 23.3 cm (9.1 in; N = 17); and white ash 25.7 cm (10.1 in; N = 15). In addition to canopy species, surveys noted the prevalence of "hazel" (*Corylus americana*), "briar" (*Smilax* spp.), and "vines" in the understory of the Oak-Hickory Forest.

MNFI ecologist Jesse Lincoln standing next to a large bur oak. Photo by Aaron P. Kortenhoven.

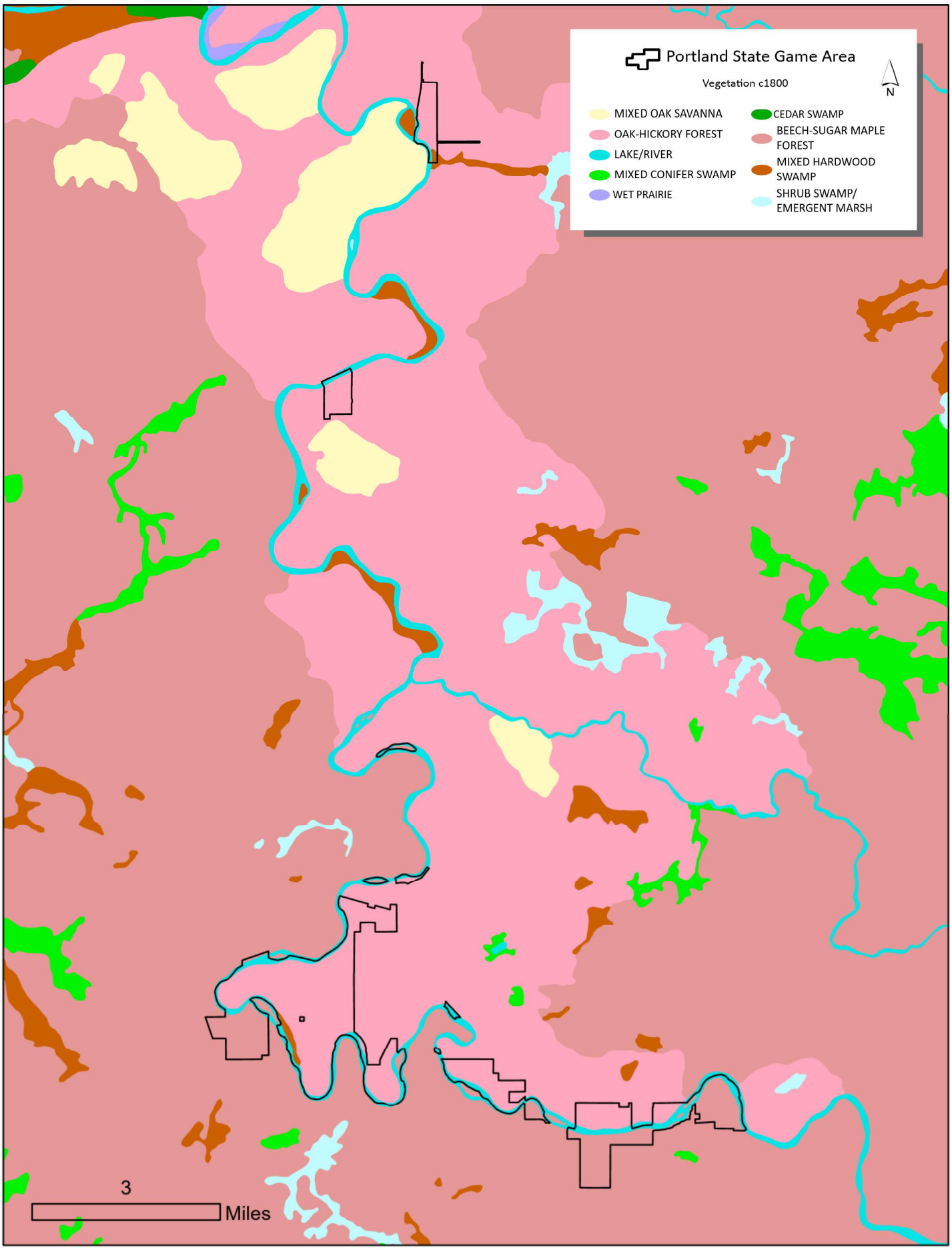
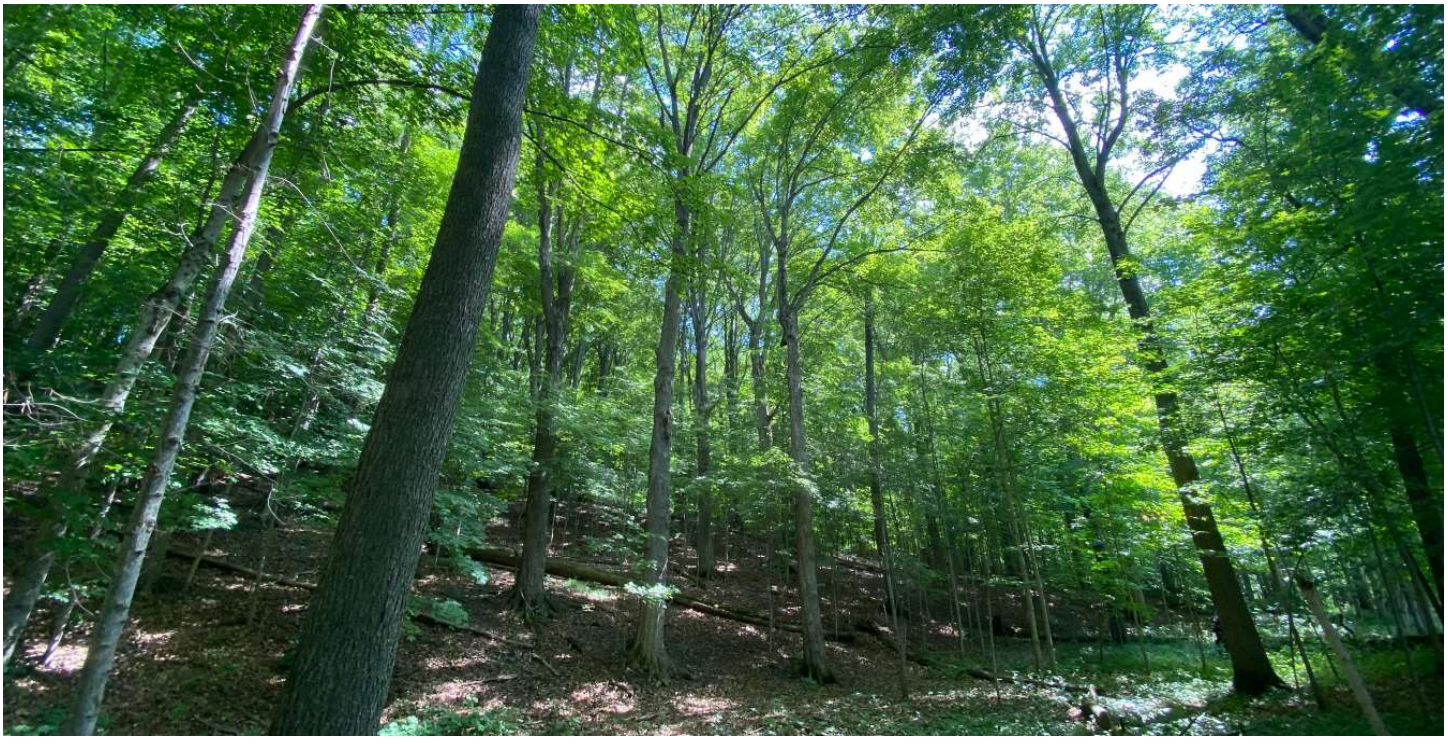


Figure 5. Vegetation of Portland State Game Area circa 1800 (Comer et al. 1995).

Where the Oak-Hickory Forest occurs along the Grand River, a diverse array of additional canopy and subcanopy associates were noted by the surveyors including hackberry (*Celtis occidentalis*), bur oak (*Quercus macrocarpa*), ironwood (*Ostrya virginiana*), eastern red cedar (*Juniperus virginiana*), black walnut (*Juglans nigra*), butternut (*Juglans cinerea*), red maple (*Acer rubrum*), sassafras (*Sassafras albidum*), sycamore (*Platanus occidentalis*), thornapple (*Crataegus* spp.), and willows (*Salix* spp.).

Mixed Hardwood Swamp occurred locally in depressions within the ground and end moraine and also in poorly drained portions of outwash. Where the surveyors noted canopy composition of these swamp forests, ash (*Fraxinus nigra* or *Fraxinus pennsylvanica;* 35%), American elm (*Ulmus americana;* 22%), and red maple (*Acer rubrum;* 13%) were prevalent canopy dominants and recorded diameters of canopy trees ranged from 10.1 to 35.5 cm (4 to 14 in) with an average of 25.6 cm (10.1 in; N = 31). Average tree diameters for these species follow: ash 26.1 cm (10.3 in; N = 11); American elm 27.2 cm (10.7 in; N = 7); and red maple 24.7 cm (9.8 in; N = 4).

Because the GLO surveys were a coarse-scale assessment, small expressions of natural communities such as small-scale wetlands and savannas were not captured in the GLO notes and therefore not included in the circa-1800 vegetation maps. Small-scale wetlands such as southern shrub-carr and southern wet meadow and fine-scale pockets of savanna likely historically occurred within the game area and surrounding area but were too small to include in the circa-1800 vegetation map. Within southern Michigan, oak savanna was common on areas of well-drained outwash and gently sloping moraine and localized on slopes with southern and western aspects. At the time of the GLO survey, oak savanna (Mixed Oak Savanna) occurred in several areas surrounding the game area. The polygons of Mixed Oak Savanna adjacent to the game area (Figure 5) were characterized by scattered white oak and black oak as the overwhelming canopy dominants with additional canopy associates including bur oak, hickories, American elm, and black cherry (*Prunus serotina*). Within these savanna areas, recorded diameters of canopy trees ranged from 12.7 to 61 cm (5 to 24 in) with an average of 32.9 cm (12.9 in) (N = 51). Many of the areas mapped as Oak-Hickory Forest or “oak lands” in the area surrounding the game area were described by the surveyors as having components of “oak plains” or “oak openings”. Within southwestern Michigan, oak savanna and oak-hickory forest occurred in a shifting forest-savanna mosaic that varied in time and space depending on the frequency and intensity of fire disturbance events. Although mapped as predominantly Oak-Hickory Forest on the circa 1800 map, portions of the game area and adjacent landscape likely transitioned to and from oak-hickory forest to oak savanna over long periods of time. In addition, within the areas of mapped forest, there were likely pockets of open oak savanna. Repeated low-intensity fires, working in concert with drought and windthrow, maintained open conditions in these oak savanna ecosystems. Within dry-mesic savanna systems, such as oak openings, it is likely that annual or nearly annual fire disturbance was the primary factor influencing the vegetative structure and floristic composition. These fires occurred during the late spring, late summer, and fall since flammability peaks in the spring before grass and forb growth resumes and then again in the late summer and autumn after the above-ground biomass dies back (Grimm 1984). These fires were caused naturally by lightning strike and also set intentionally by indigenous peoples.



Pockets of mature forests characterized by relatively high diversity of native plants and low abundance of invasive species persist on the steepest slopes along the Grand River. Photo by Jesse M. Lincoln.

The game area is characterized by a dominance of forested communities, but small open wetlands persist throughout. Photo by Jesse M. Lincoln.

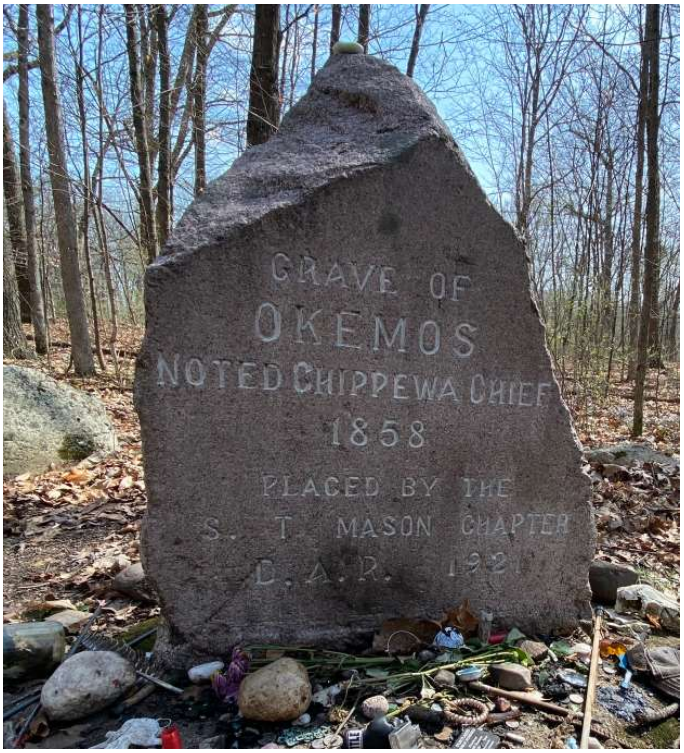
Areas of high-quality forested communities persist locally within the game area, especially along the steepest, most inaccessible slopes. Photo by Jesse M. Lincoln.

Indigenous Occupancy

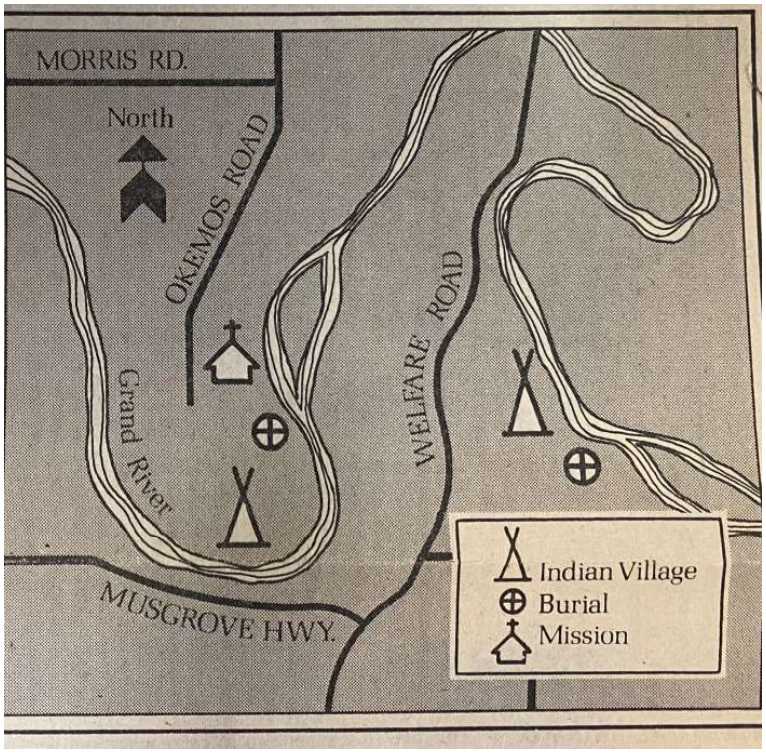
Within southwestern Michigan, Native Americans played a significant role in maintaining savanna conditions and open understories of dry-mesic southern forests through their use of fire as a land management tool (Cronon 1983, MacLeigh 1994). Throughout southern Michigan, trails, paths, and encampments were often noted within areas identified by the GLO surveyors as oak savanna, oak openings, and oak barrens and in areas along major river systems. GLO surveyors noted 18 distinct trails and paths in the landscape surrounding the game area. Tribes of Chippewa, Miami, Sauk, and Ottawa were known to frequent the Portland Area. Indigenous peoples in the region raised corn, beans, and pumpkins and harvested game and fish in the forests and rivers (Branch 1916).

Two indigenous villages have been documented along the Grand River with one occurring within the game area at the end of Okemos Road and one occurring just east of the game area east of Welfare Road. “Peshimnecon”, the village east of Welfare Road was occupied by about 600 Ottawa and Chippewa (Branch 1916) in the 1830s but was abandoned following a smallpox epidemic in 1841 (The State Journal 1982). The settlement at the end of Okemos road was called “Mishshiminecon” or “M’she-mini-coning”, which translates to “sour apples”. This settlement was occupied until the late 1850s when its occupants were forcibly relocated to a reservation (Branch 1916). Chief Okemos was reported to have died at this village in 1858 and his grave site is also reported to occur within the game area (Wieber 1975). A plaque in his honour was erected in the game area though we cannot confirm that it denotes the exact location of his grave.

A depiction of Chief Okemos from The State Journal (Wieber 1975).



The grave marker of Chief Okemos. Photo by Jesse M. Lincoln.



A map of historic villages in the Portland State Game Area from The State Journal (Wieber 1975).

Changes in Land Cover

The landcover within and around Portland SGA (Figures 1, 6, and 7) has changed significantly since the early 1800s due to logging, agriculture, tree disease, non-native insect outbreak, and fire suppression. Currently, upland forest is the most predominant land cover type in Portland SGA (55% of the game area; 1,627 ac) (Figure 7). This is a dramatic drop in upland forest cover over the past 200 years as the historic composition was 87% (2,269 ac) forested (Figure 5). Logging and conversion of upland forest to agricultural lands or non-forested uplands has accounted for this shift with 16% of the game area now corresponding to agricultural lands or non-forested uplands (Figure 7). In 1837 the village of Portland was established between the current-day game area units and the construction of a saw mill in 1869 resulted in the increase of logging and deforestation in the game area and surrounding lands (Branch 1916).

The upland and lowland forests that have not been cleared have also been dramatically altered over the past 200 years by invasive disease, invasive species infestations, deer herbivory, and fire suppression. The GLO notes documented elm and ash as significant components of both the upland and lowland forests. Dutch elm disease has virtually eliminated elm as a dominant overstory tree. In 2002, a new exotic pest, the emerald ash borer (*Agrilus planipennis*), was identified in southeastern Michigan. This Asiatic beetle has already killed millions of ash trees and altered the species composition and structure of upland and lowland forests (USDA Forest Service 2002, Roberts 2003). Both ash and elm are now generally relegated to the subcanopy of forests. Likewise, butternut (*Juglans cenerea*) was mentioned by the first surveys but has also subsequently been wiped out by a fungal blight. Within fire-dependent dry-mesic southern forest, decades of fire suppression have resulted in mesophication or the increase in mesophytic woody species including red maple, black cherry, and invasive shrubs in the understory.

Aerial photographs from 1938 (Figure 6) show how logging and the expansion of agriculture have contributed

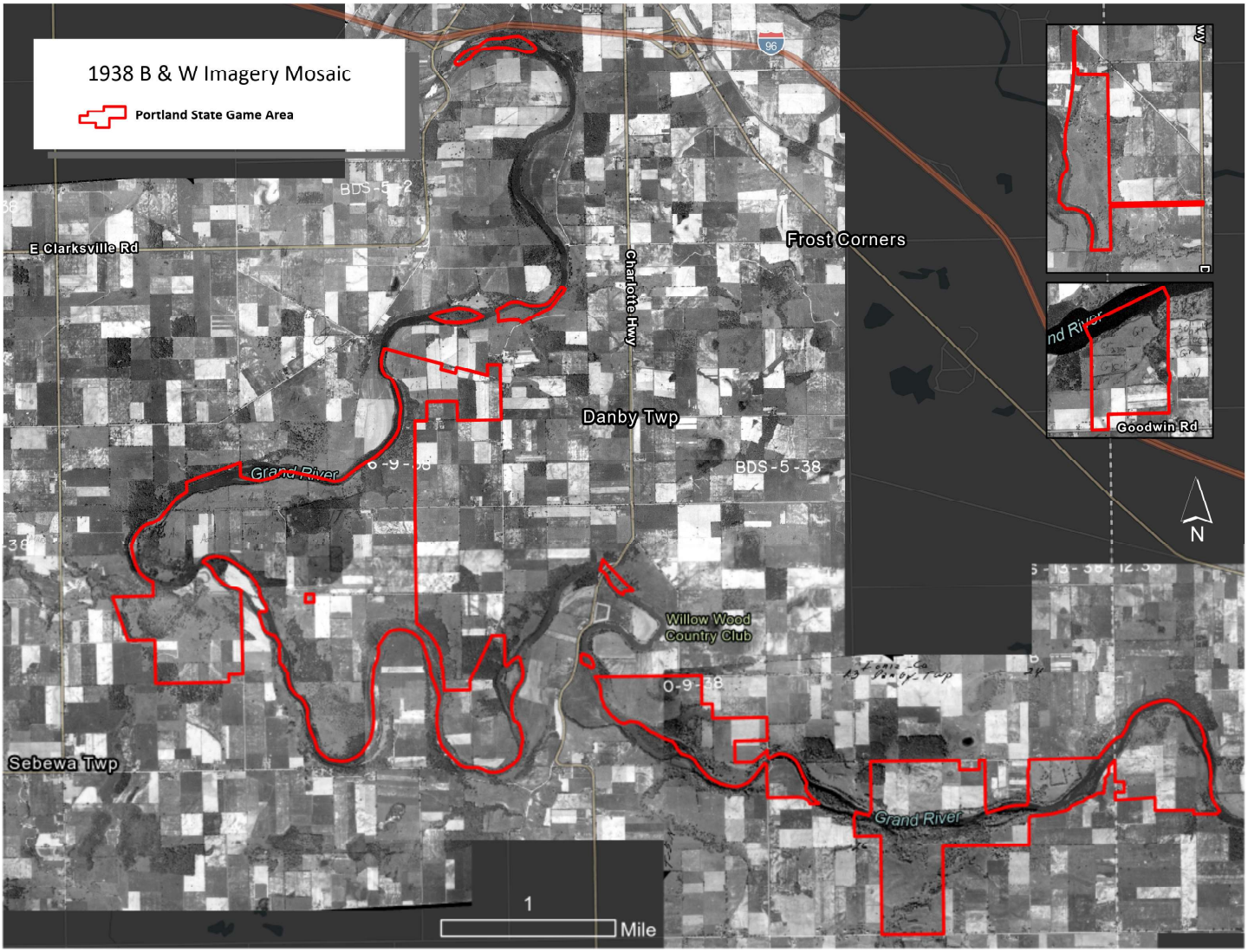


Figure 6. Mosaic of 1938 aerial photographs of Portland State Game Area. This resource can inform managers about important conservation targets because areas that were forested in the picture (typically the darker hues) tend to be dominated by native vegetation, have the oldest trees, and also exhibit the lowest levels of invasive species. Therefore, these areas generally have the highest conservation value for native biodiversity.

to habitat fragmentation and ecological degradation across the landscape. The majority of the upland forests in the game area were at one time cleared for agriculture and subsequently reverted to forest after the state took ownership. These forested stands that were cleared for agriculture tend to have the greatest concentrations of invasive species. The imagery from 1938 is particularly useful for the identification of important forest remnants (Figure 6). Areas that were forested in the imagery that have not since been logged have the lowest proportion of invasive species, oldest trees, and the greatest concentration of rare taxa, especially rare plants.

Despite the dramatic shifts in composition as a result of anthropogenic disturbance, abundant natural cover remains within Portland SGA (Figure 7) with 78% of the game area constituting natural cover and 5% (150 ac) documented as high-quality natural communities. In addition, Portland SGA remains predominantly unfragmented, especially in comparison with the surrounding land. As a whole, the Ionia Subsection (VI.4) is 57% agriculture, 12% developed, and just 21% forested. In comparison, the game area is currently 62% forested.

To gauge landscape integrity, MNFI has developed a land use integrity index that is based on the proportion of land use in a buffer surrounding an area of interest. Stands surrounded by intensive land use (e.g., row crops and residences) receive lower scores and stands surrounded by natural cover (e.g., floodplain forest and rich conifer swamp) receive higher scores. Portland SGA is characterized by high land use index scores across the game area and especially in comparison with the adjacent private lands away from the riparian corridor (See Figure 8).

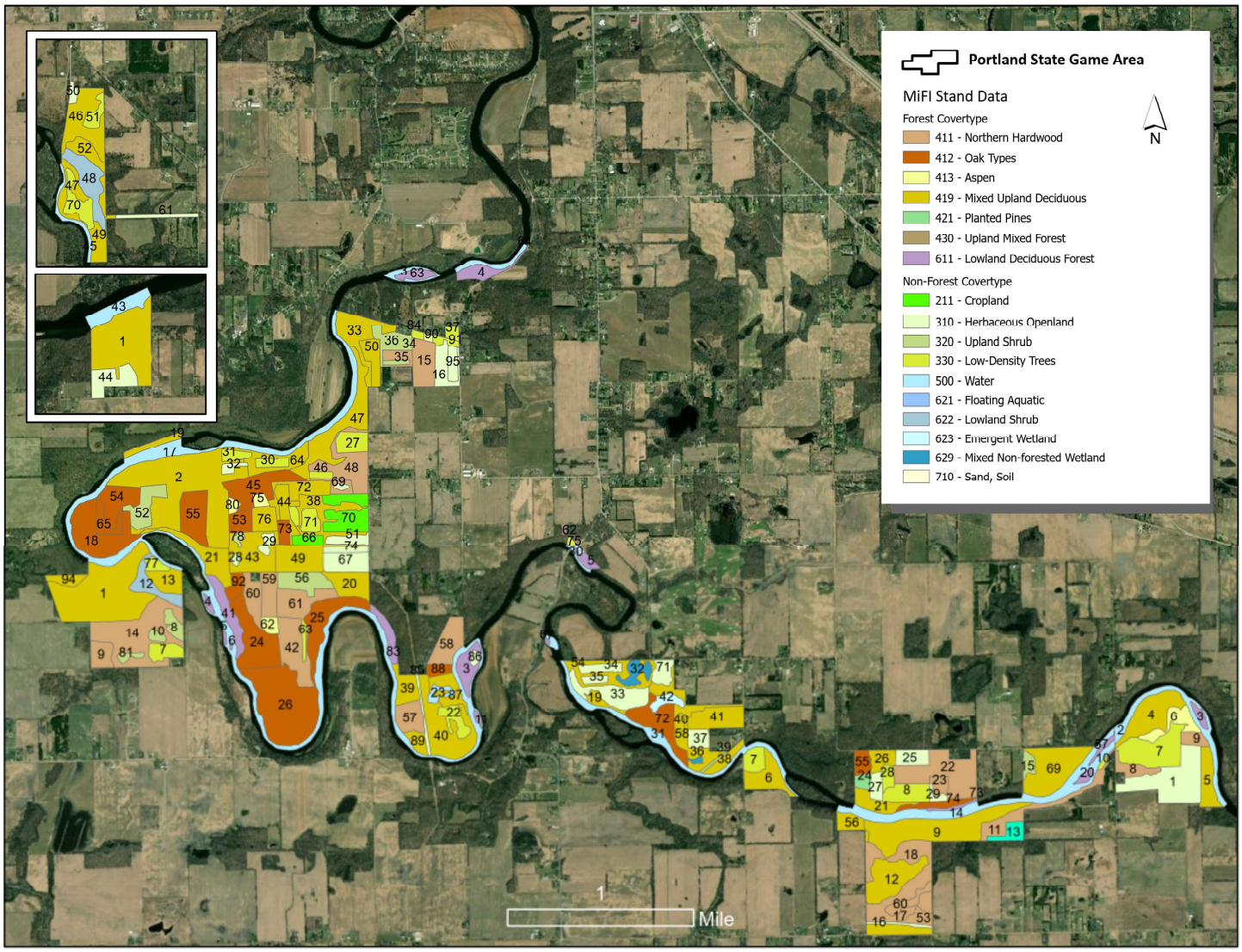


Figure 7. MiFI stand data for Portland State Game Area.

High-quality natural cover persists along the Grand River throughout Portland SGA. Photo by Jesse M. Lincoln.

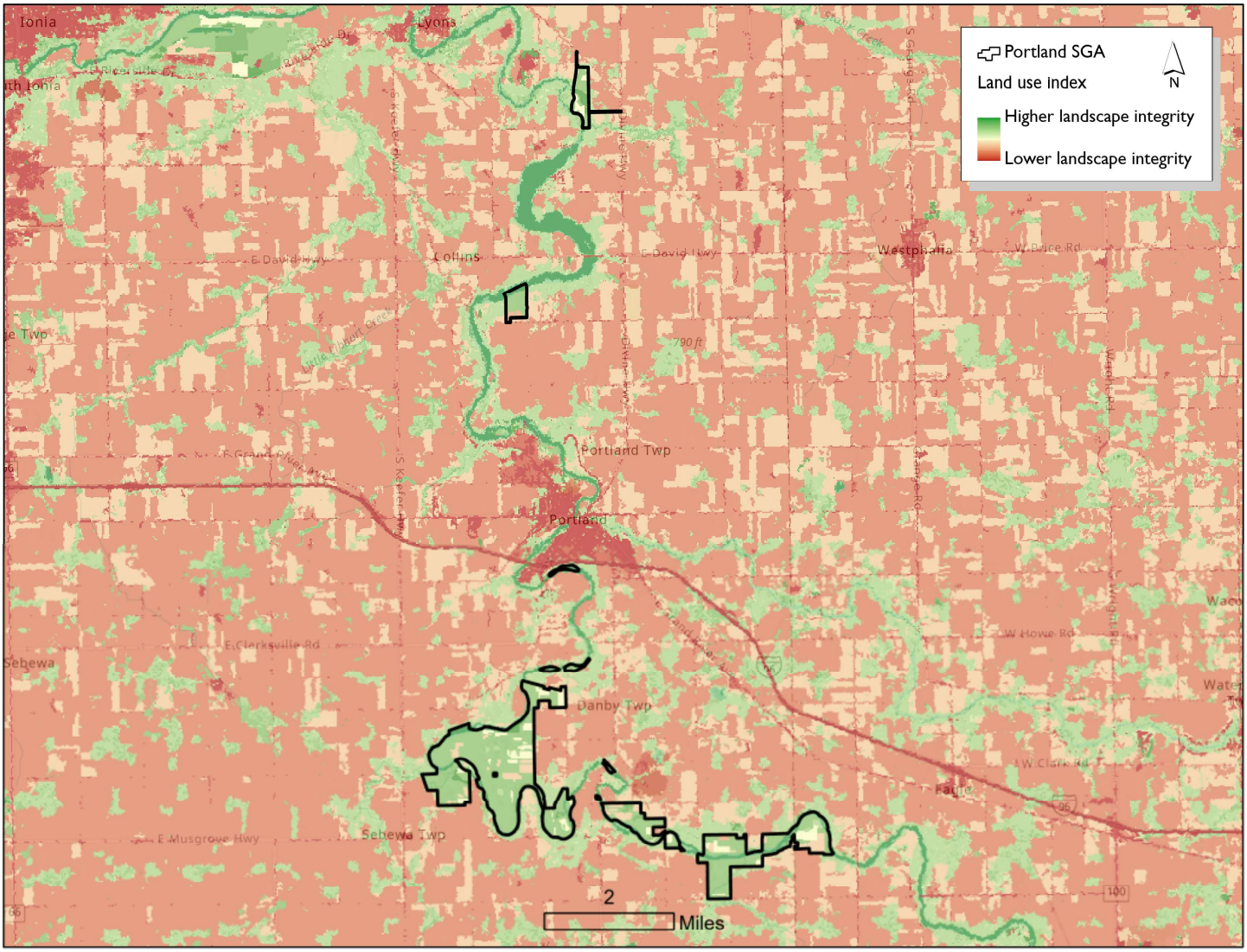


Figure 8. A land use index of Portland State Game Area. The land use index is based on the proportion of land use and natural cover surrounding an area of interest. Portland SGA is characterized by high land use index scores across the game area and especially in contrast to the city of Portland and private lands away from riparian corridors of the Grand River and its tributaries.

Methods

Throughout this report, natural community types and rare species are referred to as "elements" and their documented occurrences at specific location are referred to as element occurrences or "EOs". Ecological and rare species surveys relied on a variety of data resources to determine if potential habitat occurs within the game area, including existing natural community EOs, MiFI cover types, aerial photography, and on-the-ground observations. The documentation of new high-quality natural communities was especially dependent on areas identified during the 2015 MiFI surveys and the combination of MiFI surveys and targeted natural community surveys helped inform subsequent rare species surveys.

Target species for rare animal surveys were identified using historical distribution within Michigan, past occurrences in or near Portland SGA, and the presence of potential habitat as determined by MiFI and natural community surveys. Based on these criteria, rare animal surveys focused on woodland raptors, forest interior songbirds, unionid mussels, herptiles, and several insect groups. Surveys for target animal species were conducted in appropriate potential habitats during time periods when targeted elements were expected to be most active and detectable (e.g., breeding season). Surveys were conducted to identify new occurrences, update or expand existing occurrences, and revisit historical occurrences of select rare species. Michigan's Wildlife Action Plan (Derosier et al. 2015) identifies Species of Greatest Conservation Need (SGCN) and observations of these species were recorded when encountered.

Natural Community Surveys

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, such as timber harvest, alterations to hydrology, and fire suppression. Historically, Indigenous Peoples were an integral part of Michigan's natural communities with many natural community types being maintained by Indigenous management practices such as prescribed fire. MNFI's natural community classification recognizes 77 natural community types in Michigan (Kost et al. 2007, Cohen et al. 2015). The natural community EOs were 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, 2015).

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 EO, and given a rank of A to D based on how well it meets the above criteria. MNFI scientists utilized a combination of field surveys, aerial photographic interpretation, and Geographic Information System (GIS) analysis to assess natural community size and landscape context.

Natural community surveys detailed the vegetative structure and composition, ecological boundaries, and landscape and abiotic context of exemplary natural communities. These surveys also assessed the current ranking, classification, and delineation of these occurrences. Ecological field surveys of Portland SGA were implemented over the growing season of 2019 with follow-up surveys conducted in 2020. Qualitative meander surveys were conducted to assess the natural community classification, ecological boundaries, and ranking of the target sites. Vegetative structure and composition, soils, landscape and abiotic context, threats, management needs, and restoration opportunities were all assessed. This information is critical for informing landscape-level planning efforts, facilitating site-level decisions about prioritizing management objectives to conserve native biodiversity, and evaluating the success of restoration actions.

Methods employed during this survey followed the methodology developed during the initial evaluation of Ecological Reference Areas on State Forest land by MNFI ecologists (Cohen et al. 2008; Cohen et al. 2009b).

The ecological field surveys involved:

- compiling comprehensive plant species lists and noting dominant and representative species and opportunistically documenting rare plant populations
- describing site-specific structural attributes and ecological processes
- measuring tree diameter at breast height (DBH) of representative canopy trees and aging canopy dominants
- analyzing soils and hydrology
- noting anthropogenic disturbances
- evaluating potential threats to ecological integrity
- ground-truthing aerial photographic interpretation using GPS
- taking digital photos and GPS points at significant locations
- surveying adjacent lands when possible to assess landscape context
- evaluating the natural community classification and mapped ecological boundaries
- assigning element occurrence ranks
- noting management needs and restoration opportunities or evaluating past and current restoration activities

Following completion of the field surveys, the collected data were analyzed and transcribed to create new EO records in MNFI's statewide biodiversity conservation database (MNFI 2022). Natural community boundaries were established and information from these surveys was used to develop site descriptions, threat assessments, and management recommendations.

Floristic data were compiled into the Universal Floristic Quality Assessment Calculator (Reznicek et al. 2014, Freyman et al. 2016) to determine the Floristic Quality Index (FQI) for each natural community EO. The floristic quality assessment is derived from a mean coefficient of conservatism and floristic quality index. Each native species is assigned a value of 0 to 10 based on probability of its occurrence in a natural versus degraded habitat. Species restricted to a specialized or undisturbed habitat are assigned a value of 10, implying the species has extremely strong fidelity to a specific habitat. Native species that are not particular or indicative of natural conditions are assigned a low value of 0 to 2. From the total list of plants for an area, a mean C value is calculated and then multiplied by the square root of the total number of plants to calculate the FQI. Michigan sites with an FQI of 35 or greater possess sufficient conservatism and richness that they are considered floristically important from a statewide perspective (Herman et al. 2001). FQI scores greater than 50 indicate exceptional sites with extremely high conservation value (Herman et al. 2001). Species lists for each site are provided in the Appendix.

Rare Plant Surveys

Several populations of rare plants were documented within Portland SGA prior to the MiFI surveys. Over the course of the Integrated Inventory project, known populations of rare plants were opportunistically revisited during the course of initial vegetation mapping surveys and subsequent natural community surveys. New populations of rare plants were documented when encountered and data on existing populations was used to update existing EOs.

MNFI Lead Ecologist, Joshua G. Cohen, evaluating soils of Lyon's Shrub-Carr. Photo by Jesse M. Lincoln.

Rare Mussel Surveys

Unionid mussels were chosen as a survey target because of the potential for new occurrences of listed and special concern mussel species. Prior to this project, records for nine mussel species of Special Concern, two State Threatened, four State Endangered, and two Federally Endangered mussel species had been documented in the Lower Grand River. Historically (pre-1960), the lower Grand River ranks second in Michigan behind the Detroit River in mussel species richness with 31 of Michigan's 43 native mussel species. In more recent surveys (1989-2009) the lower Grand River is tied for third most (23) with the Kalamazoo River and St. Joseph River (Lake MI drainage) behind the St. Clair River tributaries (Belle, Pine, and Black Rivers) and the Huron River (Badra 2010). The Federally Endangered snuff box (*Epioblasma triquetra*) occurs in the lower section of the Grand River, with recent (2019) occurrences documented three miles downstream of Webber Dam. No snuffbox have been documented upstream of Webber Dam.

Mussel surveys took place in wadable habitats (less than approximately 70 cm deep) in 15 different survey sites (Table 1 and Figure 9). The search area at each site was measured to standardize sampling effort among sites and allow unionid mussel density estimates to be made. Live unionid mussels 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 live individuals was determined for each unionid mussel species at each site.

The number of shells of listed species and species of Special Concern found were counted and recorded. The riverbanks were scanned visually for mussel shell middens created by muskrats or other mammalian predators. Aquatic snails, fish, and non-native bivalves including zebra mussels (*Dreissena polymorpha*) and Asian clams (*Corbicula fluminea*) were identified and noted when encountered during mussel surveys. Sphaeriid clams were noted as present or absent as a group.

