Natural Features Inventory of Fort Custer Training Center, 2018-2021

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Cover Photos: Clockwise from top photo. Whitman Lake Woods overlooking Whitman Lake Fen; goldenseal in Cemetery Complex Ridge; Eastern box turtle (photo by Yu Man Lee); prescribed fire in tank range in Training Area 6; beaver chew on recently downed tree. Photos by Tyler J. Bassett unless otherwise noted.

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Executive Summary

Fort Custer Training Center (FCTC) is a federally owned, active National Guard Training Center operated by the Michigan Department of Military and Veteran Affairs and located on 7,570 contiguous acres in eastern Kalamazoo and western Calhoun counties in southwestern Michigan between the cities of Kalamazoo and Battle Creek. With the majority of military training concentrated in the northern 10% of FCTC, a large proportion is managed for biodiversity conservation. As such, FCTC is regionally important as a contiguous block of habitat in the anthropogenically modified landscape of southern Michigan. Situated along a series of low morainal ridges in the Kalamazoo River watershed, the sandy uplands and mucky lowlands support both high-quality and degraded examples of the oak-hickory forest, mixed oak savanna, emergent marsh/shrub swamp, and mixed hardwood swamps that historically dominated the landscape. The headwaters of several streams are found within FCTC, including large portions of surrounding uplands that can be managed to protect them. Given this wealth of natural resources and a long history of prescribed fire and invasive species management, FCTC supports incredible biodiversity, including many rare plant and animal species, and high-quality natural communities.

From 2018-2021, scientists from the Michigan Natural Features Inventory (MNFI) conducted surveys for rare plant and animal species and high-quality natural communities, conducted vegetation mapping, and assessed the management potential of the natural resources at FCTC, with a focus on biodiversity conservation. The results presented in this report build upon work conducted previously by MNFI, including similar comprehensive efforts in 1993-1994 and 2007-2008, as well as numerous other partners over the past three decades, including the Kalamazoo Nature Center (KNC), DLZ, Envirologic, Native Connections, and others.

Surveys that took place during this study updated known occurrences and documented new occurrences of threatened, endangered, and special concern plant and animal species and high-quality occurrences of natural communities. Each of these occurrences is comprised of multiple observations, often over many years. Depending a given species utilizes habitat, any single occurrence may be confined to a limited area, such as a watercress snail (*Fontigens nickliniana*) population in a single stream, a broad area, such as the territory of an eastern box turtle (*Terrapene carolina carolina*) population covering tens to hundreds of acres, or occur at an intermediate spatial scale. We updated documentation for nine occurrences of seven natural communities and documented five new natural community occurrences of five natural communities, for a total of 14 occurrences of nine communities. In this report we provide descriptions of one (1) mesic sand prairie, two (2) bogs, three (3) prairie fens, one (1) southern wet meadow, one (1) submergent marsh, one (1) inundated shrub swamp, one (1) mesic southern forest, two (2) dry-mesic southern forests, and one (1) oak barrens natural communities. During these surveys, we documented the current condition of and threats to each occurrence and compiled a vascular plant species list for each for assessing and tracking floristic quality as one indicator of condition. We updated 32 occurrences of 16 rare plant species, including four EOs we were unable to relocate, and documented 9 new occurrences of six rare plant species, including three rare species newly documented at FCTC - state threatened pointed watermeal (*Wolffia brasiliensis*), and state special concern pale avens (*Geum virginianum*) and shining wedgegrass (*Sphenopholis nitida*). Finally, we conducted surveys focused on select species of rare mollusks, snails, fish, insects (including bumblebees and moths), and reptiles, and also report on incidental observations of other rare animal species encountered during these targeted surveys. We updated 12 known occurrences of six rare animal species and documented three new occurrences of two rare animal species previously not documented at FCTC, black-and-gold bumble bee (*Bombus auricomus*) and golden borer moth (*Papaipema cerina*). There are 11 documented occurrences of seven rare bird species at FCTC. We did not focus on updating these records as KNC conducts regular avian surveys and it was not necessary to duplicate their efforts. We conducted comprehensive blitz-style surveys for the federally threatened eastern massasauga rattlesnake (*Sistrurus catenatus*) in all priority habitat areas in 2018 (280 person-hours) and 2021 (143 person-

hours). Despite recent observations at the nearby Fort Custer Recreation Center and an abundance of habitat at FCTC, the eastern massasauga rattlesnake was not observed at FCTC during this or previous surveys conducted over the last 15 years. It is highly unlikely that the eastern massasauga rattlesnake occurs at FCTC. In the course of rare species and natural community surveys we also documented several species of mollusks, fish, snails, bumble bees, moths, reptiles, and amphibians and plants that, while not considered rare, contribute to the overall biodiversity and functioning of ecosystems at FCTC. Notably, we documented 40 species or sub-specific taxa of vascular plants that had not previously been documented at FCTC, increasing the total number plant taxa known at FCTC to 879.

We completed "wall-to-wall vegetation" mapping using Michigan Forest Inventory (MiFI) framework developed by the Michigan Department of Natural Resources (MDNR). The MiFI framework involves delineating stands (generally 1-100 acres in size) by cover type using aerial imagery, followed by field surveys to ground truth stand boundaries and collect data to characterize stands. Field surveys classify cover types based on the age, quality, and composition of canopy and subcanopy vegetation, among other factors. In addition to classifying stands within the MiFI framework, we cross-walked each stand to the MNFI natural community classification and the United States National Vegetation Classification and assigned an 'Eco Score' to characterize the quality, or ecological integrity, of each stand (0-5 with increasing ecological integrity). This range of classification schemes facilitates the contextualization of ecosystems at FCTC at multiple scales (i.e., from local to national) and for multiple purposes (e.g., silviculture, biodiversity conversation, comparison to other managed areas). We developed a WebApp in ArcGIS Online that organizes this data in a single location that FCTC managers can access.

This report concludes with a general discussion of management recommendations and research and monitoring needs. In every arena of ecosystem management, we advocate for an adaptive management framework with explicit goals and a linked monitoring component to assess the effectiveness of management and allow for shifting strategies. We discuss the central role that prescribed fire has and should play in ecosystem management at FCTC, but touch on some caveats regarding its application, including species such as turtles and communities such as mesic southern forest that can be negatively impacted, and issues regarding problematic species that are difficult to manage with fire alone. Threats from invasive plants, animals, and pathogens are a common concern in modern ecosystem management, and we discuss these threats in the context of managing the natural communities at FCTC, including both persistent and emerging threats. We also discuss the impact of white-tailed deer (*Odocoileus virginianus*) overabundance on ground layer herbs and tree saplings, which is pervasive in many natural communities. FCTC supports a diversity of wetland and aquatic habitats, and we discuss the importance of maintaining water quality and associated diversity of fish and other species in these ecosystems, which depend on many management priorities from unobstructed stream flow to controlling erosion in adjacent uplands.

In turn, a primary threat to managing uplands at FCTC, by and large oak-dominated forests and savannas, is a process called 'mesophication' that threatens oak ecosystems across eastern North America. Without fire, oak regeneration (e.g., recruitment of seedlings into the canopy) is suppressed and oaks are replaced in the canopy by 'mesophytic' species like maple and cherry, triggering a cascading loss of species that only occur in oak ecosystems. Reversing mesophication and facilitating oak regeneration is a complex process involving managing with fire and silviculture, and managing for invasive species, deer overabundance, and other threats. Approaches for addressing these management issues are always evolving, and we suggest ways that managing and monitoring biodiversity at FCTC can contribute to this evolving understanding, especially for oak regeneration and deer overabundance.

Finally, we recommend future surveys and monitoring for rare species. Several rare species were newly documented during this study as occurring at FCTC, but their distribution and abundance is poorly understood.

Future surveys are likely to document additional rare species at FCTC. The work described in this report describes potential habitat for several rare species, such as larval host species for rare insects. FCTC would be an ideal site to implement standardized, consistent, and effective long-term monitoring of select species or groups of species, natural communities or other targets that could serve as a model for other long-term monitoring sites in Michigan and other states. Prudently selected monitoring targets can serve as indicators of ecosystem health, and long-term monitoring of indicator species will help inform and guide management, resulting in effective management that could benefit the target species as well as other associated species.

Introduction and Study Area

Fort Custer Training Center (FCTC) is a federally owned, active National Guard Training Center operated by the Michigan Department of Military and Veteran Affairs (DMVA) and located on 7,570 contiguous acres in eastern Kalamazoo and western Calhoun counties in southwestern Michigan between the cities of Kalamazoo and Battle Creek (Figure 1). Training activities are concentrated in the Cantonment area, and adjacent Training Areas 1 and 2 in the northeastern portion of FCTC, where most of the approximately 600 acres of developed land are located (INRMP 2020). The remaining 6,970 undeveloped acres support several natural cover types, including grasslands and shrublands (10%), a variety of forested and non-forested wetlands (10%) and upland forests (80%) (INRMP 2020).

FCTC occurs within the Battle Creek Outwash Plain sub-subsection (VI.2.1) of the Kalamazoo Interlobate subsection (VI.2) of southern Michigan, an area primarily underlain by sandy glacial outwash with localized ridges of ice-contact features or end moraine (Albert et al. 1995). The primary glacial landform at FCTC is coarse-textured end moraine (Cohen at al. 2009). The vegetation circa 1800 of FCTC was primarily oak-hickory forest, and included mixed oak savanna, emergent marsh/shrub swamp, and mixed hardwood swamp (Comer et al. 1995, Cohen et al. 2009). Most present-day forests are young, regenerating after the cessation of agriculture in the years following WWII (Figure 2). FCTC also supports fourteen high-quality examples of both forested and non-forested natural communities, and many plant and animal species of conservation concern. Baseline ecological surveys conducted by MNFI in 1993-1994 (Legge et al. 1995) and follow-up surveys in 2007-2008 (Cohen et al. 2009) identified and documented eight total occurrences of five different high quality

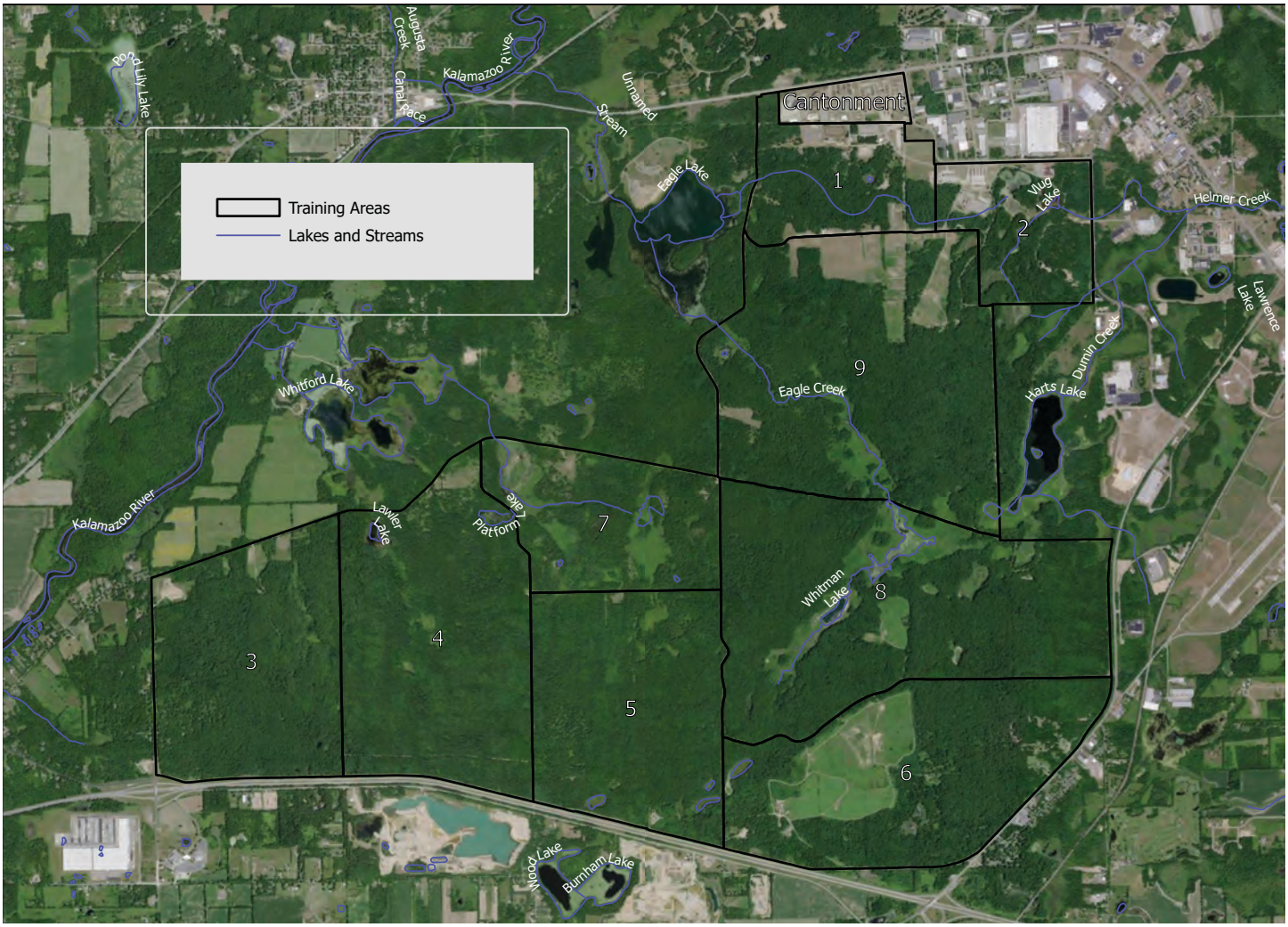

Figure 1. Fort Custer Training Center, highlighting nine training areas and major lakes and streams.

natural communities, multiple occurrences of 14 rare animal species, and 835 vascular plant taxa, including multiple occurrences of 18 rare species.

FCTC comprises a large block of contiguous public lands within a highly fragmented landscape dominated by agriculture and including the urban areas of Kalamazoo and Battle Creek. The boundaries of FCTC and the Fort Custer State Recreation Area (FCRA) fall within the Eagle Lake-Kalamazoo River sub-watershed (HUC 12 - 040500030508). Importantly, the headwaters of several small streams originate within FCTC, and are buffered by large portions of surrounding uplands that can be managed to protect them. In combination with other adjacent lands managed for conservation, including FCRA and Southwest Michigan Land Conservancy's Emmons Augusta Floodplain Forest Preserve, FCTC is a key regional ecological resource for biodiversity. An active ecosystem management program at FCTC includes regular application of prescribed fire and invasive species control, in cooperation with the Kalamazoo Nature Center (KNC), the Michigan Prescribed Fire Council, Michigan Department of Natural Resources (MDNR), and other partners. This has been critical to the persistence and quality of many of the natural features at FCTC.

The goals of this study were to: 1) reassess known natural communities and rare plant and animal occurrences, 2) identify potential rare species targets and conduct surveys, 3) document vascular plant taxa to compare with the baseline species list, 4) conduct comprehensive stand-level vegetation mapping, and 5) identify specific management conflicts relating to natural features and provide recommendations for resolution.

Figure 2. FCTC with 1938 imagery. Dark black polygons are forest, white and light gray are agriculture.

This report is organized based on the three primary foci of surveys: *Ecological Surveys* (pages 4-35) to map and describe vegetation associations, including high quality natural communities, *Plant Surveys* (pages 36-54) to report on surveys primarily for rare plant species occurrences and *Animal Surveys* (pages 55-72) to report on surveys primarily for rare animal species occurrences, including occurrences previously known and newly documented at FCTC. The report concludes by discussing *General Management Recommendations* and *Future Steps* for management, monitoring, and surveys (pages 73-82).

The structure of each section differs slightly because methods for each type of survey are different. For example, surveys for rare plant species are conducted by meanders in likely habitat and visiting previously documented occurrences and does not differ among species. Due to the mobile nature of animal species and range of behaviors, survey methods differ by group (e.g., insects vs. mollusks). As a result, we discuss details on the ecology of animals in the Methods section in the context of survey methods, whereas most species-specific information about the ecology of plant species is discussed in the Results and Discussion section in the context of management and other considerations.

There are terms used regularly throughout this report that warrant clarification here due to the frequency of their use. When discussing rare species and natural communities, we will often refer to *element occurrences* ("EOs" or "occurrences"). An element occurrence is an area of land or water where an element of biodiversity including rare species and natural communities currently or historically occurred. Each EO, which may be comprised of multiple observations of a species or community through space or time, is tracked in the Michigan Natural Heritage Database (MNFI 2021). Each EO is given a unique numeric identifier, the EOID, which we will use throughout this report to refer to specific EOs. The viability of each EO is noted by assigning a rank from A (Excellent estimated viability/ecological integrity) to D (Poor estimated viability/ecological integrity) when sufficient data is available to assess a rank. When data is not available and for instances where an EO is not located, additional ranks include E (Verified extant), F (Failed to find), H (Historical), and X (Extirpated). Finally, FCTC is subdivided into nine separate training areas ("TAs"), which we will frequently use to orient the reader geographically (Figure 1).

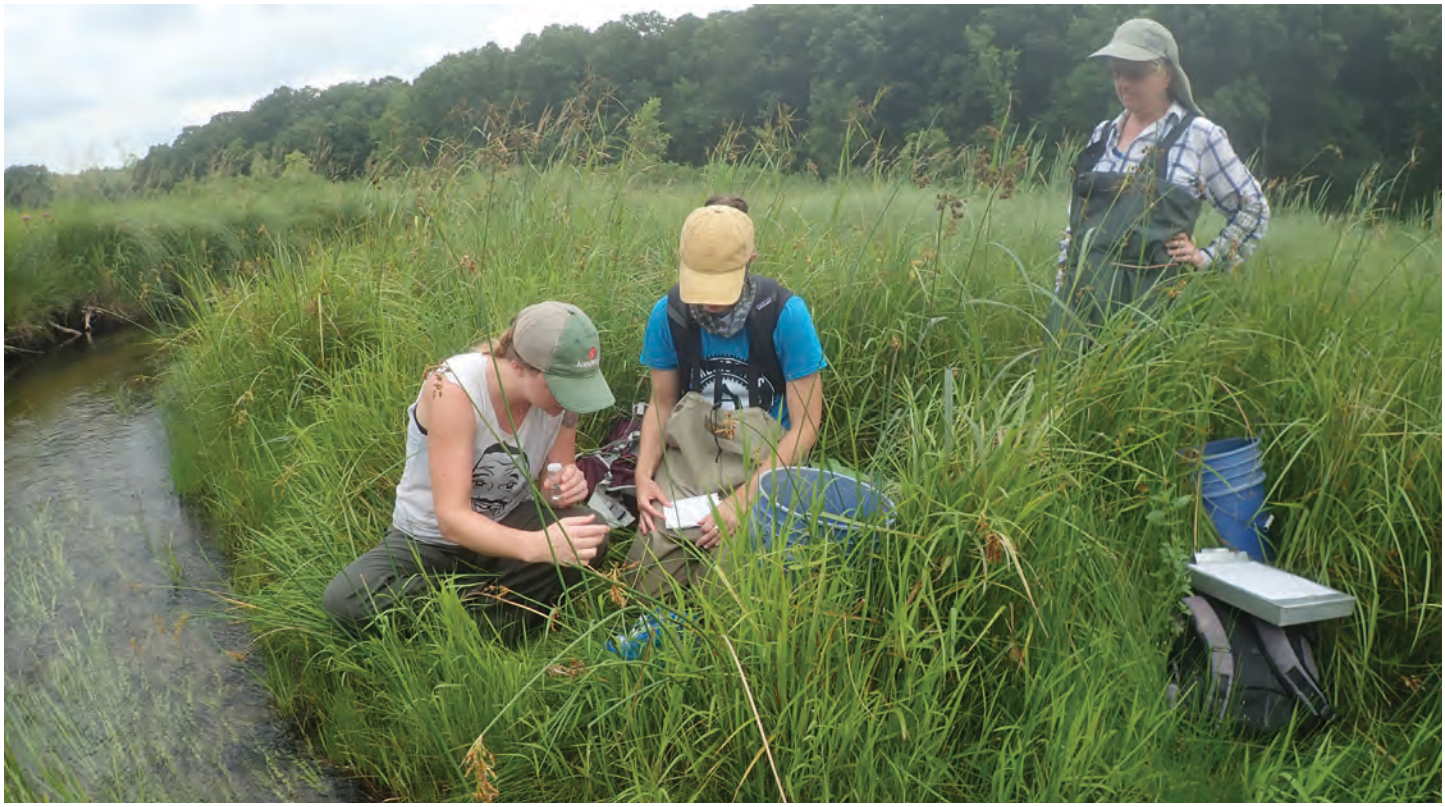

Photo 1. MNFI Zoologists taking water quality measures (alkalinity) in conjunction with rare mussel surveys in Territorial Road Fen.

Ecological Surveys

INTRODUCTION

Characterizing the ecological integrity of natural communities through ecological surveys is vital for guiding the management of biodiversity. A natural community is an assemblage of interacting plants, animals, and other organisms that repeatedly occurs under similar environmental conditions across the landscape and is predominantly structured by natural processes rather than modern anthropogenic disturbances (Cohen et al. 2014). Ecological integrity encompasses "the structure, composition, function, and connectivity of an ecosystem as compared to reference ecosystems operating within the bounds of natural or historical disturbance regimes" (Faber-Langendoen 2016). Mapping how ecological integrity varies geographically and identifying and describing examples of natural communities with exceptional ecological integrity, provides a template upon which managers can project their understanding of the landscape, what it looked like historically, and what it can support in the future when managed prudently. The state of natural communities, in terms of ecological integrity, is the coarse filter by which managers set priorities.

METHODS

Overview

We conducted ecological surveys at two levels of intensity: 1) coarse vegetation mapping and classification, and 2) high-quality natural community surveys, including Floristic Quality Assessments. First, we completed "wall-to-wall" vegetation mapping within the FCTC boundaries using the Michigan Forest Inventory (MiFI) protocol developed by the Michigan Department of Natural Resources. We used the results of these MiFI surveys to construct an updated Plant Alliance map for FCTC (sensu Thomas et al. 2009) by cross-walking MiFI data with the National Vegetation Classification (USNVC 2021). Second, we conducted in-depth surveys in high-quality natural communities, resulting in updated natural community descriptions for nine previously documented EOs and documentation of five new EOs identified during MiFI and other surveys during the current study. We also conducted a comprehensive floristic inventory for each EO, facilitating a Floristic Quality Assessment.

Michigan Forest Inventory

MiFI is a forestry protocol that classifies forest stands into a hierarchical land cover classification. It was developed originally in the late 1990s to prioritize management decisions primarily on lands owned or managed by the Michigan Department of Natural Resources (State Game Areas, Parks, Recreation Areas, and Forests). MiFI was implemented in two stages, desktop stand delineation and field surveys. First, we designated nine compartments based on the existing training area boundaries at FCTC, and then delineated stands within each compartment based on aerial photographic interpretation. We used several sources of imagery, including "leaf-on" true color and infrared NAIP satellite imagery from 2016 and 2018, true color and infrared "leaf-off" imagery from 2018, 1998 orthophotos, and black-and-white imagery from 1938. Through aerial imagery interpretation, surveyors discern boundaries between vegetation types (e.g., wetland vs. upland), and differentiate between the age and age-structure of patches of vegetation.

Second, we conducted surveys in 2019-2020 to ground-truth stand boundaries and collect stand-level data. We collected stand data in four separate fields: stand summary, canopy, sub-canopy, and comments (Figure A1). The stand summary characterizes canopy closure (0-25%, 25-50, 50-75, 75-100), average tree size, stand age based on the age of the dominant tree species, whether a stand is planted vs. natural, basal area range (1-50 ft/A, 50-80, 80-110, 110-140, 140-170), and whether a stand is upland vs. lowland. Stand age and tree size determinations are described below under canopy data collection. Basal area was determined using a forester's prism. For forested stands (>25% canopy), the MiFI database automatically calculates a "Level 4 cover type" according to the MiFI criteria (See Figure A1). For non-forested stands (i.e., 0-25% canopy closure), the Level 4 cover type is determined during the survey by the surveyor. The Level 4 cover types accommodate all vegetation types known in Michigan (e.g., "Oak" types dominated by oak species, "Northern Hardwood" types dominated by maple species) as well as several non-vegetated types (e.g., "Parking Lots" and "Roads"). Highly degraded stands, such as

agricultural fields or mown grass, do not correspond to any natural community. Canopy data includes the identity, percent cover, size distribution, estimated mean DBH in inches, and age of at least the dominant (i.e., highest percent cover) species of sufficient height to be included in the canopy. The size distribution of canopy trees includes one or more of the following: saplings (<5 in DBH), poles (5-10 in), logs (10-18 in), and overmature (>18 in). Tree age was estimated by extracting a tree core with a Haglöf 3-thread increment borer and counting rings in the field. Sub-canopy data includes the species-level identity, cover class (trace: 0-1%; low: 1-10; medium: 10-40; high: 40-70; full: 70-100), height class (<5 feet, 5-10, 10-20, < 20, variable), and size (seedling, sapling, pole, and log-sized trees, as well as shrubs) of subcanopy species. Finally, several comments were recorded, including assigning an MNFI natural community (Kost et al. 2007, Cohen et al. 2014) and an 'Eco Score', as well as any additional aspects of the stand not recorded in other fields (e.g., animal species observed or habitat features for rare species, heterogeneity in species composition, natural community, or habitat inclusions such as vernal pools). The Eco Score indicates a rapid assessment of the ecological integrity of the natural community on a scale of 0-5, as follows:

> 0 – *not a natural community* (developed areas, including regularly mown fields); 1 – *very heavily modified by past human activity* (most native vegetation is absent and invasive species may be dominant); 2 – *heavily modified by past human activity* (natural community is in an altered state but individual aspects of original natural community such as species composition or ecosystem structure are still apparent but not dominant); 3 – *moderately to heavily altered by past human activity* (natural community is in an altered state but many aspects of original natural community such as species composition or ecosystem structure are present but in a degraded state); 4 – *lightly to moderately altered by past human activity* (natural community is largely intact but individual aspects of original natural community such as species composition or ecosystem structure are somewhat degraded); 5 – *unaltered to lightly altered by past human activity* (natural community is largely intact and all aspects of original natural community such as species composition or ecosystem structure are present).

Plant Alliance mapping

We also produced a Plant Alliance map by cross-walking the MiFI data and land cover classification with the United States National Vegetation Classification (USNVC 2021). The NVC is a hierarchical vegetation classification for the United States that groups vegetation types with increasing resolution at decreasing spatial scale (USNVC 2021). Classifying land cover at FCTC according to NVC facilitates assessing conservation and management priorities both within FCTC and across multiple installations according to a common framework. At the largest scale, dominant growth forms are grouped into broad *Classes* based on how coarse vegetation types (e.g., Forest and Woodland Class) are structured by global macro-ecology drivers such as latitude and altitude. Each Class is subsequently subdivided into *Subclasses* (e.g., Temperate and Boreal Forest and Woodland Subclass), and *Formations* (e.g., Cool Temperate Forest & Woodland Formation). At an intermediate scale, biogeographic variation in dominant species and growth forms is grouped into *Divisions* (e.g., Eastern North American Forest & Woodland Division) based on regional gradients of climate and soils. Each Division is subsequently subdivided into *Macrogroups* (e.g., Central Midwest Oak Forest, Woodland & Savanna Macrogroup), and *Groups* (e.g., North-Central Oak – Hickory Forest & Woodland Group). At the smallest scale, fine-scale floristic variation across multiple vertical strata (i.e., canopy, subcanopy and ground layer vegetation) is used to classify *Alliances* (e.g., North-Central White Oak – Hickory Forest Alliance) based on local environmental conditions. Alliances are subsequently divided into *Associations* (e.g., Midwest White Oak – Hickory Forest Association). See Table A2 for hierarchical list of Macrogroups, Groups, and Alliances present at FCTC.

We used the MiFI dataset to delineate NVC Alliances at the stand scale. Previously, Thomas et al. (2009) mapped Alliances at FCTC based on the data available at the time. Due to the lack of comprehensive stand-level data at FCTC, and because ruderal Alliances had not yet been described for the USNVC, 63% of the area of FCTC was assigned as a "Potential Plant Alliance" that could not be defined. The development

of the NVC has progressed since then, and now contains multiple ruderal types that correspond to degraded landcover types that are common in the southern Michigan landscape, including at FCTC. The resolution of the MiFI dataset also allowed us to crosswalk the dominant vegetation observed at FCTC to the dominant vegetation types described in the NVC Alliances. First, we reviewed the NVC to select candidate Alliances that described vegetation types that occur at FCTC (Table A3). Then, we developed a set of rules to assign each MiFI stand to one of the candidate Alliances based on dominant vegetation, MNFI Natural Community classification, Upland vs. Lowland stands, and other data available in the MiFI data set (see Table A4 for full set of rules). A total of 30 out of 498 stands were not assigned an Alliance after several revisions of these rules, so we assigned these stands to an Alliance manually.

Natural community surveys

We conducted surveys in high-quality natural communities to update existing natural community EOs and to describe newly identified EOs. Initial MiFI surveys were used to identify areas that had the potential to qualify as high-quality natural communities. Follow-up surveys were conducted in these targeted areas, using Natural Heritage Methodology to document and describe areas of high conservation potential. We evaluated each natural community occurrence with Natural Heritage and MNFI methodology, which considers three factors to assess a natural community's ecological integrity: size, landscape context, and condition (Faber-Langendoen et al. 2016). 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.

Natural community surveys involved:

a) compiling comprehensive plant species lists and noting dominant and representative species
b) describing site-specific structural attributes and ecological processes
c) measuring tree diameter at breast height (DBH) of representative canopy trees and aging canopy dominants (where appropriate)
d) analyzing soils and hydrology
e) noting current and historical anthropogenic disturbances
f) evaluating potential threats to ecological integrity
g) ground-truthing aerial photographic interpretation using GPS
h) taking digital photos and GPS points at ecologically significant locations
i) surveying adjacent lands when possible to assess landscape context
j) evaluating the natural community classification and mapped ecological boundaries
k) assigning or updating element occurrence ranks
l) noting management needs and restoration opportunities or evaluating past and current restoration activities and noting additional management needs and restoration opportunities

We also conducted comprehensive floristic inventories and Floristic Quality Assessments (FQAs) in each natural community EO (Reznicek et al. 2014). The FQA utilizes plant species composition to derive the Floristic Quality Index (FQI), a quantitative metric of habitat quality that can be used as a relatively objective comparison among natural community occurrences of a type. Drawing upon expert consensus among botanists familiar with the flora of Michigan, each vascular plant species in Michigan has been assigned an a priori *coefficient of conservatism* (C-value) that ranges from 1 to 10 on a scale of increasing fidelity to pre-European colonization habitats (Reznicek et al. 2014). Non-native species have a C-value of 0. We calculated FQI for each natural community occurrence as , where C = C-value and n = species richness. Sites with an FQI of 35 or greater are generally considered to possess sufficient floristic conservatism to be considered of high quality (Herman et al. 2001).

RESULTS AND DISCUSSION

We updated nine existing natural community EOs and documented five new natural community EOs. Below, we provide summary descriptions of each EO, placing the value of each in a statewide context and highlighting the characteristics of each occurrence that are useful to guide prudent management. In our descriptions, we focus primarily on changes to each natural community occurrence since the previous MNFI survey, especially with respect to threats and mapped boundaries. We provide detailed descriptions

of the vegetation, soils, and vegetative structure only for newly documented natural communities. For additional detailed descriptions of previously documented EOs, see Cohen et al. (2009). For more information on natural communities in Michigan generally, see Kost et al. (2007) and Cohen et al. (2014). Finally, we provide global and state ranks (G- and S- ranks) for each natural community (see Appendix B), as well as EO rank, Floristic Quality Index (FQA), and mean Coefficient of Conservatism for each natural community occurrence. A comprehensive species list for FCTC is found in Appendix D and FQA summaries for each natural community EO is found in Appendix E.

Michigan Forest Inventory and Plant Alliance mapping

We published the final MiFI and NVC Plant Alliance spatial dataset with related tables to a WebApp available to FCTC managers via an ArcGIS Online Group and provide summary information on the key results of MiFI surveys below (Tables 1-4, Appendix A). We delineated and surveyed 498 MiFI stands among nine compartments, totaling 7,387 acres, including developed areas within Training Areas but excluding the Cantonment Area. Here, we summarize the frequency distribution of Eco Scores, and the three land cover classifications applied to FCTC lands, the Michigan Natural Features Inventory Community

Table 1. Distribution of Eco Scores in MiFI stands. Groupings correlate to low (0-2), moderate (2.5-4), and high (4.5-5.0) quality. See Figure A2.

EcoScore	Stands		Acres	
0	40	8%	530	7%
1	40	8%	435	6%
1.5	25	5%	513	7%
2	124	25%	2,550	35%
2.5	54	11%	958	13%
3	90	18%	830	11%
3.5	45	9%	820	11%
4	50	10%	384	5%
4.5	14	3%	190	3%
5	16	3%	179	2%
Total:	498		7,387	
(0-2)	229	46%	4027	55%
(2.5-4.0)	239	48%	2992	41%
(4.5-5.0)	30	6%	369	5%
Total:	498		7,387	

Table 2. Distribution of MNFI Community types across MiFI stands. See Figure A3.

MNFI Community	Stands		Acres	
Terrestrial (Upland) Class				
Dry Southern Forest	49	9.84%	1,200	16.24%
Dry-mesic Southern Forest	213	42.77%	4,249	57.51%
Mesic Sand Prairie	1	0.20%	4	0.05%
Mesic Southern Forest	24	4.82%	186	2.52%
Oak Barrens	29	5.82%	329	4.45%
Subtotal:	316	63%	5967	81%
Palustrine (Wetland) Class				
Bog	6	1.20%	28	0.37%
Emergent Marsh	10	2.01%	42	0.57%
Intermittent Wetland	1	0.20%	1	0.01%
Inundated Shrub Swamp	15	3.01%	21	0.29%
Prairie Fen	10	2.01%	129	1.75%
Rich Tamarack Swamp	1	0.20%	2	0.02%
Southern Hardwood Swamp	23	4.62%	147	1.99%
Southern Shrub-carr	26	5.22%	154	2.08%
Southern Wet Meadow	13	2.61%	46	0.62%
Submergent Marsh	16	3.21%	121	1.64%
Subtotal:	121	24%	691	9%
No Class				
NA	61	12.25%	730	9.88%
Total:	498		7,387	

Classification (Kost 2007), MiFI L4 cover types (Table A1), and NVC Plant Alliances (NVC 2021). Approximately one-half of MiFI stands were heavily to very modified by past human activity, receiving an Eco Score of 0-2 (229 or 46% of stands; 4,027 acres or 55% of area) (Table 1, Figure A2). Another large proportion of stands were lightly to heavily modified, receiving an Eco Score of 2.5-4 (239 or 48% of stands; 2,992 acres or 41% of the area). Typical of the southern Michigan landscape, few stands were lightly altered to unaltered (30 or 6% of stands; 369 acres or 5% of the area). The land cover classification schemes overlap significantly, but as they have different goals, there are key differences and there is not a 1:1 comparison at the stand level. The benchmark of the MNFI Natural Community Classification is an undisturbed ecosystem as would have occurred prior to widespread European colonization, and each occurrence represents a degraded deviation from that ideal. The most common MNFI natural communities represented by MiFI stands were two oak ecosystems: dry-mesic southern forest (213 stands; 4,249 acres) and dry southern forest (49 stands; 1,200 acres) (Table 2, Figure A3). Wetland natural communities were more evenly distributed. Several communities

Table 3. Distribution of L4 cover types among MiFI stands. See Table A1 for hierarchy of cover types. See Figure A4. *anthropogenic classes

L4 Covertype	Stands		Acres	
Forested Lowland				
6110 - Cottonwood	1	0.20%	0.8	0.01%
6113 - Lowland Maple	5	1.00%	21.6	0.29%
6119 - Mixed Lowland Deciduous Forest	15	3.01%	115.7	1.57%
6121 - Tamarack	1	0.20%	1.7	0.02%
Subtotal:	22	4.42%	140	1.89%
Non-forested Lowland				
500 - Water	7	1.41%	15.9	0.22%
621 - Floating Aquatic	12	2.41%	99.3	1.34%
622 - Lowland Shrub	1	0.20%	0.8	0.01%
6220 - Alder/willow	2	0.40%	6.9	0.09%
6221 - Fen	9	1.81%	126.4	1.71%
6222 - Shrub-Carr	12	2.41%	104.7	1.42%
6223 - Inundated Shrub Swamp	9	1.81%	11.7	0.16%
6225 - Bog	7	1.41%	28.6	0.39%
6229 - Mixed lowland shrub	16	3.21%	56.5	0.76%
623 - Emergent Wetland	2	0.40%	4.7	0.06%
6230 - Cattail	4	0.80%	17.6	0.24%
6232 - Wet Prairie	1	0.20%	3.8	0.05%
6233 - Wet Meadow	9	1.81%	29.7	0.40%
6239 - Mixed Emergent Wetland	8	1.61%	40.3	0.55%
Subtotal:	99	19.88%	547	7.40%
Forested Upland				
4110 - Sugar Maple Association	2	0.40%	14.5	0.20%
4112 - Maple, Beech, Cherry Association	1	0.20%	81	1.10%
4119 - Mixed Northern Hardwoods	23	4.62%	408.4	5.53%
4120 - Oak, Hickory	36	7.23%	472.1	6.39%
4123 - Red Oak	7	1.41%	59.5	0.81%
4124 - Red with White Oak	1	0.20%	5.7	0.08%
4125 - Black, N. Pin Oak	45	9.04%	882.8	11.95%
4126 - White, Black, N. Pin Oak	7	1.41%	65.9	0.89%
4130 - Aspen	4	0.80%	24.7	0.33%
4131 - Aspen, Oak	5	1.00%	58.8	0.80%
4139 - Aspen, Mixed Deciduous	2	0.40%	118.2	1.60%
4199 - Other Mixed Upland Deciduous	163	32.73%	3608	48.84%
429 - Mixed Upland Conifers	1	0.20%	8	0.11%
Subtotal:	297	59.64%	5,808	78.61%
Non-forested Upland				
110 - Low Intensity Urban*	6	1.20%	58.4	0.79%
122 - Road/Parking Lot*	14	2.81%	136	1.84%
123 - Other High Intensity Urban*	5	1.00%	69.5	0.94%
310 - Herbaceous Openland	8	1.61%	157.3	2.13%
3101 - Poverty Grass, Cladonia	1	0.20%	2.4	0.03%
3102 - Grass*	6	1.20%	29.6	0.40%
31022 - Warm Season Grass	6	1.20%	43.7	0.59%
3104 - Degraded*	3	0.60%	28.3	0.38%

L4 Covertype	Stands		Acres	
3105 - Mixed Upland Herbaceous	9	1.81%	63	0.85%
320 - Upland Shrub	3	0.60%	6.9	0.09%
3205 - Mixed Upland Shrub	1	0.20%	0.8	0.01%
330 - Low-Density Trees	8	1.61%	87.5	1.18%
3301 - Low Density Deciduous Trees	5	1.00%	66.1	0.89%
3303 - Mixed Low Density Trees	2	0.40%	12.5	0.17%
350 - Parks and Golf Courses*	2	0.40%	128.3	1.74%
710 - Sand, Soil	1	0.20%	2.8	0.04%
Subtotal:	80	16.06%	893	12.09%
Total:	498		7,387	

were similarly common, including prairie fen (10 stands; 129 acres), southern hardwood swamp (23 stands; 147 acres), southern shrub-carr (26 stands; 154 acres), and submergent marsh (16 stands; 121 acres). A total of 61 stands (730 acres) were too developed or degraded to be accommodated by the MNFI classification. The MiFI classification is intended to guide the management of state land for multiple uses, including game species, forestry, and biodiversity. Surveys resulted in a total of 17 forested L4 cover types (13 upland, 4 lowland) and 30 non-forested cover types (16 upland – including 6 developed types, 14 lowland) (Table 3, Figure A4). The most common upland forested cover type was 'Other Mixed Upland Deciduous' (L4199, 163 stands, 3,608 acres). These stands generally contain black oak (*Quercus velutina*) at below 40% in the canopy, have a significant component of red maple (*Acer rubrum*), wild black cherry (*Prunus serotina*), and sassafras (*Sassafras albidum*), and may include or be dominated by black walnut (*Juglans nigra*), or black locust (*Robinia pseudoacacia*). The two most common upland oak forested types, 'Black, Northern Pin Oak' (L4125) and 'Oak, Hickory' (L4120) also contributed significantly to the total (a combined 81 stands, 1,355 acres). The most common lowland forested cover type was 'Mixed Lowland Deciduous Forest' (L6199, 15 stands, 116 acres). The most common upland non-forested cover type was 'Herbaceous Openland' (L310, 8 stands, 157 acres), which includes several old fields and areas at least partially sown with native prairie plants, such as the "tank range" in TA6. The most common lowland non-forested cover types were 'Fen' (L6221, 9 stand, 126 acres) and 'Shrub-Carr' (L6222, 12 stands, 105 acres), representing wetland stands or complexes supporting a combination of prairie fen, southern shrub-carr, and southern wet meadow communities.

The NVC Classification is intended to provide a common framework for the classification of vegetation at the national scale. The crosswalk from MiFI to NVC land cover reclassifications generated 24 Plant Alliances (12 upland, 12 wetland), including the Anthropogenic Landscape Alliance for roads, parking lots, and mown grass (Table 4, Figure A5). The most common Alliance at FCTC was the Black Oak – White Oak North-Central Forest Alliance (A3226; 115 stands and 2,314 acres), which corresponds to dry-mesic southern forest and dry southern forest in the MNFI Natural Community Classification (Kost et al. 2007). The Red Maple – Black Cherry – Eastern White Pine Ruderal Forest Alliance (A3229; 70 stands, 1,924 acres) was nearly as common, and represents degraded dry and dry-mesic southern forest and a few occurrences of degraded mesic southern forest. Together, these two upland Alliances represent greater than 57% of the land cover at FCTC. Common wetland Alliances include Red-osier Dogwood – Gray Alder – Common Buttonbush Midwest Shrub Swamp Alliance (A4378; 40 stands, 175 acres), Red Maple – Ash species – Swamp White Oak Swamp Forest Alliance (A3881; 22 stands, 139 acres), and the Shrubby cinquefoil/Riddell's Goldenrod – Big Bluestem Graminoid Fen Alliance (A3704; 10 stands, 129 acres), collectively representing 6% of the land cover at FCTC. These Alliances correspond to southern shrub-carr or inundated shrub swamp, southern hardwood swamp, and prairie fen, respectively. A total of 413 acres over 29 stands were classified as 'Anthropogenic Landscape Alliance', representing developed lands not assignable to any NVC Alliance.

Table 4. Distribution of NVC Alliances across MiFI stands. Alliance hierarchy and descriptions in Tables A1-2. See Figure A5.

Alliance Common Name	Acode	Stands		Acres	
Forested Upland					
Sugar Maple - American Basswood - Northern Red Oak Forest Alliance	A0220	13	2.61%	107	1.45%
Black Oak - Northern Pin Oak Wooded Grassland Alliance	A1492	29	5.82%	329	4.45%
Tuliptree - Black Walnut - Black Locust Ruderal Forest Alliance	A3228	42	8.43%	660	8.93%
Red Maple - Black Cherry - Eastern White Pine Ruderal Forest Alliance	A3229	70	14.06%	1,924	26.04%
White Oak - Northern Red Oak - Hickory species North-Central Forest Alliance	A3323	37	7.43%	441	5.97%
Black Oak - White Oak North-Central Forest Alliance	A3326	115	23.09%	2,314	31.33%
Box-elder - Green Ash - Quaking Aspen Ruderal Forest Alliance	A4183	9	1.81%	185	2.50%
Subtotal:		315	63.25%	5,959	80.67%
Non-Forested Upland					
Orchardgrass - Fescue species - Canada Goldenrod Ruderal Mesic Meadow Alliance	A1190	23	4.62%	254	3.44%
Canada Bluegrass - Gray Goldenrod - Spotted Knapweed Ruderal Dry Meadow & Shrubland Alliance	A3934	1	0.20%	8	0.10%
Common Buckthorn - Multiflora Rose - Autumn-olive Ruderal Mesic Shrubland Alliance	A3935	9	1.81%	67	0.91%
Big Bluestem - Indiangrass - Stiff Tickseed Central Grassland Alliance	A4057	1	0.20%	4	0.05%
Anthropogenic Landscape Alliance	ADEG	29	5.82%	413	5.59%
Subtotal:		63	12.65%	745	10.09%
Forested Lowland					
Red Maple - Ash species - Swamp White Oak Swamp Forest Alliance	A3881	22	4.42%	139	1.89%
Tamarack - White Pine - Red Maple Midwest Swamp Alliance	A4397	1	0.20%	2	0.02%
Subtotal:		23	4.62%	141	1.91%
Non-Forested Lowland					
Reed Canarygrass Ruderal Marsh Alliance	A1381	1	0.20%	1	0.01%
Narrowleaf Cattail - Broadleaf Cattail - Bulrush species Deep Marsh Alliance	A1436	5	1.00%	23	0.32%
Hardstem Bulrush - River Bulrush - Softstem Bulrush Marsh Alliance	A3664	7	1.41%	28	0.38%
Shrubby-cinquefoil / Riddell's Goldenrod - Big Bluestem Graminoid Fen Alliance	A3704	10	2.01%	129	1.75%
American White Water-lily - Pond-lily species - Watershield Aquatic Vegetation Alliance	A4064	8	1.61%	94	1.27%
Pondweed species - Hornwort species - Waterweed species Aquatic Vegetation Alliance	A4066	4	0.80%	24	0.33%
Sedge species - Canada Bluejoint Midwest Wet Meadow Alliance	A4105	11	2.21%	36	0.49%
Duckweed species - Watermeal species - Common Duckmeat Aquatic Vegetation Alliance	A4147	5	1.00%	3	0.05%
Red-osier Dogwood - Gray Alder - Common Buttonbush Midwest Shrub Swamp Alliance	A4378	40	8.03%	175	2.37%
Leatherleaf / Few-seed Sedge Bog Alliance	A4399	6	1.20%	28	0.37%
Subtotal:		97	19.48%	542	7.33%
Total:		498		7,387	

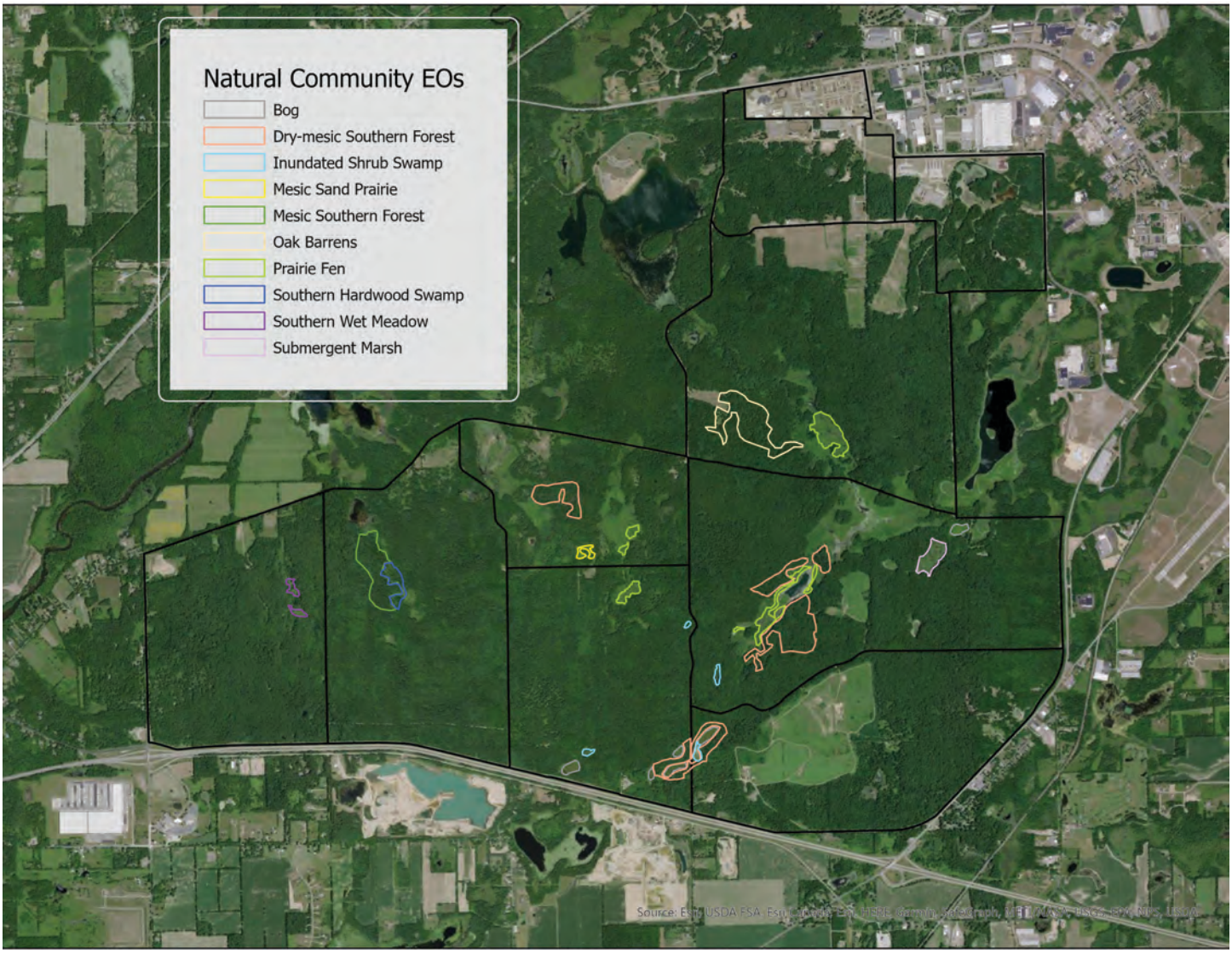

Figure 3. Natural community element occurrences (EOs) at Fort Custer Training Center.

Table 5. Summary of natural community element occurrences at Fort Custer Training Center. See Figures 3-8.

Name	EOID	Natural Community	TA	EO Rank	Hectares (Acres)	FQI	Mean C	Species richness (% native)
Mott Road Prairie	10017	Mesic Sand Prairie	7	C	1.0 (2.5)	38.1	3.3	133 (86%)
Longman Road Bogs*~	17650	Bog	5, 6	BC	4.7 (11.6)	32.8	5	43 (93%)
Perimeter Road Bog*	23896	Bog	8	C	1.1 (2.8)	26.9	5.6	23 (100%)
Mott Road Fen	5258	Prairie Fen	5, 7	BC	3.1 (7.8)	45.6	5	83 (96%)
Territorial Road Fen	16989	Prairie Fen	9	B	7.0 (17.4)	57.8	4.7	151 (93%)
Whitman Lake Fen	7503	Prairie Fen	8	BC	6.9 (17.1)	50.6	4.4	132 (92%)
42nd Road Seeps	9307	Southern Wet Meadow	3	C	1.7 (4.2)	37.8	3.6	110 (91%)
Bullfrog Marsh*	23900	Submergent Marsh	8	BC	4.5 (11.2)	37.9	5.6	53 (92%)
Longman Road Swamps*	23901	Inundated Shrub Swamp	5, 8	BC	2.1 (5.3)	28.6	4.7	37 (95%)
Cemetery Complex Seeps	3093	Southern Hardwood Swamp	4	B	3.7 (9.2)	55.9	4.3	169 (92%)
Cemetery Complex Ridge	8692	Mesic Southern Forest	4	BC	13.4 (33.2)	43.4	4.6	89 (93%)
Whitman Lake Woods	3628	Dry-mesic Southern Forest	4, 6, 8	B	30.4 (75.1)	57.7	4	208 (87%)
Saddleback Woodlands*	23953	Dry-mesic Southern Forest	7	BC	8.1 (20.1)	44.8	4.8	87 (94%)
Range 13 Barrens*	23951	Oak Barrens	9	CD	17.4 (43.1)	36.1	4.2	74 (91%)

*newly described since Cohen et al. 2009
~previously described in Thomas et al. 2009
See Appendix B for EO Rank descriptions

Natural community surveys
A summary of natural community EOs at FCTC is found in Table 5. FQA summaries for each natural community EO are in Appendix E. See Figures 3-8 for locations of natural communities within FCTC boundaries.

Mesic Sand Prairie
Globally Imperiled (G1), Critically Imperiled (S1) in Michigan

Photo 2. Showy tick-trefoil (*Desmodium canadense*) in foreground of Mott Road Prairie.

1. Mott Road Prairie (EOID 10017)
Size: 1.0 ha (2.5 A)
EO Rank: C
FQI: 38.1 (mean C: 3.3)
Species Richness: 133 (85.7% native)

Site Description: Mott Road Prairie is a small patch of mesic sand prairie in southern TA7, in a swale transitioning between prairie fen and shrub-carr lowlands to the west and the surrounding sandy upland oak ecosystems in the surrounding landscape (Figure 4). As one of only nine documented mesic sand prairies in Michigan, which range in size from 0.2 to 31 hectares, conservation of this unique community is of paramount importance (MNFI 2021). Plant species richness is very high in Mott Road Prairie, with 133 species documented over its 2.5 acres. The ecotonal nature of Mott Road Prairie, as it transitions quickly between xeric uplands and saturated lowlands likely contributes to this high richness by supporting both spatial heterogeneity of soil texture and moisture (Cohen et al. 2009, Costanza et al. 2011). A fluctuating water table adds additional heterogeneity. Mott Road Prairie supports an unique assemblage of species, including those typically found in prairie fen, such as shrubby cinquefoil (*Dasiphora fruticosa*) and Riddell's goldenrod (*Solidago riddellii*); wetland generalists, such as great blue lobelia (*Lobelia siphilitica*) and blue vervain (*Verbena hastata*); as well as prairie and savanna generalists, such as showy tick-trefoil (*Desmodium canadense*) (Photo 2), little bluestem (*Schizachyrium scoparium*), and Culver's root (*Veronicastrum virginicum*); and several native and non-native weedy species like tall goldenrod (*Solidago altissima*) and redtop (*Agrostis gigantea*), respectively. Mott Road Prairie was likely plowed for agriculture or heavily grazed historically, based on analysis of 1938 imagery (Figure 2). As a result, the species composition is derived at least in part from subsequent recolonization from the surrounding landscape after the cessation of agriculture after World War II.

Rare species documented in Mott Road Prairie include state-threatened vascular plant stiff gentian (*Gentianella quinquefolia*) and state special concern vertebrate animal, eastern box turtle (T*errapene carolina carolina*).

Management Recommendations: Invasive species and woody encroachment are the primary threats to the ecological integrity of Mott Road Prairie. High densities of woody species threaten plant diversity through competition for light and soil resources, especially of low-statured herbaceous species. The invasive shrubs autumn olive (*Elaeagnus umbellata*) and glossy buckthorn (*Frangula alnus*) are both dense in patches throughout, and the clonal opportunistic native species gray dogwood (*Cornus foemina*) and sassafras are encroaching from the sandy uplands along the margin. Additionally, the invasive herb purple loosestrife (*Lythrum salicaria*) is abundant, and the opportunistic clonal native herb tall goldenrod is also abundant in portions of the prairie. Ongoing efforts to reduce the abundance of woody and invasive species should continue. While frequent (at least every 3 years) prescribed fire is an indispensable tool for reducing the density of woody stems and stimulating the growth of native prairie species, continued manual control of invasive and opportunistic natives is also essential (Briggs et al. 2005, Wedel et al. 2021). The growth of species like tall goldenrod suggests excess fertility (i.e., high available nitrogen), possibly driven

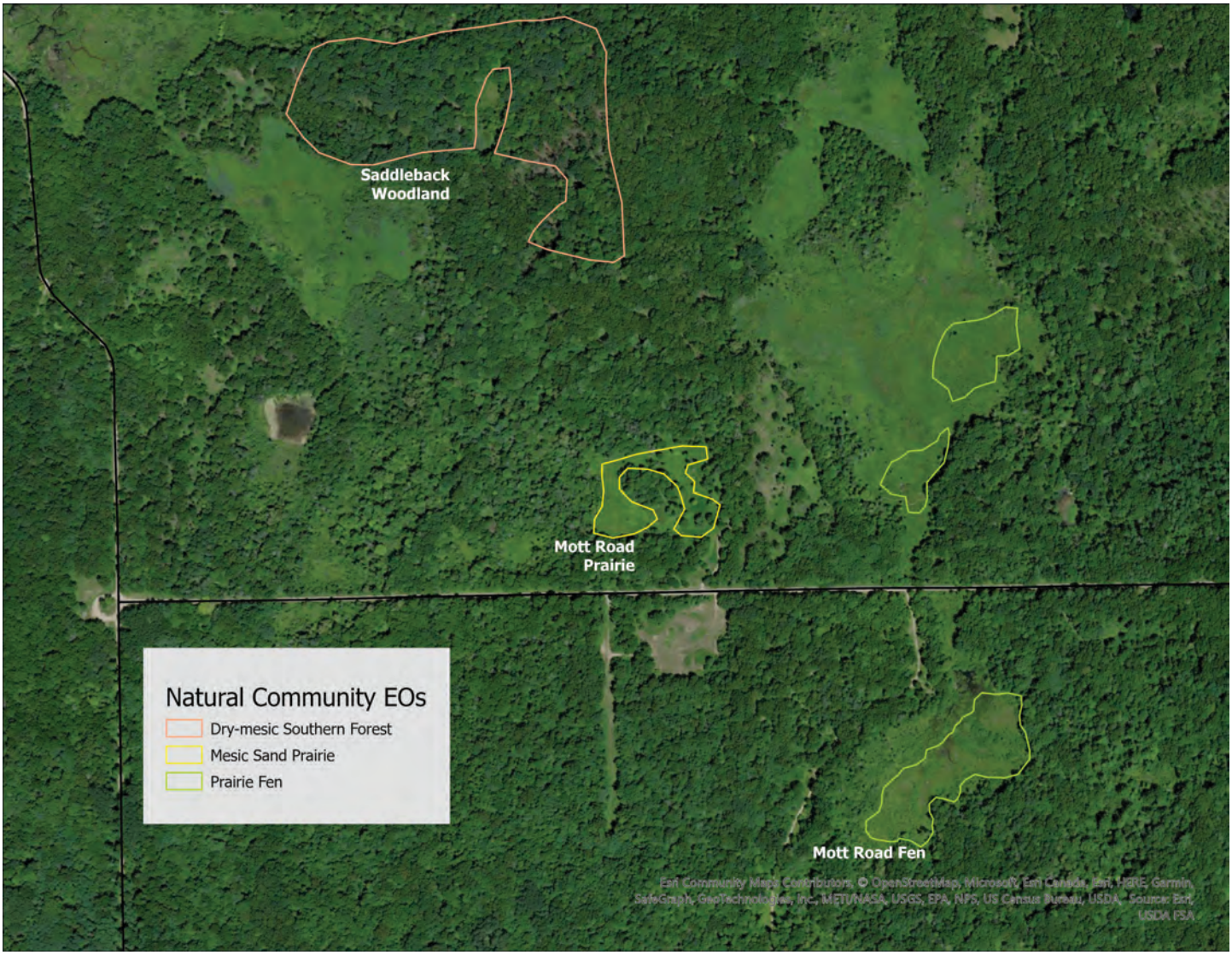

Figure 4. Mott Road Prairie (EOID 10017), Mott Road Fen (EOID 5258), and Saddleback Woodland (EOID 23953).

by the naturally high organic matter content of the prairie or due to the seasonality of prescribed fire (Howe 1995, Huberty et al. 1998). Growing season burns (e.g., in May or later) may be more effective in reducing the density of some clonal species such as sassafras or sumac, although effectiveness likely varies across edaphic or geographic gradients (Wedel et al. 2021). Box turtles used this area for nesting historically, and may do so in the future when open, sandy areas become available. It is important to consider box turtle use of this area when considering prescribing management treatments, especially fire. Herbicides should be applied with extra caution to not harm the state special concern black-and-gold bumble bee (*Bombus auricomus*), documented in the nearby Mott Road Fen and likely forages in Mott Road Prairie, either through direct impacts or by reducing floral resources.