Table 1. Locations of aquatic survey sites in Portland State Game Area.

Site	Waterbody	Access	Latitude (N)	Longitude (W)
1	Grand River	Pryor/Clintonia Rd. canoe launch	42.79999	-84.83875
2	"	Erdman Rd. canoe launch	42.91423	-84.93555
3	"	Pryor/Clintonia Rd. canoe launch	42.80382	-84.83079
4	"	Pryor/Clintonia Rd. canoe launch	42.79584	-84.84974
5	"	Pryor/Clintonia Rd. canoe launch	42.79985	-84.87449
6	"	Pryor/Clintonia Rd. canoe launch	42.80234	-84.88965
7	"	Charlotte Hwy. canoe launch	42.80235	-84.90521
8	"	Charlotte Hwy. canoe launch	42.80897	-84.92050
9	"	Charlotte Hwy. canoe launch	42.81359	-84.93331
10	"	Erdman Rd. canoe launch	42.81636	-84.93864
11	"	Erdman Rd. canoe launch	42.81566	-84.94239
12	"	Erdman Rd. canoe launch	42.82201	-84.94196
13	"	Towner/Pohl Rd. canoe launch	42.82357	-84.92662
14	"	Towner/Pohl Rd. canoe launch	42.82976	-84.91785
15	"	Okemos Rd.	42.83822	-84.89983

Some mussel surveys were conducted by boat. Photo by Peter J. Badra.

Latitude and longitude of each survey site was recorded with a handheld Garmin GPS unit (Table 1). Habitat data were recorded to describe and document stream conditions at the time of the surveys. Substrate within each search area was characterized by estimating percent composition of each of six particle size classes described in 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 water speed were estimated visually.

Conductivity and pH of Grand River water were recorded with an Oakton handheld meter. Alkalinity and hardness were measured with LaMotte kits (models 4491-DR-01 and 4824-DR-LT-01). Stream substrate at aquatic survey sites was favorable for native mussels and was comprised of a mix of particle size classes from boulder to silt (Table 2). Large woody debris and aquatic vegetation were generally present, providing cover and habitat structure for potential host fish (Table 3).

Table 2. Percentage of each substrate particle size class estimated visually at each aquatic survey site. Diameter of each size class: boulder (>256mm), cobble (256-64mm), pebble (64-16mm), gravel (16-2mm), sand (2-0.0625mm), silt/clay (<0.0625mm).

Site #	Boulder	Cobble	Pebble	Gravel	Sand	Silt
1	10	30	20	20	10	10
2			20	20	30	30
3			25	25	35	15
4	10	10	10	20	25	25
5	5	5	20	30	30	10
6			20	40	40	
7	10	30	25	20	10	5
8	20	30	20	20	10	
9			5	15	40	40
10			15	25	30	30
11		20	20	30	20	10
12	10	20	20	30	20	
13	5	20	20	30	20	5
14			15	40	35	10
15*	30	15	10	10	10	5

* Bedrock slab covered an additional 20% of site 15.

Table 3. Habitat characteristics recorded at aquatic survey sites.

Site #	Current speed (m/second)	Aquatic vegetation?	Woody debris?	Eroded banks?	%Pool	%Riffle	%Run
1	0.20	Y	Y	Y			100
2	0.13	N	Y	N			100
3	0.33	N	Y	N			100
4	0.17	N	Y	Y			100
5	0.20	Y	Y	Y			100
6	0.50	Y	Y	Y			100
7	1.00	N	Y	N			100
8	1.00	Y	N	N			100
9	0.50	Y	Y	N			100
10	1.00	Y	Y	N	50		50
11	0.33	N	Y	N			100
12	1.00	Y	Y	Y			100
13	0.33	Y	Y	Y			100
14	0.50	N	Y	N			100
15	0.10	N	N	N			100

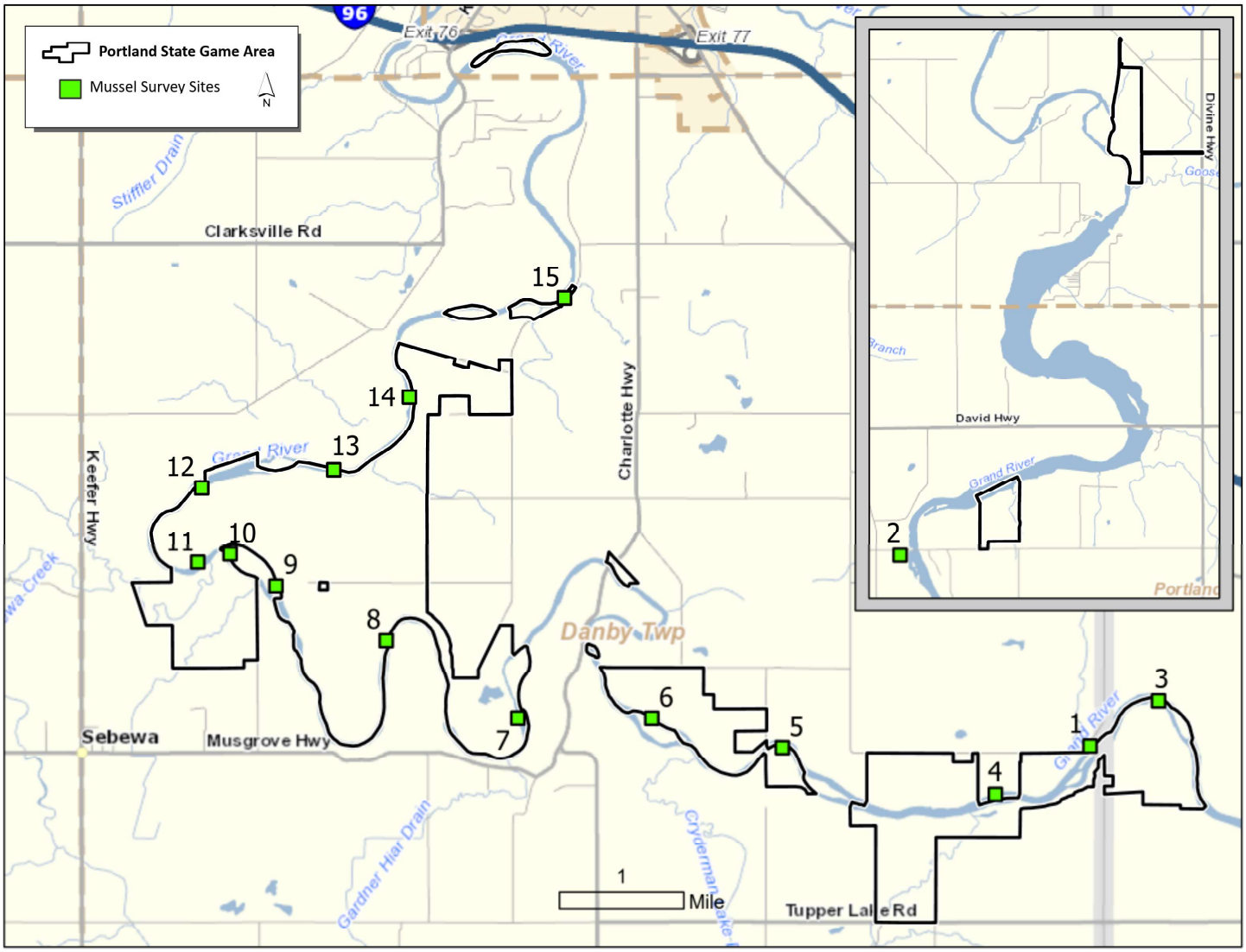


Figure 9. Location of aquatic survey sites in Portland State Game Area.

Rare Bird Surveys

Given the presence of mature forest, we focused bird surveys in the game area on rare songbirds and raptors. Rare raptor surveys targeted red-shouldered hawk (*Buteo lineatus*, State Threatened), a DNR featured species. Rare songbird surveys targeted prothonotary warbler (*Protonotaria citrea,* State Special Concern), cerulean warbler (*Setophaga cerulea*, State Threatened), hooded warbler (*Setophaga citrina*, State Special Concern), Louisiana waterthrush (*Parkesia motacilla*, State Threatened) and yellow-throated warbler (*Setophaga dominica*, State Threatened).

Forest stands covering at least 4 hectares (10 acres) were considered potential habitat for target species. We generated a 250 m X 250 m grid of points overlaid on the survey area. Points were assigned unique identification numbers and uploaded to a tablet computer for field location. Points falling within the survey stands were visited during raptor and songbird surveys. During field surveys, some points were deemed "non-suitable" habitat and surveys did not occur at these points. We did not survey points falling within pine plantations, young aspen stands, or old farmland that had reverted to forests. In addition to surveying for rare raptors and songbirds, point-count sampling was used to gather baseline information about the forest bird community, including relative abundance and species richness.

We conducted two-minute raptor surveys at systematically located point count stations (Figure 10) (Mosher et al. 1990, Anderson 2007, Bruggeman et al. 2011). Each two-minute point count consisted of one-minute broadcasts of red-shouldered hawk calls and one minute of silent listening. Surveys were conducted between April 30 and May 11, 2021. At each station the following data were recorded: whether 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 rare raptor 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 songbird point counts were conducted at the same systematically located points used for raptor surveys (Figure 10). Ralph et al. (1995) noted that it is usually more desirable to increase the number of independent point-count stations than to conduct repeated surveys at a smaller number of locations, so we visited each point only once. Surveys were conducted from May 24 to June 10, 2021, from sunrise to 6 hours after sunrise, or until weather condition made it unlikely to detect birds. In addition to documenting observations of the targeted rare species, we collected data on all birds seen or heard during each 10-minute point count. We recorded the species and number of individuals observed during three independent periods (2 minutes, 3 minutes, and 5 minutes) for a total of 10 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) which adhere to these survey 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 prothonotary warbler, cerulean warbler, hooded warbler, Louisiana waterthrush, and yellow-throated warbler.

Several bird species were observed and documented during surveys at Portland SGA in 2021, including this American robin. Photo by Aaron P. Kortenhoven.

Rose-breasted grossbeak. Photo by Aaron P. Kortenhoven.

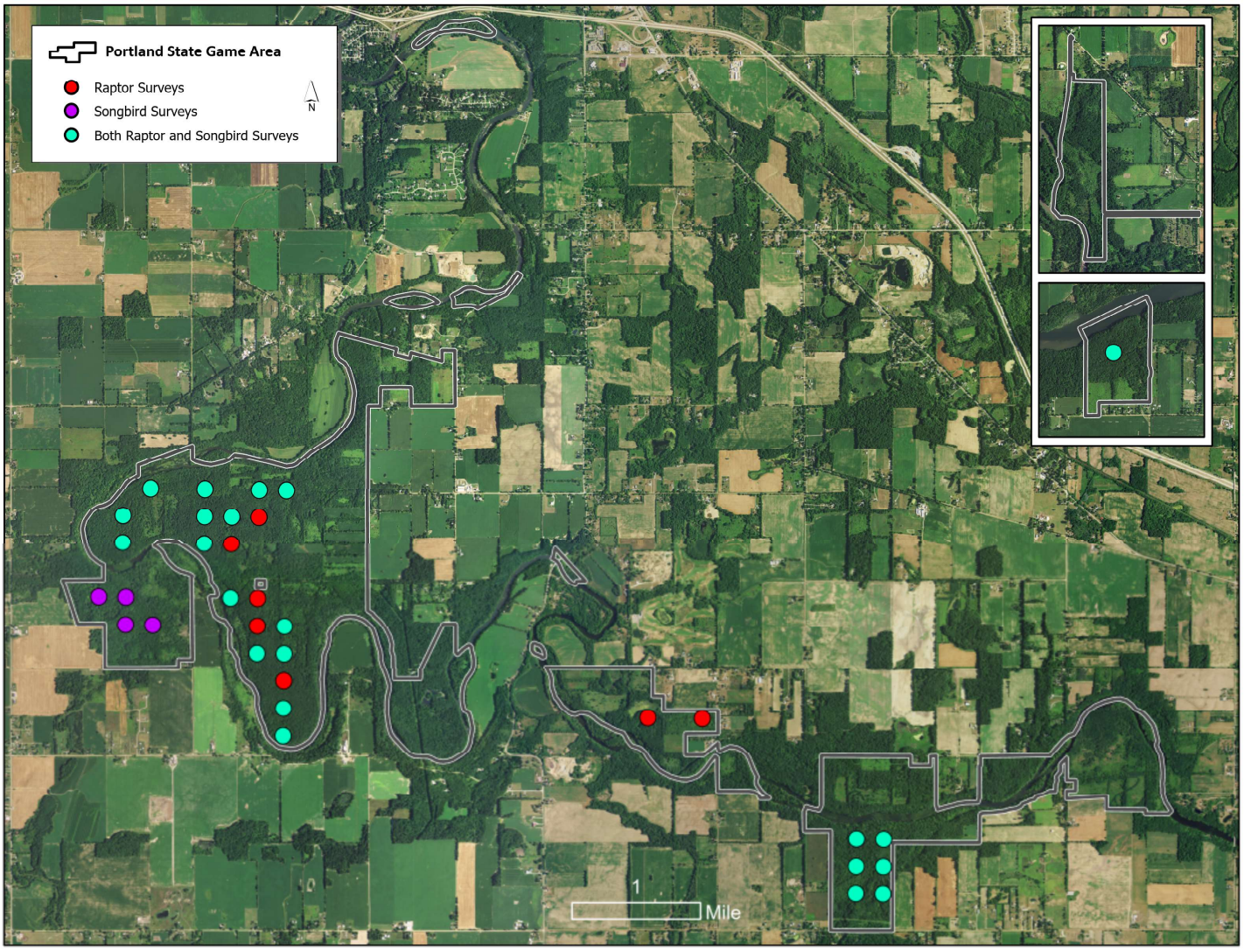


Figure 10. Location of songbird and raptor surveys in Portland State Game Area.

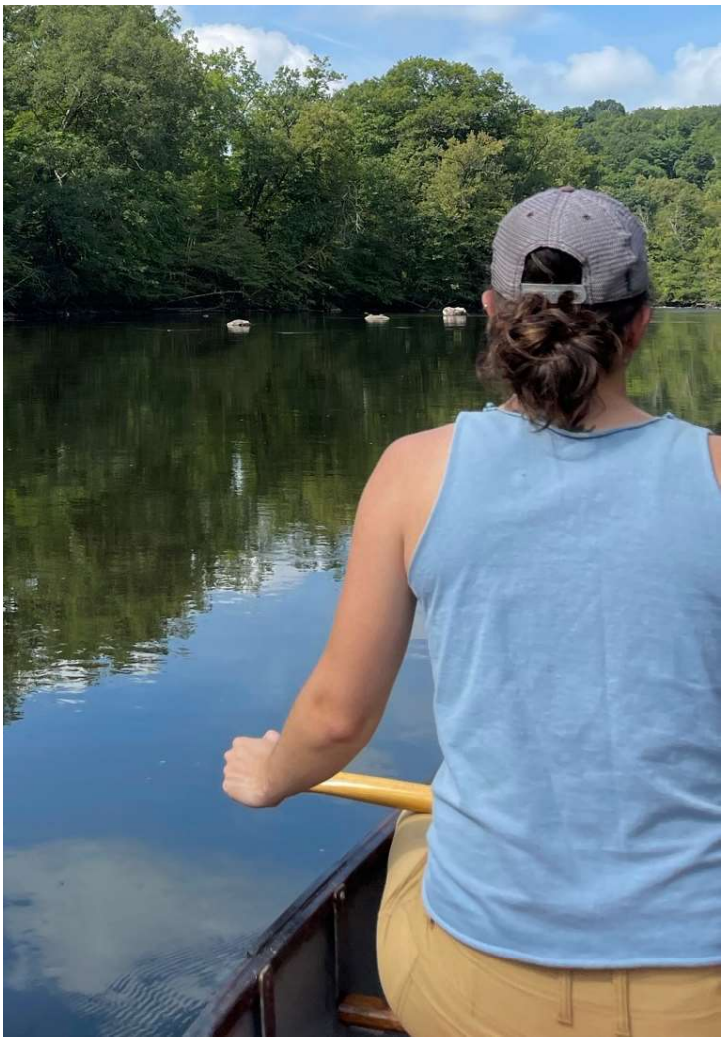
Rare Insect Surveys

We conducted surveys for regal fern borer moth (*Papaipema speciosissima*, State Special Concern) at two locations within Portland SGA in September of 2020 (Figure 11). Potential survey locations were determined by examining the aerial imagery and stand level data collected by MNFI Ecologists during vegetation inventory work in 2015. Stands that support floodplain forest, inundated shrub swamp, southern hardwood swamp, and southern wet meadow were identified as potentially containing habitat for regal fern borer moth. Final survey locations were selected from these stands by conducting ground surveys for regal fern borer moth host plants, including regal fern (*Osmunda regalis*), cinnamon fern (*O. cinnamomea*) and interrupted fern (*O. claytoniana*). We identified two locations within the game area with suitable habitat and host plant requirements (Figure 11). Surveys for regal fern borer moth utilized the technique of blacklighting, which consisted of standard mercury-vapor and UV lights powered by a portable generator. A large white sheet was used as a collecting surface. This frame was placed in a central location with larval host plants on all sides to maximize the likelihood of collecting adults. During each survey event in 2020, we collected data on *Papaipema* species abundance and richness at each site, along with associated weather and moon data on the hour and recorded this information on data forms.

There are three state listed species of bumble bees that have current statewide distributions that overlap with Portland SGA. These include black and gold bumble bee (*Bombus auricomus*, State Special Concern), American bumble bee (*B. pensylvanicus*, State Special Concern), and Sanderson's bumble bee (*B. sandersoni*, State Special Concern). A fourth species, rusty patched bumble bee (*B. affinis,* Federally Endangered, State Special Concern), has not been observed in Michigan since 1999, but historically would have likely occurred within the game area. Each of these species inhabits areas with abundant floral resources and dense ground cover, which are necessary for forage and overwintering, respectively.

We conducted a standardized meander-based bumble bee community survey at a single location in Portland SGA on July 21st, 2021, with the intent of locating a population of one of these rare bumble bee species (Figure 11). A two hour meander survey with aerial netting was completed

Blacklight set-up for regal fern borer moth surveys in Portland SGA. Photo by Logan Rowe.



Odonate surveyes were conducted by canoe along the Grand River. Photo by Ashley Cole-Wick.

in an open field dominated by a mix of wildflowers and grasses, nested within a matrix of dense forested vegetation. The survey site was selected for its abundant floral resources, its proximity to forest and wetland systems, and presence of groundcover dominated by tufts of dead vegetation. During the survey, any bumble bee observed was collected, placed in a vial with the associated floral species, and stored until the end of the survey. After the survey, each bumble bee was identified to species. If we were unable to accurately identify a specimen in the field, it was stored in a cooler and processed at a later date in the lab.

We conducted surveys for rare Odonates (dragonflies and damselflies) along the Grand River in Portland SGA in 2021 (Figure 11). Based on known ranges and available habitat, we targeted surveys on four odonate species. The elusive snaketail (*Stylurus notatus,* State Special Concern) occurs along clear rivers with moderate current. Laura's snaketail (*S. laurae*, State Special Concern) habitat comprises headwater streams. The riverine snaketail (*S. amnicola*, State Special Concern) has recently been documented in Ingham County (2013) and can be found in clear rivers with moderate current and gravel or sandy benthos (MNFI 2022). The pygmy snaketail (*Ophiogomphus howei*, State Threatened) has been documented in two counties in Michigan, including Ingham County in 2019. This dragonfly requires big rivers with high water quality and stable flow, where males patrol over stream riffles (MNFI 2022).

We surveyed five sites along the Grand River on September 1, 7, and 10 in 2021 (Figure 11). We sampled for dragonflies at each site for approximately 90 minutes, during sunny, calm, dry conditions. Surveys focused on areas with potential habitat, including woody debris and the confluence of streams flowing into the Grand River.

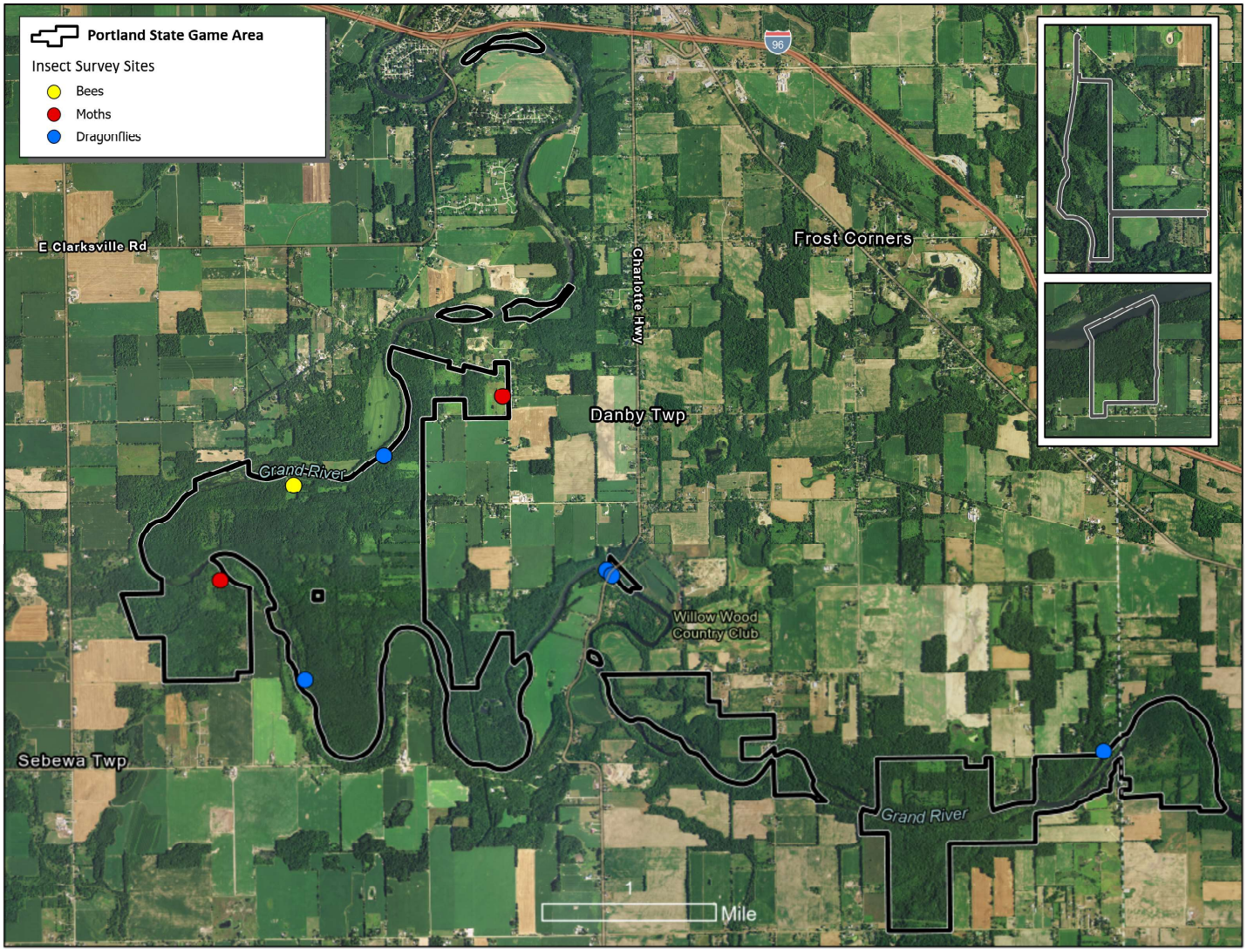


Figure 11. Location of insect surveys in Portland State Game Area.

Rare Reptile and Amphibian Surveys

Surveys for rare reptile and amphibian species (i.e., herptiles) in the Portland SGA in 2021 primarily focused on the following species: eastern box turtle (*Terrapene carolina carolina*, State Special Concern), Blanding's turtle (*Emydoidea blandingii*, State Special Concern), gray ratsnake (*Pantherophis spiloides*, State Special Concern), and marbled salamander (*Ambystoma opacum*, State Endangered). These species also have been identified as Species of Greatest Conservation Need (SGCN) in Michigan's updated Wildlife Action Plan (Derosier et al. 2015). These species were targeted for surveys because they had been previously documented in or near the game area or they had potential to occur within the game area because of the species' range within the state and presence of suitable or potential habitat for the species (Appendix H1). Surveys in 2021 also had potential for detecting several additional rare herptiles and SGCN in Michigan's Wildlife Action Plan (Derosier et al. 2015). These included the blue racer (*Coluber constrictor foxii*), northern ribbonsnake (*Thamnophis sauritus septentrionalis*), northern ring-necked snake (*Diadophis punctatus edwardsii*), and smooth green snake (*Opheodrys vernalis*) (Derosier et al. 2015).

Visual encounter or meander surveys were conducted in areas with potentially suitable habitat for target herptiles (Figure 12). Surveys were conducted from June 22 through September 23, 2021 using standard methods (Campbell and Christman 1982, Corn and Bury 1990, Crump and Scott 1994, Graeter et al. 2013). Visual encounter surveys were conducted primarily in upland forest stands; open uplands including abandoned agricultural fields; and open wetlands and waterbodies including the Grand River and vernal pools. Surveys consisted of one or 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 active individuals on the surface or under cover objects. Visual encounter surveys for marbled salamanders were focused on vernal pools, which were characterized as dry or mostly dry during the 2021 field season. Although targeted auditory surveys for breeding frogs and toads were not specifically conducted, frog species heard calling during visual encounter surveys were documented. Surveys were conducted under appropriate weather conditions when target species were expected to be active and/or visible, namely when temperatures range between 60 to 80°F (16-27°C), and winds are less than 15 mph, and there is no or light precipitation. Survey sites were visited one to three times during the field season.

Survey data forms were completed for all herptile surveys using the ArcGIS Survey123 mobile application. Survey locations and routes were recorded using the ArcGIS Survey123 and FieldMaps mobile applications on a smartphone or tablet. We documented all 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 survey times also were recorded. Whenever possible, we took photos of observed species for supporting documentation.

Eastern box turtle. Photo by Jesse M. Lincoln

Eastern garter snake. Photo by Aaron P. Kortenhoven.

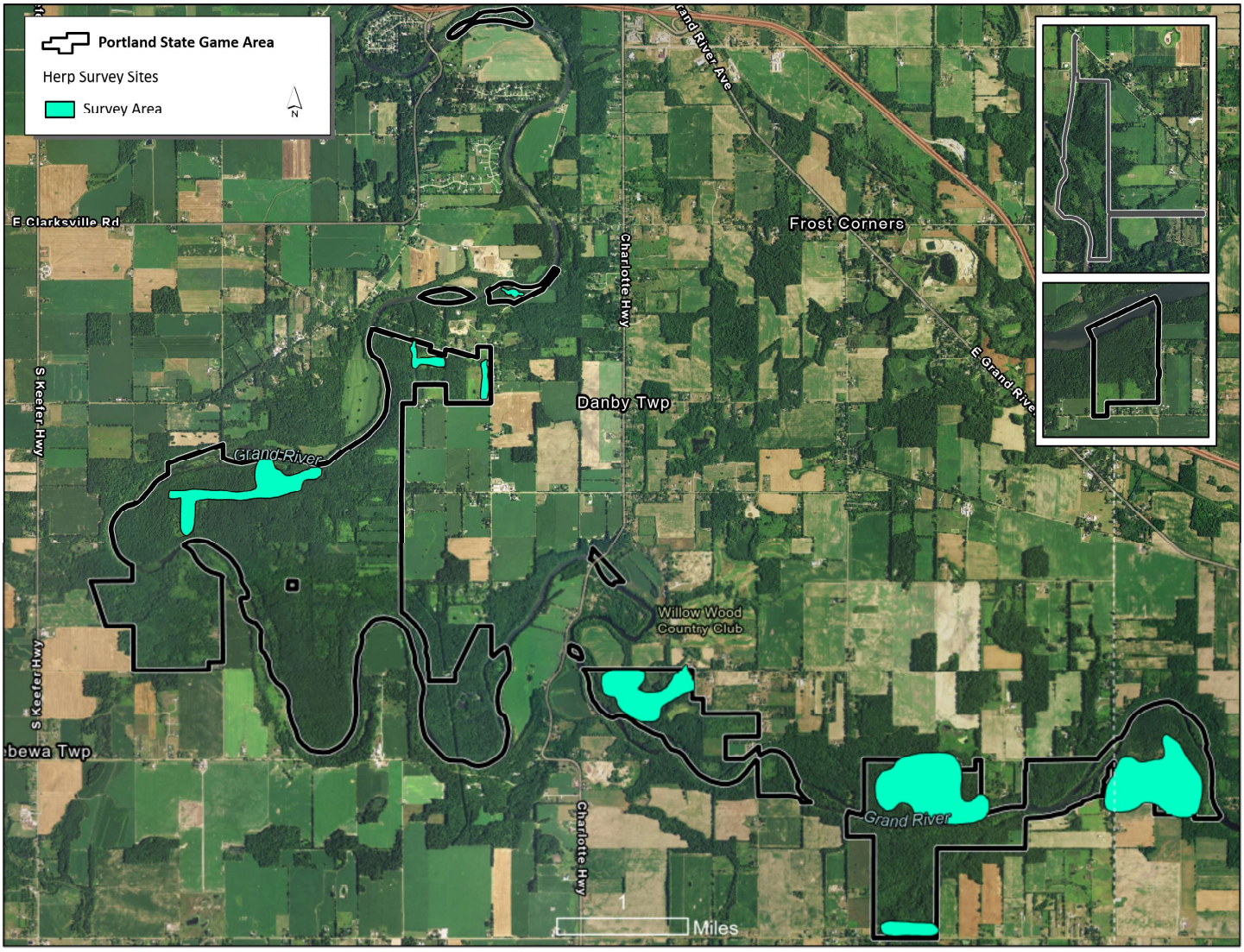


Figure 12. Location of reptile and amphibian surveys in Portland State Game Area.

Results

MNFI conservation scientists have documented 76 element occurrences (EOs) from Portland SGA. These element occurrences are composed of 5 natural community and 71 rare species occurrences with 22 plant, 39 mussel, 8 bird, and 1 insect, and 1 herptile EOs. During surveys completed for the Integrated Inventory project at Portland SGA, MNFI scientists documented 5 new natural community EOs (Table 4, Figures 13-18), 9 new rare plant EOs (Table 6, Figures 19 and 20), 39 new rare mussel EOs (Tables 7 and 8, Figures 21-24), 3 new bird EOs (Table 10, Figure 25), 1 new insect EO (Table 11, Figure 26), 1 new herptile EO (Figure 27), and provided information for updating 11 existing EOs. Data compiled on these EOs were entered into MNFI's Natural Heritage Database (MNFI 2022).

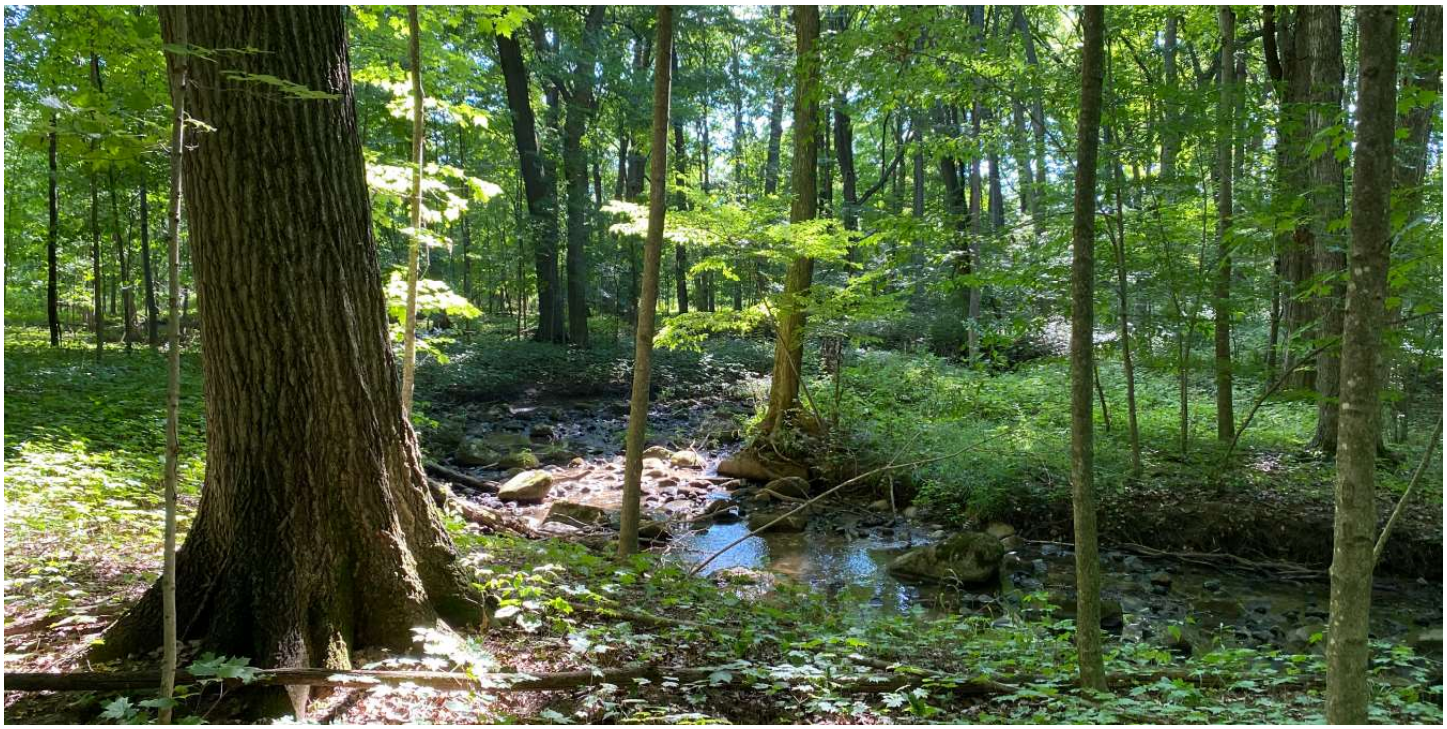
Natural Communities

MNFI ecologists documented five new high-quality natural communities in the Portland SGA including three mesic southern forest EOs and two southern shrub-carr EOs (Table 4, Figure 13-18). These high-quality natural communities cover 150 acres or 5.7 % of the game area. The following site summaries contain a detailed discussion for each of the five natural community EOs organized alphabetically by community type and then by site name.

Table 4. Natural community element occurrences in the Portland State Game Area. All natural communities described in Portland SGA were newly documented during the Integrated Inventory process.

Site Name	EO ID	Rank	Size (Ac)	First Recognized as EO	Last Visited	Compartment	Stands
Mesic Southern Forest							
Frayer Creek Woods	20441	C	45.9	2015	2019	2	9
Okemos Hills	24985	C	58.1	2020	2021	3	21, 26, 47, and 83
Sebewa Woods	24984	D	9	2020	2020	3	9
Shrub-Carr							
Lyon's Shrub-Carr	24242	C	22.2	2019	2019	2	48
Sebewa Creek Shrub-Carr	24243	C	15.3	2020	2020	3	12

Frayer Creek Woods. Photo by Jesse M. Lincoln.



Sebewa Woods mesic southern forest. Photo by Jesse M. Lincoln.

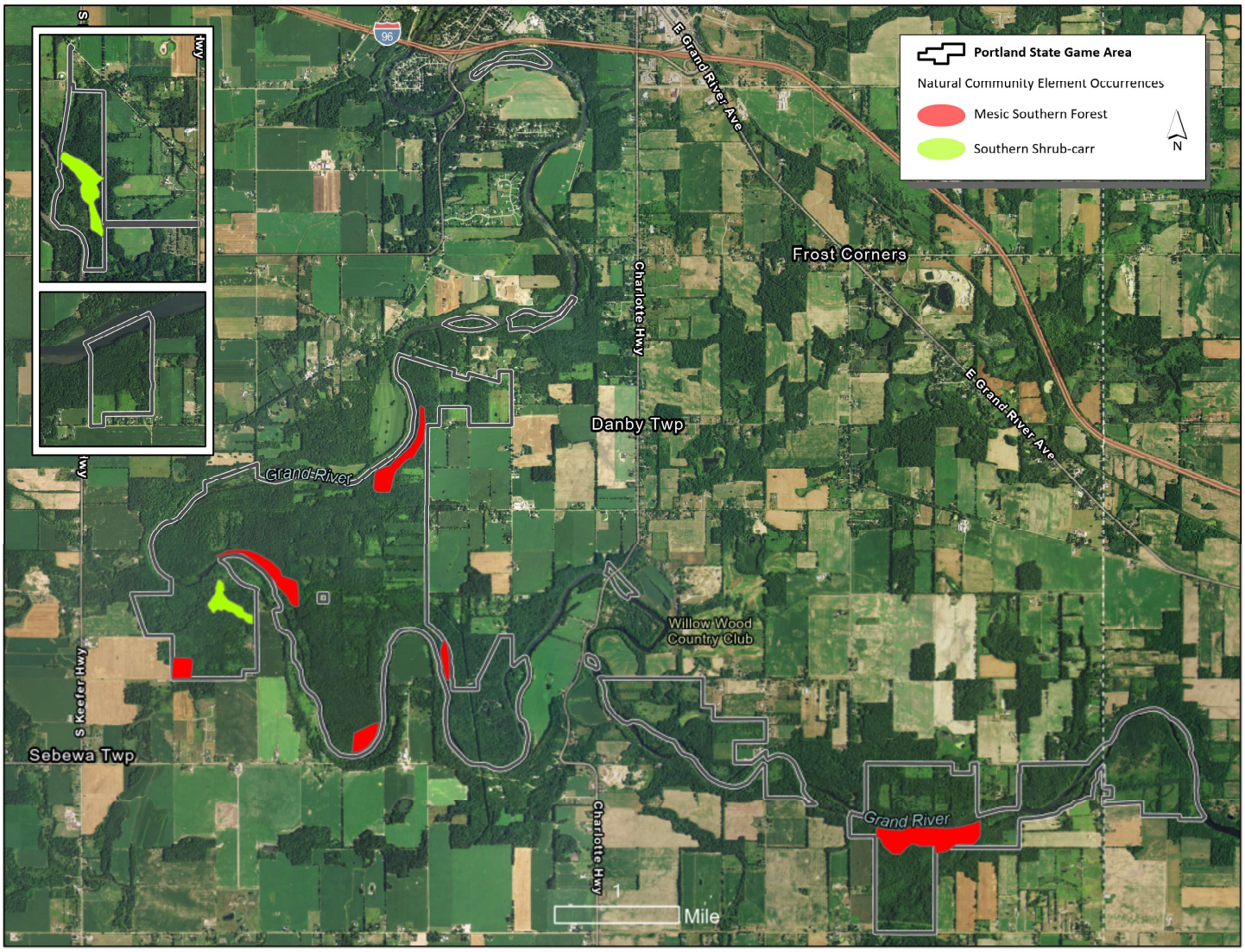


Figure 13. Natural community element occurrences in Portland State Game Area.

1. Frayer Creek Woods
Natural Community Type: Mesic Southern Forest
Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: BC
Size: 46 acres
Location: Compartment 2; Stand 9
Element Occurrence Identification Number: 20441

Frayer Creek Woods is a second-growth, mesic southern forest that occurs on the steep, north-facing slopes of the Grand River outwash channel where the river valley cuts through ground and end moraines of medium texture. Old meander scars of the river persist as large vernal pools that are above the annual flood line. Large glacial erratics occur throughout the forest with one 3 m long by 2 m wide by 1.5 m tall. The soils are circumneutral sandy clay loam over sandy clay with gravel and abundant glacial erratics, some quite large. A soil sample was taken from the top of the slope where the top 25 cm are clay loam with dark organics (pH 7.0 - 7.5) and gravel up to 2 cm in diameter. Below that is fine, sandy clay (pH 6.5-7.0) with gravel up to 2 cm in diameter, to depths of at least 1 m. Earthworms were observed throughout, though especially at the margins with younger forest. Sparser leaf litter characterizes areas where earthworms are more prevalent.

The diverse closed canopy is dominated by sugar maple (*Acer saccharum*) and black maple (*Acer nigrum*) and is characterized by large (40-100 cm dbh), maturing trees. A 54.6 cm dbh sugar maple had 132 rings observed and a 71.1 cm dbh black walnut (*Juglans nigra*) had 92 rings observed. Silver maple (*Acer saccharinum*), bur oak (*Quercus macrocarpa*), and sycamore (*Platanus occidentalis*) become more prevalent on the lower terrace along the river where the system locally transitions to floodplain forest. Black walnut, basswood (*Tilia americana*), red oak (*Quercus rubra*), American elm (*Ulmus americana*), and beech (*Fagus grandifolia*) are important components of the canopy. Additional, infrequent canopy constituents include black cherry (*Prunus serotina*), red maple (*Acer rubrum*), hackberry (*Celtis occidentalis*), bitternut hickory (*Carya cordiformis*), and chinquapin oak (*Quercus muehlenbergii*). Scattered elm were observed

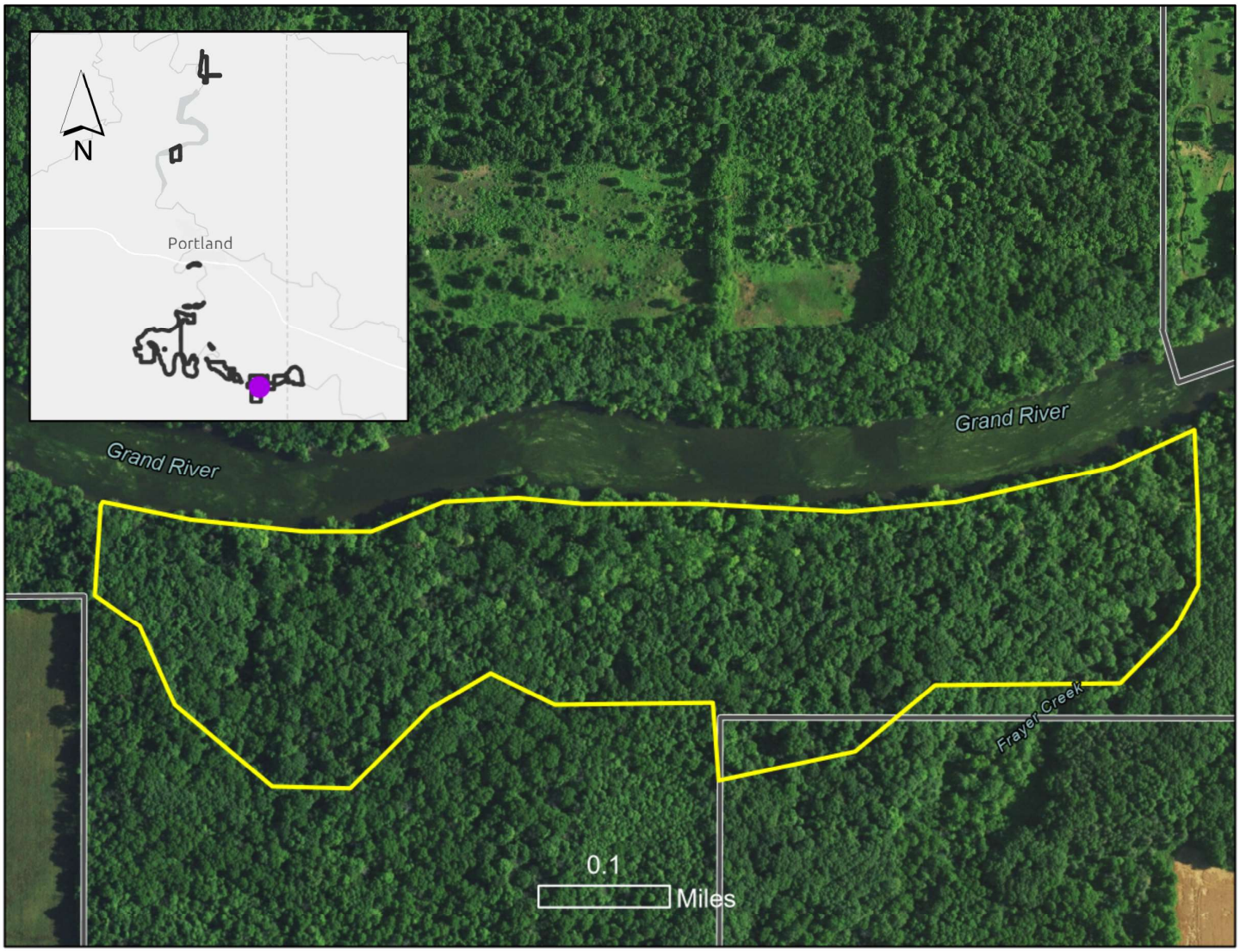


Figure 14. Location of Frayer Creek Woods mesic southern forest (ESRI 2022).

in the subcanopy and may be resistant to Dutch elm disease. Likewise, a few subcanopy blue ash (*Fraxinus quadrangulata*) seem to have survived the emerald ash borer (*Agrilus planipennis*) better than white ash (*F. americana*) and green ash (*F. pennsylvanica*), which were both important canopy constituents but have since succumbed to the invasion. White and green ash appear to have constituted around 20 to 30% of the canopy, with white ash on the slopes and green ash at the base of the slopes closer to the river and within floodplain forest zones.

Maples dominate throughout the subcanopy and understory along with elm and all three ash species. Additional significant subcanopy and understory species include ironwood (*Ostrya virginiana*), musclewood (*Carpinus caroliniana*), hackberry, bitternut hickory, basswood, beech, and chinquapin oak. Low shrubs are relatively infrequent and include gooseberries (*Ribes cynosbati* and *R. americanum*), hazelnut (*Corylus americana*), choke cherry (*Prunus virginiana*), alternate-leaved dogwood (*Cornus alternifolia*), common blackberry (*Rubus allegheniensis*), bladdernut (*Staphylea trifolia*), and red elderberry (*Sambucus racemosa*), which is particularly abundant where ash has fallen and limited the capacity of deer to browse. Invasive shrubs such as multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), honeysuckles (*Lonicera morrowii* and *L. maackii*), and autumn olive (*Elaeagnus umbellata*) are locally problematic within the forest but generally occur at low densities. Vines occur throughout but increase in dominance from the base of the slope towards the river and include grape (*Vitis riparia*), poison ivy (*Toxicodendron radicans*), and moonseed (*Menispermum canadense*).

Herbaceous vegetation is patchy and deer herbivory was evident. Characteristic herbaceous species include sedges (*Carex woodii, C. albursina, C pedunculata*, and *C. plantaginea*), wild geranium (*Geranium maculatum*), jack-in-the-pulpit (*Arisaema triphyllum*), lady fern (*Athyrium filix-femina*), false rue-anemone (*Enemion biternatum*), goldenrods (*Solidago flexicaulis, S. caesia*), Virginia wild rye (*Elymus virginicus*), spring avens (*Geum vernum*), violets (*Viola pubescens, V. sororia, V. rostrata, V. canadensis*), and black snake root (*Sanicula odorata*). An abundance of spring ephemerals is prominent in the early growing season, with spring beauty (*Claytonia virginica*), Virginia water leaf (*Hydrophyllum virginianum*), bloodroot (*Sanguinaria canadensis*), and common trillium (*Trillium grandiflorum*) being prevalent.

Steep slopes and ephemeral streams are drivers of structure and composition of Frayer Creek Woods. Photo by Aaron P. Kortenhoven.

Small streams, seeps at the base of slopes, and margins of vernal pools feature wetland species such as marsh marigold (*Caltha palustris*), swamp buttercup (*Ranunculus hispidus*), skunk cabbage (*Symplocarpus foetidus*), *Carex bromoides*, and Lake Ontario aster (*Symphyotrichum ontarionis*). The forest has excellent habitat for snow trillium (*Trillium nivale*, State Threatened) and twinleaf (*Jeffersonia diphylla*, State Special Concern) but they were not found during surveys in early May. These rare species are found in similar forests throughout Portland SGA.

Lesser celandine (*Ficaria verna*) is an invasive herbaceous species and it is extremely problematic along the river and is rapidly advancing up the slopes into the forest. Locally, lesser celandine dominates extensive zones of this forest with over 95% coverage observed locally. It was first noticed in 2022 and may have been present in 2015 but the forest may have been surveyed at a time when it wasn't detectable. Lesser celandine poses an extreme risk to the herbaceous composition of the forest. Other invasive species are ubiquitous but generally at low levels that are treatable. In addition to the invasive shrubs noted earlier, these include dame's rocket (*Hesperis matronalis*), moneywort (*Lysimachia nummularia*), and garlic mustard (*Alliaria petiolata*).

Frayer Creek Woods was visited in October of the 2015 field season and in May of 2022. A total of 121 plant species were observed with 112 native species and 9 non-native species recorded. The total FQI is 46.2 and the Total Mean C was 4.2. Conservation metrics for Frayer Creek Woods and the comprehensive species list are available in Appendix 1 and 2.

Threats and Management Recommendations
The primary threats to the Frayer Creek Woods mesic southern forest are logging, habitat fragmentation, deer herbivory, and invasive species, particularly lesser celandine. Our primary management recommendations are to prevent logging within the EO and provide a 150 ft buffer around the forest where intensive silvicultural actions such as clearcutting are avoided. Additional management recommendations are to treat lesser celandine, dame's rocket, garlic mustard, barberry, autumn olive, and multiflora rose, protect against ORVs, and reduce local deer densities. Since lesser celandine is a relatively new invasive species in Michigan, we recommend monitoring to gauge the success of control efforts and evaluate the spread of this species across the game area.

Towards the river, bur oak and basswood become more prevalent in the canopy. Photo by Jesse M. Lincoln.

The invasive lesser celandine is agressively taking over the ground layer of the forest along the river. The population is rapidly spreading up the slopes of the forest. Photo by Jesse M. Lincoln.

Large beech occur throughout Frayer Creek Woods. Photo by Jesse M. Lincoln.

2. Okemos Hills
Natural Community Type: Mesic Southern Forest
Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: C
Size: 58 acres
Location: Compartment 3; Stands 21, 26, 47, and 83.
Element Occurrence Identification Number: 24985

Okemos Hills was named for the Ojibwe Chief, John Okemos (1769 to 1858) who led a remarkable life and apparently died at a village in what is now Portland State Game Area. There is a marker in his honor that was erected by the Daughters of the American Revolution in 1921. This is in Stand 87 of Compartment 3.

Okemos Hills is a, second-growth oak-maple system occurring as four separate blocks of mature forest on the steep slopes above the Grand River where the outwash cuts through ground and end moraines of medium texture. The soils are extremely variable. One sample was taken from the top of the slope in the northernmost polygon in an area with no leaves and ocassional glacial erratics up to 1 m across. Within this sample, the top 15 cm is alkaline (pH 7.5) sandy loam with dark organics and gravel 1 to 3 cm in size with some fist-sized rocks. The sandy loam with gravel overlies tan, alkaline (pH 7.5 to 8) sand with gravel 0.5 to 3 cm in size. A second soil sample was taken from an extremely steep portion of the mid-slope of the central stand. This area had abundant moss and zones of exposed soil. The top 9 cm are fine-textured loamy sands (pH 7.0) with dark organics and 0.5 to 3 cm gravel. The loamy sands are mixed with gravel and overlie fine, loamy sand (pH 7.0) with glacial erratics throughout the profile.

The majority of the forest occurs above areas impacted by annual flood levels of the Grand River though there are small inclusions of floodplain forest along the river. In these areas, the forest is influenced by ice scour and the infrequent flooding that occurs in very narrow bands along the river and locally influences composition and causes erosion on the steepest slope. Localized windthrow also contributes to tree mortality and variability in canopy

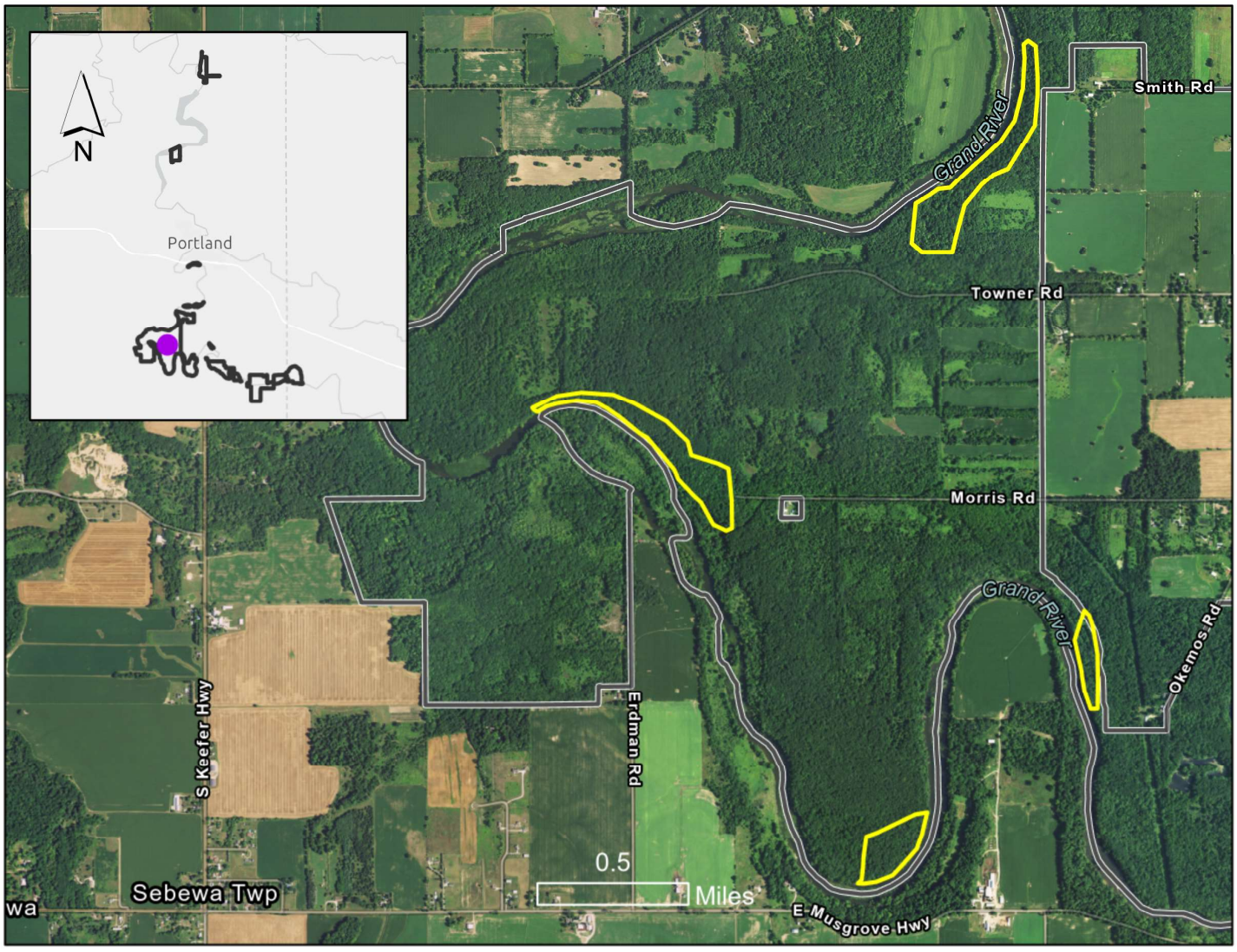


Figure 15. Location of the four polygons of Okemos Hills mesic southern forest (ESRI 2022).

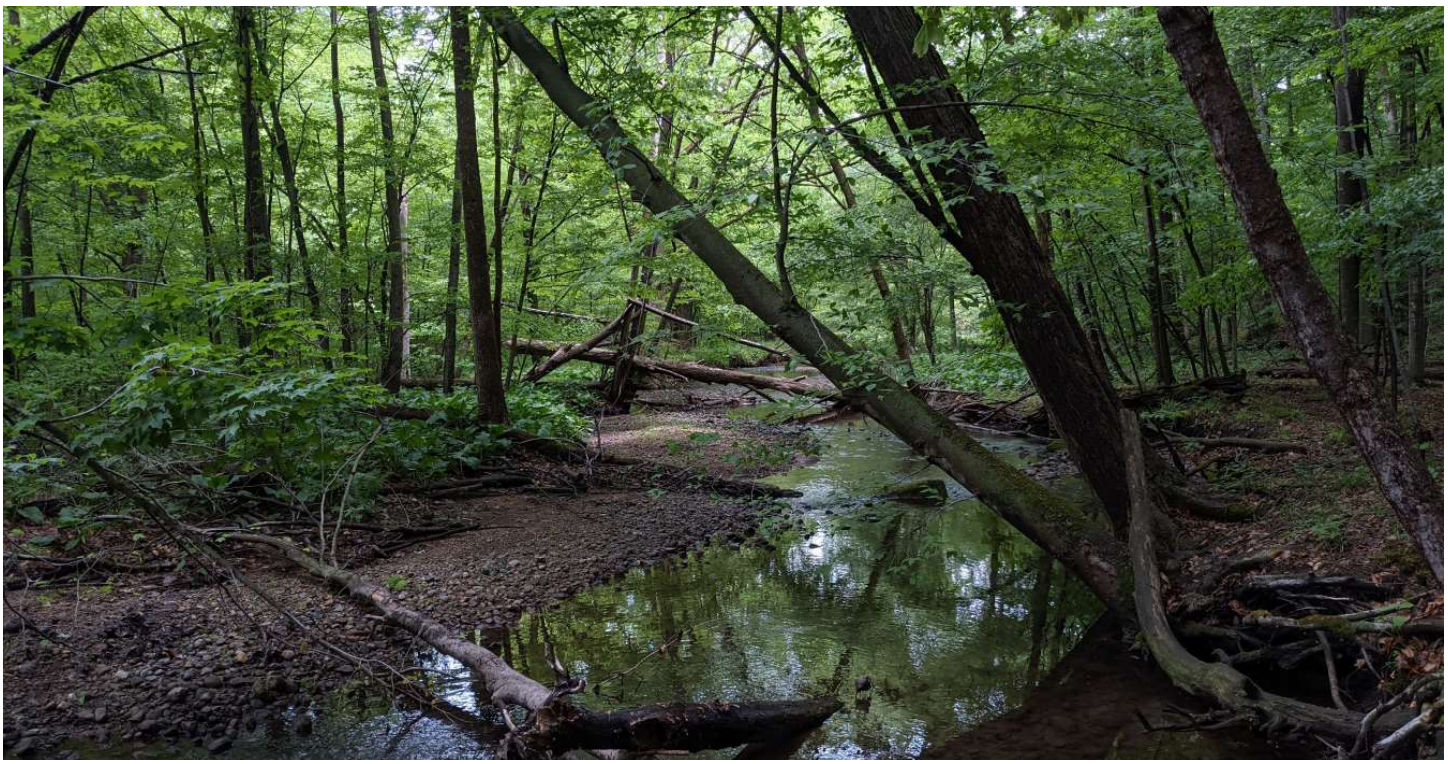
The composition of Okemos Hills changes dramatically based on slope, aspect, and proximity to the river. Photos by Jesse M. Lincoln.

structure and composition. The two central polygons of the forest may have been influenced by infrequent fire, based on landscape position, soils, species composition, and a few burnt eastern red cedar (*Juniperus virginiana*) stumps. The northcentral polygon faces southwest and was especially impacted by drought during the surveys in August of 2020 and this stand also appeared to be the most likely to have been shaped by fire. The composition of the diverse canopy corresponds to shifts in soil composition, variations in aspect of the steep slopes, and slope position with saturated soils along the river. Locally, the slopes transition to flat areas at the bottom where streams and vernal pools occasionally occur. Coarse woody debris is starting to accumulate, though much of it is likely due to the recent loss of ash. Flatter areas near the top of slopes quickly transition to dry to dry-mesic southern forest and some of these areas are clearly fire-adapted.

The diverse, closed-canopy forest is characterized by large (40-113 cm), maturing (100 to 250-year-old) trees, with red oak (*Quercus rubra*), sugar maple (*Acer saccharum*), basswood (*Tilia americana*), and white oak (*Quercus alba*) as the canopy dominants. Other common species include black maple (*Acer nigrum*), black oak (*Quercus velutina*), chinquapin oak (*Quercus muehlenbergii*), and shagbark hickory (*Carya ovata*). Black and white oak are dominant at the tops of the steep slopes where the system transitions towards dry-mesic to dry southern forest. Less frequent canopy species include black cherry (*Prunus serotina*), bitternut hickory (*Carya cordiformis*), blue ash (*Fraxinus quadrangulata*), beech (*Fagus grandifolia*), red maple (*Acer rubrum*), and eastern red cedar (only in the central polygon).

Table 5. Size and ring count for trees in Okemos Hills mesic southern forest EO.

Species	Size In	Size Cm	Ring Count
Acer rubrum	27.0	68.6	
Acer saccharum	27.0	68.6	
Acer saccharum	27.0	68.6	
Acer saccharum	21.8	55.4	
Carya cordiformis	21.0	53.3	
Celtis occidentalis	20.0	50.8	
Fraxinus quadrangulata	19.1	48.5	
Juglans nigra	22.0	55.9	
Juniperus virginiana	17.8	45.2	199
Juniperus virginiana	35.8	90.9	234
Platanus occidentalis	44.5	113.0	
Quercus alba	27.8	70.6	248
Quercus alba	33.0	83.8	
Quercus alba	34.8	88.4	
Quercus alba	23.0	58.4	140
Quercus rubra	32.8	83.3	
Quercus rubra	22.0	55.9	
Quercus velutina	21.8	55.4	99
Quercus velutina	31.5	80.0	
Tilia americana	23.1	58.7	
Tilia americana	15.1	38.4	
Tilia americana	31.5	80.0	
Ulmus rubra	22.3	56.6	



A small stream courses through the northern polygon of Okemos Hills. Photo by Aaron P. Kortenhoven.

One of the red cedars is the state champion for the species with a diameter of 90.9 cm dbh and 234 rings observed, though the center few centimeters was rotten and unreadable. It could easily be over 300 years old. It is nearly dead with only a few small living branches. A 40 cm dbh red cedar was described by the GLO surveyors in 1827 and this may have been the tree they observed. A 58.4 white oak had 140 rings observed and appears to be of the representative age of the forest. Hackberry (*Celtis occidentalis*), sycamore (*Platanus occidentalis*), Kentucky coffee tree (*Gymnocladus dioicus*), silver maple (*Acer saccharinum*), black walnut (*Juglans nigra*), bur oak (*Quercus macrocarpa*), box elder (*Acer negundo*), and red elm (*Ulmus rubra*) are more typical along the river. As noted, blue ash is rare in the canopy but seems to have survived the emerald ash borer (*Agrilus planipennis*) while canopy white ash (*F. americana*) and green ash (*F. pennsylvanica*) have since succumbed to the insect. These were both important canopy constituents and appear to have constituted around 2 to 5 % of the canopy, with white ash on the slopes and green ash at the base of the slopes nearer the river.

The subcanopy coverage is approximately 50 to 70% with frequent dominants including sugar maple, red maple, and ironwood (*Ostrya virginiana*). All three ash species are important constituents of the subcanopy along with elm. Additional subcanopy species include hackberry, bitternut hickory, basswood, beech, chinquapin oak, red oak, sassafras (*Sassafras albidum*), and red cedar. Understory and low shrub layers are patchy with 5 to 60% coverage. Species include many of the dominant canopy species as well as choke cherry (*Prunus virginiana*), prickly gooseberry (*Ribes cynosbati*), autumn olive (*Elaeagnus umbellata*), multiflora rose (*Rosa multiflora*), pasture rose (*R. carolina*), musclewood (*Carpinus caroliniana*), flowering dogwood (*Cornus florida*), alternate-leaved dogwood (*C. alternifolia*), witch-hazel (*Hamamelis virginiana*), red-berried elderberry (*Sambucus racemosa*), and morrow honeysuckle (*Lonicera morrowii*) with prickly-ash (*Zanthoxylum americanum*) and bladder-nut (*Staphylea trifolia*) more frequent along the river.

The state champion eastern red cedar occurs on the steep slopes of the central polygon of Okemos Hills. The tree had a diameter of 90 cm and had 234 rings observed, though the center was rotten. It has only a few living branches at the top. Photo by Jesse M. Lincoln.

The two northern polygons had the most comprehensive vegetation surveys completed and the subsequent description of ground cover species will focus mostly on those areas as they are the largest and most diverse with populations of rare plants. Across the forest, the herbaceous layer is highly variable with some areas supporting an extensive carpet of diverse native vegetation and other areas that were historically grazed having almost no vegetation (e.g., portions of the northernmost polygon). The northern polygon has an especially rich early spring flora with what is likely the state's largest population of twinleaf (*Jeffersonia diphylla*, State Special Concern). Other spring ephemerals include snow trillium (*Trillium nivale*, State Threatened), bloodroot (*Sanguinaria canadensis*), two-leaved toothwort (*Cardamine diphylla*), pink spring cress (*Cardamine douglassii*), white and yellow trout lily (*Erythronium albidum* and *E. americanum*), round-lobed hepatica (*Hepatica americana*), and yellow violet (*Viola pubescens*). Common species along the river are wild-ginger (*Asarum canadense*), false rue-anemone (*Enemion biternatum*), wild-rye (*Elymus virginicus, E. villosus*, and *E. riparius*), running strawberry-bush (*Euonymus obovatus*), honewort (*Cryptotaenia canadensis*), *Carex springellii*, and Canada anemone (*Anemone canadensis*). In the northern portion of the northern polygon (Stand 47) there is a small population of the fire pink (*Silene virginica*, State Endangered) growing under red oak, basswood, and ironwood along with big-leaf sandwort (*Moehringia macrophylla*), garlic mustard (*Alliaria petiolata*), black snakeroot (*Sanicula odorata*), *Carex cephaloidea*, false spikenard (*Maianthemum racemosum*), Ohio horse mint (*Blephilia ciliata*), and black raspberry (*Rubus occidentalis*). Rock cress (*Boechera dentata*, State Threatened) was documented growing along the top of the slope in the northern polygon in areas of exposed soil and gravel. Species associated with rock cress include bluestem goldenrod (*Solidago caesia*), Robin's plantain (*Erigeron pulchellus*), and small pussytoes (*Antennaria howellii*). This northern block has an extremely concerning concentration of lesser celandine (*Ficaria verna*) along the river.

The north central block (Stand 21) is very diverse in places, especially the steepest slopes where deer cannot graze as easily. This polygon also has many signals of a fire-adapted system. It was included with the mesic southern

Several species observed in the northcentral polygon of Okemos Hills were atypical of mesic southern forests and suggest portions of the system may be fire-adapted. These include Ohio horse mint (left) and spreading dogbane (right), among several others. Photos by Jesse M. Lincoln.

forest EO because of substantial overlap and for simplicity but could justifiably be mapped as a dry-mesic southern forest. This area is extremely steep and has almost no flat area at the base of the slope and has no floodplain components as most of the other polygons do. Species in the central polygons suggesting past fire disturbance include Ohio horse mint, huckleberry (*Gaylussacia baccata*), yellow-pimpernel (*Taenidia integerrima*), hairy goldenrod (*Solidago hispida*), black-eyed Susan (*Rudbeckia hirta*), culver's-root (*Veronicastrum virginicum*), pasture rose (*Rosa carolina)*, woodland sunflower (*Helianthus divaricatus*), silky wild-rye (*Elymus villosus*), flowering spurge (*Euphorbia corollata*), spreading dogbane (*Apocynum androsaemifolium*), and *Carex pensylvanica*. Deer density appears to be quite high as is evidenced by numerous trails and obvious browse on several species, including grasses, sedges, hickories, and especially mullein-foxglove (*Dasistoma macrophylla*, State Endangered).

There is an unusual concentration of rare plants in the Okemos Hills. The forest supports populations of rock cress (*Boechera dentata,* State Threatened), *Carex oligocarpa* (State Threatened, not observed in 2019 or 2020), mullein-foxglove (*Dasistoma macrophylla*, State Endangered), beak-grass (*Diarrhena obovata*, State Threatened), twinleaf (*Jeffersonia diphyla*, State Special Concern), fire pink (*Silene virginiana*, State Endangered), and snow trillium (*Trilium nivale*, State Threatened).

Okemos Hills was visited once in the 2020 field season and once in the 2021 field season to better assess the population of fire pink. A total of 151 plant species were observed with 139 native species and 12 non-native species recorded. Plant lists were developed for two of the four polygons and a combined list from both polygons is provided in the appendix. The combined Total FQI is 52.8 and the Total Mean C is 4.3. Conservation metrics for Okemos Hills and the comprehensive species list are available in Appendix 3 and 4.

Several populations of rare species have been documented in Okemos Hills, including twinleaf (top), fire pink (middle), and rock cress (early spring form, bottom). Photos by Jesse M. Lincoln.

Threats and Management Recommendations
The primary threats to the Okemos Hills mesic southern forest are habitat fragmentation, invasive species, trails, deer herbivory, and potentially fire suppression in two of the polygons with pockets of dry-mesic southern forest. Problematic invasive species in order of concern are lesser celandine, Dame's rocket (*Hesperis matronalis*), multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), oriental bittersweet (*Celastrus orbiculatus*), Japanese barberry (*Berberis thunbergii*), and a nascent population of bluegrass (*Poa nemoralis*).

Our management recommendations are to prevent logging within the EO and provide a 150 ft buffer around the forest where intensive silvicultural actions such as clearcutting are prevented. We recommend including these forest blocks within a conservation corridor and focusing resources for treating invasive species within the corridor. Within the northern portion of the northern polygon, an extremely concerning concentration of lesser celandine was documented along the river. This invasive is spreading beyond the margins of the river and several feet up the base of the slope. This seems to be a rapid expansion since the first surveys in 2015 and should be addressed immediately with special attention being paid to the population of snow trillium that occupies similar habitat. Resource managers should especially focus on lesser celandine along the river in Stands 26, 47, and 83; autumn olive and dame's rocket in Stand 21; and multiflora rose in Stand 47.

Numerous walking or biking trails are being established in these forests and we strongly urge the game area managers to work with locals to establish trails away from the highest quality forests and populations of rare species. Because these forests are often the most desirable to walk through, this will likely be a complicated endeavor. We also recommend investigating applying prescribed fire in Stands 21 and 26. It is difficult to recommend a rate of applying fire to these systems as fire disturbance is atypical for mesic southern forest. However, the number of species characteristic of fire adapted systems, the historic density of Indigenous Communities, and the presence of fire-adapted natural communities and species on the landscape suggests that fire was at least locally part of the landscape historically and therefore worth investigating as a management and conservation tool. Because of the density of rare plants susceptible to deer herbivory, we also suggest reducing deer densities.

While Okemos Hills has several areas featuring native vegetation and supports populations of rare plant species, there are numerous areas where excessive deer herbivory has caused an absence of plant life in the ground cover and understory. Photo by Jesse M. Lincoln.

Okemos Hills features a diverse canopy of large trees, including sugar maple, basswood, red oak, white oak, blue ash, american elm, and historically white and green ash. Photo by Aaron P. Kortenhoven.

The exotic invasive lesser celandine is one of the earliest flowering plants and along the river forms extensive carpets to the exclusion of native vegetation. Photo by Jesse M. Lincoln.

3. Sebewa Woods
Natural Community Type: Mesic Southern Forest
Rank: G2G3 S3, imperiled to vulnerable globally and vulnerable within the state
Element Occurrence Rank: D
Size: 9 acres
Location: Compartment 3; Stand 9.
Element Occurrence Identification Number: 24984

This is a small second-growth, mesic southern forest that occurs on rolling ground moraine. The community type historically dominated the surrounding, gently rolling terrain but is now nearly absent and typically relegated to the steepest slopes along major rivers. Very large glacial erratics occur throughout, one near a small stream was about 2 m by 1.5 m by 1 m tall. Typically, there is 3 to 5 cm of leaf litter over soils. The top 15 cm of soil are sandy loam (pH 6.5) with dark organics. This upper horizon overlies sandy loam (pH 6.5) with cobble up to 5 cm diameter which continue to a depth of at least 1 m. Earthworms were observed throughout, though especially at the margins with younger forest and along the western edge near a farm field. Areas with obvious earthworm impacts have much sparser leaf litter and minimal vegetation. Mole activity was obvious in the areas heavily impacted by earthworms and these areas are characterized by extensive areas of bare mineral soils with minimal herbaceous vegetation.