Bog

Globally Vulnerable to Secure (G3G5), Apparently Secure (S4) in Michigan

1. Longman Road Bogs (EOID 17650)
Size: 4.7 ha (11.6 A)
EORank: BC
FQI: 32.8 (: 5.0)
Species Richness: 43 (93% native)

Site Description: Longman Road Bogs is distributed among five nearby kettlehole depressions in the southern portion of TAs 5 and 6 (Figure 5). This EO is newly documented since Cohen et al. (2009). One 1.3 ha (3.2 A) bog along southern Perimeter Road in TA5 was newly documented during this study. The other four, including 0.4, 1.1, and 0.5 ha (1.0, 2.8, and 1.3 A) bogs just west of Longman in TA5, and one 1.3 ha (3.3 A) bog in TA6 were documented

Figure 5. Longman Road Bogs (EOID 17650), Longman Road Swamps (EOID 23901), and southern portion of Whitman Lake Woods (EOID 3628). The remainder of Whitman Lake Woods can be seen in Figure 6.

in the interim during another unpublished study (MNFI 2021). There are a total of 125 documented bog EOs in Michigan, although Longman Road Bogs is only one of four documented in Kalamazoo County (MNFI 2021). Bogs are common in northern Michigan, where they occupy large expanses of glacial lakeplain and large kettleholes. In southern Michigan, bogs are generally smaller, relatively uncommon, and near the southern end of their distribution in the Great Lakes region, extending only into very northern Indiana and Ohio (NatureServe 2021). This series of small bogs varies structurally from a leatherleaf- (*Chamaedaphne calyculata*) (Photo 3) dominated community with a stable Sphagnum mat over poorly decomposed, saturated fibric peat; to very loose floating Sphagnum mat over a thin layer of more finely decomposed hemic peat with scattered patches of lake sedge (*Carex lacustris*), woolgrass (*Scirpus cyperinus*), three-way sedge (*Dulichium arundinaceum*), and swamp loosestrife (*Decodon verticillatus*). Well-developed bogs within this EO have a moat supporting elements of inundated shrub swamp – buttonbush (*Cephalanthus occidentalis*) and winterberry (*Ilex verticillata*) – and a community of aquatic plants including bladderworts *(Utricularia geminiscapa, U. minor, U. vulgaris*), duckweeds (*Lemna minor, L. turionifera*), watermeals (*Wolffia borealis, W. brasiliensis, W. columbiana*), and coontial and spiny hornwort (*Ceratophyllum demersum* and *C. echinatum*), among others. Bogs on the other extreme have more shallow moats with many of the same aquatic species mentioned above. The pH in these bogs is consistently very acidic, ranging from 4.5-5.0.

Rare species documented in Longman Road Bogs include state-threatened vascular plant, pointed watermeal (*Wolffia brasiliensis*); and state special concern vertebrate animal, eastern box. Additionally,

Photo 3. Longman Rd Bog (west of Longman Rd), shown here dominated by leatherleaf (*Chamaedaphne calyculata*).

state special concern vertebrate animal, Blanding's turtle (*Emydoidea blandingii*), has been documented between two of the bogs and has potential to occur within these bogs.

Management Recommendations:
Encroachment from invasive species, especially the invasive shrub glossy buckthorn and to a lesser extent purple loosestrife, is the primary threat to structure and composition of the bogs. Both species occur at low density and their control should be a high priority. Bogs are ombrotrophic peatlands, receiving inputs of water and nutrients primarily though surface flow and precipitation, and are sensitive to shifts in water quality, including temperature and pH (Cohen and Kost 2008a). Preventing erosion and retaining excess nutrients in adjacent uplands is an important priority to protect water quality in bogs, by avoiding logging on steep slopes and managing these adjacent forests for a diverse, vegetated ground layer through the application of prescribed fire.

2. Perimeter Road Bog (EOID 23896)
Size: 1.1 ha (2.8 A)
EORank: C
FQI: 26.9 (: 5.6)
Species Richness: 23 (100% native)

Site Description: This newly documented bog EO occurs in the northwest of TA8 adjacent to Perimeter or Hill Brady Road (Figure 6). As with Longman Road Bogs, Perimeter Road Bog is small at 2.8 acres. It is one of 3 documented bogs in Calhoun County. This small bog contains the typical zonation of this community type. A central stable peat mat occupies the majority of the area, ringed by a shrub zone that intermingles with an open water zone and shallow moat on the outer ring. The central peat mat is dominated by a chain fern (*Woodwardia virginica*) (Photo 4) over a dense bed of Sphagnum mosses, with a significant shrub component occurring in both clumps and scattered throughout. Common shrubs include poison sumac (*Toxicodendron vernix*), chokeberry (*Aronia prunifolia*), and highbush blueberry (*Vaccinium corymbosum*), as well as occasional red maple saplings. The Sphagnum is 10-20 cm thick, underlain by fibric peat (pH 4.5) to 10 cm, hemic peat to 20 cm (pH 5.0), below which is finely decomposed sapric peat (pH 5.0). The finely decomposed peat suggests recent dominance by sedges, an early stage of bog development (Cohen and Kost 2008a). The peat mat is surrounded by a relatively shallow moat and a ring of buttonbush, winterberry, and whorled loosestrife. There is a well-developed aquatic plant community in this shallow moat, including several bladderwort species (*Utricularia geminiscapa, U. minor, U. vulgaris*), as well as pondweed (*Stuckenia pectinata*) and duckweeds (*Lemna turionifera, Spirodela polyrhiza*). The construction and maintenance of Perimeter

Photo 4. Perimeter Road Bog, shown here dominated by chain fern (*Woodwardia virginica*).

Road, which flanks the eastern edge of this EO, may have historical or current hydrological impacts. The road separates this bog from an emergent and submergent marsh complex to the east. The bog may have historically extended further to the east into this complex, potentially grading into an emergent or submergent marsh complex. It is unclear whether the road is diverting surface water toward the marsh complex to the east, although that is certainly a possibility.

No rare species have been documented in Perimeter Road Bog, however, the state threatened Blanchard's cricket frog (*Acris blanchardii*) has been documented (EOID 11297) in the emergent marsh directly to the east across Perimeter Road. The presence of this species, which is very sensitive to changes to water quality, suggests that impacts to water quality in both this emergent marsh and in Perimeter Road Bog from Perimeter Road are minimal (Lee et al. 2000).

Photo 5. North patch of Mott Road Fen, with marsh valerian (*Valeriana uliginosa*) in foreground.

Management Recommendations: The primary management recommendation is annual monitoring for invasive species as no invasive species were observed in or adjacent to this bog. Glossy buckthorn, narrow-leaved or hybrid cattails (*Typha angustifolia* or *T. X glauca*), and non-native phragmites (*Phragmites australis var. australis*) are the invasive species that most often threaten bogs in southern Michigan and they are found in other areas at FCTC. Monitoring for these species could be adequately accomplished by scanning this bog from the upland margins with binoculars.

<u>Prairie Fen</u>
Globally Vulnerable (G3), Vulnerable (S3) in Michigan

1. Mott Road Prairie Fen (EOID 5258)
Size: 3.1 ha (7.8 A)
EO Rank: B
FQI: 45.6 (: 5.0)
Species Richness: 83 (96.4% native)

Site Description: Mott Road Fen consists of three patches of prairie fen in TAs 5 and 7 which occur

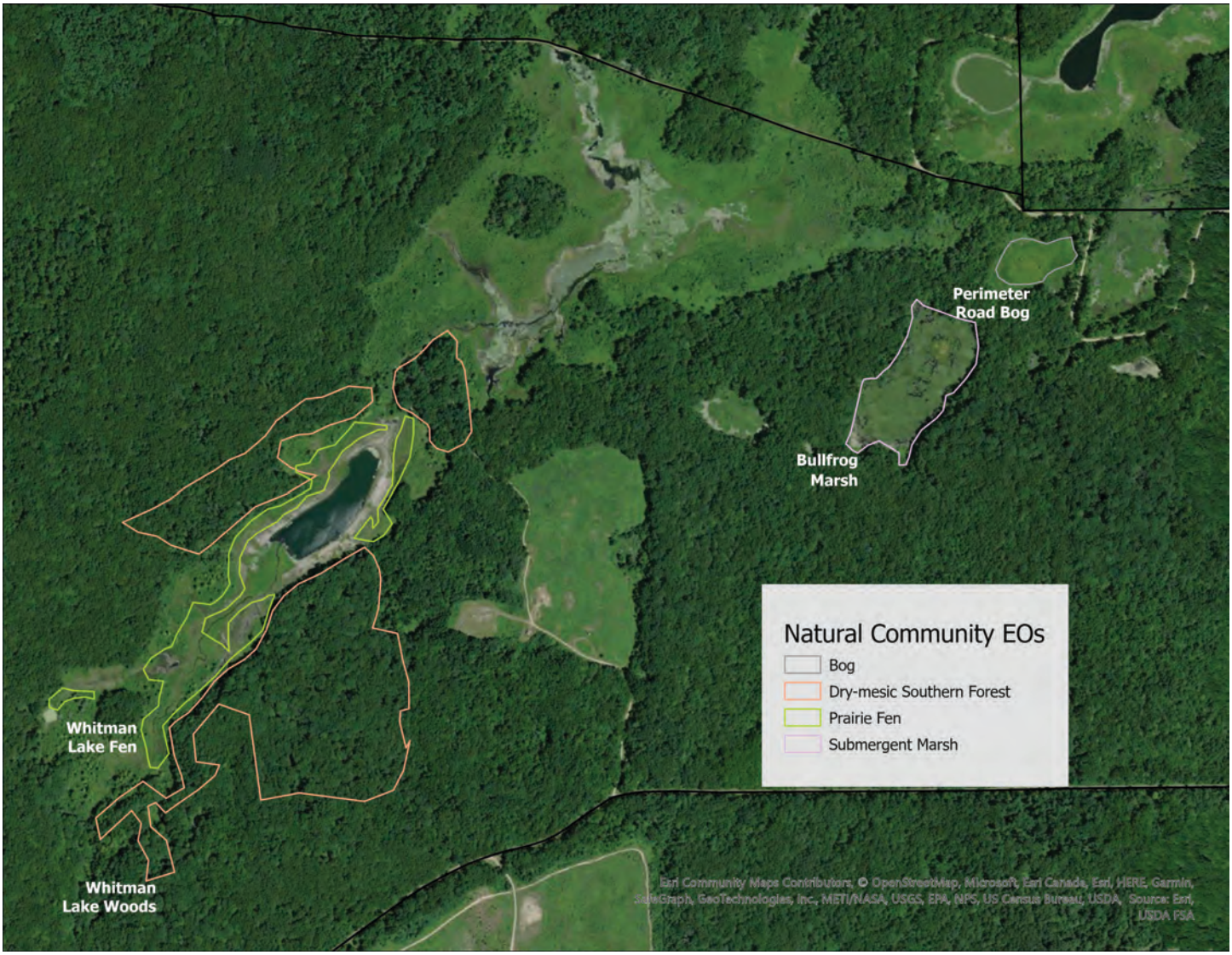

Figure 6. Perimeter Road Bog (EOID 23896), Bullfrog Marsh (EOID 23900), Whitman Lake Fen (EOID 7503), and northern portion of Whitman Lake Woods (EOID 3628). The remainder of Whitman Lake Woods can be seen in Figure 5.

on sloping peat or peat mounds within a matrix of a southern wet meadow complex including patches of southern shrub-carr and emergent marsh bisected by a narrow stream (Figure 4). One 1.8 ha (4.5 A) patch occurs south of Mott Road in TA5, and additional 0.5 and 0.9 ha (1.1 and 2.1 A) patches occur to the north of Mott Road in TA7. The northern most peat mound is higher than the surrounding wetland complex and is characterized by overwhelming dominance by tussock sedge (*Carex stricta*), a significant component of short-statured gray dogwood and marsh fern (*Thelypteris palustris*), and notable prairie fen indicator species such as shrubby cinquefoil and swamp valerian (*Valeriana uliginosa*) (Spieles et al. 1999; Photo 5). The patch of fen south of Mott Road is positioned on a sloping bed of peat and is bisected by spring runs and small sections of marl flat. Narrow-leaved sedges such as *Carex sterilis* and *C. lasiocarpa* are more common here, with a high degree of fine-scale diversity, although a willow (*Salix* spp.) dominates the portions with dense spring runs. The central patch along the stream just north of Mott Road is a small opening in coarse shrub-carr and wet meadow vegetation dominated by tussock sedge and less diverse than the larger peat mounds to the north and south. We adjusted the boundaries of this third patch during this study, expanding it slightly to better reflect the transition between prairie fen and other portions of the wetland complex. Several invasive species are occasional to locally common in and adjacent to Mott Road Fen. These are detailed below under *General Management Recommendations*.

Rare species documented in Mott Road Fen include state-threatened vascular plant, cut-leaved water parsnip (*Berula erecta*); state special concern vertebrate animals, Blanding's turtle, eastern box turtle, and pickerel frog (*Lithobates palustris*); and

Photo 6. Southern patch of Mott Road Fen, showing extensive beaver flooding, with water smartweed (*Persicaria amphibia*) in foreground.

state special concern invertebrate animals, black and gold bumble bee and golden borer (*Papaipema cerina*).

Management Recommendations: There are 161 prairie fen EOs documented in Michigan, including three at FCTC, and are well-documented in part because they have been a focus of conservation efforts. Prairie fens provide habitat for a disproportionately high number of rare species in Michigan, relative to most other natural communities, and are very sensitive to hydrological disruptions because they are strongly structured by groundwater seepage (Spieles et al. 1999). Therefore, high-quality prairie fens are an innately high priority for management and conservation. Invasive species are the primary threat to plant species diversity in Mott Road Fen. Purple loosestrife is sparse within the fen but common in the wet meadow matrix. The biocontrol beetle *Galerucella calmriensis* was released and monitored in the early 2000s to control purple loosestrife (INRMP 2020). Given the current abundance of purple loosestrife, additional releases are warranted to limit invasion into the fen. Glossy buckthorn and cattails (primarily the native *Typha latifolia*, but possibly the invasive *T. angustifolia* and *T. X glauca*) are both sparse in Mott Road Fen, in part due to historical control efforts. Glossy buckthorn occurs at generally low density in adjacent degraded wetlands whereas cattails are locally abundant in adjacent wetlands. Invasive common reed and reed canary grass (*Phalaris arundinacea*) were not observed in Mott Road Fen but occur in the wetland complex north of Mott Road, the latter at locally high abundance. Annual monitoring should occur for all invasive species within Mott Road Fen, as well as targeted efforts to control invasive species in the surrounding matrix, particularly glossy buckthorn and common reed. Beaver flooding is another potential threat to this fen, particularly to the south of Mott Road (Photo 6). Current flooding reaches the margins of this patch of fen, however, the broad seepage area to the south and the peat dome to the east appear unaffected. Annual monitoring of this fen should include assessing water levels associated with beaver flooding. If areas mapped within this EO become submerged, it may be necessary to remove dams or install a flow-through device. Herbicides should be applied with extra caution to not harm the state special concern black-and-gold bumble bee, documented in Mott Road Fen, either through direct impacts or by reducing floral resources.

2. Territorial Road Fen (EOID 16989)
Size: 7.0 ha (17.4 A)
EORank: B
FQI: 57.8 (: 4.7)
Species Richness: 151 (93.4% native)

Site Description: Territorial Road Fen is a diverse fen centered on a well-defined peat mound in a large wetland complex in southern TA9 bisected by the north-northwest-flowing Eagle Creek (Figure 1), hemmed-in by a narrow band of marl flats and broad areas of groundwater seepage (Figure 7). Narrow-leaved sedges *Carex lasiocarpa* and *C. sterilis* are co-dominant in this fen, along with twig-rush (*Cladium mariscoides*). Shrubby cinquefoil and swamp valerian are also common in the center of the peat mound, while a diversity of shrubs, including poison sumac and bog birch (*Betula pumila*), are abundant along the margins. Beaked spikerush (*Eleocharis rostellata*) forms a dense carpet in the extensive marl flats. Territorial Road Fen is structurally heterogenous, containing peat domes, streamside sedge meadow, southern shrub-carr, and marl flats in a large wetland complex in a broad stream basin associated with the north-northwest-flowing Eagle Creek.

The remainder of the complex is primarily degraded southern wet meadow, but includes southern shrub-carr, emergent marsh, and southern hardwood swamp. A large peat mound in the east-central of Territorial Road Fen harbors much of the vascular plant species richness, due in part to microheterogeneity associated with patches of *Sphagnum* moss. This peat mound is dominated by sedges (primarily *Carex sterilis* and *Cladium mariscoides*), while swamp valerian, goldenrods (primarily *Solidago uliginosa*, *S. ohiensis*), big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), shrubby cinquefoil, poison sumac, bog birch are common associates. A less-developed peat mound with minimal *Sphagnum* development, located across the stream in the southwest portion of the polygon, is less heterogenous yet also very diverse, dominated by Ohio goldenrod, tussock sedge. Marl flats are dominated by beaked spikerush. Streamside sedge meadow (Photo 6) is

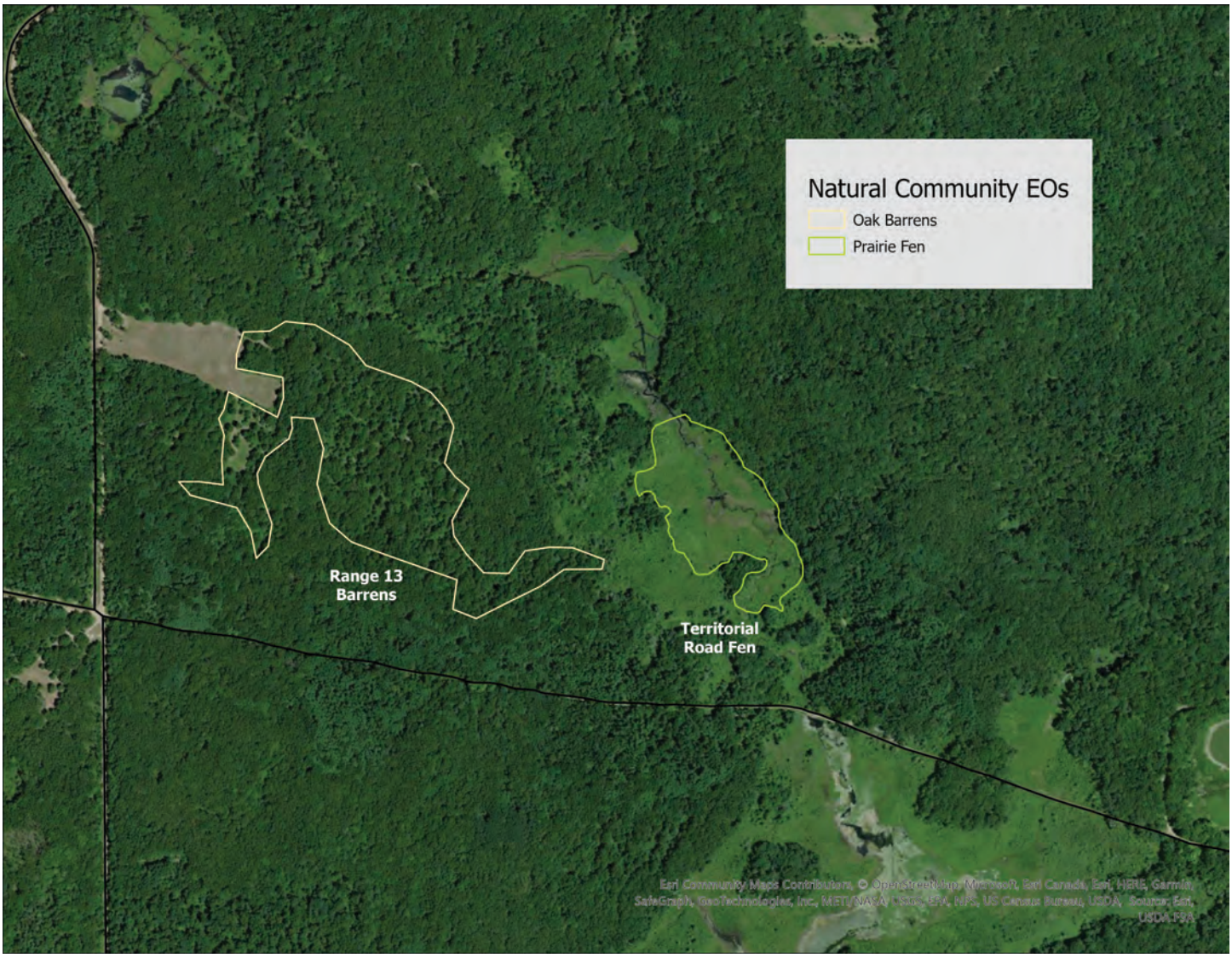

Figure 7. Territorial Road Fen (EOID 16989) and Range 13 Barrens (EOID23951).

Photo 6. Sedge-dominated portion of Territorial Road Fen.

dominated by tussock sedge, with rice cut-grass (*Leersia oryzoides*) and bur-reed (*Sparganium* sp.) common in standing water. Associated shrub-carr is dominated by dogwoods (*Cornus amomum, C. foemina, C. sericea*), and Bebb's willow (*Salix bebbiana*), poison sumac, and bog birch are common associates. The uncommon hybrid birch, *Betula X purpusii*, was also observed here (Photo 7). It is a hybrid between bog birch, which is common in the fen, and yellow birch (*Betula allegheniensis*) which is known from swamp forest to the north and west in the same drainage basin. Beavers are active in this wetland complex, although almost entirely within the Eagle Creek. Because of the breadth of this wetland basin, occasional ponding associated with beaver dams generally does not extend to the raised sections of peat mound supporting the majority of the plant diversity in Territorial Road Fen, or the marl flats associated with broad seepage areas along the margins of the mound.

Rare species documented in Territorial Road Fen include the vascular plants, state-threatened cut-leaved water parsnip and state special concern prairie dropseed (*Sporobolus heterolepis*); and state special concern vertebrate animals, Blanding's turtle and eastern box turtle.

Management Recommendations: Narrow-leaved cattail is well-established in patches throughout, include the diverse peat mound in the east of the fen. While regular prescribed fire is recommended for managing woody encroachment in this and other fens, narrow-leaved cattail often spreads more aggressively after fire. Therefore, it is recommended that narrow-leaved cattail be treated through direct application with herbicides (taking care to limit collateral damage to native species) prior to using prescribed fire in fens threatened by this invasive species. Other invasives include locally established reed canary grass, particularly in inundated margins of the stream, including portions affected by water level fluctuations associated with beaver damming. Water-level fluctuations associated with beaver activity have facilitated the establishment of invasive species in streamside sedge meadow, however, the peat mounds and adjacent marl flats that harbor the majority of the diversity are positioned above the typical high-water level and are not directly impacted. Reed canary grass should be controlled where observed to limit its spread into high quality areas.

Photo 7. Betula X purpusii, a hybrid of yellow (*B. allegheniensis*) and bog (*B. pumila*) birch, in Territorial Road Fen.

Photo 8. Tamarack-dominated portion of Whitman Lake Fen.

3. Whitman Lake Fen (EOID 7503)
Size: 6.9 ha (17.1 A)
EO Rank: BC
FQI: 50.6 (: 4.4)
Species Richness: 132 (91.7% native)

Site Description: Whitman Lake Fen occurs on sloping peat and marl flats adjacent to Whitman Lake in TA8 and a small feeder stream from the southwest and is punctuated by multiple seeps and spring runs (Figure 6). Whitman Lake Fen is comprised of multiple non-contiguous habitat patches within a structurally heterogenous wetland basin containing generally degraded submergent and emergent marsh, southern shrub-carr, and wet meadow. The boundaries of each patch, as described below, were adjusted during this study to include all areas of prairie fen more accurately and to distinguish between prairie fen and adjacent degraded communities. The majority of Whitman Lake Fen occurs on sloping peat and peat mounds. Portions of the fen with deeper peat are the most variable in structure in composition, although invasion by glossy buckthorn has homogenized large portions. These areas are dominated by tussock sedge, shrubby cinquefoil, and marsh fern, with frequent clumps of *Sphagnum* moss and scattered shrubs, such as willows (*Salix* spp.), poison sumac, and the non-native invasive glossy buckthorn. Other areas of sloping peat are bisected by spring runs and characterized by unstable substrates and are dominated by tussock sedge with frequent clumps of tufted hairgrass (*Deschampsia cespitosa*), forbs such as Ohio goldenrod (*Solidago ohiensis*), and expanding fronts of non-native invasive narrow-leaved cattail and native opportunist tall goldenrod. Areas of marl flat closer to Whitman Lake are dominated by beaked spikerush and threesquare (*Schoenoplectus pungens*) (PHOTO). We mapped a sparsely canopied patch of tamarack (*Larix laricina*) in the southwest of the fen that was previously not included in the EO. This understory of this tamarack swamp inclusion is dominated by tussock sedge and several shrub species (Photo 8). In the tamarack swamp inclusion, the tree canopy ranges from 0-40% cover (about 10% overall) and is composed entirely of tamarack ranging in size from 12 to 45 cm DBH, and in age from 25 to 64 years. Some standing dead trees are also present. Shrub cover is generally sparse, averaging about 30% cover. Poison sumac is the dominant shrub, although dogwood (*Cornus amomum, C. foemina*), willow (*Salix bebbiana, S. discolor, S. lucida*), and other species are present. The ground layer ranges from 60-100% cover, averaging about 90%, and is alternately thatchy, moist with seepage and mosses, and dense with sedges (mostly *Carex stricta, C. lasiocarpa*, and *C. sterilis*). There is patchy seepage, especially within the tamarack zone, alternating with dense sedge cover over solid peat. Several large *Sphagnum* mounds are present. The boundaries of the fen were adjusted to

more accurately to reflect this inclusion and some adjacent marl flat and seep. Beaver activity is apparent throughout the basin containing Whitman Lake Fen, with periodic inundation mostly of lower-lying portions of the wetland basin that are not mapped as part of Whitman Lake Fen. These lower areas may have historically supported a stable fen community, likely a diverse sedge meadow, but at the time of surveys support fast-growing opportunistic species that have recently established after the breaking of several dams, such as Joe-Pye weed (*Eutrochium maculatum*), boneset (*Eupatorium perfoliatum*), rice cut-grass, and nodding beggar-ticks (*Biden cernua*).

Rare species documented in Whitman Lake Fen include the vascular plants, state-threatened cut-leaved water parsnip and queen-of-the-prairie (*Filipendula rubra*), and state special concern prairie dropseed; state special concern vertebrate animals, eastern box turtle and pickerel frog; and state special concern invertebrate animal, watercress snail (*Fontigens nickliniana*).

Management Recommendations: Invasive species are the primary threat to biodiversity in many areas of this fen. These areas should be monitored annually for outbreaks of invasive species that may establish readily with the flush of available resources. Narrow-leaved cattails and hybrid are well-established, often in large patches throughout the fen. Control efforts should focus on small patches within high-quality fen, subsequently moving outward toward dense cattails on the margins of high-quality fen. A patch of invasive common reed is also well-established in the central northern portion of the fen. Recent efforts to control this species have been partially effective but will require annual treatments and monitoring. There are also patches of native common reed (*P. australis* var. *americanus*), so managers should take care to treat only the invasive species. Glossy buckthorn is well-established in dense monocultures within the fen and in adjacent degraded shrub-carr or wet meadow, particularly on peat mounds along the northern edge of the fen. Despite significant control efforts, the abundance of glossy buckthorn continues to degrade this fen and should remain a primary focus of control efforts, starting from high-quality fen closer to Whitman Lake and moving outward toward the adjacent upland slopes. Notably, a previously thriving population of state special concern prairie dropseed has been reduced by aggressive encroachment of glossy buckthorn over a very short period of time. Thorough control of glossy buckthorn in this fen should be a high priority, and this EO could be upranked if significant progress was made. As Whitman Lake Fen occurs largely on raised peat that remains above flood level, beaver activity is not a major threat to existing fen as currently mapped.

Photo 9. Mucky streambank with spicebush (*Lindera benzoin*), grasses and sedges along stream connecting two patches of 42nd Street Seeps.

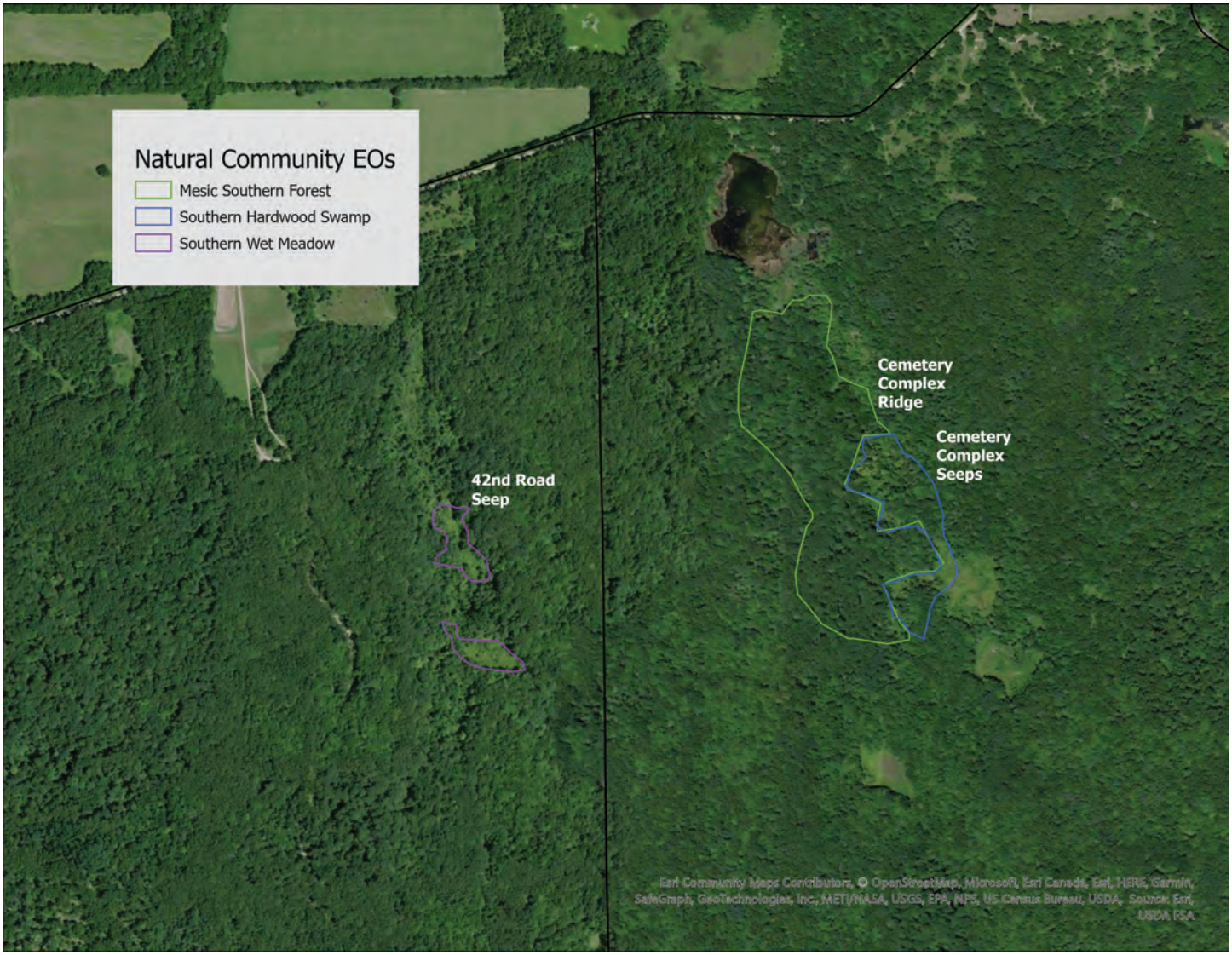

Figure 8. 42nd Road Seeps (EOID 9307), Cemetery Complex Seeps (EOID 3092), and Cemetery Complex Ridge (EOID 8692).

Southern Wet Meadow

Apparently Secure Globally (G4?) and Vulnerable (S3) in Michigan

1. 42nd Road Seep (EOID 9307)
Size: 1.7 ha (4.2 A)
EO Rank: C
FQI: 37.8 (: 3.6)
Species Richness: 110 (90.9% native)

Site Description: 42nd Road Seep occurs in a narrow drainage channel originating from a series of uphill groundwater seeps in eastern TA3 (Figure 8). It is composed of two patches, separated by a band of disturbed soil, possibly an anthropogenic berm, dominated by invasive honeysuckle (*Lonicera morrowii*, *L. tatarica*) and other shrubs. Southern wet meadow is a relatively common natural community in Michigan, although high-quality occurrences are few, with only 30 documented EOs in Michigan. This EO is transitional between southern wet meadow and southern shrub-carr. Structure is heterogenous throughout, with several large patches of native shrubs, especially spicebush (*Lindera benzoin*) and hazelnut (*Corylus americana*) (Photo 9), alternating with open sedge- and forb-dominated patches. Tussock sedge and lake sedge are common dominants. Common, weedy forbs such as jewelweed (*Impatiens capensis*), cleavers (*Galium aparine*), and rice cut-grass are locally dominant, while conservative species such as Riddell's goldenrod, swamp betony (*Pedicularis lanceolata*), and brown-eyed Susan (*Rudbeckia fulgida*) occur locally at low density. Several small seeps occur throughout and are likely responsible for maintaining heterogeneity by reducing shrub density locally.

Rare species documented in 42nd Road Seeps include a state special concern vertebrate animal, eastern box turtle. A population of goldenseal (*Hydrastis canadensis*) occurs south of this EO on the moist slopes of the basin, and may spread to the north, where suitable habitat occurs in seepy mineral soil along the shaded margins of 42nd Road Seeps.

Management Recommendations: Managing invasive species and woody encroachment overall are high priorities in the 42nd Road Seeps. The basin in which 42nd Road Seep occurs is very narrow with a high edge-to-area ratio, providing many points of entry from the adjacent forested slopes, which are degraded with a high density of invasive species such as multiflora rose (*Rosa multiflora*). A proliferation of invasive species from apparent soil disturbances within the wetland itself, and woody encroachment associated with the natural process of succession, are also contributing to the degradation of this southern wet meadow. Invasive bush honeysuckles (*Lonicera* spp.), glossy buckthorn, autumn olive, and multiflora rose occur throughout this wet meadow and are sometimes locally abundant. Invasive species should be managed mechanically and treated with herbicides. Additionally, including 42nd Road Seeps in landscape-scale prescribed fires used to manage the surrounding uplands should help to reduce encroachment of both native and invasive shrubs.

Submergent Marsh

Unrankable Globally (GU) and Apparently Secure in Michigan (G4)

1. Bullfrog Marsh (EOID 23900)
Size: 4.5 ha (11.2 A)
EO Rank: BC
FQI: 37.9 (: 5.6)
Species Richness: 53 (92.5% native)

Site Description: Bullfrog Marsh was newly documented during this study. This small marsh occurs in an isolated shallow kettle-hole depression in a band of coarse-textured end moraine in the northeast of TA8 (Figure 6). Submergent marsh occurs along the margins of most lakes and streams in Michigan, and far less commonly in isolated depressions where peat accumulation generally leads to the development of emergent plant communities like fens, wet meadows, bogs, and shrub-carr. This marsh, which is therefore a unique variant of this community type, is spring fed and has no apparent outlet. Seeps occur at the south end in a meadow on sloping highly alkaline (pH 7.5) peat, dominated by tussock sedge, blue-joint grass, and other wet meadow species, and likely occur locally throughout the marsh itself. In addition to the meadow at the south end, there are three well-defined zones. A narrow band of shrubs rings much of the perimeter. This zone is dominated by buttonbush and winterberry, with rice cut-grass and smartweeds (*Perscaria punctata, P. amphibium*) as common associates. The submergent zone that comprises the majority of the marsh is dominated by yellow water lily (*Nuphar advena*) in 1 to 2 meters of water, with locally abundant patches of another floating-leaved aquatic, water-shield (*Brasenia schreberi*) (Photo

Photo 10. Submergent and emergent vegetation in Bullfrog Marsh, dominated by yellow water lily (*Nuphar advena*).

10). Deeper troughs occur throughout, some likely excavated by beaver. There is a diverse submergent macrophyte community, including three pondweed species (*Potamogeton zosteriformis, P. natans*, and an unidentified narrow-leaved species), coontail and spiny hornwort, two bladderwort species (*Utricularia vulgaris* and *U. intermedia*), two duckweed species (*Lemna trisulca, Spirodela polyrhiza*), and species of the macroalga *Chara*. Soils are very deep, well-decomposed, circumneutral (pH 7.0) sapric peat.
A small, isolated sphagnum mat occupies less than one acre near the northeast corner (Photo 11). This somewhat acidic (pH 4.5-5.5), sedge-dominated peatland is a very small poor fen (Cohen and Kost 2008b). Wiregrass sedge (*Carex lasiocarpa*) and marsh fern are the dominant vascular plants, sharing dominance of this zone with *Sphagnum* mosses. This poor fen inclusion contributes significantly to the diversity of Bullfrog Marsh. Forbs such as purple gerardia (*Agalinis purpurea*) and swamp thistle (*Cirsium muticum*), graminoids such as fringed brome (*Bromus ciliatus*) and the sedge *Carex atlantica*, and shrubs such as poison sumac and bog willow (*Salix pedicellaris*) occur nowhere else in the marsh. Soils in the center of the sphagnum mat are fibric peat (pH 4.5) to 50 cm deep, over hemic peat (pH 5.5). Soils in the shrubby border of the mat are loose hemic peat (pH 7.5). Two beaver lodges were observed on the margins of Bullfrog Marsh. Because there is no stream or other outlet from this marsh, beaver do not appear to be drastically modifying the hydrology and are instead relying on the naturally stable water levels.

Rare species documented in Bullfrog Marsh include state threatened Blanchard's cricket frog (EOID 11297). This species has not been documented calling here since 1994, however habitat still exists and future surveys should be conducted to document this species.

Management Recommendations: Invasive species were only observed on the poor fen mat. Narrow-leaved cattail, purple loosestrife, and glossy buckthorn all occur at very low densities there. Control of these species is recommended in the next 2-3 years, before these populations expand. Annual or bi-annual monitoring for invasive species is recommended. In particular, hybrid and narrow-leaved cattails can form monocultures in submergent and emergent marsh communities and exclude other species, especially in marshes exposed to excess nutrients. Avoid clear-cutting the surrounding uplands, particular steep slopes, to reduce the input of excess nutrients into this

Photo 11. Peat island in northern portion of Bullfrog Marsh.

Photo 12. Large patch of Longman Road Swamps east of Longman Road, with buttonbush (*Cephalanthus occidentalis*).

marsh.

Inundated Shrub Swamp

Apparently Secure Globally (G4) and Vulnerable (S3) in Michigan

1. Longman Road Swamps (EOID 23901)
Size: 2.1 ha (5.3 A)
EO Rank: BC
FQI: 28.6 (: 4.7)
Species Richness: 37 (94.6% native)

Site Description: Longman Road Swamps were first documented during this study. This inundated shrub swamp EO is distributed among four isolated kettle-hole depressions and totals 5.3 acres (individual patches of 0.5, 1.1, 1.7, and 1.9 A) across TA 5, 6, and 8 (Figure 5). Inundated shrub swamps occur frequently in large and small kettlehole depressions in end moraines and glacial outwash in southern Michigan. The smallest patch (0.5 A) is directly west of Longman Road in TA5, north of the intersection with Sand Trail. It occupies a round depression surrounded by steep slopes. Zonation is well-defined, with a dense center of buttonbush in 0.5-1 meter of water densely covered in pointed watermeal and duckweeds (*Lemna trisulca*, *L. turionifera*, and *Spirodela polyrhiza*). The center zone is ringed with an emergent community dominated by smartweed (*Persicaria punctata*) and tickseed (*Bidens connata* and *B. frondosa*). Soils in this patch are mildly acidic (pH 6.0) deep clay with a thin layer of peat and leaf litter on top. The next largest patch (1.1 A) occurs between Engineer and Perimeter Roads in TA5 in a shallow depression. There are several dense patches of buttonbush and scattered winterberry in 1-2 meters of water, and several areas of open water. The open water supports a sparse aquatic macrophyte community of common duckweed (*Lemna minor*), coontail, and the aquatic liverwort, *Riccia fluitans*. Soils were not sampled in this swamp. The next largest swamp (1.7 A) occurs east of Longman in TA8, just north of Sand Trail, in a long narrow depression surrounded by steep slopes dominated by large-diameter oaks. Buttonbush clearly dominates this swamp, at approximately 75% cover, growing in water at a consistent depth of about 0.5 meters (Photo 12). The remainder includes some

open water with red duckweed (*Lemna turionifera*), greater duckweed, and common bladderwort (*Utricularia vulgaris*), and dense beds of pondweeds, *Potamogeton illinoensis and P natans*. Soils here are deep, circumneutral (pH 7.0) clay in the middle, with sandy-gravelly, slightly acidic (pH 6.5-7.0) clay along the margins. The largest swamp (1.9 A) occurs east of Longman Road in TA6, south of the intersection with Sand Trail, in the same depression and continuous with the moat of one of the Longman Road Bogs (EOID 17650). Buttonbush occurs in scattered, dense patches. The open water community has a dense cover of common, star, and great duckweed, dotted and common watermeal (*Wolffia borealis* and *W. columbiana*), as well as coontail, and humped and common bladderwort (*Utricularia gibba* and *U. vulgaris*). Soil here was mucky, loosely consolidated, circumneutral (pH 7.0) clay.

Rare species documented in Longman Road Swamps include state-threatened vascular plant, pointed watermeal; and state special concern vertebrate animals, Blanding's turtle and eastern box turtle.

Management Recommendations: Invasive species occur at very low density and are limited to narrow-leaved cattail on the margins of the smallest patch (directly west of Longman Road in TA5). No invasive species were observed in other swamps, however, glossy buckthorn is established in adjacent bogs. The primary recommendations are to monitor for invasive species annually or bi-annually, and to avoid logging in surrounding forests, particularly on steep slopes.

Photo 13. Patch of narrow-leaved spleenwort (*Homalosorus pycnocarpos*) in Cemetery Ridge Complex Seeps.

<u>Southern Hardwood Swamp</u>
Globally Vulnerable (G3) and Vulnerable (S3) in Michigan

1. Cemetery Complex Seeps (EOID 3093)
Size: 3.7 ha (9.2 A)
EO Rank: B
FQI: 55.9 (: 4.3)
Plant Species Richness: 169 (92.3% native)

Site Description: Cemetery Complex Seeps occurs within the floodplain of a narrow stream in central TA4 that spans over 30 meters in elevation, and in adjacent broad areas of groundwater seepage on steep forested slopes as well as localized flat areas of shrub-carr or sparse forest over deep peat deposits (Figure 8). Soils in a large proportion of Cemetery Complex Seeps are underlain by a dense layer of tufa, porous rocks formed from oxidized carbonate minerals (e.g., calcium, magnesium) precipitated from groundwater. Multiple spring runs bisect Cemetery Complex Seeps, leading to fine-scale structural heterogeneity. The southern shrub-carr is a characterized by sparse canopy of American elm (*Ulmus americana*) over shrub-carr dominated by spicebush, poison sumac, and red-osier dogwood (*Cornus sericea*), and a rich

ground layer dominated by sedges (*Carex bromoides* and *C. stricta*). The slopes below have a mixed canopy including red oak (*Quercus rubra*), tulip poplar (*Liriodendron tulipifera*), and basswood (*Tilia americana*), a dense shrub layer of musclewood (*Carpinus caroliniana*), spicebush, prickly gooseberry (*Ribes cynosbati*), and green ash (*Fraxinus pennsylvanica*) saplings. These slopes also support a hyper-diverse plant community, dominated by long-awned wood grass (*Brachyelytrum erectum*), bellwort (*Uvularia grandiflora*), richweed (*Collinsonia canadensis*), and early meadow rue (*Thalictrum dioicum*), with an abundance of ferns such as narrow-leaved spleenwort (*Homalosorus pycnocarpos*) (Photo 13), Goldie's fern (*Dryopteris goldiana*), and silvery spleenwort (*Deparia acrostichoides*). The narrow lower slopes along the stream include walnut and pawpaw (*Asimina triloba*) in the canopy and subcanopy, prickly ash (*Zanthoxylum americanum*) in the shrub layer, and a ground layer dominated by golden ragwort (*Packera aurea*) and black snakeroot (*Sanicula odorata*), and a diversity of other species, including Michigan lily (*Lilium michiganense*). The boundary between the Cemetery Complex Seeps and Ridge Mesic Southern Forest EO to the west is gradual and not very well-defined.

Rare plant species documented in Cemetery Complex Seeps include state threatened vascular plants cut-leaved water parsnip, showy orchis (*Galearis spectabilis*), red mulberry (*Morus rubra*), and an expansive population of goldenseal, and state special concern wahoo (*Euonymus atropurpurea*); state special concern vertebrate species eastern box turtle; and state special concern invertebrate species watercress snail. The populations of many of these species extend into the adjacent Cemetery Ridge Mesic Southern Forest EO along the steep slopes to the west.

Photo 14. Spring ephemeral plant community in Cemetery Complex Ridge.

Management Recommendations: Maintaining hydrology, controlling invasive species, and conserving the inordinately high concentration of rare species are all important management priorities in Cemetery Complex Seeps. In the context of FCTC as a whole, Cemetery Complex Seeps is a high priority for management, in large part due to high plant species diversity, and in particular the abundance of rare species. Its uniqueness in structure and hydrology, when compared to other occurrences of Southern Hardwood Swamp in Michigan, adds emphasis to that prioritization. The groundwater discharge that underlies the uniqueness and integrity of this swamp depends upon maintaining a continuous tree canopy on slopes directly adjacent to areas of groundwater discharge. Avoid or limit canopy thinning along the steep slopes above Cemetery Complex Seeps, and in the degraded forests in the surrounding landscape. Canopy mortality of green and black ash (*Fraxinus nigra*) due to the invasive insect emerald ash borer (*Agrilus planipennis*) has already led to sudden canopy gaps and associated increases in invasive species density. While they do not generally occur at high densities, invasive species are a primary and growing threat to plant diversity here, especially multiflora rose, but including Japanese barberry (*Berberis thunbergii*), oriental bittersweet (*Celastrus orbiculatus*), invasive bush honeysuckles, autumn olive, and glossy buckthorn. Monitoring and managing this and other invasive species should be a high priority in Cemetery Complex Seeps. Due to a preponderance of fire-sensitive species, prescribed fire should be avoided and mechanical control should be utilized. The investment of resources while invasive species are at low to moderate density increases the probability of controlling these species and prevents the need for much more costly investment of labor and materials to control dense infestations in the future.

<u>Mesic Southern Forest</u>
Imperiled to Vulnerable Globally (G2G3) and Vulnerable (S3) in Michigan

1. Cemetery Complex Ridge (EOID 8692)
Size: 13.4 ha (33.2 A)
EORank: BC
FQI: 43.4 (: 4.6)
Species Richness: 89 (93.3% native)

Site Description: Cemetery Complex Ridge occurs

on the shaded, east-facing slopes above Cemetery Complex Seeps in TA4 (Figure 8). This former dry-mesic southern forest EO was reclassified as a mesic southern forest based on the prevalence and diversity of spring ephemeral and mesophytic ground layer forbs and other plant species that are characteristic of mesic southern forest in Michigan (Photo 14). Natural communities occur as a continuum along several environmental gradients (e.g., soils, community composition), and this forest could arguably be considered on the "mesic extreme" of dry-mesic southern forest, or the "dry-mesic extreme" of mesic southern forest. It was initially classified as a dry-mesic southern forest (Legge et al. 1995) due to the dominance of red oak of the canopy, at about 60% overall and locally at 90%. Red oak is often prevalent in the canopy of both mesic and dry-mesic southern forests but typically only dominant in the latter. While red oak is dominant in the canopy of Cemetery Complex Ridge, the combined abundance of mesophytic species in the canopy is about 20%, including the typical mesic southern forest dominant, sugar maple (*Acer saccharum*), in addition to (*Celtis occidentalis*), basswood, tulip tree, and bitternut hickory (*Carya cordiformis*). The presence of a representative mesophytic ground layer strongly suggests that this EO should be classified and managed as a mesic forest. Mesophytic ground layer species present here include wooly bear sedge (*Carex albursina*), showy orchis, goldenseal, great waterleaf (*Hydrophyllum appendiculatum*), ginseng (*Panax quinquefolius*), wild blue phlox (*Phlox divaricata*), Christmas fern (*Polystichum acrostichoides*), and bloodroot (*Sanguinaria canadensis*). These mesophytic species depend upon the maintenance of a moist microclimate at ground level, which is maintained in part by the accumulation of leaf litter on the forest floor. Fire, a typical management tool for dry-mesic and not mesic communities, reduces the density of leaf litter and limits the microclimate on which these fire-sensitive species depend and is not appropriate here.

Rare species documented in Cemetery Complex Ridge include state threatened vascular plant species showy orchis, goldenseal, and ginseng; state special concern vertebrate species eastern box turtle and state threatened cerulean warbler (*Setophaga cerulea*). Cerulean warblers depend on the large patch of mature forest of Cemetery Seeps and Cemetery Ridge and especially the high dense canopy of red oak in Cemetery Complex Ridge. Large patches of forest with mature canopy that cerulean warbler and other neo-tropical migrant birds depend on are extremely rare in southern Michigan.

Management Recommendations: Invasive species, including non-native earthworms, constitute the most direct threat to species diversity and composition in Cemetery Complex Ridge, and maintaining closed-canopied conditions is also vital for maintaining appropriate light, temperature, and moisture conditions in mesic forest. Leaf litter maintains a moist microclimate at the ground level, which many mesophytic species and tree seedlings depend upon. Leaf decomposition is also important for building up soil organic matter and nutrient cycling. The presence of non-native earthworms can consume leaf litter at rates faster than they are deposited, leading to stressed conditions for native herbaceous ground layer species and tree seedlings, and facilitating the spread of invasive species such as garlic mustard (*Alliaria petiolata*) (Bohlen et al. 2004, Nuzzo et al. 2009). There is no known effective management for non-native earthworms. While occasional canopy gaps are important for allowing tree saplings to recruit into the canopy, large canopy gaps can also lead to conditions that are too warm and dry for many mesophytic species, as well as providing a large burst of light for invasive species to become firmly established in the understory. Similar to Cemetery Complex Seeps, the invasive shrub multiflora rose is a primary threat in Cemetery Complex Ridge, although autumn olive and Japanese barberry are also established and should be managed. Garlic mustard is also present, at densities low enough to be manageable. Invasive species within Cemetery Complex Ridge and Cemetery Complex Seeps and in forests immediately surrounding them should be managed simultaneously to reduce propagule pressure and limit reestablishment.

Dry-mesic Southern Forest
Apparently Secure Globally (G4) and Vulnerable (S3) in Michigan

1. Whitman Lake Woods (EOID 3628)
Size: 30.4 ha (75.1 A)
EO Rank: B
FQI: 57.7 (: 4.0)
Species Richness: 208 (87% native)

Photo 15. Diverse, fire-dependent ground layer in Whitman Lake Woods; northern bedstraw (*Galium boreale*) and others.

Site Description: Whitman Lake Woods is comprised of four patches, an 8.9 ha (22.1 A) patch on slopes above bogs in TA5 and 8 spanning Longman Road (Figure 5), and patches of 16.0, 4.9, and 2.5 ha (39.5, 12.1, and 6.1 A) in TA8 on slopes above Whitman Lake (Figure 6). Two existing polygons representing the boundaries of this EO were remapped and two new polygons were added. With these changes, the EO reduced in size from 114 acres to 75 acres overall but the overall condition of the EO is higher as portions of the EO that contained younger, more disturbed forest were removed. The two existing polygons (southern and central) were remapped to exclude younger forest with a sparse canopy in 1938 imagery and currently have higher invasive species densities. A small area in the southwestern edge was also excluded where a large contiguous patch of canopy trees was felled by straight-line winds associated with a *derecho* in July 2011. The southern polygon delineates the slopes above Longman Road Bogs (EOID 17650) on either side of Longman Road. White oak (*Quercus alba*) is abundant in the canopy of the western half of the southern polygon, particularly along a low flattish ridge between two bogs. The remainder of this polygon is dominated by a red and black oak. Repeated prescribed fires have maintained a diverse and generally open understory with a fair amount of oak regeneration, however, saplings of sassafras, cherry and red maple are becoming moderately dense in areas. Garlic mustard and other invasive species are beginning to encroach form the southern margin near the blowdown and should be monitored annually. The central polygon delineates an area south of Whitman Lake, including some mildly rolling topography dominated by black oak in the canopy, Pennsylvania sedge (*Carex pensylvanica*) in the ground layer, and including a small shallow kettle with a particularly high density of ferns such as interrupted fern (*Osmunda claytoniana*) and maidenhair fern (*Adiantum pedatum*). The north-facing slopes above Whitman Lake Fen (EOID 7503) are also very diverse, supporting a community of species with savanna affinities, including culver's root, alum root (*Heuchera americana*), hairy goldenrod (*Solidago hispida*), northern bedstraw (*Galium boreale*), and others (Photo 15). Mesophication, the shift from fire-dependent oak ecosystems to fire-sensitive mesic ecosystems that occurs when fire is suppressed long-term (see *General Management Recommendations* for a more detailed discussion), is not advanced in much of this polygon, except for some locally abundant wild black cherry saplings. Oak regeneration, which is limited in ecosystems experiencing mesophication, is sparse as well. Invasive species are encroaching from the more disturbed forest to the south. Two additional polygons were added to this EO during this study, a 4.7 A (1.9 ha) patch directly northeast of Whitman Lake and an 8.8 A (3.6 ha) northern patch on the south-facing slopes above Whitman Lake. This was based on field

Photo 16. Dappled light reaching ground and supporting ground layer diversity in Whitman Lake Woods. Note yellow flowers of downy false foxglove (*Aureolaria virginica*) in bottom center.

observations (e.g., canopy age and composition) and aerial imagery interpretation indicating these patches have been continually forested since at least 1938. The northeast polygon is an uneven-aged forest patch with moderate slopes facing primarily northwest, and a canopy co-dominated by red and black oak. Ground layer diversity is exceptionally high (85 native species recorded in this small patch). Oak regeneration is minimal to moderate, composed mostly of seedlings, while mesophication is moderate, composed mostly of cherry and sassafras. Some recently fallen trees at the top of the slope have increased light availability, and Japanese barberry and other invasives appear to be spreading in response to this sudden pulse of resources. The northern polygon, a steep, south-facing slope, is dominated by white oak. The understory is relatively open and ground layer composition includes many species with savanna affinities, including woodland sunflower (*Helianthus divaricatus*), rough hawkweed (*Hieracium scabrum*), violet bush clover (*Lespedeza violacea*), downy false foxglove (*Aureolaria virginica*), and others (Photo 16). Regeneration of both oaks and mesophytic species are relatively high in this portion of the EO. Invasive shrubs multiflora rose, autumn olive, and barberry are all locally abundant. The south-facing aspect, and additional light availability from recently downed canopy trees, contribute significantly to this regeneration.

Rare species documented in Whitman Lake Woods include state threatened vascular plant species beaked agrimony (*Agrimonia rostellata*) and upland boneset (*Eupatorium sessilifolium*), and state special concern species (recommended; see *Plant Surveys*) shining wedgegrass (*Sphenopholis nitida*); state threatened vertebrate animal cerulean warbler and state special concern hooded warbler (*Setophaga citrina*), eastern box turtle, and Blanding's turtle. See comments about cerulean warblers under Cemetery Complex Ridge.

Management Recommendations: Controlling invasive woody species and using prescribed fire to maintain and expand plant species diversity and oak regeneration are the primary management goals in Whitman Woods. Invasive shrubs are only very locally common or abundant and absent from Iarge swaths of Whitman Woods, but multiflora rose, Japanese barberry, and autumn olive are dense in a swale north of Whitman Lake, in gently rolling ground far back from the slopes south of the lake, and frequently along the edges of Whitman Lake Woods, adjacent to degraded forest stands. Annual or bi-annual monitoring for invasives, combined with concentrated efforts to reduce the density of invasive shrubs and mesophytic species, is recommended. The combination of manual control and regular prescribed fire is required to manage these infestations. Regular

Photo 17. Ground layer vegetation in central plateau of Saddleback Woodland.

prescribed fire, ideally every 3-5 years, should be continued to maintain and expand the ground layer plant diversity, open understory, and regeneration of oak saplings that are all characteristics of ecological integrity in this forest. Mesophytic trees wild black cherry and red maple, are locally dense in the sapling layers. Consider managing these species mechanically, concurrently with woody invasive species. As with other forested EOs at FCTC, white-tailed deer (*Odocoileus virginianus*) densities are likely limiting canopy regeneration and ground layer plant species diversity.

2. Saddleback Woodland (EOID 23953)
Size: 8.1 ha (20.1 A)
EO Rank: BC
FQI: 44.8 (: 4.8)
Species Richness: 87 (94.3% native)

Site Description: This is a newly documented EO occurring in central TA7 (Figure 4). On a broad ridge and adjacent sloping bowl between a fen complex to the west and a narrow stream valley to the north, Saddleback Woodland spans a range of slope, aspect, soil texture, and light availability over a relatively small area. Oak regeneration is notable in the understory, mesophytic trees are uncommon in the sapling layer, and the herbaceous component of the ground layer is abundant or dense in much of Saddleback Woodland. These indicators of ecological integrity are in part a response to the application of prescribed fire at FCTC. With an estimated dominant age of 170-180 years, multiple age classes were represented (92-268 years), suggesting long term pattern of canopy mortality and replacement (between 1920s and 1700s), due to windfall, disease, and fire mortality. Some dead-standing and large downed trees, moderate coarse woody debris, but also a few stumps indicating light thinning historically. This dry-mesic southern forest has inclusions of both oak barrens and dry southern forest. The core of the EO is a level plateau in the central-west and associated north- and east-facing slopes wrapping around a small boggy wetland dominated by lake sedge with patches of shrubs, including poison sumac, highbush blueberry, and winterberry. There is a patchy understory of Pennsylvania sedge and scattered shrubs and nearly closed-canopied conditions (estimated at 90%), maintaining moist conditions and a ground flora with forest affinities, such as wild geranium (*Geranium maculatum*), may apple (*Podophyllum peltatum*), and bluestem goldenrod (*Solidago caesia*) (Photo 17). Red oak and pignut hickory (*Carya glabra*) are prominent in the canopy here, although white and

Photo 18. Burn scars on oak (*Quercus* spp.) and hickory (*Carya* spp.) species in eastern portion of Saddleback Woodland.

black are co-dominant. Soils here rich sandy loam (pH 6.5) down to 10-12 cm, over ferric sand (pH 6.5), with a thin O-horizon. A small patch of 70-yr old bigtooth aspen (*Populus grandidentata*) in the west of this plateau corresponds with an old field visible in 1938 imagery. On the steep west-facing slope on the western extent of the EO, black oak is dominant and white oak co-dominant in the sparse canopy (50-60%), with very high oak regeneration in the understory. With high light availability, this slope supports a diverse community of species with savanna affinities, including woodland sunflower, dwarf dandelion (*Krigia biflora*), hairy bush clover (*Lespedeza hirta*), black oatgrass (*Piptochaetium avenaceum*) and a significant population of state threatened slender yellow flax (*Linum virginianum*). There are patches of bare soil due to erosion along the steep slope. Soils here are rocky loamy sand (pH 6.5) to 4-6 cm, over sand (pH 5.5). The O-horizon is negligible, and the A-horizon of loamy sand may be erodible due to steep slopes. In the east of the EO is a sloping bowl and associated west-facing slope with a drier microhabitat, an understory dominated by Pennsylvania sedge and a canopy (70-85%) dominated by black oak and containing likely Hill's oak (*Quercus ellipsoidalis*) (may be *Q. rubra*, *Q. velutina*, or hybrid *Q.* X *hawksiniae*) (Photo 18). Soils here are loamy sand (pH 5.5) to 6-8 cm, over sand. (pH 5.5). This dry southern forest inclusion occupies one-third to one-half of this EO and could be mapped separately.

Rare species documented in Saddleback Woodland include state threatened vascular plant species slender yellow flax, and (recommended; see *Plant Surveys*) shining wedgegrass. State special concern vertebrates, eastern box turtle and Blanding's turtle, also have been documented within this natural community or in the wetland immediately adjacent to it.

Management Recommendations: Prescribed fire

has been effective at creating an open understory by reducing understory woody density and increasing light availability to the ground layer. Maintain regular (every 3-5 years) prescribed fire to maintain an open understory, limit mesophytic species, and encourage oak regeneration and recruitment into the overstory. Consider adjusting the timing and extent of fire and potential impacts on eastern box turtles and Blanding's turtles. An increasingly heterogenous light environment due to scattered canopy mortality, due in part to prescribed fire and potentially select canopy thinning of mesophytic species, should be a secondary but important priority. The degree of canopy removal should depend on monitoring the ground layer response to management with fire, particularly the increasing abundance of ground layer species with savanna affinities. Herbicides should be applied with extra caution to not harm the state special concern black-and-gold bumble bee, documented in the nearby Mott Road Fen and likely forages in Mott Road Prairie, either through direct impacts or by reducing floral resources.