This forest is dominated by mature sugar maple (*Acer saccharum*) and beech (*Fagus grandifolia*). Diameters typically range from 40 to 90 cm dbh and tree ages were between 110 to 120, suggesting a logging event around 1900. Red oak (*Quercus rubra*), basswood (*Tilia americana*), black cherry (*Prunus serotina*), and bitternut hickory (*Carya cordiformis*) are occasional to infrequent in the canopy. The subcanopy is overwhelmingly dominated by sugar maple with ironwood (*Ostrya virginiana*), beech, American elm (*Ulmus americana*), and white ash (*Fraxinus americana*) as common associates. The understory and low shrub layers include musclewood (*Carpinus caroliniana*),

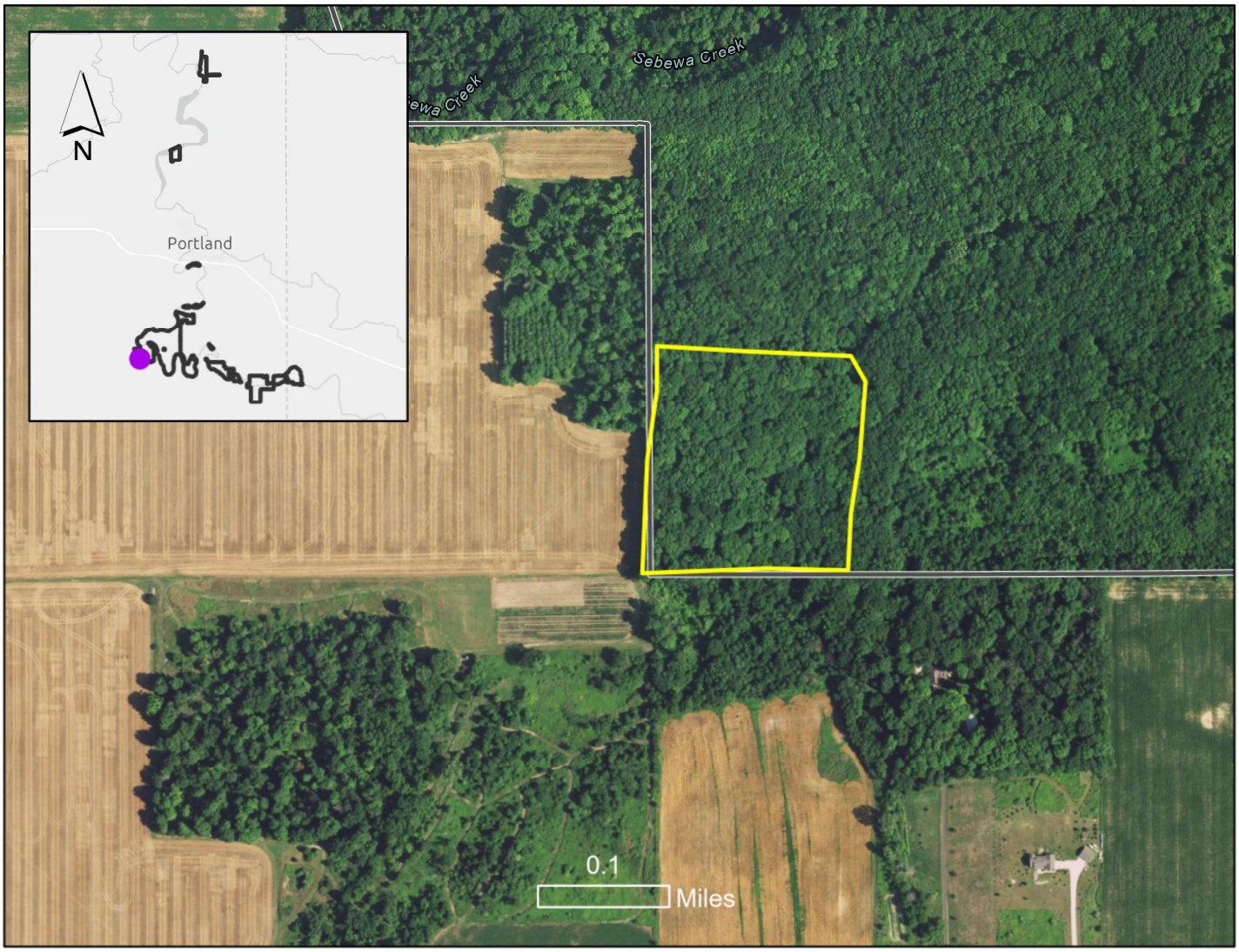
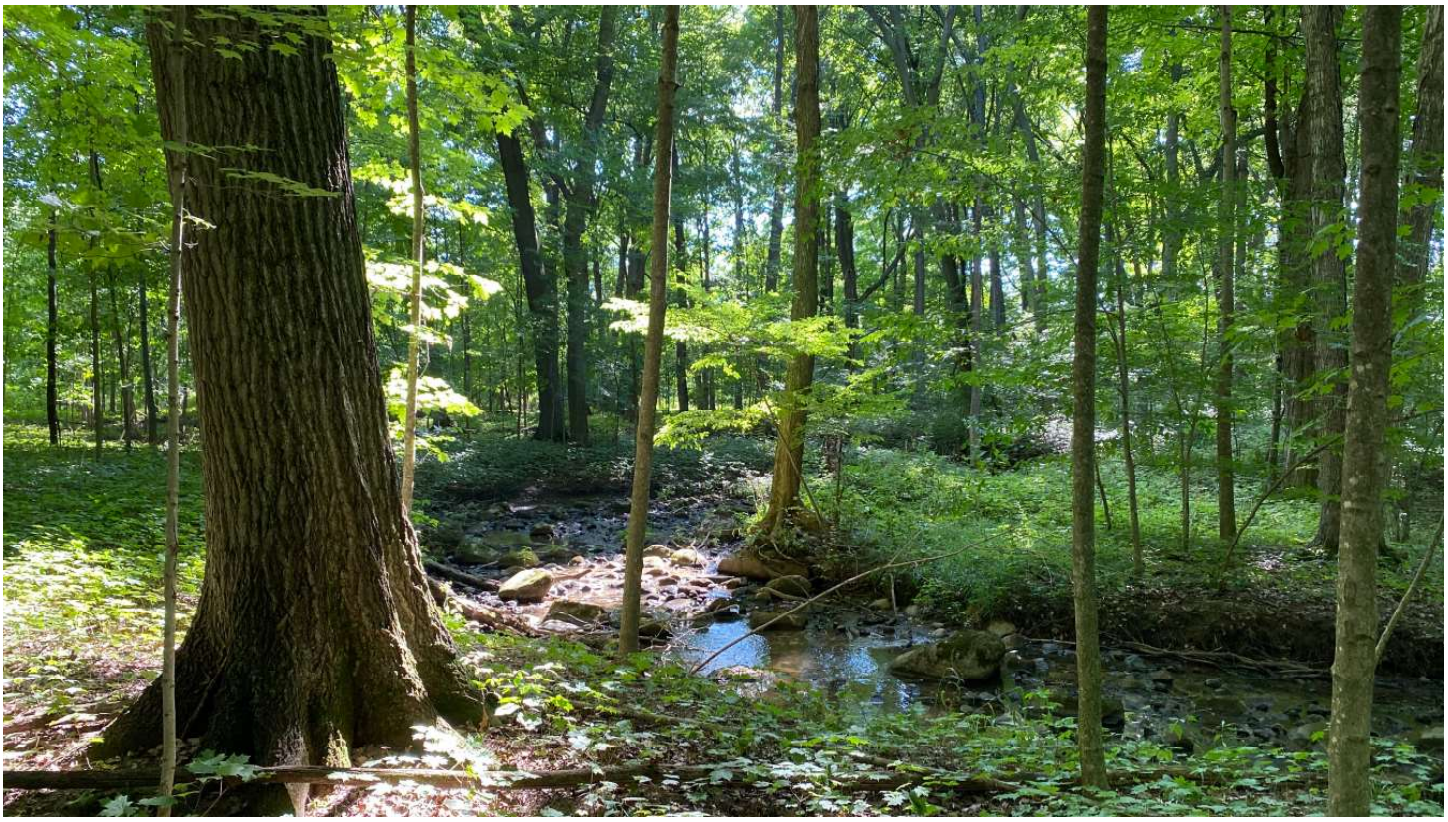


Figure 16. Location of Sebewa Woods mesic southern forest (ESRI 2022).



Most forests away from the steep slopes of the Grand River have been cleared and converted to agriculture. Sebewa Woods is unusual in that even though the forest was logged, it was not converted to agriculture, making it a rare mesic southern forest in a sea of agriculture. Photos by Jesse M. Lincoln.

multiflora rose (*Rosa multiflora*), prickly gooseberry (*Ribes cynosbati*), red-berried elder (*Sambucus racemosa*), and black raspberry (*Rubus occidentalis*) along with areas of very dense sugar maple.

The herbaceous layer is diverse, especially compared to surrounding stands that have reverted to forest from agriculture or have been recently clearcut. Common species include sedges (*Carex woodii, C. plantaginea, C. albursina, C. pedunculata*, and *C. gracillima*) and numerous spring ephemerals, including spring-beauty (*Claytonia virginica*), squirrel-corn (*Dicentra canadensis*), yellow trout lily (*Erythronium americanum*), common trillium (*Trillium grandiflorum*), and violets (*Viola canadensis*, *V. pubescens*, and *V. sororia*). Other characteristic species include clearweed (*Pilea pumila*), wild geranium (*Geranium maculatum*), poison-ivy (*Toxicodendron radicans*), calico aster (*Symphyotrichum lateriflorum*), may-apple (*Podophyllum peltatum*), wood nettle (*Laportea canadensis*), false rue-anemone (*Enemion biternatum*), and wild leeks (*Allium tricoccum*). Invasive species are generally infrequent but appear to be increasing in dominance and include multiflora rose (*Rosa multiflora*), dame's rocket (*Hesperis matronalis*), and garlic mustard (*Alliaria petiolata*).

Sebewa Woods was visited in August of the 2020 field season. A total of 56 plant species were observed with 53 native species and 3 non-native species recorded. The total FQI is 31.7 and the Total Mean C was 4.2. Conservation metrics for Sebewa Woods and the comprehensive species list are available in Appendix 5 and 6.

Threats and Management Recommendations

The primary threats to the Sebewa Woods are logging, habitat fragmentation, deer herbivory, and invasive species, particularly Dame's rocket and multiflora rose. There are also problems with earthworms in the western portion but it is unclear what action is best to combat this issue. Our primary management recommendations are to include this forest in a conservation corridor and connect it to other important areas by providing a conservation buffer around Stand 9 that extends along the stream that runs through it and runs north to the Sebewa Shrub Carr. Within this conservation corridor we recommend preventing clearcutting, protecting sensitive soils from equipment, and prioritizing treatment of invasive species. Additional specific management recommendations for Sebewa Woods are to treat dame's rocket and multiflora rose, protect against ORVs, and reduce local deer densities.

Worms are consuming the leaf litter, leaving exposed mineral soil and causing the decline of characteristic vegetation. Photo by Jesse M. Lincoln.

Most forests away from the steep slopes of the river have been cleared and converted to agriculture. Sebewa Woods is unusual in that following logging in the late 1800s, the forest was not converted to farmland, making it a rare mesic southern forest in a sea of agriculture. Photo by Jesse M. Lincoln.

4. Lyon's Shrub-Carr
Natural Community Type: Southern Shrub-Carr
Rank: GU S4, globally unrankable and apparently secure within the state
Element Occurrence Rank: C
Size: 22 acres
Location: Compartment 2; Stand 48.
Element Occurrence Identification Number: 24242

Lyon's Shrub-Carr was named after Lucious Lyon, who first surveyed this area for the General Land Office in 1827. His notes were used to develop the circa-1800 vegetation map of the area. This is a non-forested, shrub-dominated wetland on a terrace above the Grand River floodplain. Saturated soils are fed by a constant flow of minerotrophic groundwater emerging from the base of the steep slopes of the ground moraine that border the Grand River outwash channel. Soils are alkaline (pH 8.0) sapric peats to depth of 20 cm. The peats overlie 60 cm of sandy clays (pH 8.0) that overlie hard clay (pH 8.0). The shrub-carr contains ant mounds as well as numerous seeps with deep muck. The constant flow of groundwater is preventing or slowing succession to closed-canopy swamp forest. Infrequent fires may have also acted in concert to maintain the shrub-carr.

Lyon's Shrub-Carr is a shrub-dominated wetland featuring a sparse canopy and a dense and diverse herbaceous layer. The canopy coverage is generally 10 to 20 % with bur oak (*Quercus macrocarpa*), American elm (*Ulmus americana*), basswood (*Tilia americana*), and occasional eastern red cedar (*Juniperus virginiana*). Historically, green ash (*Fraxinus pennslvanica*) was also a component of the canopy prior to canopy mortality from emerald ash borer. Canopy trees are generally 15 to 30 cm. A 42.9 cm dbh bur oak had 136 observed rings. A 30 cm dbh eastern red cedar had 51 observed rings. The understory is variable with dense shrub thickets prevalent throughout but also several extensive zones of open wetland that are characterized by a sparse understory and are dominated by herbaceous species. Characteristic tall shrub species include musclewood

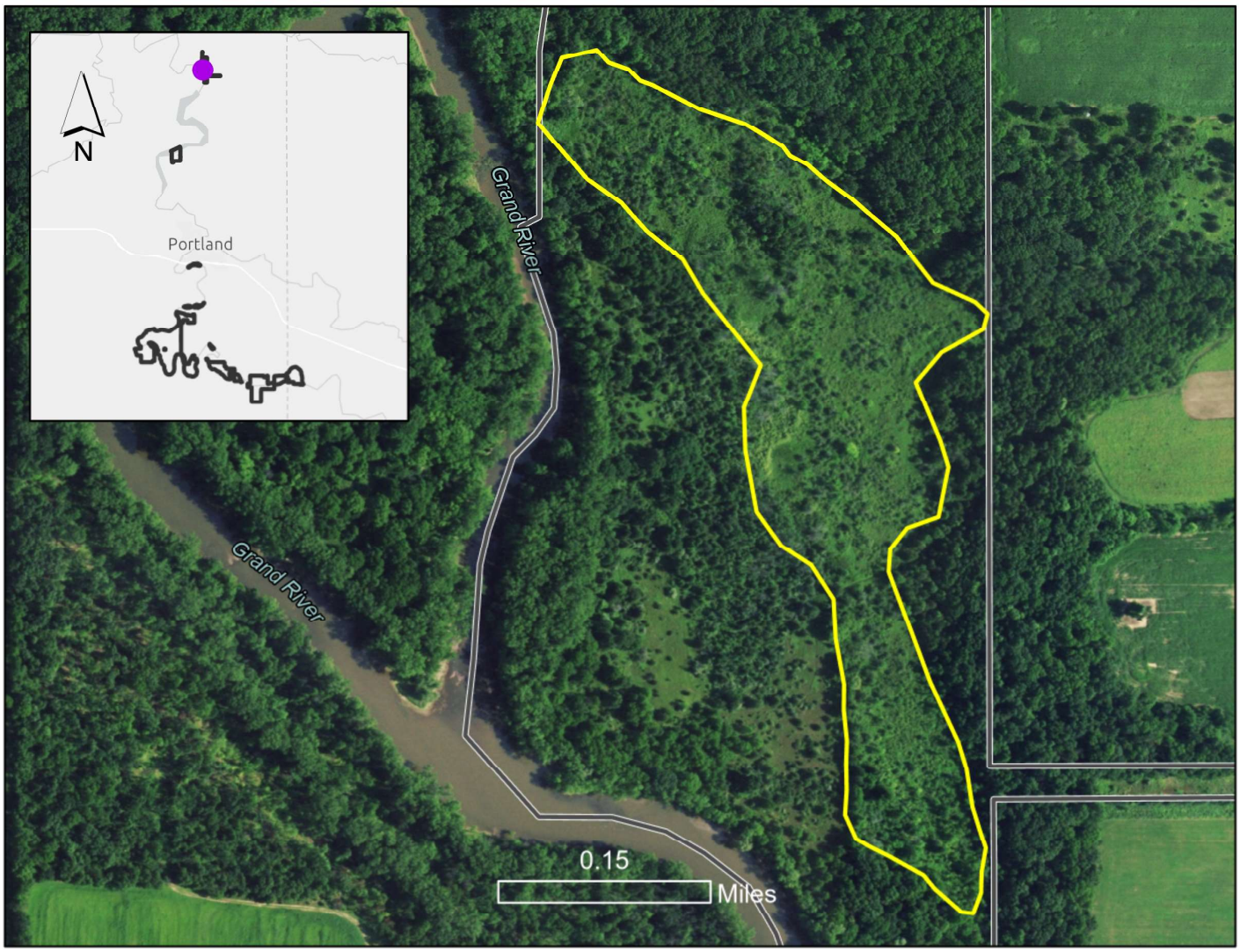


Figure 17. Location of Lyon's Shrub-Carr southern shrub-carr (ESRI 2022).

(*Carpinus caroliniana*), pussy willow (*Salix discolor*), poison sumac (*Toxicodendron vernix*), American elm, and green ash. Zones of thick and impenetrable multiflora rose (*Rosa multiflora*) and autumn olive (*Elaeagnus umbellata*) occur locally and intermingle with poison sumac. Other tall shrubs include spicebush (*Lindera benzoin*), dogwoods (*Cornus amomum* and *C. foemina*), and nannyberry (*Viburnum lentago*).

The herbaceous layer is diverse with zonation corresponding to proximity to seepage areas near the base of adjacent slopes; concentrations of ant mounds; and coverage of shrubs, which can suppress herbaceous vegetation. Large areas are dominated by *Carex lacustris*, common cat-tail (*Typha latifolia*), Joe-pye-weed (*Eutrochium maculatum*), and asters (*Symphyotrichum firmum*, *S. lateriflorum, S. novae-angliae*). Common graminoids include sedges (*Carex sterilis*, *C. stricta*, *C. hystericinia*), cut grass (*Leersia* oryzoides), leafy satin grass (*Muhlenbergia mexicana*), bulrush (*Scirpus atrovirens*), rush (*Juncus brachycephalus*), creeping bent (*Agrostis stolonifera*), and fringed brome (*Bromus ciliatus*). Common forbs include swamp goldenrod (*Solidago patula*), boneset (*Eupatorium perfoliatum*), rough bedstraw (*Galium asprellum*), ground nut (*Apios americana*), common mountain mint (*Pycnanthemum virginianum*), Missouri ironweed (*Vernonia missurica*), golden alexanders (*Zizia aurea*), and water dock (*Rumex verticillatus*). River-bank grape (*Vitis riparia*) is common throughout.

Lyon's Shrub-Carr was visited in September of the 2019 field season. Seventy-seven plant species were observed with 69 native species and 8 non-native species recorded. The total FQI is 32.5 and the Total Mean C was 3.7. Conservation metrics for Lyon's Shrub-Carr and the comprehensive species list are in Appendix 7 and 8.

Threats and Management Recommendations

The primary threats to Lyon's Shrub-Carr are invasive species, ORVs, and deer. There is a significant, though manageable, component of invasive species. In addition, high deer densities are likely altering the composition of the herbaceous layer. The most dominant invasive species are multiflora rose and autumn olive. Reed canary grass (*Phalaris arundinacea*) is locally abundant and may be problematic for the system. Moneywort (*Lysimachia nummularia*) is locally abundant in the ground cover but it does not seem like there is a realistic treatment to address this species. Invasive species treatment should prioritize control of multiflora rose, Autumn olive, and reed canary grass. Owners of adjacent parcels of private property appear to be building trails and driving ORVs through portions of the shrub-carr. In addition to control of invasive species, our primary management recommendations are to prevent intensive silvicultural actions within a 150 ft buffer around the wetland. Additional management recommendations are to protect against ORVs and reduce local deer densities.

Lyon's Shrub-Carr is characterized by thickets of silky dogwood, spicebush, and musclewood with open zones of sedges, cat-tail, and asters occurring between the dense shrub thickets. Constant seepage from the adjacent forested slopes slows the growth of trees and maintains the open conditions. Photo by Jesse M. Lincoln.

5. Sebewa Creek Shrub-Carr
Natural Community Type: Southern Shrub-Carr
Rank: GU S4, globally unrankable and apparently secure within the state
Element Occurrence Rank: BC
Size: 15 acres
Location: Compartment 3; Stand 12.
Element Occurrence Identification Number: 24243

Sebewa Creek Shrub-Carr is a non-forested, shrub-dominated wetland on a morainal terrace above the Grand River outwash channel. Saturated soils are fed by a constant flow of minerotrophic groundwater. Soils are alkaline (pH 7.5-8.0) sapric peats to depth of 60 cm overlying sandy clay (pH 8.0).

The constant flow of groundwater is preventing succession to closed-canopy swamp forest. The sparse canopy (5 to 30%) consists of American elm (*Ulmus americana*), basswood (*Tilia americana*), bur oak (*Quercus macrocarpa*), and quaking aspen (*Populus tremuloides*). Historically black and green ash (*Fraxinus nigra* and *F. pennsylvanica*) appear to have been important canopy constituents. Canopy trees are generally stunted and are around 7 m tall and 15 to 30 cm dbh. A 13.5 cm dbh bur oak had 44 observed rings. The understory is variable (10 to 30%) with musclewood (*Carpinus caroliniana*), pussy willow (*Salix discolor*), poison sumac (*Toxicodendron vernix*), black and green ash, American elm, and eastern red cedar (*Juniperus virginiana*).

The tall shrub layer is patchy to locally dominant (30 to 80 % coverage) and characteristic shrubs range in dominance. Common species include dogwoods (*Cornus amomum, C. foemina, C. sericea*), speckled alder (*Alnus incana*), willows (*Salix exigua, S. discolor, S. bebbiana*), Michigan holly (*Ilex verticillata*), wild black currant (*Ribes americanum*), spicebush (*Lindera benzoin*), swamp rose (*Rosa palustris*), and nannyberry (*Viburnum lentago*). The invasive shrubs multiflora rose (*Rosa multiflora*) and autumn olive (*Elaeagnus umbellata*) are locally abundant.

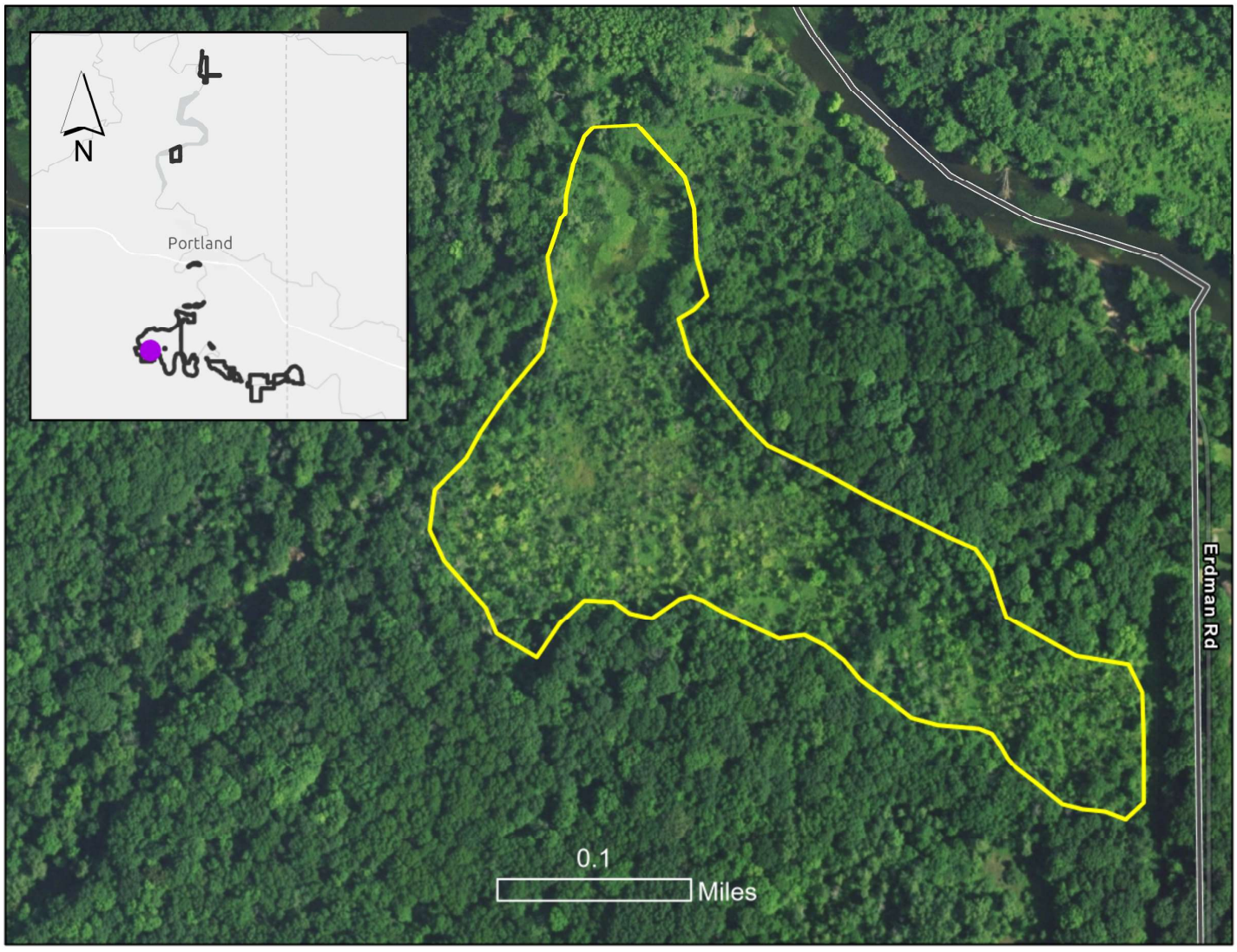


Figure 18. Location of Sebewa Creek Shrub-Carr southern shrub-carr (ESRI 2022).

Sebewa-Creek Shrub Carr occurs where groundwater seeps create permanently saturated soils and slow the growth and encroachment of trees. Photo by Jesse M. Lincoln.

Zones of Sebewa-Creek Shrub-carr are dominated by nannyberry, silky dogwood, Michigan holly, and sedges. Photo by Jesse M. Lincoln.

Shrub thickets are prevalent throughout Sebewa Creek Shrub-carr, but there are several extensive zones of open wetland with sparse shrub cover that are dominated by herbaceous species. The herbaceous layer is diverse with zonation and species composition corresponding to coverage of shrubs, which can suppress herbaceous vegetation; proximity to seepage areas; and depth of organic soils. There are various patterns of vegetation dominance. Some areas are dominated by *Carex stricta*, with common cat-tail (*Typha latifolia*), Joe-pye-weed (*Eutrochium maculatum*), and marsh fern (*Thelypteris palustris*). Another zone with scattered American elm and nannyberry is dominated by *Carex lacustris*, smooth swamp aster (*Symphyotrichum firmum*), sensitive fern (*Onoclea sensibilis*), and common cat-tail. Other common herbaceous species throughout the shrub-carr include boneset (*Eupatorium perfoliatum*), flat-topped white aster (*Doellingeria umbellata*), fringed brome (*Bromus ciliatus*), ground nut (*Apios americana*), hog-peanut (*Amphicarpaea bracteata*), swamp agrimony (*Agrimonia parviflora*), tall sunflower (*Helianthus giganteus*), fowl manna grass (*Glyceria striata*), bulrush (*Scirpus atrovirens*), late goldenrod (*Solidago gigantea*), purple avens (*Geum rivale*), common bur-reed (*Sparganium eurycarpum*), purplestem angelica (*Angelica atropurpurea*), and northern bugle weed (*Lycopus uniflorus*).

The shrub-carr also contains several seeps with deep muck where animals, especially deer, appear to be congregating in large numbers. The seeps have abundant *Chara*, which forms unusual mats and crusty mounds as it accumulates. The area around the seeps is diverse as it transitions to the more typical shrub-carr structure. Species in the seep zone include *Carex sterilis*, swamp goldenrod (*Solidago patula*), common cat-tail, cowbane (*Oxypolis rigidior*), panic grass (*Dichanthelium implicatum*), rush (*Juncus brachycephalus*), hardstem bulrush (*Schoenoplectus acutus*), grass-of-parnassus (*Parnassia glauca*), sneezeweed (*Helenium autumnale*), golden alexanders (*Zizia aurea*), and the non-native narrow-leaved cat-tail (*Typha angustifolia*), with Bebb's willow (*Salix bebbiana*), and quaking aspen (*Populus tremuloides*) at the margins.

The seep area of the shrub-carr is especially diverse but is threatened by expansion of the non-native narrow-leaved cat-tail. Photo by Jesse M. Lincoln.

Sebewa Creek Shrub-Carr was visited once in the 2020 field season. A total of 108 plant species were observed with 101 native species and 7 non-native species recorded. The total FQI is 41.6 and the Total Mean C was 4. Conservation metrics for Sebewa Creek Shrub-Carr and the comprehensive species are in Appendix 9 and 10.

Threats and Management Recommendations

The primary threats to Sebewa Creek Shrub-Carr are invasive species, ORVs, and deer. There is a significant, though manageable, component of invasive species. Multiflora rose, autumn olive, and narrow-leaved cat-tail are the most prevalent invasive species and could be easily treated. The non-native cat-tail is especially concerning as it threatens the most diverse area of the shrub-carr around the open seep in the western portion of the wetland. In addition, high deer densities are likely altering the composition of the herbaceous layer. Landowners to the southwest appear to be developing trails and driving ORVs through Sebewa Creek. Our primary management recommendations are to include the shrub-carr and adjacent streams in a conservation corridor along Sebewa Creek and along the small stream that feeds the eastern portion of the shrub-carr. Within this conservation corridor, we suggest that land managers prevent logging and damage to saturated soils; prioritize the treatment of invasive species (especially autumn olive, multiflora rose, and narrow-leaved cat-tail); protect against ORVs by contacting neighbors; and reduce local deer densities through a special deer hunt to manage population for conflicts.

Characteristic vegetation in seeps within the Sebewa Creek Shrub-Carr include sneezeweed (left) and chara (right). Photos by Jesse M. Lincoln.

Rare Plants

New populations of rare plants were documented when encountered and EOs were updated when existing populations were revisited (Table 6 and Figures 19 and 20). These include new populations of mullein-foxglove (*Dasistoma macrophylla*, State Endangered), snow trillium (*Trillium nivale*, State Threatened), rock cress (*Boechera dentata*, State Threatened), twinleaf (*Jeffersonia diphylla*, State Special Concern), red mulberry (*Morus rubra*, State Threatened), beak-grass (*Diarrhena obovata*, State Threatened) and cattail sedge (*Carex typhina,* State Threatened). Neither beak-grass nor cattail sedge had been documented in the game area prior to MiFI surveys.

The three EOs of fire pink (*Silene virginiana*, State Endangered) occurring in Portland SGA comprise the last documented population of fire pink in the state. The populations of rock cress, snow trillium, false-mullein (*Dasistoma macrophylla*, State Endangered) and twinleaf, are likely the largest populations of these species in the state. While rock cress and twinleaf seem to be relatively stable, many of the other rare species appear to be in serious decline. One population of snow trillium (EOID 585) had an estimated 50,000 individuals in 1988. The site had an estimated 500 stems in 2019. This constitutes a 99% decline in 30 years. Of the 10 records of snow trillium in Michigan, 5 are in the game area and only one of the other populations has been confirmed since 2000. Within the game area, this species seems to be losing habitat to lesser celandine and snow trillium is known to be browsed by deer. Furthermore, this population of snow trillium has likely been impacted by a trail that intersects the population and was recently constructed in 2018. The fire pink (EOID 3625) had over 200 plants observed in 1988 and a similar number observed in 2021. Nearly all of the false-mullein, an annual, was severely browsed by deer with many plants appearing to not be able to reproduce as a result of the browse.

Table 6. Rare plant element occurrences within Portland State Game Area or nearby. Status abbreviations are as follows: E, State Endangered; T, State Threatened; SC, Species of Special Concern. EO rank abbreviations are as follows: AB, excellent to good estimated viability, B, good estimated viability; C, fair estimated viability; CD, fair to poor estimated viability; and H, historic record.

Scientific Name	Common Name	EOID	State Status	Rank	Last Observed	Compartment	Stand
*Boechera dentata**	Rock cress	13313	T	AB	2022	2 and 3	numerous
Carex oligocarpa	Eastern few-fruited sedge	13343	T	CD	2003	3	47
*Carex typhina**	Cattail sedge	23123	T	CD	2015	3	57
*Carex typhina**	Cattail sedge	25443	T	CD	2020	3	1
*Dasistoma macrophylla**	Mullein-foxglove	13335	E	CD	2021	3	18 and 21
*Dasistoma macrophylla**	Mullein-foxglove	25441	E	CD	2015	3	39
*Diarrhena obovata**	Beak grass	23144	T	CD	2015	3	26
*Diarrhena obovata**	Beak grass	23147	T	CD	2015	3	47
Euonymus atropurpureus	Wahoo	13344	SC	H	2003	3	40
*Jeffersonia diphylla**	Twinleaf	3026	SC	AB	2021	3	83
Jeffersonia diphylla	Twinleaf	5237	SC	AB	2021	3	45 and 47
Jeffersonia diphylla	Twinleaf	13338	SC	B	2020	3	1
Morus rubra	Red mulberry	13336	T	D	2003	3	18
*Morus rubra**	Red mulberry	23337	T	C	2015	2	72
*Morus rubra**	Red mulberry	23338	T	D	2015	3	1
Silene virginica	Fire pink	3625	E	AB	2021	3	21
Silene virginica	Fire pink	8684	E	C	2021	3	47
Silene virginica	Fire pink	13337	E	CD	2021	3	1
Trillium nivale	Snow trillium	585	T	C	2020	3	26
Trillium nivale	Snow trillium	3357	T	H	2003	3	18
Trillium nivale	Snow trillium	4279	T	CD	2022	3	47
*Trillium nivale**	Snow trillium	25442	T	CD	2021	3	83

* denotes a new record or expanded population as a result of MiFI Surveys

False mullien (left), rock cress (top right), and cat-tail sedge (bottom right) are rare species found in Portland SGA. Photos by Jesse M. Lincoln.

Twinleaf (left) and fire pink (right) are rare species found in Portland SGA. Photos by Jesse M. Lincoln.

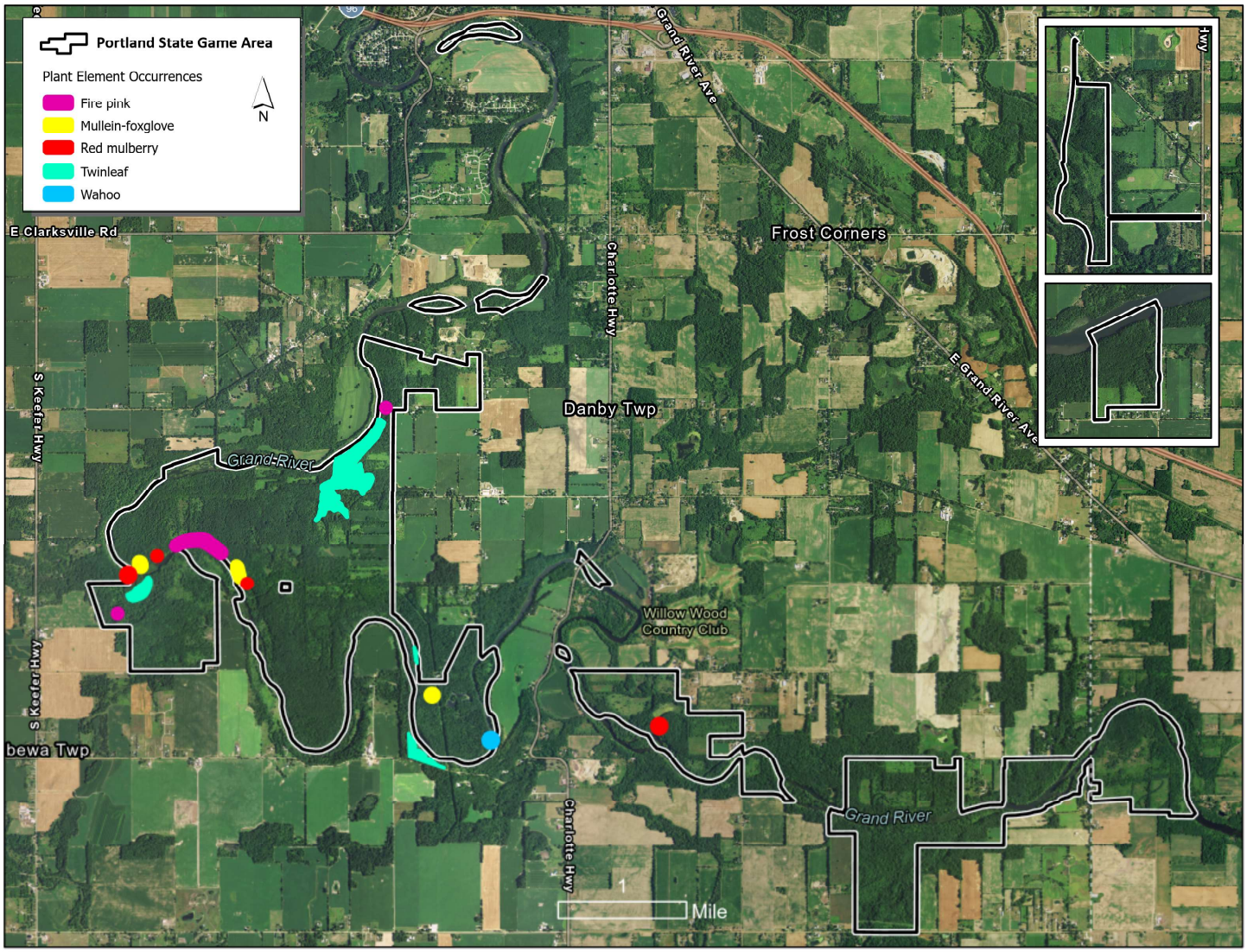


Figure 19. Location of rare plant element occurrences in Portland State Game Area.

The populations of snow trillium in Portland SGA are some of the largest in the state. Photo by Jesse M. Lincoln.

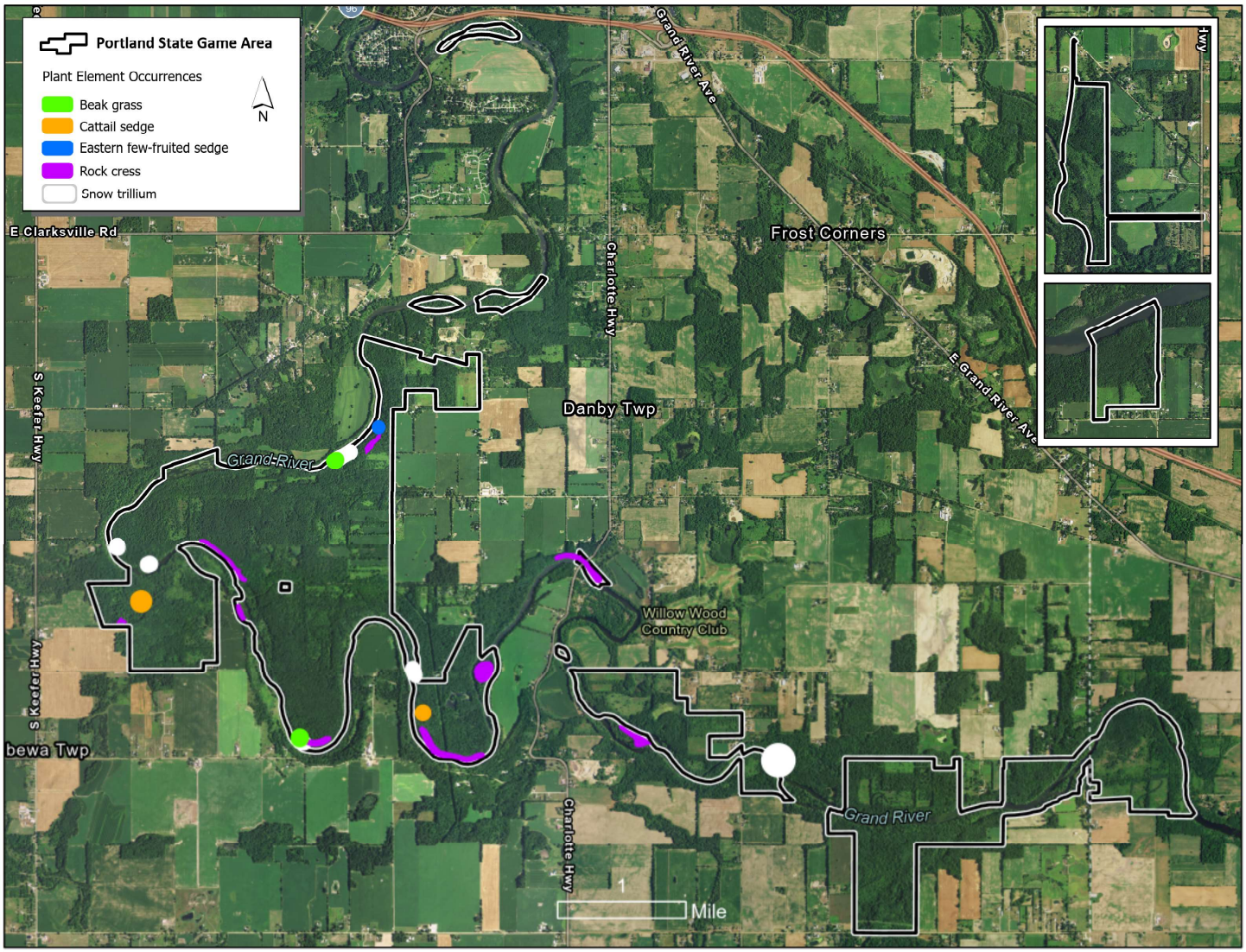


Figure 20. Location of rare plant element occurrences in Portland State Game Area.

Rare Mussels

We documented 39 new EOs for 6 mussel species within Portland SGA (Table 7 and Figures 21-24). Aquatic surveys were performed at 15 sites in the Grand River within Portland SGA (Table 1, pg 17; Figure 9, pg 18). Conditions for performing aquatic surveys were favorable with adequate water clarity. Although parts of the Grand River are too deep to wade, a large amount of wadable habitat was available and survey sites were selected from these stretches of river. A total of 14 unionid mussel species were found including 2 State Threatened species and 4 Species of Special Concern (Tables 7 and 8). All 6 of these species are Species of Greatest Conservation Need (SGCN).

Live individuals of the following species were found: mucket (*Actinionaias ligamentina*), Wabash pigtoe (*Fusconaia flava*), plain pocketbook (*Lampsilis cardium*), flutedshell (*Lasmigona costata*), round pigtoe (*Pleurobem sintoxia*), and giant floater (*Pyganodon grandis*). The remaining eight species were represented by shells alone. Though there was a relatively high number of species found at each site, the number of live individuals found was low. Only seven of the fifteen sites had live individuals, and at these sites, species were represented by only one to four live individuals per site. The eight sites with no live individuals averaged over seven species of shell per site. This unusual scenario could be indicative of a sizable mussel population decline within the past few years. The condition of most of the shells found were moderately to heavily worn. Relatively few recent dead shells were found.

Asian clams (*Corbicula fluminea*) are common and abundant in the Grand River within the Portland SGA. Densities of Asian clams were on the order of 100s of live individuals per square meter and 1000s of shells at some locations. No zebra mussels (*Dreissena polymorpha*) were found. Chinese or Japanese mysterysnail (*Cipangopaludina chinensis* or *C. japonica*) were found at ten of the fifteen aquatic survey sites. These non-native invasive snails were introduced to North America in the late 1800s for the food market. They are currently found in at least 37 states including several major watersheds in Michigan and can have negative impacts on native aquatic species. Chinese mysterysnail (*C. chinensis*) has been shown to reduce the density of native snail species in mesocosm experiments and, when co-occurring with rusty crayfish (*Faxonius rusticus*), lead to extirpations of native snails (Johnson et al. 2009).

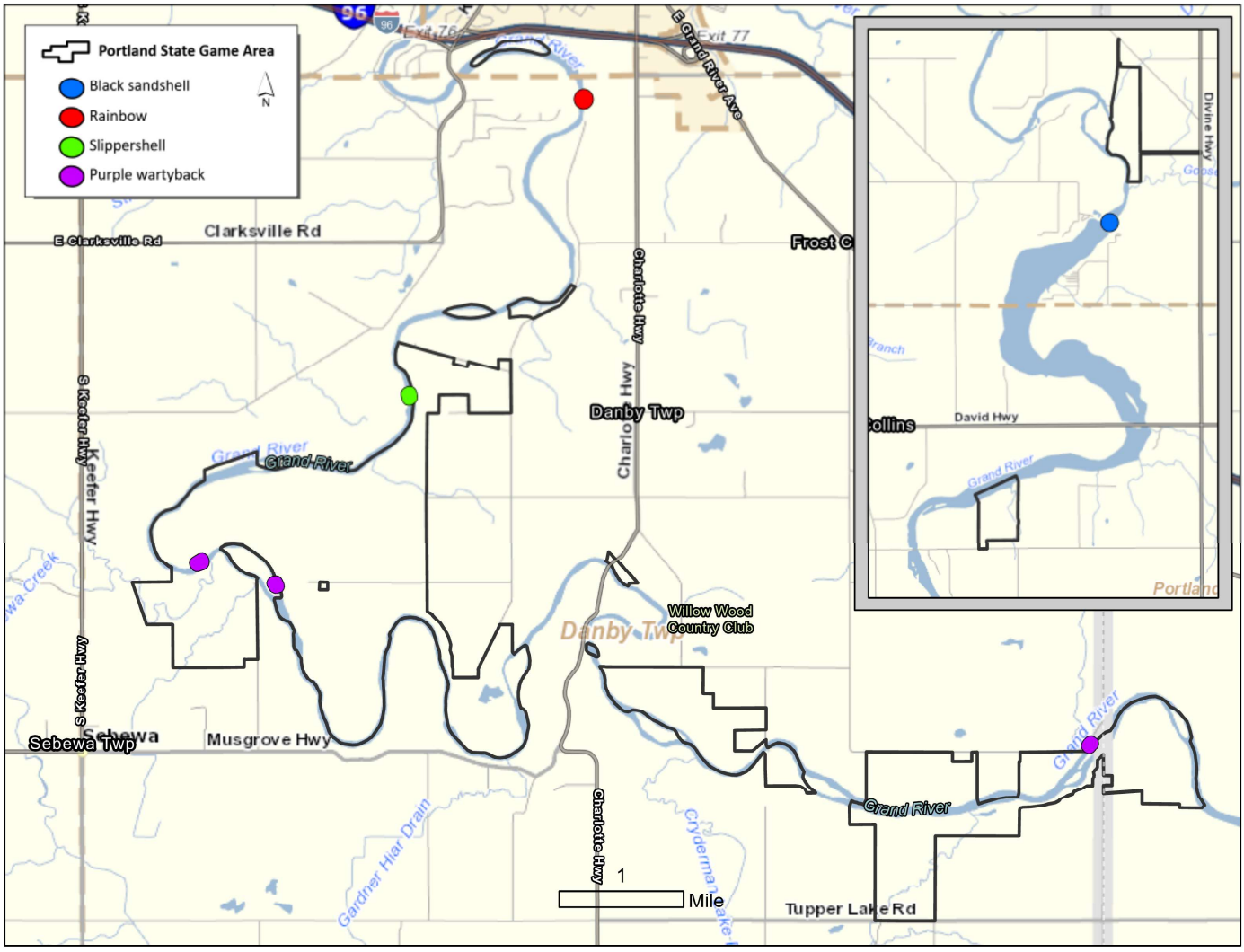


Figure 21. Location of rare mussel element occurrences in Portland State Game Area.

Table 7. Rare mussel element occurrences documented within Portland State Game Area during 2021 surveys. Status abbreviations are as follows: Fed E, Federally Endangered; E, State Endangered; T, State Threatened; SC, Species of Special Concern. Element occurrence (EO) rank abbreviations are as follows: E, verified extant; H, historical.

Common Name	Scientific Name	State Status	Federal Status	EO ID	EO Num	EO Rank	Year First Observed	Year Last Observed	Survey Site #
Elktoe	*Alasmidonta marginata*	SC		25510	270	E	2021	2021	Site 1
Elktoe	*Alasmidonta marginata*	SC		25514	271	E	2021	2021	Site 2
Elktoe	*Alasmidonta marginata*	SC		25516	272	E	2021	2021	Site 3
Elktoe	*Alasmidonta marginata*	SC		25519	273	E	2021	2021	Site 4
Elktoe	*Alasmidonta marginata*	SC		25525	274	E	2021	2021	Site 7
Elktoe	*Alasmidonta marginata*	SC		25530	275	E	2021	2021	Site 9
Elktoe	*Alasmidonta marginata*	SC		25534	276	E	2021	2021	Site 11
Elktoe	*Alasmidonta marginata*	SC		25537	277	E	2021	2021	Site 12
Elktoe	*Alasmidonta marginata*	SC		25540	278	E	2021	2021	Site 13
Elktoe	*Alasmidonta marginata*	SC		25543	279	E	2021	2021	Site 14
Elktoe	*Alasmidonta marginata*	SC		25546	280	E	2021	2021	Site 15
Slippershell	*Alasmidonta viridis*	T		25544	392	E	2021	2021	Site 14
Purple wartyback	*Cyclonaias tuberculata*	T		25511	107	E	2021	2021	Site 1
Purple wartyback	*Cyclonaias tuberculata*	T		25531	108	E	2021	2021	Site 9
Purple wartyback	*Cyclonaias tuberculata*	T		25535	109	E	2021	2021	Site 11
Flutedshell	*Lasmigona costata*	SC		25512	203	E	2021	2021	Site 1
Flutedshell	*Lasmigona costata*	SC		25515	204	E	2021	2021	Site 2
Flutedshell	*Lasmigona costata*	SC		25517	205	E	2021	2021	Site 3
Flutedshell	*Lasmigona costata*	SC		25520	206	E	2021	2021	Site 4
Flutedshell	*Lasmigona costata*	SC		25522	207	E	2021	2021	Site 5
Flutedshell	*Lasmigona costata*	SC		25524	208	E	2021	2021	Site 6
Flutedshell	*Lasmigona costata*	SC		25526	209	E	2021	2021	Site 7
Flutedshell	*Lasmigona costata*	SC		25528	210	E	2021	2021	Site 8
Flutedshell	*Lasmigona costata*	SC		25532	211	E	2021	2021	Site 9
Flutedshell	*Lasmigona costata*	SC		25533	212	E	2021	2021	Site 10
Flutedshell	*Lasmigona costata*	SC		25536	213	E	2021	2021	Site 11
Flutedshell	*Lasmigona costata*	SC		25538	214	E	2021	2021	Site 12
Flutedshell	*Lasmigona costata*	SC		25541	215	E	2021	2021	Site 13
Flutedshell	*Lasmigona costata*	SC		25545	216	E	2021	2021	Site 14
Flutedshell	*Lasmigona costata*	SC		25547	217	E	2021	2021	Site 15
Round pigtoe	*Pleurobema sintoxia*	SC		25523	234	E	2021	2021	Site 5
Round pigtoe	*Pleurobema sintoxia*	SC		25529	235	E	2021	2021	Site 8
Ellipse	*Venustaconcha ellipsiformis*	SC		25513	165	E	2021	2021	Site 1
Ellipse	*Venustaconcha ellipsiformis*	SC		25518	166	E	2021	2021	Site 3
Ellipse	*Venustaconcha ellipsiformis*	SC		25521	167	E	2021	2021	Site 4
Ellipse	*Venustaconcha ellipsiformis*	SC		25527	168	E	2021	2021	Site 7
Ellipse	*Venustaconcha ellipsiformis*	SC		25539	169	E	2021	2021	Site 12
Ellipse	*Venustaconcha ellipsiformis*	SC		25542	170	E	2021	2021	Site 13
Ellipse	*Venustaconcha ellipsiformis*	SC		25548	171	E	2021	2021	Site 15

Purple wartyback (left) and round pigtoe (right) were documented during aquatic surveys. Photos by Peter J. Badra.

Table 8. Unionid mussel species found at each aquatic survey site. Numbers of live unionid mussels (#) given and number shells of rare species are given in parentheses (S(#)) if only shells were found at a site. Presence/absence of non-native bivalves is noted. (SC= State Special Concern).

		1	2	3	4	5	6
Common name	Species	#	#	#	#	#	#
Mucket	*Actinonaias ligamentina*	S	1	S	S	S	S
Elktoe (SC)	*Alasmidonta marginata*	S(2)	S(1)	S(6)	S(3)		
Slippershell (T)	*Alasmidonta viridis*						
Purple wartyback (T)	*Cyclonaias tuberculata*	S(1)					
Spike	*Eurynia dilatata*	S	S	S	S	S	S
Wabash pigtoe	*Fusconaia flava*	S	S	S	S	S	S
Plain pocketbook	*Lampsilis cardium*	S		S	S	S(1)	S
Fatmucket	*Lampsilis siliquoidea*						
White heelsplitter	*Lasmigona complanata*						
Flutedshell (SC)	*Lasmigona costata*	S(6)	S(1)	S(7)	S(13)	S(9)	S(9)
Round pigtoe (SC)	*Pleurobema sintoxia*				S(6)	S(1)	
Giant floater	*Pyganodon grandis*	1	S		S		
Strange floater	*Strophitus undulatus*				S	S	
Ellipse (SC)	*Venustaconcha ellipsiformis*	S(1)		S(4)	S(3)		
	# species live	1	1	0	0	0	0
	# species live or shell	9	6	7	10	7	5
	Area searched (m^2)	76	135	75	124	210	64
Asian clams	*Corbicula fluminea*	S	S	L	L*	L	L
Zebra mussels	*Dreissena polymorpha*						

* Thousands of Asian clam shells per m^2 in addition to live individuals

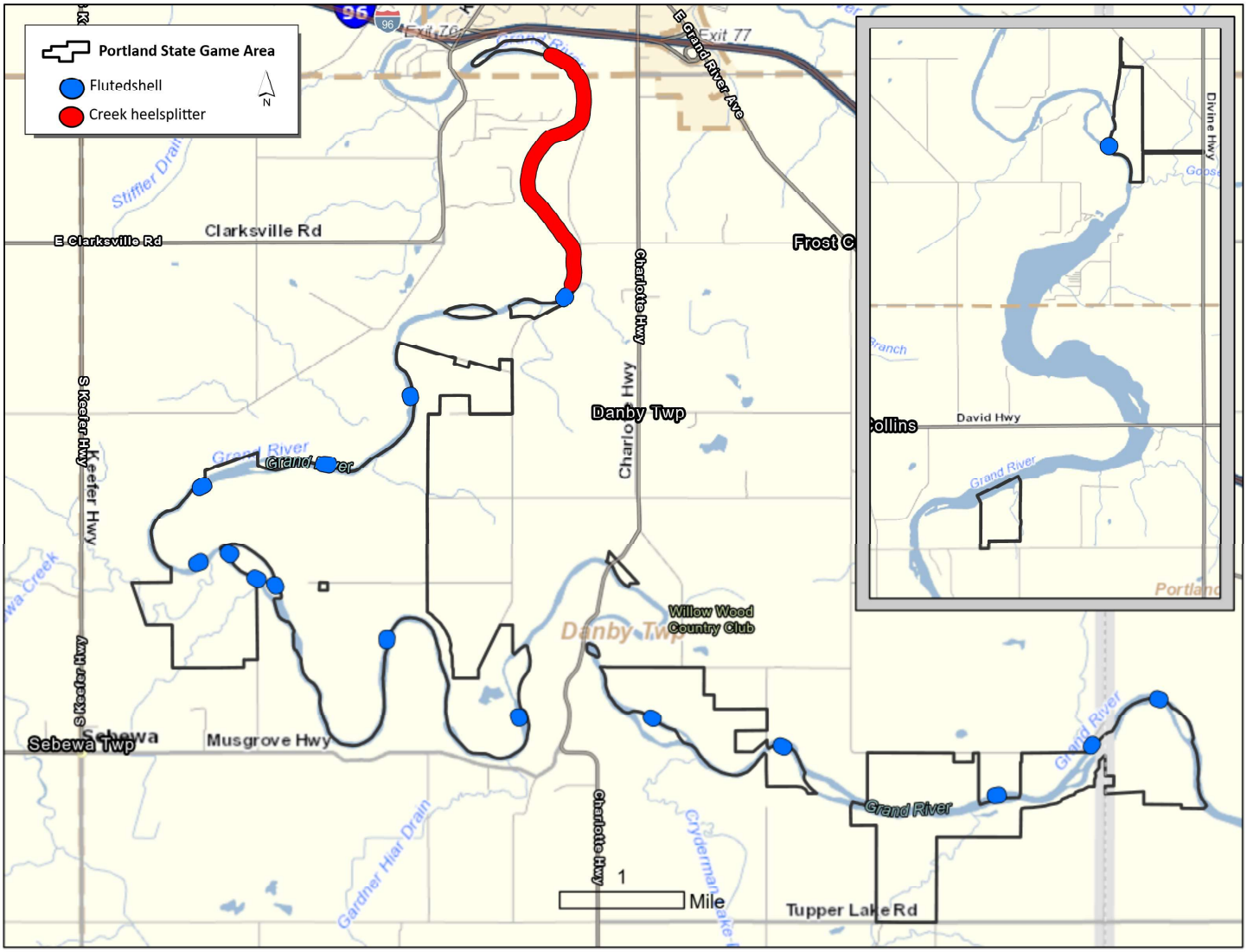


Figure 22. Location of rare mussel element occurrences in Portland State Game Area.

Table 8, continued. Unionid mussel species found at each aquatic survey site. Numbers of live unionid mussels (#) given and number shells of rare species are given in parentheses (S(#)) if only shells were found at a site. Presence/absence of non-native bivalves is noted. (SC= State Special Concern).

		7	8	9	10	11	12	13	14	15
Common name	Species	#	#	#	#	#	#	#	#	#
Mucket	*Actinonaias ligamentina*	S	S	S	S	3	4	3	S	1
Elktoe (SC)	*Alasmidonta marginata*	S(3)		S(2)		S(1)	S(2)	S(2)	S(8)	S(1)
Slippershell (T)	*Alasmidonta viridis*								S(6)	
Purple wartyback (T)	*Cyclonaias tuberculata*			S(3)		S(1)				
Spike	*Eurynia dilatata*	S	S	S	S	S	S	S	S	S
Wabash pigtoe	*Fusconaia flava*	1	S	S	S	S	S			
Plain pocketbook	*Lampsilis cardium*	S	S	S	S	2	S	3	S	1
Fatmucket	*Lampsilis siliquoidea*		S	S			S		S	
White heelsplitter	*Lasmigona complanata*								S(1)	
Flutedshell (SC)	*Lasmigona costata*	S(10)	S(32)	S(2)	S(9)	S(39)	S(1)	1+S(10)	S(6)	S(3)
Round pigtoe (SC)	*Pleurobema sintoxia*		S(2)				1			
Giant floater	*Pyganodon grandis*	S	S	S						
Strange floater	*Strophitus undulatus*	S				S	S	S		
Ellipse (SC)	*Venustaconcha ellipsiformis*	S(1)					S(1)	S(2)		S(1)
	# species live	1	0	0	0	2	2	3	0	2
	# species live or shell	9	8	9	5	8	10	7	8	6
	Area searched (m^2)	76	80	180	61	80	93	204	84	156
Asian clams	*Corbicula fluminea*	S	S	S	L	L	L	L	L	L
Zebra mussels	*Dreissena polymorpha*									

Table 9. Incidental finds at aquatic survey sites, including aquatic snails and limpets (Gastropoda), fingernail clams (Sphaeriidae), and fish.

Common Name	Species/Taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Snails	Gastropoda															
Pointed campeloma	*Campeloma decisum*		X			X			X	X	X	X	X	X		
Chinese/Japanese mystery snail	*Cipangopaludina chinensis/japonica*	X	X	X	X	X	X	X	X			X	X			
Liver elimia	*Elimia livescens*	X	X	X	X	X		X	X				X		X	X
Sharp hornsnail	*Pleurocera acuta*			X	X	X	X	X		X		X		X	X	
Striped whitelip snail	*Webbhelix multilineata*		X													
Fingernail clams	Sphaeriidae	X			X	X							X			
Crayfish	Decapoda	X														
Fish	Osteichthyes															
Yellow bullhead	*Ameiurus natalis*			X												
Common carp	*Cyprinus carpio*										X	X	X			
Greenside darter	*Etheostoma blennioides*								X							X
Johnny darter	*Etheostoma nigrum*				X											
Smallmouth bass	*Micropterus dolomieu*	X		X				X	X							X

Greenside darter (left) and empty slippershells (right) were documented during aquatic surveys. Photos by Peter J. Badra.

Chinese mysterysnail is also a host for the trematode parasite *Aspidogaster conchicola*, which can spread to native unionid mussels (Hueher and Etges 1977). Chinese mysterysnail and Japanese mysterysnail (*C. japonica*) are not reliably distinguished by shell characters alone. Though they may be different phenotypes of the same species, they are genetically distinct (David and Cote 2019).
Aquatic snail species (Gastropoda) were noted at all 15 sites and Fingernail clams (Sphaeriidae) were noted at four of the sites. Five fish species were observed: Johnny darter (*Etheostoma nigrum*), a host for the slippershell (*Alasmidonta viridis*, State Threatened) and ellipse (*Venustaconcha ellipsiformis*, State Special Concern); yellow bullhead (*Ameiurus natalis*), a host for the purple wartyback (*Cyclonaias tuberculata*, State Threatened); common carp (*Cyprinus carpio*) a host for flutedshell; smallmouth bass (*Micropterus dolomieu*) a host for flutedshell; and greenside darter (*Etheostoma blennioides*) another host for ellipse (Table 9).

Water chemistry measures were taken at aquatics survey site 1 on September 2, 2021. Total alkalinity was 172ppm and total water hardness was 208ppm. Water conductivity was 668µS and pH 8.62. These measures are within a range that is generally suitable for aquatic animal life.

Chinese mystery snails are large, invasive snails. Photo by Peter J. Badra.

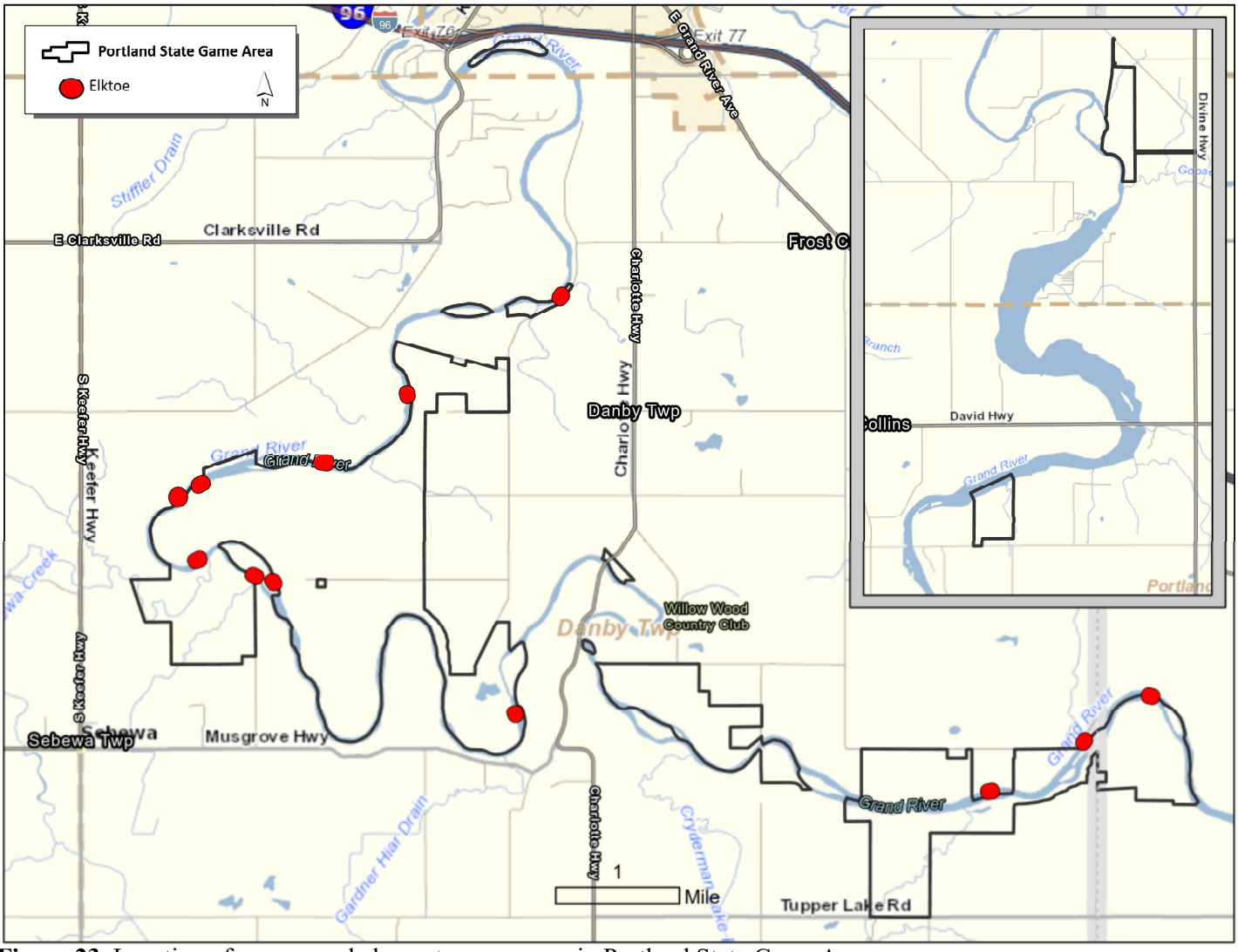


Figure 23. Location of rare mussel element occurrences in Portland State Game Area.

Live mucket (*Actinonaias ligamentina*) (three on the right) and one round pigtoe (*Pleurobema sintoxia, S*tate Special Concern) (left) found at aquatic survey site 12. Photo by Peter J. Badra.

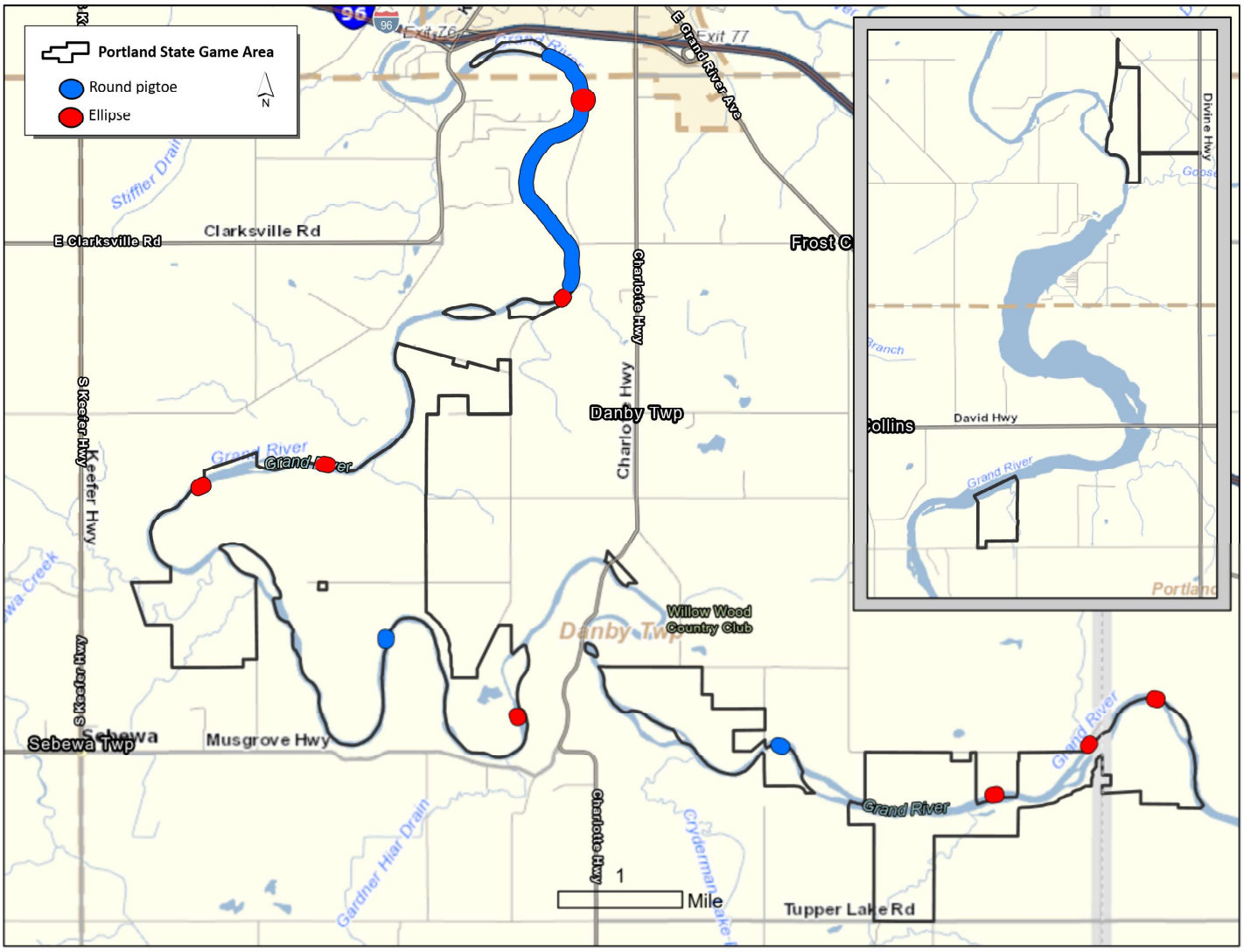


Figure 24. Location of rare mussel element occurrences in Portland State Game Area.

Rare Birds

We completed rare raptor surveys at 32 points within the game area. Red-shouldered hawks were not detected, and we did not record any active red-shouldered hawk nests. We conducted forest songbird surveys at 24 points. Three new songbird EOs were documented during these surveys (Table 10 and Figure 25). We recorded four singing male cerulean warblers at three survey points within Okemos Hills mesic southern forest. These observations constitute a new EO (EO ID 25364) and were recorded south of an existing cerulean warbler EO (EO ID 13396) that is also located in the game area (Figure 25). We documented three singing male hooded warblers at three points within Portland SGA (Figure 25). These hooded warbler observations were the first documented in the game area and represent a new EO in the Natural Heritage Database (EO ID 25312). We documented two vocalizing male red-headed woodpeckers at two points within Portland SGA (Figure 25). These red-headed woodpecker observations are a new EO have been entered into our Natural Heritage Database (EO ID 25761) (Figure 25).

We recorded a total of 47 bird species during point counts at the Portland SGA (Appendix 11). The 12 most detected species were: tufted titmouse (*Baeolophus bicolor;* 86%), red-eyed vireo (*Vireo olivaceus;* 77%), eastern wood-pewee (*Contopus virens;* 73%), indigo bunting (*Passerina cyanea;* 64%), northern cardinal (*Cardinalis cardinalis;* 59%), yellow warbler (*Setophaga petechia;* 59%), rose-breasted grosbeak (*Pheucticus ludovicianus;* 55%), Acadian flycatcher (*Empidonax virescens;* 50%), American redstart (*Setophaga ruticilla;* 45%), brown-headed cowbird (*Cyanocitta cristata;* 45%), scarlet tanager (*Piranga olivacea;* 45%), and wood thrush (*Hylocichla mustelina;* 41%).

The following ten species were regularly observed (20-36% of points surveyed): red-bellied woodpecker (*Melanerpes carolinus;* 36%), American robin (*Turdus migratorius* 32%), great-crested flycatcher (*Myiarchus crinitus*; 27%), least flycatcher (*Empidonax minimus*; 27%), song sparrow (*Melospiza melodia*; 27%), yellow-throated vireo (*Vireo flavifrons*; 27%), American crow (*Corvus brachyrhynchos*; 23%), Baltimore oriole (*Icterus galbula*; 23%), downy woodpecker (*Picoides pubescens*; 23%), and warbling vireo (*Vireo gilvus*; 23%). Ten (21%) of the species were detected at 10 to 19% of the survey points and 14 species (30%) were detected at less than 10% of the survey points.

Several bird species detected have special conservation status (Table 10). Three species are MDNR featured species for habitat management. These featured species are red-headed woodpecker, wood thrush and wild turkey (*Meleagris gallopavo*). Cerulean warbler, hooded warbler, red-headed woodpecker, and wood thrush are Species of Greatest Conservation Need (SGCN; Derosier et al. 2015). Red-headed woodpecker, wood thrush, and cerulean warbler are also focal species for conservation efforts under the Landbird Habitat Conservation Strategy (Potter et al. 2007) of the Upper Mississippi River and Great Lakes Region Joint Venture.

Hooded warblers were documented in Portland SGA in 2021. Photo by Aaron P. Kortenhoven.

Table 10. Rare bird element occurrences and birds of special conservation status found within Portland State Game Area. State status abbreviation are as follows: SC, State Special Concern and T, State Threatened. Rank abbreviations are as follows: D, poor estimated viability and E, verified extant but with insufficient information to rank viability.

Common Name	Scientific Name	EO ID	EO Rank	State Status	Featured Species	SGCN	JV Focal Species	Year First Observed	Year Last Observed
Listed Species									
Bald eagle	*Haliaeetus leucocephalus*	16355	E	SC				2009	2019
Cerulean warbler	*Setophaga cerulea*	13396	D	T		X	X	2003	2003
Cerulean warbler	*Setophaga cerulea*	25364	E	T		X	X	2021	2021
Hooded warbler	*Setophaga citrina*	25312	E	SC		X		2021	2021
Red-bellied woodpecker	*Melanerpes carolinus*	25761	E	SC	X	X	X	2021	2021
Unlisted Species									
Black-billed cuckoo	*Coccyzus erythropthalmus*				X			NA	2021
Pileated woodpecker	*Dryocopus pileatus*				X			NA	2021
Wood thrush	*Hylocichla mustelina*				X	X	X	NA	2021

Cerulean warblers were documented at Portland State Game Area in 2021. Photo by Aaron P. Kortenhoven.

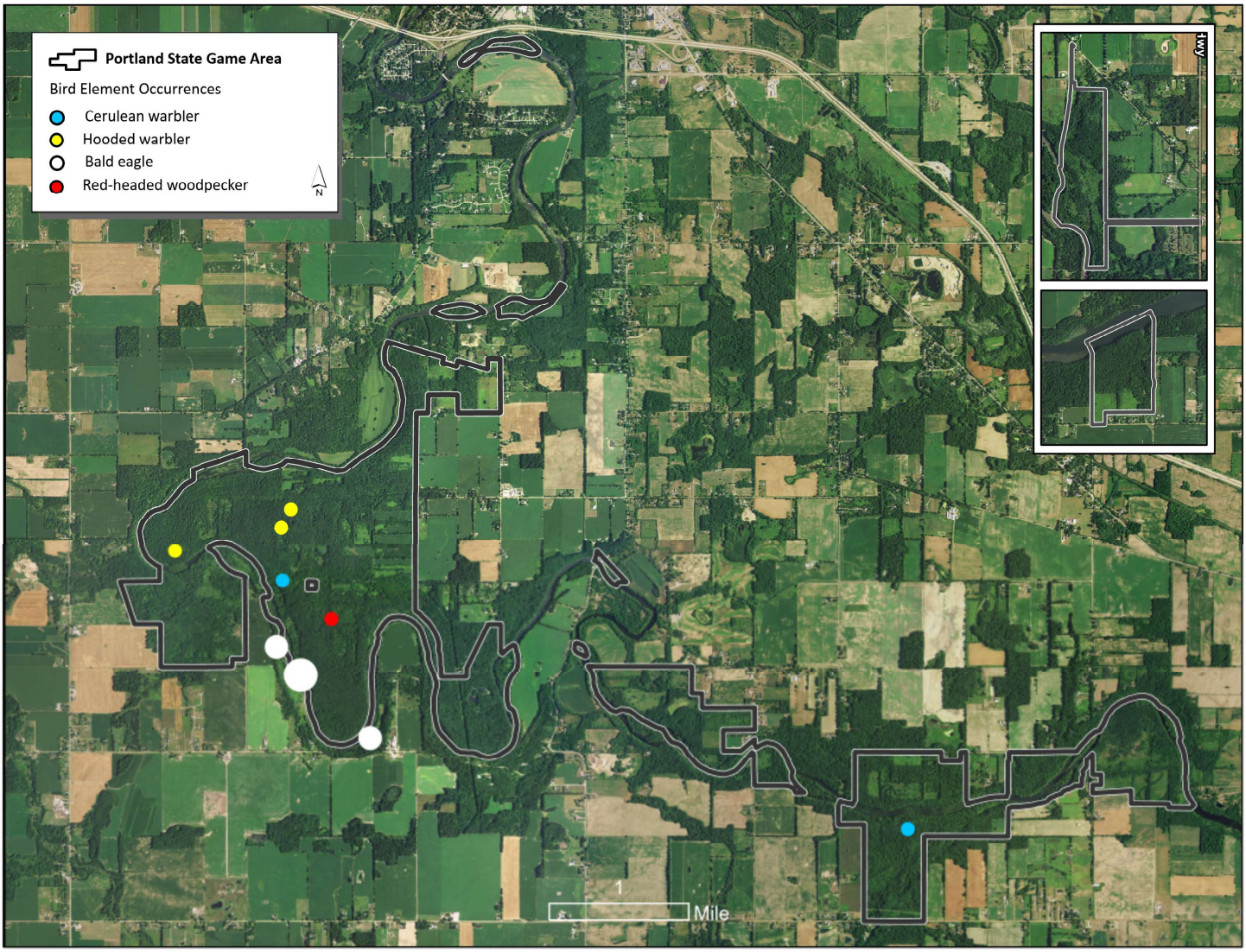


Figure 25. Location of rare bird element occurrences in Portland State Game Area.

Rare Insects

We documented a total of 90 occurrences of 6 bumble bee species during the two-hour survey, including a new occurrence of black and gold bumble bee (*Bombus auricomus,* State Special Concern) at Portland SGA (EO ID 24525) (Figure 26). We encountered 10 blooming wildflower species during the bumble bee surveys including yarrow (*Achillea millefolium*), spotted knapweed (*Centaurea stoebe*), wild carrot (*Daucus carota*), daisy fleabane (*Erigeron annuus*), common St. John's-wort (*Hypericum perforatum*), wild-bergamot (*Monarda fistulosa*), stiff goldenrod (*Solidago rigida*), black-eyed Susan (*Rudbeckia hirta*), early goldenrod (*Solidago juncea*), and mullein (*Verbascum thapsus*). However, bumble bees were primarily utilizing a single species, wild-bergamot (Table 11).

Table 11. Bumble bee species and associated plant species observed during meander surveys at Portland State Game Area in 2021.