Oak Barrens

Possibly Imperiled Globally (G2?) and Critically Imperiled in Michigan (S1)

1. Range 13 Barrens (EOID 23951)
Size: 17.4 ha (43.1 A)
EO Rank: CD
FQI: 36.1 (: 4.2)
Species Richness: 75 (90.5% native)

Site Description: Range 13 Barrens is a newly documented EO occurring in southwestern TA9 near Range 13 (Figure 8). The canopy, which on average is at least 60% cover and patchy with multiple open gaps, is dominated by black oak, with occasional white oak, sassafras, and wild black cherry. Comparison of current and historical aerial imagery shows considerable canopy closure since 1998 when canopy cover was 30-40%. According to 1938 aerial imagery, Range 13 Barrens has a history of tillage agriculture, which presumably led to local extirpation of many ground layer species. However, many characteristic barrens species occur here today, having persisted in the seedbank or dispersed into the site after the cessation of agriculture, which likely occurred in the 1940s. The dominant canopy trees are less than 80 years old, consistent with this timing. The generally sparse ground layer is locally dominated by patches of different species - Kentucky and Canada bluegrass (*Poa pratensis* and *P. compressa*), Pennsylvania sedge, dewberry (*Rubus flagellaris*), little bluestem, and black oak seedlings and leaf litter, in decreasing order of frequency. Patches of bare soil are common, generally associated with local dominance of non-vascular taxa such as reindeer lichen (*Cladonia* spp.) and haircap moss (*Polytrichum* spp.) (Photo 19). Recent prescribed fire has been

Photo 19. Sparsely vegetation ground layer in Range 13 Barrens, dominated by non-vascular plants.

partially effective at slowing woody encroachment, although clones of sassafras and shining sumac (*Rhus copallina*) are dense in areas and locally shade out conservative barrens species. Some characteristic conservative forbs such as rough blazing star *(Liatris aspera*), wild lupine (*Lupinus perennis*), and green milkweed *(Asclepias viridiflora*) occur occasionally, as well as other fire-dependent, conservative species such as black oatgrass and New Jersey tea (*Ceanothus americanus*). A large population of state special concern leadplant (*Amorpha canescens*) is thriving here, primarily associated with former tree rows. Oak regeneration is high, contains multiple age classes, is dominated by black oak but contains white oak of multiple classes. Autumn olive is dense in occasional clumps; multiflora rose, Japanese barberry and Morrow's honeysuckle (*Lonicera morrowii*) are uncommon but found throughout; and spotted knapweed (*Centaurea stoebe*) occurs rarely. Soils are sandy loam or loamy sand up to 13 cm, over loamy sand or sand (pH 5.5) with minimal detectable O-horizon.

Rare species documented in Range 13 Barrens include state special concern vascular plant species leadplant. Leadplant is the larval host for the state endangered leadplant moth (*Schinia lucens*), and the abundance of its host species at FCTC (as well as in the adjacent FCRA), suggests the potential for the presence of this rare insect.

Management Recommendations: Regular prescribed fire is vital for the persistence of this oak barrens. Expanding some of the openings containing heliophytic ground flora may be beneficial for several of these species, especially where the canopy is expanding into gaps and increasing shade. Dominance by bluegrass species higher in areas of high shade, so could be reduced by increasing canopy openness and repeated prescribed fire. The subcanopy is fairly dense (upwards of 75% cover).

Plant Surveys

INTRODUCTION

A diversity of vascular plant species thrive at FCTC due to large patches of contiguous habitat with a diversity of natural communities. This diversity is supported by a long history of prudent ecological management. As of 2009 (Cohen et al.), 839 vascular plant species had been documented at FCTC, including 18 species listed as threatened, endangered, or special concern in Michigan and tracked in MNFI's Natural Heritage Database (MNFI 2021), accounting for a total of 36 vascular plant element occurrences (EOs). However, given the large area covered and the diversity of habitats therein, it is unrealistic to assume that previous surveys have documented every plant species that the natural communities of FCTC can support. The size and detectability of many plant populations fluctuate demographically and in response to succession as a natural ecological process or in response to ongoing ecosystem management such as fire. Additionally, the protected status of several plant species has changed since MNFI surveys in 2007-2008, resulting in species that are both newly tracked and those that are no longer tracked as state-listed species (MNFI 2021). The decline or expansion of rare species populations can also serve as an indicator for the ecological integrity of natural communities. Updating the status of the flora of FCTC, especially that of listed species, is vital to guiding ecosystem management. Plant surveys were conducted to achieve the following objectives: 1) update known existing occurrences of listed plant species, 2) document any new occurrences of listed species; and 3) document the presence of non-listed species previously not documented at FCTC.

METHODS

Prior to conducting surveys, we reviewed all known listed plant EOs and examined the habitat types and natural community EOs at FCTC to assemble a list of potential survey targets (Cohen et al. 2009, Thomas et al. 2009, INRMP 2020, MNFI 2021). We also reviewed data from surveys conducted since 2009 for reports of additional species or occurrences (INRMP 2020). Plant surveys were focused on updating occurrences of previously documented listed species, documenting new occurrences of listed species, and documenting non-listed vascular plant species not previously documented at FCTC. We conducted targeted meander surveys for listed species within known and likely occupied habitat, as well as recording incidental observations made during ecological and animal surveys. We did not conduct targeted surveys for non-listed species. Using existing spatial and tabular data on the locations and habitat descriptions from the MNFI Natural Heritage Database (2021) and other sources, we used georeferenced maps to aid in navigation and relocation of existing EOs. When observations of listed species were made, we recorded the location with the Avenza application on a Samsung Galaxy 8A tablet, or noted the location in field notebooks in reference to a landmark such as a road, water body, or MiFI stand (see Figures A2-4). We collected data on the population size, ecological condition, and landscape context for each rare plant occurrence, noting associated species, threats to the viability of populations, and overall habitat quality. When observations were made of listed or non-listed species not previously documented at FCTC, we recorded the location as above, and documented the occurrence with a photograph or by collecting a voucher specimen. Specimens are vouchered at the Michigan State University Herbarium, and where collection of multiple specimens were made, additional vouchers provided to the University of Michigan Herbarium and FCTC.

RESULTS AND DISCUSSION

Rare plant surveys

We documented nine new and updated 32 existing EOs of 18 listed vascular plant species, including four EOs we were unable to relocate (Table 6). Two of the 18 species are newly documented at FCTC, including pale avens (Geum virginianum, state threatened) and pointed watermeal (Wolffia brasiliensis, state threatened). Additionally, we documented three populations of shining wedgegrass (*Sphenopholis nitida*, not listed), which is believed to be in decline and has been recommended for listing by the rare plant technical advisory committee (Reznicek et al. 2019). Pointed watermeal has recently been recommended for delisting, because many recent reports indicate this species are more common than previously believed

Table 6. Summary of rare plant element occurrences at Fort Custer Training Center.

Scientific Name	Common Name	Training Areas	State Status	Updates	New	Not Located
Agrimonia rostellata	Beaked agrimony	5, 8, 9	T**	2	1	
Amorpha canescens	Leadplant	9	SC	2		
Berula erecta	Cut-leaved water parsnip	4, 5, 7, 8, 9	T**	4		
Corydalis flavula	Yellow fumewort	1, 2, 4, 7, 8, 9	T	6		
Cuscuta pentagona	Dodder	7	SC	1		
Euonymus atropurpureus	Wahoo	4	SC			1
Eupatorium sessilifolium	Upland boneset	8, 9	T	1	1	
Filipendula rubra	Queen-of-the-prairie	7, 8	T	1		1
Galearis spectabilis	Showy orchis	4, 7	T	1		1
Gentianella quinquefolia	Stiff gentain	4, 5, 6	T	2		
*Geum virginianum**	Pale avens	9	SC**		1	
Hydrastis canadensis	Goldenseal	3, 4, 5	T	3		
Linum virginianum	Virginia flax	7, 9	T	1		1
Morus rubra	Red mulberry	4	T	1		
Panax quinquefolius	Ginseng	4	T	1		
*Sphenopholis nitida**	Shining wedgegrass	7, 8, 9	NA**		3	
Spiranthes ovalis	Oval ladie's-tresses	4	T**	1		
Sporobolus heterolepis	Prairie dropseed	8, 9	SC	1		
*Wolffia brasiliensis**	Pointed water meal	5, 6, 9	T**		3	

*newly documented species at FCTC

** status change recommended *(see text)*

(Reznicek et al. 2019). We include pointed watermeal here as this is the first report of this species from FCTC.

Modifications have been made to the list of species tracked in MNFI's Natural Heritage Database since 2009. Two species that were included in the previous study are not included here. Purple twayblade (*Liparis liliifolia*), formerly a species of special concern, was delisted in 2009. Chestnut (*Castanea dentata*) is not included here despite being listed as endangered in Michigan. The native range of chestnut is now considered to be limited to the southeastern portion of the state and occurrences outside its native range are considered to result from cultivation and therefore are not afforded legal protection (Voss and Reznicek 2012).

Below, we summarize the *distribution and status* of each listed plant species at FCTC, provide context on the statewide *significance* of FCTC occurrences, and give recommendations on the *conservation and management* of each species. The value of FCTC occurrences to statewide conservation is best considered in the context of those EOs represented by extant populations. When taking the statewide significance of FCTC occurrences of each species into account, we refer to the number of occurrences of each species that are *likely extant* in Michigan. Occurrences are considered to not be likely extant if they were previously documented but are now considered *extirpated* (i.e., due to development) or *historical*, species that have not been observed in at least 30 years. FCTC occurrences may be a small proportion of total EOs, but a large proportion of likely extant EOs, so including extirpated and historical EOs in the comparison may underestimate the importance of FCTC for the conservation of each rare species.

Beaked agrimony *(Agrimonia rostellata)*

Globally secure (G5); Imperiled (S2) and listed as Threatened (T) in Michigan

Beaked agrimony is a perennial forb associated with upland forests in southern Michigan, primarily but not exclusively those dominated by oak species, and

Photo 20. Beaked agrimony, showing glandular and essentially hairless axis of inflorescence.

shadier portions of barrens and savannas. It is common across much of eastern North America and considered imperiled or vulnerable in Delaware, Michigan, Nebraska, and New York (NatureServe 2021).

FCTC Distribution and Status: We documented one new occurrence of beaked agrimony (EOID 23660), additional sub-populations associated with a second occurrence (EOID 960), and confirmed the persistence of a third (EOID 8680). Beaked agrimony is mostly associated with high-quality dry-mesic southern forest at FCTC and elsewhere in southern Michigan but appears to also persist in degraded forests under large-diameter oaks in old tree rows and uncut margins of lakes and swamps. Two occurrences, in Whitman Woods west of Longman Road in TA5 and on slopes above Hart's Lake in TA9, comprise large populations, both totaling nearly one hundred individuals within a relatively small area (< 1 ha). Additional observations near Hart's Lake, in degraded forest to the north and south, are composed of widely scattered individuals and small discrete patches of a few individuals.

Significance: Statewide, three of the ten likely extant occurrences of beaked agrimony occur at FCTC (MNFI 2021). Therefore, conservation of this species at FCTC contributes significantly to its status in Michigan. While populations of this species may be expanding at FCTC due to prescribed fire and invasive species management, beaked agrimony may also be more common than was once thought but has escaped detection in the past. Multiple sub-populations occur in degraded forests, although likely associated with old tree rows. The ability of this species to disperse into regenerating, post-agricultural forests and establish stable sub-populations is not clear. The Technical Committee has recommended that the state status of beaked agrimony be changed from threatened to special concern (Reznicek et al. 2019).

Conservation and Management: With the addition of new sub-populations and one new EO, further monitoring and surveys for beaked agrimony is warranted to better characterize the extent of the species at FCTC. Focused surveys in existing populations and other likely habitat are needed to better understand the population status of this species at FCTC. Beaked agrimony likely benefits from prescribed fire and invasive species control that allow light penetration to the ground layer, reduces leaf litter and competition from fire-sensitive species, and stimulates germination.

Leadplant *(Amorpha canescens)*

Globally secure (G5); Vulnerable (S2) and listed as Special Concern (SC) in Michigan

Leadplant is a long-lived perennial shrub associated with prairies and open savannas, concentrated in southwestern Michigan, particularly in dry, sandy soils, and can persist for long periods of time in a great deal of shade (Penskar 2008). In Michigan, leadplant is rare due to the degradation of prairie and savanna habitat. It is common across much of the Great Plains and considered imperiled or vulnerable in Arkansas, Manitoba, Michigan, Montana, Ontario, and Wyoming. (NatureServe 2021).

FCTC Distribution and Status: We updated two EOs of leadplant in dry southern forest and oak barrens in TA9, occurring north (EOID 16936) and south (EOID 7094) of Eagle Creek, respectively. Both EOs are comprised of multiple sub-populations, each containing multiple individuals. The northern EO

Photo 21. Leadplant, blooming in filtered light following prescribed fire.

contained three sub-populations, including one newly documented in 2019. We did not relocate the eastern sub-population along Reese Road, but the central sub-population at the north end of an old field persists and we documented a third along an old tree row to the west. The southern EO, to the east and southeast of Range 13, contains four sub-populations. We were unable to relocate the two southern sub-populations in this EO, although the northern two sub-populations were composed of nearly 150 individuals, including a few seedlings. However, due to competition for light from encroaching trees and shrubs, only approximately 10 individuals among the 100s at FCTC were observed flowering or fruiting.

Significance: Statewide, two of 36 likely extant EOs occur at FCTC, with an additional two at the adjacent FCRA. Collectively, these four EOs represent a significant concentration of large populations with the potential to thrive under ongoing prescribed fire management. Several other EOs in Michigan are comprised of very few individuals in areas such as road rights-of-way that limit management opportunities. Leadplant is the sole larval food plant for the state endangered leadplant moth (*Schinia lucens*). Surveys for this rare moth are encouraged, considering the large concentration of leadplant at FCTC and FCRA.

Conservation and Management: Throughout Michigan, leadplant is threatened by loss and degradation of its habitat (Penskar 2008). Prescribed fire management is essential to the persistence of leadplant in Michigan. Despite liberal use of fire, leadplant is threatened by shade from tree and shrub encroachment where it persists at FCTC. Consider focused woody species management in all areas where leadplant is found, focusing on all shrub and sapling stems around leadplant individuals, as well as mesophytic canopy trees such as wild black cherry (*Prunus serotina*).

Cut-leaved water parsnip *(Berula erecta)*

Globally apparently secure to secure (G4G5); Imperiled (S2) and listed as Threatened (T) in Michigan

Cut-leaved water parsnip is a low-statured perennial forb associated with cool, alkaline seeps and spring runs in prairie fens and hardwood and conifer swamps. The species is found throughout much of the southern Lower Peninsula. It is common in western North America to the Great Plains but occurs sparingly in the Midwest. It is considered imperiled or vulnerable in Arizona, British Columbia, Iowa, Minnesota, Michigan, Oklahoma, and Wyoming (NatureServe 2021).

FCTC Distribution and Status: We updated four EOs of cut-leaved water parsnip at FCTC, each composed of multiple small and large sub-populations found in individual seeps or spring runs. The four EOs correspond to three major sub-watersheds: one along Eagle Creek in TAs 8 and 9 including Whitman Lake and Territorial Road fens (EOID 1148); two associated with unnamed seeps and spring runs in TAs 5 and 7, one in Mott Road fen (EOID 5164) and one in areas downstream of Mott Road fen including Mitchell's Pond (EOID 10329); and one associated with Cemetery Complex Seeps in TA4 (EOID 8104). Significance: Statewide, four of the 44 likely extant EOs of this species occur within FCTC. The species is widespread, with 64 documented EOs (including those not likely extant) in the western half of Michigan's

Photos 22 and 23. Cut-leaved water parsnip basal leaves (below) and flowering stalks (above).

Lower Peninsula, and 23 of these EOs in Kalamazoo County. While regionally common, cut-leaved water parsnip is limited to sensitive microhabitats dependent on the maintenance of groundwater hydrology, which FCTC is uniquely positioned to do by managing large areas of wetlands and contiguous uplands. The Technical Committee has recommended that the state status of cut-leaved water parsnip be changed from threatened to special concern (Reznicek et al. 2019).

Conservation and Management: Cut-leaved water parsnip is limited to localized areas of groundwater discharge, or spring runs, so is highly dependent on maintaining groundwater recharge in the surrounding landscape by limiting impervious surfaces and overall maintaining vegetated land cover to capture precipitation and limit runoff (Abbas 2011). Spring runs receive water from both local "groundwater mounds" and from multiple regional groundwater sources, making it difficult to predict which recharge areas (e.g., upland habitats receiving precipitation) are contributing to a specific discharge area such as a seep or spring (Sampath et al. 2016). FCTC manages large contiguous areas of the landscape that serve as the recharge areas for groundwater-dependent wetlands both on and off site. Maintaining native vegetated upland cover, ideally diverse high quality native habitats, is vital for reducing runoff and increasing infiltration into groundwater aquifers that ensure the long-term persistence of cut-leaved water parsnip (Dripps and Bradbury 2010, Schenk et al. 2020).

Yellow fumewort *(Corydalis flavula)*

Globally secure (G5); Imperiled (S2) and listed as Threatened (T) in Michigan

Yellow fumewort is known in Michigan from floodplain forests and early successional upland forests dominated by black locust (*Robinia psuedoacacia*) and is limited in distribution to two southwestern counties, Berrien and Kalamazoo. The majority of Michigan occurrences are known from black locust stands in FCTC, FCRA, and FCNC. It is common in floodplains and throughout eastern North America, and considered imperiled or vulnerable in Connecticut, Delaware, Georgia, Michigan, Nebraska, New Jersey, New York, and Ontario (NatureServe 2021).

FCTC Distribution and Status: We updated six yellow fumewort EOs at FCTC, modifying

boundaries and adding sub-populations to some of the occurrences. These EOs occur in TAs 4 and 7 along Augusta-Climax Road (EOID 2240), in TA2 (EOID 6949), in TA1 near the armory (EOID 8958), in TA9 along Armstrong Road (EOID 620), in TAs 7, 8, and 9 along Territorial and Longman Roads near their intersection (EOID 7763), and in TA9 on either side of Reese Road (EOID 11994). All populations of yellow fumewort, which are almost entirely limited to stands dominated by the invasive tree black locust in areas historically supporting oak barrens, appear secure. Across FCTC, there are likely hundreds of thousands of individuals, and populations do not appear to fluctuate greatly from year to year, regardless of management history (i.e., fire).

Photos 24 and 25. Yellow fumewort in flower (below) and in fruit (below).

Significance: Statewide, all but two likely extant EOs of yellow fumewort occur at FCTC, FCRA, or FCNC (MNFI 2021). Yellow fumewort was not documented during recent surveys in likely habitat associated with the adjacent Kalamazoo River floodplain in FCRA and the Augusta Floodplain-Emmons Preserve managed by the Southwest Michigan Land Conservancy (Bassett 2021). Continued efforts to understand the ecology of the species in the novel habitat of black locust stands should shed light on the curious distribution of this species in Michigan (Bassett 2021).

Conservation and Management: The consistent association with the problematic invasive black locust, which appears to facilitate yellow fumewort growth, is a conundrum (Slaughter 2009). The results of the current study, as well as ongoing research suggest that yellow fumewort is secure at FCTC and adjacent areas, with or without management (Bassett 2021).

Dodder *(Cuscuta pentagona)*

Globally apparently secure to secure (G4G5); Critically imperiled (S1) and listed as Special Concern (SC) in Michigan

Dodder is an annual, parasitic vine, known in Michigan only from sandy fields and woods in Kalamazoo County. Dodder species are difficult to distinguish, however, nearly all Michigan species are extremely rare. Additionally, despite their rarity, no legal protection is afforded to dodder because all species are prohibited noxious weeds under Michigan State law – Michigan Seed Law (Act 329 of 1965) and Regulations 715 (Under Act 329) Seed Law Implementation, and the Noxious Weeds Act 359 of 1941. This species of dodder is found throughout much of North America, and considered imperiled or vulnerable in Colorado, Michigan, North Carolina, Ohio, Saskatchewan, and Wisconsin (NatureServe 2021).

FCTC Distribution and Status: Dodder is known from a small portion of a single sandy degraded oak

Photo 26. Dodder parasitizing flowering spurge (*Euphorbia corollata*) and spotted knapweed (*Centaurea stoebe*).

barrens in TA7, directly to the east of Mott Road Prairie (EOID 19122), where it has been observed within the same roughly 150 m^2 since its original discovery in 2009 (MNFI 2021). This dodder species has been documented growing on many host species. Host species for this occurrence include spotted knapweed (*Centaurea stoebe*), yellow hawkweed (*Hieracium caespitosum*), flowering spurge (*Euphorbia corollata*), ox-eye daisy (*Leucanthemum vulgare*), round-fruited panic grass (*Dichanthelium sphaerocarpon*), and slender sand sedge (*Cyperus lupulinus*).

Significance: This is the only known extant occurrence of this dodder species in Michigan. Managing this species and its habitat is of paramount importance. Prescribed fire, which is vital for the maintenance of the oak barrens natural community where this EO occurs, may also have direct positive effects on this species, such as through stimulating seed germination (T. Bassett, pers obs).

Conservation and Management: This species was documented 2009 shortly after a prescribed fire program had been initiated at FCTC. As an annual species, it may depend on the disturbance of fire to stimulate seed germination, in addition to importance of fire for reducing the encroachment of woody species. In particular, high densities of sprouts of sassafras (*Sassafras albidum*) threaten to shade out this valuable occurrence. Both frequent prescribed fire and manual control of this and other woody species should remain a high priority here.

Photo 27. Wahoo, showing bright pink arils.

Wahoo *(Euonymus atropurpureus)*

Globally secure (G5); Vulnerable (S3) and listed as Special Concern (SC) in Michigan

Eastern wahoo is a perennial shrub that occurs in floodplain and hardwood swamp forests throughout southern Michigan. It is found throughout eastern North America and into the Great Plains, and is considered imperiled or vulnerable in Alabama, Delaware, Florida, Georgia, Louisiana, Mississippi, Michigan, North Carolina, North Dakota, Ontario, and South Carolina (NatureServe 2021).

FCTC Distribution and Status: This species was reported as occurring only locally in the Cemetery Complex Seeps in TA4 (EOID 16937) in 1994, based on a single specimen. We were unable to relocate this species during surveys in October of 2019 and 2020, when the pink arils surrounding the fruits would have made the species detectable. Sufficient suitable habitat exists for this species, and it may be found during future surveys.

Significance: Statewide, there are 28 EOs that are likely extant, however the FCTC EO is not one of them. Many occurrences represent recent observations, suggesting that with focused surveys additional EOs may be discovered (or re-discovered).

Conservation and Management: Continued surveys are needed for this species. Often associated with floodplain forests, surveys should include adjacent areas of the Kalamazoo River floodplain.

Upland boneset (*Eupatorium sessilifolium*)
Globally secure (G5); Critically imperiled (S1) and listed as Threatened (T) in Michigan

Upland boneset is a colonial, perennial forb found in dry to mesic forests and savannas in southern Michigan. It occurs across much of eastern North America and a few Great Plains states, and is considered imperiled or vulnerable in Delaware, Georgia, Iowa, Nebraska, New Hampshire, Maine, Michigan, Minnesota, and Vermont (NatureServe 2021).

FCTC Distribution and Status: Upland boneset occurs along the top of steep, mostly south-facing slopes in dry and dry-mesic southern forests in three locations in TAs 8 (EOID 16935) and 9 (EOID 23651). The occurrence in TA9 was discovered during the current study. Two sub-populations, one directly to the east of the intersection of Longman and Mott roads in TA8 and the new occurrence just south of Range 1 in TA9, are comprised of dozens of plants and hundreds of stems. A third sub-population, directly to the west of Whitman Lake, is comprised of only four plants. While multiple stems flowered in each population, the majority of those stems were grazed by white-tailed deer (*Odocoileus virginianus*) prior to setting fruit.

Significance: Statewide, two of the ten likely extant EOs occur in FCTC, with an additional EO occurring on a south-facing slope above Hart's Lake directly east of FCTC. As a result, management of this species at FCTC, particularly through the continued application of prescribed fire and invasive species management, is very important for the conservation of upland boneset in Michigan.

Conservation and Management: Upland boneset appears to thrive with prescribed fire, which is ultimately necessary for the persistence of this species. The institution of a regular prescribed fire program at FCTC is responsible for the reduction of understory shrub density that allowed upland boneset

Photos 28 and 29. Upland boneset in flower (above), and after apparent deer herbivory (below).

to be detectable, leading to its discovery at FCTC in 2007 (MNFI 2021). Regular prescribed fire (2-3 fires per decade) is recommended in the burn units where upland boneset is found. White-tailed deer herbivory, however, is dramatically reducing flower, fruit, and seed production of upland boneset. Efforts to reduce the density of deer at FCTC would benefit the fitness of upland boneset populations. The westernmost sub-population near Longman Road is also threatened by an expanding population of the invasive tree, tree-of-heaven (*Ailanthus altissima*).

Queen-of-the-prairie (*Filipendula rubra*)
Globally apparently secure to secure (G4G5); Imperiled (S2) and listed as Threatened (T) in Michigan

Photo 30. Queen-of-the-prairie in early fruit.

Queen-of-the-prairie is a perennial forb of prairie fens and sedge meadows in Michigan, and additionally found in blacksoil prairies elsewhere in its range in northeastern North America. It is considered imperiled or vulnerable in much of its range, including Illinois, Indiana, Iowa, Maryland, Massachusetts, Michigan, Missouri, New Jersey, North Carolina, and Virginia (NatureServe 2021).

FCTC Distribution and Status: There is one extant population of queen-of-the-prairie at FCTC in the northeastern corner the Whitman Lake Fen in TA8 (EOID 9696). This population is large, covering about 1,000 m^2 and containing hundreds of individuals, including many flowering individuals and many apparent seedlings. An additional occurrence in a wetland complex in the northwestern corner of TA7 (EOID 898) has not been observed since water levels were raised in that wetland (now referred to as "Mitchell's Pond"), presumably extirpating the plants through inundation.

Significance: The extant occurrence of queen-of-the-prairie at FCTC is one of 16 likely extant occurrences in Michigan. Kalamazoo and Calhoun counties together support the majority of EOs of this species in Michigan, with 16 of the total 21 documented (including EOs in the state.

Conservation and Management: Despite the apparent ability to persist in partial light of sparse shrub thickets, ultimately the conservation of this species requires limiting shrub and tree encroachment (O'Connor and Penskar 2007). Regular prescribed fire is recommended to limit woody encroachment. While woody encroachment has not apparently become dense enough to negatively impact queen-of-the-prairie at Whitman Lake Fen, shrub density around this occurrence should be monitored, and treated accordingly, particularly the invasive glossy buckthorn (*Frangula alnus*).

Showy orchis (*Galearis spectabilis*)
Globally secure (G5); Imperiled (S2) and listed as Threatened (T) in Michigan

Showy orchis is a short-statured but large-flowered, perennial orchid of mesic forests and occasionally cool, moist microhabitats in drier forests in southern Michigan and the western Upper Peninsula. Widespread across much of eastern North America and parts of the Great Plains, it is however considered imperiled or vulnerable in large portions of its range, including Alabama, Connecticut, Delaware, Georgia, Illinois, Kansas, Maine, Michigan, Mississippi, Nebraska, Newfoundland, New Brunswick, New Hampshire, New York, Nova Scotia, Quebec, and Rhode Island (NatureServe 2021).

Photo 31. Showy orchis in bloom.

FCTC Distribution and Status: There is one extant EO comprised of a large population in Cemetery Complex Ridge and Seeps in TA4 (EOID 3822), and one EO in southeastern TA7 that has not been observed since 1994 (EOID 3821) (MNFI 2021). The Cemetery Ridge and Seeps occurrence totals nearly 100 individuals (78 plants were observed during this study, including 37 flowering or fruiting individuals). Mostly limited to cool and moist microhabitats near springs and cool streams, during this study we documented a few newly observed individuals in relatively drier microhabitats upslope from previously documented observations.

Significance: The extant showy orchis EO at FCTC is one of 22 likely extant EOs in Michigan. Showy orchis is fairly widespread in Michigan, occurring throughout the southern lower peninsula and in scattered locations in the northern lower and western upper peninsulas. However, it is limited to specific if poorly defined microhabitats, and so each occurrence is likely very sensitive to habitat alterations as well as being valuable for understanding this cryptic species.

Conservation and Management: Conservation of showy orchis is dependent on maintaining cool, moist conditions (Higman and Penskar 1997). Avoid use of canopy removal and prescribed fire in Cemetery Complex Ridge where this population occurs to avoid desiccation.

Photo 32. Stiff gentian in bloom.

Stiff gentian (Gentianella quinquefolia)

Globally secure (G5); Imperiled (S2) and listed as Threatened (T) in Michigan

Stiff gentian is a diminutive annual forb found in calcareous soils in a diversity of open and partially shaded habitats in Michigan. Known from much of eastern North America, it is considered imperiled or vulnerable in Connecticut, Iowa, Kentucky, Maryland, Massachusetts, Michigan, Mississippi, Ontario, and Vermont (NatureServe 2021).

FCTC Distribution and Status: Stiff gentian is known from the margins of groundwater seeps in ecotones between moist thinly wooded areas and open fens in TAs 4 (EOID 1663), 5 and 7 (EOID 744). While population estimates have ranged from

50-100 plants in previous surveys, we only observed small clumps of 1-5 plants during this study. An annual species, population fluctuations are not uncharacteristic.

Significance: FCTC supports two of only nine likely extant EOs, and 18 total documented EOs of stiff gentian in Michigan. The conservation of these occurrences is therefore quite important for the conservation of the species in the state. Many records are very old, and likely extirpated.

Conservation and Management: Stiff gentian appears to have microhabitat requirements related to calcareous soils, partial light, and possibly proximity to groundwater and seeps. Avoiding heavy soil disturbance (e.g., vehicle traffic) is recommended, although light soil disturbance may stimulate seedbank germination. Focused surveys for additional populations and monitoring of known populations is the highest priority for this species.

Pale avens (*Geum virginianum*)
Globally secure (G5); Critically imperiled to imperiled (S1S2) and listed as Special Concern (SC) in Michigan

Pale avens is a perennial forb from dry-mesic southern forest in southern Michigan. Widespread in eastern North America, it is considered imperiled or vulnerable on the edges of its range in Alabama, Arkansas, Delaware, Massachusetts, Michigan, Missouri, New Jersey, New York, and Ontario (NatureServe 2021).

FCTC Distribution and Status: One new occurrence was documented during this study (EOID 23658), comprised of a single small population (up to 10 individuals) on a south-facing slope above Hart's Lake in southeastern TA9. In this location, pale avens is associated with two other rare plant species of open oak woodlands, beaked agrimony and upland boneset.

Significance: Statewide, only 12 EOs of pale avens have been documented, with only eight EOs likely extant. Conservation of this occurrence, and additional surveys at FCTC, are important for the conservation of this species in Michigan. This species is likely overlooked due to the presence of similar species in our flora. Pale avens is distinguished from the similar and ubiquitous white avens (*Geum canadense*) by dense pubescence on the flowering stalk, as well as much large stipules or bracts at the base of leaves. The Technical Committee has recommended that the state status of pale avens be changed from special concern to threatened (Reznicek et al. 2019).

Conservation and Management: Known from a range of fire-dependent oak ecosystems in Michigan, pale avens likely depends on regular to occasional prescribed fire for persistence. Mechanically reducing the density of invasive shrubs will likely benefit this species.

Goldenseal (*Hydrastis canadensis*)
Globally vulnerable to apparently secure (G3G4); Imperiled (S2) and listed as Threatened (T) in Michigan

Photo 33. Pale avens, showing creamy white petals and densely short-hairy stems.

Photo 34. Goldenseal in bloom. Note lack of petals.

Goldenseal is an aggressively colonial, perennial forb of moist soils in mesic and swamp forests, often found in calcareous soils near springs and seeps. This species is sought after for the supposed medicinal qualities of the knotty rhizome, so is at risk of overharvesting throughout its range in eastern North America. It is considered imperiled or vulnerable in Alabama, Connecticut, Delaware, Georgia, Indiana, Iowa, Kansas, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, New Jersey, New York, North Carolina, Ontario, South Carolina, Vermont, Virginia, and West Virginiana (NatureServe 2021).

FCTC Distribution and Status: There are three EOs of goldenseal, in moist forests above springs and seeps in three different sub-watersheds in TAs 3 (EOID 16933), 4 (EOID 10268), and 5 (EOID 16978), respectively. The populations near the springs that feed into Mott Road Fen South in TA5 and the 42nd Road Seeps in TA3 are relatively small, occupying 10s of square meters. In Cemetery Seeps in TA4, in contrast, goldenseal covers 1,000s of square meters distributed among much of the area.

Significance: Statewide, FCTC supports three of 75 likely extant EOs. Despite a large number of occurrences statewide, many are not on protected land and therefore susceptible to habitat degradation and overharvesting. Therefore, FCTC can play an important role in the conservation of this species in Michigan.

Conservation and Management: Protecting goldenseal habitat is the most important conservation measure (Penskar et al. 2001). The cool, moist microhabitats where goldenseal is generally found are sensitive to the reduction of forest canopy that moderates climate, so limit or avoid canopy thinning in the habitats supporting goldenseal. This species is also at risk from overharvesting, so measures should be considered to limit access to habitats where it is found.

Slender yellow flax (*Linum virginianum*)

Globally apparently secure to secure (G4G5); Imperiled (S2) and listed as Threatened (T) in Michigan

Slender yellow flax is diminutive perennial forb (20-40 cm in height) of dry, sandy hillsides in oak forests and savannas. Secure throughout much of its range in eastern North America and the southern Great Plains, slender yellow flax is considered imperiled or vulnerable in Michigan, New Jersey, North Carolina, and Ontario (NatureServe 2021).

FCTC Distribution and Status: A small population in oak uplands adjacent to the Territorial Road Fen in TA9 was not relocated during this survey (EOID 16932), but an EO first documented in 2009 on a west facing slope above a large sedge meadow in the center of TA7 was updated (EOID 17050). This population was comprised of at least 65 individuals scattered across a lower slope associated with species of oak barrens (e.g., *Piptochaetium avenaceum*, *Viola pedata*) and dry-mesic southern forest (e.g., *Hylodesmum nudiflorum*, *Muhlenbergia tenuiflora*).

Significance: Statewide, two of nine likely extant EOs of slender yellow flax occur at FCTC, including one EO that was not relocated during this survey but was observed as recently as 2008, so is likely to persist (MNFI 2021). One additional EO occurs

Photo 35. Slender yellow flax in bloom

directly to the west at FCRA. Efforts to conserve these populations are therefore extremely important for the conservation of this species in the state.

Conservation and Management: Slender yellow flax thrives in communities and landscape positions with high light availability. As a diminutive species, shade from even limited woody encroachment can threaten the persistence of this species. Prescribed fire is therefore an essential management tool for slender yellow flax. Aggressively reducing woody species where it occurs is also recommended, including invasive shrubs such as bush honeysuckle (*Lonicera* spp.) and native tree saplings such as wild black cherry, red maple (*Acer rubrum*) and in some cases, oak species (*Quercus* spp.).

Red mulberry (*Morus rubra*)
Globally secure (G5); Imperiled (S2) and listed as Threatened (T) in Michigan

Red mulberry is a small understory tree of swamp and floodplain forests in southern Michigan. Widespread in eastern North America and the southern Great Plains, this species is rare in the northern part of its range, considered imperiled or vulnerable in Delaware, Massachusetts, Michigan, Minnesota, Ontario, Pennsylvania, and Vermont (NatureServe 2021).

Photo 36. Red mulberry, viewed from below. Note the minimal lobing of leaves.

FCTC Distribution and Status: Only a single individual of red mulberry has ever been observed at FCTC, in the Cemetery Seeps in TA4, and was relocated during the survey (EOID 16934). Despite extensive searches in 2019 and 2020, no additional seedlings, saplings or other individuals were observed. The superficially similar, exotic white mulberry (*Morus alba*) is widespread at FCTC in disturbed habitats, and care should be taken not to confuse the two species.

Significance: Statewide, one of 24 likely extant EOs of red mulberry occurs at FCTC.

Conservation and Management: The highest priority for red mulberry at FCTC is continued surveys for more individuals and protection of the single extant individual. Competition from woody invasive species is a threat, so control efforts in Cemetery Complex Seeps will likely benefit red mulberry (Penskar 2009a).

Ginseng (*Panax quinquefolius*)
Globally vulnerable to apparently secure (G3G4); Imperiled to vulnerable (S2S3) and listed as Threatened (T) in Michigan

Ginseng is a perennial herb of rich forests mostly in the Lower Peninsula of Michigan. As with goldenseal, this species is sensitive to overharvesting for its purported medicinal value. Occurring throughout eastern North America and the eastern Great Plains, it is considered imperiled or vulnerable in much of its range, including Connecticut, Delaware, District of Columbia, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Nebraska, New Hampshire, New Jersey, North Carolina, Oklahoma, Ontario, Quebec, Rhode Island, South Dakota, Tennessee, Vermont, Virginia, and West Virginia (NatureServe 2021).

FCTC Distribution and Status: There is a single

Photo 37. Ginseng, showing bright red fruits.

EO of ginseng at FCTC (EOID 2483), comprised of approximately 20 individuals scattered among upper slopes of the Cemetery Ridge Mesic Southern Forest. This is a decline from about 50 individuals observed in 2008. Potential causes for this decline include the loss of insulating leaf litter and humous layer due to earthworm activity or the use of prescribed fire in Cemetery Complex Ridge.

Significance: The occurrence of ginseng at FCTC is one of 102 likely extant EOs in Michigan. While this suggests that ginseng is relatively secure in the state, as with goldenseal it is vulnerable to overharvesting for its purported medicinal benefits, so populations in managed and protected areas like FCTC are very important for the persistence of the species in Michigan.

Conservation and Management: This species is sensitive to ground-level moisture fluctuations so benefits greatly from the retention of leaf litter and rich humus layer. Reductions of leaf litter where ginseng occurs at FCTC, which could be caused by prescribed fire or exotic earthworms, should be minimized. This species is also at risk from overharvesting, so measures should be considered to limit access to habitats where it is found (Penskar and Higman 1996).

Photo 38. Shining wedgegrass (narrow grass in bottom center and scattered around central individual).

Shining wedgegrass (*Sphenopholis nitida*)

Globally secure (G5); Not ranked (SNR) and proposed to be listed as Special Concern (SC) in Michigan

Shining wedgegrass is a sparse grass found in dry, open oak forests, particularly on bluffs and slopes (Voss and Reznicek 2012). Occurring in eastern North America and the southern Great Plains, it is considered imperiled or vulnerable in Illinois, Massachusetts, and Ontario (NatureServe 2021). This species is not currently listed in Michigan but has been recommended for listing as recent collections are few.

FCTC Distribution and Status: Three sparse populations of this species were documented during this study, the first time shining wedgegrass has been reported from FCTC.

Significance: The status of this species has not been formally assessed in Michigan, although it is believed to be rare. The Technical Committee has recommended that the state status of shining wedgegrass be changed from unlisted to special

concern (Reznicek et al. 2019). Management and monitoring of these populations will greatly benefit our understanding of its ecology and distribution and help with such an assessment.

Conservation and Management: Little is known about management of shining wedgegrass, but given its sparse low growth form subject to shading from competitive shrubs and saplings, and associated with fire-dependent oak ecosystems, it likely responds well to management with prescribed fire that maintains an open understory.

Photo 39. Oval ladie's-tresses in bloom.

Oval ladies'-tresses (*Spiranthes ovalis*)
Globally secure (inexact) (G5?); Critically imperiled (S1) and listed as Threatened (T) in Michigan

Oval ladies'-tresses is a diminutive orchid of dry, sandy forests and savannas in southern Michigan. Ranging across much of eastern North America and the southern Great Plains, it is considered imperiled or vulnerable in the District of Columbia, Florida, Georgia, Illinois, Iowa, Michigan, Mississippi, North Carolina, Pennsylvania, Tennessee, and West Virginia (NatureServe 2021).

FCTC Distribution and Status: Oval ladies'-tresses was documented in 1994 (EOID 702) in disturbed sand near the shores of a pond in northern TA4 below Cemetery Complex Seeps, and not documented there since that time (Legge et al. 1995, Cohen et al. 2009). In 2019 we observed 2 individuals in a transitional forest uphill from that location, directly above Cemetery Complex Seeps.

Significance: The occurrence of oval ladies'-tresses is one of only 13 likely extant EOs in Michigan. While dramatic population fluctuations are typical in this and other orchids, most occurrences are comprised of only a few individuals. However, most occurrences are found in disturbed habitats, and 8 of the 13 EOs are new reports, observed only in the last decade (MNFI 2021). This suggests that the species may be expanding its range somewhat in Michigan. The Technical Committee has recommended that the state status of oval ladies'-tresses be changed from threatened to special concern (Reznicek et al. 2019).

Conservation and Management: Little is known about management needs for this species. Its consistent association with disturbed habitat suggests that some form of disturbance such as fire or canopy thinning to reduce woody encroachment and expose bare soil for germination will benefit oval ladies'-tresses. Continued surveys for this species to better understand its distribution at FCTC would be beneficial as well.

Prairie dropseed (*Sporobolus heterolepis*)
Globally secure (G5); Vulnerable (S3) and listed as Special Concern (SC) in Michigan

Prairie dropseed occurs mostly in prairie fens in southern Michigan and various prairie-like habitats in northern Michigan. It is known primarily from dry to mesic prairies in much of its range, which centers on the Great Plains but extends eastward sporadically. It is considered imperiled or vulnerable in Connecticut, Georgia, Illinois, Kansas, Kentucky, Manitoba, Maryland, Massachusetts, Michigan, New York, North Carolina, Ohio, Oklahoma, Ontario, Pennsylvania, Quebec, Saskatchewan, Tennessee, Virginia, and Wyoming (NatureServe 2021).

FCTC Distribution and Status: A single EO occurs at FCTC (EOID 3974), occurring in both Whitman

Photos 40 and 41. Prairie dropseed bearing seeds (above) and showing characteristic dense basal clump (below).

Lake and Territorial prairie fens (EOIDs 7503 and 16989). In fens, prairie dropseed is often limited to areas of deep peat accumulation known as peat mounds. The northern population centered on a peat mound in Territorial Road fen appears stable, but there have been significant declines in the Whitman Lake population, the invasive shrub glossy buckthorn is well-established on peat mounds.

Significance: The FCTC occurrence of prairie dropseed represents one of 31 likely extant EOs in Michigan, and one of 18 in southern Michigan. This occurrence is one of several in protected locations in Michigan.

Conservation and Management: Competition from invasive species is perhaps the greatest threat to prairie dropseed at FCTC and elsewhere in Michigan, including non-native common reed, narrow-leaved cattail, and glossy buckthorn. Continued management of these species is strongly encouraged, especially in Whitman Lake fen where recent invasive species management has made extensive progress. Continued application of prescribed fire in these fens is also essential (Higman and Penskar 1999).

Pointed water meal (*Wolffia brasiliensis*)
Globally secure (G5); Critically imperiled (S1) and listed as Threatened (T) in Michigan

Pointed water meal is found in a variety of non-acidic or mildly acidic aquatic habitats (pH > 6.0), often in bog moats or inundated shrub swamps (Penskar 2009b). It is considered imperiled or vulnerable in California, Georgia, Illinois, Kansas, Maryland, Michigan, Minnesota, Montana, Nebraska, North Carolina, and West Virginia (NatureServe2021).

FCTC Distribution and Status: Pointed water meal was documented in several ponds at FCTC, including the Cemetery Complex Seeps Pond in TA4 (EOID 23902), Mitchell's Pond in TA7 (EOID 23903), Longman Road swamp in TA5 (EOID 23904), and in the moats of several of the Longman Road bogs in TAs 5 and 8 (EOID 23904). The species appears to be well established, having been overlooked in previous surveys.

Significance: Containing three of 11 likely extant EOs in Michigan, the FCTC is a significant contributor to

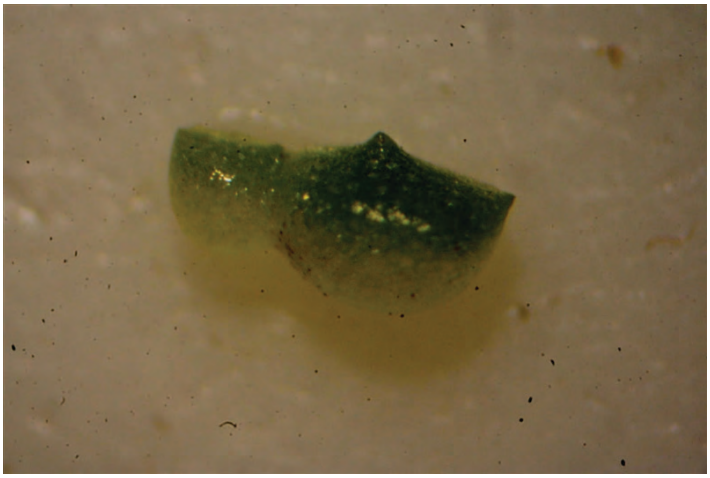

Photo 42. Pointed water meal, showing characteristic pointed back.

the conservation of pointed water meal in the state. There are several new reports of this species, so it is unclear how vital these occurrences are to the conservation of the species in the state. The Technical Committee has recommended that pointed water meal be delisted entirely (Reznicek et al. 2019).

Conservation and Management: Additional surveys are the highest priority for this species.

New species added to flora

We documented 40 vascular plant species or sub-specific taxa that represent new reports for FCTC (Table 7), bringing the total number of taxa to 879 (Appendix D). Three of these species are of conservation concern, including state threatened pale avens and pointed water meal, and shining wedgegrass, which has been recommended for listing in Michigan. See above under *Rare plant surveys* for discussion of those species. There were two non-native species added to the flora of FCTC. A few pear (*Pyrus communis*) trees were observed, in young forest in TAs 1 and 8, likely persisting from cultivation. An exotic willow-herb (*Epilobium parviflorum*) was collected in Whitman Lake Fen, where it was uncommon. The remainder of the newly documented taxa are native species. Four native species were added to the flora of FCTC due to recent nomenclatural changes. For example, a tick-trefoil (*Desmodium perplexum*) was formerly included in the concept of *D. paniculatum*, and both *D. perplexum* and *D. paniculatum* occur at FCTC. Similarly, the common reed (*Phragmites australis*) is now considered to be represented by two varieties, one non-native (*P. australis* var. *australis*) and the recently segregated native (*P. australis* var. *americanus*).

The remainder of the native species represent new observations of relatively small populations that were simply overlooked during previous surveys. Examples include a hawthorn (*Crataegus macrosperma*), shining clubmoss (*Huperzia lucidula*), and New York fern (*Thelypteris noveboracensis*), and nine species first observed at FCTC during a 2020-21 study focusing on documenting aquatic macrophytes (Cole-Wick et al. 2021). Finally, the semi-aquatic species *Alisma plantago-aquatica* is now considered to be represented in Michigan by two separate species, *A. subcordatum* and *A. triviale*. We did not encounter this species during this study, so we were unable to confirm which of these two species occurs at FCTC.

Photo 43. Bulrush (*Bolboschoenus fluviatilis*), newly documented at FCTC in TA 7 near Mott Road Fen.

Table 7. Vascular plant species newly documented at Fort Custer Training Center during this study, either through direct observation, or because of taxonomic reorganization.

Scientific Name	Common Name	Native/ Adventive	TA	Collected	Source of Novelty	Note
Allium burdickii	Wild leek	N	4	Yes	Taxonomic	Split from *A. tricoccum*
Alnus incana	Speckled alder	N	7	No	Observation	
Alopecurus aequalis	Short-awned foxtail	N	8	Yes	Observation	
Betula allegheniensis	Yellow birch	N	9	No	Observation	
Betula X purpusii	Hybrid birch	N	9	No	Observation	pic on file
Bolboschoenus fluviatilis	Bulrush	N	7	Yes	Observation	pic on file
Brasenia schreberi	Water-shield	N	2, 8	Yes	Observation	**Cole-Wick et al. 2021
Bromus nottowayanus	Satin brome	N	4	No	Taxonomic	Split from *B. pubescens*
Carex atlantica	sedge	N	8	Yes	Observation	pic on file
Carex canescens	sedge	N	7	Yes	Observation	pic on file
Carex lasiocarpa	Sedge	N	8	No	Observation	
Chaerophyllum procumbens	Wild-chervil	N	9	Yes	Observation	
Crataegus macrosperma	Hawthorn	N	8	Yes	Observation	
Desmodium perplexum	Tick-trefoil	N	7	Yes	Taxonomic	Split from *D. paniculatum*
Dichanthelium boreale	Northern panic grass	N	8	Yes	Observation	
Epilobium parviflorum	Willow-herb	A	8	Yes	Observation	
Erigeron pulchellus	Robin's-plantain	N	8	No	Observation	
*Geum virginianum**	Pale avens	N	9	No	Observation	
Glyceria septentrionalis	Floating manna grass	N	8	Yes	Observation	
Heteranthera dubia	Water star-grass	N	4	Yes	Observation	**Cole-Wick et al. 2021
Hieracium kalmii	Canada hawkweed	N	7	No	Observation	
Huperzia lucidula	Shining clubmoss	N	8	Yes	Observation	
Lemna turionifera	Red duckweed	N	ALL	No	Taxonomic	Split from *L. minor*
Myriophyllum sibricum	Spiked water milfoil	N	2	Yes	Observation	**Cole-Wick et al. 2021
Nuphar variegata	Yellow pond-lily	N	6, 8	No	Observation	**Cole-Wick et al. 2021
Phragmites australis var. americanus	Common reed	N	8	No	Taxonomic	Split from *P. australis*
Poa languida	Bluegrass	N	5,8, 9	Yes	Observation	
Poa sylvestris	Woodland bluegrass	N	7	No	Observation	

Scientific Name	Common Name	Native/ Adventive	TA	Collected	Source of Novelty	Note
Potamogeton amplifolius	Large-leaved pondweed	N	8	No	Observation	**Cole-Wick et al. 2021
Pyrus communis	Common pear	A	1,8	Yes	Observation	
Salix pedicellaris	Bog willow	N	8	Yes	Observation	
*Sphenopholis nitida**	Shining wedgegrass	N	7,8,9	Yes	Observation	pic on file
Stuckenia filiformis	Narrow-leaved pondweed	N	4, 7, 8, 9	Yes	Observation	**Cole-Wick et al. 2021
Thelypteris noveboracensis	New York fern	N	5	Yes	Observation	pic on file
Utricularia geminiscapa	Bog bladderwort	N	8	No	Observation	**Cole-Wick et al. 2021
Utricularia purpurea	Purple bladderwort	N	7	No	Observation	**Cole-Wick et al. 2021
Vaccinium angustifolium	Lowbush blueberry	N	7,8	No	Observation	
Viola labradorica	Dog vioet	N	9	Yes	Observation	
*Wolffia brasiliensis**	Pointed water meal	N	4, 5, 7	No	Observation	**Cole-Wick et al. 2021
Zannichellia palustris	Horned pondweed	N	4	Yes	Observation	**Cole-Wick et al. 2021

*Listed plant species

Several observations made during aquatic macrophyte surveys (Cole-Wick et al. 2021)

Photo 44. New York fern (*Thelypteris noveboracensis*), newly documented at FCTC in TA 5, south of Mott Road Fen..

Animal Surveys

INTRODUCTION

In this section we present methods and findings for the rare mollusk, fish, herpetofauna, and insect species we surveyed between 2018 and 2021 (Tables 8, C1). We identified survey targets by examining federally- or state-listed species known or likely to occur at FCTC, their historical distributions within Michigan, and presence of potential habitat. A variety of data sources were used to determine if potential habitats were present, including natural community occurrences, aerial photography interpretation, and our knowledge of the sites. We conducted surveys for species in potential habitats during time periods when targets were expected to be most active and detectable (e.g., adult flight period for insects). There are several EOs of rare bird species at FCTC (Table 8). We did not conduct surveys for rare bird species, as annual surveys are conducted by KNC (INRMP 2020). We also did not conduct surveys for tiger spiketail (*Cordulegaster erronea*, special concern) because documentation of this rare dragonfly was current at the time we began our study. Tiger spiketail was thought to be extirpated from Michigan but was recently rediscovered at FCTC in 2016 (EOID 21346) in TA5 just of the southern portion of Mott Road Fen (O'Brien et al. 2017). MNFI concurrently conducted a separate population assessment the prairie vole (*Microtus ochrogaster*, state endangered) confirming the continued presence of this rare mammal at FCTC, results of which are presented in a separate report (Cole-Wick et al. 2022).

METHODS

Survey methods differs among animal taxa, so we present methods separately for each group of species. When methods for multiple species were similar, or when multiple taxa were targeted in the same surveys, methods for those species are presented together. While most surveys were timed for the probability of observing focal species, we also present findings on incidental observations of other animal species.

Snails, mussels & fish

Photo 45. Watercress snail.

Watercress snail (*Fontigens nickliniana*)
Globally secure (G5); Imperiled to vulnerable (S2S3) and listed as Special Concern (SC) in Michigan

The watercress snail is an aquatic snail that lives in headwater seeps, springs, and small streams where it is strongly associated with the semi-aquatic plant species, watercress (*Nasturtium officinale*; Berry 1943). They are thought to graze on epiphytic diatoms and detritus rather than the watercress plant itself. The hard water of seeps provides calcium that watercress snails use to produce their shells. There are three EOs of watercress snail at FCTC, which have not been documented since 1994 (EOID 4908 in the Cemetery Complex Seeps; and EOID 10435 in Whitman Lake Fen) or 1995 (EOID 6641 in the wetland basin containing Mott Road Fen) (MNFI 2021; Table 8). We focused survey effort at nine sites, within existing EOs and in additional locations supporting large populations of watercress (Figure 9, Table C1). We conducted surveys by locating small headwater streams, where we hiked upstream while visually searching substrate, aquatic vegetation, and semi-aquatic vegetation. Search effort was concentrated on watercress and other emergent plants with similar structure. Empty snail shells and live snails were collected in polyethylene bags with ethanol and labeled. Due to the very small size (3-5 mm in length) of watercress snails, species identifications were made in the lab with the aid of a stereoscope at 10-20x magnification.

Table 8. Rare animal element occurrences at Fort Custer Training Center.

Scientific Name	Common Name	Training Areas	State Status	EO ID	EO Rank	Last Observed
Acris blanchardi	Blanchard's Cricket Frog	4, 5, 7	T	2650	AB	2016
Acris blanchardi	Blanchard's Cricket Frog	1, 2	T	11297	H	1994
Acris blanchardi	Blanchard's Cricket Frog	8	T	2949	BC	2016
Ammodramus henslowii	Henslow's warbler	6	E	6788	D	2007
Ammodramus savannarum	Grasshopper sparrow	1, 9	SC	6235	H	1974
Ammodramus savannarum	Grasshopper sparrow	6	SC	15997	CD	2007
*Bombus auricomus**	Black and Gold Bumble Bee	7	SC	23639	B?	**2019**
*Bombus auricomus**	Black and Gold Bumble Bee	3	SC	23638	C	**2020**
Chondestes grammacus	Lark sparrow	2, 9	X	20400	E	2015
Cordulegaster erronea	Tiger spiketail	5	SC	21346	E	2016
Emydoidea blandingii	Blanding's Turtle	2, 5, 6, 7, 8, 9	SC	3052	AB	**2021**
Flexamia reflexa	Leafhopper	2	SC	14424	H	1994
Fontigens nickliniana	Watercress Snail	5, 7	SC	6641	BC	**2019**
Fontigens nickliniana	Watercress Snail	4	SC	4908	BC	**2019**
Fontigens nickliniana	Watercress Snail	8	SC	10435	BC	**2019**
Haliaeetus leucocephalus	Bald eagle	8	SC	19363	E	**2019**
Lithobates palustris	Pickerel Frog	3, 5, 7, 8, 9	SC	23002	AB	**2021**
Microtus ochrogaster	Prairie vole	7	E	9949	C?	2006
Notropis anogenus	Pugnose shiner	8	E	3569	H	1994
*Papaipema cerina**	Golden Borer Moth	7	SC	23849	BC	**2019**
Pygarctia spraguei	Sprague's pygarctia	5	SC	10138	H	1994
Setophaga cerulea	Cerulean warbler	1, 3, 4, 5, 6, 7, 8, 9	T	2951	BC	**2019**
Setophaga citrina	Hooded warbler	4	SC	11526	H	1994
Setophaga citrina	Hooded warbler	3	SC	9385	H	1994
Setophaga citrina	Hooded warbler	6, 8	SC	3450	H	1994
Setophaga citrina	Hooded warbler	4, 5, 6	SC	8400	H	1994
Spiza americana	Dickcissel	6	SC	16003	C?	2007
Terrapene carolina carolina	Eastern Box Turtle	ALL	SC	1660	AB	**2021**

Last observed dates in **bold** observed during this study.

Footnote: surveys for eastern massasauga rattlesnake *(Sistrurus catenatus catenatus* ; state special concern, federally threatened), slippershell (*Alasmindonta viridis* ; state threatened), frosted elfin (*Callphyrs irus* ; state threatened), Karner blue *(Lycaeides melissa samuelis* ; state threatened, federally endangered), persius dusky wing (*Erynnis persius persius*), Sanderson's and American bumble bee (*Bombus sandersoni and B. pensylvanicus*), and regal fern and blazing star borer moths (*Papaipema speciosissima and P. beeriana*) were unsuccessful.

Photo 46. Slippershell.

Slippershell (*Alasmidonta viridis*)
Globally apparently secure to secure (G4G5); Imperiled to vulnerable (S2S3) and listed as Threatened (T) in Michigan

The slippershell is a freshwater mussel that inhabits small streams with sand and gravel substrates. It is one of the smallest native mussel species in Michigan with a maximum length around 6 cm and a life span of up to 10 years. There were no EOs for state-listed mussel species prior to this study, however, the slippershell is the most likely rare mussel species to occur in FCTC considering the presence of small headwater stream habitat. We conducted mussel surveys targeting slippershell and other native unionid mussel species at four sites within FCTC (Figure 9, Table C1). Site 1 was in an unnamed stream running north-south through Cemetery Complex Seeps. Survey sites 2 and 3 are located in Eagle Creek in TA8 near Territorial Road Fen (EOID 16989), about 250 m and 450 m north of Territorial Road respectively. A visual survey in the outlet stream northeast of Whitman Lake was also performed (site 4).

Mussel surveys took place in wadable habitats, where we surveyed from bank to bank to include the widest range of microhabitats. We measured the search area at each site to standardize sampling. Visual surveys for live unionids and shells use glass bottom buckets, as well as tactile searches by running hands over and into the stream substrate to ensure that buried individuals are detected, including smaller sized mussels such as slippershell. We recorded habitat data to describe and document stream conditions at the time of the surveys. Habitat data included substrate particle size, woody debris, aquatic vegetation, exposed solid clay substrate, and eroded banks. We visually estimated percentage of the search area with pool, riffle, and run habitat, and a rough characterization of current speed by recording the length of time suspended particles travel a known distance. Conductivity and pH of stream water were recorded with an Oakton handheld meter and water alkalinity and hardness were measured with LaMotte kits.

Photo 47. Pugnose shiner.

Pugnose shiner *(Notropis anogenus*)
Globally vulnerable (G3); Critically imperiled to imperiled (S1S2) and listed as Endangered (E) in Michigan

The pugnose shiner is a small (4-6 cm) fish in the minnow family (Cyprinidae). It lives in clear vegetated lakes and vegetated pools and runs of low gradient streams and rivers. Pugnose shiner has not been documented in Kalamazoo County since 2002 (MNFI 2021, Table 8). It was found in Hart's Lake (Calhoun County) in 1994, when Hart's Lake was a part of FCTC (Figure 1). We surveyed four lakes (Vlug Lake in TA2, Lawler Lake in TA4, Whitman Lake in TA8, and Platform Lake in TA4) using baited minnow traps set with the aid of a paddleboard (Figures 1 and 9, Table C1). Nine traps were baited with crackers and distributed along the margins of each lake at varying depths (Photo 54). Depth of traps set in Vlug Lake, Lawler Lake, and Whitman Lake ranged from 0.5 m to 1.5 m, and in Platform Lake ranged from 0.5 m to 2 m. All traps were checked and removed from the lake the same day, except for those in Whitman Lake where the traps were checked the same day, reset, and left overnight to be rechecked and removed the next day. Fish were photographed, identified, and returned to the spot they were found. Due to the calm, clear water of the lakes we also employed visual detection and identification of fish.

Amphibians and reptiles (Herpetofauna)

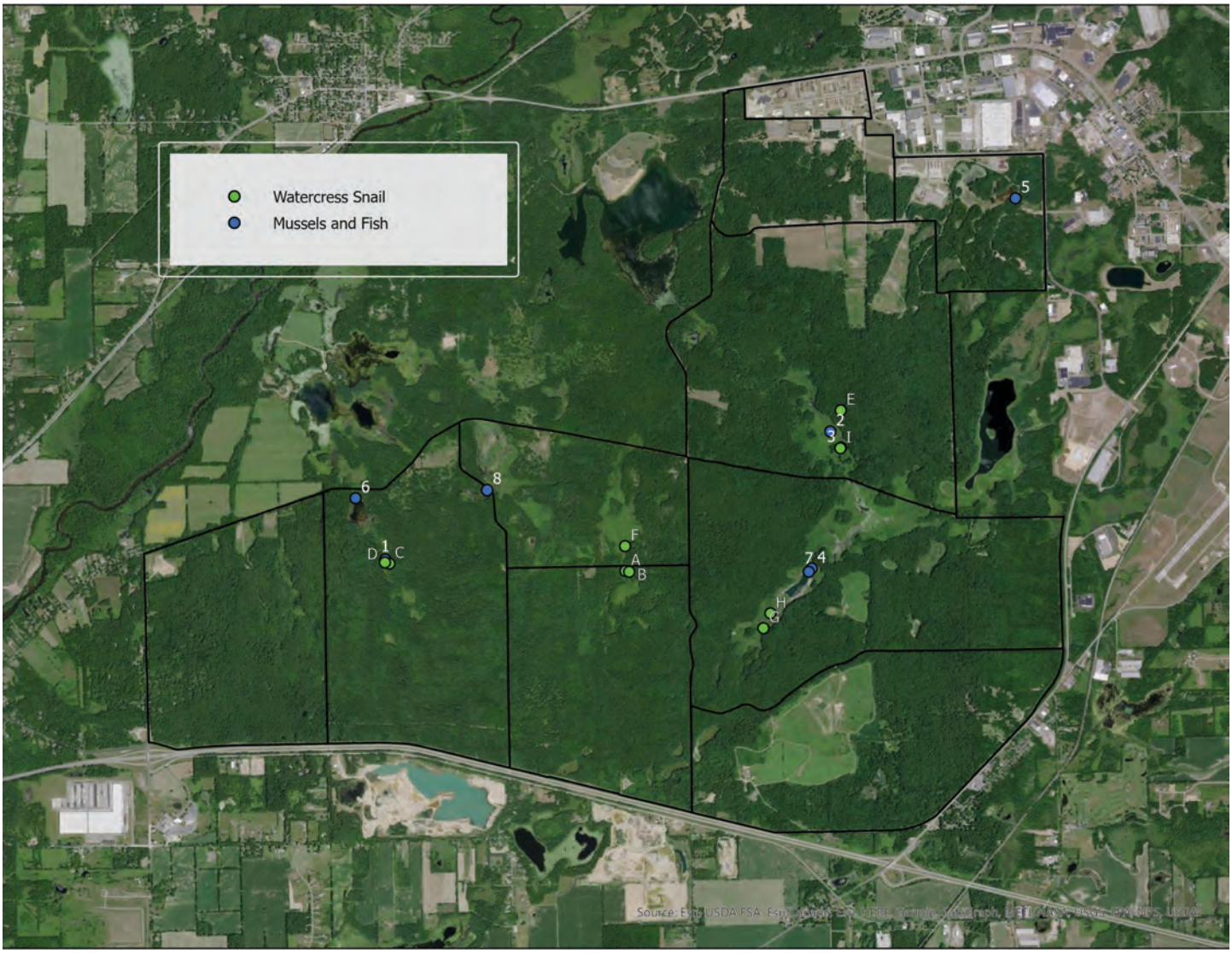

Figure 9. Sampling locations for watercress snail (A-I), slippershell (1-4), and pugnose shiner (5-8).

Eastern massasauga rattlesnake (*Sistrurus catenatus*)

Globally vulnerable (G3); Federally Threatened (T); Vulnerable (S3) and listed as Special Concern (SC) in Michigan

The eastern massasauga rattlesnake is found in a variety of wetland and upland habitats including undisturbed groundwater-fed wetlands with adjacent sandy uplands, of which there are an abundance at FCTC (Legge et al. 1995, Szymanski 1998, Tobin 2005, Cohen et al. 2009, Szymanski et al. 2016). In 2018 and 2021, we conducted massasauga surveys in previously identified priority survey sites (Lee and DLZ 2020; Figure 10). Herpetofaunal surveys focused on the eastern massasauga, although other herpetofauna were documented incidentally during these and other surveys (see below).

In 2018, we conducted blitz-style visual surveys (Photo 48) for massasaugas in seven of the 13 priority survey sites identified in 2017 as a part of an earlier FCTC-funded project to identify high priority areas for massasauga surveys: Territorial Road Wetland North, Territorial Road Wetland South, Mott Road Fen North A and B, Mott Road Fen South, Whitman Lake Fen North A, Whitman Lake Fen South A (Lee and DLZ 2020, Figure 10, Table C1). The sampling locationWhitman Lake Fen North A is equivalent to the natural community EO, Territorial Road Fen (EOID 16989). Surveys were conducted on May 16-19 and May 23, 2018. KNC staff assisted with these surveys and recruited volunteers to assist in the blitz-style surveys. A total of seven MNFI and KNC science staff and 102 volunteers participated in the surveys, including 28 high school students and two teachers from KNC's Heronwood Field Station. These surveys consisted of teams ranging in size from 5 to 15 people (except for one team of 32) walking slowly 2-3 m apart through suitable habitat while visually searching

for snakes basking, resting, or moving. We surveyed each site 1-4 times, as military activities allowed. We recorded survey effort, surveyor information, weather conditions, as well as presence and quality of suitable habitat. Survey locations and routes were recorded on a GPS unit and/or tablet.

In 2021, we again conducted blitz-style visual surveys for eastern massasaugas. Surveys were conducted from May 11-15, 2021. Because of the ongoing Covid-19 pandemic, we decided to limit the number of surveyors overall and per team to facilitate physical distancing during field surveys and indoors to ensure the safety of surveyors and reduce the risk of transmission of Covid-19. Surveyors consisted of six MNFI staff and AmeriCorps members, seven KNC staff, and three volunteers recruited by KNC. Surveyors were separated into two teams ranging in size from 4 to 8 people, with each team surveying a unit in the morning and afternoon. Surveys consisted of surveyors walking slowly through suitable habitat, looking for massasaugas basking, resting, or moving on or under vegetation, woody debris, or other cover. Survey data, locations, and routes were recorded with a GPS unit or on a Samsung Galaxy tablet using a combination of ArcGIS Survey123 app data form, the FieldMaps app, other mobile apps.

Surveys in 2021 focused primarily on four survey units: Whitman Lake Fen North A, Whitman Lake Fen South A, Mott Road Fen North A, and Territorial Road Wetland South. Each of these units were surveyed 3-4 times during the survey period. Three additional units - Whitman Lake Fen South B, Mott Road Fen North B, and Territorial Road Wetland North - were surveyed only once or twice during the survey week. The habitats in these three units were less suitable or lower quality for massasaugas and/or were more

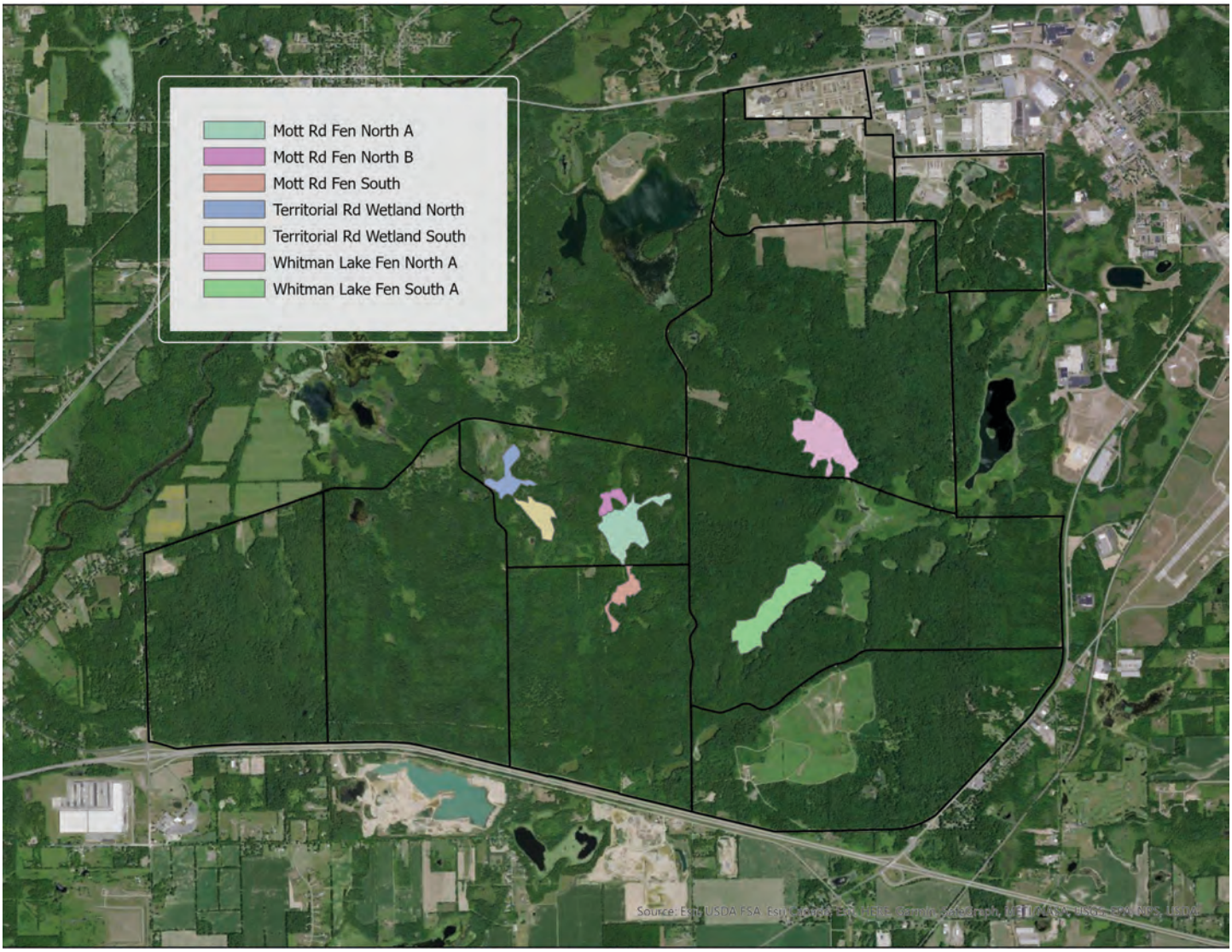

Figure 10. Sampling locations for eastern massasauga rattlesnake. The sampling location Whitman Lake Fen North A is equivalent to the natural community EO, Territorial Road Fen (EOID 16989).

Photo 48. Volunteers conducting eastern massasauga surveys in Territorial Road South (see Figure 10).

challenging to survey and detect snakes (e.g., denser shrubby vegetation and/or wetter). Mott Road Fen South was surveyed in 2018 but was not surveyed in 2021 because the unit had been flooded by a beaver dam and was too wet for surveys.

Other herpetofauna

We documented other rare amphibian and reptile species when observed incidentally during eastern massasauga surveys, as well as while conducting other surveys detailed in this report. Additional herptile species with previously documented occurrences at FCTC include: Blanding's turtle (*Emydoidea blandingii*, state special concern and federal candidate species; G4, S2S3), eastern box turtle (*Terrapene carolina carolina*, state special concern; G5T5, S2S3), pickerel frog (*Lithobates palustris*, state special concern; G5, S3S4), and Blanchard's cricket frog (*Acris blanchardi*, state threatened; G5, S2S3) (Table 8). Species observed were photographed when possible, and locations were recorded with a GPS unit or on a Samsung Galaxy tablet using the Avenza or Survey 123 applications.

Insects

We conducted rare insect surveys for one butterfly species, one leafhopper species, and three moth species. Additionally, we conducted bumble bee surveys focused on four rare species with added goal of documenting all common and rare bumble bee species. Butterfly, bumble bee, and leafhopper surveys were conducted in similar ideal weather conditions on days with no precipitation, temperatures above 15°C, and when winds were ≤ 25 kph. Moth surveys were conducted via blacklight surveys at night and are described in greater detail below.

Bumble bees (*Bombus* spp.)

Bumble bees are important pollinators of flowering plants and can play critical roles in the stability of plant-pollinator communities. Historically, at least

20 species of bumble bees occupied Michigan, while recent assessments place the current number closer to 15 (Rowe et al. 2019). Documented declines in bumble bee abundance and species richness are attributed to increases in pesticides, parasites, pathogens, and habitat loss (NRC 2007). Reductions in bumble bee populations lead to a decrease in ecosystem services or reduced fitness of flowering plants that rely on them for pollination (Biesmeijer et al. 2006).

FCTC is within the historic range of the Federally endangered rusty patched bumble bee (*Bombus affinis,* state special concern; G2, SH) and the current ranges of three state special concern species: black-and-gold bumble bee (*B. auricomus*; G5, S2*)*, American bumble bee (*B. pensylvanicus*; G3G4, S1*)*, and Sanderson's bumble bee (*B. sandersoni*; G5, S2S3*)*. None of these species have been historically documented at FCTC, with the exception of a historical collection of American bumble bee from 1963 (MNFI 2021). While these species were our primary targets, the goal of bumble bee surveys was to collect data on all common and rare bumble bee species. FCTC is predominately forested but contains many open habitats with ample floral resources that may support common and rare bumble bees. As generalist foragers, bumble bees do not require specific species of flowering plants, however, populations are generally stronger in habitats that provide diverse and consistently abundant floral resources (Wood et al. 2019).

Surveys for bumble bees have not previously been conducted at FCTC. We identified suitable habitat at FCTC by examining aerial imagery and referencing previous natural community surveys (e.g., Cohen et al. 2009) to identify herbaceous-dominated habitat that had a high likelihood of containing floral resources.

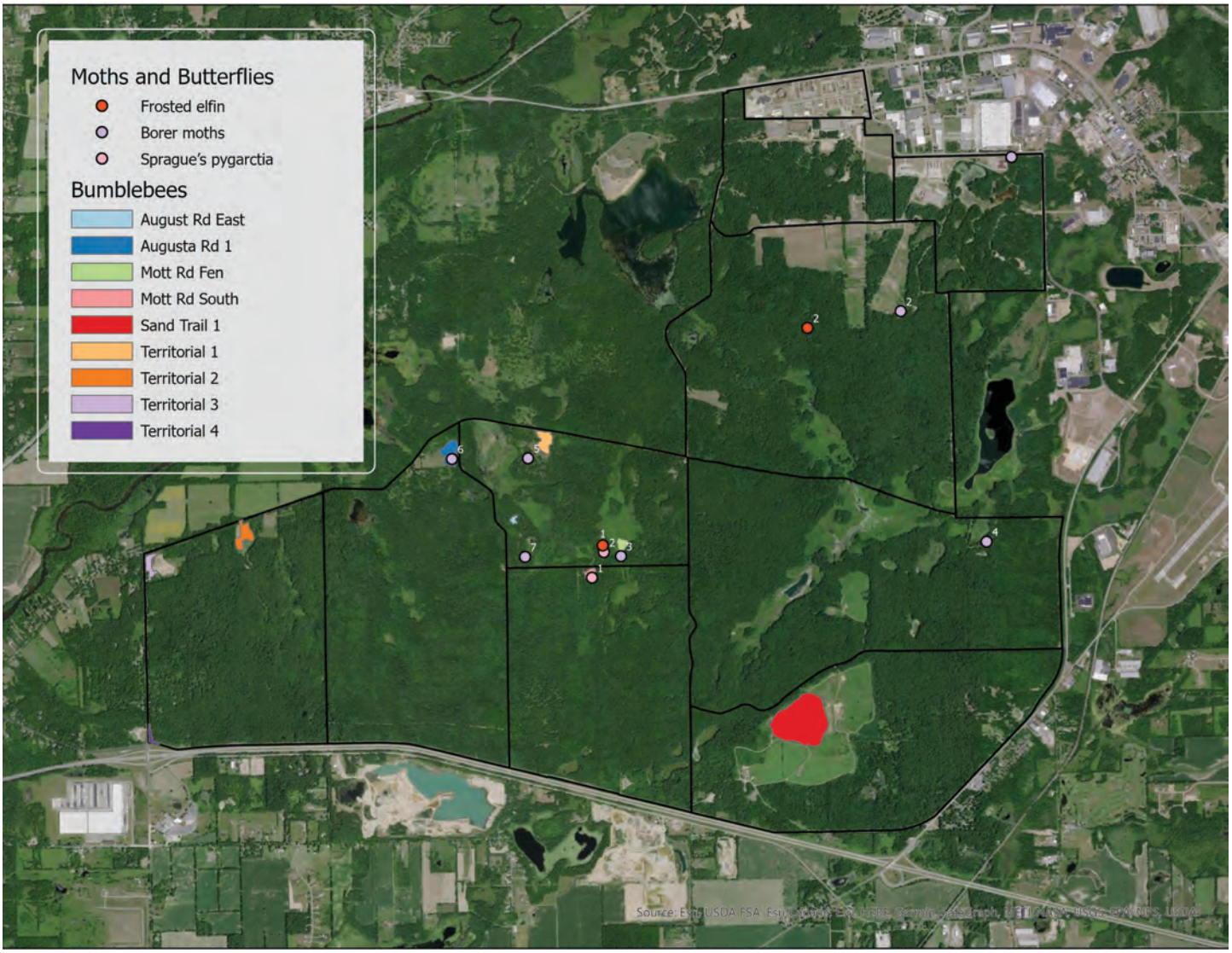

Figure 11. Sampling locations for moths, butterflies, and bumblees. Sampling location for *Flexamia reflex*a in TA 2 (Photo 49) not shown here.

Photo 49. Survey location for *Flexamia reflexa* in TA 2.

Site visits were made prior to surveys to assess the quality of the floral habitat at each location. We then selected 10 survey locations for bumble bee surveys (Figure 11, Table C1). Each site was surveyed by conducting a 30-minute meander walk, focusing survey efforts where floral resources were most abundant, and were surveyed 1-3 in both 2019 and 2020. Bumble bees were collected using an aerial net, placed in a plastic vial, and held until the end of the 30-minute survey. For each bee, we recorded the date, site, species, and the plant species from which it was collected. All bees were then released unless a voucher specimen was needed to confirm identification in the lab.

A leafhopper (*Flexamia reflexa*)
Globally not ranked (GNR); Critically imperiled (S1) and listed as Special Concern (SC) in Michigan

Flexamia reflexa is a rare leafhopper that is found in habitat supporting its host plant, Indian grass (*Sorghastrum nutans*). Indian grass, and therefore this leafhopper, may be found in prairies, prairie fens, rights-of-way, and savannas. One EO of this leafhopper species was last observed in 1994 (EOID 14424) at FCTC in prairie habitat in the extreme northeast corner of TA2 (Figure 1, Photo 49). This site was partially destroyed by the construction of the Navy Operational Support Center in 2012. We did not find Indian grass in this area, however we conducted sweep netting here in prairie habitat dominated by big and little bluestem (*Andropogon gerardii* and *Schizachyrium scoparium*) on August 15, 2019. We used a standard insect sweep net, collected all plant material and insects, transferred to plastic bags, placed them in coolers. We processed the bags in the lab, sorting all insects from plant materials prior to identifying insects under 10-20x magnification.

Frosted elfin (*Callophyrs irus*)
Globally imperiled to vulnerable (G2G3); Imperiled to vulnerable (S2S3) and listed as Threatened (T) in Michigan

Frosted elfin is a rare Lycaenid butterfly found throughout the eastern United States. This species has undergone significant range reduction in Michigan in recent decades (Gehring 2006). Michigan populations are concentrated in the southwestern portion of the state and often co-occur with the Karner blue butterfly (*Lycaeides melissa samuelis,* state threatened and federally endangered) and the Persius duskywing (*Erynnis persius persius,* state threatened), as they share the host plant wild lupine (*Lupinus perennis*). The frosted elfin also feeds on wild indigo (*Baptisia tinctoria*) where it occurs in suitable habitat, although wild indigo has never been documented at FCTC. Frosted elfin is found in open habitats such as oak savannas, oak-pine barrens, openings within oak and pine forests, and forest edges – which are maintained by fire or sometimes incidentally through anthropogenic disturbances other than fire (Nielsen 1999, Glassberg 1999). In Michigan, frosted elfin has one flight in spring, typically from the first week of May through the first week of June (Gehring 2006).

We surveyed for the frosted elfin three times during

Photo 50. Frosted elfin in oak-pine barrens, Allegan State Game Area.

the flight season in 2019 (May 14, 16, 23) after verifying that the species' flight had begun at nearby known occupied sites (Allegan State Game Area, Allegan County, Michigan; May 14, 2019). There are no records of this rare butterfly at FCTC, despite the presence of its host plant in appropriate habitat. We conducted meander surveys in suitable habitat where lupine grows. Lupine has historically been found in four locations at FCTC, however only two populations are currently large enough to potentially support lupine feeders such as the frosted elfin, so we focused surveys in these two locations in TA7 and TA9 (Figure 11, Table C1). We also concurrently surveyed for the presence of frequently co-occuring rare lepidopterans, Karner blue and Persius duskywing.

Borer moths (*Papaipema* spp.)

Borer moths in the genus *Papaipema* are nocturnal owlets in the family Noctuidae. Adults lay their eggs on or near larval host plants in the late summer and early fall. Upon emergence, caterpillars bore into the roots, rhizomes, and stems of their host plant, where they forage on plant material until they pupate in summer and emerge later in the same year (Cuthrell 1999). Many borer moths are specialist feeders, relying on native plant species found in high-quality natural areas, such as wet and dry prairies. Habitat destruction or degradation has reduced host plant abundance across historic species' ranges, which has led to decreases in the numbers of associated borer moths. Host plants for the regal fern borer moth (*Papaipema speciosissima*, state special concern; G3, S3), the blazing star borer moth (*P. beeriana*, state special concern; G2G3, S2), Culver's root borer (*P. sciata*, state special concern; G3, S3) occur at FCTC - regal fern (*Osmunda regalis*), rough blazing star (*Liatris aspera*), and Culver's root (*Veronicastrum virginicum*), respectively. Prior surveys for *P. beeriana* and *P. sciata*, but not *P. speciosissima*, have been conducted at FCTC, although no rare borer moths in the genus *Papaipema* were documented during these surveys (Cohen et al. 2009). We conducted surveys for *P. beeriana* and *P. speciosissima* during this study, identifying seven locations for these surveys at FCTC (one for *P. speciosissima* - site 3 or Mott Rd Fen - and six for *P. beeriana*) (Figure 11, Table C1). We did not conduct surveys for *P. sciata* during this study because populations of the host plant Culver's root were too few, widely scattered, and comprised of too few individuals. Blacklight surveys for borer moths were conducted during mid-September and early October. See below under Sprague's pygarctia for detailed blacklight sampling methods.

Photo 51. Borer moths: *Papaipema beeriana* (top), *P. sciata* (middle), and *P. speciosissima* (bottom).

Sprague's pygarctia (*Pygarctia spraguei*)

Globally secure (G5); Imperiled to vulnerable (S2S3) and listed as Special Concern (SC) in Michigan

Sprague's pygarctia is a moth in the family Erebidae that uses flowering spurge (*Euphorbia corollata*) as a host plant (Photo 52). Larvae feed on the leaves and stems in the spring, while adults can be observed late May through the first week of August. It is restricted primarily to openings in oak barrens and oak-pine

Photo 52. Flowering spurge (white flowers), the host plant for Sprague's pygarctia.

barrens in Michigan. Across its geographic range, it has been found associated with prairie and savanna, as well as managed areas such as low intensity fields and right-of-way lines. FCTC has one historic occurrence (EOID 10138), last observed in 1994 in a field in north-central TA5 near Mott Road. We conducted blacklight surveys for Sprague's pygarctia in two locations during June 2019 (Table C1). Additionally, we conducted larval searches on flowering spurge at two locations, one at the site of the existing EO, and one north across Mott Road in TA7 at a degraded oak barrens remnant, on August 15, 2019 (Table C1). Surveys were conducted for six hours and involved checking stems for damage associated with larval herbivory.

All moth surveys were conducted via blacklight, which consisted of a 2 m² metal conduit frame supporting a large white sheet that was used as a collecting surface (Photo 53). For the light attractant we used standard mercury-vapor and UV lights powered by a portable generator. Moths attracted to the lights were collected directly off the sheet or the ground near the sheet. The setup was placed with larval hostplants on all sides to maximize the likelihood of attracting adults (Figure/Photo 1). All moth surveys were conducted on nights with low wind, no precipitation, and generally high humidity levels (usually 70% or greater). For *Papaipema* spp., we conducted surveys in mid-September to early October between 8:00pm and 1:00am with temperatures between 9°C and 18°C. For Sprague's pygarctia, we conducted surveys in mid-June between 9:00pm and 2:00am with temperatures ranging from 20°C to 23°F.

Photo 53. Blacklighting for moths in Mott Road Fen.

RESULTS AND DISCUSSION

Snails, mussels & fish

See Appendix C for select photos of snails, mussels, and fish observed.

Watercress snail (*Fontigens nickliniana*)

We documented watercress snails at six of the nine sites surveyed, including all three existing EOs. (Tables 8 and 9, Figure 9). Live watercress snails were located on stems and leaves of watercress but were most abundant in the tiny mud and silt flats under and around watercress plants (approximately 1 m^2 area around plants). The watercress snails documented in these surveys update 3 EOs, last documented in 1994 or 1995, and expand the known geographic extent of each EO as well (Table 8). These findings also expand the known geographic extent of each three previously known occurrences. We did not find snails at the location of a known occurrence in South Mott Road Fen, likely because of the construction of a relatively recent beaver dam, which has flooded suitable habitat.

We also documented 9 other aquatic and 5 terrestrial snail species during surveys for watercress snails, as well as incidentally when conducting other surveys (Tables 9, 10). These additional observations all represent common species. Since survey methods for this project were designed to target watercress snails it is likely the full diversity of terrestrial and aquatic snails at these sites was not detected.

It is likely the watercress snail populations extend upstream and downstream of the locations they were found, and there are additional potential sites not surveyed in the scope of this project. Additional watercress snail surveys would allow the true geographic extent of the species in FCTC to be determined and documented. While this snail is considered a species of special concern in Michigan, its actual status may be much less secure. Its range in the state is restricted mainly to southwest Michigan and it has only been recorded in three counties since 2000 (MNFI 2021). The occurrences documented in these surveys are the first in Kalamazoo County in 24 years. Due to relatively high abundance of watercress snail habitat, FCTC may be one of a few strongholds for the species in Michigan. Additional surveys would allow for a more accurate assessment of the species' status in Michigan and help provide information needed to guide management efforts at the local and state level before it becomes threatened or endangered.

Table 9. Snalls documented during watercress snail surveys. See Figure 9 for locations, Appendix C for photos.

		Survey Site								
Scientific Name	**Common Name**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Aquatic Snails										
Campeloma decisum	Pointed campeloma					x				x
Elimia livescens	Liver elimia					x				x
Fontigens nickliniana	Watercress snail	x		x	x		x	x	x	
Fossaria exigua	Graceful fossaria						x		x	
Fossaria obrussa	Golden fossaria							x		
Gyraulus deflectus	Flexed gyro							x	x	
Helisoma anceps	Two-ridge rams-horn					x		x	x	x
Physella acuta	Pewter physa			x			x	x	x	
Planorbella trivolvis	Marsh rams-horn					x			x	
Planorbella campanulata	Bellmouth rams-horn								x	x
Terrestrial Snails										
Anguispira alternata	Flamed tigersnail									x
Cochlicopa lubrica	Glossy pillar						x			
Mesodon thyroidus	White-lip globe								x	x
Oxyloma retusum	Blunt ambersnail			x						
Webbhelix multilineata	Striped whitelip			x			x			

Watercress snails require the cool wet environment of small headwater streams and seeps to survive. The natural canopy cover, vegetation, and hydrology, surrounding these areas regulates the temperature and moisture within levels this species has adapted to live. Shade from the tree canopy and hydrology (groundwater upwelling) of the seeps and headwater streams are critical habitat components. Maintaining the seeps and streams, and as large a buffer around them as possible unaltered will maximize the chances these watercress snail populations will persist. Snail species can be impacted by herbicides, heavy metals, and other toxins. Invasive plants that may outcompete watercress and change the vegetative structure of the snail's microhabitats should be controlled. For example purple loosestrife (*Lythrum salicaria*) and narrow-leaved cattail (*Typha angustifolia*) occur near seeps with watercress and watercress snails in Mott Road Whitman Lake, and Territorial Road Fens. However, care should be taken to avoid exposing snails to herbicide when conducting control efforts.

Slippershell (*Alasmidonta viridis*)

No live mussels were observed at the four sites surveyed during this study. However, shells of Wabash pigtoe (*Fusconaia flava*) and cylindrical papershell (*Anodontoides ferrussacianus*) were found in a brief visual survey of the outlet stream of Whitman Lake (site 4 in Table C1). We found no mussels while visually surveying the stream reach between site 2 and site 3 when walking between sites. Aquatic snails were noted as incidental finds at all four sites and unidentified sphaeriid clams were found at sites 2 and 3, indicating generally suitable conditions for mollusks. Largemouth bass (*Micropterus salmoides*), which can serve as a host for many mussel species, were seen at site 2. Additionally, giant floater (*Pyganodon grandis*) was found during aquatic plant surveys of Lawler Pond. All three of these mussel species are relatively common and are native to Michigan.

Most native mussel species are found in medium to large rivers, habitats that are lacking at FCTC, rather than the small headwater streams that are frequent at FCTC. The slippershell is found almost exclusively in the latter and has one of the strongest associations to headwater habitats of any freshwater mussel species (Carman 2002). Other mussels that can sometimes occur in smaller streams, in addition to the Wabash

pigtoe and cylindrical papershell that we observed, include creek heelsplitter (*Lasmigona compressa*, state special concern) and spike (*Eurynia dilatata*). Given the available habitat at FCTC it is expected that the mussel fauna would be restricted to these species, but it is somewhat surprising that no live specimens of any species were observed. Physical stream habitat and water chemistry at mussel survey sites was generally suitable for mussels (Table C2), so these do not appear to be a limiting factor for their presence. Given that empty shells of Wabash pigtoe and cylindrical papershell were observed at the outlet of Whitman Lake, future surveys downstream of where these shells were found could reveal live populations of these or additional species, including the state-listed slippershell and creek heelsplitter.

Pugnose shiner (*Notropis anogenus*)

We documented six fish species during minnow trap surveys (Table 10, Figure 9). No pugnose shiners were confirmed, however underwater photographs taken during visual surveys revealed a group of fish in Platform Lake that closely resembled pugnose shiner. Identification was not conclusive based on the photos. We documented numerous red-bellied dace (*Phoxinus eos*) in Platform Lake, along with one brook stickleback (*Culaea inconstans*). Vlug Lake was dominated by pumpkinseed (*Lepomis gibbosus*). Lawler Lake was dominated by largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis machrochirus*). We documented only largemouth bass in Whitman Lake, many of which were of an older and larger size class. These were not captured in traps but were detected and identified visually. Traps were checked, reset, and left overnight in Whitman Lake, but no fish were captured. No fish other than largemouth bass were seen in visual surveys in Whitman Lake. The dominance of largemouth bass in Lawler Lake and Whitman Lake may be excluding smaller prey fish like pugnose minnow. The establishment of a large red-bellied dace population in Platform Lake, also a smaller prey fish, is likely attributable to the lack of largemouth bass. This suggests the potential for pugnose shiner to occur in Platform Lake. No fish mortality occurred during the surveys.

Table 10. Fish, snails, and mussels documented during slippershel and pugnose shiner surveys. See Figure 9 for locations, Appendix C for photos.

Scientific Name	Common Name	Vlug Lake	Lawler Lake	Whitman Lake	Platform Lake
Fish					
Culaea inconstans	Brook stickleback				x
Esox americanus vermiculatus	Grass Pickerel	x			
Lepomis gibbosus	Pumpkinseed	x			
Lepomis macrochirus	Bluegill		x		
Micropterus salmoides	Largemouth bass		x	x	
Phoxinus eos	Northern red-belly dace				x
Aquatic Snails					
Campeloma decisum	Pointed campeloma			x*	
Elimia livescens	Liver elimia			x*	
Helisoma anceps	Two-ridge rams-horn			x*	x
Physella acuta	Pewter physa			x*	x
Planorbella trivolvis	Marsh rams-horn	x		x*	x
Planorbella campanulata	Bellmouth rams-horn	x	x		x
Terrestrial Snails					
Webbhelix multilineata	Striped whitelip		x		
Mussels					
Anodontoides ferrussacianus	Cylindrical papershell			x*	
Fusconaia flava	Wabash pigtoe			x*	
Pyganodon grandis	Giant floater		x		
Fingernail Clams					
Sphaeriidae	Unidentified fingernail clams	x		x*	

** incidental finds in outlet stream*

Photo 54. An example of a set baited minnow trap in Vlug Lake.

Amphibians and reptiles (Herpetofauna)

Eastern massasauga rattlesnake (*Sistrurus catenatus*)

No eastern massasauga rattlesnakes were documented during surveys in FCTC in 2018 or 2021, despite over 280 person-hours and over 143 person-hours of searching, respectively. High-quality eastern massasauga habitat, based on vegetation type and structure, appears to be present in four of the seven priority areas that were surveyed in 2018 and 2021, Whitman Lake Fen North A, Whitman Lake Fen South A, Mott Road Fen North A, and Territorial Road Wetland South (Figure 10). Patches of high-quality massasauga habitat also appear to occur in Whitman Lake Fen North B, Whitman Lake Fen South B, Mott Road Fen North B, and Mott Road Fen South (at least in 2018 prior to flooding by beavers). In 2018, Whitman Lake Fen South A and Mott Road Fen North A and B were surveyed three to four times, but Whitman Lake Fen North A was surveyed once. This area was surveyed several times in 2017 but with only 1-2 surveyors during each visit. Additionally, Mott Road Fen North A and B and Territorial Road Wetland South had been burned for habitat management just prior to massasauga surveys in 2018. While reduced vegetative cover in the recently burned areas may have made it easier to see animals on the surface, massasaugas may not have been active or basking in the recently burned areas or may have moved to areas with more protective ground cover. In 2021, we were able to survey Whitman Lake Fen South A, Mott Road Fen North A, Whitman Lake Fen North A, and Territorial Road Wetland South three or four times over the course of two days with survey teams of 4-8 people, resulting in between 21 and 40 person-hours of surveys in each of these units. Additionally, in 2021, none of these areas had been burned immediately prior to the surveys. In 2018, Mott Road Fen South and Territorial Road Wetland North contained suitable habitat for massasaugas, but the available habitat

Table 11. Herpetofauna documented during eastern massasauga surveys. See Figure 10 for locations.

Scientific Name	Common name	Year	Territorial Rd North	Territorial Rd South	Mott Road Fen North	Mott Road Fen South	Whitman Lake Fen North A	Whitman Lake Fen South A
Sistrurus catenatus	Eastern massasauga	2018	0	0	0	0	0	0
		2021	0	0	0	0	0	0
Terrapene carolina carolina	Eastern box turtle	2018	0	7-8	13	1	1	3
		2021	0	4	0	0	1	1
Emydoidea blandingii	Blanding's turtle	2018	0	1	1	0	1	0
		2021	0	0	0	0	0	0
Lithobates palustris	Pickerel frog	2018	0	Several	1	0	1	Several
		2021	0	0	1	0	0	6

was smaller and shrub densities were higher, which likely resulted in limited basking opportunities for snakes and reduced their detectability (Lee and Legge 2000). In 2021, Mott Road Fen South was flooded due to a beaver dam and could not be surveyed, and a large portion of Territorial Road Wetland North was very dense with shrubs and/or very wet and was very difficult to survey.

Although suitable habitat for eastern massasaugas is available, surveys to date have not documented this species at FCTC (Legge et al. 1995, Tobin 2005, Tobin 2016). This is particularly puzzling given two reports of massasaugas in the FCRA within the last 15 years (MNFI 2021). Given the cryptic nature of eastern massasaugas, Casper et al. (2001) recommended a minimum of forty person hours of surveys distributed over a standard field season (April-October) before determining that massasaugas are absent from a given site. Most of these survey hours should be expended in two time-windows reflecting presumed maximum activity levels of the massasauga, spring emergence and mid- to late summer basking (Casper et al. 2001). Massasauga populations can persist at low densities for long periods of time and can be very difficult to detect at low densities (Casper et al. 2001). As a result, Casper et al. (2001) recommend that continuing negative results *after five survey years* (with a minimum effort of 40 person hours per year, appropriately spread throughout the field season of April-October) should be interpreted to mean that the population is "of questionable viability" or "potentially extirpated." Further recommendations at that stage suggest convening a panel of experts to assess habitat quality and identify additional factors that may be contribute to species absence or population declines (such as poaching), and assessment and implementation of appropriate habitat improvement actions, with continuing periodic surveys to detect response to habitat improvements (Casper et al. 2001). Continuing negative results *after ten survey years* should be interpreted to mean that the population can be considered "extirpated for management purposes", and that no management response is recommended (Casper et al. 2001). Continuing negative results *after fifteen survey years* should be reviewed by a panel of experts to make final determination of species absence or permanent population extirpation (Casper et al. 2001).

While significant survey effort to document eastern massasaugas at FCTC has been conducted for over 15 years, the minimum of 40 person hours of surveys recommended by Casper (2001) may not have been conducted within all areas of suitable habitat each year. Prior to the 2018 and 2021 surveys reported here, surveys were generally conducted by one or two observers, which may reduce detectability of this cryptic snake. However, additional natural features surveys and research have been conducted within the massasauga survey sites by qualified scientists, with no confirmed reports of the species. The blitz-style surveys in 2018 and 2021 were conducted in mid-late May during appropriate survey conditions. Blitz-style surveys have been implemented at several known massasauga populations in Michigan and have been successful at documenting large numbers of massasaugas at occupied sites (Bradke et al. 2018a and 2018b, Hileman et al. 2018, Lee 2020). Based on the long history of surveys for massasauga rattlesnakes and in potential habitat, it is likely that eastern massasaugas do not occur within FCTC. If they do, they occur at extremely low densities or may be transient individuals from FCRA. Although the massasauga reports from FCRA were provided by sources familiar with massasaugas, these reports have not been verified with photo documentation or by a species expert (MNFI 2021). Additional surveys should be conducted in FCRA to confirm the presence and extent of the distribution of massasaugas within FCRA and adjacent areas with suitable habitat.

Other herpetofauna

We documented several rare herptile species during massasauga surveys in 2018 and 2021 including 30 eastern box turtles in five sites, three Blanding's turtles in three sites, and several pickerel frogs (Photo 57) in four sites (Figure 10, Table C1). Additionally, an eastern box turtle (Photo 55) and two Blanding's turtle (Photo 56) were encountered during ecological and botanical surveys in 2020 and 2021. These observations represent updates of previously documented occurrences of each of these species, often expanding the known extent of these occurrences by identifying specific sites or adding additional sites (Table 8; MNFI 2021). Given the number and distribution of observations and extended history of occurrence (i.e., 15-46 years) of these species within FCTC (MNFI 2021), long-lived nature of eastern box turtles and Blanding's turtles (i.e., typically at least

Photo 55. Eastern box turtle.

Photo 56. Blanding's turtle.

40-50 years; Harding and Mifsud 2017), extensive available habitat for these species, and protected nature of FCTC and adjacent state recreation area, populations of these three rare species within FCTC have been estimated to have excellent to good viability (Table 8; MNFI 2021). The box turtle population at FCTC which includes box turtles within the Fort Custer State Recreation Area and other adjacent areas is particularly significant. However, the box turtle, Blanding's turtle and pickerel frog populations at FCTC continue to face threats to long-term persistence or viability (see below). Three previously documented EOs for Blanchard's cricket frogs (*Acris blanchardi*, state threatened) were not surveyed nor reconfirmed during this study (Table 8). These were all last observed in 1994 in TA8, directly south of Territorial Road between Whitman Lake and Territorial Road Fens (EOID 11297), in Bullfrog Marsh (EOID 12647), and in a marsh due east of Perimeter Road Bog (EOID 23896). However, the Michigan Herp Atlas has reports of Blanchard's cricket frogs occurring in other parts of FCTC in TA2, TA4, TA5, and TA7 from 2004 to 2016 (Michigan Herp Atlas 2019, MNFI 2021).

There are many potential threats to rare herptile species, although these threats have not been systematically assessed at FCTC. Potential threats include: 1) habitat loss and degradation through vegetative succession, invasion by non-native plant species, and hydrological alterations, particularly loss and degradation of suitable nesting habitat for turtles that are safe from predators; 2) direct mortality or other adverse impacts to health or fitness of adults or juveniles due to roads, land use and land management activities (e.g., training activities, prescribed fire, forest management activities), and chemical contaminants; 3) lack of population recruitment due to nest predation; and 4) climate change. These threats have been documented in other populations of these species, particularly the eastern box turtle and Blanding's turtle (Hyde 1999, Lee 1999, Congdon and Keinath 2006, Compton 2007, Gibson 2009, Erb 2012, Willey and Jones 2014, Harding and Mifsud 2017, Melvin 2017, Laarman et al. 2018), and have been documented or may be occurring within the populations of these species in FCTC. For long-lived species characterized by late sexual maturity and low reproductive success such as the eastern box turtle and Blanding's turtle, populations of these species are extremely vulnerable to increases in adult and, to a lesser degree, juvenile mortality rates (Congdon et al. 1993, Erb 2011). Studies on box turtle and Blanding's turtle population dynamics suggest that high levels of reproduction, high adult population densities and low adult mortality are needed to ensure viability (Congdon et al. 1993, Doroff and Keith 1990, Hall et al. 1999). The threats noted above should be examined and addressed, and population recruitment should be examined and addressed. Pickerel frogs and Blanchard's cricket frogs appear to prefer clean and cool water, may be intolerant of pollution, and may be particularly sensitive to chemical contamination in aquatic and wetland habitats (Lee et al. 2000, Harding and Mifsud 2017). Disease (e.g., *Chytridiomycosis* in frogs, ranavirus in turtles and amphibians) and illegal collection or poaching of turtles are additional threats that could impact populations of these species (e.g., eastern box turtles; Erb 2012) and should be monitored within FCTC.

Photo 57. Pickerel frog.

Photo 58. Black-and-gold bumble bee.

Additional, non-listed species observed during this study include northern leopard frogs (*Lithobates pipiens*), eastern American toads (*Anaxyrus americanus americanus*), American bullfrogs (*Lithobates catesbeianus*), green frogs (*Lithobates clamitans*), spring peepers (*Pseudacris crucifer*), wood frogs (*Lithobates sylvaticus*), eastern garter snakes (*Thamnophis sirtalis sirtalis*), eastern hog-nosed snakes (*Heterodon patirhinos*), northern watersnakes (*Nerodia sipedon sipedon*), northern ribbonsnakes, DeKay's brown snakes (*Storeria dekayi*), an eastern milksnake (*Lampropeltis triangulum*), blue racers (*Coluber constrictor foxii*), spiny softshell turtles (*Apalone spinifera*) and snapping turtles (*Chelydra serpentina*). The northern ribbonsnake and blue racer have been identified as species of greatest conservation need in Michigan's Wildlife Action Plan (Derosier et al. 2015).

Insects

Bumble bees (*Bombus* spp.)

In 2019 and 2020, we conducted 37 bumble bee surveys at ten locations. During these surveys we recorded 698 bumble bees, representing seven species (Table 12), including the black-and-gold bumble bee (Photo 58), a species that had not previously been documented at FCTC (Table 8). We recorded the black-and-gold bumble bee five times during this study, comprising two new EOs, including one near Mott Road Fen north of Mott Road (EOID 23639), and one distributed among two fields along Territorial Road (Territorial Road 2 and 3 in Table C1) in the north of TA3 (EOID 23638). As generalist foragers, bumble bees will visit diverse assemblage of flowering plants throughout their flight duration from May to October. Therefore, it is crucial that a variety of pollen and nectar species are available for their entire flight season for forage to support colony growth and reproduction. Many restoration and conservation programs that target high-quality natural communities such as wet and dry prairies will likely benefit numerous species of bumble bees. During the late spring, foragers rely heavily on flowering shrubs and trees associated with forest edges, while in the summer, they rely more heavily on herbaceously dominated species growing in open areas. At FCTC, these areas generally contain a mix of non-native and native flowering species such as wild bergamot (*Monarda fistulosa*), spotted knapweed (*Centaurea stoebe*), goldenrods (*Solidago* spp.), and clovers (*Trifolium* spp.). Application of herbicides should be limited and are discouraged in areas that are occupied by rare bumblebee species. Application of such chemicals should be limited and are discouraged in areas that are occupied by rare species. Any activity the reduces the availability of flowering plants will likely harm populations of bumble bees. Reduced mowing, removal of shrubby invasive species, and targeted restoration that includes forbs can all benefit bumble bees. Given the presence of the black-and-gold bumble bee, habitat management should focus on areas occupied by this rare species. Additional surveys are needed to determine the full extent of this species (and presence of other rare bumble bee species). See Rowe 2020 for a comprehensive report on this portion of the study.

A leafhopper (*Flexamia reflexa*)

No *Flexamia* species or other rare insects were observed during our sweepnet surveys of historically occupied habitat. This negative survey result is

Table 11. Bumbless observed during surveys in 2019-2020. See Figure 11 for locations

Scientific Name	Common Name	Year	# observed
Bombus auricomus	Black-and-gold bumble bee	2019	4
		2020	1
Bombus bimaculatus	Two-spotted bumble bee	2019	82
		2020	39
Bombus citrinus	Lemon cuckoo bumble bee	2019	11
		2020	13
Bombus fervidus	Yellow bumble bee	2019	8
		2020	16
Bombus griseocollis	Brown-belted bumble bee	2019	68
		2020	11
Bombus impatiens	Common eastern bumble bee	2019	242
		2020	121
Bombus vagans	Half-black bumble bee	2019	34
		2020	48
	Totals:	2019	**449**
		2020	**249**

not surprising, given the absence of its host plant, Indian grass, from the survey site, and the significant reduction in habitat area due to the construction of the Navy Operational Support Center. This leafhopper species may still occur at the survey site at low density or elsewhere at FCTC in habitats that support Indian grass. Additional surveys are recommended for this species where the host plants are abundant (see *Future Steps*, below).

Frosted elfin (*Callophyrs irus*)

No frosted elfin, nor other rare butterflies, were documented during our surveys. Previous investigations have also failed to find these rare butterfly species (Cohen et al. 2009, Cole-Wick 2018). Extant wild lupine populations at FCTC occur in degraded oak-barrens and openings in dry southern forest, however lupine has declined in recent years due to increasing canopy cover and understory encroachment of early successional woody species, in particular the clonal tree sassafras (*Sassafras albidum*). Additionally, we were unable to locate historical lupine populations in TA8. Prescribed fire and mechanical removal of early successional plants that outcompete wild lupine is likely necessary to ensure its continued presence at these sites. Due the lack of occurrences of frosted elfin, despite many years of searching, we do not recommend further surveys for this species.

Borer moths (*Papaipema* spp.)

We documented 24 individuals of *Papaipema* moths during surveys in 2019 and 13 individuals in 2020 (Table 13). We did not observe regal fern borer moth (*P. speciosissima*) nor blazing star borer moth (*P. beeriana*), however, we did document a new occurrence of golden borer (*P. cerina*, state special concern, EOID 23849) at Mott Road Fen North (Photo 59). The golden borer relies on its host plants: lilies (*Lilium michiganense* and likely others), May-apple (*Podophyllum peltatum*), bottlebrush grass (*Elymus hystrix*), and dark green bulrush (*Scirpus atrovirens*) and the primary habitat with which this borer is associated is dry-mesic forests and hydric grasslands (Rare Species Explorer 2021). However, it has been discovered in other habitats across its geographic range. Little is known about this species' ecology and the occurrence at FCTC is one of five in Michigan. We recommend further surveys to determine the extent of this species at FCTC.

In general, rare *Papaipema* moths occupy a variety of habitats, depending on host plant location. While their populations tend to be strongly associated with high-quality natural communities, observations occur in other areas, both natural and managed. Since most species are tied to specific host plants, ensuring that populations of these are hosts are abundant is crucial. Managing habitats in a way that encourages new growth is ideal. At FCTC, the primary habitats containing host plants for rare *Papaipema* spp. include dry mesic southern forest, prairie fen, and oak barrens, but also include managed fields that contain prairie host plant species such as rough blazing star. It is recommended that the survey locations in this study be a starting point for conservation of existing host plant populations. Then, habitat restoration at FCTC should be prioritized in dry-mesic southern forests, emergent marshes, oak openings, and prairie fens. Since populations of rare borer moths at FCTC are small, beginning a management program is imperative to their recovery and conservation.

Photo 59. Golden borer moth.

Sprague's pygarctia (*Pygarctia spraguei*)

We did not observe Sprague's pygarctia during surveys in 2019 nor did we find evidence of larval herbivory at either survey site. However, populations of the host plant flowering spurge are still abundant at survey locations, and in multiple open fields at FCTC. Management recommendations for this species are the same as that of the frosted elfin, as they share habitat at FCTC. Prescribed burning with ample refugia will benefit this species. Additional surveys are recommended for this species where host plants are abundant (see *Future Steps*, below).

Table 13. Borer moths observed during 2019-2020 surveys. See Figure 11 for locations.

		2019 Surveys					2020 Surveys			
Scientific Name	**Common Name**	**Denso Rd**	**Range Rd**	**Mott Rd Fen**	**Hill Brady**	**Total 2019**	**Territorial Rd**	**Augusta Rd**	**Mott Rd West**	**Total 2020**
P. birdi	Umbeliffer borer	0	1	1	0	2	0	0	0	0
P. cataphracta	Burdock borer	0	0	0	1	1	0	0	1	1
P. cerina (SC)	Golden borer	0	0	1	0	1	0	0	0	0
P. cerussata	Ironweed borer	0	0	0	0	0	0	0	1	1
P. eupatorii	Joe-pye weed borer	0	0	2	0	2	0	0	0	0
P. impecuniosa	Aster borer	0	0	1	0	1	0	0	0	0
P. inquaesita	Sensitive fern borer	1	0	8	4	13	1	0	9	10
P. nebris	Stalk borer	0	2	0	0	2	0	0	1	1
P. nepheleptena	Turtle head borer	0	0	1	1	2	0	0	0	0
	Site totals:	1	3	14	6	24	1	0	12	13

Surveys conducted between 9/18-24/19 (Denso Rd, Range Rd, Mott Rd Fen, Hill Brady) and 9/14-23/20 (Territorial Rd, Augusta Rd, Mott Rd West)

Conclusions

GENERAL MANAGEMENT RECOMMENDATIONS

We suggest management recommendations with an adaptive management framework in mind. Adaptive management, to the extent possible, has explicit goals, although articulating specific goals is beyond the scope of this report. Each goal should have associated monitoring component to assess the effectiveness of management and allow for strategies to adapt to changing ecological conditions and new research. We suggest some key monitoring priorities in the next section.

Prescribed fire

The ongoing prescribed fire program at FCTC has yielded and will continue to yield many positive outcomes for biodiversity and ecosystem management, specifically because of the abundance of fire-dependent species and ecosystems. Plant species diversity is positively linked with fire in most of the natural communities occurring at FCTC, including the oak ecosystems (i.e., dry-mesic southern forest, dry southern forest, oak barrens) that dominate the landscape (Leach and Givnish 1999, Cohen 2001, Lee and Kost 2007, Ladwig et al. 2018). Many rare, fire-dependent species of oak ecosystems at FCTC have flourished in recent years. For example, the recent documentation of the plants upland boneset (*Eupatorium sessilifolium*), slender yellow flax (*Linum virginianum*), shining wedgegrass (*Sphenopholis nitida*), and pale avens (*Geum avens*) at FCTC is at least in part attributable to fire (Cohen et al. 2009, *this study*). Restoration of the open understory structure through reductions in woody species density, combined with population-level effects including increased germination and viability, likely increased the size and detectability of these populations (Tester et al. 1989, Briggs et al. 2005, Peterson and Reich 2008). These fire effects not only benefit rare species but underpin the maintenance of understory plant diversity overall (Vander Yacht et al. 2017, Bassett et al. 2020). In a landscape that evolved with fire, conducting landscape-scale fires has also been beneficial, for example "softening" the transition between open ecosystems such as prairie fen and forested oak ecosystems. These ecotones support communities of species that may not be found in abundance in either adjacent community but thrive with intermediate light availability or soil moisture.

Photo 60. Prescribed fire in Training Area 6.

There will always be challenges with applying prescribed fire at FCTC. The response of problematic and invasive species to fire, articulated in Cohen et al. (2009) and long since acknowledge by managers at FCTC, continues to be an impediment to achieving management goals. The expansion of native, clonal woody species sassafras (*Sassafras albidum*) and staghorn and shining sumac (*Rhus typhina* and *R. copallina*) following fires confounds efforts to use fire to reduce woody species density and increasing light availability in prairie and barrens ecosystems. Areas threatened by encroachment of these clonal species include Mott Road Prairie (EOID 10017) and the degraded oak barrens to the east in TA7, Range 13 Oak Barrens (EOID 23951), a barrens opening in TA9 south of Reese Road and west of Armstrong Road, and occupied prairie vole (*Microtus ochrogaster*) habitat in TA7. We encourage continued experimentation with varied prescribed fire seasonality, specifically growing season burns. Supplementing prescribed fire with mechanical treatments, as was recently implemented at the Mott Road oak barrens site in TA7, will probably be an ongoing requirement in many areas. Some invasive species also increase in density or abundance in response to prescribed fire. For example, narrow-leaved and hybrid cattail (*Typha angustifolia* and *T. X glauca*) invade high quality prairie fen and have been shown to spread rapidly from rhizomes following

Photo 61. Transition from prairie fen (Whitman Lake Fen) in foreground, to dry-mesic southern forest (Whitman Lake Woods) in background.

initially reduced cover after prescribed fire (Bansal et al. 2019). Woody species like oriental bittersweet (*Celastrus orbiculatus*) may either resprout or respond with dense seedling recruitment after fire. Consider focused monitoring of these species after fire, in conjunction with existing fire response management conducted by KNC, to prioritize follow herbicide treatments and other management options.

Avoiding fire-sensitive areas and accommodating fire-sensitive species, particularly herptiles, may also be necessary. The Cemetery Complex Seeps (EOID 3093) and Ridge (EOID 8692) is a high-quality fire sensitive ecosystem complex surrounded by degraded, fire-dependent oak ecosystems. Allowing fires to extend into these areas in the past has potentially harmed rare species such as the state-threatened tree red mulberry (*Morus rubra*; Cohen et al. 2009), as well as the mesophytic ground layer (pers obs, T. Bassett). The reclassification of Cemetery Complex Ridge from dry-mesic southern forest to mesic southern forest emphasizes the fact that the natural disturbance regime in this forest community is not fire. Rather, excluding fire and allowing for regular windfall will allow for the long-term recruitment of mesophytic canopy tree species and maintain the most humous and leaf litter that the diverse mesophytic ground layer plant community relies on.

While prescribed fire enhances habitat for herptile species that utilize fire-dependent upland ecosystems, such as the eastern box turtle and Blanding's turtle, fire can also lead to mortality or otherwise adversely impact individuals and populations of these species if conducted during key stages of their active season (April-October) (Hyde 1999, Lee 1999). If prescribed fires need to occur during spring and early summer, it is recommended that prescribed fires avoid the early spring emergence period (April to mid-May) when turtles and other herptiles may be lethargic or less active after emerging from their winter hibernacula. Instead, fires should be conducted later in the spring or into the growing season when turtles are fully active and may be able to evade slow-moving flames or find suitable refugia during prescribed fires (Melvin 2017). These growing season burns may also be consistent with other goals, including reducing encroachment by clonal woody species (e.g., sassafras, sumac). Burning in early to mid-July to mid-August would reduce the potential for adversely impacting turtles, particularly in upland nesting habitats (Laarman et al. 2018). This avoids emergence, nesting season (mid-May to late June), and hatchling emergence (mid-August through October) (Melvin 2017, Laarman et al. 2018). If these seasons cannot be avoided, conducting slow-moving fires such as backburns is recommended so individuals have time to avoid fire, as well as dividing occupied habitat into multiple burn units and leaving at least

one burn unit unburned at a time to serve as refugia for turtles during fires.

Mesophication

The dominant land cover types at FCTC are oak ecosystems, primarily the natural community dry-mesic southern forest but including dry southern forest and oak barrens. Oak ecosystems throughout the eastern United States are undergoing a successional process called "mesophication" due to a century or more of fire-suppression (Nowacki and Abrams 2008). Understory tree composition in many oak ecosystems has shifted from fire-dependent but shade-intolerant oak and hickory species, to fire-sensitive and shade-tolerant species (e.g., maples, cherries) typical of mesic forests, with corresponding shifts in ground layer vegetation (Abrams 1992, Nowacki and Abrams 2008). The result is a growing "regeneration debt" in oak ecosystems, where oak seedling and sapling densities are insufficient to replace overstory oaks over the long term (Miller and McGill 2019, Vickers et al. 2019). In southern Michigan in particular, oak regeneration is limited by competition with mesophytic species such as red maple (*Acer rubrum*) and wild black cherry (*Prunus serotina*), particularly in more productive soils along ice-contact ridges and moraines, landforms that are prominent at FCTC (Iverson et al. 2008, Lee and Kost 2008). Browse pressure from white-tailed deer (*Odocoileus virginianus*) is another major limiting factor in oak regeneration (Rooney and Waller 2003, Dey 2014, McWilliams et al. 2018).

Photo 62. Maples in understory providing dense shade associated with mesophication.

Despite the inextricable link between mesophication and fire suppression, fire alone is not sufficient for reversing its effects, except potentially in sites with droughty soils where oaks have a competitive edge (Brose et al. 2013, Bowles et al. 2017, Iverson et al. 2017, Bassett et al. 2020). Oak ecosystems undergoing mesophication are not able to sustain the fire intensity to cause mortality in all but the smallest stems of most species (generally, stems that are pole-sized, ~ 12 cm DBH, and above are not susceptible), including fire-sensitive species like red maple. Mesophication increases ground-level moisture levels and alters ground layer fuels, particularly through the build-up of humus, that limit the spread and intensity of fire and maintain conditions suitable for mesophytic species. With mesophication, ground layer conditions are characterized by a sparse ground layer and flat, mat-forming, and moisture-retaining leaf litter of maple and other mesophytic tree species (and an associated humus layer); in the absence of mesophication, the ground layer is characterized by a continuous, often graminoid-dominated herbaceous community and dry, flammable oak leaf litter. Overcoming mesophication requires a combination of prescribed fire with silviculture and small-scale understory management (Dey et al. 2017). Successful management for oak regeneration requires paying close attention to demography, targeting management to benefit key life history stages in oak species, emphasizing acorn, seedling, and sapling success during appropriate stages of the management process (Dey 2014). For example, opening the overstory to increase light availability in the ground layer will not be effective if a sufficient density of oak advance regeneration (e.g., saplings and older seedlings) is not available to take advantage of that light (Dey 2014). Approaches to reverse mesophication are well-studied in parts of the eastern United States, including Missouri (Dey 2014, Fan et al. 2015) and Pennsylvania (Brose et al. 2008), but not in Michigan. Adapting these approaches will require additional research.

Invasive species

The density and abundance of invasive species is in large part a legacy of the intersection between land use patterns and the movement of organisms by human cultures (Foley et al. 2005). This legacy can be hard to reverse, but understanding it is necessary for successful invasive species management. The recent decimation of ash (*Fraxinus* spp.) in southern Michigan and beyond with the spread of the emerald ash borer (*Agrilus planipennis*) is an example of a species whose impact is large and apparent, but because its introduction occurred only in the early 2000s, the extent of its impact is still not known.

Other invasive species became established decades ago, and more gradually. Invasive plant species such as multiflora rose (*Rosa multiflora*) and autumn olive (*Elaeagnus umbellata*) were distributed and planted by conservation organizations and governmental agencies in the decades following WWII for soil conservation and wildlife benefits. Others are escapes from landscape plantings, including Japanese barberry (*Berberis thunbergii*), bush honeysuckles (*Lonicera* spp.), common privet (*Ligustrum vulgare*), common buckthorn (*Rhamnus cathartica*), and glossy buckthorn (*Frangula alnus*). The establishment and spread of these and other invasive species coincided with increasing rates of rural and suburban spawl in

Photo 63. Densely invaded post-agricultural forest in TA 8, with black locust (*Robinia psuedoacacia*) in canopy, and Japanese barberry (*Berberis thunbergii*) in understory.

the Midwestern United States following World War II, which heralded increased rates of habitat loss, degradation, and fragmentation (Radeloff et al. 2005).

This pattern is apparent at FCTC, where the abandonment of many former agriculture fields after WWII (likely due to low productivity in sandy soils and increased availability of food imports for troops) has resulted in regenerating forests with dense populations of these same invasive shrubs in the understory. Indeed, the dominant age of most forested stands that were in active agriculture in 1938, which was a large percentage of the land cover of FCTC, is generally between 70 and 80 years – placing their origin between 1940 and 1950 (Figure 2). Because these species are widespread at FCTC with likely robust seed banks, our recommendation is to focus on managing these species aggressively only in high-quality natural communities (including, but not limited to EOs), reduce their density in areas adjacent to high-quality natural communities, and avoid managing these species aggressively in degraded communities except for the goal of increasing connectivity between high-quality patches of a natural community (Figures A2 and A3). The ongoing prescribed fire program will likely help to reduce the density of these species in degraded areas and reduce the dispersal of these species into high-quality areas.