Species	Spotted Knapweed	Wild-bergamot	Total
Bombus auricomus	0	6	6
Bombus bimaculatus	0	33	33
Bombus citrinus	0	1	1
Bombus griseocollis	0	4	4
Bombus impatiens	1	41	42
Bombus vagans	0	4	4
Total	**1**	**89**	**90**

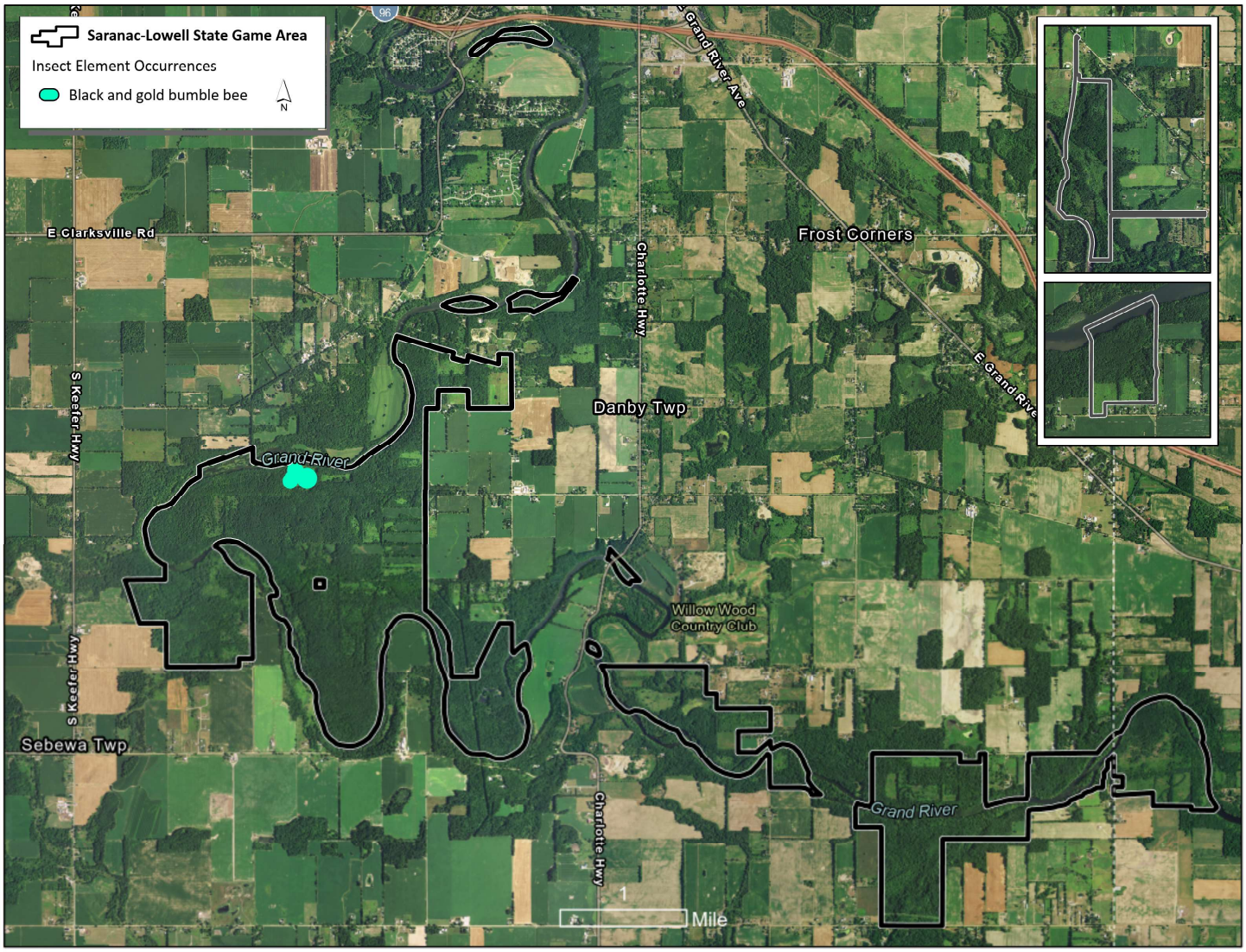


Figure 26. Location of rare insect element occurrence in Portland State Game Area.

Habitat at the location of bumble bee surveys in Portland State Game Area. Photo by Logan Rowe.

A new record for black and gold bumble bee was documented during meander surveys. Photo by Logan Rowe.

We did not observe any regal fern borer (*Papaipema speciosissima)* during blacklight surveys in 2020 at Portland SGA. However, survey efforts yielded *P. furcata* (ash-tip borer moth), *P. rigida* (rigid sunflower borer moth), and *P. pterisii* (bracken fern borer moth). While none of these species are listed in Michigan, *P. furcata* is listed as Critically Imperiled (S1) in Pennsylvania and *P. rigida* is listed as Imperiled (S2) in Indiana. Future studies to evaluate the status of these two species in Michigan are merited.

We conducted Odonate surveys at five sites along the Grand River over three days in 2021. We sampled for dragonflies at each site for approximately 90 minutes, during sunny, calm, dry conditions. No rare Odonates, nor other rare species were observed. We observed common dragonflies, such as the widow skimmer (*Libellula luctuosa*) and Eastern amberwing (*Perithemis tenera*), green darner (*Anax junius*) as well as common damselflies, such as the American rubyspot (*Hetaerina americana*) and bluets (e.g., *Enallagma cyathigerum*).

Though no rare Odonates were documented, several common species were observed, such as bluets (top photo) and green darners (bottom photo). Photos by Aaron P. Kortenhoven.

Rare Reptiles and Amphibians

Targeted reptile and amphibian surveys in the Portland SGA in 2021 documented six common reptile and amphibian species but no rare species. The six common reptile and amphibian species detected included gray treefrog (*Hyla versicolor*), bullfrog (*Lithobates catesbeianus*), northern leopard frog (*Lithobates pipiens*), northern map turtle (*Graptemys geographica*), painted turtle (*Chrysemys picta*), and eastern gartersnake (*Thamnophis sirtalis sirtalis*). Ecologists also observed large groups of spiny softshell turtles (*Apalone spinifera*) in the Grand River during natural community surveys. One eastern box turtle was observed in the game area incidentally during ecological surveys conducted by MNFI in 2015 (MNFI 2022). This turtle was observed in the northern portion of the game area near the river along the edge of a young, somewhat degraded dry-mesic southern forest stand and an abandoned agricultural field. This eastern box turtle observation represents a new EO of this species (EO ID 25912) and is currently the only rare herptile EO in the game area (Figure 27).

One Eastern box turtle was documented in Portland SGA in 2015. Photo by Jesse M. Lincoln.

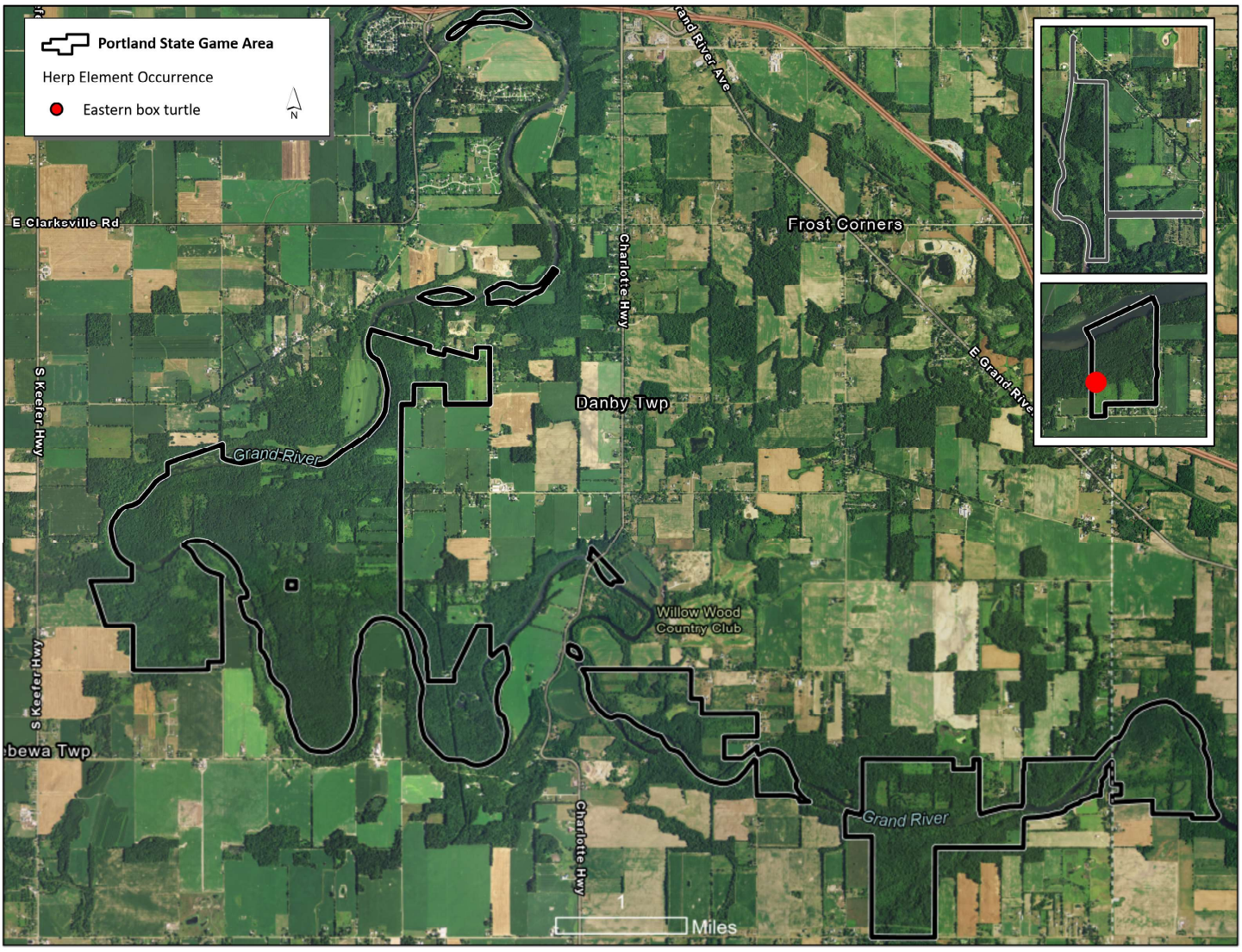


Figure 27. Location of rare reptile element occurrence in Portland State Game Area.

Discussion

As stated within the DNR's Master Plan for Portland SGA, this public land was acquired because wildlife habitat and hunting recreation are declining as urbanization, industrialization, and intensive farming are contributing to the destruction of such habitats. The game area occurs in an area of expansive agriculture and offers a large variety of recreational opportunities including hunting, fishing, and non-consumptive uses. Because of the prevailing land use in the surrounding area, Portland State Game Area is now effectively an island of natural cover in a sea of agricultural development. It contains several areas of high-quality natural communities as well as populations of rare plants and animals.

The concentration of rare plants in Portland SGA is unusual for southern Michigan, especially relative to the game area's small size, the degraded and fragmented nature of the landscape surrounding the game area, and the impacts of Euro-colonization over the past two centuries. Many of the species at Portland SGA are rare within the state and rare across their range. Often, a species that is designated as rare in Michigan, may be common in other areas of its range and its rarity in Michigan is an artifact of fewer populations at the edge of the species' range. Other species that are rare in Michigan, are rare or infrequent across their range and these are generally at increased risk of substantial decline. Many of the rare plant species in Portland SGA are rare and declining in Michigan and across their range. Therefore, the concentration of rare plants and high-quality natural communities within which they occur are especially important conservation targets.

Additionally, some of the rare plant species are found only in a narrow area around Portland SGA and nowhere else in Michigan and these represent the last populations in the state. The last known population fire pink in Michigan occurs only within the boundaries Portland SGA. Rock cress has a substantial population in the game area but the only known populations occur along the Grand River and nowhere else in Michigan. Only one population of snow trillium has been documented outside of Portland SGA in the past 23 years and other populations have disappeared over the past several decades. False mullien is known only from two locations outside of the game area. The populations of rare plants in Portland SGA represent important genetic material for the long-term health of their species. Considerable attention should be afforded the populations of rare plant species and long-term planning

Populations of rare plants, such as snow trillium (left) and fire pink (right), are a critical feature of Portland SGA. Photos by Jesse M. Lincoln.

should focus on protecting and enhancing these critical populations through holistic management. The approach for conserving rare plants should be centered around establishing conservation corridors to connect areas of high-quality natural communities, treating invasive species within those corridors, and applying fire to specific areas within those corridors.

Protecting and managing representative natural communities is critical to biodiversity conservation because native organisms are best adapted to environmental and biotic forces with which they have survived and evolved over millennia. Biodiversity is most easily and effectively protected by preventing high-quality sites from degrading, and invasive plants are much easier to eradicate when their populations are small and not yet well-established. Stewardship actions within the game area should focus on the highest quality examples of natural community types, especially those harboring populations of rare species, and work to improve connectivity between areas of high-quality habitat and populations of rare species by reducing invasive species. Generally, we recommend that management efforts to maintain ecological integrity and native biodiversity be focused within and around natural communities that provide potential habitat for numerous rare plant and animal species. To that end, we provide the following management recommendations for your consideration.

We believe the main management needs in order of importance are to: 1) establish corridors of natural cover to minimize forest fragmentation along the river and to connect the most important natural communities containing populations of rare species; 2) immediately develop a comprehensive approach to treating invasive species within the conservation corridor; 3) develop plans to apply prescribed fire; 4) investigate improving aquatic connectivity along the Grand River; 5) reduce deer browse pressure; and 6) monitor these activities to facilitate adaptive management.

Fundamentally, our primary recommendations are to minimize fragmentation of the highest quality forests, address serious infestations of invasive species, return fire to the landscape, and reduce the deleterious impacts of high browse pressure. The following discussion section has been organized around these management recommendations. In addition, based on our experience researching and surveying this game area, we provide recommendations for future survey needs.

The corridor of natural cover along the Grand River is a biodiversity hotspot and should be prioritized, protected, and improved with a conservation corridor. Photo by Jesse M. Lincoln.

Establishing Conservation Corridors

Forested riparian areas, such as Portland SGA, provide important wildlife habitat within regions of extensive agriculture. Many of the forests within the game area were logged and then cleared for agriculture. When the farms failed, the land was transferred to state ownership. The highest quality forests remaining in the game area correspond to areas that were partially logged but not converted into agriculture. Based on the ages of trees and the pattern of European colonization in the area, the forests at Portland SGA were logged in the late 1800s but the forests identified in this report as natural communities escaped intensive land clearing. Because they were spared intensive clearing, the forests tend to reflect descriptions of historic conditions: they have the lowest proportion of invasive species, the oldest trees, and the greatest concentration of rare taxa. The Okemos Hills mesic southern EO is an especially diverse example of the community type with numerous rare plants, including Michigan's largest documented populations of snow trillium, twinleaf, rock cress, and the last remaining population of fire pink. The plant diversity of the Okemos Hills can be partially attributed to the forest's land use history. In contrast, forests that were logged, cleared, farmed, and then reverted to forest are floristically depauperate in comparison with a much higher component of invasive species. The high-quality forests in Portland SGA tend to persist on the steepest slopes along the Grand River where agriculture was unfeasible.

Although the Portland SGA is relatively unfragmented compared to the surrounding landscape, anthropogenic disturbance has fragmented forests within the game area. The effects of forest fragmentation on native plants and animals and ecosystem processes are drastic (Heilman et al. 2002). Local population extinctions within fragments are accelerated by reduced habitat and population size. 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, which thrive in response to forest clearing (Brosofske et al. 2001, Heilman et al. 2002, Hewitt and Kellman 2004).

Activities that reduce the cover of mature forest or increase fragmentation will also reduce the value of Portland SGA to forest-interior nesting songbirds. These forests currently support populations of cerulean warbler and hooded warbler and provide potential nesting habitat for prothonotary warbler, yellow-throated warbler, and other Neotropical migrant songbirds. These species occur in landscapes dominated by mature deciduous forest and breeding populations require large block of forests to remain viable.

Forest management at Portland SGA will ideally consider the habitat needs of the rare songbird species we documented. Since the species of rare songbird found

Land that has been cleared and reverted to forest tends to have a high degree of invasive species, such as multiflora rose (foreground). The boundary between cleared (flat foreground) and uncleared (sloping background) can be stark, as above. Photo by Jesse M. Lincoln.

Large populations of sago pondweed (*Stuckenia pectinata*) form extensive colonies in the Grand River. It is a native aquatic plant that provides food for myriad wildlife and is sensitive to poor water quality. Photo by Jesse M. Lincoln.

at Portland SGA rely on mature forest, we recommend allowing the existing mature stands of riparian forest and adjacent upland forest to continue to mature. The maintenance and expansion of mature forest blocks within the game area will likely benefit rare avian species, and other forest-interior species, such as Acadian flycatcher and wood thrush. We observed brown-headed cowbirds at 45% of the point-count stations surveyed. Cowbirds thrive in fragmented landscapes and reduce the reproductive success of forest-breeding songbirds through nest parasitism (Robinson et al. 1995). Efforts to stop forest fragmentation around the highest quality forest may reduce brown-headed cowbird nest parasitism of important species.

Fragmentation, particularly logging of forests can also have deleterious impacts on aquatic systems. The potential for timber harvest to affect stream habitat and aquatic animal communities is well documented. Increases in sedimentation or sediment load in rivers because of timber harvest can lead to changes in abundance of fish (Broadmeadow and Nisbet 2004; Nislow and Lowe 2006) and invertebrates (Noel et al. 1986; Brown et al. 1997). Changes in the amount of instream coarse woody debris caused by timber harvest can affect stream habitat (Smokorowski and Pratt 2007) and aquatic animal communities (Bilby and Ward 1991). Maintaining forested buffers on slopes along streams is a commonly used and important practice to mitigate impacts to aquatic species and ecosystems (Olson et al. 2007). Portland SGA currently provides natural riparian buffers along approximately 6 river miles. These buffers of natural cover contribute to the viability of the six listed mussel populations within the SGA and federally endangered snuffbox populations downstream of the SGA. Excessive sedimentation can impact native mussel populations directly (Brim-Box and Mossa 1999) and also indirectly if habitat for fish hosts is degraded by runoff generated by timber harvest.

Preventing fragmentation and degradation of forests with vernal pools is also a critical aspect of protecting water quality and conserving biodiversity. Vernal pools are generally isolated, temporary pools of water or wetlands in shallow depressions, primarily in forested ecosystems (Thomas et al. 2010). Usually small, vernal pools contribute important ecosystem services including nutrient cycling, water storage and infiltration, groundwater

recharge, and flood control (Colburn 2004, Calhoun and deMaynadier 2008). In addition, vernal pools provide important benefits for maintaining water quality by absorbing sheet flow and sequestering nutrients and solids. Vernal pools also provide critical habitat for over 550 animal species in the northeastern U.S., including amphibians and invertebrates specialized for life in vernal pools and dependent on these unique habitats for their survival (Colburn 2004). Vernal pools occasionally occur within the forests of Portland SGA. Forest management should focus on protecting the vernal pool's physical basin. Additionally, fragmentation of forests surrounding the vernal pool should be avoided to maintain habitat for associated species, particularly pond-breeding amphibians (Calhoun and deMaynadier 2008). Activities that disturb soils or tree canopies within and immediately adjacent to vernal pools should be avoided. Construction of roads and landings and applications of chemicals (e.g., herbicides and/or pesticides) should be avoided within a 30-meter (100 ft) buffer around a vernal pool and minimized within the adjacent landscape (Calhoun and deMaynadier 2008). The State of Michigan's sustainable soil and water quality practices for forest lands recommend maintaining at least 70% canopy closure within a 30-meter (100 ft or 1.4 ac) buffer, preventing disturbance within the vernal pool depression, and limiting use of heavy equipment within 30 meters (100 ft) of the pool to when the soil is dry or frozen to avoid creating deep ruts (Michigan DNR and Michigan DEQ 2018).

Large, mature woodlands host much more native biodiversity than small, young forests and are particularly important for conservation. Forest patches that have been forested for a long time will likely be more-species rich than recently established forests, due to slow immigration of forest specialists (Valdes et al. 2020). Dampening the effects of forest fragmentation can be realized by preventing timber harvest in large blocks of mature, contiguous forest and adjacent stands. The delivery of some ecosystem services may decline with low habitat connectivity within an intensively managed landscape matrix. Additionally, older forest patches have higher topsoil carbon storage potential. Loss of area, increased isolation, and greater exposure to human disturbances along forest edges are leading causes of biodiversity loss and reduced ecosystem functioning (Haddad et al. 2015, Valdes et al 2020).

Because high-quality forests occupy only 4.3% of the game area, we recommend the five following specific actions to minimize fragmentation and degradation of these important forests that host the most native biodiversity: 1) prevent logging in the high-quality forest EOs; 2) establish no-cut buffers of 400 ft from the Grand River and 150 ft from natural community EOs; 3) prevent impacts to small order streams and vernal pools by establishing 100 ft buffers adjacent to them; 4) avoid dramatically altering canopy of forests over 100 years old, particularly if they are near documented high-quality natural communities; and 5) treat invasive species within areas of the highest quality, mature forest; within areas where timber harvest is planned; and along the river.

We have created a potential conservation corridor overlay to help planning efforts protect the riparian system, high-quality natural communities, and populations of rare species (Figure 28). This conservation corridor includes the most sensitive areas where we recommend avoiding intensive silvicultural actions, such as clearcutting. Within the conservation area, we suggest focusing management actions on promoting ecological integrity such as treatment of invasive species and application of prescribed fire. The conservation area covers habitat within 400 ft of the river, based on recommendations for rivers designated as Natural Rivers. It includes high-quality natural communities with an added 150 ft buffer to minimize degradation of the communities. Within the conservation corridor we have also included the oldest forested stands that have mature trees and limited invasive species. These stands do not currently meet MNFI standards for inclusion as natural communities EOs but could potentially become EOs over time with sustained restoration activity.

Areas of mature trees with minimal invasive species were included in the conservation corridor. Photo by Aaron P. Kortenhoven.

We suggest the elimination of timber harvest in the high-quality natural communities to best protect populations of rare species, native biodiversity, and slow the increasing dominance of invasive species. Selective timber harvest would still be a critical part of forest improvement outside of the high-quality communities. Management objectives would ideally focus on removing weedy species and retaining more desirable species of trees, such as bur oak, chinquapin oak, blue ash, and other long-lived species. Ideally, any work within the conservation corridor will focus on improving habitat for rare species, primarily by maintaining semi-closed canopy conditions, reducing invasive species, and avoiding damaging soil. We suggest that eliminating intensive timber harvest surrounding high-quality forests will have the greatest positive impact on protecting aquatic systems and will also help limit forest fragmentation and will thereby most effectively protect native biodiversity – especially the numerous rare plant species. Treating invasive species within the conservation corridor and applying prescribed burns are management tools that are recommended for enhancing ecosystem services and promoting native biodiversity within the conservation area.

Informal trails are being built throughout the game area. In some cases, these bisect populations of rare plants. We urge managers to work with stakeholders that are developing these trails to keep them away from the highest quality forests and away from populations of rare species We suggest that trails be strategically developed to serve as burn breaks in areas where prescribed fire is going to be prioritized.

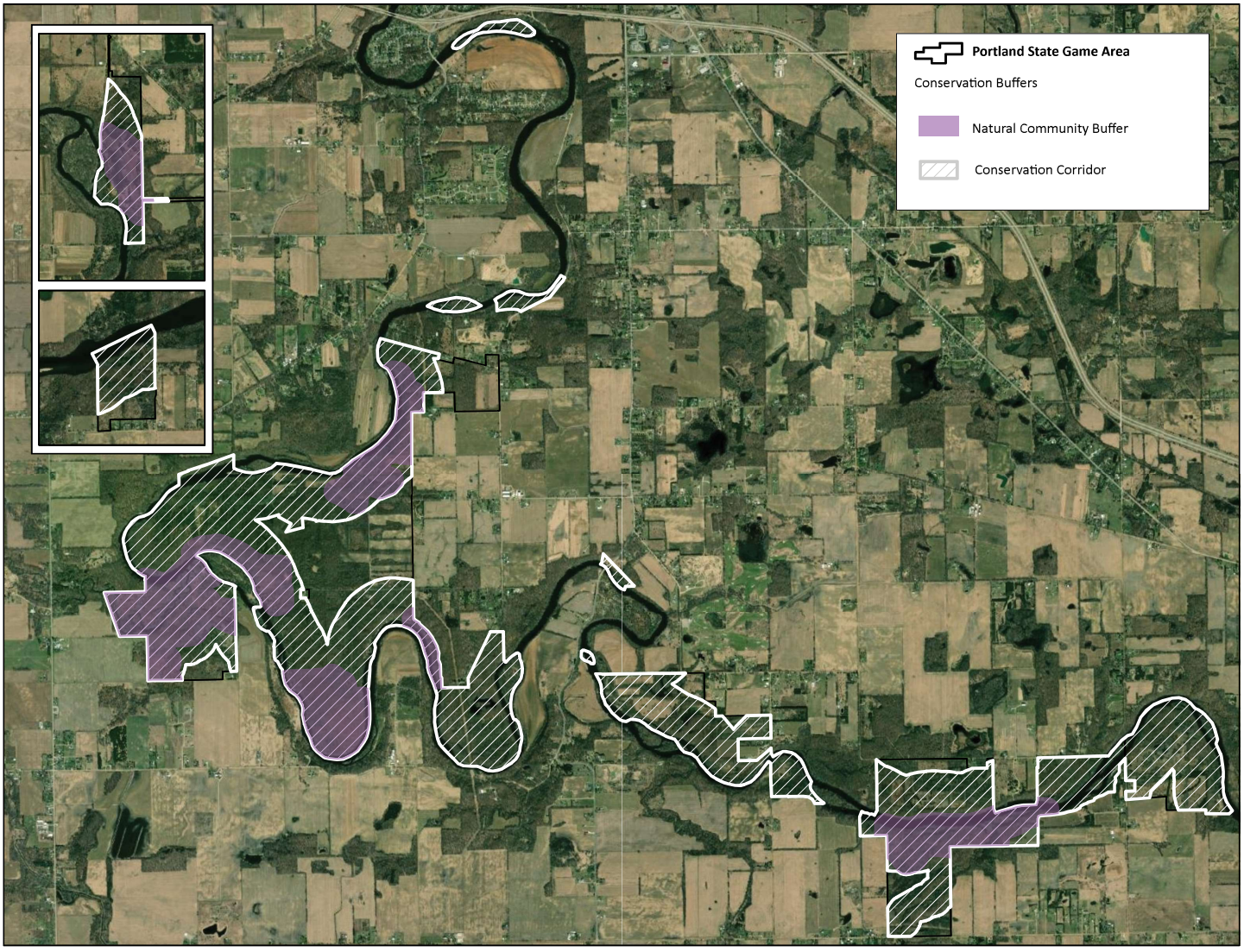


Figure 28. Proposed conservation corridor for Portland State Game Area. To prevent habitat fragmentation, protect ecological integrity of the highest quality forests, limit erosion along the river, and protect populations of rare species, we suggest that land managers avoid timber management in Tier 1 (purple) conservation areas around natural community EOs. Tier 2 conservation areas (white) are zones where we propose promoting connectivity between natural community EOs through treatment of invasive species and implementing forestry actions that avoid negatively impacting aoils and maintain long-lived canopy species. The conservation corridor includes uplands 400 ft from the edge of the Grand River; natural community element occurrences buffered by 150 ft; and other areas of forest that were not cleared for agriculture and have the highest restoration potential.

Addressing Invasive Species

Invasive species in Portland SGA pose an extreme threat to the composition of the most important natural communities and also to populations of rare plant species. The treatment of invasive species in Portland SGA should be a top priority for land managers. We encourage a multi-faceted approach to invasive species control and emphasize that improving the landscape context surrounding the high-quality natural areas is critical. Initial treatment of widespread invasive species should be focused in the highest quality forests, zones along the river impacted by lesser celandine (*Ficaria verna*), and easily accessible populations (near roads or parking areas) of the most severe invasive species. Ideally, treatment would be implemented by someone trained on the identification of rare species and the location of rare plant populations clearly communicated. Treatment should be implemented by someone familiar with applying herbicides in sensitive areas and wetlands.

Reducing background levels of the most pernicious invasive species across the game area will reduce the propagule pressure for these invaders. This is best facilitated by preventing additional habitat fragmentation around high-quality natural communities. Ideally, invasive species management at Portland SGA will focus on reducing infestations of invasive species that are impacting high-quality natural communities and populations of rare species within the conservation corridor. Addressing priority invasive species outside of the highest quality natural communities will ideally focus on the most problematic species, such as lesser celandine along the entirety of the river, narrow-leaved cat-tail in Sebewa Creek Shrub-Carr, and dame's rocket and autumn olive in Okemos Hills.

Evaluating and treating invasive species in forests should occur before modifying the canopy composition. Timber harvest in fragmented landscapes can significantly increase populations of invasive species, especially oriental bittersweet, autumn olive, multiflora rose, and Japanese barberry. Forest management in the absence of addressing invasive species can detrimentally affect attributes of regenerating forest ecosystems. The rapid expansion of invasive species following logging operations can decrease biological diversity, forest productivity, water and soil quality, and contributions to the carbon cycle (Pimentel et al. 2000).

Within Portland SGA, the most pronounced concern from invasive species occurs within forests along the Grand River where lesser celandine has erupted over the past decade. Some areas that had no noticeable levels of lesser celandine during the 2015 MiFI surveys now have dense carpets along the river in early spring. These infestations have the potential to rapidly expand beyond the river's edge and engulf the entirety of the forest. We suggest that control of this species is an important priority for the DNR within Portland SGA. Lesser celandine emerges before most native spring ephemerals and may be readily controlled because herbicide can be applied with minimal risk of collateral damage. However, snow trillium and rock cress occupy the same habitat along the river, emerge early, and are therefore especially at risk from early-season herbicide applications. We strongly urge the DNR to mount an immediate response to this invasive species to address this pressing threat. Instructional YouTube videos developed by The Woodland Steward clearly outline the threat posed by this species and offer potential approaches to treatment.

Lesser celandine is one of the more concerning invasive species to arise in recent decades. Photo by Jesse M. Lincoln.

Additional species of concern, particularly in Okemos Hills are dame's rocket, autumn olive, and multiflora rose. Autumn olive and multiflora rose are also problematic in the Lyon's Shrub-Carr and Sebewa Creek Shrub-Carr, as are narrow-leaved cat-tail and reed canary grass. Newly establishing invasive species should be removed as rapidly as possible before they infest additional areas. Treating invasive species is difficult and expensive, and severe infestations can take several years to control. Partnerships with organizations such as Mid-Michigan Cooperative Invasive Species Management Area will be important for reducing existing populations and addressing new populations.

According to the DNR's original Portland State Game Area Master Plan from 1977, the state purchased 190,600 trees and shrubs and planted them throughout the game area. Autumn olive and multiflora rose were the main species of shrub planted. To reduce the risk of introducing problematic species, we recommend that the DNR immediately instate a policy to plant only species known to be native to the region, particularly focusing on Michigan genotypes when available.

The invasive dame's rocket (above) has 4 petals which helps distinguish it from the native phlox which has 5 petals. Photo by Jesse M. Lincoln.

Autumn olive has formed thickets in portions of Okemos Hills (above). Invasive shrubs like autumn olive and multiflora rose are especially problematic in portions of all of the high-quality natural communities in Portland State Game Area, likely a result of having been planted by the DNR. Jesse M. Lincoln

Fire as an Ecological Process

Based on historic descriptions of the natural communities on the local landscape, known occupancy of Indigenous Peoples along the Grand River, and current plant communities supporting species characteristic of fire-adapted communities, we presume that fire was likely a regular disturbance component across the game area and surrounding landscape. Within the game area, fire was likely most prevalent along the east and north side of the Grand River. Currently, much of the landscape is fire suppressed with minimal fires prescribed. Application of prescribed fire in priority areas within the game area will reduce mesophytic species in forested ecosystems and promote herbaceous diversity. This approach will be beneficial to the documented natural communities, populations of some rare plants, and numerous game species.

MNFI has developed a model for assessing prescribed fire needs on state game areas (Cohen et al. 2021). This model suggests that portions of the uplands in Portland SGA would benefit from application of prescribed fire (Figure 29). We recommend focusing prescribed fire efforts in two different project areas in Portland SGA. The first project area contains two polygons of Okemos Hills (Stands 21 and 26) and Stand 24 in Compartment 3. The second project area is Stand 72 in Compartment 2. Land managers could consider developing permanent project areas and applying prescribed fire with the goals of reducing dominance of mesophytes like red maple in the subcanopy but also to increase herbaceous vegetation and promote recruitment of oaks.

As part of the effort to reintroduce fire to the landscape, we suggest the development of permanent project boundaries using existing features such as roads, trails, and the river that can act as burn breaks to facilitate burning across ecotones and avoid creating new burn breaks near sensitive areas, especially along slopes. Developing large, permanent burn units that include younger forests adjacent to the highest quality natural communities can also provide

Old red cedar stumps in the northcentral polygon of Okemos Hills frequently had charing. Historic fires may have been a critical disturbance maintaining populations of rare plants. Fire should be cautiously implemented in Portland SGA, focusing on Stands 21, 24, and 26 in comparment 3 and Stand 72 in Compartment 2. Photo by Jesse M. Lincoln.

forests with various age classes, a common goal of wildlife managers that is often achieved through timber harvest alone. Because application of fire produces regrowth that is favored by deer, including areas of low-quality forest in the prescribed burn can help prevent deleterious browse within high-quality forests after a burn. Fire-suppressed forests sites in Portland SGA should be burned using a fire-return interval of one to two burns per decade.

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. Refugia, or unburned areas, are critical if prescribed burning needs to occur during spring and early summer. We suggest burning relatively large areas and striving 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. Areas adjacent to where fire is applied can be burned in alternate years or seasons to protect populations of fire-sensitive species. This allows unburned units to serve as refugia for immobile invertebrates and slow-moving herptile species.

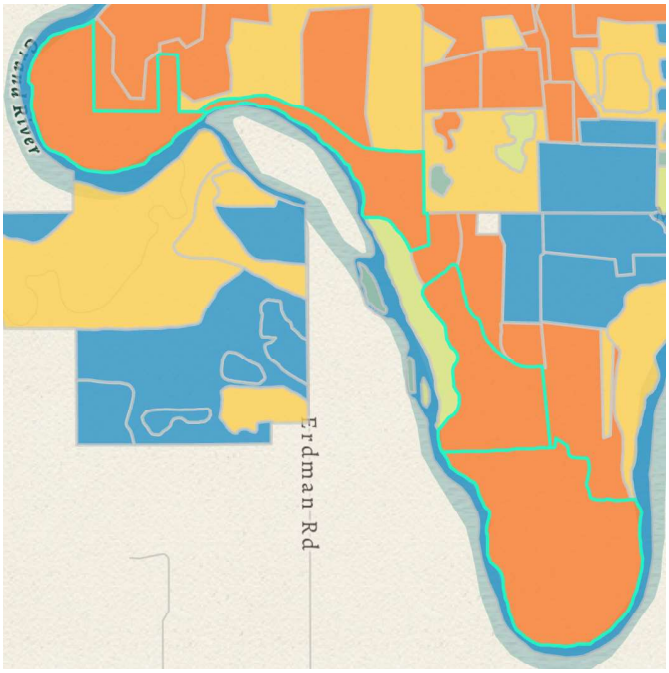


Figure 30. One of the priority prescribed fire areas with target stands highlighted.

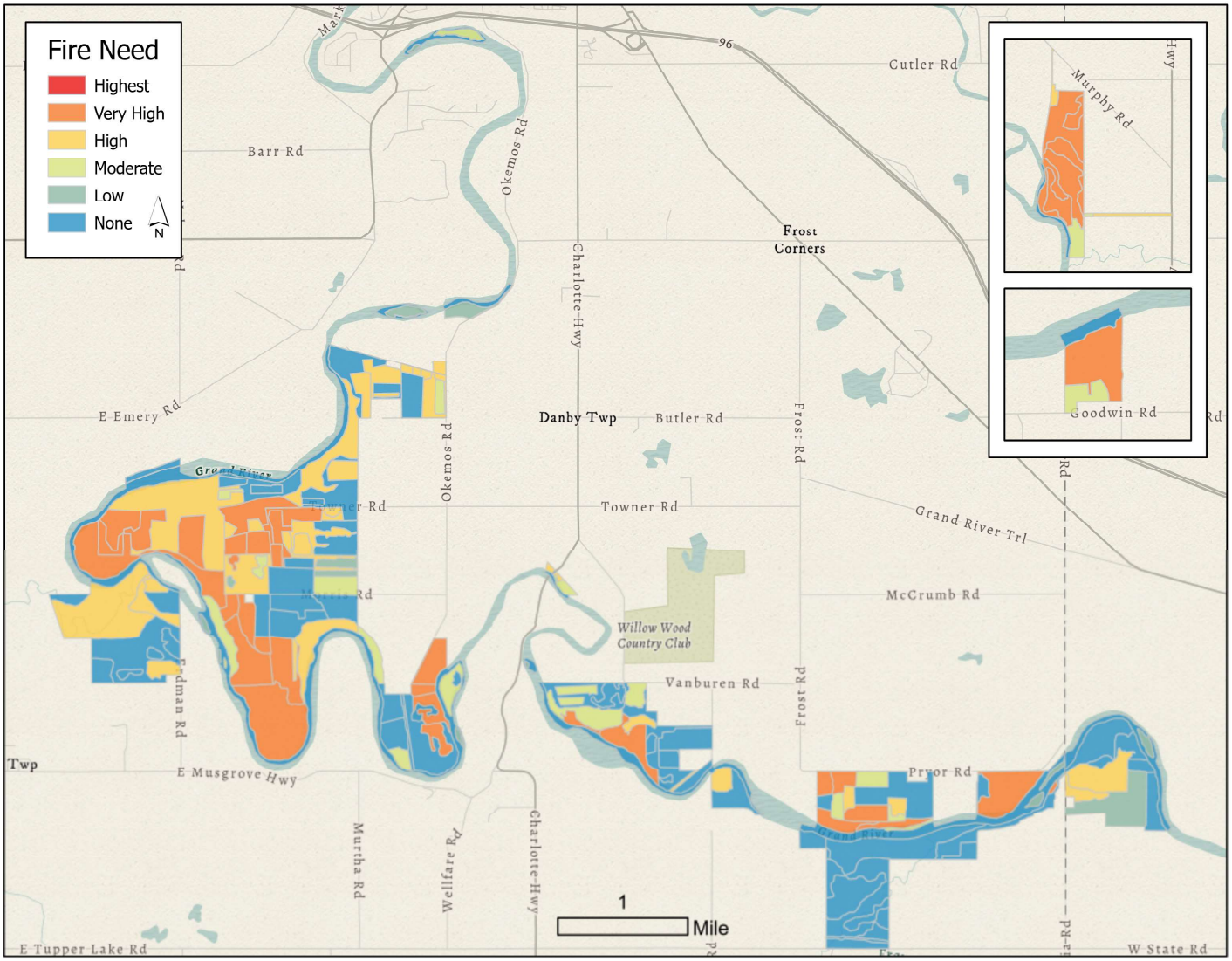


Figure 29. Prescribed fire needs assessment of Portland State Game Area. Extensive areas of the game area have a "high" or "very high" need, especially north and east of the Grand River.