Another priority for invasive species control is the early detection of new species and infestations, and a prudent management response when those species are detected (i.e., "early detection and rapid response" or EDRR; Pysek and Richardson 2010, Reaser 2020). One component of the response may include taking the time to study a potentially invasive species or the impact of that species on a particular ecosystem. However, monitoring for several known invasive plant species is recommended, specifically those that are known to occur in Kalamazoo, Calhoun, or adjacent counties; have been documented spreading in southern Michigan or adjacent areas of Indiana, Ohio, and Illinois; and for which habitat occurs at FCTC. When detected, the following species should be eradicated without delay: black and pale swallow-wort (*Vincetoxicum nigrum* and *V. rossicum*), Japanese stilt-grass (*Microstegium vimineum*), Chinese yam (*Dioscorea oppositifolia*), and mile-a-minute weed (*Persicaria perfoliata*), and wild parsnip (*Pastinaca sativa*), primarily in upland habitats; fanwort (*Cabomba caroliniana*), hydrilla (*Hydrilla verticillata*), and flowering rush (*Butomus umbellatus* (flowering rush) in wetlands. The likelihood of these regional priority species invading FCTC habitats is high. A small population of black swallow-wort is established in TA2, and was observed along Vlug Road. Small, individual populations of Japanese stiltgrass and mile-a-minute weed have recently been documented and rapidly eradicated in in Kalamazoo and Calhoun counties, respectively.

The above list is by no means exhaustive – there are certainly additional species that should be a high priority for eradication if detected. There are also several fungal and viral pathogens and insect pests that should be the focus of monitoring and rapid response if detected: beech leaf disease (associated with the nematode *Litylenchus crenatae*), beech bark disease (caused by fungi *Neonectria faginata* and *Neonectria ditissima* and spread by beech scale insect, *Cryptococcus fagisuga*), sudden oak death (caused by fungus *Phytophthora ramorum*), and oak wilt (caused by the fungus *Ceratocystis*

fagacearum); and the insects Asian longhorned beetle (*Anoplophora glabripennis*) and spotted lanternfly (*Lycorma delicatula*). Oak wilt would be particularly damaging to the overall ecological integrity of FCTC. Best practices for avoiding oak wilt include avoiding injuring (including logging) oak trees from April through July. Tree-of-heaven (*Ailanthus altissima*), an invasive tree with several known established populations at FCTC, is the preferred host species for spotted lanternfly, which may also feed on both economically important, horticultural species and native species of crabapple (*Malus* spp.), cherry (*Prunus* spp.), and grape (*Vitis* spp.). Southern Michigan is at particularly high risk for invasion by spotted lanternfly, so controlling tree-of-heaven is vital to reduce the risk of invasion (Rowe et al. 2020).

Deer overabundance

High white-tailed deer (*Odocoileus virginianus*) densities generally degrade ecosystems and can be a barrier to management success (Rooney and Waller 2003, Cote et al. 2004). Through preferential browsing of tree seedlings and palatable understory herbs, high deer herbivory reduces understory plant diversity, altering herbaceous composition and limiting the recruitment of particular tree species to the canopy. Deer herbivory can also facilitate establishment and population growth of invasive species by reducing competition from native species and creating bare ground for seed establishment (Knight et al. 2009). At FCTC, the viability of rare plant species populations in particular are threatened by deer herbivory, for example upland boneset and show orchis (*Galearis spectabilis*) (Figure pic of EUPSES). The regeneration of oak ecosystems also appears to be impacted by deer herbivory on oak seedlings (Rooney and Waller 2003, Dey 2014, McWilliams et al. 2018). These impacts of deer overabundance may not be easily reversible if population growth in native plants is depressed for a long period, so efforts to reduce deer densities are urgent (Cote et al. 2004).

Depending on the density and longevity of deer overabundance, removing deer alone may result in noticeable benefits to the restoration of native herbaceous species (Kalisz et al. 2014). Managers can mediate the impacts of deer overabundance by increasing the resiliency of ecosystems as well as by directly reducing the density or abundance of deer. For example, managing large blocks of mature contiguous forest reduces the tendency for deer to congregate in that landscape, by reducing the density of low browse associated with clearcuts edge habitat. Large habitat patches also increase the resiliency and viability of plant populations, including understory herbs (MacArthur and Wilson 1967). The ideal deer density for canopy regeneration and thriving understory plant

Photo 64. Deer herbivory on forest understory herbs: (L ro R) smooth false foxglove (*Aureolaria flava*), richweed (*Collinsonia canadensis*) and state threatened upland boneset (*Eupatorium sessilifolium*).

populations requires focused research to determine but may be as low as 5-10 deer/km^2 (15-25/mi^2) (Ristau et al. 2012, McWilliams et al. 2018). Antlerless hunts (i.e., hunting does rather than bucks) may be necessary to reduce population growth (Cote et al. 2004).

Biodiversity and water quality in aquatic habitats

Managing both uplands and wetlands to maximize water quality will be beneficial for a wide variety of aquatic and semi-aquatic fish, mussels, snails, herptiles, and plant species. Maintaining free flowing streams is essential to the long-term viability of mussel, fish, and other riverine species. Avoiding the creation of barriers to fish passage can allow for the migration of individuals to new habitats and the exchange of genes between populations. Since unionid mussels are reliant on fish hosts to transport them, barriers to fish movement are also barriers to mussel migration and gene flow among mussel populations. Gene flow among populations prevents negative impacts from inbreeding and genetic isolation of populations (Watters 1996, Haag 2012). Maintaining naturally vegetated buffers in uplands adjacent to wetland ecosystems, and in wetland ecosystems themselves, controls the flow, nutrient-

Photo 65. Maintaining wooded uplands protects water quality. Biodiversity in the moats on the borders of Longman Road Bogs (foreground) are protected by the ecological integrity of Whitman Lake Woods (background).

levels, and temperature of surface water into wetlands, streams, and ponds. Both naturally forested uplands and naturally vegetated wetlands can greatly benefit stream ecosystems and contribute to the long-term viability of native mussels, fish, and other species that are part of these systems. Riparian buffers regulate temperature through shade, contribute energy through the input of leaves, and create habitat for fish and aquatic macroinvertebrates with large woody debris. Many cyprinid fish, and pugnose shiners (*Notropis anogenus*) in particular, are intolerant of turbid water. Maintaining as much natural vegetation in the watershed as possible can help to minimize erosion, siltation, and turbidity that can negatively impact this species. Impervious surfaces like roads and parking lots contribute to flashiness (extreme changes in flow) of streams and rivers, which leads to increased erosion and turbidity in streams and lakes, reducing the density of aquatic vegetation. These overall reductions in both water quality and aquatic vegetation are likely to negatively impact several rare species, including the Blanding's turtle (*Emydoidea blandingii*) (Lee 1999) and Blanchard's cricket frog (*Acris blanchardii*) (Lee et al. 2000). Maintaining natural vegetation and reducing impervious surfaces also stabilizes groundwater hydrology that rare natural communities like prairie fen and rare plant species such as cut-leaved water parsnip (*Berula erecta*) rely on.

FURTHER STEPS

We recommend expanded rare species surveys and long-term rare species and ecosystem monitoring. Rare species that would benefit from expand surveys include newly documented species, to better understand their abundance and distribution to inform management, and species for which suitable habitat exists but which have not previously been the focus of surveys. Long-term species and ecosystem monitoring is necessary for managers to gauge the effectiveness of management such as prescribed fire, silviculture, and invasive species management, and to know when and how to adapt management to changing conditions. FCTC has existing long-term monitoring programs, including the Range and Training Land Assessment implemented in 1998 and executed by Envirologic that utilizes a coarse vegetation monitoring protocol to track broad vegetation trends and Fire Effects Monitoring implemented in 2016 by the Kalamazoo Nature Center that specifically focuses on the response of species composition and vegetative structure to prescribed fire (INRMP 2020). Oak ecosystem issues and deer overabundance are two additional acute management priorities facing FCTC.

Rare insect surveys

Additional surveys for rare insects at FCTC are needed to better understand rare insect populations

and are likely to lead to the documentation of new EOs, specifically for bumblebees (*Bombus* spp.) and several species that rely on larval host species known to occur at FCTC. This study documented the presence of black-and-gold (*Bombus auricomus*) at FCTC, but their extent is poorly known. Ongoing survey work is needed to attain better population estimates and to better understand the ways in which bumble bees (particularly declining species) interact with their environments, including foraging preferences and nesting locations. The areas surveyed in 2019 and 2020 represent a small fraction of the overall area of FCTC and were completed during the time when bumble bee workers are most active (late June – late August). Future survey work should prioritize additional survey locations with abundant floral resources. These efforts should contain both spring and fall surveys when bumble bees may be foraging from plant species not blooming during the survey timeframe in this study. This would allow for a better representation of bumble bee diets at FCTC and help in the identification of additional floral resources used by bumble bees within the base. By identifying additional locations at FCTC with occurrences of at-risk bumble bee species, targeted habitat management plans can be developed to enhance season long foraging resource availability to fit the dietary needs of bumble bees and to increase the connectedness of utilized floral habitats. In addition to regularly monitoring of their populations and managing habitat, increasing nectar resources throughout FCTC and FCRA through expanded efforts to replace monocultures of invasive species such as spotted knapweed (*Centaurea stoebe*) with diverse, forb-rich native grassland plantings will help these and other bumblebee species.

Larval host species for several moths and other insects occur at FCTC, often at densities that may be sufficient to support viable populations of those insect species. We first documented golden borer moths (*Papaipema cerina*) during this study (EOID 23849), and additional populations may occur at FCTC in habitats supporting its likely larval host species, probably one of the lilies (*Lilium michiganense* and likely others), May-apple (*Podophyllum peltatum*), bottlebrush grass (*Elymus hystrix*), and dark green bulrush (*Scirpus atrovirens*). Conducting additional surveys in the same or nearby locations would help to better understand the status of the documented

Photo 66. Richweed (*Collinsonia canadensis*) is the larval host for astute stonewood borer (*Papaipema astuta*).

occurrences, and expanding surveys into other areas supporting the putative larval host species may reveal additional occurrences. We did not observe four other *Papaipema* spp. during this and previous studies that have the potential to occur at FCTC, blazing star, regal fern, Culver's root, and astute stoneroot borers (*P. beeriana*, *P. speciosissima, P. sciata,* and *P. astuta*). Surveys have been conducted for all but *P. astuta* in the past, but negative survey results are probably because populations of the host plants were too infrequent at FCTC and sparse where they occurred. If these borer moth species currently occur at FCTC at low detectability, increased population sizes of their host plant species may reveal occurrences of blazing star and Culver's root borer. Regal fern borer should be targeted in swamps where its host species royal fern (*Osmunda regalis*) is abundant, whereas astute stoneroot borer should be sought where its host plant richweed (*Collinsonia canadensis*) is abundant, such as in the western extent of Whitman Lake Woods.

We did not rediscover the rare moth flowering spurge borer (*Pygarctia spraguei*) where it was last observed in an old field in 1994, despite the presence of its host plant, flowering spurge (*Euphorbia corollata*). Future surveys should target flowering spurge populations in higher quality oak barrens and other habitats. Doll's merolonche (*Merolonche dolli*) is a moth species known only from the northern lower peninsula in Michigan, but as a blueberry (*Vaccinium* spp.) feeder its host plants occur throughout the state. Surveys for this moth should focus on areas where blueberry species are abundant, including Perimeter Road Bog (EOID 23896) and the margins of dry-mesic southern forest adjacent to fen, such as portions of Whitman Lake Woods (EOID 3628). Great Plains spittlebug (*Lepyronia gibbosa*) is found associated with various prairie grasses such as big bluestem (*Andropogon gerardii*), little bluestem, and

Photo 67. MNFI Zoologist Ashley Cole-Wick conducting watercress snail surveys. Note tiny watercress snail, barely visible on her fingertip.

Indian grass (*Sorghastrum nutans*). These species occur in dense patches in several locations at FCTC, including the "tank range" in TA6, the field adjacent to Lawler Cemetery in TA4, and several locations throughout TAs 2 and 7. Finally, an EO of a rare leafhopper (*Flexamia reflexa*) last observed in 1994 (EOID 14424) was not relocated during this study in the northeast corner of TA2, most likely due to the absence of its host species, Indian grass. Future surveys are warranted in dense stands of Indian grass in other areas at FCTC. Surveys should also target the state endangered leadplant moth (*Schinia lucens*) where its hostplant leadplant (*Amorpha canescens*) is abundant in TA9.

Watercress snail and land snail surveys

We recommend additional rare snail surveys, focusing on watercress snail specifically and rare land snails in general. Watercress snail (*Fontigens nickliniana*) is a species of special concern in Michigan, however its actual status may be much less secure. Its distribution in Michigan is restricted mainly to the southwestern part of the state and it has only been recorded in three counties since 2000, Cass, Kalamazoo, and St. Joseph (MNFI 2021). Surveys at FCTC in 2019 confirmed the species persists in the same habitats where originally documented in 1994 and 1995. FCTC, which contains an abundance of watercress snail habitat, may be one of just a few strongholds for the species in Michigan. Expanded surveys for this species will allow for a more accurate status assessment and help provide information needed to guide management efforts before it becomes threatened or endangered.

Documented occurrences of rare land snails in Michigan (e.g., *Catinella protracta, Glyphyalinia solida*) are even more sparse, with no occurrences known from FCTC and no known occurrences in Michigan for some species (MNFI 2021). The abundance of habitat data generated during this study and detailed in this report can facilitate identifying potential survey sites, and provides an opportunity to document rare land snail species at FCTC.

Rare herptile surveys

We documented several occurrences of two rare herptile species during this study, eastern box turtle (*Terrapene carolina carolina*) and Blanding's turtle. Based on nearby documented occurrences and the presence of available habitat at FCTC, we recommend future surveys for additional rare herptile species, including spotted turtles (*Clemmys guttata*, state threatened) and Kirtland's snakes (*Clonophis kirtlandii*, state endangered) in prairie fens and other emergent wetlands and vernal pools; marbled salamanders (*Ambystoma opacum*, state endangered) in the vernal pools and surrounding upland and lowland forests; gray ratsnakes *(Pantherophis spiloides*, state special concern) in upland and lowland forests; and mudpuppies (*Necturus maculosus,* state special concern) in Hart's Lake and potentially Whitman Lake. Surveys also are needed to determine if Blanchard's cricket frog (*Acris blanchardi*, state threatened) still occurs in several locations in the north of TA8 (EOID 12297), as the species was last reported from that area in 1994 and to clarify the species' distribution and extent at FCTC. Additional monitoring and research are needed to assess and clarify the status, trends, and long-term viability of these populations and inform management efforts for currently documented species. Identifying critical habitats for these species (e.g., breeding, nesting, and overwintering areas) would help inform their management and protection. Information on threats facing these populations also is needed to determine their impacts on long-term population viability and if additional management actions are needed. A comprehensive assessment of the eastern box turtle at FCTC is also warranted. The eastern box turtle population at FCTC appears to be large and may be one of the largest populations in southwest Michigan and potentially the state. This species utilizes a variety of upland and wetland habitats for different life stages that are utilized by other herp species and other taxa

groups and face similar threats as some of these other species. Monitoring and managing the box turtle population can inform and benefit management of the box turtle and other herptile species, and inform conservation and management of box turtles at other sites in Michigan.

Oak ecosystems

Monitoring for issues that threaten the future of oak ecosystems should be a high priority for ecosystem management at FCTC, given the preponderance of oak ecosystems at FCTC. This monitoring priority encompasses mesophication in general, and specifically oak regeneration, oak wilt and sudden oak death, and the management of diverse ground layer plant communities. Benchmarks for monitoring oak regeneration have not been set for southern Michigan. In other words, the threshold size- or age-class distribution of oak seedlings and saplings to ensure replacement of existing canopy oaks has not been determined. However, assigning the appropriate metrics for monitoring should be straightforward, based on protocols developed for other regions of the Eastern United States, as well as an understanding of the process of mesophication (Nowacki and Abrams 2008, Brose et al. 2013, Dey 2014). Monitoring should include multiple size-classes (from seedlings to canopy trees) of at least oak and hickory species and typical mesophytic species (i.e., red maple and wild black cherry) known inhibit oak recruitment, although monitoring all woody species would allow for detecting the influence of other species on oak recruitment. Leaf litter cover and depth, light availability, and soil texture and productivity may all play a role in how recruitment varies in oak ecosystems (Lee and Kost 2007). Establishing replicated monitoring plots across management regimes (fire frequency, silvicultural prescriptions, deer exclosures, etc.) would allow for an adaptive management approach, and contribute to the regional effort managing for oak regeneration (Michigan DNR, US Forest Service, consulting foresters). The regeneration of oak species is only one component of ensuring the future of oak ecosystems. Including a component for monitoring ground layer plant diversity would broaden the scope of such a monitoring effort and facilitate a finer-scale assessment of the ecological integrity of oak ecosystems moving forward. Monitoring for the response of key animal species such as red-headed woodpecker (*Melanerpes erythrocephalus*) or eastern box turtle would add value to the effort. Finally, the loss of oak species from the canopy of forests and barrens at FCTC due to the diseases oak wilt and sudden oak death would certainly endanger the future of oak ecosystems at FCTC. A parallel, annual effort to survey for these threats would be compatible with the broader goal of managing for the future of oak ecosystems.

Photo 68. Prescribed fire (left, see burn scars at base of white oak) and silviculture (right) are important tools for encouraging oak regeneration when applied prudently.

Deer exclosures

We frequently encountered the impacts of white-tailed deer overabundance during surveys, in particular selective browsing of rare and common herbaceous plant species and seedlings of canopy trees, but the severity of those impacts on populations and ecosystems is not clear. More aggressive action to ameliorate the impacts of deer on ecological integrity may be necessary, for example through increased hunting pressure, especially on antlerless deer. Without establishing a baseline for where those impacts are greatest, and which species or natural communities are most impacted, it will be difficult to demonstrate the effectiveness of any change in deer management. A series of experimental exclosures with paired sampling inside and outside of the exclosures would achieve this

goal. Exclosures should be placed in multiple natural communities across multiple Training Areas, to better understand how deer impacts are distributed. Including deer exclosures in oak ecosystem monitoring plots (previous paragraph) would facilitate an assessment of the role deer herbivory plays in limiting oak regeneration.

Standardized monitoring

FCTC has the wealth of biodiversity, management infrastructure, and long-term commitment to conservation to support a standardized monitoring program. Monitoring of rare species and natural communities is often reactive, established in response to acute threats and focused on one or a few targets at a time (Parrish et al. 2003, Lindenmayer et al. 2012, Faber-Langendoen et al. 2016). Standardized long-term monitoring programs for multiple taxonomic groups at the same site, in contrast, can identify threats and forecast species declines as early-warning indicators and management approaches can be adjusted promptly to avoid drastically negative ecosystem impacts (Schmeller et al. 2018). Coordinating monitoring efforts among different taxonomic groups that respond to different environmental cues can serve as indicators of ecological integrity of natural communities, especially when paired with monitoring key environmental variables. This ability to detect fine-scale changes to ecological integrity provides a feedback mechanism that leads to effective management that can benefit both target species and other associated species. For example, monitoring data indicating declining plant species diversity in prairies and barrens would hypothetically be an early warning for potential declines in the rare black-and-gold bumblebee. Subsequent changes to management that increase plant species diversity would bolster the entire pollinator community in addition to rare bumblebee populations. FCTC can serve as a testing ground and a model for other conservation organizations managing similar ecosystems and landscapes and similar scales in southern Michigan and elsewhere. For example, the prescribed fire program at FCTC has. An effective monitoring program hinges on setting clear conservation goals and establishing accurate metrics. In other words, monitoring should focus on species and ecological processes that reflect overall ecological integrity (Lindenmayer et al. 2012). The information and insights in this and other reports provides a sufficient foundation for determining the right goals and metrics for FCTC (Legge et al. 1995, Cohen et al. 2009, Bassett 2020, Cole-Wick et al. 2020, INRMP 2020, Rowe 2020).

Photo 69. Sunset over wetland complex and oak woodland in Training Area 8, with eastern extent of Territorial Road in the right of the frame.

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Appendix A. Land Cover Summaries

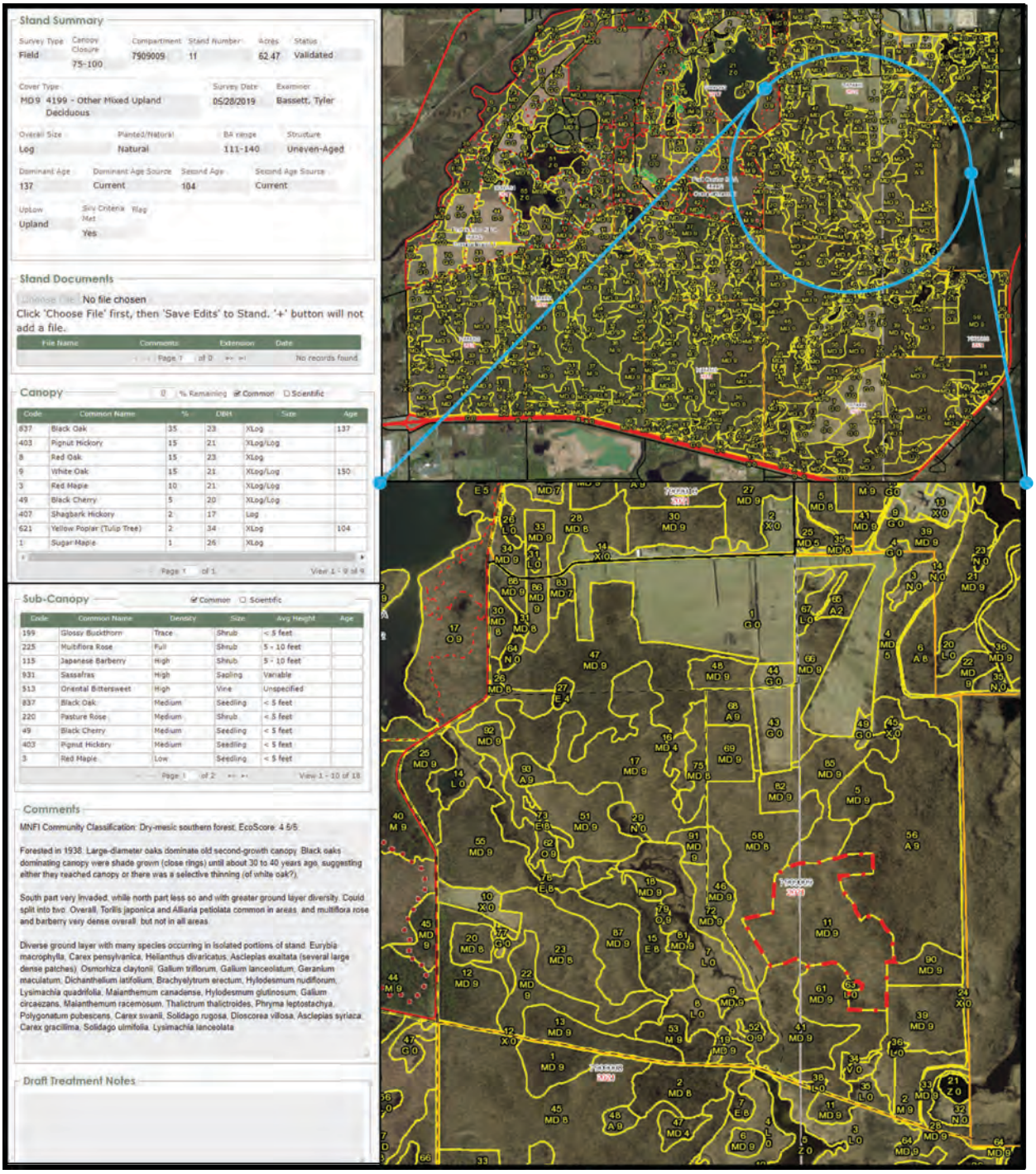


Figure A1. Example MiFI interface.

Table A1 (next page). Hierarchy of MiFI cover types.

LEVEL I LEVEL II LEVEL III LEVEL IV LEVEL V

1 Urban

11 Low Intensity Urban

12 High Intensity Urban

- 121 Airport
- 122 Roads/Parking Lot
- 123 Other High Intensity Urban

2 Agricultural

21 Herbaceous Agriculture

- 211 Cropland
  - 2111 Non-vegetated Farmland
  - 2112 Row Crop
  - 2113 Forage Crop
  - 2114 Other Cropland
- 212 Non-tilled Herbaceous Agriculture

22 Non Herbaceous Agriculture

- 221 Christmas tree plantation
- 222 Orchard/Vineyard/Nursery

3 Upland Openland

- 310 Herbaceous Openland
  - 3101 Poverty Grass, Cladonia
  - 3102 Grass
  - 31021 Cool Season Grass
  - 31022 Warm Season Grass
  - 3103 Rubus, Fern
  - 3104 Degraded
  - 3105 Mixed Upland Herbaceous
- 320 Upland Shrub
  - 3201 Sweet Fern
  - 3202 Autumn Olive/Honeysuckle
  - 3203 Upland Blueberry
  - 3204 Mast Producing Shrub
  - 3205 Mixed Upland Shrub
- 330 Low Density Trees
  - 3301 Low Density Deciduous Trees
  - 3302 Low Density Conifer Trees
  - 3303 Mixed Low Density Trees
- 350 Parks/Golf Courses

4 Upland Forest

41 Upland Deciduous Forest

- 411 Northern Hardwood
  - 4110 Sugar Maple Association
  - 4111 Sugar Maple, Hard Mast Association
  - 4112 Maple Association

LEVEL I LEVEL II LEVEL III LEVEL IV LEVEL V

- 4113 Red Maple, Conifer
- 4114 Beech, Hemlock
- 4115 Yellow Birch, Hemlock
- 4116 Mixed Northern Hardwood – Aspen
- 4117 Mixed Northern Hardwood - Pine
- 4119 Mixed Northern Hardwoods

412 Oak

- 4120 Oak, Hickory
- 4121 Oak, Aspen
- 4122 Oak, Pine
- 4123 Red Oak
- 4124 Red with White Oak
- 4125 Black, Northern Pin Oak
- 4126 White, Black, Northern Pin Oak
- 4129 Mixed Oak

413 Aspen

- 4130 Aspen
- 4131 Aspen, Oak
- 4132 Aspen, Jack Pine
- 4133 Aspen, Mixed Pine
- 4134 Aspen, Spruce/Fir
- 4135 Aspen, Cedar
- 4136 Aspen, Mixed Conifer
- 4137 Aspen, Birch
- 4139 Aspen, Mixed Deciduous

414 Other Upland Deciduous

- 4140 Paper Birch

419 Mixed Upland Deciduous

- 4190 Mixed Upland Deciduous with Cedar
- 4191 Mixed Upland Deciduous with Conifer
- 4192 Mixed Southern Upland Deciduous
- 4193 Birch, Aspen
- 4199 Other Mixed Upland Deciduous

42 Upland Coniferous Forest

421 Planted Pines

4210 Planted White Pine types

- 42100 Planted White Pine
- 42101 Planted White Pine, Mixed Deciduous

4211 Planted Red Pine types

- 42110 Planted Red Pine
- 42111 Planted Red Pine, Mixed Deciduous

4212 Planted Jack Pine

- 42120 Planted Jack Pine
- 42121 Planted Jack Pine, Mixed Deciduous

4213 Planted Scotch Pine types

- 42130 Planted Scotch Pine

4214 Planted Mixed Pine types

- 42140 Planted Mixed Pine

LEVEL I LEVEL II LEVEL III LEVEL IV LEVEL V

42141 Planted Mixed Pine, Mixed Deciduous

422 Natural Pines

4220 Natural White Pine types

42200 Natural White Pine

42201 Natural White Pine, Mixed Deciduous

4221 Natural Red Pine Types

42210 Natural Red Pine

42211 Natural Red Pine, Mixed Deciduous

4222 Natural Jack Pine types

42220 Natural Jack Pine

42221 Natural Jack Pine, Mixed Deciduous

4226 Natural Mixed Pine Types

42290 Natural Mixed Pine

42250 Natural Pine, Oak

42260 Natural Mixed Pine, Mixed Deciduous

423 Other (Non-Pine) Upland Conifers

Planted Upland Conifers

42300 Planted Larch

42301 Planted Larch, Mixed Deciduous

42310 Planted Spruce

42311 Planted Spruce, Mixed Deciduous

Non-planted Upland Conifers

42320 Upland Spruce

42330 Upland Fir

42340 Upland Spruce/Fir

42350 Upland Hemlock

42360 Upland Cedar

42370 Upland Cedar, Aspen

42380 Non-Pine Upland Conifer, Mxd Deciduous

42390 Mixed Non-Pine Upland Conifers

429 Mixed Upland Conifers

43 Upland Mixed Forest

4310 Pine, Oak Mix

4311 Pine, Aspen Mix

4312 Hemlock, Mixed Deciduous

4319 Mixed Upland Forest

5 Water

50 Water

6 Wetlands

61 Lowland Forest

611 Lowland Deciduous Forest

6110 Cottonwood

6111 Lowland Balsam Poplar

6112 Lowland Aspen

6113 Lowland Maple

6114 Lowland Oak

LEVEL I LEVEL II LEVEL III LEVEL IV LEVEL V

- 6115 Lowland Ash
- 6116 Lowland Birch
- 6117 Lowland Deciduous, Mixed Coniferous
- 6118 Lowland Deciduous with Cedar
- 6119 Mixed Lowland Deciduous Forest

612 Lowland Coniferous Forest

- 6120 Lowland Cedar
- 6121 Tamarack
- 6122 Black Spruce
- 6123 Lowland Fir
- 6124 Lowland Spruce-Fir
- 6125 Lowland Black Spruce, Jack Pine
- 6126 Lowland Jack Pine
- 6127 Lowland Pine
- 6128 Lowland Coniferous, Mixed Deciduous
- 6129 Mixed Coniferous Lowland Forest

613 Lowland Mixed Forest

- 6130 Fir, Aspen, Maple
- 6131 Hemlock, White Pine, Maple, Birch
- 6132 Mixed Lowland Forest with Cedar
- 6139 Mixed Lowland Forest

62 Nonforested Wetlands

621 Floating Aquatic

622 Lowland Shrub

- 6220 Alder/Willow
- 6221 Fen
- 6222 Shrub-Carr
- 6223 Inundated Shrub Swamp
- 6224 Treed Bog
- 6225 Bog
- 6229 Mixed Lowland Shrub

623 Emergent Wetland

- 6230 Cattail
- 6231 Phragmites
- 6232 Wet Prairie
- 6233 Wet Meadow
- 6239 Mixed Emergent Wetland

629 Mixed Non-forest Wetland

7 Bare/Sparsely Vegetated

710 Sand, Soil

720 Exposed Rock

730 Mud Flats

790 Other Bare/Sparsely Vegetated

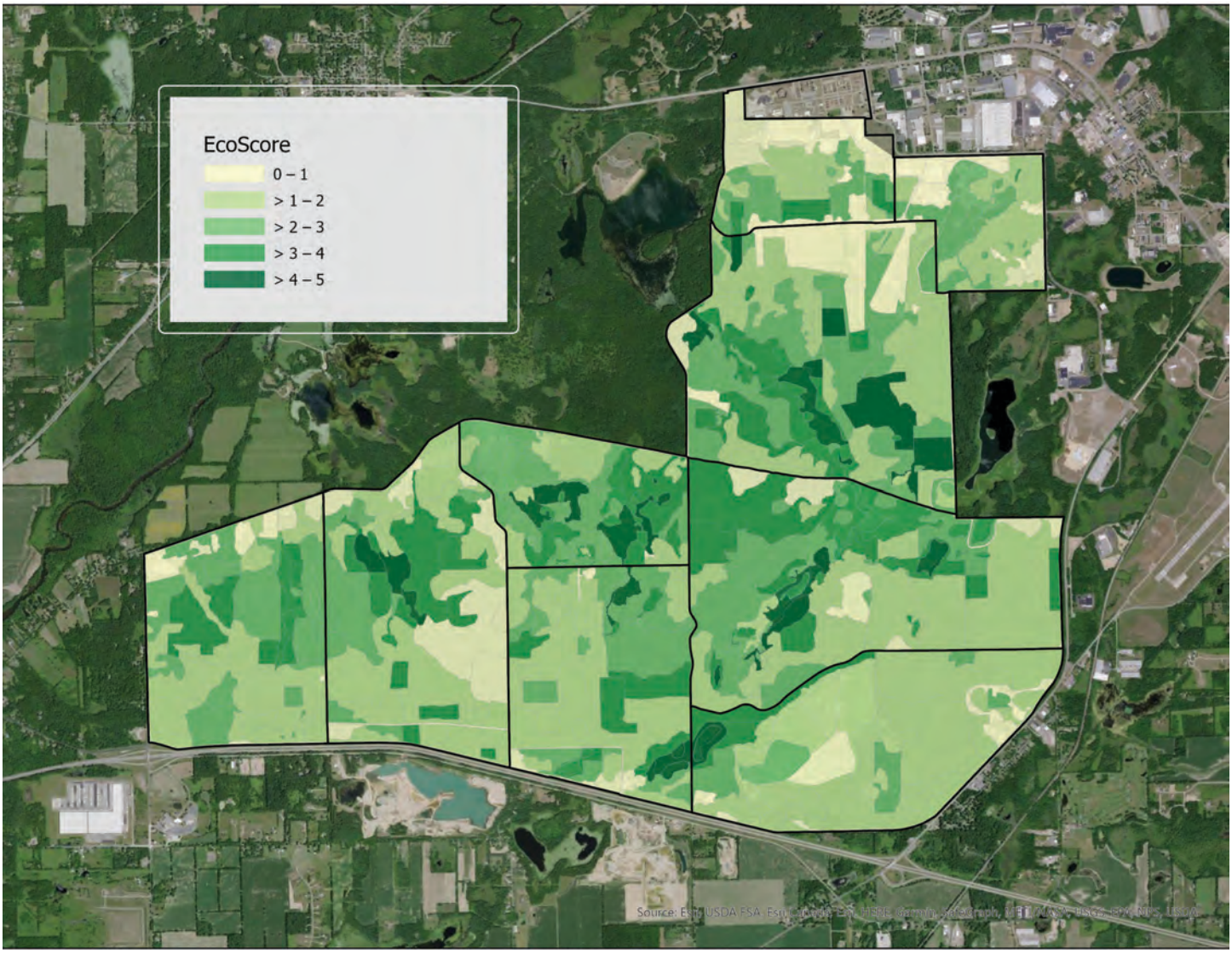


Figure A2. Distribution of Eco Scores across MiFI Stands (see Table 1, pg 7 and included below for convenience).

EcoScore	Stands		Acres	
0	40	8%	530	7%
1	40	8%	435	6%
1.5	25	5%	513	7%
2	124	25%	2,550	35%
2.5	54	11%	958	13%
3	90	18%	830	11%
3.5	45	9%	820	11%
4	50	10%	384	5%
4.5	14	3%	190	3%
5	16	3%	179	2%
Total:	498		7,387	
(0-2)	229	46%	4027	55%
(2.5-4.0)	239	48%	2992	41%
(4.5-5.0)	30	6%	369	5%
Total:	498		7,387	

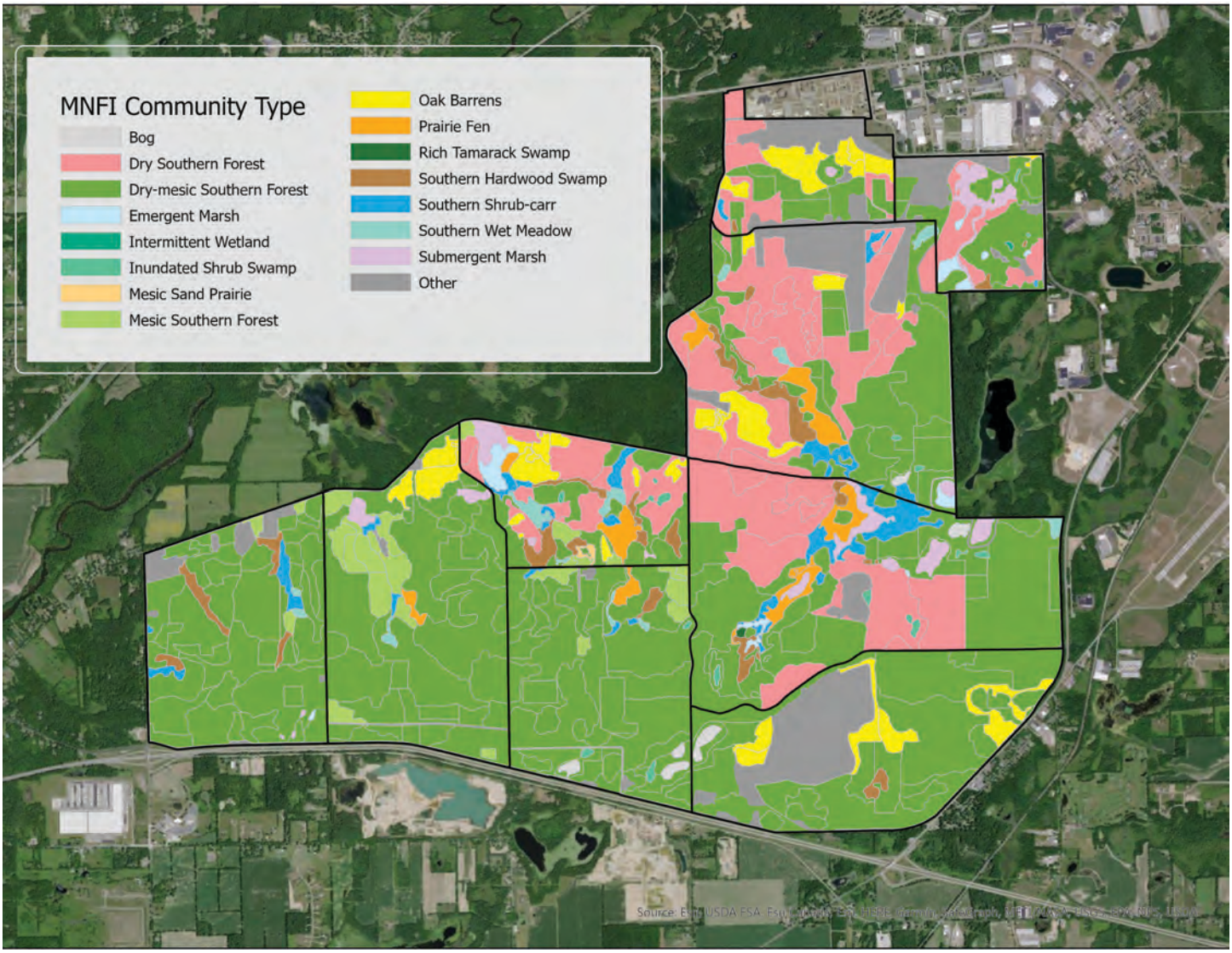


Figure A3. Distribution of MNFI Natural Community types across MiFI Stands (see Table 2, pg 7 and included below for convenience).

MNFI Community	Stands		Acres	
Terrestrial (Upland) Class				
Dry Southern Forest	49	9.84%	1,200	16.24%
Dry-mesic Southern Forest	213	42.77%	4,249	57.51%
Mesic Sand Prairie	1	0.20%	4	0.05%
Mesic Southern Forest	24	4.82%	186	2.52%
Oak Barrens	29	5.82%	329	4.45%
Subtotal:	316	63%	5967	81%
Palustrine (Wetland) Class				
Bog	6	1.20%	28	0.37%
Emergent Marsh	10	2.01%	42	0.57%
Intermittent Wetland	1	0.20%	1	0.01%
Inundated Shrub Swamp	15	3.01%	21	0.29%
Prairie Fen	10	2.01%	129	1.75%
Rich Tamarack Swamp	1	0.20%	2	0.02%
Southern Hardwood Swamp	23	4.62%	147	1.99%
Southern Shrub-carr	26	5.22%	154	2.08%
Southern Wet Meadow	13	2.61%	46	0.62%
Submergent Marsh	16	3.21%	121	1.64%
Subtotal:	121	24%	691	9%
No Class				
NA	61	12.25%	730	9.88%
Total:	498		7,387	

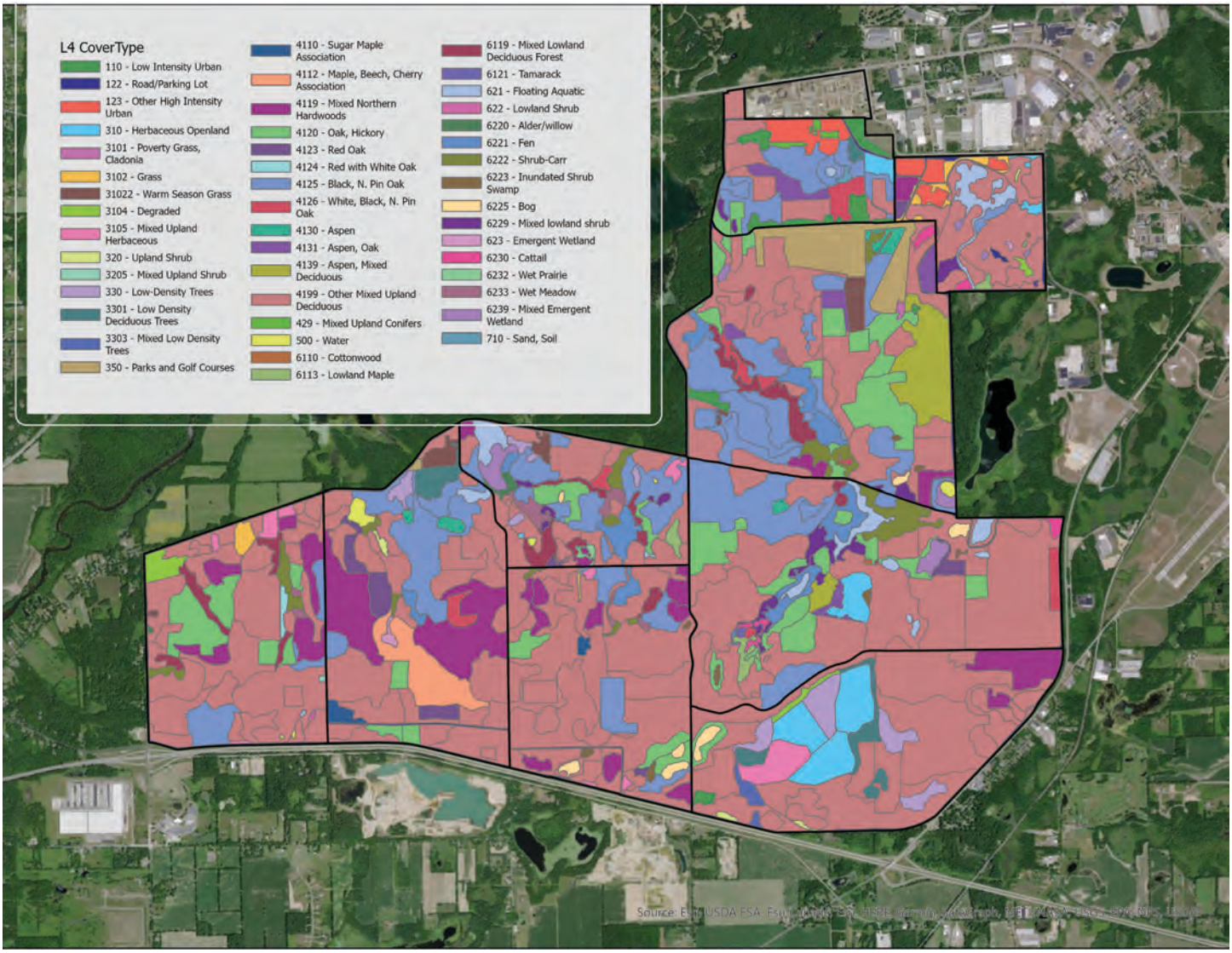


Figure A4. Distribution of L4 cover types across MiFI Stands (see Table 3, pg 8).

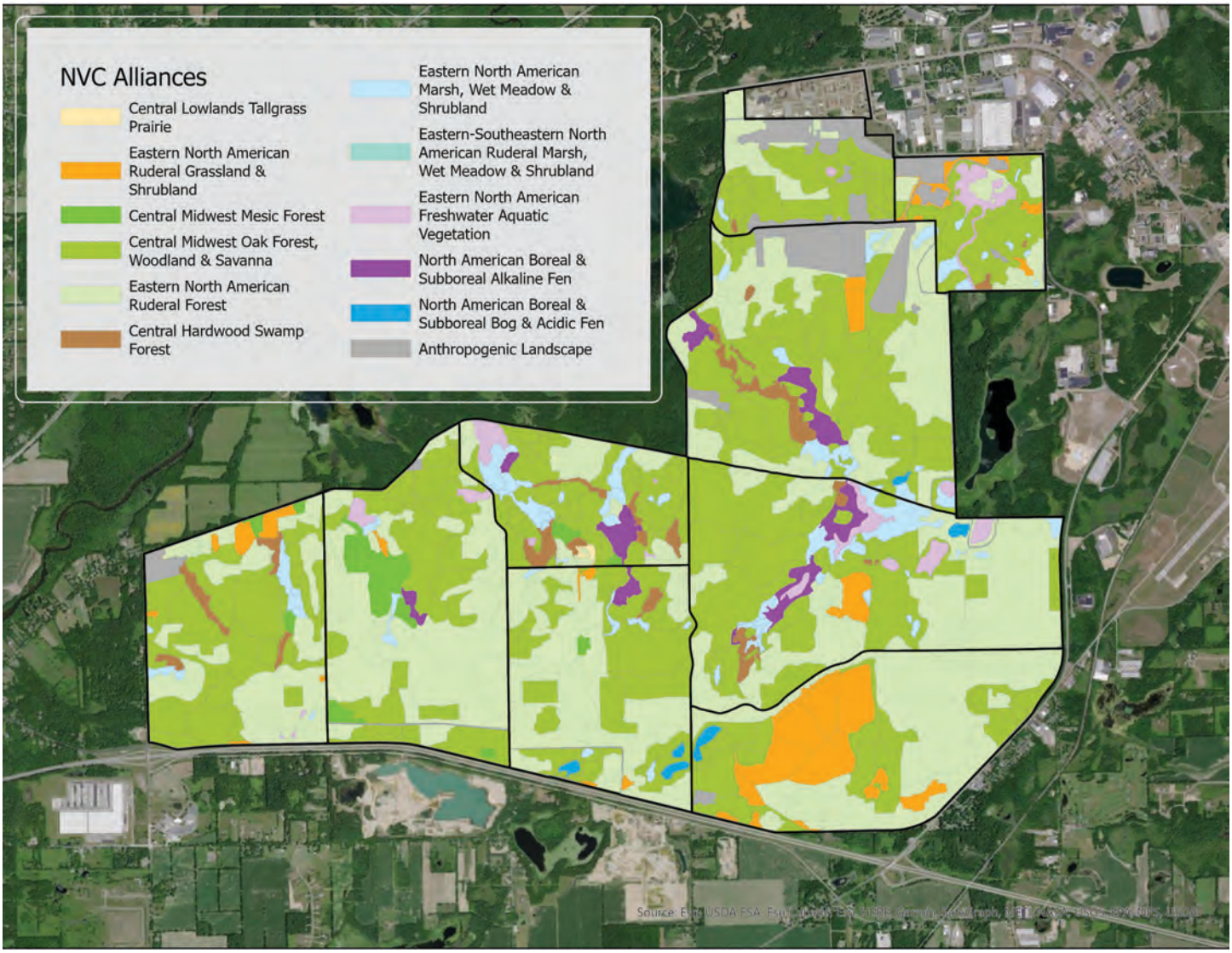


Figure A5. Distribution of NVC Alliances across MiFI Stands (see Table 4, pg 10).

Table A2. Hierarchy of NVC Alliances within Groups and Macrogroups, and crosswalk to MNFI Natural Community Classification.

Code	Alliance Name	MNFI Community
	Macrogroup or *Group* Name	
M012	**Central Midwest Oak Forest, Woodland & Savanna Macrogroup**	
G181	*Central Midwest Oak Openings & Barrens Group*	
A1492	Black Oak - Northern Pin Oak Wooded Grassland Alliance	Oak barrens
G649	*North-Central Oak - Hickory Forest & Woodland Group*	
A3323	White Oak - Northern Red Oak - Hickory species North-Central Forest Alliance	Dry-mesic southern forest
A3326	Black Oak - White Oak North-Central Forest Alliance	Dry and Dry-mesic southern forest
M013	**Eastern North American Ruderal Forest Macrogroup**	
G030	*Eastern North American Native Ruderal Forest Group*	
A3228	Tuliptree - Black Walnut - Black Locust Ruderal Forest Alliance	NA
A3229	Red Maple - Black Cherry - Eastern White Pine Ruderal Forest Alliance	NA
A4183	Box-elder - Green Ash - Quaking Aspen Ruderal Forest Alliance	NA
M054	**Central Lowlands Tallgrass Prairie Macrogroup**	
G333	*Central Tallgrass Prairie Group*	
A4057	Big Bluestem - Indiangrass - Stiff Tickseed Central Grassland Alliance	Mesic sand prairie
M069	**Eastern North American Marsh, Wet Meadow & Shrubland Macrogroup**	
G125	*Eastern North American Freshwater Marsh Group*	
A1436	Narrowleaf Cattail - Broadleaf Cattail - Bulrush species Deep Marsh Alliance	Emergent marsh/Southern wet meadow
A3664	Hardstem Bulrush - River Bulrush - Softstem Bulrush Marsh Alliance	Emergent marsh
G770	*Midwest Wet Prairie, Wet Meadow & Shrub Swamp Group*	
A4105	Sedge species - Canada Bluejoint Midwest Wet Meadow Alliance	Southern wet meadow
A4378	Red-osier Dogwood - Gray Alder - Common Buttonbush Midwest Shrub Swamp Alliance	Southern shrub carr/Inundated shrub swamp
M108	**Eastern North American Freshwater Aquatic Vegetation Macrogroup**	
G114	*Eastern North American Freshwater Aquatic Vegetation Group*	
A4064	American White Water-lily - Pond-lily species - Watershield Aquatic Vegetation Alliance	Submergent marsh
A4066	Pondweed species - Hornwort species - Waterweed species Aquatic Vegetation Alliance	Submergent marsh
A4147	Duckweed species - Watermeal species - Common Duckmeat Aquatic Vegetation Alliance	Submergent marsh
M123	**Eastern North American Ruderal Grassland & Shrubland Macrogroup**	
G059	*Eastern North American Ruderal Meadow & Shrubland Group*	
A1190	Orchardgrass - Fescue species - Canada Goldenrod Ruderal Mesic Meadow Alliance	NA
A3934	Canada Bluegrass - Gray Goldenrod - Spotted Knapweed Ruderal Dry Meadow & Shrubland Alliance	NA

Code	Alliance Name	MNFI Community
	Macrogroup or *Group* Name	
A3935	Common Buckthorn - Multiflora Rose - Autumn-olive Ruderal Mesic Shrubland Alliance	NA
M303	**Eastern-Southeastern North American Ruderal Marsh, Wet Meadow & Shrubland Macrogroup**	
G556	*Eastern Ruderal Wet Meadow & Marsh Group*	
A1381	Reed Canarygrass Ruderal Marsh Alliance	NA
M503	**Central Hardwood Swamp Forest Macrogroup**	
G918	*Central Appalachian-Northeast Alkaline Swamp Group*	
A3881	Red Maple - Ash species - Swamp White Oak Swamp Forest Alliance	Southern hardwood swamp
A4397	Tamarack - White Pine - Red Maple Midwest Swamp Alliance	Rich tamarack swamp
M876	**North American Boreal & Subboreal Bog & Acidic Fen Macrogroup**	
G748	*Eastern North American Boreal-Subboreal Bog & Acidic Fen Group*	
A4399	Leatherleaf / Few-seed Sedge Bog Alliance	Bog
M877	**North American Boreal & Subboreal Alkaline Fen Macrogroup**	
G183	*Midwest Prairie Alkaline Fen Group*	
A3704	Shrubby-cinquefoil / Riddell's Goldenrod - Big Bluestem Graminoid Fen Alliance	Prairie fen
M882	**Central Midwest Mesic Forest Macrogroup**	
G021	*North-Central Beech - Maple - Basswood Forest Group*	
A0220	Sugar Maple - American Basswood - Northern Red Oak Forest Alliance	Mesic southern forest

Table A3. Descriptions of NVC Alliances (see https://usnvc.org/explore-classification/).

Alliance AKA	Acode	Description
Black Oak - Northern Pin Oak Barrens	A1492	This fire-dependent oak barrens alliance is found in the Great Lakes region and northeastern Great Plains. Herbaceous species dominate this alliance, but trees and shrubs are common and can be abundant in the prolonged absence of fire. Trees and shrubs may be scattered across the landscape or clumped. The most abundant trees are *Quercus macrocarpa* and *Quercus ellipsoidalis*, which have a height of 5-15 m and an open canopy (10-60%). Cover in the tall-shrub and low-shrub layers varies from 0-40%. Short-shrub species include *Amorpha canescens, Corylus americana, Rhus glabra*, and *Toxicodendron radicans*. *Symphoricarpos occidentalis* can be common on heavier soils. The herb layer is dominated by graminoids, with forbs more prominent in shaded areas. Herbaceous species include *Ambrosia psilostachya, Amphicarpaea bracteata, Andropogon gerardii, Artemisia ludoviciana, Calamovilfa longifolia, Carex pensylvanica, Carex* spp., *Comandra umbellata, Hesperostipa spartea, Parthenocissus quinquefolia, Schizachyrium scoparium*, and *Sorghastrum nutans*. Stands of this alliance are found on well-drained, coarse-textured sandy soils derived from glacial outwash or end moraine formations. Soils range from almost pure sand, to loamy sand, to sandy loam. The soils have low fertility, organic matter, and moisture-retention capacity. Factors which affect seasonal soil moisture are strongly related to variation in this type; slope, aspect, topographic position, elevation, depth to water table, and presence or absence of less permeable soil layers are among these factors. The conditions were also favorable to periodic fires, necessary to maintain the open structure and floristic composition.
North-Central White Oak - Hickory Forest	A3323	This dry-mesic oak forest alliance is widely distributed in the central Midwest region of the United States and possibly in southwest Ontario, Canada. Stands are 15-25 m tall, with a closed, deciduous canopy. The shrub and herbaceous strata are typically well-developed. *Quercus alba* usually dominates, either alone or in combination with *Quercus rubra* (especially on moister sites) and sometimes *Quercus velutina* and *Quercus falcata* (especially on drier sites). *Carya* species (particularly *Carya tomentosa, Carya glabra*, or *Carya ovata*) are typically common either in the canopy or subcanopy. Other associates include *Fraxinus americana, Ulmus americana, Tilia americana, Acer saccharum, Acer rubrum*, and more locally, *Quercus macrocarpa* and *Quercus ellipsoidalis*. Stands are found on gentle to moderately steep lower to upper slopes on uplands and on steep valley sides. The soils are moderately deep to deep and vary from silts to clays and loams. The parent material ranges from glaciated till to unglaciated soils over limestone, shale, sandstone and other bedrock types. Stands are fire-dependent, and in its absence, many stands are succeeding to types dominated by *Acer saccharum, Tilia americana, Acer rubrum*, and other mesic tree associates.

Alliance AKA	Acode	Description
North-Central Black Oak - White Oak Forest	A3326	This dry oak forest alliance is found throughout the central midwestern United States and southwestern Ontario, Canada. The tree canopy is moderately closed, occasionally scrubby, and with typically 60-100% cover. *Quercus velutina* is the dominant tree species with *Quercus alba* and *Carya* spp. as common associates. Typical shrubs and small trees include *Cornus florida, Corylus americana, Ostrya virginiana, Sassafras albidum, Vaccinium* spp., *Viburnum acerifolium* , and *Hamamelis virginiana* . Some common herbs (but this list is incomplete) include *Amphicarpaea bracteata, Danthonia spicata, Antennaria plantaginifolia, Desmodium nudiflorum* , and *Prenanthes altissima* . Stands can be found on mid to upper slopes and terraces where dry or dry-mesic conditions persist and where soils are more sandy and/or rocky. Many stands are found on coarser-textured soils. These forests require a combination of drought and fire to persist.
Ruderal Tuliptree - Black Walnut - Black Locust Forest	A3228	This alliance includes deciduous forests dominated by *Gleditsia triacanthos, Juglans nigra, Liriodendron tulipifera* , or *Robinia pseudoacacia* primarily in areas which were once clearcut, old fields, or cleared by fire or other natural disturbances, and then planted to these species, but with no regular maintenance. Three suballiances are recognized based on dominant species: (1) *Liriodendron tulipifera* stands occur on old clearcut sites and old fields. This suballiance includes pure, often even-aged stands of *Liriodendron tulipifera* . Associated species vary with geographic location. Throughout most of the range of this suballiance *Acer rubrum, Robinia pseudoacacia, Betula lenta, Acer saccharum* , and *Acer negundo* are common components. (2) *Juglans nigra - Gleditsia triacanthos* stands are often associated with former homesites or other disturbances on fertile alluvial deposits. Associated canopy trees vary from site to site and can include *Liriodendron tulipifera, Juglans cinerea, Robinia pseudoacacia, Fraxinus americana, Ulmus americana, Platanus occidentalis, Acer saccharum, Acer nigrum* , and *Morus rubra* . The shrub layer may or may not be well-developed; common species include *Asimina triloba, Viburnum prunifolium, Lindera benzoin, Corylus americana* , and the exotic invasive *Rosa multiflora* . (3) *Robinia pseudoacacia* stands occur in pure stands or makes up the majority of the canopy. These are short-lived forests that typically result from planting or invasion following land abandonment or fire, or from other severe disturbance.

Alliance AKA	Acode	Description
Northeastern Ruderal Conifer - Hardwood Forest	A3229	This early-successional forest vegetation of the northeastern United States occurs on sites that are becoming reforested after having been cleared for agriculture or otherwise heavily modified in the past. Environmental setting varies, but generally sites are dry-mesic to mesic, with small seepage inclusions in some examples. Physiognomy of this vegetation is highly variable, ranging from closed forest to open woodland and scrub. The generalist set of native, non-planted species include a combination of tree species, such as *Acer rubrum, Fraxinus americana, Liriodendron tulipifera, Pinus strobus* , and *Prunus serotina* . Other associates can include *Acer negundo, Acer saccharinum, Ailanthus altissima, Amelanchier* spp., *Betula lenta, Betula populifolia, Juglans nigra, Juniperus virginiana, Pinus strobus, Populus grandidentata, Quercus* spp., *Robinia pseudoacacia, Sassafras albidum* , and *Ulmus americana* . The low-shrub layer, if present, is usually characterized by the presence of *Rubus* spp. such as *Rubus allegheniensis, Rubus flagellaris, Rubus hispidus* , or *Rubus phoenicolasius* . This layer is often dominated by exotic species such as *Berberis thunbergii, Crataegus* spp., *Lonicera morrowii, Lonicera tatarica, Rhamnus cathartica* , and *Rosa multiflora* . The herbaceous layer is variable, often containing grasses and forbs of both native and exotic origin. The invasive species *Alliaria petiolata, Microstegium vimineum* , and *Polygonum cespitosum* can be abundant in this disturbed forest type. These forests are often young and resulted from the colonization of old agricultural fields by woody species. Recent disturbance or abundant invasive species give these forest stands a weedy character. It is unlikely that these stands will succeed to a natural plant community dominated by native species.
Ruderal Box-elder - Green Ash - Quaking Aspen Forest	A4183	This upland forest alliance is found in the north-central United States. The moderately open to closed tree canopy is dominated by early-successional native trees, particularly *Acer negundo, Fraxinus pennsylvanica* , and *Populus tremuloides* . *Prunus serotina* can be common and many other native or exotic species can be present at lower levels, including planted conifers in some stands.

Alliance AKA	Acode	Description
Central Mesic Tallgrass Prairie	A4057	This mesic tallgrass prairie alliance occurs mainly in the glaciated midwestern United States and southern Ontario with outliers in north-central Kansas and adjacent Nebraska. Tallgrasses dominate the moderate to dense vegetation cover. *Andropogon gerardii* and *Sorghastrum nutans* are the most widespread and common species. *Panicum virgatum, Schizachyrium scoparium* , and *Sporobolus heterolepis* are frequent associated grasses. Forb composition tends to vary more than the grasses with a wide variety possible. *Aletris farinosa, Coreopsis palmata, Dalea candida, Eryngium yuccifolium, Helianthus pauciflorus ssp. pauciflorus, Liatris pycnostachya, Liatris spicata, Oligoneuron rigidum, Ratibida pinnata, Rosa carolina, Rudbeckia hirta* , and *Symphyotrichum ericoides* are a few. *Amorpha canescens* , a sub-shrub species, and *Salix humilis* are also typically present. This alliance is found on flat to rolling landscapes. Soils are usually fine-textured but one variant occurs on sandy soils near the southern Great Lakes.
Eastern Cattail - Bulrush Deep Marsh	A1436	
Eastern Bulrush Deep Marsh	A3664	This alliance is found in the northeastern United States and adjacent southern Canada. Vegetation is characterized by medium to tall graminoids which typically range from 1 to over 2 m. The vegetation is moderately dense to dense. Some stands are heavily dominated by one or two *Schoenoplectus* spp., while others have several graminoids common throughout the stand. The most abundant species are typically *Schoenoplectus acutus, Bolboschoenus fluviatilis* , and *Schoenoplectus tabernaemontani* . Species composition and abundance can vary from year to year depending mostly on water level fluctuations. In most years, typical species include *Lemna* spp., *Phragmites australis, Schoenoplectus americanus* (in alkaline stands), *Triglochin maritima* (in alkaline stands), *Typha latifolia* , and *Utricularia macrorhiza* . *Potamogeton* spp. often occur in the deeper parts of stands of this alliance and where emergent species are not densely packed. Shrubs, such as *Salix* spp., are not common but may become established in shallow water areas. During droughts, species more tolerant of low water, such as *Polygonum amphibium* , may invade and alter the species composition of stands. Stands of this alliance are flooded for most or all of the growing season and can range from having no water (exposed soil) to water approximately 1.5 m deep, but usually it is less than 1 m. Within a stand, water levels can vary by up to 1 m during the year. The water can be fresh to mildly saline throughout most of this alliance's range. Across its range, soils are deep, poorly drained, muck, peat, or mineral.
Midwest Sedge - Bluejoint Wet Meadow	A4105	*DESCRIPTION NOT AVAILABILE*
Midwest Mixed Shrub Swamp	A4378	*DESCRIPTION NOT AVAILABILE*

Alliance AKA	Acode	Description
Water-lily - Pond-lily Aquatic Vegetation	A4064	This alliance, common throughout most of the eastern and central United States and adjacent Canadian provinces, contains vegetation which may occur in a variety of slow-moving waterbodies, including rivers, millponds, streams, shallow ponds or lakes, or on shores of deeper waterbodies including freshwater tidal areas. Stands are dominated by hydromorphic-rooted aquatic plants, typically *Nuphar* spp., with or without *Nymphaea odorata* and *Nymphoides aquatica* . Emergent vegetation is less than 25%, and typically plant species diversity is low. Other species present may include *Utricularia* spp., *Potamogeton* spp., and others. In the north, *Brasenia schreberi* may be locally dominant. Other characteristic northern species include *Nymphaea tetragona* and *Potamogeton amplifolius* . Associates found in the Midwest include *Polygonum amphibium* . Stands of this alliance are permanently to semipermanently flooded, and water depth is generally greater than 0.5 m and up to 2 m.
Pondweed - Hornwort - Waterweed Aquatic Vegetation	A4066	This alliance is widespread in the eastern United States and adjacent Canada from the western tallgrass prairies to the Atlantic Coast. Submergent vegetation dominates. Typical dominants are *Potamogeton* spp., including *Potamogeton natans, Potamogeton zosteriformis* , and *Potamogeton richardsonii* ; *Ceratophyllum* spp., including *Ceratophyllum demersum* ; *Elodea* spp., including *Elodea canadensis* ; and *Myriophyllum* spp., including *Myriophyllum verticillatum* . Other associated species include emergents such as *Zizania palustris, Utricularia macrorhiza, Nuphar* spp., *Ranunculus longirostris, Chara* spp., *Lemna* spp., *Spirodela polyrrhiza* , and *Vallisneria americana* . This common alliance is found in permanently flooded wetlands with water usually less than 2 m deep.
Duckweed Aquatic Vegetation	A4147	This aquatic association of floating vegetation is known to occur throughout temperate eastern North America. *Lemna* spp. *Spirodela polyrrhiza* , and *Wolffia* spp. typically dominate but may be mixed with other plant taxa. These small plants may float on the water's surface or become stranded and possibly rooted during drawdown periods. The composition of examples varies across this wide distributional range. Associated rooted floating aquatics include *Potamogeton* spp., *Sagittaria* spp., or *Polygonum* spp. While these latter species are rooted submerged species, and technically not part of the strictly floating community, they do intermingle. Biomass can be abundant under eutrophic conditions. This alliance occupies wetlands that are permanently, semipermanently or seasonally flooded. Water chemistry is fresh. The standing water habitat is relatively shallow, generally less than 2-4 m and occurs as ponds, lakes, ditches, stock ponds, and backwater sloughs of river and stream channels. Standing water for much or most of the growing season is characteristic. Depth of the water is of no consequence to floating plants; they occur where the wind pushes them.

Alliance AKA	Acode	Description
Northern & Central Ruderal Mesic Old-field Meadow	A1190	This broadly defined type includes mesic abandoned pastures and agricultural fields and is largely composed of non-native cool-season grasses and herbs (generally of European origin) in the early stages of succession. The fields are typically mowed every one to five years. Physiognomically, these grasslands are generally composed of mid-height (0.5 to 1 m tall) grasses and forbs, with occasional scattered shrubs (<25%). Species composition varies from site to site, depending on land-use history and perhaps soil type, but in general this vegetation is quite wide-ranging in northeastern and midwestern states and at higher elevations (610-1220 m [2000-4000 feet]) in the southeastern states. Dominant grasses vary from site to site but generally include the exotic grasses *Agrostis stolonifera, Agrostis hyemalis, Anthoxanthum odoratum, Bromus inermis, Bromus tectorum, Dactylis glomerata, Schedonorus arundinaceus, Lolium perenne, Phleum pratense* as well as weedy natives such as *Elymus repens, Poa pratensis* , and, less commonly, *Schizachyrium scoparium* . Forbs may be minor or dominant and include the exotic forbs *Achillea millefolium, Cerastium arvense* (and hybrids), *Daucus carota, Hieracium* spp., *Vicia cracca* , as well as weedy natives such as *Ambrosia artemisiifolia, Asclepias syriaca, Euthamia graminifolia, Oenothera biennis, Potentilla simplex, Solidago altissima, Solidago canadensis, Solidago juncea, Solidago nemoralis, Solidago rugosa, Trifolium* spp., *Symphyotrichum lanceolatum, Symphyotrichum lateriflorum, Symphyotrichum novae-angliae* , and many others. This vegetation is quite wide-ranging in northeastern and midwestern states and possibly occurs at higher elevations in the southeastern states and southern Canada.
Northern & Central Ruderal Dry Old-field Meadow & Shrubland	A3934	This alliance includes three variants of dry ruderal grasslands: (1) Dry semi-natural grasslands found on sandy or rock substrates and includes weedy native grasses *Festuca* spp., *Poa compressa* , and *Schizachyrium scoparium* , and an assortment of dry invasive forbs such as *Centaurea stoebe ssp. micranthos* and *Solidago nemoralis* ; (2) Vegetation dominated by the weedy native *Andropogon virginicus var. virginicus* that occurs on old fields, pastures, and rocky sites. Associated species vary with geography and habitat and include a mix of native and exotic species; and (3) Invasive grass dune vegetation, including stands of the non-native sedge *Carex kobomugi* that invades and overtakes coastal sand dunes dominated by *Ammophila breviligulata* and/or *Panicum amarum var. amarum* . It is reported along the central New Jersey coast and at First Landing/Seashore State Park in Virginia.

Alliance AKA	Acode	Description
Northern & Central Ruderal Mesic Old-field Shrubland	A3935	This alliance is common in former agricultural areas in the northeastern and midwestern United States and temperate regions of eastern Canada. It comprises primarily shrubby old fields dominated by exotic shrubs, such as *Berberis thunbergii, Elaeagnus angustifolia, Euonymus alatus, Lonicera japonica, Lonicera morrowii, Ligustrum vulgare, Rhamnus cathartica* , and *Rosa multiflora* , as well as weedy natives, such as *Cornus racemosa, Rhus glabra, Rhus typhina* , and *Viburnum prunifolium* Less commonly, *Gaylussacia baccata, Vaccinium pallidum, Vaccinium stamineum* , and/or *Vaccinium angustifolium* may be dominant. Sapling or small trees are often present but form <10% cover; they include exotic trees such as *Robinia pseudoacacia* , and many weedy natives, such as *Acer rubrum, Betula populifolia, Cornus florida, Fraxinus americana, Juglans nigra, Juniperus virginiana, Populus deltoides, Prunus serotina* , and *Prunus virginiana* . The herbaceous layer is variable depending on the density of shrub cover. Common species include exotics such as *Achillea millefolium, Agrostis gigantea, Alliaria petiolata, Anthoxanthum odoratum, Bromus inermis, Centaurea* spp., *Daucus carota, Galium mollugo, Schedonorus arundinaceus, Trifolium repens* , as well as weedy natives such as *Euthamia graminifolia, Festuca rubra, Monarda fistulosa, Oxalis stricta, Poa pratensis, Solidago rugosa, Solidago gigantea* , and *Solidago nemoralis* , among many others. Vines can be absent or dominant, sometimes covering the tall and short shrubs. Common vines are exotic *Celastrus orbiculatus* and *Lonicera japonica* , and weedy natives such as *Parthenocissus quinquefolia, Toxicodendron radicans, Vitis aestivalis* , and *Vitis labrusca* .
Eastern Ruderal Reed Canarygrass Marsh	A1381	This alliance is found throughout the northeastern and midwestern United States, but its distribution as a natural type is complicated elsewhere. Stands are typically minerotrophic wetlands rather than river shores. Stands are dominated by *Phalaris arundinacea* , which tends to occur in monocultures or associated with *Calamagrostis canadensis* . Other associates in the Northeast include *Agrostis gigantea, Alnus incana* or *Alnus serrulata, Viburnum dentatum* , and *Viburnum nudum* . Western stands tend to be monotypic. Further work is required to resolve the natural versus introduced nature of this type in North America before a thorough alliance description can be completed.
Midwest Red Maple - Ash Rich Swamp	A3881	This alliance includes shallow depressional or seepage swamp forests in the north-central region of the U.S. Hardwood swamp stands are dominated by *Acer rubrum, Acer saccharinum, Fraxinus pennsylvanica* , and *Ulmus americana* . Other swamp tree species that may be present include *Fraxinus nigra* and *Quercus bicolor* . Swamps are seasonally wet. Flooding typically occurs during the winter and spring and often extends into the growing season; water may be ponded for most of the year in shallow depressions.

Alliance AKA	Acode	Description
Midwest Conifer-Hardwood Rich Swamp	A4397	DESCRIPTION NOT AVAILABILE
Eastern Boreal-Subboreal Bog	A4399	DESCRIPTION NOT AVAILABILE
Midwest Prairie Fen	A3704	This alliance is currently found in the north-central Midwest of the United States and perhaps in southwestern Ontario, Canada. Stands are a variable combination of low shrubs and herbs on minerotrophically rich mucks, often called prairie fens. The shrub layer is low (0.5-1 m) and varies from scattered to dense cover over a dense herbaceous layer. Patterning within large fens may occur, leading to recognizable zones, such as sedge flats, which occur around the spring discharge; fen meadows, which occur in the adjacent saturated zone as a variable combination of shrubs and herbs; and tall-shrub fens, which occur on more elevated portions or edges of the fen. The most consistent shrub dominant is *Dasiphora fruticosa ssp. floribunda* , but other shrubs include *Salix candida* . Typical herbaceous associates include a variety of sedges that vary across the range of the alliance, including *Carex sterilis, Carex lasiocarpa* , and *Carex stricta* . Many prairie species may be typically associated, including *Andropogon gerardii, Oligoneuron ohioense, Sorghastrum nutans, Sporobolus heterolepis* , and others. Fire probability is higher in prairie fens than in most other fens. Soils are saturated mucks, neutral to alkaline, marly, and with excessive water-retaining capacity.

Alliance AKA	Acode	Description
Sugar Maple - American Basswood - Northern Red Oak Forest	A0220	This alliance, found in the midwestern United States, forms the westernmost portion of the mesic deciduous forests that occupy much of the eastern United States. Stands of this alliance are found on well-drained, nutrient-rich loamy soils to dry-mesic fine sandy loams and loamy sands and have a moderately dense to dense tree canopy dominated by some combination of *Acer saccharum, Quercus rubra* , and *Tilia americana* . Other common canopy species include *Acer rubrum, Carya* spp., *Celtis occidentalis, Fraxinus pennsylvanica, Quercus alba* , and *Ulmus* spp. *Carpinus caroliniana* (in the southern half of this alliance's range) and *Ostrya virginiana* are characteristic subcanopy trees. The dense canopy tends to inhibit the formation of a significant shrub layer. Scattered shrubs of *Acer spicatum* (in the north), *Corylus americana, Hamamelis virginiana, Ribes* spp., *Sambucus* spp., *Viburnum acerifolium* (in the north), and *Zanthoxylum americanum* may be found in stands of this alliance. Spring ephemerals are a distinctive part of the herbaceous layer, especially in the southern part of this alliance's range. Common herbaceous species include *Anemone quinquefolia, Carex pensylvanica, Claytonia* spp., *Dicentra cucullaria, Erythronium* spp., *Eurybia macrophylla* (in the north), *Hepatica nobilis var. acuta, Laportea canadensis, Polygonatum pubescens, Sanicula odorata, Trillium grandiflorum* , and *Uvularia grandiflora* . This alliance tends to be more intolerant of fire than forests on more droughty soils to the south and west. Along the western edge of its range, stands are found on sites protected from fire. The most common disturbance is a single-tree or small-group gap dynamic. Larger windthrow events or fire can occur but typically on a 500- to 1000-year cycle. Those stands with *Quercus rubra* as the predominant canopy species may result from a combination of natural disturbances, such as slightly more frequent fire, and human-caused disturbances. Conversion to agriculture, logging, and urban development have impacted this alliance across its range. Large white-tailed deer populations in portions of the range of this alliance can also impact regeneration of some tree and herbaceous species.
Anthropogenic Landscape Alliance	ADEG	This alliance is not included in the NVC. It is a placeholder for severely anthropogenically altered elements of the landscape. Stands mapped to this alliance include paved and gravel roads and parking lots, buildings, and mowed lawns.

Table A4. Ruleset for MiFI to NVC Alliance crosswalk.

Community	MiFI (various categories)	Canopy	Subcanopy	Alliance Code
IF Community = Rich Tamarack Swamp, THEN				**A4397**
IF Community = Oak Barrens, THEN				**A1492**
IF Community = Southern Hardwood Swamp, THEN				**A3881**
IF Community = Dry Southern Forest, AND		Canopy species >= **40 %** = Quercus velutina OR Quercus alba OR Quercus velutina X rubra OR Quercus ellipsoidalis OR Carya glabra, THEN		**A3326**
IF Community = Dry-mesic Southern Forest, AND		Canopy species **>= 40 %** = Quercus velutina OR Quercus alba OR Quercus velutina X rubra OR Quercus ellipsoidalis OR Carya glabra, THEN		**A3326**
IF Community = Dry-mesic Southern Forest, AND		Canopy species **>= 40 %** = Quercus alba OR Quercus rubra OR Quercus macrocarpa or Carya glabra, THEN		**A3323**
IF Community = Mesic Southern Forest, AND		Canopy species **>= 40 %** = Quercus rubra OR Acer saccharum OR Celtis occidentalis		**A0220**
	IF Up_Low = Upland OR Upland w/ Low, AND	Canopy species **>= 40 %** = Acer rubrum OR Prunus serotina		**A3229**
	IF Up_Low = Upland OR Upland w/ Low, AND	Canopy species **>= 40 %** = Robinia pseudoacacia OR Juglans nigra OR Liriodendron tuliperfia OR **Picea abies**		**A3228**
	IF Up_Low = Upland OR Upland w/ Low, AND	Canopy species **>= 40 %** = Populus tremuloides OR Populus grandidentata		**A4183**
IF Community = Mesic Sand Prairie, THEN				**A4057**
IF Community =Prairie Fen, THEN				**A3704**
IF Community =Bog, THEN				**A4399**
IF Community = Inundated Shrub Swamp OR Southern Shrub-carr, AND	Low_Shrub = Medium: 10-40% OR High: 40-70% OR Full: >70%, THEN			**A4378**

Community	MiFI (various categories)	Canopy	Subcanopy	Alliance Code
IF Community = Southern Wet Meadow OR Emergent Marsh OR Intermittent Wetland, AND			Subcanopy species = Full: >70% = Typha spp.	**A1436**
IF Community = Southern Wet Meadow OR Emergent Marsh, AND			Subcanopy species = Full: >70% = Phalaris arundinacea	**A1381**
IF Community = Southern Wet Meadow OR Emergent Marsh, AND			Subcanopy species = Full: >70% = Lythrum salicaria	**A3030**
IF Community = Southern Wet Meadow OR Emergent Marsh, AND			Subcanopy species = Full: >70% = Phragmites australis	**A1431**
IF Community = Southern Wet Meadow, AND			Subcanopy species <= High: 40-70% = Phragmites australis OR Phalaris arundinacea OR Lythrum salicaria OR Typha spp.	**A4105**
IF Community = Emergent Marsh, AND			Subcanopy species <= High: 40-70% = Phragmites australis OR Phalaris arundinacea OR Lythrum salicaria OR Typha spp.	**A3664**
IF Community = Submergent Marsh, AND			Subcanopy species INCLUDES Nymphaea spp.	**A4064**
IF Community = Submergent Marsh, AND			Subcanopy species INCLUDES Potamogeton spp. and DOES NOT INCLUDE Nymphaea spp.	**A4066**
IF Community = Submergent Marsh, AND			Subcanopy species INCLUDES Lemna spp. and DOES NOT INCLUDE Nymphaea spp. OR Potamogeton spp.	**A4147**
IF Community = NA or no call *or (blank)*, AND	IF L4 = "310 - Herbaceous Openland", AND			**A1190**
IF Community = NA or no call *or (blank)*, AND	IF L4 = "310 - Herbaceous Openland", AND			**A3934**
IF Community = NA or no call *or (blank)*, AND	IF L4 = "320 - Upland Shrub" OR "3205 - Mixed Upland Shrub", THEN			**A3935**

Community	MiFI (various categories)	Canopy	Subcanopy	Alliance Code
IF Community = NA or no call *or (blank)* , AND	L4 = "330 - Low Density Trees" OR "3301 - Low Density Decidous Trees" OR "3303 - Mixed Low Density Trees", THEN			**A3935**
	IF L4 = "3104 - Degraded" OR "122 - Road/Parking Lot" OR "110 - Low Intensity Urban" OR "123 - Other High Intensity Urban", THEN			**ADEG**

Appendix B. Element Ranking Definitions

Table B1. Global element ranking definitions.

Global Rank		DEFINITION
GX	Presumed Extinct (species) or Eliminated(ecosystems)	Not located despite intensive searches and virtually no likelihood of rediscovery (species); Eliminated throughout its range, due to loss of key dominant and characteristic taxa and/or elimination of the sites and ecological processes on which the type depends (ecosystems).
GH	Possibly Extinct (species) or Eliminated (ecosystems)	Known from only historical occurrences but still some hope of rediscovery. Examples of evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is extinct or eliminated throughout its range.
G1	Critically Imperiled	At very high risk of extinction or elimination due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors.
G2	Imperiled	At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
G3	Vulnerable	At moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
G4	Apparently Secure	At fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
G5	Secure	At very low risk or extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.

Table B2. State element ranking definitions.

Global Rank		DEFINITION
GX	Presumed Extinct (species) or Eliminated(ecosystems)	Not located despite intensive searches and virtually no likelihood of rediscovery (species); Eliminated throughout its range, due to loss of key dominant and characteristic taxa and/or elimination of the sites and ecological processes on which the type depends (ecosystems).
GH	Possibly Extinct (species) or Eliminated (ecosystems)	Known from only historical occurrences but still some hope of rediscovery. Examples of evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is extinct or eliminated throughout its range.
G1	Critically Imperiled	At very high risk of extinction or elimination due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors.
G2	Imperiled	At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
G3	Vulnerable	At moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
G4	Apparently Secure	At fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
G5	Secure	At very low risk or extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.

Appendix C. Animal Surveys, Auxiliary Information

Table C1. Sampling locations for rare animal species. See Figures 9-11.

AQUATIC SURVEYS (Mollusks and Fish)

Watercress snail survey locations

Site	Site Name	TA	Latitude	Longitude	EOID
A	Mott Road Fen South	5	42.296460	-85.324100	6641
B	Mott Road Fen South	5	42.296410	-85.323670	N/A
C	Cemetery Complex Seeps	4	42.297210	-85.349720	4908
D	Cemetery Complex Seeps	4	42.297310	-85.350190	4908
E	Territorial Road Fen	9	42.309220	-85.300580	N/A
F	Mott Road Fen North	7	42.298460	-85.324100	6641
G	Whitman Lake Fen	8	42.291750	-85.309170	10435
H	Whitman Lake Fen	8	42.292940	-85.308410	10435
I	Territorial Road Fen	9	42.306170	-85.300670	N/A

Slippershell and fish survey locations

Site	Site Name	TA	Latitude	Longitude	Survey target
1	Cemetery Complex Seeps	4	42.297550	-85.350140	Slippershell
2	Territorial Road Fen	9	42.307530	-85.301720	Slippershell
3	Territorial Road Fen	9	42.306220	-85.300580	Slippershell
4	Whitman Lake Fen	8	42.296535	-85.303873	Incidental mussel observation
5	Vlug Lake	2	42.326210	-85.281400	Pugnose shiner
6	Lawler Lake	4	42.302512	-85.353299	Pugnose shiner
7	Whitman Lake	8	42.296290	-85.304190	Pugnose shiner
8	Platform Lake	4	42.303070	-85.339020	Pugnose shiner

HERPETILE SURVEYS (Snakes, turtles, and frogs)

Massasauga survey locations

Site	Site Name	TA	Latitude	Longitude	Survey Dates
1	Territorial Road Wetland North	7	42.303647	-85.3368143	5/16-17/2018; 5/13/2021
2	Territorial Road Wetland South	7	42.301014	-85.3336527	5/16 & 18/2018, 5/13 & 15/2021
3	Mott Road Fen North A and B	7	42.300140	-85.324529	5/16 & 18 & 23/2018, 5/13-14/2021
4	Mott Road Fen South	5	42.294748	-85.3244806	5/18-19/2018
5	Whitman Lake Fen North A	9	42.306615	-85.3024443	5/17/2018, 5/11-12/2021
6	Whitman Lake Fen South A	8	42.293581	-85.3079893	5/17-/19/2018, 5/11-12/2021

INSECT SURVEYS (Moths and Bees)

Frosted elfin survey locations

Site	Site Name	TA	Latitude	Longitude
1	Mott Road Barrens	7	42.298534	-85.326479
2	Armstrong Road Barrens	9	42.315893	-85.304050

Papaipema survey locations

Site	Site Name	TA	Latitude	Longitude	Date

1	Denso Rd	2	42.329530	-85.281730	09/18/2019
2	Range Rd	9	42.317170	-85.293920	09/19/2019
3	Mott Rd Fen	7	42.297670	-85.324530	09/23/2019
4	Hill Brady	8	42.298590	-85.284790	09/24/2019
5	Territorial Rd	7	42.305580	-85.334510	09/14/2020
6	Augusta Rd	4	42.305580	-85.342780	09/17/2020
7	Mott Rd West	7	42.297670	-85.334950	09/23/2020

Sprague's pygarctia survey locations

Site	Site Name	TA	Latitude	Longitude	Date
1	Mott Rd South	5	42.295952	-85.327698	08/15/2019
2	Mott Rd Barrens	7	42.297997	-85.326383	08/15/2019

Bumblee survey locations

Site	Site Name	TA	Latitude	Longitude	# B. auricomus
5	Augusta Rd 1	4	42.306515	-85.342505	
6	Augusta Rd East	7	42.300798	-85.336094	
7	Mott Rd Fen	7	42.298159	-85.324930	1 (EOID 23639)
9	Mott Rd South	5	42.296429	-85.327871	
8	Sand Trail 1	6	42.283659	-85.306832	
1	Territorial Rd 1	7	42.307376	-85.333267	
2	Territorial Rd 2	3	42.300238	-85.365089	3 (EOID 23638)
3	Territorial Rd 3	3	42.296752	-85.375350	1 (EOID 23638)
4	Territorial Rd 4	3	42.283528	-85.375531	

Table C2. Environmental parameters for mussel sampling locations.
See Table C1 and Figure 9.

	Site 1	Site 2	Site 3
pH	8.00	8.23	8.27
Conductivity (µS)	-	496	527
Alkalinity (mg/l $CaCO_3$)	280	204	196
Hardness (mg/l)	240	195	196
Water temp. (C)	-	26.0	26.7
Boulder	2	-	-
Cobble	30	-	10
Pebble	30	5	20
Gravel	20	-	30
Sand	16	15	30
Silt	2	80	10
Current speed (m/second)	0.33-1	<0.1	0.5-1
Aquatic vegetation?	Y	Y	Y
Woody debris?	Y	Y	Y
Eroded banks?	N	N	N
%Pool	5	10	33
%Riffle	50	-	34
%Run	45	90	33

Figure C1

Figure C2

Figure C3

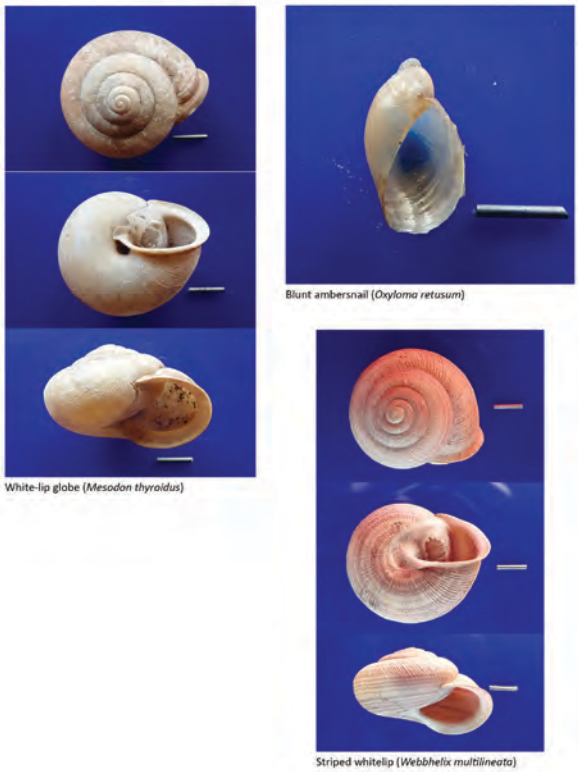


Figure C4

Figures C1-4. Aquatic and terrestrial snail species found during watercress snail (*Fontigens nickliniana*) surveys within Fort Custer Training Center, Summer 2019. Bar in snail photos is 5mm long. Photos by Peter J. Badra.

Brook stickleback (*Culaea inconstans*)

Grass pickerel (*Esox americanus vermiculatus*)

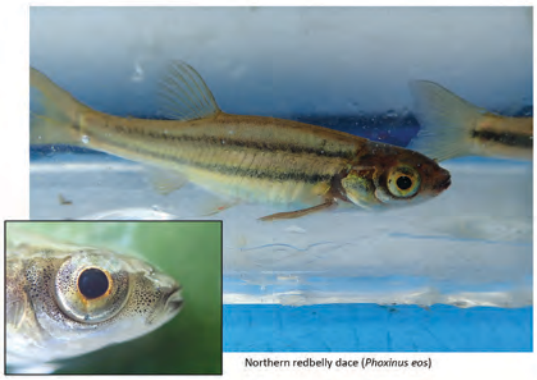
Figure C5

Pumpkinseed (*Lepomis gibbosus*)

Bluegill (*Lepomis macrochirus*)

Figure C6

Largemouth bass (*Micropterus salmoides*)



Northern redbelly dace (*Phoxinus eos*)

Figure C7

Figures C5-7. Fish species found during pugnose shiner (*Notropis anogenus*) surveys within Fort Custer Training Center, Summer 2020. Photos by Peter J. Badra.

Table C3. Rare herptiles observed during eastern massasauga rattlesnake surveys..

Survey Site	Survey Date	Eastern Massasauga	Eastern Box Turtle	Blanding's Turtle	Pickerel Frog
Territorial Road Wetland North	05/16/2018	0	0	0	0
Territorial Road Wetland North	05/17/2018	0	0	0	0
Territorial Road Wetland North	05/13/2021	0	0	0	0
Territorial Road Wetland South	05/16/2018	0	6-7	1	Several
Territorial Road Wetland South	05/18/2018	0	1	0	1
Territorial Road Wetland South	05/13/2021	0	1	0	0
Territorial Road Wetland South	05/15/2021	0	3	0	0
Mott Road Fen North A and B	05/16/2018	0	5	0	0
Mott Road Fen North A and B	05/18/2018	0	1	1	1
Mott Road Fen North A and B	05/23/2018	0	7	0	0
Mott Road Fen North A and B	05/13/2021	0	0	0	0
Mott Road Fen North A and B	05/14/2021	0	0	0	1
Mott Road Fen South	05/18/2018	0	1	0	0
Mott Road Fen South	05/19/2018	0	0	0	0
Whitman Lake Fen North A	05/17/2018	0	1	1	1
Whitman Lake Fen North A	05/11/2021	0	1	0	0
Whitman Lake Fen North A	05/12/2021	0	0	0	0
Whitman Lake Fen South A	05/17/2018	0	0	0	5-6
Whitman Lake Fen South A	05/18/2018	0	0	0	Several
Whitman Lake Fen South A	05/19/2018	0	3	0	20+
Whitman Lake Fen South A	05/11/2021	0	1	0	6
Whitman Lake Fen South A	05/12/2021	0	0	0	0

Family	Scientific name	Common name	Status	Native/Adventive
Adoxaceae				
	Sambucus canadensis L.	elderberry		N
	Viburnum acerifolium L.	maple-leaved arrow-wood		N
	Viburnum lentago L.	nannyberry		N
	Viburnum opulus L.	European highbush cranberry		A
	Viburnum trilobum Marshall	highbush cranberry		N
	Viburnum rafinesquianum Schult.	downy arrow-wood		N
Agavaceae				
	Yucca filamentosa L.	yucca		A
Alismataceae				
	Alisma plantago-aquatica L.	water-plantain		N
	Sagittaria latifolia Willd.	common arrowhead		N
Alliaceae				
	Allium burdickii (Hanes) A. G. Jones	wild lek		N
	Allium tricoccum Aiton	wild leek		N
	Allium vineale L.	field garlic		A
Amaranthaceae				
	Amaranthus albus L.	tumbleweed		N
	Chenopodium album L.	lamb's quarters		A
	Chenopodium hybridum L.	maple-leaved goosefoot		N
	Cycloloma atriplicifolium (Sprengel) Coulter	winged pigweed		A
Anacardiaceae				
	Rhus copallina L.	winged sumac		N
	Rhus glabra L.	smooth sumac		N
	Rhus typhina L.	staghorn sumac		N
	Toxicodendron radicans (L.) Kuntze	poison-ivy		N
	Toxicodendron vernix (L.) Kuntze	poison sumac		N
Annonaceae				
	Asimina triloba (L.) Dunal	pawpaw		N
Apiaceae				
	Angelica atropurpurea L.	angelica		N
	Berula erecta (Hudson) Cov.	water-parsnip	**T**	N
	Chaerophyllum procumbens (L.) Crantz	wild-chervil		N
	Cicuta bulbifera L.	water hemlock		N
	Cicuta maculata L.	water hemlock		N
	Cryptotaenia canadensis (L.) DC.	honewort		N
	Daucus carota L.	Queen-Anne's-lace		A
	Erigenia bulbosa (Michaux) Nutt.	harbinger-of-spring		N
	Osmorhiza claytonii (Michaux) C. B. Clarke	hairy sweet-cicely		N
	Osmorhiza longistylis (Torrey) DC.	smooth sweet-cicely		N

Family	Scientific name	Common name	Status	Native/Adventive
	Oxypolis rigidior (L.) Raf.	cowbane		N
	Sanicula canadensis L.	black snakeroot		N
	Sanicula odorata (Raf.) Pryer & Phillippe	black snakeroot		N
	Sanicula trifoliata Bickn.	black snakeroot		N
	Taenidia integerrima (L.) Drude	yellow-pimpernel		N
	Torilis japonica (Houtt.) DC.	hedge-parsley		A
	Zizia aurea (L.) Koch	golden Alexanders		N
Apocynaceae				
	Apocynum cannabinum L.	Indian hemp		N
	Asclepias amplexicaulis Sm.	clasping milkweed		N
	Asclepias exaltata L.	poke milkweed		N
	Asclepias incarnata L.	swamp milkweed		N
	Asclepias syriaca L.	common milkweed		N
	Asclepias tuberosa L.	butterfly-weed		N
	Asclepias viridiflora Raf.	green milkweed		N
	Vinca minor L.	periwinkle		A
Aquifoliaceae				
	Ilex opaca Aiton	American holly		A
	Ilex verticillata (L.) A. Gray	Michigan holly		N
Araceae				
	Arisaema dracontium (L.) Schott	green dragon		N
	Arisaema triphyllum (L.) Schott	jack-in-the-pulpit		N
	Lemna minor L.	small duckweed		N
	Lemna trisulca L.	star duckweed		N
	Lemna turionifera Landolt	red duckweeed		N
	Peltandra virginica (L.) Schott & Endl.	arrow-arum		N
	Spirodela polyrhiza (L.) Schleiden	great duckweed		N
	Symplocarpus foetidus (L.) Nutt.	skunk-cabbage		N
	Wolffia borealis (Engelm.) Landolt & Wildi ex Gandhi, Wiersema & Brouillet	dotted water meal		N
	Wolffia brasiliensis Wedd.	pointed watermeal		N
	Wolffia columbiana Karsten	common water meal		N
Araliaceae				
	Aralia nudicaulis L.	wild sarsaparilla		N
	Aralia racemosa L.	spikenard		N
	Panax quinquefolius L.	ginseng	**T**	N
	Panax trifolius L.	dwarf ginseng		N
Aristolochiaceae				
	Asarum canadense L.	wild-ginger		N
Asparagaceae				

Family	Scientific name	Common name	Status	Native/Adventive
	Asparagus officinalis L.	asparagus		A
Aspleniaceae				
	Asplenium platyneuron (L.) Oakes ex D. C. Eaton	ebony spleenwort		N
Asteraceae				
	Achillea millefolium L.	yarrow		N
	Ageratina altissima (L.) R. M. King & H. Rob.	white snakeroot		N
	Ambrosia artemisiifolia L.	common ragweed		N
	Ambrosia trifida L.	giant ragweed		N
	Antennaria neglecta Greene	cat's foot		N
	Antennaria parlinii Fern.	smooth pussytoes		N
	Arctium minus Schk.	common burdock		A
	Artemisia campestris L.	wormwood		N
	Doellingeria umbellata (Mill.) Nees	tall flat-top white aster		N
	Bidens cernua L.	nodding bur-marigold		N
	Bidens connata Muhl.	purple-stemmed tickseed		N
	Bidens frondosa L.	common beggar-ticks		N
	Bidens polylepis S. F. Blake	Ozark tickseed sunflower		A
	Bidens trichosperma (Michx.) Britton	tall swamp-marigold		N
	Centaurea jacea L.	brown knapweed		A
	Centaurea stoebe L.	spotted knapweed		A
	Chondrilla juncea L.	skeleton-weed		A
	Cichorium intybus L.	chicory		A
	Cirsium arvense (L.) Scop.	Canadian-thistle		A
	Cirsium discolor (Muhl.) Spreng.	pasture-thistle		N
	Cirsium muticum Michaux	swamp-thistle		N
	Cirsium vulgare (Savi) Tenore	bull-thistle		A
	Conyza canadensis (L.) Cronq.	horseweed		N
	Coreopsis tripteris L.	tall coreopsis		N
	Crepis capillaris (L.) Wallr.	hawk's beard		A
	Erechtites hieraciifolia (L.) Raf.	fireweed		N
	Erigeron annuus (L.) Pers.	annual fleabane		N
	Erigeron philadelphicus L.	marsh fleabane		N
	Erigeron pulchellus Michx.	Robin's-plantain		N
	Erigeron strigosus Muhl.	daisy fleabane		N
	Eupatorium perfoliatum L.	common boneset		N
	Eupatorium sessilifolium L.	upland boneset	**T**	N
	Eurybia macrophylla (L.) Cass.	big-leaved aster		N
	Euthamia graminifolia (L.) Nutt.	grass-leaved goldenrod		N
	Eutrochium maculatum (L.) E. E. Lamont	Joe-pye weed		N
	Eutrochium purpureum (L.) E. E. Lamont	purple Joe-pye weed		N

Family	Scientific name	Common name	Status	Native/Adventive
	Helenium flexuosum Raf.	sneezeweed		A
	Helianthus decapetalus L.	pale sunflower		N
	Helianthus divaricatus L.	woodland sunflower		N
	Helianthus giganteus L.	tall sunflower		N
	Helianthus strumosus L.	pale-leaved sunflower		N
	Hieracium aurantiacum L.	orange hawkweed		A
	Hieracium caespitosum Dumort	king-devil		A
	Hieracium gronovii L.	hairy hawkweed		N
	Hieracium kalmii L.	Canada hawkweed		N
	Hieracium longipilum Torrey	long-bearded hawkweed		N
	Hieracium piloselloides Villars	glaucous king-devil		A
	Hieracium scabrum Michaux	rough hawkweed		N
	Hypochaeris radicata L.	spotted cat's-ear		A
	Krigia biflora (Walter) Blake	false dandelion		N
	Krigia virginica (L.) Willd.	dwarf dandelion		N
	Lactuca biennis (Moench) Fern.	tall blue lettuce		N
	Lactuca canadensis L.	tall lettuce		N
	Lactuca saligna L.	willow lettuce		A
	Leucanthemum vulgare Lam.	ox-eye daisy		A
	Liatris aspera Michaux	rough blazing star		N
	Liatris scariosa (L.) Willd.	northern blazing star		N
	Matricaria discoidea D.C.	pineapple-weed		A
	Polymnia canadensis L.	leafcup		N
	Prenanthes altissima L.	tall white lettuce		N
	Pseudognaphalium macounii (Greene) Kartesz	clammy cudweed		N
	Pseudognaphalium obtusifolium (L.) Hilliard & B. L. Burtt	old-field balsam		N
	Ratibida pinnata (Vent.) Barnh.	yellow coneflower		N
	Rudbeckia fulgida Aiton	black-eyed Susan		N
	Rudbeckia hirta L.	black-eyed Susan		N
	Rudbeckia laciniata L.	cut-leaved coneflower		N
	Rudbeckia triloba L.	three-lobed coneflower		N
	Packera aurea (L.) Á. Löve & D. Löve	golden ragwort		N
	Packera paupercula Michx.	balsam ragwort		N
	Solidago altissima L.	tall goldenrod		N
	Solidago caesia L.	blue-stemmed goldenrod		N
	Solidago canadensis L.	Canada goldenrod		N
	Solidago gigantea Ait.	late goldenrod		N
	Solidago hispida Muhl.	white goldenrod		N
	Solidago juncea Ait.	early goldenrod		N
	Solidago nemoralis Ait.	old-field goldenrod		N

Family	Scientific name	Common name	Status	Native/Adventive
	Solidago ohioensis RIddell	Ohio goldenrod		N
	Solidago patula Muhl.	swamp goldenrod		N
	Solidago riddellii Frank	Riddell's goldenrod		N
	Solidago rugosa Miller	rough goldenrod		N
	Solidago speciosa Nutt.	showy goldenrod		N
	Solidago uliginosa Nutt.	bog goldenrod		N
	Solidago ulmifolia Muhl.	elm-leaved goldenrod		N
	Sonchus arvensis L.	perennial sow thistle		A
	Sonchus asper (L.) Hill	prickly sow thistle		A
	Symphyotrichum cordifolium (L.) G. L. Nesom	heart-leaved aster		N
	Symphyotrichum laeve (L.) G. L. Nesom	smooth aster		N
	Symphyotrichum lanceolatum (Willd.) G. L. Nesom	eastern lined aster		N
	Symphyotrichum lateriflorum (L.) Á. Löve & D. Löve	side-flowering aster		N
	Symphyotrichum novae-angliae (L.) G. L. Nesom	New England aster		N
	Symphyotrichum oolentangiense (Riddell) G. L. Nesom	prairie heart-leaved aster		N
	Symphyotrichum pilosum (Willd.) G. L. Nesom	hairy aster		N
	Symphyotrichum puniceum (L.) Á. Löve & D. Löve	swamp aster		N
	Symphyotrichum urophyllum (DC.) G. L. Nesom	arrow-leaved aster		N
	Taraxacum officinale L.	common dandelion		A
	Tragopogon dubius Scop.	goat's-beard		A
	Tragopogon pratensis L.	common goat's-beard		A
	Vernonia missurica Raf.	Missouri ironweed		N
Athyriaceae				
	Athyrium filix-femina (L.) Roth	lady fern		N
	Deparia acrostichoides (Michx.) Desv.	silvery spleenwort		N
Balsaminaceae				
	Impatiens capensis Meerb.	spotted touch-me-not		N
Berberidaceae				
	Berberis thunbergii DC.	Japanese barberry		A
	Caulophyllum thalictroides (L.) Michaux	blue cohosh		N
	Podophyllum peltatum L.	may-apple		N
Betulaceae				
	Alnus glutinosa (L.) Gaertner	black alder		A
	Alnus incana (L.) Moench	speckled alder		N
	Betula alleghaniensis Britton	yellow birch		N
	Betula pendula Roth	European white birch		A
	Betula pumila L.	bog birch		N
	Betula × purpusii C. K. Schneid	hybrid birch		N
	Carpinus caroliniana Walter	blue-beech		N
	Corylus americana Walter	hazelnut		N

Family	Scientific name	Common name	Status	Native/Adventive
	Ostrya virginiana (Miller) K. Koch	ironwood; hop-hornbeam		N
Bignoniaceae				
	Campsis radicans (L.) Bureau	trumpet vine		A
	Catalpa speciosa Warder	northern catalpa		A
Blechnaceae				
	Woodwardia virginica (L.) Smith	Virginia chain-fern		N
Boraginaceae				
	Hackelia virginiana (L.) Johnst.	beggar's lice		N
	Hydrophyllum appendiculatum Michaux	great waterleaf		N
	Myosotis scorpioides L.	forget-me-not		A
Brassicaceae				
	Alliaria petiolata (Bieb.) Cavara & Grande	garlic mustard		A
	Alyssum alyssoides (L.) L.	pale alyssum		A
	Arabidopsis thaliana (L.) Heynh.	mouse-ear cress		A
	Barbarea vulgaris R. Br.	yellow rocket		A
	Berteroa incana (L.) DC.	hoary alyssum		A
	Boechera canadensis (L.) Al-Shehbaz	sickle-pod		N
	Capsella bursa-pastoris (L.) Medicus	shepherd's purse		A
	Cardamine bulbosa (Muhl.) BSP.	spring cress		N
	Cardamine concatenata (Michx.) O. Schwarz	cut-leaved toothwort		N
	Cardamine diphylla (Michx.) Alph. Wood	two-leaved toothwort		N
	Cardamine douglassii Britton	pink spring cress		N
	Cardamine hirsuta L.	hoary bitter cress		A
	Cardamine pensylvanica Willd.	Pennsylvania bitter cress		N
	Cardamine pratensis L.	cuckoo-flower		N
	Hesperis matronalis L.	dame's rocket		A
	Lepidium campestre (L.) R. Br.	field cress		A
	Lepidium densiflorum Schrader	small peppergrass		A
	Lepidium virginicum L.	common peppergrass		N
	Nasturtium officinale R. Br.	watercress		A
	Rorippa palustris L. Besser var. *hispida* (Desv.) Rydb.	yellow cress		N
	Rorippa palustris L. Besser var. *fernaldiana* (Butters & Abbe)	yellow cress		N
	Sisymbrium altissimum L.	tumble mustard		A
	Sisymbrium officinale L.	hedge mustard		A
	Turritis glabra L.	tower mustard		N
Cabombaceae				
	Brasenia schreberi J. F. Gmel.	water-shield		N
Campanulaceae				
	Campanula aparinoides Pursh	marsh bellflower		N

Family	Scientific name	Common name	Status	Native/Adventive
	Campanula rotundifolia L.	harebell		N
	Campanulastrum americanum (L.) Small	tall bellflower		N
	Lobelia inflata L.	Indian tobacco		N
	Lobelia kalmii L.	bog lobelia		N
	Lobelia siphilitica L.	great blue lobelia		N
	Lobelia spicata Lam.	pale spiked lobelia		N
	Triodanis perfoliata (L.) Nieuwl.	Venus's looking glass		N
Cannabaceae				
	Celtis occidentalis L.	hackberry		N
	Humulus lupulus L.	common hop		N
Capparaceae				
	Polanisia dodecandra (L.) DC.	clammy-weed		N
Caprifoliaceae				
	Lonicera dioica L.	red honeysuckle		N
	Lonicera maackii Maxim.	Amur honeysuckle		A
	Lonicera morrowii A. Gray	Morrow honeysuckle		A
	Lonicera xbella Zabel	hybrid honeysuckle		A
Caryophyllaceae				
	Arenaria serpyllifolia L.	thyme-leaved sandwort		A
	Dianthus armeria L.	deptford pink		A
	Saponaria officinalis L.	bouncing bet		A
	Scleranthus annuus L.	knawel		A
	Silene antirrhina L.	sleepy catchfly		N
	Silene pratensis (Rafn.) Godron & Gren.	white catchfly		A
	Silene vulgaris (Moench) Garcke	bladder campion		A
	Stellaria longifolia Willd.	long-leaved chickweed		N
	Stellaria media (L.) Vill.	common chickweed		A
Celastraceae				
	Celastrus orbiculatus Thunb.	Oriental bittersweet		A
	Celastrus scandens L.	American bittersweet		N
	Euonymus alata (Thunb.) Siebold	winged wahoo		A
	Euonymus atropurpurea Jacq.	wahoo; burning-bush	**SC**	N
	Euonymus obovata Nutt.	running strawberry-bush		N
Ceratophyllaceae				
	Ceratophyllum demersum L.	coontail		N
	Ceratophyllum echinatum A. Gray	spiny hornwort		N
Cistaceae				
	Crocanthemum canadense (L.) Britton	common rockrose		N
	Lechea mucronata Raf.	hairy pinweed		N
Commelinaceae				

Family	Scientific name	Common name	Status	Native/Adventive
	Tradescantia ohiensis Raf.	common spiderwort		N
Convallariaceae				
	Convallaria majalis L.	lily-of-the-valley		A
	Maianthemum canadense Desf.	Canada mayflower		N
	Maianthemum racemosum (L.) Link	false spikenard		N
	Maianthemum stellatum (L.) Link	starry false Solomon-seal		N
	Polygonatum biflorum (Walter) Ell.	Solomon-seal		N
	Polygonatum pubescens (Willd.) Pursh	downy Solomon-seal		N
	Uvularia grandiflora Sm.	bellwort		N
Convolvulaceae				
	Calystegia sepium (L.) R. Br.	hedge bindweed		N
	Cuscuta campestris Yuncker	field dodder	**SC**	N
	Cuscuta cephalanthi Engelm.	buttonbush dodder		N
	Cuscuta gronovii Willd.	common dodder		N
Cornaceae				
	Cornus alternifolia L. f.	alternate-leaved dogwood		N
	Cornus amomum Miller	silky dogwood		N
	Cornus florida L.	flowering dogwood		N
	Cornus foemina Miller	gray dogwood		N
	Cornus sericea L.	red-osier dogwood		N
Crassulaceae				
	Sedum telephium L.	live forever		A
Cucurbitaceae				
	Sicyos angulatus L.	bur-cucumber		N
Cupressaceae				
	Juniperus virginiana L.	red-cedar		N
	Thuja occidentalis L.	northern white-cedar; arborvitae		N
Cyperaceae				
	Bolboschoenus fluviatilis (Torr.) Soják	bulrush		N
	Carex aggregata Mack.	sedge		N
	Carex albursina Sheldon	sedge		N
	Carex amphibola Steudel	sedge		N
	Carex annectens (Bickn.) Bickn.	sedge		N
	Carex aquatilis Wahl.	sedge		N
	Carex atlantica L. H. Bailey	sedge		N
	Carex bebbii (Bailey) Fern.	sedge		N
	Carex bicknellii Britton	sedge		N
	Carex blanda Dewey	sedge		N
	Carex brevior (Dewey) Mack.	sedge		N
	Carex bromoides Willd.	sedge		N

Family	Scientific name	Common name	Status	Native/Adventive
	Carex buxbaumii Wahl.	sedge		N
	Carex canescens L.	sedge		N
	Carex cephalophora Willd.	sedge		N
	Carex comosa Boott	sedge		N
	Carex crinita Lam.	sedge		N
	Carex cristatella Britton	sedge		N
	Carex cryptolepis Mack.	sedge		N
	Carex diandra Schrank	sedge		N
	Carex flava L.	sedge		N
	Carex frankii	sedge		N
	Carex gracillima Schw.	sedge		N
	Carex granularis Willd.	sedge		N
	Carex grisea Wahlenb.	sedge		N
	Carex hirtifolia Mack.	sedge		N
	Carex hitchcockiana Dewey	sedge		N
	Carex hystericina Willd.	sedge		N
	Carex interior Bailey	sedge		N
	Carex jamesii Schw.	James' sedge		N
	Carex lacustris Willd.	sedge		N
	Carex laevivaginata (Kuk.) Mack.	sedge		N
	Carex lasiocarpa Ehrh.	sedge		N
	Carex laxiculmis Schw.	sedge		N
	Carex leptalea Wahl.	sedge		N
	Carex lupulina Willd.	sedge		N
	Carex muhlenbergii Willd.	sedge		N
	Carex pellita Willd.	sedge		N
	Carex pensylvanica Lam.	sedge		N
	Carex prairea Dewey	sedge		N
	Carex pseudo-cyperus L.	sedge		N
	Carex radiata (Wahlenb.) Small	straight-styled wood sedge		N
	Carex rosea Schkuhr ex. Willd.	curly-styled wood sedge		N
	Carex sartwellii Dewey	sedge		N
	Carex scoparia Willd.	sedge		N
	Carex sparganioides Willd.	sedge		N
	Carex spicata Hudson	sedge		A
	Carex sterilis Willd.	sedge		N
	Carex stipata Willd.	sedge		N
	Carex stricta Lam.	sedge		N
	Carex swanii (Fern.) Mack.	sedge		N
	Carex tetanica Schk.	sedge		N

Family	Scientific name	Common name	Status	Native/Adventive
	Carex tribuloides Wahl.	sedge		N
	Carex utriculata F. Boott	sedge		N
	Carex vulpinoidea Michaux	sedge		N
	Cladium mariscoides (Muhl.) Torrey	twig-rush		N
	Cyperus diandrus Steudel	umbrella sedge		N
	Cyperus lupulinus (Spreng.) Marcks	slender sand sedge		N
	Cyperus bipartitus Kunth	brook nut sedge		N
	Cyperus strigosus L.	long scaled nut sedge		N
	Dulichium arundinaceum (L.) Britton	three-way sedge		N
	Eleocharis elliptica Kunth	golden-seeded spike rush		N
	Eleocharis erythropoda Steudel	spike-rush		N
	Eleocharis intermedia Schultes	spike-rush		N
	Eleocharis obtusa (Willd.) Schultes	spike-rush		N
	Eleocharis rostellata Torrey	spike-rush		N
	Eriophorum viridi-carinatum (Engelm.) Fern.	green-keeled cotton-grass		N
	Rhynchospora capillacea Torrey	beak-rush		N
	Schoenoplectus acutus (Muhl. Ex Bigelow) A.&D. Love	hardstem bulrush		N
	Schoenoplectus pungens (Vahl) Palla	three-square		N
	Schoenoplectus tabernaemontani (K.C. Gmel.) Palla	softstem bulrush		N
	Scirpus atrovirens Willd.	bulrush		N
	Scirpus cyperinus (L.) Kunth	wool-grass		N
	Scirpus pendulus Muhl.	bulrush		N
	Scleria verticillata Willd.	nut-rush		N
Cystopteridaceae				
	Cystopteris bulbifera (L.) Bernh.	bulblet fern		N
Dioscoreaceae				
	Dioscorea villosa L.	wild yam		N
Diplaziopsidaceae				
	Homalosorus pycnocarpos (Spreng.) Pic. Serm.	narrow-leaved spleenwort		N
Droseraceae				
	Drosera rotundifolia L.	round-leaved sundew		N
Dryopteridaceae				
	Dryopteris carthusiana (*D. spinulosa*) (Vill.) H. P. Fuchs	spinulose woodfern		N
	Dryopteris cristata (L.) A. Gray	crested shield fern		N
	Dryopteris goldiana (Hooker) A. Gray	Goldie's woodfern		N
	Dryopteris intermedia (Muhl. ex Willd.) A. Gray	evergreen woodfern		N
	Polystichum acrostichoides (Michaux) Schott.	Christmas fern		N
Elaeagnaceae				
	Elaeagnus umbellata Thunb.	autumn-olive		A
Equisetaceae				

Family	Scientific name	Common name	Status	Native/Adventive
	Equisetum arvense L.	common horsetail		N
	Equisetum fluviatile L.	water horsetail		N
	Equisetum laevigatum A. Br.	smooth scouring rush		N
	Equisetum variegatum Schleich.	variegated scouring rush		N
Ericaceae				
	Chamaedaphne calyculata (L.) Moench	leatherleaf		N
	Chimaphila maculata (L.) Pursh	spotted wintergreen		N
	Gaylussacia baccata (Wang) K.Koch	huckleberry		N
	Hypopitys monotropa Crantz	pinesap		N
	Monotropa uniflora L.	Indian pipe		N
	Pyrola elliptica Nutt.	large-leaved shinleaf		N
	Vaccinium angustifolium Aiton	lowbush blueberry		N
	Vaccinium corymbosum L.	smooth highbush blueberry		N
	Vaccinium myrtilloides Michaux	Canada blueberry		N
Euphorbiaceae				
	Acalypha rhomboidea Raf.	three-seeded mercury		N
	Euphorbia corollata L.	flowering spurge		N
	Euphorbia cyparissias L.	Cypress spurge		A
	Euphorbia maculata L.	nodding spurge		N
	Euphorbia nutans Lag.	eyebane		N
	Euphorbia vermiculata Raf.	hairy spurge		A
Fabaceae				
	Amorpha canescens Pursh	lead plant	**SC**	N
	Amphicarpaea bracteata (L.) Fern.	hog-peanut		N
	Apios americana Medicus	groundnut		N
	Cercis canadensis L.	redbud		N
	Desmodium canadense (L.) DC.	showy tick-trefoil		N
	Desmodium ciliare (Willd.) DC.	hairy tick-trefoil		N
	Desmodium illinoense A. Gray	prairie tick-trefoil		N
	Desmodium marilandicum (L.) DC.	small-leaved tick trefoil		N
	Desmodium paniculatum (L.) DC.	panicled tick-trefoil		N
	Desmodium perplexum B. G. Schub.	panicled tick-trefoil		N
	Desmodium rotundifolium DC.	round-leaved tick-trefoil		N
	Desmodium sessilifolium (Torrey) T. & G.	sessile-leaved tick-trefoil		N
	Hylodesmum glutinosum (Willd.) H. Ohashi & R. R. Mill	clustered-leaved tick-trefoil		N
	Hylodesmum nudiflorum (L.) H. Ohashi & R. R. Mill	naked tick-trefoil		N
	Gleditsia triacanthos L.	honey locust		N
	Lathyrus latifolius L.	everlasting pea		A
	Lathyrus palustris L.	marsh pea		N
	Lathyrus venosus Willd.	veiny pea		N

Family	Scientific name	Common name	Status	Native/Adventive
	Lespedeza capitata Michaux	round-headed bush-clover		N
	Lespedeza hirta (L.) Hornem.	hairy bush-clover		N
	Lespedeza intermedia (Watson) Britton	bush-clover		N
	Lespedeza virginica (L.) Britton	slender bush-clover		N
	Lupinus perennis L.	wild lupine		N
	Medicago lupulina L.	black medick		A
	Robinia hispida L.	bristly locust		A
	Robinia pseudoacacia L.	black locust		A
	Securigera varia (L.) Lassen	crown-vetch		A
	Tephrosia virginiana (L.) Pers.	goat's-rue		N
	Trifolium arvense L.	rabbitfoot clover		A
	Trifolium campestre Schreber	low hop clover		A
	Trifolium dubium Sibth.	little hop clover		A
	Trifolium hybridum L.	alsike clover		A
	Trifolium pratense L.	red clover		A
	Trifolium repens L.	white clover		A
	Vicia americana Willd.	American vetch		N
	Vicia caroliniana Walter	pale or wood vetch		N
	Vicia villosa Roth	hairy vetch		A
Fagaceae				
	Castanea dentata (Marsh.) Borkh.	American chestnut		N
	Fagus grandifolia Ehrh.	American beech		N
	Quercus alba L.	white oak		N
	Quercus macrocarpa Michaux	bur oak		N
	Quercus rubra L.	red oak		N
	Quercus velutina Lam.	black oak		N
Gentianaceae				
	Frasera caroliniensis (Walter)	American columbo		N
	Gentiana andrewsii Griseb.	bottle gentian		N
	Gentianella quinquefolia (L.) Small	stiff gentian	**T**	N
	Gentianopsis crinita (Froel.) Ma	fringed gentian		N
	Gentianopsis procera (Holm.) Ma	small fringed gentian		N
Geraniaceae				
	Erodium cicutarium L'Her.	storksbill; alfileria		A
	Geranium maculatum L.	wild geranium		N
Grossulariaceae				
	Ribes americanum Miller	wild black currant		N
	Ribes cynosbati L.	prickly or wild gooseberry		N
	Ribes hirtellum Michaux	swamp gooseberry		N
Haloragaceae				

Family	Scientific name	Common name	Status	Native/Adventive
	Myriophyllum sibiricum Komarov	spiked water-milfoil		N
	Myriophyllum verticillatum L.	water-milfoil		N
Hamamelidaceae				
	Hamamelis virginiana L.	witch-hazel		N
Hemerocallidaceae				
	Hemerocallis fulva (L.) L.	orange day-lily		A
Hyacinthaceae				
	Muscari botryoides (L.) Miller	grape-hyacinth		A
	Ornithogalum umbellatum L.	star-of-Bethlehem		A
Hydrocharitaceae				
	Elodea canadensis Michaux	common waterweed		N
	Najas flexilis (Willd.) Rostk. & Schmidt	slender naiad		N
	Najas guadalupensis (Sprengel) Magnus	southern naiad		N
	Najas marina L.	spiny naiad		A
Hypericaceae				
	Hypericum ascyron L.	giant St. John's-wort		N
	Hypericum majus (A. Gray) Britton	larger Canada St. John's-wort		N
	Hypericum mutilum L.	weak St. John's-wort		N
	Hypericum perforatum L.	common St. John's-wort		A
	Hypericum punctatum Lam.	spotted St. John's-wort		N
	Triadenum fraseri (Spach) Gl.	marsh St. John's-wort		N
Hypoxidaceae				
	Hypoxis hirsuta (L.) Cov.	star-grass		N
Iridaceae				
	Iris virginica L.	southern blue flag		N
Juglandaceae				
	Carya cordiformis (Wang.) K.Koch	bitternut hickory		N
	Carya glabra (Miller) Sweet	pignut hickory		N
	Carya ovata (Miller) K. Koch	shagbark hickory		N
	Juglans cinerea L.	butternut		N
	Juglans nigra L.	black walnut		N
Juncaceae				
	Juncus acuminatus Michaux	sharp-fruited rush		N
	Juncus brachycephalus (Engelm.) Buch.	rush		N
	Juncus dudleyi Wieg.	Dudley's rush		N
	Juncus effusus L.	soft-stemmed rush		N
	Juncus nodosus L.	joint rush		N
	Juncus tenuis Willd.	path rush		N
	Juncus torreyi Cov.	Torrey's rush		N
	Luzula multiflora (Retz.) Lej.	common wood rush		N

Family	Scientific name	Common name	Status	Native/Adventive
Juncaginaceae				
	Triglochin palustre L.	slender bog arrow-grass		N
Lamiaceae				
	Clinopodium vulgare (L.) Fritsch	wild basil		N
	Collinsonia canadensis L.	richweed		N
	Glechoma hederacea L.	ground ivy		A
	Lamium purpureum L.	purple dead-nettle		A
	Leonurus cardiaca L.	motherwort		A
	Lycopus americanus Muhl.	common water horehound		N
	Lycopus uniflorus Michaux	northern bugle weed		N
	Mentha canadensis L.	wild mint		N
	Mentha spicata L.	spearmint		A
	Monarda fistulosa L.	wild bergamot		N
	Monarda punctata L.	horsemint		N
	Nepeta cataria L.	catnip		A
	Prunella vulgaris L.	lawn prunella		N
	Pycnanthemum virginianum (L.) Durand & Jackson	common mountain mint		N
	Satureja hortensis L.	savory		A
	Scutellaria galericulata L.	common skullcap		N
	Scutellaria lateriflora L.	mad-dog skullcap		N
	Stachys hyssopifolia Michaux	hyssop hedge nettle		N
	Teucrium canadense L.	wood sage		N
Lauraceae				
	Lindera benzoin (L.) Blume	spicebush		N
	Sassafras albidum (Nutt.) Nees	sassafras		N
Lentibulariaceae				
	Utricularia geminiscapa Benj.	bog bladderwort		N
	Utricularia gibba L.	humped bladderwort		N
	Utricularia intermedia Hayne	flat-leaved bladderwort		N
	Utricularia minor L.	small bladderwort		N
	Utricularia purpurea Walter	purple bladderwort		N
	Utricularia vulgaris L.	great bladderwort		N
Liliaceae				
	Lilium michiganense Farw.	Michigan lily		N
Limnanthaceae				
	Floerkea proserpinacoides Willd.	false mermaid		N
Linaceae				
	Linum virginianum L.	Virginia flax	**T**	N
Linderneaceae				
	Lindernia dubia (L.) Pennell	false pimpernel		N