Aquatic System Considerations

The unusually large number of shells of multiple species found at mussel survey sites within Portland SGA, along with low numbers of live individuals, could be indicative of a recent die-off. Potential causes of a mass mortality event could include disease, toxic effect from a past spill or other point source discharge, invasive species, sudden heavy siltation of the river bottom, or other impacts. High densities of Asian clam shells were found throughout the Grand River along the Portland SGA. Dense populations of Asian clam can produce ammonia levels that exceed lethal levels for unionid mussels, causing large die-offs (Cherry et al. 2005). Additionally, unionid mussel die-offs have been linked to viral infections (e.g. densovirus (Parvoviridae; Densovirinae)) and these may be an indirect consequence of these and other interacting ecological stressors (Richard et al. 2020).

Several dams on the Grand River restrict anadromous fishes from migrating into the upper stretches of the Grand River. Webber Dam is located 15.5 river miles (25 km) downstream of Portland SGA and Portland Dam is located 8.5 river miles (13.7 km) downstream of Portland SGA. The two dams are barriers to movement of potential fish hosts of listed mussels, including the federally endangered snuffbox, between Portland SGA and the rest of the lower Grand River where snuffbox populations have been documented. Though there is a fish ladder at both dams, fish passage structures have been shown on average to be only partially successful; 61.7 % for salmonid upstream passage but only 21.1 % for non-salmonid upstream passage (Noonan et al. 2012). Unionid mussel in the Grand River rely on non-salmonid fishes as hosts and additional improvements in connectivity would benefit mussel populations. In cases where dam removal is not feasible there may still be opportunities to improve fish passage by modifying existing structures. For example, on the Grand River in Ontario, Canada, enlarging and repositioning fishway entrances resulted in a 2.6 to 3 fold increase in fishway use for pumpkinseed (*Lepomis gibbosus*) (Bunt 2001), a species that acts a host for many species of mussels in Michigan. Specific management recommendations that would benefit the Grand River watershed, including the reach through Portland SGA, are outlined in Hanshue 2017.

An unusually large number of empty mussel shells and relatively low numbers of live mussels was found. Potential causes for mussel die-offs should be investigated. Photo by Jesse M. Lincoln.

Dampening Deer Browse Pressure

High deer browse pressure was noted as a threat throughout the high-quality forests of Portland SGA and has caused significant impacts to the floristic composition and structure of forests throughout the game area. Through preferential browse, deer impact the successional trajectory of forested ecosystems and reduce abundance and diversity of herbaceous vegetation. The intensity of browsing can prevent the persistence or establishment of seedling or sapling banks of palatable species (Peterson and Pickett 1995, Peterson 2000). In southern Michigan forested ecosystems, oak species, for example, are often preferentially browsed imparting a competitive advantage to red maple. In addition to the drastic changes to tree recruitment, deer browsing has had perhaps even greater impact to forb and shrub diversity and composition of mesic forests. Most herbaceous species and shrubs never outgrow the "molar zone" or zone of susceptibility to deer browse (Waller and Alverson 1997). With a single bite, deer can remove the leaf area and reproductive structures of long-lived understory forbs, many of which lack the capacity for regrowth after grazing. Many spring herbs require decades to fully recover from deer browsing. Herbaceous plants constitute 87% of deer's summer diet. Concentrated herbivory can lead to reduction of forb reproductive capacity and plant size, and even to the local extirpation of sensitive plants (Alverson et al. 1988, Rooney and Dress 1997, Augustine and Frelich 1998, Rooney and Waller 2003). Indirect impacts of deer herbivory can include the reduction of pollinators and seed dispersers of sensitive herbs (Waller and Alverson 1997, Ruhren and Handel 2003). Close to a hundred threatened and endangered plants are jeopardized by deer herbivory (Miller et al. 1992). As a result of high deer densities across the Great Lakes, forb species that are less palatable and more tolerant of grazing have increased in frequency in mesic forests (i.e., ferns, graminoids, and club mosses): deer browse has contributed to the region-wide homogenization of forest flora and reduction of floral genetic diversity (Van Deelen et al. 1996, Rooney and Dress 1997, Augustine and Frelich 1998, Rooney 2001, Rooney and Waller 2003, Kraft et al. 2004).

A primary threat to floristic diversity of mesic forest is from deer herbivory: as mentioned above, deer herbivory alters species composition and structure. Changes in herbaceous plant size and reproductive rates can be dramatically reversed when deer herbivory is eliminated for only two years (Augustine and Frelich 1998). Recovery of seedling and sapling banks (advanced regeneration) requires a more prolonged period of low deer densities (8 to 10 years with < 4 deer/km) (Whitney 1984, Alverson et al. 1988, Tester et al. 1997, Rooney et al. 2000). Conservation and restoration of mesic forest communities require active long-term management of deer at low densities, which may be realized through increased hunting pressure (Alverson et al. 1988, Augustine and Frelich 1998) and/or culling. In addition, eliminating managed wildlife openings within forested landscapes and allowing early-successional forest to succeed to more long-lived forest will diminish suitable habitat for deer and reduce deer populations across the landscape. Approximately 10% of Portland SGA is open uplands that could be converted to forested or savanna habitat. In addition to reducing deer browse pressure, this type of restoration effort can help dampen forest fragmentation, increase the riparian buffer along the Grand River, and increase the carbon sequestration capacity and climate resiliency of the game area. Where resources are available, deer exclosure fences may be erected around concentrations of sensitive herbs and susceptible saplings. Establishment of exclosures around populations of rare plant populations should be evaluated.

Within the game area, excessive deer herbivory has locally caused an absence of plant life in the ground cover and understory. Photo by Aaron P. Kortenhoven.

Monitoring

We strongly encourage the implementation of targeted monitoring of populations of rare species documented within the Portland SGA. Rare plant populations are collapsing under heavy browse of white-tailed deer, expansion of invasive species, and isolation of populations. We also suggest the implementation of continual 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 Portland SGA.

Considering the importance of this game area for neotropical migrants birds and the potential impacts of forest fragmentation, monitoring for rare songbirds should also be continued. We recommend conducting songbird point counts periodically to monitor use of the game area by rare avian species and track overall forest bird assemblages. Periodic surveys would allow us to determine if the stands where rare birds were observed continue to be occupied. We recommend conducting periodic songbird point counts to monitor forest songbird activity in the game area and to track rare forest warblers. These surveys will give insight into their long-term viability in a fragmented landscape. Periodic surveys will also allow us to determine if the forests where cerulean warbler and hooded warbler are observed continue to be occupied by these species. Periodic surveys will provide an opportunity to monitor the effects of management actions on these and other species of management interest. Although we did not detect yellow-throated warbler in 2021, suitable nesting habitat was observed, and this species has been recorded along the Grand River in this area every year since 2013 (Ebird data base 2022).

Effects of fire will need to be carefully monitored and plans should be adjusted based on the response of vegetation and rare species. Because fire affects the plant species that are growing at the time of application, varying the timing of the fires will need to be carefully considered. The exact seasonality, frequency, and conditions under which burns take place should be continually evaluated by local experts familiar with the site and with consideration for the rare species that occupy burn units. Periodic surveys would also provide an opportunity to monitor the effects of management actions on these and other species of management interest.

Many of the rare species that we targeted are cryptic by nature and difficult to document in a single field season. Portland SGA contains suitable habitat for the rare insect species that were surveyed for and we recommend continued surveys for these targets. Additionally, many rare species within the game area are facing serious decline and may increase in abundance following active stewardship of priority natural areas. Limiting habitat fragmentation, reducing populations of invasive species, and applying prescribed fires can increase populations of rare species. Continual monitoring is a valuable tool to evaluate the success of ecosystem stewardship on populations of rare species and should be an integral part of adaptive managment of this unique public land.

Mussel populations in the Grand River should be monitored to clairfy population trends. Photo by Peter J. Badra.

Conclusions

Game areas in Michigan are culturally significant public lands that are also extremely important for protecting our natural heritage. These lands harbor native biodiversity, protect significant populations of rare species, promote ecological resilience of the landscape, maintain ecological integrity of important examples of our natural communities, and provide myriad ecosystem services to the public. In this report, scientists from Michigan Natural Features Inventory provided detailed information about several important high-quality natural communities and populations of rare species documented during surveys in Portland SGA. To maintain the game area's critical contribution to biodiversity protection, resilience, ecological integrity, and ecosystems services, we recommend that managers prioritize actions around sustaining the unique natural communities and populations of rare species by establishing a conservation corridor to prevent forest fragmentation around the high-quality natural communities; developing a collaborative, sustained, and continual approach to treating invasive species within the conservation corridor; applying prescribed fire to fire-adapted natural communities; reducing deer browse pressure; improving connectivity of aquatic systems; and monitoring these stewardship actions to inform future management actions.

The Portland State Game Area substantially contributes to the native biodiversity of the region and supports a high concentration of populations of rare plants. The surrounding landscape has had an extreme loss of natural cover over the past two centuries and remaining networks of green infrastructure like the Portland SGA are critical for the protection of native biodiversity. As natural cover of the surrounding landscape continues to decrease and degrade on private lands, public lands such as Portland SGA will have an expanding role in the protection of Michigan's natural heritage and quality of life for its residents. It is big enough to protect native biodiversity, offer myriad recreational opportunities, and maintain the critical access to hunting, fishing, and trapping for which it was purchased. The importance of Portland SGA as both a reservoir of biodiversity and an access point for citizens to experience that nature will only grow with the passage of time. However, in order for the natural and cultural assets of Portland SGA to persist, prompt and decisive stewardship must be implemented and sustained to address the threats to native biodiversity that jeopardize the natural heritage it harbors.

Compared to public land, private land offers very little in the way of protective habitat for native biodiversity. The contrast is especially stark around Portland State Game Area (left side of the river) and the surrounding fragmented private land (right side of the river). Photo by Jesse M. Lincoln.

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Appendix 1. Conservation metrics for Freyer Creek Woods mesic southern forest (EO ID 20441 pg 27).

Frayer Creek Forest
Practitioner: Jesse Lincoln
Portland SGA

11/11/2015

Conservatism-Based Metrics:

Total Mean C:	4.2
Native Mean C:	4.5
Total FQI:	46.2
Native FQI:	47.6
Adjusted FQI:	43.3
% C value 0:	9.9
% C value 1-3:	22.3
% C value 4-6:	54.5
% C value 7-10:	13.2
Native Tree Mean C:	4.4
Native Shrub Mean C:	4.3
Native Herbaceous Mean C:	4.6

Physiognomy Metrics:

Tree:	20	16.50%
Shrub:	15	12.40%
Vine:	4	3.30%
Forb:	60	49.60%
Grass:	3	2.50%
Sedge:	10	8.30%
Rush:	0	0%
Fern:	9	7.40%
Bryophyte:	0	0%

Species Richness:

Total Species:	121	
Native Species:	112	92.60%
Non-native Species:	9	7.40%

Duration Metrics:

Annual:	4	3.30%
Perennial:	114	94.20%
Biennial:	3	2.50%
Native Annual:	4	3.30%
Native Perennial:	106	87.60%
Native Biennial:	2	1.70%

Species Wetness:

Mean Wetness:	1.3
Native Mean Wetness:	1.3

Appendix 2. Plant species observed in Freyer Creek Woods mesic southern forest (EO ID 20441 pg 27).

Scientific Name	Common Name	Acronym	Native?	C	W
Acer rubrum	red maple	ACERUB	native	1	0
Acer saccharinum	silver maple	ACESAI	native	2	-3
Acer saccharum	sugar maple	ACESAU	native	5	3
Agrimonia gryposepala	tall agrimony	AGRGRY	native	2	3
Alliaria petiolata	**garlic mustard**	**ALLPET**	**non-native**	**0**	**3**
Allium tricoccum	wild leek	ALLTRI	native	5	3
Anemone quinquefolia	wood anemone	ANEQUI	native	5	3
Arisaema triphyllum	jack-in-the-pulpit	ARITRI	native	5	0
Asarum canadense	wild-ginger	ASACAN	native	5	5
Athyrium filix-femina	lady fern	ATHFIL	native	4	0
Berberis thunbergii	**japanese barberry**	**BERTHU**	**non-native**	**0**	**3**
Caltha palustris	marsh-marigold	CALPAR	native	6	-5
Cardamine concatenata	cut-leaved toothwort	CARCON	native	5	3
Cardamine diphylla	two-leaved toothwort	CARDIP	native	5	3
Cardamine douglassii	pink spring cress	CARDOU	native	6	-3
Carex albursina	sedge	CXALBU	native	5	5
Carex bromoides	sedge	CXBROM	native	6	-3
Carex grayi	sedge	CXGRAY	native	6	-3
Carex hirtifolia	sedge	CXHIRI	native	5	3
Carex laxiflora	sedge	CXLAXF	native	8	0
Carex muskingumensis	sedge	CXMUSK	native	6	-5
Carex pedunculata	sedge	CXPEDU	native	5	3
Carex pensylvanica	sedge	CXPENS	native	4	5
Carex plantaginea	sedge	CXPLAN	native	8	5
Carex woodii	sedge	CXWOOD	native	8	3
Carya cordiformis	bitternut hickory	CARCOR	native	5	0
Celtis occidentalis	hackberry	CELOCC	native	5	0
Cicuta maculata	water hemlock	CICMAC	native	4	-5
Claytonia virginica	spring-beauty	CLAVIR	native	4	3
Cornus alternifolia	alternate-leaved dogwood	CORALT	native	5	3
Corylus americana	hazelnut	CORAMA	native	5	3
Cryptotaenia canadensis	honewort	CRYCAN	native	2	0
Cystopteris tenuis	fragile fern	CYSTEN	native	5	5
Dicentra canadensis	squirrel-corn	DICCAN	native	7	5
Dicentra cucullaria	dutchmans-breeches	DICCUC	native	7	5
Dryopteris carthusiana	spinulose woodfern	DRYCAR	native	5	-3
Elaeagnus umbellata	**autumn-olive**	**ELAUMB**	**non-native**	**0**	**3**
Elymus hystrix	bottlebrush grass	ELYHYS	native	5	3
Elymus virginicus	virginia wild-rye	ELYVIR	native	4	-3
Enemion biternatum	false rue-anemone	ENEBIT	native	8	0
Epifagus virginiana	beech-drops	EPIVIR	native	10	5
Equisetum arvense	common horsetail	EQUARV	native	0	0
Equisetum hyemale	scouring rush	EQUHYE	native	2	0
Erythronium americanum	yellow trout lily	ERYAME	native	5	5
Euonymus obovatus	running strawberry-bush	EUOOBO	native	5	3
Eurybia macrophylla	big-leaved aster	EURMAC	native	4	5
Fagus grandifolia	american beech	FAGGRA	native	6	3
Ficaria verna	**lesser celandine**	**FICVER**	**non-native**	**0**	**-3**
Floerkea proserpinacoides	false mermaid	FLOPRO	native	7	0
Fraxinus americana	white ash	FRAAME	native	5	3
Fraxinus pennsylvanica	red ash	FRAPEN	native	2	-3
Fraxinus quadrangulata	blue ash	FRAQUA	native	8	3
Galium aparine	annual bedstraw	GALAPA	native	0	3
Galium triflorum	fragrant bedstraw	GALTRR	native	4	3

Appendix 2, (continued). Plant species observed in Freyer Creek Woods mesic southern forest (EO ID 20441 pg 27).

Scientific Name	Common Name	Acronym	Native?	C	W
Geranium maculatum	wild geranium	GERMAC	native	4	3
Geranium robertianum	herb robert	GERROB	native	3	3
Geum canadense	white avens	GEUCAN	native	1	0
Geum vernum	spring avens	GEUVER	native	4	3
Hackelia virginiana	beggars lice	HACVIR	native	1	3
Hepatica acutiloba	sharp-lobed hepatica	HEPACU	native	8	5
Heracleum maximum	cow-parsnip	HERMAX	native	3	-3
Hesperis matronalis	**dames rocket**	**HESMAT**	**non-native**	**0**	**3**
Homalosorus pycnocarpos	narrow-leaved spleenwort	HOMPYC	native	10	0
Hydrophyllum canadense	canada waterleaf	HYDCAE	native	7	0
Hydrophyllum virginianum	virginia waterleaf	HYDVIR	native	4	0
Juglans nigra	black walnut	JUGNIG	native	5	3
Laportea canadensis	wood nettle	LAPCAN	native	4	-3
Lilium michiganense	michigan lily	LILMIC	native	5	-3
Lindera benzoin	spicebush	LINBEN	native	7	-3
Lonicera maackii	**amur honeysuckle**	**LONMAA**	**non-native**	**0**	**5**
Lonicera morrowii	**morrow honeysuckle**	**LONMOR**	**non-native**	**0**	**3**
Lysimachia nummularia	**moneywort**	**LYSNUM**	**non-native**	**0**	**-3**
Maianthemum racemosum	false spikenard	MAIRAC	native	5	3
Menispermum canadense	moonseed	MENCAE	native	5	0
Mitella diphylla	bishops-cap	MITDIP	native	8	3
Onoclea sensibilis	sensitive fern	ONOSEN	native	2	-3
Ostrya virginiana	ironwood; hop-hornbeam	OSTVIR	native	5	3
Persicaria virginiana	jumpseed	PERVIR	native	4	0
Phlox divaricata	wild blue phlox	PHLDIV	native	5	3
Phytolacca americana	pokeweed	PHYAME	native	2	3
Platanus occidentalis	sycamore	PLAOCC	native	7	-3
Podophyllum peltatum	may-apple	PODPEL	native	3	3
Polygonatum pubescens	downy solomon seal	POLPUB	native	5	5
Polystichum acrostichoides	christmas fern	POLACR	native	6	3
Populus grandidentata	big-tooth aspen	POPGRA	native	4	3
Prunus serotina	wild black cherry	PRUSER	native	2	3
Prunus virginiana	choke cherry	PRUVIR	native	2	3
Quercus macrocarpa	bur oak	QUEMAC	native	5	3
Quercus muehlenbergii	chinquapin oak	QUEMUE	native	5	3
Quercus rubra	red oak	QUERUB	native	5	3
Ranunculus abortivus	small-flowered buttercup	RANABO	native	0	0
Ranunculus hispidus	swamp buttercup	RANHIS	native	5	0
Ribes americanum	wild black currant	RIBAME	native	6	-3
Ribes cynosbati	prickly or wild gooseberry	RIBCYN	native	4	3
Rosa multiflora	**multiflora rose**	**ROSMUL**	**non-native**	**0**	**3**
Rubus allegheniensis	common blackberry	RUBALL	native	1	3
Rubus occidentalis	black raspberry	RUBOCC	native	1	5
Sambucus racemosa	red-berried elder	SAMRAC	native	3	3
Sanguinaria canadensis	bloodroot	SANCAA	native	5	3
Sanicula odorata	black snakeroot	SANODO	native	2	0
Smilax hispida	bristly greenbrier	SMIHIS	native	5	0
Solidago caesia	bluestem goldenrod	SOLCAE	native	6	3
Solidago flexicaulis	zigzag goldenrod	SOLFLE	native	6	3
Solidago gigantea	late goldenrod	SOLGIG	native	3	-3
Sphenopholis intermedia	slender wedgegrass	SPHINT	native	4	0
Staphylea trifolia	bladdernut	STATRI	native	9	0
Symphyotrichum cordifolium	heart-leaved aster	SYMCOR	native	4	5
Symphyotrichum lateriflorum	calico aster	SYMLAT	native	2	0

Appendix 2, (continued). Plant species observed in Freyer Creek Woods mesic southern forest (EO ID 20441 pg 27).

Scientific Name	Common Name	Acronym	Native?	C	W
Symphyotrichum ontarionis	lake ontario aster	SYMONT	native	6	0
Symplocarpus foetidus	skunk-cabbage	SYMFOE	native	6	-5
Thelypteris palustris	marsh fern	THEPAL	native	2	-3
Tilia americana	basswood	TILAME	native	5	3
Toxicodendron radicans	poison-ivy	TOXRAD	native	2	0
Trillium grandiflorum	common trillium	TRIGRA	native	5	3
Ulmus americana	american elm	ULMAME	native	1	-3
Urtica dioica	stinging nettle	URTDIO	native	1	0
Viola canadensis	canada violet	VIOCAN	native	5	3
Viola pubescens	yellow violet	VIOPUB	native	4	3
Viola rostrata	long-spurred violet	VIOROS	native	6	3
Viola sororia	common blue violet	VIOSOR	native	1	0
Vitis riparia	river-bank grape	VITRIP	native	3	0

Appendix 3. Combined conservation metrics for two of the four polygons of Okemos Hills mesic southern forest (EO ID 24985 pg 31).

Okemos Hills - combined 08/24/2021
Portland SGA
Practitioner: Jesse M. Lincoln

Conservatism-Based Metrics:

Total Mean C:	4.3
Native Mean C:	4.6
Total FQI:	52.8
Native FQI:	54.2
Adjusted FQI:	44.1
% C value 0:	11.9
% C value 1-3:	20.5
% C value 4-6:	52.3
% C value 7-10:	15.2
Native Tree Mean C:	4.5
Native Shrub Mean C:	4.5
Native Herbaceous Mean C:	4.7

Physiognomy Metrics:

Tree:	31	20.50%
Shrub:	15	9.90%
Vine:	6	4%
Forb:	78	51.70%
Grass:	9	6%
Sedge:	6	4%
Rush:	0	0%
Fern:	6	4%
Bryophyte:	0	0%

Species Richness:

Total Species:	151	
Native Species:	139	92.10%
Non-native Species:	12	7.90%

Duration Metrics:

Annual:	5	3.30%
Perennial:	141	93.40%
Biennial:	5	3.30%
Native Annual:	4	2.60%
Native Perennial:	131	86.80%
Native Biennial:	4	2.60%

Species Wetness:

Mean Wetness:	2.4
Native Mean Wetness:	2.3

Appendix 4. Plant species observed in Okemos Hills mesic southern forest (EO ID 24985 pg 31).

Common Name	Scientific Name	Acronym	Native?	C	W
box-elder	*Acer negundo*	ACENEG	native	0	0
black maple	*Acer nigrum; a. saccharum*	ACENIG	native	4	3
red maple	*Acer rubrum*	ACERUB	native	1	0
silver maple	*Acer saccharinum*	ACESAI	native	2	-3
sugar maple	*Acer saccharum*	ACESAU	native	5	3
yellow giant hyssop	*Agastache nepetoides*	AGANEP	native	5	3
white snakeroot	*Ageratina altissima*	AGEALT	native	4	3
garlic mustard	***Alliaria petiolata***	**ALLPET**	**non-native**	**0**	**3**
wild leek	*Allium tricoccum*	ALLTRI	native	5	3
field garlic	***Allium vineale***	**ALLVIN**	**non-native**	**0**	**3**
hog-peanut	*Amphicarpaea bracteata*	AMPBRA	native	5	0
canada anemone	*Anemone canadensis*	ANECAN	native	4	-3
thimbleweed	*Anemone virginiana*	ANEVIR	native	3	3
small pussytoes	*Antennaria howellii*	ANTHOW	native	2	5
spreading dogbane	*Apocynum androsaemifolium*	APOAND	native	3	5
wild-ginger	*Asarum canadense*	ASACAN	native	5	5
common milkweed	*Asclepias syriaca*	ASCSYR	native	1	5
ebony spleenwort	*Asplenium platyneuron*	ASPPLA	native	2	3
japanese barberry	***Berberis thunbergii***	**BERTHU**	**non-native**	**0**	**3**
ohio horse mint	*Blephilia ciliata*	BLECIL	native	7	5
rock cress	*Boechera dentata*	BOEDEN	native	9	5
smooth bank cress	*Boechera laevigata*	BOELAE	native	5	5
harebell	*Campanula rotundifolia*	CAMROT	native	6	3
cut-leaved toothwort	*Cardamine concatenata*	CARCON	native	5	3
two-leaved toothwort	*Cardamine diphylla*	CARDIP	native	5	3
pink spring cress	*Cardamine douglassii*	CARDOU	native	6	-3
sedge	*Carex albursina*	CXALBU	native	5	5
sedge	*Carex cephaloidea*	CXCEPD	native	5	3
sedge	*Carex hirtifolia*	CXHIRI	native	5	3
sedge	*Carex laxiflora*	CXLAXF	native	8	0
sedge	*Carex pensylvanica*	CXPENS	native	4	5
sedge	*Carex sprengelii*	CXSPRE	native	5	0
blue-beech	*Carpinus caroliniana*	CARCAO	native	6	0
bitternut hickory	*Carya cordiformis*	CARCOR	native	5	0
pignut hickory	*Carya glabra*	CARGLA	native	5	3
shagbark hickory	*Carya ovata*	CAROVA	native	5	3
blue cohosh	*Caulophyllum thalictroides*	CAUTHA	native	5	5
oriental bittersweet	***Celastrus orbiculatus***	**CELORB**	**non-native**	**0**	**5**
hackberry	*Celtis occidentalis*	CELOCC	native	5	0
alternate-leaved dogwood	*Cornus alternifolia*	CORALT	native	5	3
flowering dogwood	*Cornus florida*	CORFLO	native	8	3
honewort	*Cryptotaenia canadensis*	CRYCAN	native	2	0
fragile fern	*Cystopteris protrusa*	CYSPRO	native	5	3
fragile fern	*Cystopteris tenuis*	CYSTEN	native	5	5
mullein-foxglove	*Dasistoma macrophylla*	DASMAC	native	10	3
beak grass	*Diarrhena obovata*	DIAOBO	native	9	-3
broad-leaved panic grass	*Dichanthelium latifolium*	DICLAT	native	5	3
autumn-olive	***Elaeagnus umbellata***	**ELAUMB**	**non-native**	**0**	**3**
riverbank wild-rye	*Elymus riparius*	ELYRIP	native	8	-3
silky wild-rye	*Elymus villosus*	ELYVIL	native	5	3
virginia wild-rye	*Elymus virginicus*	ELYVIR	native	4	-3
false rue-anemone	*Enemion biternatum*	ENEBIT	native	8	0
scouring rush	*Equisetum hyemale*	EQUHYE	native	2	0
robins-plantain	*Erigeron pulchellus*	ERIPUL	native	5	3

Appendix 4 (continued). Plant species observed in Okemos Hills mesic southern forest (EO ID 24985 pg 31).

Common Name	Scientific Name	Acronym	Native?	C	W
white trout lily	*Erythronium albidum*	ERYALB	native	7	3
yellow trout lily	*Erythronium americanum*	ERYAME	native	5	5
running strawberry-bush	*Euonymus obovatus*	EUOOBO	native	5	3
flowering spurge	*Euphorbia corollata*	EUPCOR	native	4	5
american beech	*Fagus grandifolia*	FAGGRA	native	6	3
nodding fescue	*Festuca subverticillata*	FESSUB	native	5	3
lesser celandine	***Ficaria verna***	**FICVER**	**non-native**	**0**	**-3**
white ash	*Fraxinus americana*	FRAAME	native	5	3
blue ash	*Fraxinus quadrangulata*	FRAQUA	native	8	3
annual bedstraw	*Galium aparine*	GALAPA	native	0	3
white wild licorice	*Galium circaezans*	GALCIR	native	4	3
shining bedstraw	*Galium concinnum*	GALCON	native	5	3
huckleberry	*Gaylussacia baccata*	GAYBAC	native	7	3
wild geranium	*Geranium maculatum*	GERMAC	native	4	3
white avens	*Geum canadense*	GEUCAN	native	1	0
spring avens	*Geum vernum*	GEUVER	native	4	3
kentucky coffee-tree	*Gymnocladus dioicus*	GYMDIO	native	9	3
beggars lice	*Hackelia virginiana*	HACVIR	native	1	3
witch-hazel	*Hamamelis virginiana*	HAMVIR	native	5	3
woodland sunflower	*Helianthus divaricatus*	HELDIV	native	5	5
round-lobed hepatica	*Hepatica americana*	HEPAME	native	6	5
cow-parsnip	*Heracleum maximum*	HERMAX	native	3	-3
dames rocket	***Hesperis matronalis***	**HESMAT**	**non-native**	**0**	**3**
prairie alum root	*Heuchera richardsonii*	HEURIC	native	8	3
virginia waterleaf	*Hydrophyllum virginianum*	HYDVIR	native	4	0
clustered-leaved tick-trefoil	*Hylodesmum glutinosum*	HYLGLU	native	5	5
twinleaf	*Jeffersonia diphylla*	JEFDIP	native	9	3
black walnut	*Juglans nigra*	JUGNIG	native	5	3
red-cedar	*Juniperus virginiana*	JUNVIR	native	3	3
tall lettuce	*Lactuca canadensis*	LACCAN	native	2	3
wood nettle	*Laportea canadensis*	LAPCAN	native	4	-3
michigan lily	*Lilium michiganense*	LILMIC	native	5	-3
indian-tobacco	*Lobelia inflata*	LOBINF	native	0	3
morrow honeysuckle	***Lonicera morrowii***	**LONMOR**	**non-native**	**0**	**3**
false spikenard	*Maianthemum racemosum*	MAIRAC	native	5	3
starry false solomon-seal	*Maianthemum stellatum*	MAISTE	native	5	0
big-leaf sandwort	*Moehringia macrophylla*	MOEMAC	native	10	5
slender satin grass	*Muhlenbergia tenuiflora*	MUHTEN	native	8	5
star-of-bethlehem	***Ornithogalum nutans***	**ORNNUT**	**non-native**	**0**	**5**
hairy sweet-cicely	*Osmorhiza claytonii*	OSMCLI	native	4	3
smooth sweet-cicely	*Osmorhiza longistylis*	OSMLON	native	3	3
ironwood; hop-hornbeam	*Ostrya virginiana*	OSTVIR	native	5	3
virginia creeper	*Parthenocissus quinquefolia*	PARQUI	native	5	3
wood-betony	*Pedicularis canadensis*	PEDCAN	native	10	3
jumpseed	*Persicaria virginiana*	PERVIR	native	4	0
lopseed	*Phryma leptostachya*	PHRLEP	native	4	3
sycamore	*Platanus occidentalis*	PLAOCC	native	7	-3
bluegrass	***Poa nemoralis***	**POANEM**	**non-native**	**0**	**3**
may-apple	*Podophyllum peltatum*	PODPEL	native	3	3
solomon-seal	*Polygonatum biflorum*	POLBIF	native	4	3
christmas fern	*Polystichum acrostichoides*	POLACR	native	6	3
cottonwood	*Populus deltoides*	POPDEL	native	1	0
self-heal	*Prunella vulgaris*	PRUVUL	native	0	0
wild black cherry	*Prunus serotina*	PRUSER	native	2	3

Appendix 4 (continued). Plant species observed in Okemos Hills mesic southern forest (EO ID 24985 pg 31).

Common Name	Scientific Name	Acronym	Native?	C	W
choke cherry	*Prunus virginiana*	PRUVIR	native	2	3
bracken fern	*Pteridium aquilinum*	PTEAQU	native	0	3
white oak	*Quercus alba*	QUEALB	native	5	3
bur oak	*Quercus macrocarpa*	QUEMAC	native	5	3
chinquapin oak	*Quercus muehlenbergii*	QUEMUE	native	5	3
red oak	*Quercus rubra*	QUERUB	native	5	3
black oak	*Quercus velutina*	QUEVEL	native	6	5
small-flowered buttercup	*Ranunculus abortivus*	RANABO	native	0	0
prickly or wild gooseberry	*Ribes cynosbati*	RIBCYN	native	4	3
pasture rose	*Rosa carolina*	ROSCAR	native	4	3
multiflora rose	***Rosa multiflora***	**ROSMUL**	**non-native**	**0**	**3**
black raspberry	*Rubus occidentalis*	RUBOCC	native	1	5
black-eyed susan	*Rudbeckia hirta*	RUDHIR	native	1	3
red-berried elder	*Sambucus racemosa*	SAMRAC	native	3	3
bloodroot	*Sanguinaria canadensis*	SANCAA	native	5	3
black snakeroot	*Sanicula odorata*	SANODO	native	2	0
sassafras	*Sassafras albidum*	SASALB	native	5	3
fire pink	*Silene virginica*	SILVIR	native	10	5
upright carrion-flower	*Smilax ecirrata*	SMIECI	native	6	5
bristly greenbrier	*Smilax hispida*	SMIHIS	native	5	0
bluestem goldenrod	*Solidago caesia*	SOLCAE	native	6	3
zigzag goldenrod	*Solidago flexicaulis*	SOLFLE	native	6	3
hairy goldenrod	*Solidago hispida*	SOLHIS	native	3	5
slender wedgegrass	*Sphenopholis intermedia*	SPHINT	native	4	0
bladdernut	*Staphylea trifolia*	STATRI	native	9	0
heart-leaved aster	*Symphyotrichum cordifolium*	SYMCOR	native	4	5
calico aster	*Symphyotrichum lateriflorum*	SYMLAT	native	2	0
yellow-pimpernel	*Taenidia integerrima*	TAEINT	native	8	5
early meadow-rue	*Thalictrum dioicum*	THADIO	native	6	3
basswood	*Tilia americana*	TILAME	native	5	3
hedge-parsley	***Torilis japonica***	**TORJAP**	**non-native**	**0**	**3**
poison-ivy	*Toxicodendron radicans*	TOXRAD	native	2	0
common trillium	*Trillium grandiflorum*	TRIGRA	native	5	3
snow trillium	*Trillium nivale*	TRINIV	native	10	3
american elm	*Ulmus americana*	ULMAME	native	1	-3
slippery elm	*Ulmus rubra*	ULMRUB	native	2	0
culvers-root	*Veronicastrum virginicum*	VERVIR	native	8	0
maple-leaved viburnum	*Viburnum acerifolium*	VIBACE	native	6	5
yellow violet	*Viola pubescens*	VIOPUB	native	4	3
common blue violet	*Viola sororia*	VIOSOR	native	1	0
river-bank grape	*Vitis riparia*	VITRIP	native	3	0
prickly-ash	*Zanthoxylum americanum*	ZANAME	native	3	3

Appendix 5. Conservation metrics for Sebewa Woods mesic southern forest (EO ID 24984 pg 39).

Sebewa Woods 08/20/2020
Practitioner: Jesse M. Lincoln

Conservatism-Based Metrics:

Total Mean C:	4.2
Native Mean C:	4.5
Total FQI:	31.4
Native FQI:	32.8
Adjusted FQI:	43.8
% C value 0:	5.4
% C value 1-3:	23.2
% C value 4-6:	62.5
% C value 7-10:	8.9
Native Tree Mean C:	4.5
Native Shrub Mean C:	3.3
Native Herbaceous Mean C:	4.6

Physiognomy Metrics:

Tree:	13	23.20%
Shrub:	5	8.90%
Vine:	1	1.80%
Forb:	27	48.20%
Grass:	2	3.60%
Sedge:	6	10.70%
Rush:	0	0%
Fern:	2	3.60%
Bryophyte:	0	0%

Species Richness:

Total Species:	56	
Native Species:	53	94.60%
Non-native Species:	3	5.40%

Duration Metrics:

Annual:	3	5.40%
Perennial:	51	91.10%
Biennial:	2	3.60%
Native Annual:	3	5.40%
Native Perennial:	49	87.50%
Native Biennial:	1	1.80%

Species Wetness:

Mean Wetness:	2.1
Native Mean Wetness:	2

Appendix 6. Plant species observed in Sebewa Woods mesic southern forest (EO ID 24984 pg 39).

Common Name	Scientific Name	Acronym	Native?	C	W
black maple	*Acer nigrum; a. saccharum*	ACENIG	native	4	3
sugar maple	*Acer saccharum*	ACESAU	native	5	3
garlic mustard	***Alliaria petiolata***	**ALLPET**	**non-native**	**0**	**3**
wild leek	*Allium tricoccum*	ALLTRI	native	5	3
wood anemone	*Anemone quinquefolia*	ANEQUI	native	5	3
sedge	*Carex albursina*	CXALBU	native	5	5
sedge	*Carex gracillima*	CXGRAA	native	4	3
sedge	*Carex pedunculata*	CXPEDU	native	5	3
sedge	*Carex pensylvanica*	CXPENS	native	4	5
sedge	*Carex plantaginea*	CXPLAN	native	8	5
sedge	*Carex woodii*	CXWOOD	native	8	3
blue-beech	*Carpinus caroliniana*	CARCAO	native	6	0
bitternut hickory	*Carya cordiformis*	CARCOR	native	5	0
hackberry	*Celtis occidentalis*	CELOCC	native	5	0
enchanters-nightshade	*Circaea canadensis*	CIRCAN	native	2	3
spring-beauty	*Claytonia virginica*	CLAVIR	native	4	3
squirrel-corn	*Dicentra canadensis*	DICCAN	native	7	5
evergreen woodfern	*Dryopteris intermedia*	DRYINT	native	5	0
bottlebrush grass	*Elymus hystrix; hystrix patula*	ELYHYS	native	5	3
false rue-anemone	*Enemion biternatum*	ENEBIT	native	8	0
beech-drops	*Epifagus virginiana*	EPIVIR	native	10	5
yellow trout lily	*Erythronium americanum*	ERYAME	native	5	5
running strawberry-bush	*Euonymus obovatus*	EUOOBO	native	5	3
american beech	*Fagus grandifolia*	FAGGRA	native	6	3
white ash	*Fraxinus americana*	FRAAME	native	5	3
wild geranium	*Geranium maculatum*	GERMAC	native	4	3
spring avens	*Geum vernum*	GEUVER	native	4	3
beggars lice	*Hackelia virginiana*	HACVIR	native	1	3
dames rocket	***Hesperis matronalis***	**HESMAT**	**non-native**	**0**	**3**
spotted touch-me-not	*Impatiens capensis*	IMPCAP	native	2	-3
wood nettle	*Laportea canadensis*	LAPCAN	native	4	-3
cut grass	*Leersia oryzoides*	LEEORY	native	3	-5
ironwood; hop-hornbeam	*Ostrya virginiana*	OSTVIR	native	5	3
wild blue phlox	*Phlox divaricata*	PHLDIV	native	5	3
pokeweed	*Phytolacca americana*	PHYAME	native	2	3
clearweed	*Pilea pumila*	PILPUM	native	5	-3
may-apple	*Podophyllum peltatum*	PODPEL	native	3	3
christmas fern	*Polystichum acrostichoides*	POLACR	native	6	3
wild black cherry	*Prunus serotina*	PRUSER	native	2	3
white oak	*Quercus alba*	QUEALB	native	5	3
red oak	*Quercus rubra*	QUERUB	native	5	3
swamp buttercup	*Ranunculus hispidus*	RANHIS	native	5	0
prickly or wild gooseberry	*Ribes cynosbati*	RIBCYN	native	4	3
multiflora rose	***Rosa multiflora***	**ROSMUL**	**non-native**	**0**	**3**
black raspberry	*Rubus occidentalis*	RUBOCC	native	1	5
red-berried elder	*Sambucus racemosa*	SAMRAC	native	3	3
late figwort	*Scrophularia marilandica*	SCRMAR	native	5	3
calico aster	*Symphyotrichum lateriflorum*	SYMLAT	native	2	0
skunk-cabbage	*Symplocarpus foetidus*	SYMFOE	native	6	-5
basswood	*Tilia americana*	TILAME	native	5	3
poison-ivy	*Toxicodendron radicans*	TOXRAD	native	2	0
common trillium	*Trillium grandiflorum*	TRIGRA	native	5	3
american elm	*Ulmus americana*	ULMAME	native	1	-3
canada violet	*Viola canadensis*	VIOCAN	native	5	3
yellow violet	*Viola pubescens*	VIOPUB	native	4	3
common blue violet	*Viola sororia*	VIOSOR	native	1	0

Appendix 7. Conservation metrics for Lyon's Shrub-carr southern shrub-carr (EO ID 24242 pg 43).

Lyons Shrub-carr 09/20/2019
Practitioner: Jesse M. Lincoln

Conservatism-Based Metrics:

Total Mean C:	3.7
Native Mean C:	4.1
Total FQI:	32.5
Native FQI:	34.1
Adjusted FQI:	38.8
% C value 0:	13
% C value 1-3:	35.1
% C value 4-6:	41.6
% C value 7-10:	10.4
Native Tree Mean C:	3.3
Native Shrub Mean C:	3.7
Native Herbaceous Mean C:	4.3

Physiognomy Metrics:

Tree:	8	10.40%
Shrub:	12	15.60%
Vine:	5	6.50%
Forb:	35	45.50%
Grass:	8	10.40%
Sedge:	6	7.80%
Rush:	1	1.30%
Fern:	2	2.60%
Bryophyte:	0	0%

Species Richness:

Total Species:	77	
Native Species:	69	89.60%
Non-native Species:	8	10.40%

Duration Metrics:

Annual:	2	2.60%
Perennial:	74	96.10%
Biennial:	1	1.30%
Native Annual:	2	2.60%
Native Perennial:	66	85.70%
Native Biennial:	1	1.30%

Species Wetness:

Mean Wetness:	-2.3
Native Mean Wetness:	-2.6

Appendix 8. Plant species observed in Lyon's Shrub-carr southern shrub-carr (EO ID 24242 pg 43).

Common Name	Scientific Name	Acronym	Native?	C	W
redtop	***Agrostis gigantea***	**AGRGIG**	**non-native**	**0**	**-3**
creeping bent	***Agrostis stolonifera***	**AGRSTO**	**non-native**	**0**	**-3**
thimbleweed	*Anemone virginiana*	ANEVIR	native	3	3
groundnut	*Apios americana*	APIAME	native	3	-3
jack-in-the-pulpit	*Arisaema triphyllum*	ARITRI	native	5	0
swamp milkweed	*Asclepias incarnata*	ASCINC	native	6	-5
common milkweed	*Asclepias syriaca*	ASCSYR	native	1	5
japanese barberry	***Berberis thunbergii***	**BERTHU**	**non-native**	**0**	**3**
false nettle	*Boehmeria cylindrica*	BOECYL	native	5	-5
fringed brome	*Bromus ciliatus*	BROCIL	native	6	-3
sedge	*Carex hystericina*	CXHYST	native	2	-5
sedge	*Carex lacustris*	CXLACU	native	6	-5
sedge	*Carex leptalea*	CXLEPA	native	5	-5
sedge	*Carex sterilis*	CXSTER	native	10	-5
sedge	*Carex stricta*	CXSTRI	native	4	-5
blue-beech	*Carpinus caroliniana*	CARCAO	native	6	0
turtlehead	*Chelone glabra*	CHEGLB	native	7	-5
wood reedgrass	*Cinna arundinacea*	CINARU	native	7	-3
swamp thistle	*Cirsium muticum*	CIRMUT	native	6	-5
silky dogwood	*Cornus amomum*	CORAMO	native	2	-3
gray dogwood	*Cornus foemina*	CORFOE	native	1	0
red-osier	*Cornus sericea*	CORSER	native	2	-3
wild yam	*Dioscorea villosa*	DIOVIL	native	4	0
autumn-olive	***Elaeagnus umbellata***	**ELAUMB**	**non-native**	**0**	**3**
cinnamon willow-herb	*Epilobium coloratum*	EPICOL	native	3	-5
common horsetail	*Equisetum arvense*	EQUARV	native	0	0
boneset	*Eupatorium perfoliatum*	EUPPER	native	4	-3
joe-pye-weed	*Eutrochium maculatum*	EUTMAC	native	4	-5
red ash	*Fraxinus pennsylvanica*	FRAPEN	native	2	-3
rough bedstraw	*Galium asprellum*	GALASP	native	5	-5
yellow avens	*Geum aleppicum*	GEUALE	native	3	0
water-pennywort	*Hydrocotyle americana*	HYDAME	native	6	-5
spotted touch-me-not	*Impatiens capensis*	IMPCAP	native	2	-3
rush	*Juncus brachycephalus*	JUNBRP	native	7	-5
red-cedar	*Juniperus virginiana*	JUNVIR	native	3	3
cut grass	*Leersia oryzoides*	LEEORY	native	3	-5
spicebush	*Lindera benzoin*	LINBEN	native	7	-3
great blue lobelia	*Lobelia siphilitica*	LOBSIP	native	4	-3
common water horehound	*Lycopus americanus*	LYCAME	native	2	-5
northern bugle weed	*Lycopus uniflorus*	LYCUNI	native	2	-5
fringed loosestrife	*Lysimachia ciliata*	LYSCIL	native	4	-3
moneywort	***Lysimachia nummularia***	**LYSNUM**	**non-native**	**0**	**-3**
whorled loosestrife	*Lysimachia quadriflora*	LYSQUR	native	10	-5
swamp saxifrage	*Micranthes pensylvanica*	MICPEN	native	10	-5
white mulberry	***Morus alba***	**MORALB**	**non-native**	**0**	**3**
leafy satin grass	*Muhlenbergia mexicana*	MUHMEX	native	3	-3
virginia creeper	*Parthenocissus quinquefolia*	PARQUI	native	5	3
reed canary grass	***Phalaris arundinacea***	**PHAARU**	**non-native**	**0**	**-3**
timothy	***Phleum pratense***	**PHLPRA**	**non-native**	**0**	**3**
clearweed	*Pilea pumila*	PILPUM	native	5	-3
quaking aspen	*Populus tremuloides*	POPTRE	native	1	0
common mountain mint	*Pycnanthemum virginianum*	PYCVIR	native	5	-3
bur oak	*Quercus macrocarpa*	QUEMAC	native	5	3
wild black currant	*Ribes americanum*	RIBAME	native	6	-3

Appendix 8 (continued). Plant species observed in Lyon's Shrub-carr southern shrub-carr (EO ID 24242 pg 43).

Common Name	Scientific Name	Acronym	Native?	C	W
multiflora rose	***Rosa multiflora***	**ROSMUL**	**non-native**	**0**	**3**
dwarf raspberry	*Rubus pubescens*	RUBPUB	native	4	-3
water dock	*Rumex verticillatus*	RUMVER	native	7	-5
common arrowhead	*Sagittaria latifolia*	SAGLAT	native	4	-5
pussy willow	*Salix discolor*	SALDIS	native	1	-3
black snakeroot	*Sanicula odorata*	SANODO	native	2	0
bulrush	*Scirpus atrovirens*	SCIATV	native	3	-5
swamp goldenrod	*Solidago patula*	SOLPAT	native	6	-5
riddells goldenrod	*Solidago riddellii*	SOLRID	native	6	-5
bog goldenrod	*Solidago uliginosa*	SOLULI	native	4	-5
smooth swamp aster	*Symphyotrichum firmum*	SYMFIR	native	4	-3
calico aster	*Symphyotrichum lateriflorum*	SYMLAT	native	2	0
new england aster	*Symphyotrichum novae-angliae*	SYMNOV	native	3	-3
marsh fern	*Thelypteris palustris*	THEPAL	native	2	-3
basswood	*Tilia americana*	TILAME	native	5	3
poison-ivy	*Toxicodendron radicans*	TOXRAD	native	2	0
poison sumac	*Toxicodendron vernix*	TOXVER	native	6	-5
broad-leaved cat-tail	*Typha latifolia*	TYPLAT	native	1	-5
american elm	*Ulmus americana*	ULMAME	native	1	-3
missouri ironweed	*Vernonia missurica*	VERMIS	native	4	0
nannyberry	*Viburnum lentago*	VIBLEN	native	4	0
river-bank grape	*Vitis riparia*	VITRIP	native	3	0
golden alexanders	*Zizia aurea*	ZIZAUR	native	6	0

Appendix 9. Conservation metrics for Sebewa Creek Shrub-carr southern shrub-carr (EO ID 24243 pg 45).

Sebewa Shrub-Carr 08/20/2020
Practitioner: Jesse M. Lincoln

Conservatism-Based Metrics:

Total Mean C:	4
Native Mean C:	4.2
Total FQI:	41.6
Native FQI:	42.2
Adjusted FQI:	40.6
% C value 0:	9.3
% C value 1-3:	31.5
% C value 4-6:	46.3
% C value 7-10:	13
Native Tree Mean C:	4
Native Shrub Mean C:	3.6
Native Herbaceous Mean C:	4.4

Physiognomy Metrics:

Tree:	9	8.30%
Shrub:	20	18.50%
Vine:	5	4.60%
Forb:	50	46.30%
Grass:	9	8.30%
Sedge:	10	9.30%
Rush:	1	0.90%
Fern:	4	3.70%
Bryophyte:	0	0%

Species Richness:

Total Species:	108	
Native Species:	101	93.50%
Non-native Species:	7	6.50%

Duration Metrics:

Annual:	4	3.70%
Perennial:	103	95.40%
Biennial:	1	0.90%
Native Annual:	4	3.70%
Native Perennial:	96	88.90%
Native Biennial:	1	0.90%

Species Wetness:

Mean Wetness:	-2.3
Native Mean Wetness:	-2.4

Appendix 10. Plant species observed in Sebewa Creek Shrub-carr southern shrub-carr (EO ID 24243 pg 45).

Common Name	Scientific Name	Acronym	Native?	C	W
swamp agrimony	*Agrimonia parviflora*	AGRPAR	native	4	0
redtop	***Agrostis gigantea***	**AGRGIG**	**non-native**	**0**	**-3**
speckled alder	*Alnus incana; a. rugosa*	ALNINC	native	5	-3
hog-peanut	*Amphicarpaea bracteata*	AMPBRA	native	5	0
wood anemone	*Anemone quinquefolia*	ANEQUI	native	5	3
purplestem angelica	*Angelica atropurpurea*	ANGATR	native	6	-5
groundnut	*Apios americana*	APIAME	native	3	-3
swamp milkweed	*Asclepias incarnata*	ASCINC	native	6	-5
common milkweed	*Asclepias syriaca*	ASCSYR	native	1	5
fringed brome	*Bromus ciliatus*	BROCIL	native	6	-3
blue-joint	*Calamagrostis canadensis*	CALCAN	native	3	-5
sedge	*Carex hystericina*	CXHYST	native	2	-5
sedge	*Carex lacustris*	CXLACU	native	6	-5
sedge	*Carex pseudo-cyperus*	CXPSEU	native	5	-5
sedge	*Carex sterilis*	CXSTER	native	10	-5
sedge	*Carex stipata*	CXSTIP	native	1	-5
sedge	*Carex stricta*	CXSTRI	native	4	-5
blue-beech	*Carpinus caroliniana*	CARCAO	native	6	0
turtlehead	*Chelone glabra*	CHEGLB	native	7	-5
water hemlock	*Cicuta bulbifera*	CICBUL	native	5	-5
wood reedgrass	*Cinna arundinacea*	CINARU	native	7	-3
swamp thistle	*Cirsium muticum*	CIRMUT	native	6	-5
silky dogwood	*Cornus amomum*	CORAMO	native	2	-3
gray dogwood	*Cornus foemina*	CORFOE	native	1	0
red-osier	*Cornus sericea*	CORSER	native	2	-3
tick-trefoil	*Desmodium perplexum*	DESPER	native	5	5
panic grass	*Dichanthelium implicatum*	DICIMP	native	3	0
wild yam	*Dioscorea villosa*	DIOVIL	native	4	0
flat-topped white aster	*Doellingeria umbellata*	DOEUMB	native	5	-3
crested shield fern	*Dryopteris cristata*	DRYCRI	native	6	-5
autumn-olive	***Elaeagnus umbellata***	**ELAUMB**	**non-native**	**0**	**3**
spike-rush	*Eleocharis palustris*	ELEPAL	native	5	-5
great hairy willow-herb	***Epilobium hirsutum***	**EPIHIR**	**non-native**	**0**	**-3**
common horsetail	*Equisetum arvense*	EQUARV	native	0	0
boneset	*Eupatorium perfoliatum*	EUPPER	native	4	-3
joe-pye-weed	*Eutrochium maculatum*	EUTMAC	native	4	-5
black ash	*Fraxinus nigra*	FRANIG	native	6	-3
red ash	*Fraxinus pennsylvanica*	FRAPEN	native	2	-3
annual bedstraw	*Galium aparine*	GALAPA	native	0	3
short-stalked bedstraw	*Galium brevipes*	GALBRE	native	6	-5
purple avens	*Geum rivale*	GEURIV	native	7	-5
fowl manna grass	*Glyceria striata*	GLYSTR	native	4	-5
sneezeweed	*Helenium autumnale*	HELAUT	native	5	-3
tall sunflower	*Helianthus giganteus*	HELGIG	native	5	-3
sawtooth sunflower	*Helianthus grosseserratus*	HELGRO	native	2	-3
michigan holly	*Ilex verticillata*	ILEVER	native	5	-3
spotted touch-me-not	*Impatiens capensis*	IMPCAP	native	2	-3
pale touch-me-not	*Impatiens pallida*	IMPPAL	native	6	-3
rush	*Juncus brachycephalus*	JUNBRP	native	7	-5
red-cedar	*Juniperus virginiana*	JUNVIR	native	3	3
wood nettle	*Laportea canadensis*	LAPCAN	native	4	-3
marsh pea	*Lathyrus palustris*	LATPAL	native	7	-3
cut grass	*Leersia oryzoides*	LEEORY	native	3	-5
common duckweed	*Lemna minor*	LEMMIN	native	5	-5

Appendix 10 (continued). Plant species observed in Sebewa Creek Shrub-carr southern shrub-carr (EO ID 24243 pg 45).

Common Name	Scientific Name	Acronym	Native?	C	W
spicebush	*Lindera benzoin*	LINBEN	native	7	-3
great blue lobelia	*Lobelia siphilitica*	LOBSIP	native	4	-3
morrow honeysuckle	***Lonicera morrowii***	**LONMOR**	**non-native**	**0**	**3**
northern bugle weed	*Lycopus uniflorus*	LYCUNI	native	2	-5
whorled loosestrife	*Lysimachia quadriflora*	LYSQUR	native	10	-5
wild mint	*Mentha canadensis*	MENCAS	native	3	-3
swamp saxifrage	*Micranthes pensylvanica*	MICPEN	native	10	-5
wild-bergamot	*Monarda fistulosa*	MONFIS	native	2	3
watercress	***Nasturtium microphyllum***	**NASMIC**	**non-native**	**0**	**-5**
sensitive fern	*Onoclea sensibilis*	ONOSEN	native	2	-3
cowbane	*Oxypolis rigidior*	OXYRIG	native	6	-5
grass-of-parnassus	*Parnassia glauca*	PARGLA	native	8	-5
virginia creeper	*Parthenocissus quinquefolia*	PARQUI	native	5	3
swamp-betony	*Pedicularis lanceolata*	PEDLAN	native	8	-3
jumpseed	*Persicaria virginiana*	PERVIR	native	4	0
reed canary grass	*Phalaris arundinacea*	PHAARU	native	0	-3
sycamore	*Platanus occidentalis*	PLAOCC	native	7	-3
quaking aspen	*Populus tremuloides*	POPTRE	native	1	0
bur oak	*Quercus macrocarpa*	QUEMAC	native	5	3
swamp buttercup	*Ranunculus hispidus*	RANHIS	native	5	0
wild black currant	*Ribes americanum*	RIBAME	native	6	-3
multiflora rose	***Rosa multiflora***	**ROSMUL**	**non-native**	**0**	**3**
swamp rose	*Rosa palustris*	ROSPAL	native	5	-5
black raspberry	*Rubus occidentalis*	RUBOCC	native	1	5
dwarf raspberry	*Rubus pubescens*	RUBPUB	native	4	-3
wild red raspberry	*Rubus strigosus*	RUBSTR	native	2	0
black-eyed susan	*Rudbeckia hirta*	RUDHIR	native	1	3
great water dock	*Rumex orbiculatus*	RUMORB	native	9	-5
common arrowhead	*Sagittaria latifolia*	SAGLAT	native	4	-5
bebbs willow	*Salix bebbiana*	SALBEB	native	1	-3
pussy willow	*Salix discolor*	SALDIS	native	1	-3
sandbar willow	*Salix exigua*	SALEXI	native	1	-3
hardstem bulrush	*Schoenoplectus acutus*	SCHACU	native	5	-5
bulrush	*Scirpus atrovirens*	SCIATV	native	3	-5
wool-grass	*Scirpus cyperinus*	SCICYP	native	5	-5
tall goldenrod	*Solidago altissima*	SOLALT	native	1	3
late goldenrod	*Solidago gigantea*	SOLGIG	native	3	-3
swamp goldenrod	*Solidago patula*	SOLPAT	native	6	-5
common bur-reed	*Sparganium eurycarpum*	SPAEUR	native	5	-5
slender wedgegrass	*Sphenopholis intermedia*	SPHINT	native	4	0
bladdernut	*Staphylea trifolia*	STATRI	native	9	0
smooth swamp aster	*Symphyotrichum firmum*	SYMFIR	native	4	-3
new england aster	*Symphyotrichum novae-angliae*	SYMNOV	native	3	-3
purple meadow-rue	*Thalictrum dasycarpum*	THADAS	native	3	-3
marsh fern	*Thelypteris palustris*	THEPAL	native	2	-3
basswood	*Tilia americana*	TILAME	native	5	3
poison-ivy	*Toxicodendron radicans*	TOXRAD	native	2	0
poison sumac	*Toxicodendron vernix*	TOXVER	native	6	-5
narrow-leaved cat-tail	***Typha angustifolia***	**TYPANG**	**non-native**	**0**	**-5**
broad-leaved cat-tail	*Typha latifolia*	TYPLAT	native	1	-5
american elm	*Ulmus americana*	ULMAME	native	1	-3
missouri ironweed	*Vernonia missurica*	VERMIS	native	4	0
nannyberry	*Viburnum lentago*	VIBLEN	native	4	0
golden alexanders	*Zizia aurea*	ZIZAUR	native	6	0

Appendix 11. Bird species documented during surveys of Portland State Game Area.

Common Name	Scientific Name	State Status	Featured Species	SGCN	JV Focal Species	Prop. of Points
Acadian Flycatcher	*Empidonax virescens*					0.50
Alder Flycatcher	*Empidonax alnorum*					0.05
American Crow	*Corvus brachyrhynchos*					0.23
American Goldfinch	*Spinus tristis*					0.14
American Redstart	*Setophaga ruticilla*					0.45
American Robin	*Turdus migratorius*					0.32
Baltimore Oriole	*Icterus galbula*					0.23
Black-billed Cuckoo	*Coccyzus erythropthalmus*					0.14
Black-capped Chickadee	*Poecile atricapillus*					0.18
Blue Jay	*Cyanocitta cristata*					0.05
Blue-winged Warbler	*Coccyzus erythropthalmus*					0.05
Brown Creeper	*Poecile atricapillus*					0.09
Brown-headed Cowbird	*Cyanocitta cristata*					0.45
Canada Goose	*Molothrus ater*					0.09
Cerulean Warbler	*Setophaga cerulea*	T		X	X	0.14
Chipping Sparrow	*Spizella passerina*					0.05
Common Yellowthroat	*Geothlypis trichas*					0.14
Downy Woodpecker	*Picoides pubescens*					0.23
Eastern Wood-Pewee	*Contopus virens*					0.73
Gray Catbird	*Dumetella carolinensis*					0.18
Great-crested Flycatcher	*Myiarchus crinitus*					0.27
Hairy Woodpecker	*Picoides villosus*					0.14
Hooded Warbler	*Setophaga citrina*	SC		X		0.09
House Wren	*Troglodytes aedon*					0.05
Indigo Bunting	*Passerina cyanea*					0.64
Least Flycatcher	*Empidonax minimus*					0.27
Mourning Dove	*Zenaida macroura*					0.05
Northern Cardinal	*Cardinalis cardinalis*					0.59
Ovenbird	*Seiurus aurocapilla*					0.14
Red-bellied Woodpecker	*Melanerpes carolinus*			X		0.36
Red-eyed Vireo	*Vireo olivaceus*					0.77
Red-headed Woodpecker	*Melanerpes erythrocephalus*	SC	X		X	0.09
Red-winged Blackbird	*Agelaius phoeniceus*					0.18
Rose-breasted Grosbeak	*Pheucticus ludovicianus*					0.55
Ruby-throated Hummingbird	*Archilochus colubris*					0.05
Sandhill Crane	*Antigone canadensis*					0.09
Scarlet Tanager	*Piranga olivacea*					0.45
Song Sparrow	*Melospiza melodia*					0.27
Tufted Titmouse	*Baeolophus bicolor*					0.86
Veery	*Catharus fuscescens*					0.05
Warbling Vireo	*Vireo gilvus*					0.23
Wild Turkey	*Meleagris gallopavo*		X			0.05
Wood Thrush	*Hylocichla mustelina*		X	X	X	0.41
Yellow Warbler	*Setophaga petechia*					0.59
Yellow-billed Cuckoo	*Coccyzus americanus*					0.18
Yellow-throated Vireo	*Vireo flavifrons*					0.27

THE STATE JOURNAL

Thursday, June 5, 1975

Living Today

SECTION D

Chief Okemos the Warrior
Early Mid-Michigan Hero

By JIM WIEBER
Staff Writer

The old man sat somewhat royally in the cluttered railroad baggage car, puffing on tobacco burning slowly in a clay pipe, wearing a cloth turban atop his head and an always sharpened buckhorn-handled knife stuck in a belt around his pudgy waist.

He was trading stories, apparently with some other oldtimers, when a conductor on the Detroit and Milwaukee train interrupted Okemos and asked for his ticket.

OKEMOS DIDN'T understand much English, and when the bystanders began to smile because of his hesitation, the old man thought the conductor had said something offensive.

Jumping to his feet in anger, old Okemos told the conductor:

"Big Chief, me — plenty fight once!"

THIS WAS Chief Okemos in late 1858 only weeks before his death in December of that year. He burst with pride and conceit when recalling his earlier years as an often-acclaimed warrior. But people listened to this chief of a mixed band of Ottawas, Chippewas and Pottawatomies — probably the most talked about native American who ever lived in central Michigan.

People listened, as numerous accounts of pioneers have said, because Chief Okemos, who lived to be perhaps 80 years of age, became a legend while still a young man.

"Okemos has passed a most eventful life, the story of which, if truthfully told, would excel imagination, as much as truth is said to be stranger than fiction," said a friend of Okemos, Rufus Hosmer, who wrote the chief's obituary for the Lansing State Republican on Dec. 14, 1858.

LANSING AUTHOR Birt Darling, who has studied the life and legend of Okemos, made this note almost a century later, in 1950:

"As to Okemos himself, little of his ancestry is known beyond his own proud and frequent reiteration that he was Pontiac's nephew. The place where he established his village, where the town now bearing his name stands . . . was certainly at the boundaries of all three Indian nations.

"Had white emigration not disturbed him, he might have started a new tribe composed of the elements of the three older ones. It had happened many times before in the thousands of years of Indian occupation of this country."

★★★★★★★
SPIRIT OF '76
★★★★★★★

BUT WHITE emigration in time destroyed the dreams of Okemos and other native Americans. Some of the descendants of Okemos' band survive today near Mt. Pleasant; others were rounded up by soldiers nearly a century and a half ago and were forced to live on other lands across the Mississippi.

Okemos stayed and lived along the Grand River near Portland at a place of natural beauty called M'she-miniconing (often Shimnicon), although the native American really never liked the land, according to several historians.

"Shimnicon was not really a desirable spot for growing the corn and squash and other provisions the Indians wanted," said Ford Ceasar, Lansing historian. "The place meant 'sour apples' to Okemos and his followers. The land was rocky . . . nothing like the fertile soil they had been used to working."

ALTHOUGH OKEMOS became a mendicant in his later years — historians say it was not on his own volition — he did, indeed, live "a most eventful life," much of it near and around Lansing.

Unfortunately, not all historians — as Hosmer perceived in 1858 — told their stories of Okemos accurately. Some described him as drunk. Some said he fought in but one battle, and that he lost his will to stand up against the white man after it.

It is true that the lies, liquor and extortion used by white men forced more and more Indians from their land and often made many of the native American people feel less than human.

"I DO not think I possess any morbid sentimentality for Indians," noted a famed historian 95 years ago. "I simply wish to represent them as we found them. What they are now is easily seen by the few wretched specimens around us."

"O-ge-mah" — how Okemos' followers pronounced his name — retained his pride. Although he was described in pioneer accounts as an honest, hospitable and friendly person, Okemos was not fond of the white men who cut the forests where he hunted and scattered his people in far off lands.

"Okemos was small in stature but he was a remarkable man in every respect," said historian Ceasar. "There's no doubt about his courage in many, many battles (between 1790 and 1813) and his talent as a great leader.

"YET, OKEMOS was also a very, very gentle man who mellowed considerably as he became older," added Ceasar, who is writing a history of Ingham County as a Bicentennial project for the Ingham County Board of Commissioners.

"I have learned in my research that Okemos' wife suffered from consumption (tuberculosis) and that he served as her nurse and gave her the very best of care until her death," Ceasar said.

Okemos took to the warpath as a warrior in the late 18th century — when 4,000 Indians were allied with the British in the War of 1812.

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Chief Okemos Mid-Michigan Hero

Concluded from Pg. D-1

WILLIAM HENRY Harrison was one of his enemies in battle — at both Tippecanoe and at Chatham in Canada. So were Gens. St. Clair and Wayne and Harmer and Hull — noted and controversial leaders of American troops in wars against the Ottawas and the British.

It was in 1813 near Fort Sandusky in northern Ohio where Okemos was involved in "the great event of his life . . . that which gave him his chieftainship and caused him to be revered by his tribe."

Accounts vary, but apparently Okemos, his cousin, Man-e-to-corb-way, and 16 other young warriors were hiding in the brush outside the fort waiting to ambush a company of 20 U.S. Cavalrymen.

"Our ambush was located on a slight ridge, with brush directly in our front," the chief recalled.

"OUR PLAN was first to fire and cripple them, and then make a dash with the tomahawk. We waited until they approached so near that we could count the buttons on their coats, when firing commenced."

The cavalrymen, with sabers drawn, charged the 18 Indians, however, and with the sound of a bugle the Indians were completely surrounded by scores of cavalrymen.

They were trapped. Says Okemos:

"THE PLUMES of their hats looked like a flock of a thousand pigeons just hovering for flight."

Every Indian, including Okemos, was cut down by bullet or sword. The cavalrymen, before leaving the field, leaned forward with their swords over most of the fallen braves and pushed their steel spears through their hearts or lungs to assure their death.

Okemos remembered that he had knocked one soldier off his saddle with the club end of his rifle, and that he was charging another soldier when he felt something like a red-hot iron piercing his skull.

OKEMOS REMEMBERED nothing else of the battle until several hours later when he, Man-e-to-corb-way, and another warrior regained consciousness. Some say the three men crawled into a canoe and drifted downstream on the river to the safety of a distant Indian village where they were nursed to good health.

Whatever the case, Man-e-to-corb-way spent the rest of his life as a cripple. Okemos, who received deep saber cuts across his temples in addition to several stab wounds, regained his strength and fought against the Americans for nearly another year.

Years later, at the Jason Nichols farm near the present site of Lansing's Capital City Airport, family members would recall how a young Nichols boy could place three fingers in the indentation in Okemos' skull from the saber blow.

Okemos commanded the war party of Ottawas, who with other Indians, defeated Gen. Arthur St. Clair on the Miami River in 1791. He was also in the battle on the Maumee River, Aug. 20, 1794, when the Indians suffered a severe defeat by Gen. Anthony Wayne.

During the War of 1812, Okemos fought for the British under a colonel's commission, but quit fighting after the battle of the Thames in Canada in October of 1813 after Tecumseh, another great chief, was killed.

BUT THERE was another important chapter of Okemos' life history of which little is recorded — the bloody Indian wars between 1794 and 1811.

Okemos and his tribe once fought off invading Chippewas from Wisconsin who tried to take their Michigan hunting grounds. In the other, about 1800, Okemos participated in a great fight which demolished the famous Shawnee Chief Elkhart's attempt at expanding his Indiana hunting grounds into southern Michigan.

Elkhart made war against the Pottawatomies, under Pokagon, who asked Okemos and Wakazoo of the Ottawas for help.

MEETING NEAR the present city of Battle Creek, the defending tribes marched across the open prairies near Climax and Schoolcraft and towards the present day city of Three Rivers.

The ensuing battle was described by historians as "the bloodiest battle of all the Indian wars of Michigan," lasting four days.

"To the credit of Okemos belongs the winning of this great fight," said historian Albert Cowles nine decades ago. "In generalship and strategy he outranked Elkhart, and administered a crushing and lasting blow to the great Shawnee nation."

OKEMOS DIED Dec. 5, 1858 along the Looking Glass River three miles east of DeWitt. A stone monument marks his supposed gravesite at Shimnicon near Portland.

Grand River ghost towns once Indian settlements

By DAN HAGER
Journal Correspondent

Michigan, like the Old West, has its share of ghost towns.

The communities died out for any of several reasons — they were missed by a railroad, or the lumber gave out, or a business depression thwarted development, or the chosen site just wasn't any good for a town to grow on.

South of Portland are two ghost towns. The first one disappeared when its residents picked up and moved to the second, which became a town like no other in Michigan.

BOTH WERE Indian villages, and both were situated on the Grand River along the stretch where it makes a series of sweeping meanders about four miles south of Portland.

The first village was there already when the early white settlers came into the country. It bordered the Grand about two and a half miles north of the present community of Mulliken, a quarter mile or so east of Charlotte Highway which connects Portland and Mulliken.

There were some 600 persons living in the Indian village in the 1830s. The Indian name for it was translated as "apple orchard," and it was rendered into the Roman alphabet in various forms, such as Peshimnecon and other versions fairly close to that.

Catastrophe hit the village in 1841. Some of its residents returned from a trip to Grand Rapids carrying smallpox, and the disease swept through, killing about three-quarters of the population.

FIVE YEARS later the village took a different turn. It was visited by the Rev. Manasseh Hickey, a Methodist missionary. At first the villagers weren't willing to listen to what he had to say, but as he retreated he left behind his two interpreters, an Indian couple, who calmed them down. Hickey was later invited back.

Between his preaching and their attendance at a camp meeting at Charlotte about the same time, most of Peshimnecon's residents became Christians. Hickey had an additional plan for them, though. After becoming Christianized, he thought, they also should become good Yankees.

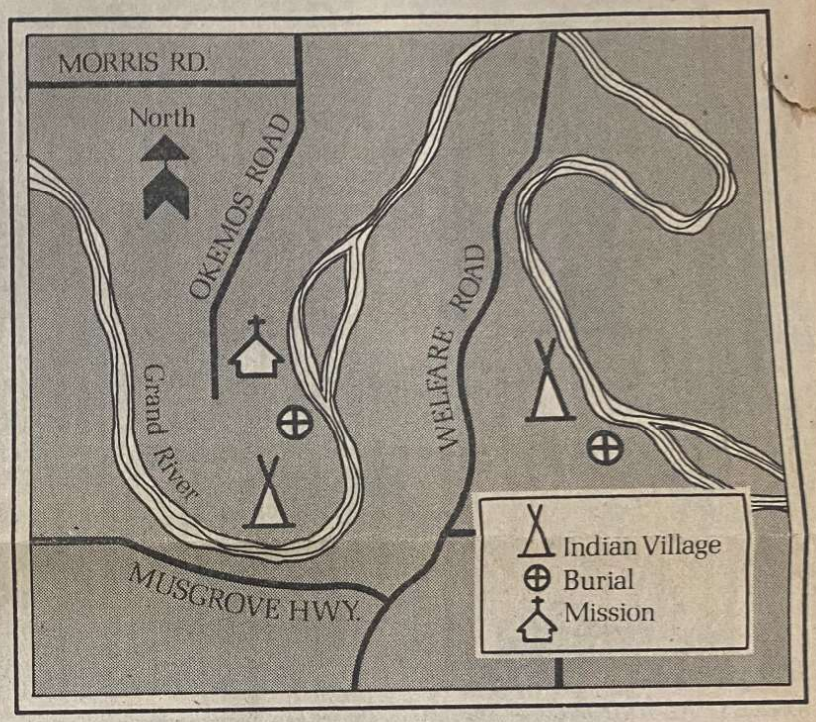
He proposed that they buy land and turn into yeoman farmers. They thought it sounded like a pretty good idea, too.

Hickey bought up most of a quarter section for the Indians about three-quarters of a mile to the west, up on the bluffs across the next broad meander downstream on the Grand. The land is now a part of the Portland State Game Area where Okemos Road runs dead into it.

Hickey had the land surveyed into 20 lots, which the Indians cleared and tilled and built log houses upon. Each lot had frontage on the river. The new village became know as Mishshiminecon.

SOON HICKEY secured a little money from a New York benefactor and decided to invest it in a new mission house at the village. He was helped in the project by John Compton, a settler who lived across the river. The logs selected by Compton were sawed at a mill at Sebewa, a couple of miles away. In a short time the mission house took shape and was completed.

It was portioned off into two sections. One served as a meeting room for church services and schooling sessions. The other was occupied as living quarters by either a missionary or a teacher.



Compton became a little of both to the Indians. He not only preached at Sunday services when Hickey and succeeding missionaries were away, but Compton also was the first teacher at the school. He had to wade through the shallow waters of the Grand to get there, but he always showed up on time, even when the river was choked with ice. The Indians gave him the name Te-cum-a-gaw-shee, which translates as "wade through the river."

The settlement became so successful in a few years that it outgrew the facilities of the original mission house. A new church and school were built.

BUT THEY were barely in use when an edict arrived that shattered the community. The federal government decided in the late 1850s it was time to put Indians on reservations. That included the residents of Mishshiminecon too, even though they dressed like and comported themselves like settlers as much as the white farmers themselves. The Indians were forced to move to the reservation near Mt. Pleasant. They sold the land at Mishshiminecon to a neighboring landholder.

The church building remained even though its users had departed. It became a town hall for the Township of Danby for about a quarter century and remained standing into this century, a kind of monument to a village unique in Michigan history.

At about the same time the Indians were being uprooted, the chief Okemos, head of a Chippewa band living along the Red Cedar where the city of Okemos is now, took sick and died, apparently on a visit at Mishishiminecon. His burial site was right there. For 63 years the only memorial to its location was a pile of rocks, but in 1921 the Stevens T. Mason Chapter of the Daughters of the American Revoution erected a granite monument over the grave.

IT'S NEXT to a winding, bumpy trail off Okemos Road in a tangle of woods and underbrush high above the Grand in the state game area. Outside of that small reminder, the one-time flourishing town of Mishshiminecon has disappeared.