Family	Scientific name	Common name	Status	Native/Adventive
Lycopodiaceae				
	Diphasiastrum digitatum (Dillenius ex. A. Braun) Holub	ground-cedar		N
	Huperzia lucidula (Michx.) R.Trevis.	shining clubmoss		N
Lythraceae				
	Decodon verticillatus (L.) Ell.	whorled or swamp loosestrife		N
	Lythrum salicaria L.	purple loosestrife		A
Magnoliaceae				
	Liriodendron tulipifera L.	tulip tree		N
Malvaceae				
	Abutilon theophrasti Medicus	velvetleaf		A
	Malva neglecta Wallr.	cheeses		A
	Tilia americana L.	basswood		N
Melanthiaceae				
	Aletris farinosa L.	colic root		N
Menispermaceae				
	Menispermum canadense L.	moonseed		N
Molluginaceae				
	Mollugo verticillata L.	carpet-weed		A
Moraceae				
	Maclura pomifera (Raf.) Schneider	osage orange		A
	Morus alba L.	white mulberry		A
	Morus rubra L.	red mulberry	**T**	N
Nymphaeaceae				
	Nuphar advena (Aiton) Aiton f.	yellow pond-lily		N
	Nuphar variegata Durand	yellow pond-lily		N
	Nymphaea odorata Aiton	sweet-scented waterlily		N
Oleaceae				
	Fraxinus americana L.	white ash		N
	Fraxinus nigra Marsh.	black ash		N
	Fraxinus pennsylvanica Marsh.	red ash		N
	Fraxinus quadrangulata Michaux	blue ash		N
	Syringa vulgaris L.	common lilac		A
Onagraceae				
	Circaea canadensis (L.) Hill	enchanter's-nightshade		N
	Epilobium coloratum Biehler	cinnamon willow-herb		N
	Epilobium hirsutum L.	great hairy willow-herb		A
	Epilobium leptophyllum Raf.	fen willow-herb		N
	Epilobium parviflorum Schreb.	willow-herb		A
	Epilobium strictum Sprengel	downy willow-herb		N
	Ludwigia palustris (L.) Ell.	water-purslane		N

Family	Scientific name	Common name	Status	Native/Adventive
	Oenothera biennis L.	common evening-primrose		N
Onocleaceae				
	Matteuccia struthiopteris (L.) Todaro	ostrich fern		N
	Onoclea sensibilis L.	sensitive fern		N
Ophioglossaceae				
	Botrypus virginianus (L.) Michx.	rattlesnake fern		N
	Sceptridium dissectum (Spreng.) Lyon	cut-leaved grape-fern		N
	Sceptridium multifidum ((S. G. Gmel.) M. Nishida	leather grape-fern		N
Orchidaceae				
	Aplectrum hyemale (Willd.) Torrey	putty root		N
	Corallorhiza maculata Raf.	spotted coral-root		N
	Corallorhiza odontorhiza (Willd.) Nutt.	fall coral-root		N
	Cypripedium parviflorum Salisb. var. makasin (Farw.) Sheviak	small yellow lady-slipper		N
	Cypripedium parviflorum Salisb. var. pubescens (Willd.) O. W. Knight	large yellow lady-slipper		N
	Cypripedium reginae Walter	showy or queen's lady-slipper		N
	Galearis spectabilis (*Orchis s.*) (L.) Raf.	showy orchis	**T**	N
	Liparis liliifolia (L.) Rich. ex Lindl.	lily-leaved twayblade		N
	Liparis loeselii (L.) Rich.	Loesel's twayblade		N
	Platanthera hyperborea (L.) Lindl.	tall northern bog orchid		N
	Platanthera lacera (Michaux) G. Donn in Sweet	green-fringed orchid		N
	Platanthera psycodes (L.) Lindl.	small purple-fringed orchid		N
	Spiranthes cernua (L.) Rich.	nodding ladies'-tresses		N
	Spiranthes lacera (Raf.) Raf.	slender ladies'-tresses		N
	Spiranthes ochroleuca (Rydb.) Rydb.	yellow ladies'-tresses		N
	Spiranthes ovalis Lindley	oval ladies'-tresses	**T**	N
Orobanchaceae				
	Agalinis purpurea (*Gerardia p.*) (L.) Pennell	purple gerardia		N
	Aureolaria flava (L.) Farw.	smooth false foxglove		N
	Aureolaria pedicularia (L.) Raf.	annual false foxglove		N
	Conopholis americana (L.) Wallr.	squawroot		N
	Epifagus virginiana (L.) Bart.	beech drops		N
	Pedicularis canadensis L.	wood-betony		N
	Pedicularis lanceolata Michaux	swamp-betony		N
Osmundaceae				
	Osmundastrum cinnamomeum (L.) C. Presl	cinnamon fern		N
	Osmunda claytoniana L.	interrupted fern		N
	Osmunda regalis L.	royal fern		N
Oxalidaceae				

Family	Scientific name	Common name	Status	Native/Adventive
	Oxalis fontana Bunge	yellow wood-sorrel		N
	Oxalis stricta L.	common yellow wood-sorrel		N
Papaveraceae				
	Corydalis flavula (Raf.) DC.	yellow harlequin	**T**	N
	Dicentra canadensis (Goldie) Walp.	squirrel-corn		N
	Dicentra cucullaria (L.) Bernh.	Dutchman's breeches		N
	Sanguinaria canadensis L.	bloodroot		N
Parnassiaceae				
	Parnassia glauca Raf.	grass-of-Parnassus		N
Penthoraceae				
	Penthorum sedoides L.	ditch stonecrop		N
Phrymaceae				
	Mimulus ringens L.	monkey-flower		N
	Phryma leptostachya L.	lopseed		N
Phytolaccaceae				
	Phytolacca americana L.	pokeweed		N
Pinaceae				
	Abies balsamea (L.) Miller	balsam fir		N
	Larix laricina (DuRoi) K. Koch	tamarack		N
	Picea abies (L.) Karsten	Norway spruce		A
	Picea glauca (Moench) A. Voss	white spruce		N
	Pinus banksiana Lamb.	jack pine		N
	Pinus resinosa Aiton	red pine		N
	Pinus strobus L.	white pine		N
	Pinus sylvestris L.	scotch pine		A
Plantaginaceae				
	Chelone glabra L.	turtlehead		N
	Nuttallanthus canadensis (L.) D. A. Sutton	blue toadflax		N
	Penstemon digitalis Nutt.	foxglove beard-tongue		N
	Penstemon hirsutus (L.) Willd.	hairy beard-tongue		N
	Plantago aristata Michaux	buckthorn		A
	Plantago lanceolata L.	English plantain		A
	Plantago rugelii Dcne.	red-stalked plantain		N
	Veronica anagallis-aquatica L.	water speedwell		N
	Veronica arvensis L.	corn speedwell		A
	Veronica officinalis L.	common speedwell		A
	Veronica peregrina L.	purslane speedwell or neckweed		N
	Veronicastrum virginicum (L.) Farw.	Culver's root		N
Platanaceae				
	Platanus occidentalis L.	sycamore		N

Family	Scientific name	Common name	Status	Native/Adventive
Poaceae				
	Agrostis gigantea Roth	redtop		A
	Agrostis hyemalis (Walter) BSP.	ticklegrass		N
	Agrostis perennans (Walter) Tuckerman	autumn bent grass		N
	Alopecurus aequalis Sobol.	short-awned foxtail		N
	Andropogon gerardii Vitman	big bluestem		N
	Andropogon virginicus L.	broom-sedge		N
	Anthoxanthum odoratum L.	sweet vernal grass		A
	Aristida basiramea Vasey	fork-tipped three-awned grass		N
	Aristida purpurascens Poiret	three-awned grass		N
	Arrhenatherum elatius (L.) Presl	tall oatgrass		A
	Avenella flexuosa (L.) Drejer	hair grass		N
	Brachyelytrum erectum (Roth) Beauv.	long-awned wood grass		N
	Bromus ciliatus L.	fringed brome		N
	Bromus inermis Leysser	smooth brome		A
	Bromus japonicus Murray	Japanese brome		A
	Bromus latiglumis (Shear) Hitchc.	ear-leaved brome		N
	Bromus mollis L.	soft chess		A
	Bromus nottowayanus	satin brome		N
	Bromus pubescens Willd.	Canada brome		N
	Bromus racemosus L.	smooth chess		A
	Bromus squarrosus L.	brome		A
	Bromus tectorum L.	cheat grass		A
	Calamagrostis canadensis (Michaux) Beauv.	blue-joint grass		N
	Calamagrostis stricta (Timm) Koeler ssp. *inexpansa* (A. Gray) C.W. Greene	bog reedgrass		N
	Cenchrus longispinus (Hackel) Fern.	sandbur		N
	Cinna arundinacea L.	wood reedgrass		N
	Coelorachis cylindrica (Michx.) Nash	joint grass		A
	Dactylis glomerata L.	orchard grass		A
	Danthonia spicata (L.) R. & S.	poverty grass; oatgrass		N
	Deschampsia cespitosa (L.) Beauv.	hair grass		N
	Dichanthelium boreale (Nash) Freckmann	northern panic grass		N
	Dichanthelium clandestinum (L.) Gould	panic grass		N
	Dichanthelium depauperatum (Muhl.) Gould	panic grass		N
	Dichanthelium dichotomum (L.) Gould	panic grass		N
	Dichanthelium implicatum (Scribn.) Kerguélen	panic grass		N
	Dichanthelium latifolium (L.) Harvill	broad-leaved panic grass		N
	Dichanthelium oligosanthes (Schult.) Gould	panic grass		N
	Dichanthelium praecocius (Hitchc. & Chase) Mohlenbr.	panic grass		N

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	Dichanthelium sphaerocarpon (Elliott) Gould	round-fruited panic grass		N
	Digitaria cognata (Schult.) Pilg.	fall witch grass		N
	Digitaria ischaemum (Schreber) Muhl.	smooth crab grass		A
	Digitaria sanguinalis (L.) Scop.	hairy crab grass		A
	Echinochloa crusgalli (L.) Beauv.	barnyard grass		A
	Echinochloa muricata (Beauv.) Fern.	barnyard grass		N
	Echinochloa walteri (Pursh) Heller	salt-marsh cockspur grass		N
	Eleusine indica (L.) Gaertner	goose grass		A
	Elymus repens (L.) Gould	quack grass		A
	Elymus riparius Wieg.	riverbank wild-rye		N
	Elymus trachycaulus (Link) Gould	slender wheat grass		N
	Elymus villosus Willd.	silky wild-rye		N
	Elymus virginicus L.	Virginia wild-rye		N
	Eragrostis cilianensis (All.) Mosher	stink grass		A
	Eragrostis minor Host	low love grass		A
	Eragrostis pectinacea (Michaux) Nees	love grass		N
	Eragrostis spectabilis (Pursh) Steudel	purple love grass		N
	Festuca octoflora Walter	six-weeks fescue		N
	Festuca rubra L.	red fescue		A
	Festuca subverticillata (*F. obtusa*) (Persh.) E. Alexeev.	nodding fescue		N
	Festuca trachyphylla (Hack.) Krajina	sheep fescue		A
	Glyceria canadensis (Michaux) Trin.	rattlesnake grass		N
	Glyceria septentrionalis Hitchc.	floating manna grass		N
	Glyceria striata (Lam.) Hitchc.	fowl manna grass		N
	Hystrix patula Moench	bottlebrush grass		N
	Leersia oryzoides (L.) Sw.	cut grass		N
	Leersia virginica Willd.	white grass		N
	Lolium arundinaceum (Schreb.) Darbysh.	tall fescue		A
	Lolium perenne L.	perennial rye grass		A
	Lolium pratense (Huds.) Darbysh.	meadow fescue		A
	Muhlenbergia frondosa (Poiret) Fern.	common satin grass		N
	Muhlenbergia glomerata (Willd.) Trin.	marsh wild-timothy		N
	Muhlenbergia mexicana (L.) Trin.	leafy satin grass		N
	Muhlenbergia schreberi J. F. Gmelin	nimblewill		N
	Panicum capillare L.	witch grass		N
	Panicum dichotomiflorum Michaux	panic grass		N
	Panicum virgatum L.	switch grass		N
	Pascopyrum smithii (Rydb.) Barkworth & D. R. Dewey	Smith's wheat grass		A
	Paspalum ciliatifolium Michaux	hairy lens grass		N
	Phalaris arundinacea L.	reed canary grass		N

Family	Scientific name	Common name	Status	Native/Adventive
	Phleum pratense L.	timothy		A
	Phragmites australis (Cav.) Steudel subsp. *americanus* Saltonst., P. M. Peterson & Soreng	reed		N
	Phragmites australis (Cav.) Steudel subsp. *australis*	reed		A
	Piptochaetium avenaceum (L.) Parodi	black oatgrass		N
	Poa annua L.	annual bluegrass		A
	Poa compressa L.	Canada bluegrass		A
	Poa languida Hitchc.	bluegrass		N
	Poa pratensis L.	Kentucky bluegrass		A
	Poa sylvestris A. Gray	woodland bluegrass		N
	Poa trivialis L.	bluegrass		A
	Puccinellia pallida (Torrey) Clausen	puccinellia		N
	Schizachyrium scoparium (Michx.) Nash	little bluestem grass		N
	Setaria glauca (L.) Beauv.	yellow foxtail		A
	Setaria viridis (L.) Beauv.	green foxtail		A
	Sorghastrum nutans (L.) Nash	Indian grass		N
	Spartina pectinata Link	cordgrass		N
	Sphenopholis intermedia (Rydb.) Rydb.	slender wedgegrass		N
	Sphenopholis nitida (Biehler) Scribn.	shining wedgegrass		N
	Sporobolus cryptandrus (Torrey) A. Gray	sand dropseed		N
	Sporobolus heterolepis (A. Gray) A. Gray	prairie dropseed	**SC**	N
	Sporobolus neglectus Nash	small rush grass		N
	Tridens flavus (L.) Hitchc.	purpletop		N
Polemoniaceae				
	Phlox divaricata L.	woodland phlox		N
	Phlox paniculata L.	garden phlox		A
	Phlox pilosa L.	prairie phlox		N
Polygalaceae				
	Polygala polygama Walter	racemed milkwort		N
	Polygala sanguinea L.	field milkwort		N
Polygonaceae				
	Fallopia convolvulus (L.) Á. Löve	false buckwheat		A
	Fallopia scandens (L.) Holub	false buckwheat		N
	Persicaria amphibia (L.) Delabare var. *emersa* (Michx.) J. C. Hickman	water smartweed		N
	Persicaria amphibia (L.) Delabare var. *stipulacea* (N. Coleman) H. Hara	water smartweed		N
	Persicaria hydropiper (L.) Delabare	water-pepper		N
	Persicaria hydropiperoides (Michx.) Small	water-pepper		N
	Persicaria lapathifolia (L.) Delabare	nodding smartweed		N

Family	Scientific name	Common name	Status	Native/Adventive
	Persicaria maculosa Gray	lady's-thumb		A
	Persicaria pensylvanica (L.) M. Gómez	bigseed smartweed		N
	Persicaria punctata (Elliott) Small	smartweed		N
	Persicaria sagittata (L.) H. Gross	arrow-leaved tear-thumb		N
	Persicaria virginiana (L.) Gaertn.	jumpseed		N
	Polygonum aviculare L.	knotweed		A
	Polygonum tenue Michaux	slender knotweed		N
	Rumex acetosella L.	sheep sorrel		A
	Rumex crispus L.	curly dock		A
	Rumex obtusifolius L.	bitter dock		A
	Rumex orbiculatus A. Gray	great water dock		N
Pontederiaceae				
	Heteranthera dubia (Jacq.) MacMill.	water star-grass		N
	Pontederia cordata L.	pickerel weed		N
Portulacaceae				
	Claytonia virginica L.	spring-beauty		N
Potamogetonaceae				
	Potamogeton amplifolius Tuck.	large-leaved pondweed		N
	Potamogeton foliosus Raf.	leafy pondweed		N
	Potamogeton friesii Rupr.	Fries's pondweed		N
	Potamogeton gramineus L.	pondweed		N
	Potamogeton illinoensis Morong	Illinois pondweed		N
	Potamogeton natans L.	pondweed		N
	Potamogeton pusillus L.	small pondweed		N
	Potamogeton zosteriformis Fern.	flat-stemmed pondweed		N
	Stuckenia filiformis (Pers.) Börner	narrow-leaved pondweed		N
	Stuckenia pectinata (L.) Börner	sago pondweed		N
	Zannichellia palustris L.	horned pondweed		N
Primulaceae				
	Lysimachia ciliata L.	fringed loosestrife		N
	Lysimachia lanceolata Walter	lance-leaved loosestrife		N
	Lysimachia quadriflora Sims	whorled loosestrife		N
	Lysimachia quadrifolia L.	four-leaved loosestrife		N
	Lysimachia terrestris (L.) BSP.	swamp candles		N
	Lysimachia thyrsiflora L.	tufted loosestrife		N
Pteridaceae				
	Adiantum pedatum L.	maidenhair fern		N
	Pteridium aquilinum (L.) Kuhn	bracken fern		N
Ranunculaceae				
	Actaea pachypoda Ell.	doll's-eyes		N

Family	Scientific name	Common name	Status	Native/Adventive
	Actaea rubra (Aiton) Willd.	red baneberry		N
	Anemone cylindrica A. Gray	thimbleweed		N
	Anemone quinquefolia L.	wood anemone		N
	Anemone virginiana L.	thimbleweed		N
	Aquilegia canadensis L.	wild columbine		N
	Caltha palustris L.	marsh-marigold		N
	Clematis virginiana L.	virgin's bower		N
	Hepatica americana (DC.) Ker	round-lobed hepatica		N
	Hydrastis canadensis L.	goldenseal	**T**	N
	Isopyrum biternatum (Raf.) T. & G.	false rue anemone		N
	Ranunculus abortivus L.	small-flowered buttercup		N
	Ranunculus hispidus Michaux	swamp buttercup		N
	Ranunculus pensylvanicus L. f.	bristly crowfoot		N
	Ranunculus recurvatus Poiret	hooked crowfoot		N
	Ranunculus sceleratus L.	cursed crowfoot		N
	Thalictrum dasycarpum Fisch. & Ave-Lall.	purple meadow-rue		N
	Thalictrum dioicum L.	early meadow-rue		N
	Thalictrum thalictroides (L.) Eames & B. Boivin	rue anemone		N
Rhamnaceae				
	Ceanothus americanus L.	New Jersey-tea		N
	Frangula alnus Mill.	glossy buckthorn		A
	Rhamnus alnifolia L'Her.	alder-leaved buckthorn		N
	Rhamnus cathartica L.	common buckthorn		A
Rosaceae				
	Agrimonia gryposepala Wallr.	tall agrimony		N
	Agrimonia parviflora Aiton	swamp agrimony		N
	Agrimonia pubescens Wallr.	soft agrimony		N
	Agrimonia rostellata Wallr.	beaked agrimony	**T**	N
	Amelanchier arborea (Michaux f.) Fern.	juneberry		N
	Amelanchier laevis Wieg.	smooth shadbush		N
	Amelanchier spicata (Lam.) K. Koch	shadbush serviceberry		N
	Comarum palustre L.	marsh cinquefoil		N
	Crataegus calpodendron (Ehrh.) Medicus	hawthorn		N
	Crataegus crus-galli L.	cockspur thorn		N
	Crataegus holmesiana Ashe	hawthorn		N
	Crataegus macrosperma Ashe	hawthorn		N
	Crataegus margaretta Ashe	hawthorn		N
	C. monogyna X punctata	hybrid hawthorn		I
	Dasiphora fruticosa (L.) Rydb.	shrubby cinquefoil		N
	Drymocallis arguta (Pursh) Rydb.	tall or prairie cinquefoil		N

Family	Scientific name	Common name	Status	Native/Adventive
	Filipendula rubra (Hill) Robinson	queen-of-the-prairie	**T**	N
	Fragaria virginiana Miller	wild strawberry		N
	Geum aleppicum Jacq.	yellow avens		N
	Geum canadense Jacq.	white avens		N
	Geum virginianum L.	pale avens	**SC**	N
	Malus coronaria (L.) Miller	American crab		N
	Malus pumila Miller	apple		A
	Malus sieboldi Regel	toringo crab		A
	Potentilla argentea L.	silvery cinquefoil		A
	Potentilla norvegica L.	rough cinquefoil		N
	Potentilla recta L.	rough-fruited cinquefoil		A
	Potentilla simplex Michaux	old-field cinquefoil		N
	Prunus avium (L.) L.	sweet cherry		A
	Prunus mahaleb L.	perfumed cherry		A
	Prunus serotina Ehrh.	wild black cherry		N
	Prunus virginiana L.	choke cherry		N
	Pyrus communis L.	common pear		A
	Rosa carolina L.	pasture rose		N
	Rosa multiflora Murray	multiflora rose		A
	Rosa palustris Marsh.	swamp rose		N
	Rubus allegheniensis Porter	common blackberry		N
	Rubus flagellaris Willd.	northern dewberry		N
	Rubus hispidus L.	swamp dewberry		N
	Rubus occidentalis L.	black raspberry		N
	Rubus pensylvanicus Poiret	dewberry		N
	Rubus pubescens Raf.	dwarf raspberry		N
	Rubus strigosus Michaux	wild red raspberry		N
	Sorbus decora (Sarg.) C. K.Schneid.	mountain-ash		N
	Spiraea alba Du Roi	meadowsweet		N
	Spiraea tomentosa L.	steeplebush		N
	Spiraea x vanhouttei (Briot) Carr.	bridal-wreath		A
Rubiaceae				
	Cephalanthus occidentalis L.	buttonbush		N
	Galium aparine L.	annual bedstraw		N
	Galium asprellum Michaux	rough bedstraw		N
	Galium boreale L.	northern bedstraw		N
	Galium circaezans Michaux	white wild licorice		N
	Galium lanceolatum Torrey	yellow wild licorice		N
	Galium obtusum Bigel.	wild madder		N
	Galium pilosum Ait.	hairy bedstraw		N

Family	Scientific name	Common name	Status	Native/Adventive
	Galium tinctorium L.	stiff bedstraw		N
	Galium trifidum L.	small bedstraw		N
	Galium triflorum Michaux	fragrant bedstraw		N
	Mitchella repens L.	partridge berry		N
Rutaceae				
	Zanthoxylum americanum Miller	prickly-ash		N
Salicaceae				
	Populus deltoides Marsh.	cottonwood		N
	Populus grandidentata Michaux	big-toothed aspen		N
	Populus tremuloides Michaux	quaking aspen		N
	Salix bebbiana Sarg.	Bebb's willow		N
	Salix candida Willd.	hoary willow		N
	Salix discolor Muhl.	pussy willow		N
	Salix eriocephala Michaux	willow		N
	Salix exigua Nutt.	sandbar willow		N
	Salix X rubens Shrank	hybrid willow		N
	Salix pedicellaris Pursh	bog willow		N
	Salix sericea Marsh.	silky willow		N
	Salix serissima (Bailey) Fern.	autumn willow		N
Santalaceae				
	Comandra umbellata (L.) Nutt.	bastard-toadflax		N
Sapindaceae				
	Acer negundo L.	box elder		N
	Acer nigrum Michaux f.	black maple		N
	Acer platanoides L.	Norway maple		A
	Acer rubrum L.	red maple		N
	Acer saccharinum L.	silver maple		N
	Acer saccharum Marsh.	sugar maple		N
Saxifragaceae				
	Heuchera americana L.	alum root		N
	Micranthes pensylvanica (L.) Haw.	swamp saxifrage		N
	Mitella diphylla L.	bishop's cap		N
Scrophulariaceae				
	Scrophularia lanceolata Small	early figwort		N
	Scrophularia marilandica L.	late figwort		N
	Verbascum blattaria L.	moth mullein		A
	Verbascum thapsus L.	common mullein		A
Selaginellaceae				
	Selaginella eclipes Buck.	selaginella		N
Simaroubaceae				

Family	Scientific name	Common name	Status	Native/Adventive
	Ailanthus altissima (Miller) Swingle	tree-of-heaven		A
Smilicaceae				
	Smilax lasioneura Hooker	carrion-flower		N
	Smilax hispida Raf.	bristly green-brier		N
Solanaceae				
	Physalis heterophylla Nees	clammy ground-cherry		N
	Solanum carolinense L.	horse nettle		A
	Solanum dulcamara L.	bittersweet nightshade		A
	Solanum physalifolium Rusby	hairy nightshade		A
	Solanum ptychanthum Dunal	black nightshade		N
Staphyleaceae				
	Staphylea trifolia L.	bladdernut		N
Thelypteridaceae				
	Phegopteris hexagonoptera Fée	broad beech-fern		N
	Thelypteris noveboracensis (L.) Nieuwl.	New York fern		N
	Thelypteris palustris Schott	marsh fern		N
Trilliaceae				
	Trillium cernuum L.	nodding trillium		N
	Trillium grandiflorum (Michaux) Salisb.	common trillium		N
Typhaceae				
	Sparganium americanum Nutt.	American bur-reed		N
	Sparganium emersum Rehm.	green-fruited bur-reed		N
	Typha angustifolia L.	narrow-leaved cat-tail		A
	Typha latifolia L.	broad-leaved cat-tail		N
Ulmaceae				
	Ulmus americana L.	American elm		N
	Ulmus glabra Huds.	wych elm		A
	Ulmus rubra Muhl.	slippery elm		N
Urticaceae				
	Boehmeria cylindrica (L.) Sw.	false nettle		N
	Laportea canadensis (L.) Wedd.	wood nettle		N
	Parietaria pensylvanica Willd.	pellitory		N
	Pilea fontana (Lunell) Rydb.	bog clearweed		N
	Urtica dioica L.	nettle		N
Valerianaceae				
	Valeriana uliginosa (T. & G.) Rydb.	bog valerian		N
Verbenaceae				
	Verbena bracteata Lag. & Rodr.	creeping vervain		A
	Verbena hastata L.	blue vervain		N
	Verbena stricta Vent.	hoary vervain		N

Family	Scientific name	Common name	Status	Native/Adventive
	Verbena urticifolia L.	white vervain		N
Violaceae				
	Viola arvensis Murray	field pansy		A
	Viola canadensis L.	Canada violet		N
	Viola cucullata Aiton	marsh violet		N
	Viola labradorica Schrank	dog violet		N
	Viola lanceolata L.	lance-leaved violet		N
	Viola macloskeyi F. E. Lloyd	smooth white violet		N
	Viola pubescens Aiton	yellow violet		N
	Viola rostrata Pursh	long-spurred violet		N
	Viola sagittata Aiton	arrow-leaved violet		N
	Viola sororia Willd.	common blue violet		N
	Viola striata Aiton	cream violet		N
Vitaceae				
	Parthenocissus inserta (A. Kerner) Fritsch	thicket creeper		N
	Parthenocissus quinquefolia (L.) Planchon	Virginia creeper		N
	Vitis aestivalis Michaux	summer grape		N
	Vitis riparia Michaux	riverbank grape		N

Mott Road Prairie EO ID 10017								
08/01/2018								
Other Notes:	Also 9/11/20							
Conservatism-Based Metrics:								
Total Mean C:	3.3							
Native Mean C:	3.9							
Total FQI:	38.1							
Native FQI:	41.6							
Adjusted FQI:	36.1							
% C value 0:	16.5							
% C value 1-3:	36.8							
% C value 4-6:	36.8							
% C value 7-10:	9.8							
Native Tree Mean C:	4.5							
Native Shrub Mean C:	3.2							
Native Herbaceous Mean C:	3.9							
Species Richness:								
Total Species:	133							
Native Species:	114	85.70%						
Non-native Species:	19	14.30%						
Species Wetness:								
Mean Wetness:	-0.2							
Native Mean Wetness:	-0.6							
Physiognomy Metrics:								
Tree:	10	7.50%						
Shrub:	16	12%						
Vine:	6	4.50%						
Forb:	66	49.60%						
Grass:	17	12.80%						
Sedge:	11	8.30%						
Rush:	3	2.30%						
Fern:	4	3%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	5	3.80%						
Perennial:	123	92.50%						
Biennial:	5	3.80%						
Native Annual:	4	3%						
Native Perennial:	107	80.50%						
Native Biennial:	3	2.30%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Agrimonia gryposepala	Rosaceae	AGRGRY	native	2	3	forb	perennial	tall agrimony
Agrostis gigantea	Poaceae	AGRGIG	non-native	0	-3	grass	perennial	redtop

Ambrosia artemisiifolia	Asteraceae	AMBART	native	0	3	forb	annual	common ragweed
Amphicarpaea bracteata	Fabaceae	AMPBRA	native	5	0	vine	annual	hog-peanut
Anemone cylindrica	Ranunculaceae	ANECYL	native	6	5	forb	perennial	thimbleweed
Anemone virginiana	Ranunculaceae	ANEVIR	native	3	3	forb	perennial	thimbleweed
Apocynum cannabinum; a. sibiricum	Apocynaceae	APOCAN	native	3	0	forb	perennial	indian-hemp
Asclepias incarnata	Apocynaceae	ASCINC	native	6	-5	forb	perennial	swamp milkweed
Asclepias syriaca	Apocynaceae	ASCSYR	native	1	5	forb	perennial	common milkweed
Asclepias tuberosa	Apocynaceae	ASCTUB	native	5	5	forb	perennial	butterfly-weed
Asparagus officinalis	Asparagaceae	ASPOFF	non-native	0	3	forb	perennial	garden asparagus
Bromus ciliatus	Poaceae	BROCIL	native	6	-3	grass	perennial	fringed brome
Calamagrostis canadensis	Poaceae	CALCAN	native	3	-5	grass	perennial	blue-joint
Carex cristatella	Cyperaceae	CXCRIS	native	3	-3	sedge	perennial	sedge
Carex gracillima	Cyperaceae	CXGRAA	native	4	3	sedge	perennial	sedge
Carex granularis	Cyperaceae	CXGRAN	native	2	-3	sedge	perennial	sedge
Carex hystericina	Cyperaceae	CXHYST	native	2	-5	sedge	perennial	sedge
Carex pensylvanica	Cyperaceae	CXPENS	native	4	5	sedge	perennial	sedge
Carex spicata	Cyperaceae	CXSPIC	non-native	0	3	sedge	perennial	sedge
Carex swanii	Cyperaceae	CXSWAN	native	4	3	sedge	perennial	sedge
Carex vulpinoidea	Cyperaceae	CXVULP	native	1	-5	sedge	perennial	sedge
Celastrus orbiculatus	Celastraceae	CELORB	non-native	0	5	vine	perennial	oriental bittersweet
Centaurea cyanus	Asteraceae	CENCYA	non-native	0	5	forb	annual	bachelors-button
Cicuta maculata	Apiaceae	CICMAC	native	4	-5	forb	biennial	water hemlock
Cinna arundinacea	Poaceae	CINARU	native	7	-3	grass	perennial	wood reedgrass
Circaea canadensis; c. lutetiana	Onagraceae	CIRCAN	native	2	3	forb	perennial	enchanters-nightshade
Cirsium muticum	Asteraceae	CIRMUT	native	6	-5	forb	biennial	swamp thistle
Coreopsis tripteris	Asteraceae	CORTRP	native	7	0	forb	perennial	tall coreopsis
Cornus florida	Cornaceae	CORFLO	native	8	3	tree	perennial	flowering dogwood
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Cornus sericea; c. stolonifera	Cornaceae	CORSER	native	2	-3	shrub	perennial	red-osier
Cuscuta gronovii	Convolvulaceae	CUSGRO	native	3	-3	vine	annual	common dodder
Cyperus strigosus	Cyperaceae	CYPSTR	native	3	-3	sedge	perennial	long scaled nut sedge
Dasiphora fruticosa; potentilla f.	Rosaceae	DASFRU	native	8	-3	shrub	perennial	shrubby cinquefoil
Daucus carota	Apiaceae	DAUCAR	non-native	0	5	forb	biennial	queen-annes-lace
Desmodium canadense	Fabaceae	DESCAD	native	3	0	forb	perennial	showy tick-trefoil
Desmodium paniculatum	Fabaceae	DESPAN	native	4	3	forb	perennial	panicled tick-trefoil
Desmodium perplexum; d. paniculatum	Fabaceae	DESPER	native	5	5	forb	perennial	tick-trefoil

Dichanthelium implicatum; panicum i.	Poaceae	DICIMP	native	3	0	grass	perennial	panic grass
Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive
Elymus riparius	Poaceae	ELYRIP	native	8	-3	grass	perennial	riverbank wild-rye
Elymus virginicus	Poaceae	ELYVIR	native	4	-3	grass	perennial	virginia wild-rye
Equisetum hyemale	Equisetaceae	EQUHYE	native	2	0	fern	perennial	scouring rush
Erigeron annuus	Asteraceae	ERIANN	native	0	3	forb	biennial	daisy fleabane
Eupatorium perfoliatum	Asteraceae	EUPPER	native	4	-3	forb	perennial	boneset
Euphorbia corollata	Euphorbiaceae	EUPCOR	native	4	5	forb	perennial	flowering spurge
Euthamia graminifolia	Asteraceae	EUTGRA	native	3	0	forb	perennial	grass-leaved goldenrod
Eutrochium maculatum; eupatorium m.	Asteraceae	EUTMAC	native	4	-5	forb	perennial	joe-pye-weed
Fragaria virginiana	Rosaceae	FRAVIR	native	2	3	forb	perennial	wild strawberry
Frangula alnus; rhamnus frangula	Rhamnaceae	FRAALN	non-native	0	0	shrub	perennial	glossy buckthorn
Fraxinus pennsylvanica	Oleaceae	FRAPEN	native	2	-3	tree	perennial	red ash
Gentianella quinquefolia	Gentianaceae	GENQUI	native	9	0	forb	annual	stiff gentian
Geum aleppicum	Rosaceae	GEUALE	native	3	0	forb	perennial	yellow avens
Glyceria striata	Poaceae	GLYSTR	native	4	-5	grass	perennial	fowl manna grass
Helenium flexuosum	Asteraceae	HELFLE	non-native	0	0	forb	perennial	sneezeweed
Hieracium gronovii	Asteraceae	HIEGRO	native	5	5	forb	perennial	hairy hawkweed
Ilex verticillata	Aquifoliaceae	ILEVER	native	5	-3	shrub	perennial	michigan holly
Juncus brachycephalus	Juncaceae	JUNBRP	native	7	-5	rush	perennial	rush
Juncus dudleyi	Juncaceae	JUNDUD	native	1	-3	rush	perennial	dudleys rush
Juncus effusus	Juncaceae	JUNEFF	native	3	-5	rush	perennial	soft-stemmed rush
Leersia virginica	Poaceae	LEEVIR	native	5	-3	grass	perennial	white grass
Lindera benzoin	Lauraceae	LINBEN	native	7	-3	shrub	perennial	spicebush
Liriodendron tulipifera	Magnoliaceae	LIRTUL	native	9	3	tree	perennial	tulip tree
Lobelia siphilitica	Campanulaceae	LOBSIP	native	4	-3	forb	perennial	great blue lobelia
Lobelia spicata	Campanulaceae	LOBSPI	native	4	0	forb	perennial	pale spiked lobelia
Lycopus americanus	Lamiaceae	LYCAME	native	2	-5	forb	perennial	common water horehound
Lysimachia ciliata	Myrsinaceae	LYSCIL	native	4	-3	forb	perennial	fringed loosestrife
Lythrum salicaria	Lythraceae	LYTSAL	non-native	0	-5	forb	perennial	purple loosestrife
Malus prunifolia	Rosaceae	MALPRU	non-native	0	5	tree	perennial	crabapple
Melilotus officinalis	Fabaceae	MELLOF	non-native	0	3	forb	biennial	yellow sweet-clover
Monarda fistulosa	Lamiaceae	MONFIS	native	2	3	forb	perennial	wild-bergamot
Muhlenbergia frondosa	Poaceae	MUHFRO	native	3	-3	grass	perennial	common satin grass
Muhlenbergia mexicana	Poaceae	MUHMEX	native	3	-3	grass	perennial	leafy satin grass
Oenothera fruticosa	Onagraceae	OENFRU	native	7	3	forb	perennial	sundrops
Onoclea sensibilis	Onocleaceae	ONOSEN	native	2	-3	fern	perennial	sensitive fern
Osmunda regalis	Osmundaceae	OSMREG	native	5	-5	fern	perennial	royal fern
Oxypolis rigidior	Apiaceae	OXYRIG	native	6	-5	forb	perennial	cowbane

Packera aurea; senecio a.	Asteraceae	PACAUR	native	5	-3	forb	perennial	golden ragwort
Panicum virgatum	Poaceae	PANVIR	native	4	0	grass	perennial	switch grass
Pedicularis canadensis	Orobanchaceae	PEDCAN	native	10	3	forb	perennial	wood-betony
Pedicularis lanceolata	Orobanchaceae	PEDLAN	native	8	-3	forb	perennial	swamp-betony
Penstemon digitalis	Plantaginaceae	PENDIG	native	2	0	forb	perennial	foxglove beard-tongue
Persicaria virginiana; polygonum v.	Polygonaceae	PERVIR	native	4	0	forb	perennial	jumpseed
Phleum pratense	Poaceae	PHLPRA	non-native	0	3	grass	perennial	timothy
Poa compressa	Poaceae	POACOM	non-native	0	3	grass	perennial	canada bluegrass
Poa pratensis	Poaceae	POAPRA	non-native	0	3	grass	perennial	kentucky bluegrass
Populus grandidentata	Salicaceae	POPGRA	native	4	3	tree	perennial	big-tooth aspen
Prunella vulgaris	Lamiaceae	PRUVUL	native	0	0	forb	perennial	self-heal
Pycnanthemum virginianum	Lamiaceae	PYCVIR	native	5	-3	forb	perennial	common mountain mint
Quercus velutina	Fagaceae	QUEVEL	native	6	5	tree	perennial	black oak
Rhamnus cathartica	Rhamnaceae	RHACAT	non-native	0	0	tree	perennial	common buckthorn
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rubus allegheniensis	Rosaceae	RUBALL	native	1	3	shrub	perennial	common blackberry
Rubus flagellaris	Rosaceae	RUBFLA	native	1	3	shrub	perennial	northern dewberry
Rudbeckia hirta	Asteraceae	RUDHIR	native	1	3	forb	perennial	black-eyed susan
Salix bebbiana	Salicaceae	SALBEB	native	1	-3	shrub	perennial	bebbs willow
Salix discolor	Salicaceae	SALDIS	native	1	-3	shrub	perennial	pussy willow
Salix exigua	Salicaceae	SALEXI	native	1	-3	shrub	perennial	sandbar willow
Sassafras albidum	Lauraceae	SASALB	native	5	3	tree	perennial	sassafras
Schizachyrium scoparium; andropogon s.	Poaceae	SCHSCO	native	5	3	grass	perennial	little bluestem
Scirpus atrovirens	Cyperaceae	SCIATV	native	3	-5	sedge	perennial	bulrush
Scirpus pendulus	Cyperaceae	SCIPEN	native	3	-5	sedge	perennial	bulrush
Smilax hispida; s. tamnoides	Smilacaceae	SMIHIS	native	5	0	vine	perennial	bristly greenbrier
Solidago altissima	Asteraceae	SOLALT	native	1	3	forb	perennial	tall goldenrod
Solidago gigantea	Asteraceae	SOLGIG	native	3	-3	forb	perennial	late goldenrod
Solidago juncea	Asteraceae	SOLJUN	native	3	5	forb	perennial	early goldenrod
Solidago patula	Asteraceae	SOLPAT	native	6	-5	forb	perennial	swamp goldenrod
Solidago riddellii	Asteraceae	SOLRID	native	6	-5	forb	perennial	riddells goldenrod
Solidago rugosa	Asteraceae	SOLRUG	native	3	0	forb	perennial	rough-leaved goldenrod
Sorghastrum nutans	Poaceae	SORNUT	native	6	3	grass	perennial	indian grass
Spiraea alba	Rosaceae	SPIALB	native	4	-3	shrub	perennial	meadowsweet
Symphyotrichum cordifolium; aster c.	Asteraceae	SYMCOR	native	4	5	forb	perennial	heart-leaved aster
Symphyotrichum firmum; aster puniceus	Asteraceae	SYMFIR	native	4	-3	forb	perennial	smooth swamp aster
Symphyotrichum laeve; aster l.	Asteraceae	SYMLAE	native	5	3	forb	perennial	smooth aster

Symphyotrichum lateriflorum; aster l.	Asteraceae	SYMLAT	native	2	0	forb	perennial	calico aster
Symphyotrichum novae-angliae; aster n.	Asteraceae	SYMNOV	native	3	-3	forb	perennial	new england aster
Symphyotrichum puniceum; aster p.	Asteraceae	SYMPUN	native	5	-5	forb	perennial	swamp aster
Symphyotrichum urophyllum; aster sagittifolius	Asteraceae	SYMURO	native	2	5	forb	perennial	arrow-leaved aster
Thelypteris palustris	Thelypteridaceae	THEPAL	native	2	-3	fern	perennial	marsh fern
Toxicodendron radicans	Anacardiaceae	TOXRAD	native	2	0	vine	perennial	poison-ivy
Toxicodendron vernix	Anacardiaceae	TOXVER	native	6	-5	shrub	perennial	poison sumac
Tradescantia ohiensis	Commelinaceae	TRAOHI	native	5	3	forb	perennial	common spiderwort
Trifolium hybridum	Fabaceae	TRIHYB	non-native	0	3	forb	perennial	alsike clover
Trifolium pratense	Fabaceae	TRIPRA	non-native	0	3	forb	perennial	red clover
Ulmus americana	Ulmaceae	ULMAME	native	1	-3	tree	perennial	american elm
Verbena hastata	Verbenaceae	VERHAS	native	4	-3	forb	perennial	blue vervain
Verbena urticifolia	Verbenaceae	VERURT	native	4	0	forb	perennial	white vervain
Vernonia missurica	Asteraceae	VERMIS	native	4	0	forb	perennial	missouri ironweed
Veronicastrum virginicum	Plantaginaceae	VERVIR	native	8	0	forb	perennial	culvers-root
Viburnum lentago	Adoxaceae	VIBLEN	native	4	0	shrub	perennial	nannyberry
Vitis riparia	Vitaceae	VITRIP	native	3	0	vine	perennial	river-bank grape
Zizia aurea	Apiaceae	ZIZAUR	native	6	0	forb	perennial	golden alexanders

Longman Road Bogs EOID 17650								
08/20/2020								
Other Notes:	Also: Riccia, Ricciopsis, Sphagnum							
Conservatism-Based Metrics:								
Total Mean C:	5							
Native Mean C:	5.4							
Total FQI:	32.8							
Native FQI:	34.2							
Adjusted FQI:	52.1							
% C value 0:	7							
% C value 1-3:	20.9							
% C value 4-6:	48.8							
% C value 7-10:	23.3							
Native Tree Mean C:	1							
Native Shrub Mean C:	6.3							
Native Herbaceous Mean C:	5.3							
Species Richness:								
Total Species:	43							
Native Species:	40	93%						
Non-native Species:	3	7%						
Species Wetness:								
Mean Wetness:	-4.2							
Native Mean Wetness:	-4.4							
Physiognomy Metrics:								
Tree:	1	2.30%						
Shrub:	7	16.30%						
Vine:	1	2.30%						
Forb:	29	67.40%						
Grass:	1	2.30%						
Sedge:	3	7%						
Rush:	1	2.30%						
Fern:	0	0%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	7	16.30%						
Perennial:	36	83.70%						
Biennial:	0	0%						
Native Annual:	7	16.30%						
Native Perennial:	33	76.70%						
Native Biennial:	0	0%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple

Bidens connata	Asteraceae	BIDCON	native	5	-3	forb	annual	purple-stemmed tickseed
Bidens frondosa	Asteraceae	BIDFRO	native	1	-3	forb	annual	common beggar-ticks
Bidens trichosperma; b. coronatus	Asteraceae	BIDTRI	native	7	-5	forb	annual	tickseed-sunflower
Carex lacustris	Cyperaceae	CXLACU	native	6	-5	sedge	perennial	sedge
Cephalanthus occidentalis	Rubiaceae	CEPOCC	native	7	-5	shrub	perennial	buttonbush
Ceratophyllum echinatum	Ceratophyllaceae	CERECH	native	10	-5	forb	perennial	spiny hornwort
Chamaedaphne calyculata	Ericaceae	CHACAL	native	8	-5	shrub	perennial	leatherleaf
Comarum palustre; potentilla p.	Rosaceae	COMPAL	native	7	-5	forb	perennial	marsh cinquefoil
Decodon verticillatus	Lythraceae	DECVER	native	7	-5	shrub	perennial	whorled or swamp loosestrife
Dulichium arundinaceum	Cyperaceae	DULARU	native	8	-5	sedge	perennial	three-way sedge
Epilobium coloratum	Onagraceae	EPICOL	native	3	-5	forb	perennial	cinnamon willow-herb
Epilobium leptophyllum	Onagraceae	EPILEP	native	6	-5	forb	perennial	fen willow-herb
Erechtites hieraciifolius	Asteraceae	EREHIE	native	2	3	forb	annual	fireweed
Frangula alnus; rhamnus frangula	Rhamnaceae	FRAALN	non-native	0	0	shrub	perennial	glossy buckthorn
Galium tinctorium	Rubiaceae	GALTIN	native	5	-5	forb	perennial	stiff bedstraw
Ilex verticillata	Aquifoliaceae	ILEVER	native	5	-3	shrub	perennial	michigan holly
Impatiens capensis	Balsaminaceae	IMPCAP	native	2	-3	forb	annual	spotted touch-me-not
Juncus effusus	Juncaceae	JUNEFF	native	3	-5	rush	perennial	soft-stemmed rush
Leersia oryzoides	Poaceae	LEEORY	native	3	-5	grass	perennial	cut grass
Lemna minor	Araceae	LEMMIN	native	5	-5	forb	perennial	common duckweed
Lemna turionifera; l. minor	Araceae	LEMTUR	native	5	-5	forb	perennial	red duckweed
Lycopus uniflorus	Lamiaceae	LYCUNI	native	2	-5	forb	perennial	northern bugle weed
Lythrum salicaria	Lythraceae	LYTSAL	non-native	0	-5	forb	perennial	purple loosestrife
Persicaria amphibia; polygonum a.	Polygonaceae	PERAMP	native	6	-5	forb	perennial	water smartweed
Persicaria punctata; polygonum p.	Polygonaceae	PERPUN	native	5	-5	forb	annual	smartweed
Persicaria sagittata; polygonum s.	Polygonaceae	PERSAG	native	5	-5	forb	annual	arrow-leaved tear-thumb
Potamogeton zosteriformis	Potamogetonaceae	POTZOS	native	5	-5	forb	perennial	flat-stemmed pondweed
Scirpus cyperinus	Cyperaceae	SCICYP	native	5	-5	sedge	perennial	wool-grass
Solanum dulcamara	Solanaceae	SOLDUL	non-native	0	0	vine	perennial	bittersweet nightshade
Sparganium americanum	Typhaceae	SPAAME	native	6	-5	forb	perennial	american bur-reed
Spiraea tomentosa	Rosaceae	SPITOM	native	5	-3	shrub	perennial	steeplebush

Spirodela polyrhiza	Araceae	SPIPOL	native	6	-5	forb	perennial	greater duckweed
Toxicodendron vernix	Anacardiaceae	TOXVER	native	6	-5	shrub	perennial	poison sumac
Triadenum fraseri	Hypericaceae	TRIFRA	native	6	-5	forb	perennial	marsh st. johns-wort
Typha latifolia	Typhaceae	TYPLAT	native	1	-5	forb	perennial	broad-leaved cat-tail
Utricularia geminiscapa	Lentibulariaceae	UTRGEM	native	8	-5	forb	perennial	bog bladderwort
Utricularia minor	Lentibulariaceae	UTRMIN	native	10	-5	forb	perennial	small bladderwort
Utricularia vulgaris	Lentibulariaceae	UTRVUL	native	6	-5	forb	perennial	common bladderwort
Viola macloskeyi	Violaceae	VIOMAC	native	6	-5	forb	perennial	smooth white violet
Wolffia borealis; w. punctata	Araceae	WOLBOR	native	5	-5	forb	perennial	dotted water meal
Wolffia brasiliensis; w. papulifera	Araceae	WOLBRA	native	10	-5	forb	perennial	pointed water meal
Wolffia columbiana	Araceae	WOLCOL	native	5	-5	forb	perennial	common water meal

Perimeter Road Bog								
08/10/2020								
Other Notes:	Also Riccia, mat-forming Eleocharis (E. acicularis?)							
Private/Public:	Public							
Conservatism-Based Metrics:								
Total Mean C:	5.6							
Native Mean C:	5.6							
Total FQI:	26.9							
Native FQI:	26.9							
Adjusted FQI:	56							
% C value 0:	0							
% C value 1-3:	17.4							
% C value 4-6:	60.9							
% C value 7-10:	21.7							
Native Tree Mean C:	1							
Native Shrub Mean C:	5.8							
Native Herbaceous Mean C:	5.8							
Species Richness:								
Total Species:	23							
Native Species:	23	100%						
Non-native Species:	0	0%						
Species Wetness:								
Mean Wetness:	-4.3							
Native Mean Wetness:	-4.3							
Physiognomy Metrics:								
Tree:	1	4.30%						
Shrub:	5	21.70%						
Vine:	0	0%						
Forb:	15	65.20%						
Grass:	0	0%						
Sedge:	1	4.30%						
Rush:	0	0%						
Fern:	1	4.30%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	1	4.30%						
Perennial:	22	95.70%						
Biennial:	0	0%						
Native Annual:	1	4.30%						
Native Perennial:	22	95.70%						
Native Biennial:	0	0%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name

Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Aronia prunifolia	Rosaceae	AROPRU	native	5	-3	shrub	perennial	chokeberry
Bidens cernua	Asteraceae	BIDCER	native	3	-5	forb	annual	nodding beggar-ticks
Brasenia schreberi	Cabombaceae	BRASCH	native	6	-5	forb	perennial	water-shield
Cephalanthus occidentalis	Rubiaceae	CEPOCC	native	7	-5	shrub	perennial	buttonbush
Ceratophyllum demersum	Ceratophyllaceae	CERDEM	native	1	-5	forb	perennial	coontail
Cicuta bulbifera	Apiaceae	CICBUL	native	5	-5	forb	perennial	water hemlock
Dulichium arundinaceum	Cyperaceae	DULARU	native	8	-5	sedge	perennial	three-way sedge
Galium trifidum	Rubiaceae	GALTRD	native	6	-3	forb	perennial	small bedstraw
Ilex verticillata	Aquifoliaceae	ILEVER	native	5	-3	shrub	perennial	michigan holly
Lemna turionifera; l. minor	Araceae	LEMTUR	native	5	-5	forb	perennial	red duckweed
Liparis loeselii	Orchidaceae	LIPLOE	native	5	-3	forb	perennial	loesels twayblade
Persicaria hydropiperoides; polygonum h.	Polygonaceae	PERHYS	native	5	-5	forb	perennial	mild water-pepper
Scutellaria lateriflora	Lamiaceae	SCULAT	native	5	-5	forb	perennial	mad-dog skullcap
Sparganium americanum	Typhaceae	SPAAME	native	6	-5	forb	perennial	american bur-reed
Spirodela polyrhiza	Araceae	SPIPOL	native	6	-5	forb	perennial	greater duckweed
Stuckenia pectinata; potamogeton p.	Potamogetonaceae	STUPEC	native	3	-5	forb	perennial	sago pondweed
Toxicodendron vernix	Anacardiaceae	TOXVER	native	6	-5	shrub	perennial	poison sumac
Utricularia geminiscapa	Lentibulariaceae	UTRGEM	native	8	-5	forb	perennial	bog bladderwort
Utricularia minor	Lentibulariaceae	UTRMIN	native	10	-5	forb	perennial	small bladderwort
Utricularia vulgaris	Lentibulariaceae	UTRVUL	native	6	-5	forb	perennial	common bladderwort
Vaccinium corymbosum	Ericaceae	VACCOR	native	6	-3	shrub	perennial	highbush blueberry
Woodwardia virginica	Blechnaceae	WOOVIR	native	10	-5	fern	perennial	virginia chain-fern

Mott Road Fen EOID 5258								
09/05/2019								
Other Notes:	Also surveyed 9/22/20; Also: Sphagnum sp., Chara sp.							
Conservatism-Based Metrics:								
Total Mean C:	5							
Native Mean C:	5.2							
Total FQI:	45.6							
Native FQI:	46.5							
Adjusted FQI:	51.1							
% C value 0:	3.6							
% C value 1-3:	30.1							
% C value 4-6:	38.6							
% C value 7-10:	27.7							
Native Tree Mean C:	3.3							
Native Shrub Mean C:	5							
Native Herbaceous Mean C:	5.4							
Species Richness:								
Total Species:	83							
Native Species:	80	96.40%						
Non-native Species:	3	3.60%						
Species Wetness:								
Mean Wetness:	-3.3							
Native Mean Wetness:	-3.4							
Physiognomy Metrics:								
Tree:	3	3.60%						
Shrub:	18	21.70%						
Vine:	2	2.40%						
Forb:	40	48.20%						
Grass:	8	9.60%						
Sedge:	10	12%						
Rush:	1	1.20%						
Fern:	1	1.20%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	4	4.80%						
Perennial:	78	94%						
Biennial:	1	1.20%						
Native Annual:	4	4.80%						
Native Perennial:	75	90.40%						
Native Biennial:	1	1.20%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name

Alnus incana; a. rugosa	Betulaceae	ALNINC	native	5	-3	shrub	perennial	speckled alder
Andropogon gerardii	Poaceae	ANDGER	native	5	0	grass	perennial	big bluestem
Apocynum cannabinum; a. sibiricum	Apocynaceae	APOCAN	native	3	0	forb	perennial	indian-hemp
Asclepias incarnata	Apocynaceae	ASCINC	native	6	-5	forb	perennial	swamp milkweed
Bromus ciliatus	Poaceae	BROCIL	native	6	-3	grass	perennial	fringed brome
Calamagrostis canadensis	Poaceae	CALCAN	native	3	-5	grass	perennial	blue-joint
Carex aquatilis	Cyperaceae	CXAQUA	native	7	-5	sedge	perennial	sedge
Carex hystericina	Cyperaceae	CXHYST	native	2	-5	sedge	perennial	sedge
Carex lasiocarpa	Cyperaceae	CXLASI	native	8	-5	sedge	perennial	sedge
Carex sterilis	Cyperaceae	CXSTER	native	10	-5	sedge	perennial	sedge
Carex stricta	Cyperaceae	CXSTRI	native	4	-5	sedge	perennial	sedge
Carpinus caroliniana	Betulaceae	CARCAO	native	6	0	tree	perennial	blue-beech
Chelone glabra	Plantaginaceae	CHEGLB	native	7	-5	forb	perennial	turtlehead
Cirsium muticum	Asteraceae	CIRMUT	native	6	-5	forb	biennial	swamp thistle
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Cornus sericea; c. stolonifera	Cornaceae	CORSER	native	2	-3	shrub	perennial	red-osier
Cuscuta gronovii	Convolvulaceae	CUSGRO	native	3	-3	vine	annual	common dodder
Dasiphora fruticosa; potentilla f.	Rosaceae	DASFRU	native	8	-3	shrub	perennial	shrubby cinquefoil
Deschampsia cespitosa	Poaceae	DESCES	native	9	-3	grass	perennial	hair grass
Desmodium canadense	Fabaceae	DESCAD	native	3	0	forb	perennial	showy tick-trefoil
Doellingeria umbellata; aster u.	Asteraceae	DOEUMB	native	5	-3	forb	perennial	flat-topped white aster
Drosera rotundifolia	Droseraceae	DROROT	native	6	-5	forb	perennial	round-leaved sundew
Eleocharis elliptica	Cyperaceae	ELEELL	native	6	-5	sedge	perennial	golden-seeded spike rush
Eleocharis rostellata	Cyperaceae	ELEROS	native	10	-5	sedge	perennial	spike-rush
Elymus trachycaulus; agropyron t.	Poaceae	ELYTRA	native	8	3	grass	perennial	slender wheatgrass
Eupatorium perfoliatum	Asteraceae	EUPPER	native	4	-3	forb	perennial	boneset
Eutrochium maculatum; eupatorium m.	Asteraceae	EUTMAC	native	4	-5	forb	perennial	joe-pye-weed
Frangula alnus; rhamnus frangula	Rhamnaceae	FRAALN	non-native	0	0	shrub	perennial	glossy buckthorn
Galium asprellum	Rubiaceae	GALASP	native	5	-5	vine	perennial	rough bedstraw
Galium boreale	Rubiaceae	GALBOR	native	3	0	forb	perennial	northern bedstraw
Gentianopsis crinita	Gentianaceae	GENCRI	native	8	-3	forb	annual	fringed gentian
Gentianopsis virgata; g. procera	Gentianaceae	GENVIR	native	8	-5	forb	annual	small fringed gentian
Helianthus giganteus	Asteraceae	HELGIG	native	5	-3	forb	perennial	tall sunflower
Juncus brachycephalus	Juncaceae	JUNBRP	native	7	-5	rush	perennial	rush
Lindera benzoin	Lauraceae	LINBEN	native	7	-3	shrub	perennial	spicebush
Lobelia kalmii	Campanulaceae	LOBKAL	native	10	-5	forb	perennial	bog lobelia
Lycopus americanus	Lamiaceae	LYCAME	native	2	-5	forb	perennial	common water horehound

Lycopus uniflorus	Lamiaceae	LYCUNI	native	2	-5	forb	perennial	northern bugle weed
Lysimachia quadriflora	Myrsinaceae	LYSQUR	native	10	-5	forb	perennial	whorled loosestrife
Lythrum salicaria	Lythraceae	LYTSAL	non-native	0	-5	forb	perennial	purple loosestrife
Maianthemum stellatum; smilacina s.	Convallariaceae	MAISTE	native	5	0	forb	perennial	starry false solomon-seal
Mentha canadensis; m. arvensis	Lamiaceae	MENCAS	native	3	-3	forb	perennial	wild mint
Monarda fistulosa	Lamiaceae	MONFIS	native	2	3	forb	perennial	wild-bergamot
Muhlenbergia glomerata	Poaceae	MUHGLO	native	10	-5	grass	perennial	marsh wild-timothy
Muhlenbergia mexicana	Poaceae	MUHMEX	native	3	-3	grass	perennial	leafy satin grass
Oxypolis rigidior	Apiaceae	OXYRIG	native	6	-5	forb	perennial	cowbane
Parnassia glauca	Parnassiaceae	PARGLA	native	8	-5	forb	perennial	grass-of-parnassus
Persicaria sagittata; polygonum s.	Polygonaceae	PERSAG	native	5	-5	forb	annual	arrow-leaved tear-thumb
Populus tremuloides	Salicaceae	POPTRE	native	1	0	tree	perennial	quaking aspen
Pycnanthemum virginianum	Lamiaceae	PYCVIR	native	5	-3	forb	perennial	common mountain mint
Rhamnus alnifolia	Rhamnaceae	RHAALN	native	8	-5	shrub	perennial	alder-leaved buckthorn
Rhynchospora capillacea	Cyperaceae	RHYCAL	native	10	-5	sedge	perennial	beak-rush
Ribes americanum	Grossulariaceae	RIBAME	native	6	-3	shrub	perennial	wild black currant
Ribes hirtellum	Grossulariaceae	RIBHIR	native	6	-3	shrub	perennial	swamp gooseberry
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rubus pubescens	Rosaceae	RUBPUB	native	4	-3	shrub	perennial	dwarf raspberry
Salix amygdaloides	Salicaceae	SALAMY	native	3	-3	tree	perennial	peach-leaved willow
Salix bebbiana	Salicaceae	SALBEB	native	1	-3	shrub	perennial	bebbs willow
Salix candida	Salicaceae	SALCAN	native	9	-5	shrub	perennial	hoary willow
Salix discolor	Salicaceae	SALDIS	native	1	-3	shrub	perennial	pussy willow
Salix eriocephala	Salicaceae	SALERI	native	2	-3	shrub	perennial	willow
Salix sericea	Salicaceae	SALSEC	native	6	-5	shrub	perennial	silky willow
Salix serissima	Salicaceae	SALSES	native	8	-5	shrub	perennial	autumn willow
Schoenoplectus acutus; scirpus a.	Cyperaceae	SCHACU	native	5	-5	sedge	perennial	hardstem bulrush
Schoenoplectus tabernaemontani; scirpus validus	Cyperaceae	SCHTAB	native	4	-5	sedge	perennial	softstem bulrush
Solidago altissima	Asteraceae	SOLALT	native	1	3	forb	perennial	tall goldenrod
Solidago ohioensis	Asteraceae	SOLOHI	native	8	-5	forb	perennial	ohio goldenrod
Solidago patula	Asteraceae	SOLPAT	native	6	-5	forb	perennial	swamp
Solidago riddellii	Asteraceae	SOLRID	native	6	-5	forb	perennial	riddells
Solidago rugosa	Asteraceae	SOLRUG	native	3	0	forb	perennial	rough-leaved goldenrod
Solidago uliginosa	Asteraceae	SOLULI	native	4	-5	forb	perennial	bog goldenrod
Sorghastrum nutans	Poaceae	SORNUT	native	6	3	grass	perennial	indian grass

Symphyotrichum boreale; aster b.	Asteraceae	SYMBOR	native	9	-5	forb	perennial	northern bog aster
Symphyotrichum firmum; aster puniceus	Asteraceae	SYMFIR	native	4	-3	forb	perennial	smooth swamp aster
Symphyotrichum lanceolatum; aster l.	Asteraceae	SYMLAN	native	2	-3	forb	perennial	panicled aster
Symphyotrichum novae-angliae; aster n.	Asteraceae	SYMNOV	native	3	-3	forb	perennial	new england aster
Symphyotrichum puniceum; aster p.	Asteraceae	SYMPUN	native	5	-5	forb	perennial	swamp aster
Thalictrum dasycarpum	Ranunculaceae	THADAS	native	3	-3	forb	perennial	purple meadow-rue
Thelypteris palustris	Thelypteridaceae	THEPAL	native	2	-3	fern	perennial	marsh fern
Toxicodendron vernix	Anacardiaceae	TOXVER	native	6	-5	shrub	perennial	poison sumac
Typha latifolia	Typhaceae	TYPLAT	native	1	-5	forb	perennial	broad-leaved cat-tail
Valeriana uliginosa	Valerianaceae	VALULI	native	10	-5	forb	perennial	swamp valerian
Viola cucullata	Violaceae	VIOCUC	native	5	-5	forb	perennial	marsh violet

Territorial Rd Fen EOID 16989								
08/08/2018								
Other Notes:	Additional surveys: 8/19/19; 9/5/19							
Conservatism-Based Metrics:								
Total Mean C:	4.7							
Native Mean C:	5.1							
Total FQI:	57.8							
Native FQI:	60.6							
Adjusted FQI:	49.3							
% C value 0:	7.3							
% C value 1-3:	25.8							
% C value 4-6:	44.4							
% C value 7-10:	22.5							
Native Tree Mean C:	4.4							
Native Shrub Mean C:	4.7							
Native Herbaceous Mean C:	5.2							
Species Richness:								
Total Species:	151							
Native Species:	141	93.40%						
Non-native Species:	10	6.60%						
Species Wetness:								
Mean Wetness:	-2.6							
Native Mean Wetness:	-2.8							
Physiognomy Metrics:								
Tree:	10	6.60%						
Shrub:	26	17.20%						
Vine:	8	5.30%						
Forb:	71	47%						
Grass:	12	7.90%						
Sedge:	16	10.60%						
Rush:	3	2%						
Fern:	5	3.30%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	6	4%						
Perennial:	144	95.40%						
Biennial:	1	0.70%						
Native Annual:	6	4%						
Native Perennial:	134	88.70%						
Native Biennial:	1	0.70%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple

Agalinis purpurea	Orobanchaceae	AGAPUR	native	7	-3	forb	annual	purple false foxglove
Agrostis gigantea	Poaceae	AGRGIG	non-native	0	-3	grass	perennial	redtop
Amphicarpaea bracteata	Fabaceae	AMPBRA	native	5	0	vine	annual	hog-peanut
Andropogon gerardii	Poaceae	ANDGER	native	5	0	grass	perennial	big bluestem
Angelica atropurpurea	Apiaceae	ANGATR	native	6	-5	forb	perennial	purplestem angelica
Apios americana	Fabaceae	APIAME	native	3	-3	vine	perennial	groundnut
Apocynum cannabinum; a. sibiricum	Apocynaceae	APOCAN	native	3	0	forb	perennial	indian-hemp
Arisaema triphyllum	Araceae	ARITRI	native	5	0	forb	perennial	jack-in-the-pulpit
Asclepias incarnata	Apocynaceae	ASCINC	native	6	-5	forb	perennial	swamp milkweed
Asclepias syriaca	Apocynaceae	ASCSYR	native	1	5	forb	perennial	common milkweed
Berberis thunbergii	Berberidaceae	BERTHU	non-native	0	3	shrub	perennial	japanese barberry
Berula erecta	Apiaceae	BERERE	native	10	-5	forb	perennial	water-parsnip
Betula alleghaniensis	Betulaceae	BETALL	native	7	0	tree	perennial	yellow birch
Betula pumila	Betulaceae	BETPUM	native	8	-5	shrub	perennial	bog birch
Boehmeria cylindrica	Urticaceae	BOECYL	native	5	-5	forb	perennial	false nettle
Bromus ciliatus	Poaceae	BROCIL	native	6	-3	grass	perennial	fringed brome
Bromus latiglumis	Poaceae	BROLAT	native	6	-3	grass	perennial	ear-leaved brome
Calamagrostis canadensis	Poaceae	CALCAN	native	3	-5	grass	perennial	blue-joint
Caltha palustris	Ranunculaceae	CALPAR	native	6	-5	forb	perennial	marsh-marigold
Campanula aparinoides	Campanulaceae	CAMAPA	native	7	-5	forb	perennial	marsh bellflower
Carex aquatilis	Cyperaceae	CXAQUA	native	7	-5	sedge	perennial	sedge
Carex bebbii	Cyperaceae	CXBEBB	native	4	-5	sedge	perennial	sedge
Carex cryptolepis	Cyperaceae	CXCRYP	native	8	-5	sedge	perennial	sedge
Carex lacustris	Cyperaceae	CXLACU	native	6	-5	sedge	perennial	sedge
Carex lasiocarpa	Cyperaceae	CXLASI	native	8	-5	sedge	perennial	sedge
Carex lurida	Cyperaceae	CXLURI	native	3	-5	sedge	perennial	sedge
Carex pellita; c. lanuginosa	Cyperaceae	CXPELL	native	2	-5	sedge	perennial	sedge
Carex sterilis	Cyperaceae	CXSTER	native	10	-5	sedge	perennial	sedge
Carex stricta	Cyperaceae	CXSTRI	native	4	-5	sedge	perennial	sedge
Carpinus caroliniana	Betulaceae	CARCAO	native	6	0	tree	perennial	blue-beech
Chelone glabra	Plantaginaceae	CHEGLB	native	7	-5	forb	perennial	turtlehead
Cicuta bulbifera	Apiaceae	CICBUL	native	5	-5	forb	perennial	water hemlock
Cirsium arvense	Asteraceae	CIRARV	non-native	0	3	forb	perennial	canada thistle
Cirsium muticum	Asteraceae	CIRMUT	native	6	-5	forb	biennial	swamp thistle
Cladium mariscoides	Cyperaceae	CLAMAR	native	10	-5	sedge	perennial	twig-rush
Clematis virginiana	Ranunculaceae	CLEVIR	native	4	0	vine	perennial	virgins bower
Comandra umbellata	Santalaceae	COMUMB	native	5	3	forb	perennial	bastard-toadflax
Cornus amomum	Cornaceae	CORAMO	native	2	-3	shrub	perennial	silky dogwood
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Cornus sericea; c. stolonifera	Cornaceae	CORSER	native	2	-3	shrub	perennial	red-osier
Corylus americana	Betulaceae	CORAMA	native	5	3	shrub	perennial	hazelnut

Cuscuta gronovii	Convolvulaceae	CUSGRO	native	3	-3	vine	annual	common dodder
Cyperus bipartitus; c. rivularis	Cyperaceae	CYPBIP	native	3	-3	sedge	annual	brook nut sedge
Dasiphora fruticosa; potentilla f.	Rosaceae	DASFRU	native	8	-3	shrub	perennial	shrubby cinquefoil
Deschampsia cespitosa	Poaceae	DESCES	native	9	-3	grass	perennial	hair grass
Desmodium canadense	Fabaceae	DESCAD	native	3	0	forb	perennial	showy tick-trefoil
Doellingeria umbellata; aster u.	Asteraceae	DOEUMB	native	5	-3	forb	perennial	flat-topped white aster
Drosera rotundifolia	Droseraceae	DROROT	native	6	-5	forb	perennial	round-leaved sundew
Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive
Eleocharis elliptica	Cyperaceae	ELEELL	native	6	-5	sedge	perennial	golden-seeded spike rush
Eleocharis rostellata	Cyperaceae	ELEROS	native	10	-5	sedge	perennial	spike-rush
Epilobium coloratum	Onagraceae	EPICOL	native	3	-5	forb	perennial	cinnamon willow-herb
Equisetum hyemale	Equisetaceae	EQUHYE	native	2	0	fern	perennial	scouring rush
Eupatorium perfoliatum	Asteraceae	EUPPER	native	4	-3	forb	perennial	boneset
Euthamia graminifolia	Asteraceae	EUTGRA	native	3	0	forb	perennial	grass-leaved goldenrod
Eutrochium maculatum; eupatorium m.	Asteraceae	EUTMAC	native	4	-5	forb	perennial	joe-pye-weed
Frangula alnus; rhamnus frangula	Rhamnaceae	FRAALN	non-native	0	0	shrub	perennial	glossy buckthorn
Galium asprellum	Rubiaceae	GALASP	native	5	-5	vine	perennial	rough bedstraw
Gentianopsis crinita	Gentianaceae	GENCRI	native	8	-3	forb	annual	fringed gentian
Geum aleppicum	Rosaceae	GEUALE	native	3	0	forb	perennial	yellow avens
Glyceria striata	Poaceae	GLYSTR	native	4	-5	grass	perennial	fowl manna grass
Helianthus giganteus	Asteraceae	HELGIG	native	5	-3	forb	perennial	tall sunflower
Hypericum boreale	Hypericaceae	HYPBOR	native	5	-5	forb	perennial	northern st. johns-wort
Ilex verticillata	Aquifoliaceae	ILEVER	native	5	-3	shrub	perennial	michigan holly
Iris virginica	Iridaceae	IRIVIR	native	5	-5	forb	perennial	southern blue flag
Juncus brachycephalus	Juncaceae	JUNBRP	native	7	-5	rush	perennial	rush
Juncus canadensis	Juncaceae	JUNCAN	native	6	-5	rush	perennial	canadian rush
Juncus dudleyi	Juncaceae	JUNDUD	native	1	-3	rush	perennial	dudleys rush
Lathyrus palustris	Fabaceae	LATPAL	native	7	-3	vine	perennial	marsh pea
Liatris spicata	Asteraceae	LIASPI	native	8	0	forb	perennial	marsh blazing-star
Lindera benzoin	Lauraceae	LINBEN	native	7	-3	shrub	perennial	spicebush
Lobelia kalmii	Campanulaceae	LOBKAL	native	10	-5	forb	perennial	bog lobelia
Lonicera morrowii	Caprifoliaceae	LONMOR	non-native	0	3	shrub	perennial	morrow honeysuckle
Lycopus americanus	Lamiaceae	LYCAME	native	2	-5	forb	perennial	common water horehound
Lycopus uniflorus	Lamiaceae	LYCUNI	native	2	-5	forb	perennial	northern bugle weed
Lysimachia quadriflora	Myrsinaceae	LYSQUR	native	10	-5	forb	perennial	whorled loosestrife
Lysimachia thyrsiflora	Myrsinaceae	LYSTHY	native	6	-5	forb	perennial	tufted loosestrife

Lythrum salicaria	Lythraceae	LYTSAL	non-native	0	-5	forb	perennial	purple loosestrife
Maianthemum stellatum; smilacina s.	Convallariaceae	MAISTE	native	5	0	forb	perennial	starry false solomon-seal
Mentha canadensis; m. arvensis	Lamiaceae	MENCAS	native	3	-3	forb	perennial	wild mint
Mentha Ã—piperita	Lamiaceae	MENPIP	non-native	0	-5	forb	perennial	peppermint
Micranthes pensylvanica; saxifraga p.	Saxifragaceae	MICPEN	native	10	-5	forb	perennial	swamp saxifrage
Monarda fistulosa	Lamiaceae	MONFIS	native	2	3	forb	perennial	wild-bergamot
Muhlenbergia glomerata	Poaceae	MUHGLO	native	10	-5	grass	perennial	marsh wild-timothy
Nasturtium officinale	Brassicaceae	NASOFF	native	4	-5	forb	perennial	watercress
Onoclea sensibilis	Onocleaceae	ONOSEN	native	2	-3	fern	perennial	sensitive fern
Osmunda cinnamomea	Osmundaceae	OSMCIN	native	5	-3	fern	perennial	cinnamon fern
Osmunda regalis	Osmundaceae	OSMREG	native	5	-5	fern	perennial	royal fern
Oxypolis rigidior	Apiaceae	OXYRIG	native	6	-5	forb	perennial	cowbane
Parnassia glauca	Parnassiaceae	PARGLA	native	8	-5	forb	perennial	grass-of-parnassus
Parthenocissus quinquefolia	Vitaceae	PARQUI	native	5	3	vine	perennial	virginia creeper
Pedicularis lanceolata	Orobanchaceae	PEDLAN	native	8	-3	forb	perennial	swamp-betony
Persicaria amphibia; polygonum a.	Polygonaceae	PERAMP	native	6	-5	forb	perennial	water smartweed
Phalaris arundinacea	Poaceae	PHAARU	native	0	-3	grass	perennial	reed canary grass
Pilea pumila	Urticaceae	PILPUM	native	5	-3	forb	annual	clearweed
Populus tremuloides	Salicaceae	POPTRE	native	1	0	tree	perennial	quaking aspen
Pycnanthemum virginianum	Lamiaceae	PYCVIR	native	5	-3	forb	perennial	common mountain mint
Quercus bicolor	Fagaceae	QUEBIC	native	8	-3	tree	perennial	swamp white oak
Quercus macrocarpa	Fagaceae	QUEMAC	native	5	3	tree	perennial	bur oak
Quercus rubra	Fagaceae	QUERUB	native	5	3	tree	perennial	red oak
Rhamnus alnifolia	Rhamnaceae	RHAALN	native	8	-5	shrub	perennial	alder-leaved buckthorn
Ribes hirtellum	Grossulariaceae	RIBHIR	native	6	-3	shrub	perennial	swamp gooseberry
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rosa palustris	Rosaceae	ROSPAL	native	5	-5	shrub	perennial	swamp rose
Rubus occidentalis	Rosaceae	RUBOCC	native	1	5	shrub	perennial	black raspberry
Rubus pubescens	Rosaceae	RUBPUB	native	4	-3	shrub	perennial	dwarf raspberry
Rudbeckia hirta	Asteraceae	RUDHIR	native	1	3	forb	perennial	black-eyed susan
Rudbeckia laciniata	Asteraceae	RUDLAC	native	6	-3	forb	perennial	cut-leaf coneflower
Rumex verticillatus	Polygonaceae	RUMVER	native	7	-5	forb	perennial	water dock
Sagittaria latifolia	Alismataceae	SAGLAT	native	4	-5	forb	perennial	common arrowhead
Salix bebbiana	Salicaceae	SALBEB	native	1	-3	shrub	perennial	bebbs willow
Salix candida	Salicaceae	SALCAN	native	9	-5	shrub	perennial	hoary willow
Sambucus canadensis	Adoxaceae	SAMCAN	native	3	-3	shrub	perennial	elderberry
Sassafras albidum	Lauraceae	SASALB	native	5	3	tree	perennial	sassafras

Schoenoplectus acutus; scirpus a.	Cyperaceae	SCHACU	native	5	-5	sedge	perennial	hardstem bulrush
Schoenoplectus tabernaemontani; scirpus validus	Cyperaceae	SCHTAB	native	4	-5	sedge	perennial	softstem bulrush
Scirpus atrovirens	Cyperaceae	SCIATV	native	3	-5	sedge	perennial	bulrush
Scutellaria galericulata	Lamiaceae	SCUGAL	native	5	-5	forb	perennial	marsh skullcap
Solidago altissima	Asteraceae	SOLALT	native	1	3	forb	perennial	tall goldenrod
Solidago canadensis	Asteraceae	SOLCAN	native	1	3	forb	perennial	canada goldenrod
Solidago ohioensis	Asteraceae	SOLOHI	native	8	-5	forb	perennial	ohio goldenrod
Solidago patula	Asteraceae	SOLPAT	native	6	-5	forb	perennial	swamp goldenrod
Solidago riddellii	Asteraceae	SOLRID	native	6	-5	forb	perennial	riddells goldenrod
Solidago rugosa	Asteraceae	SOLRUG	native	3	0	forb	perennial	rough-leaved goldenrod
Solidago uliginosa	Asteraceae	SOLULI	native	4	-5	forb	perennial	bog goldenrod
Sorghastrum nutans	Poaceae	SORNUT	native	6	3	grass	perennial	indian grass
Spartina pectinata	Poaceae	SPAPEC	native	5	-3	grass	perennial	cordgrass
Spiraea tomentosa	Rosaceae	SPITOM	native	5	-3	shrub	perennial	steeplebush
Sporobolus heterolepis	Poaceae	SPOHET	native	10	3	grass	perennial	prairie dropseed
Symphyotrichum boreale; aster b.	Asteraceae	SYMBOR	native	9	-5	forb	perennial	northern bog aster
Symphyotrichum lanceolatum; aster l.	Asteraceae	SYMLAN	native	2	-3	forb	perennial	panicled aster
Symphyotrichum lateriflorum; aster l.	Asteraceae	SYMLAT	native	2	0	forb	perennial	calico aster
Symphyotrichum novae-angliae; aster n.	Asteraceae	SYMNOV	native	3	-3	forb	perennial	new england aster
Symphyotrichum puniceum; aster p.	Asteraceae	SYMPUN	native	5	-5	forb	perennial	swamp aster
Symplocarpus foetidus	Araceae	SYMFOE	native	6	-5	forb	perennial	skunk-cabbage
Thelypteris palustris	Thelypteridaceae	THEPAL	native	2	-3	fern	perennial	marsh fern
Tilia americana	Malvaceae	TILAME	native	5	3	tree	perennial	basswood
Toxicodendron vernix	Anacardiaceae	TOXVER	native	6	-5	shrub	perennial	poison sumac
Triadenum fraseri	Hypericaceae	TRIFRA	native	6	-5	forb	perennial	marsh st. johns-wort
Triantha glutinosa; tofieldia g.	Melanthiaceae	TRIGLU	native	10	-5	forb	perennial	false asphodel
Typha angustifolia	Typhaceae	TYPANG	non-native	0	-5	forb	perennial	narrow-leaved cat-tail
Ulmus americana	Ulmaceae	ULMAME	native	1	-3	tree	perennial	american elm
Vaccinium corymbosum	Ericaceae	VACCOR	native	6	-3	shrub	perennial	highbush blueberry
Vaccinium myrtilloides	Ericaceae	VACMYR	native	4	-3	shrub	perennial	canada blueberry
Valeriana uliginosa	Valerianaceae	VALULI	native	10	-5	forb	perennial	swamp valerian
Verbena hastata	Verbenaceae	VERHAS	native	4	-3	forb	perennial	blue vervain
Vernonia missurica	Asteraceae	VERMIS	native	4	0	forb	perennial	missouri ironweed
Viola cucullata	Violaceae	VIOCUC	native	5	-5	forb	perennial	marsh violet
Vitis riparia	Vitaceae	VITRIP	native	3	0	vine	perennial	river-bank grape
Zanthoxylum americanum	Rutaceae	ZANAME	native	3	3	shrub	perennial	prickly-ash

Whitman Lake Fen EOID 7503								
08/22/2018								
Other Notes:	Also: Chara, Sphagnum							
Conservatism-Based Metrics:								
Total Mean C:	4.4							
Native Mean C:	4.8							
Total FQI:	50.6							
Native FQI:	52.8							
Adjusted FQI:	46							
% C value 0:	9.8							
% C value 1-3:	28							
% C value 4-6:	40.9							
% C value 7-10:	21.2							
Native Tree Mean C:	5							
Native Shrub Mean C:	4							
Native Herbaceous Mean C:	5							
Species Richness:								
Total Species:	132							
Native Species:	121	91.70%						
Non-native Species:	11	8.30%						
Species Wetness:								
Mean Wetness:	-3							
Native Mean Wetness:	-3.2							
Physiognomy Metrics:								
Tree:	3	2.30%						
Shrub:	19	14.40%						
Vine:	6	4.50%						
Forb:	65	49.20%						
Grass:	14	10.60%						
Sedge:	18	13.60%						
Rush:	2	1.50%						
Fern:	5	3.80%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	8	6.10%						
Perennial:	123	93.20%						
Biennial:	1	0.80%						
Native Annual:	8	6.10%						
Native Perennial:	112	84.80%						
Native Biennial:	1	0.80%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Agalinis purpurea	Orobanchaceae	AGAPUR	native	7	-3	forb	annual	purple false foxglove

Andropogon gerardii	Poaceae	ANDGER	native	5	0	grass	perennial	big bluestem
Angelica atropurpurea	Apiaceae	ANGATR	native	6	-5	forb	perennial	purplestem angelica
Asclepias incarnata	Apocynaceae	ASCINC	native	6	-5	forb	perennial	swamp milkweed
Asclepias syriaca	Apocynaceae	ASCSYR	native	1	5	forb	perennial	common milkweed
Berula erecta	Apiaceae	BERERE	native	10	-5	forb	perennial	water-parsnip
Betula pumila	Betulaceae	BETPUM	native	8	-5	shrub	perennial	bog birch
Bidens cernua	Asteraceae	BIDCER	native	3	-5	forb	annual	nodding beggar-ticks
Boehmeria cylindrica	Urticaceae	BOECYL	native	5	-5	forb	perennial	false nettle
Bromus ciliatus	Poaceae	BROCIL	native	6	-3	grass	perennial	fringed brome
Calamagrostis canadensis	Poaceae	CALCAN	native	3	-5	grass	perennial	blue-joint
Caltha palustris	Ranunculaceae	CALPAR	native	6	-5	forb	perennial	marsh-marigold
Calystegia sepium	Convolvulaceae	CALSEP	native	2	0	vine	perennial	hedge bindweed
Campanula aparinoides	Campanulaceae	CAMAPA	native	7	-5	forb	perennial	marsh bellflower
Carex aquatilis	Cyperaceae	CXAQUA	native	7	-5	sedge	perennial	sedge
Carex bebbii	Cyperaceae	CXBEBB	native	4	-5	sedge	perennial	sedge
Carex comosa	Cyperaceae	CXCOMO	native	5	-5	sedge	perennial	sedge
Carex flava	Cyperaceae	CXFLAV	native	4	-5	sedge	perennial	sedge
Carex hystericina	Cyperaceae	CXHYST	native	2	-5	sedge	perennial	sedge
Carex lasiocarpa	Cyperaceae	CXLASI	native	8	-5	sedge	perennial	sedge
Carex leptalea	Cyperaceae	CXLEPA	native	5	-5	sedge	perennial	sedge
Carex pellita; c. lanuginosa	Cyperaceae	CXPELL	native	2	-5	sedge	perennial	sedge
Carex stricta	Cyperaceae	CXSTRI	native	4	-5	sedge	perennial	sedge
Chelone glabra	Plantaginaceae	CHEGLB	native	7	-5	forb	perennial	turtlehead
Cicuta bulbifera	Apiaceae	CICBUL	native	5	-5	forb	perennial	water hemlock
Cirsium arvense	Asteraceae	CIRARV	non-native	0	3	forb	perennial	canada thistle
Cirsium muticum	Asteraceae	CIRMUT	native	6	-5	forb	biennial	swamp thistle
Cladium mariscoides	Cyperaceae	CLAMAR	native	10	-5	sedge	perennial	twig-rush
Clematis virginiana	Ranunculaceae	CLEVIR	native	4	0	vine	perennial	virgins bower
Cornus amomum	Cornaceae	CORAMO	native	2	-3	shrub	perennial	silky dogwood
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Cornus sericea; c. stolonifera	Cornaceae	CORSER	native	2	-3	shrub	perennial	red-osier
Cyperus bipartitus; c. rivularis	Cyperaceae	CYPBIP	native	3	-3	sedge	annual	brook nut sedge
Cyperus strigosus	Cyperaceae	CYPSTR	native	3	-3	sedge	perennial	long scaled nut sedge
Dasiphora fruticosa; potentilla f.	Rosaceae	DASFRU	native	8	-3	shrub	perennial	shrubby cinquefoil
Deschampsia cespitosa	Poaceae	DESCES	native	9	-3	grass	perennial	hair grass
Dichanthelium implicatum; panicum i.	Poaceae	DICIMP	native	3	0	grass	perennial	panic grass
Doellingeria umbellata; aster u.	Asteraceae	DOEUMB	native	5	-3	forb	perennial	flat-topped white aster
Dryopteris carthusiana	Dryopteridaceae	DRYCAR	native	5	-3	fern	perennial	spinulose woodfern
Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive

Eleocharis rostellata	Cyperaceae	ELEROS	native	10	-5	sedge	perennial	spike-rush
Epilobium coloratum	Onagraceae	EPICOL	native	3	-5	forb	perennial	cinnamon willow-herb
Epilobium parviflorum	Onagraceae	EPIPAR	non-native	0	-5	forb	perennial	willow-herb
Epilobium strictum	Onagraceae	EPISTR	native	8	-5	forb	perennial	downy willow-herb
Eupatorium perfoliatum	Asteraceae	EUPPER	native	4	-3	forb	perennial	boneset
Euthamia graminifolia	Asteraceae	EUTGRA	native	3	0	forb	perennial	grass-leaved goldenrod
Eutrochium maculatum; eupatorium m.	Asteraceae	EUTMAC	native	4	-5	forb	perennial	joe-pye-weed
Filipendula rubra	Rosaceae	FILRUB	native	10	-3	forb	perennial	queen-of-the-prairie
Frangula alnus; rhamnus frangula	Rhamnaceae	FRAALN	non-native	0	0	shrub	perennial	glossy buckthorn
Galium asprellum	Rubiaceae	GALASP	native	5	-5	vine	perennial	rough bedstraw
Gentianopsis crinita	Gentianaceae	GENCRI	native	8	-3	forb	annual	fringed gentian
Geum aleppicum	Rosaceae	GEUALE	native	3	0	forb	perennial	yellow avens
Helianthus giganteus	Asteraceae	HELGIG	native	5	-3	forb	perennial	tall sunflower
Hypericum boreale	Hypericaceae	HYPBOR	native	5	-5	forb	perennial	northern st. johns-wort
Ilex verticillata	Aquifoliaceae	ILEVER	native	5	-3	shrub	perennial	michigan holly
Impatiens capensis	Balsaminaceae	IMPCAP	native	2	-3	forb	annual	spotted touch-me-not
Juncus brachycephalus	Juncaceae	JUNBRP	native	7	-5	rush	perennial	rush
Juncus dudleyi	Juncaceae	JUNDUD	native	1	-3	rush	perennial	dudleys rush
Larix laricina	Pinaceae	LARLAR	native	5	-3	tree	perennial	tamarack
Lathyrus palustris	Fabaceae	LATPAL	native	7	-3	vine	perennial	marsh pea
Leersia oryzoides	Poaceae	LEEORY	native	3	-5	grass	perennial	cut grass
Lindera benzoin	Lauraceae	LINBEN	native	7	-3	shrub	perennial	spicebush
Liriodendron tulipifera	Magnoliaceae	LIRTUL	native	9	3	tree	perennial	tulip tree
Lobelia kalmii	Campanulaceae	LOBKAL	native	10	-5	forb	perennial	bog lobelia
Lobelia siphilitica	Campanulaceae	LOBSIP	native	4	-3	forb	perennial	great blue lobelia
Lonicera morrowii	Caprifoliaceae	LONMOR	non-native	0	3	shrub	perennial	morrow honeysuckle
Lycopus americanus	Lamiaceae	LYCAME	native	2	-5	forb	perennial	common water horehound
Lycopus uniflorus	Lamiaceae	LYCUNI	native	2	-5	forb	perennial	northern bugle weed
Lysimachia quadriflora	Myrsinaceae	LYSQUR	native	10	-5	forb	perennial	whorled loosestrife
Lythrum salicaria	Lythraceae	LYTSAL	non-native	0	-5	forb	perennial	purple loosestrife
Mentha canadensis; m. arvensis	Lamiaceae	MENCAS	native	3	-3	forb	perennial	wild mint
Mentha Ã—piperita	Lamiaceae	MENPIP	non-native	0	-5	forb	perennial	peppermint
Mimulus ringens	Phrymaceae	MIMRIN	native	5	-5	forb	perennial	monkey-flower
Monarda fistulosa	Lamiaceae	MONFIS	native	2	3	forb	perennial	wild-bergamot
Muhlenbergia glomerata	Poaceae	MUHGLO	native	10	-5	grass	perennial	marsh wild-timothy
Muhlenbergia mexicana	Poaceae	MUHMEX	native	3	-3	grass	perennial	leafy satin grass

Nasturtium officinale	Brassicaceae	NASOFF	native	4	-5	forb	perennial	watercress
Onoclea sensibilis	Onocleaceae	ONOSEN	native	2	-3	fern	perennial	sensitive fern
Osmunda cinnamomea	Osmundaceae	OSMCIN	native	5	-3	fern	perennial	cinnamon fern
Osmunda regalis	Osmundaceae	OSMREG	native	5	-5	fern	perennial	royal fern
Oxypolis rigidior	Apiaceae	OXYRIG	native	6	-5	forb	perennial	cowbane
Packera aurea; senecio a.	Asteraceae	PACAUR	native	5	-3	forb	perennial	golden ragwort
Parthenocissus quinquefolia	Vitaceae	PARQUI	native	5	3	vine	perennial	virginia creeper
Pedicularis lanceolata	Orobanchaceae	PEDLAN	native	8	-3	forb	perennial	swamp-betony
Persicaria amphibia; polygonum a.	Polygonaceae	PERAMP	native	6	-5	forb	perennial	water smartweed
Persicaria lapathifolia; polygonum l.	Polygonaceae	PERLAP	native	0	-3	forb	annual	nodding smartweed
Persicaria punctata; polygonum p.	Polygonaceae	PERPUN	native	5	-5	forb	annual	smartweed
Phalaris arundinacea	Poaceae	PHAARU	native	0	-3	grass	perennial	reed canary grass
Phragmites australis var. australis	Poaceae	PHRAUU	non-native	0	-3	grass	perennial	reed
Pilea pumila	Urticaceae	PILPUM	native	5	-3	forb	annual	clearweed
Pycnanthemum virginianum	Lamiaceae	PYCVIR	native	5	-3	forb	perennial	common mountain mint
Rhynchospora capillacea	Cyperaceae	RHYCAL	native	10	-5	sedge	perennial	beak-rush
Ribes americanum	Grossulariaceae	RIBAME	native	6	-3	shrub	perennial	wild black currant
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rosa palustris	Rosaceae	ROSPAL	native	5	-5	shrub	perennial	swamp rose
Rubus allegheniensis	Rosaceae	RUBALL	native	1	3	shrub	perennial	common blackberry
Rudbeckia fulgida	Asteraceae	RUDFUL	native	9	-5	forb	perennial	black-eyed susan
Rudbeckia hirta	Asteraceae	RUDHIR	native	1	3	forb	perennial	black-eyed susan
Rumex verticillatus	Polygonaceae	RUMVER	native	7	-5	forb	perennial	water dock
Salix bebbiana	Salicaceae	SALBEB	native	1	-3	shrub	perennial	bebbs willow
Salix discolor	Salicaceae	SALDIS	native	1	-3	shrub	perennial	pussy willow
Salix eriocephala	Salicaceae	SALERI	native	2	-3	shrub	perennial	willow
Schizachyrium scoparium; andropogon s.	Poaceae	SCHSCO	native	5	3	grass	perennial	little bluestem
Schoenoplectus acutus; scirpus a.	Cyperaceae	SCHACU	native	5	-5	sedge	perennial	hardstem bulrush
Schoenoplectus pungens; scirpus americanus	Cyperaceae	SCHPUN	native	5	-5	sedge	perennial	threesquare
Schoenoplectus tabernaemontani; scirpus validus	Cyperaceae	SCHTAB	native	4	-5	sedge	perennial	softstem bulrush
Scirpus atrovirens	Cyperaceae	SCIATV	native	3	-5	sedge	perennial	bulrush
Scutellaria galericulata	Lamiaceae	SCUGAL	native	5	-5	forb	perennial	marsh skullcap
Solanum dulcamara	Solanaceae	SOLDUL	non-native	0	0	vine	perennial	bittersweet nightshade
Solidago altissima	Asteraceae	SOLALT	native	1	3	forb	perennial	tall goldenrod
Solidago ohioensis	Asteraceae	SOLOHI	native	8	-5	forb	perennial	ohio goldenrod

Solidago patula	Asteraceae	SOLPAT	native	6	-5	forb	perennial	swamp goldenrod
Solidago riddellii	Asteraceae	SOLRID	native	6	-5	forb	perennial	riddells goldenrod
Solidago rugosa	Asteraceae	SOLRUG	native	3	0	forb	perennial	rough-leaved goldenrod
Solidago uliginosa	Asteraceae	SOLULI	native	4	-5	forb	perennial	bog goldenrod
Sorghastrum nutans	Poaceae	SORNUT	native	6	3	grass	perennial	indian grass
Spartina pectinata	Poaceae	SPAPEC	native	5	-3	grass	perennial	cordgrass
Spiraea tomentosa	Rosaceae	SPITOM	native	5	-3	shrub	perennial	steeplebush
Spiranthes cernua	Orchidaceae	SPICER	native	4	-3	forb	perennial	nodding ladies-tresses
Sporobolus heterolepis	Poaceae	SPOHET	native	10	3	grass	perennial	prairie dropseed
Symphyotrichum boreale; aster b.	Asteraceae	SYMBOR	native	9	-5	forb	perennial	northern bog aster
Symphyotrichum firmum; aster puniceus	Asteraceae	SYMFIR	native	4	-3	forb	perennial	smooth swamp aster
Symphyotrichum lanceolatum; aster l.	Asteraceae	SYMLAN	native	2	-3	forb	perennial	panicled aster
Symphyotrichum lateriflorum; aster l.	Asteraceae	SYMLAT	native	2	0	forb	perennial	calico aster
Symphyotrichum novae-angliae; aster n.	Asteraceae	SYMNOV	native	3	-3	forb	perennial	new england aster
Symphyotrichum puniceum; aster p.	Asteraceae	SYMPUN	native	5	-5	forb	perennial	swamp aster
Thelypteris palustris	Thelypteridaceae	THEPAL	native	2	-3	fern	perennial	marsh fern
Toxicodendron vernix	Anacardiaceae	TOXVER	native	6	-5	shrub	perennial	poison sumac
Typha angustifolia	Typhaceae	TYPANG	non-native	0	-5	forb	perennial	narrow-leaved cat-tail
Verbena hastata	Verbenaceae	VERHAS	native	4	-3	forb	perennial	blue vervain
Viola cucullata	Violaceae	VIOCUC	native	5	-5	forb	perennial	marsh violet

42nd Rd Seeps EOID 9307								
08/15/2018								
Other Notes:								
Conservatism-Based Metrics:								
Total Mean C:	3.6							
Native Mean C:	3.9							
Total FQI:	37.8							
Native FQI:	39							
Adjusted FQI:	37.2							
% C value 0:	10.9							
% C value 1-3:	34.5							
% C value 4-6:	49.1							
% C value 7-10:	5.5							
Native Tree Mean C:	4							
Native Shrub Mean C:	3.8							
Native Herbaceous Mean C:	3.9							
Species Richness:								
Total Species:	110							
Native Species:	100	90.90%						
Non-native Species:	10	9.10%						
Species Wetness:								
Mean Wetness:	-1.7							
Native Mean Wetness:	-2							
Physiognomy Metrics:								
Tree:	13	11.80%						
Shrub:	16	14.50%						
Vine:	8	7.30%						
Forb:	54	49.10%						
Grass:	7	6.40%						
Sedge:	8	7.30%						
Rush:	1	0.90%						
Fern:	3	2.70%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	6	5.50%						
Perennial:	101	91.80%						
Biennial:	3	2.70%						
Native Annual:	6	5.50%						
Native Perennial:	91	82.70%						
Native Biennial:	3	2.70%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Acer saccharum	Sapindaceae	ACESAU	native	5	3	tree	perennial	sugar maple
Agrostis gigantea	Poaceae	AGRGIG	non-native	0	-3	grass	perennial	redtop

Amphicarpaea bracteata	Fabaceae	AMPBRA	native	5	0	vine	annual	hog-peanut
Apios americana	Fabaceae	APIAME	native	3	-3	vine	perennial	groundnut
Arisaema triphyllum	Araceae	ARITRI	native	5	0	forb	perennial	jack-in-the-pulpit
Asclepias incarnata	Apocynaceae	ASCINC	native	6	-5	forb	perennial	swamp milkweed
Asclepias syriaca	Apocynaceae	ASCSYR	native	1	5	forb	perennial	common milkweed
Calamagrostis canadensis	Poaceae	CALCAN	native	3	-5	grass	perennial	blue-joint
Caltha palustris	Ranunculaceae	CALPAR	native	6	-5	forb	perennial	marsh-marigold
Campanula aparinoides	Campanulaceae	CAMAPA	native	7	-5	forb	perennial	marsh bellflower
Carex bebbii	Cyperaceae	CXBEBB	native	4	-5	sedge	perennial	sedge
Carex bromoides	Cyperaceae	CXBROM	native	6	-3	sedge	perennial	sedge
Carex gracillima	Cyperaceae	CXGRAA	native	4	3	sedge	perennial	sedge
Carex hystericina	Cyperaceae	CXHYST	native	2	-5	sedge	perennial	sedge
Carex leptalea	Cyperaceae	CXLEPA	native	5	-5	sedge	perennial	sedge
Carex stricta	Cyperaceae	CXSTRI	native	4	-5	sedge	perennial	sedge
Carex vulpinoidea	Cyperaceae	CXVULP	native	1	-5	sedge	perennial	sedge
Carpinus caroliniana	Betulaceae	CARCAO	native	6	0	tree	perennial	blue-beech
Carya cordiformis	Juglandaceae	CARCOR	native	5	0	tree	perennial	bitternut hickory
Chelone glabra	Plantaginaceae	CHEGLB	native	7	-5	forb	perennial	turtlehead
Cicuta maculata	Apiaceae	CICMAC	native	4	-5	forb	biennial	water hemlock
Cirsium muticum	Asteraceae	CIRMUT	native	6	-5	forb	biennial	swamp thistle
Clematis virginiana	Ranunculaceae	CLEVIR	native	4	0	vine	perennial	virgins bower
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Cornus sericea; c. stolonifera	Cornaceae	CORSER	native	2	-3	shrub	perennial	red-osier
Corylus americana	Betulaceae	CORAMA	native	5	3	shrub	perennial	hazelnut
Cryptotaenia canadensis	Apiaceae	CRYCAN	native	2	0	forb	perennial	honewort
Cuscuta gronovii	Convolvulaceae	CUSGRO	native	3	-3	vine	annual	common dodder
Desmodium paniculatum	Fabaceae	DESPAN	native	4	3	forb	perennial	panicled tick-trefoil
Desmodium perplexum; d. paniculatum	Fabaceae	DESPER	native	5	5	forb	perennial	tick-trefoil
Doellingeria umbellata; aster u.	Asteraceae	DOEUMB	native	5	-3	forb	perennial	flat-topped white aster
Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive
Elymus hystrix; hystrix patula	Poaceae	ELYHYS	native	5	3	grass	perennial	bottlebrush grass
Elymus riparius	Poaceae	ELYRIP	native	8	-3	grass	perennial	riverbank wild-rye
Epilobium coloratum	Onagraceae	EPICOL	native	3	-5	forb	perennial	cinnamon willow-herb
Equisetum hyemale	Equisetaceae	EQUHYE	native	2	0	fern	perennial	scouring rush
Eupatorium perfoliatum	Asteraceae	EUPPER	native	4	-3	forb	perennial	boneset
Euthamia graminifolia	Asteraceae	EUTGRA	native	3	0	forb	perennial	grass-leaved goldenrod
Eutrochium maculatum; eupatorium m.	Asteraceae	EUTMAC	native	4	-5	forb	perennial	joe-pye-weed
Frangula alnus; rhamnus frangula	Rhamnaceae	FRAALN	non-native	0	0	shrub	perennial	glossy buckthorn
Fraxinus nigra	Oleaceae	FRANIG	native	6	-3	tree	perennial	black ash

Fraxinus pennsylvanica	Oleaceae	FRAPEN	native	2	-3	tree	perennial	red ash
Galium aparine	Rubiaceae	GALAPA	native	0	3	forb	annual	annual bedstraw
Geum canadense	Rosaceae	GEUCAN	native	1	0	forb	perennial	white avens
Ilex verticillata	Aquifoliaceae	ILEVER	native	5	-3	shrub	perennial	michigan holly
Impatiens capensis	Balsaminaceae	IMPCAP	native	2	-3	forb	annual	spotted touch-me-not
Juncus dudleyi	Juncaceae	JUNDUD	native	1	-3	rush	perennial	dudleys rush
Lactuca canadensis	Asteraceae	LACCAN	native	2	3	forb	biennial	tall lettuce
Laportea canadensis	Urticaceae	LAPCAN	native	4	-3	forb	perennial	wood nettle
Leersia virginica	Poaceae	LEEVIR	native	5	-3	grass	perennial	white grass
Lemna trisulca	Araceae	LEMTRI	native	6	-5	forb	perennial	star duckweed
Lilium michiganense	Liliaceae	LILMIC	native	5	-3	forb	perennial	michigan lily
Lindera benzoin	Lauraceae	LINBEN	native	7	-3	shrub	perennial	spicebush
Liparis loeselii	Orchidaceae	LIPLOE	native	5	-3	forb	perennial	loesels twayblade
Lobelia siphilitica	Campanulaceae	LOBSIP	native	4	-3	forb	perennial	great blue lobelia
Lonicera morrowii	Caprifoliaceae	LONMOR	non-native	0	3	shrub	perennial	morrow honeysuckle
Lonicera tatarica	Caprifoliaceae	LONTAT	non-native	0	3	shrub	perennial	tartarian honeysuckle
Lycopus americanus	Lamiaceae	LYCAME	native	2	-5	forb	perennial	common water horehound
Lycopus uniflorus	Lamiaceae	LYCUNI	native	2	-5	forb	perennial	northern bugle weed
Lysimachia ciliata	Myrsinaceae	LYSCIL	native	4	-3	forb	perennial	fringed loosestrife
Lythrum salicaria	Lythraceae	LYTSAL	non-native	0	-5	forb	perennial	purple loosestrife
Mentha canadensis; m. arvensis	Lamiaceae	MENCAS	native	3	-3	forb	perennial	wild mint
Mimulus ringens	Phrymaceae	MIMRIN	native	5	-5	forb	perennial	monkey-flower
Muhlenbergia mexicana	Poaceae	MUHMEX	native	3	-3	grass	perennial	leafy satin grass
Onoclea sensibilis	Onocleaceae	ONOSEN	native	2	-3	fern	perennial	sensitive fern
Oxypolis rigidior	Apiaceae	OXYRIG	native	6	-5	forb	perennial	cowbane
Packera aurea; senecio a.	Asteraceae	PACAUR	native	5	-3	forb	perennial	golden ragwort
Parthenocissus quinquefolia	Vitaceae	PARQUI	native	5	3	vine	perennial	virginia creeper
Pedicularis lanceolata	Orobanchaceae	PEDLAN	native	8	-3	forb	perennial	swamp-betony
Persicaria sagittata; polygonum s.	Polygonaceae	PERSAG	native	5	-5	forb	annual	arrow-leaved tear-thumb
Persicaria virginiana; polygonum v.	Polygonaceae	PERVIR	native	4	0	forb	perennial	jumpseed
Pilea pumila	Urticaceae	PILPUM	native	5	-3	forb	annual	clearweed
Poa pratensis	Poaceae	POAPRA	non-native	0	3	grass	perennial	kentucky bluegrass
Populus grandidentata	Salicaceae	POPGRA	native	4	3	tree	perennial	big-tooth aspen
Populus tremuloides	Salicaceae	POPTRE	native	1	0	tree	perennial	quaking aspen
Prunella vulgaris	Lamiaceae	PRUVUL	native	0	0	forb	perennial	self-heal
Prunus serotina	Rosaceae	PRUSER	native	2	3	tree	perennial	wild black cherry
Quercus macrocarpa	Fagaceae	QUEMAC	native	5	3	tree	perennial	bur oak
Quercus rubra	Fagaceae	QUERUB	native	5	3	tree	perennial	red oak
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rosa palustris	Rosaceae	ROSPAL	native	5	-5	shrub	perennial	swamp rose

Rudbeckia fulgida	Asteraceae	RUDFUL	native	9	-5	forb	perennial	black-eyed susan
Rudbeckia laciniata	Asteraceae	RUDLAC	native	6	-3	forb	perennial	cut-leaf coneflower
Rumex obtusifolius	Polygonaceae	RUMOBT	non-native	0	0	forb	perennial	bitter dock
Salix exigua	Salicaceae	SALEXI	native	1	-3	shrub	perennial	sandbar willow
Salix lucida	Salicaceae	SALLUC	native	3	-3	shrub	perennial	shining willow
Salix nigra	Salicaceae	SALNIG	native	5	-5	tree	perennial	black willow
Sambucus canadensis	Adoxaceae	SAMCAN	native	3	-3	shrub	perennial	elderberry
Sanicula odorata; s. gregaria	Apiaceae	SANODO	native	2	0	forb	perennial	black snakeroot
Scirpus atrovirens	Cyperaceae	SCIATV	native	3	-5	sedge	perennial	bulrush
Solanum dulcamara	Solanaceae	SOLDUL	non-native	0	0	vine	perennial	bittersweet nightshade
Solidago canadensis	Asteraceae	SOLCAN	native	1	3	forb	perennial	canada goldenrod
Solidago gigantea	Asteraceae	SOLGIG	native	3	-3	forb	perennial	late goldenrod
Solidago patula	Asteraceae	SOLPAT	native	6	-5	forb	perennial	swamp goldenrod
Solidago riddellii	Asteraceae	SOLRID	native	6	-5	forb	perennial	riddells goldenrod
Solidago rugosa	Asteraceae	SOLRUG	native	3	0	forb	perennial	rough-leaved goldenrod
Symphyotrichum lateriflorum; aster l.	Asteraceae	SYMLAT	native	2	0	forb	perennial	calico aster
Symphyotrichum puniceum; aster p.	Asteraceae	SYMPUN	native	5	-5	forb	perennial	swamp aster
Symplocarpus foetidus	Araceae	SYMFOE	native	6	-5	forb	perennial	skunk-cabbage
Thelypteris palustris	Thelypteridaceae	THEPAL	native	2	-3	fern	perennial	marsh fern
Tilia americana	Malvaceae	TILAME	native	5	3	tree	perennial	basswood
Toxicodendron radicans	Anacardiaceae	TOXRAD	native	2	0	vine	perennial	poison-ivy
Toxicodendron vernix	Anacardiaceae	TOXVER	native	6	-5	shrub	perennial	poison sumac
Typha latifolia	Typhaceae	TYPLAT	native	1	-5	forb	perennial	broad-leaved cat-tail
Verbena hastata	Verbenaceae	VERHAS	native	4	-3	forb	perennial	blue vervain
Vernonia missurica	Asteraceae	VERMIS	native	4	0	forb	perennial	missouri ironweed
Viburnum lentago	Adoxaceae	VIBLEN	native	4	0	shrub	perennial	nannyberry
Viola cucullata	Violaceae	VIOCUC	native	5	-5	forb	perennial	marsh violet
Vitis riparia	Vitaceae	VITRIP	native	3	0	vine	perennial	river-bank grape

Bullfrog Marsh EOID 23900								
06/24/2021								
Other Notes:	With Erick Elgin; named after the abundance and volume of bullfrogs present during survey; also: narrow-leaved Potamogeton, Chara,							
Conservatism-Based Metrics:								
Total Mean C:	5.2							
Native Mean C:	5.6							
Total FQI:	37.9							
Native FQI:	39.2							
Adjusted FQI:	53.8							
% C value 0:	7.5							
% C value 1-3:	15.1							
% C value 4-6:	50.9							
% C value 7-10:	26.4							
Native Tree Mean C:	1							
Native Shrub Mean C:	6							
Native Herbaceous Mean C:	5.6							
Species Richness:								
Total Species:	53							
Native Species:	49	92.50%						
Non-native Species:	4	7.50%						
Species Wetness:								
Mean Wetness:	-4.5							
Native Mean Wetness:	-4.5							
Physiognomy Metrics:								
Tree:	1	1.90%						
Shrub:	7	13.20%						
Vine:	0	0%						
Forb:	33	62.30%						
Grass:	3	5.70%						
Sedge:	8	15.10%						
Rush:	0	0%						
Fern:	1	1.90%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	3	5.70%						
Perennial:	49	92.50%						
Biennial:	1	1.90%						
Native Annual:	3	5.70%						
Native Perennial:	45	84.90%						

Native Biennial:	1	1.90%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Agalinis purpurea	Orobanchaceae	AGAPUR	native	7	-3	forb	annual	purple false foxglove
Asclepias incarnata	Apocynaceae	ASCINC	native	6	-5	forb	perennial	swamp milkweed
Brasenia schreberi	Cabombaceae	BRASCH	native	6	-5	forb	perennial	water-shield
Bromus ciliatus	Poaceae	BROCIL	native	6	-3	grass	perennial	fringed brome
Calamagrostis canadensis	Poaceae	CALCAN	native	3	-5	grass	perennial	blue-joint
Carex aquatilis	Cyperaceae	CXAQUA	native	7	-5	sedge	perennial	sedge
Carex atlantica; c. howei	Cyperaceae	CXATLA	native	7	-3	sedge	perennial	sedge
Carex lacustris	Cyperaceae	CXLACU	native	6	-5	sedge	perennial	sedge
Carex lasiocarpa	Cyperaceae	CXLASI	native	8	-5	sedge	perennial	sedge
Carex stricta	Cyperaceae	CXSTRI	native	4	-5	sedge	perennial	sedge
Cephalanthus occidentalis	Rubiaceae	CEPOCC	native	7	-5	shrub	perennial	buttonbush
Ceratophyllum demersum	Ceratophyllaceae	CERDEM	native	1	-5	forb	perennial	coontail
Ceratophyllum echinatum	Ceratophyllaceae	CERECH	native	10	-5	forb	perennial	spiny hornwort
Cicuta bulbifera	Apiaceae	CICBUL	native	5	-5	forb	perennial	water hemlock
Cirsium muticum	Asteraceae	CIRMUT	native	6	-5	forb	biennial	swamp thistle
Comarum palustre; potentilla p.	Rosaceae	COMPAL	native	7	-5	forb	perennial	marsh cinquefoil
Drosera intermedia	Droseraceae	DROINT	native	8	-5	forb	perennial	spatulate-leaved sundew
Dulichium arundinaceum	Cyperaceae	DULARU	native	8	-5	sedge	perennial	three-way sedge
Eleocharis elliptica	Cyperaceae	ELEELL	native	6	-5	sedge	perennial	golden-seeded spike rush
Eleocharis erythropoda	Cyperaceae	ELEERY	native	4	-5	sedge	perennial	spike-rush
Eutrochium maculatum; eupatorium m.	Asteraceae	EUTMAC	native	4	-5	forb	perennial	joe-pye-weed
Frangula alnus; rhamnus frangula	Rhamnaceae	FRAALN	non-native	0	0	shrub	perennial	glossy buckthorn
Ilex verticillata	Aquifoliaceae	ILEVER	native	5	-3	shrub	perennial	michigan holly
Impatiens capensis	Balsaminaceae	IMPCAP	native	2	-3	forb	annual	spotted touch-me-not
Leersia oryzoides	Poaceae	LEEORY	native	3	-5	grass	perennial	cut grass
Lemna trisulca	Araceae	LEMTRI	native	6	-5	forb	perennial	star duckweed
Lycopus uniflorus	Lamiaceae	LYCUNI	native	2	-5	forb	perennial	northern bugle weed
Lythrum salicaria	Lythraceae	LYTSAL	non-native	0	-5	forb	perennial	purple loosestrife
Menyanthes trifoliata	Menyanthaceae	MENTRI	native	8	-5	forb	perennial	buckbean
Micranthes pensylvanica; saxifraga p.	Saxifragaceae	MICPEN	native	10	-5	forb	perennial	swamp saxifrage
Nuphar advena	Nymphaeaceae	NUPADV	native	8	-5	forb	perennial	yellow pond-lily

Persicaria amphibia; polygonum a.	Polygonaceae	PERAMP	native	6	-5	forb	perennial	water smartweed
Persicaria punctata; polygonum p.	Polygonaceae	PERPUN	native	5	-5	forb	annual	smartweed
Potamogeton natans	Potamogetonaceae	POTNAT	native	5	-5	forb	perennial	pondweed
Potamogeton zosteriformis	Potamogetonaceae	POTZOS	native	5	-5	forb	perennial	flat-stemmed pondweed
Rosa palustris	Rosaceae	ROSPAL	native	5	-5	shrub	perennial	swamp rose
Sagittaria latifolia	Alismataceae	SAGLAT	native	4	-5	forb	perennial	common arrowhead
Salix pedicellaris	Salicaceae	SALPED	native	8	-5	shrub	perennial	bog willow
Scutellaria galericulata	Lamiaceae	SCUGAL	native	5	-5	forb	perennial	marsh skullcap
Sparganium emersum; s. chlorocarpum	Typhaceae	SPAEME	native	6	-5	forb	perennial	green-fruited bur-reed
Spiraea tomentosa	Rosaceae	SPITOM	native	5	-3	shrub	perennial	steeplebush
Spirodela polyrhiza	Araceae	SPIPOL	native	6	-5	forb	perennial	greater duckweed
Symplocarpus foetidus	Araceae	SYMFOE	native	6	-5	forb	perennial	skunk-cabbage
Thelypteris palustris	Thelypteridaceae	THEPAL	native	2	-3	fern	perennial	marsh fern
Toxicodendron vernix	Anacardiaceae	TOXVER	native	6	-5	shrub	perennial	poison sumac
Triadenum fraseri	Hypericaceae	TRIFRA	native	6	-5	forb	perennial	marsh st. johns-wort
Typha angustifolia	Typhaceae	TYPANG	non-native	0	-5	forb	perennial	narrow-leaved cat-tail
Typha Ã—glauca	Typhaceae	TYPGLA	non-native	0	-5	forb	perennial	hybrid cat-tail
Urtica dioica	Urticaceae	URTDIO	native	1	0	forb	perennial	stinging nettle
Utricularia minor	Lentibulariaceae	UTRMIN	native	10	-5	forb	perennial	small bladderwort
Utricularia vulgaris	Lentibulariaceae	UTRVUL	native	6	-5	forb	perennial	common bladderwort
Viola cucullata	Violaceae	VIOCUC	native	5	-5	forb	perennial	marsh violet

Longman Road Swamps EOID 23901								
06/24/2021								
Other Notes:	Also - Riccia fluitans, Chara sp. aquatic moss							
Conservatism-Based Metrics:								
Total Mean C:	4.7							
Native Mean C:	5							
Total FQI:	28.6							
Native FQI:	29.6							
Adjusted FQI:	48.6							
% C value 0:	5.4							
% C value 1-3:	24.3							
% C value 4-6:	51.4							
% C value 7-10:	18.9							
Native Tree Mean C:	n/a							
Native Shrub Mean C:	6							
Native Herbaceous Mean C:	4.9							
Species Richness:								
Total Species:	37							
Native Species:	35	94.60%						
Non-native Species:	2	5.40%						
Species Wetness:								
Mean Wetness:	-4.1							
Native Mean Wetness:	-4.3							
Physiognomy Metrics:								
Tree:	0	0%						
Shrub:	3	8.10%						
Vine:	1	2.70%						
Forb:	27	73%						
Grass:	2	5.40%						
Sedge:	2	5.40%						
Rush:	1	2.70%						
Fern:	1	2.70%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	3	8.10%						
Perennial:	34	91.90%						
Biennial:	0	0%						
Native Annual:	3	8.10%						
Native Perennial:	32	86.50%						
Native Biennial:	0	0%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Athyrium filix-femina	Athyriaceae	ATHFIL	native	4	0	fern	perennial	lady fern

Berberis thunbergii	Berberidaceae	BERTHU	non-native	0	3	shrub	perennial	japanese barberry
Bidens connata	Asteraceae	BIDCON	native	5	-3	forb	annual	purple-stemmed tickseed
Bidens frondosa	Asteraceae	BIDFRO	native	1	-3	forb	annual	common beggar-ticks
Carex tribuloides	Cyperaceae	CXTRIB	native	3	-3	sedge	perennial	sedge
Cephalanthus occidentalis	Rubiaceae	CEPOCC	native	7	-5	shrub	perennial	buttonbush
Ceratophyllum demersum	Ceratophyllaceae	CERDEM	native	1	-5	forb	perennial	coontail
Ceratophyllum echinatum	Ceratophyllaceae	CERECH	native	10	-5	forb	perennial	spiny hornwort
Cinna arundinacea	Poaceae	CINARU	native	7	-3	grass	perennial	wood reedgrass
Ilex verticillata	Aquifoliaceae	ILEVER	native	5	-3	shrub	perennial	michigan holly
Juncus effusus	Juncaceae	JUNEFF	native	3	-5	rush	perennial	soft-stemmed rush
Leersia oryzoides	Poaceae	LEEORY	native	3	-5	grass	perennial	cut grass
Lemna minor	Araceae	LEMMIN	native	5	-5	forb	perennial	common duckweed
Lemna trisulca	Araceae	LEMTRI	native	6	-5	forb	perennial	star duckweed
Lemna turionifera; l. minor	Araceae	LEMTUR	native	5	-5	forb	perennial	red duckweed
Ludwigia palustris	Onagraceae	LUDPAL	native	4	-5	forb	perennial	water-purslane
Lycopus uniflorus	Lamiaceae	LYCUNI	native	2	-5	forb	perennial	northern bugle weed
Nuphar advena	Nymphaeaceae	NUPADV	native	8	-5	forb	perennial	yellow pond-lily
Nuphar variegata	Nymphaeaceae	NUPVAR	native	7	-5	forb	perennial	yellow pond-lily
Nymphaea odorata	Nymphaeaceae	NYMODO	native	6	-5	forb	perennial	sweet-scented waterlily
Penthorum sedoides	Penthoraceae	PENSED	native	3	-5	forb	perennial	ditch stonecrop
Persicaria amphibia; polygonum a.	Polygonaceae	PERAMP	native	6	-5	forb	perennial	water smartweed
Persicaria hydropiperoides; polygonum h.	Polygonaceae	PERHYS	native	5	-5	forb	perennial	mild water-pepper
Persicaria sagittata; polygonum s.	Polygonaceae	PERSAG	native	5	-5	forb	annual	arrow-leaved tear-thumb
Potamogeton illinoensis	Potamogetonaceae	POTILL	native	5	-5	forb	perennial	illinois pondweed
Potamogeton natans	Potamogetonaceae	POTNAT	native	5	-5	forb	perennial	pondweed
Scirpus cyperinus	Cyperaceae	SCICYP	native	5	-5	sedge	perennial	wool-grass
Scutellaria lateriflora	Lamiaceae	SCULAT	native	5	-5	forb	perennial	mad-dog skullcap
Spirodela polyrhiza	Araceae	SPIPOL	native	6	-5	forb	perennial	greater duckweed
Typha angustifolia	Typhaceae	TYPANG	non-native	0	-5	forb	perennial	narrow-leaved cat-tail
Urtica dioica	Urticaceae	URTDIO	native	1	0	forb	perennial	stinging nettle
Utricularia gibba	Lentibulariaceae	UTRGIB	native	8	-5	forb	perennial	humped bladderwort
Utricularia vulgaris	Lentibulariaceae	UTRVUL	native	6	-5	forb	perennial	common bladderwort
Vitis riparia	Vitaceae	VITRIP	native	3	0	vine	perennial	river-bank grape
Wolffia borealis; w. punctata	Araceae	WOLBOR	native	5	-5	forb	perennial	dotted water meal

Wolffia brasiliensis; w. papulifera	Araceae	WOLBRA	native	10	-5	forb	perennial	pointed water meal
Wolffia columbiana	Araceae	WOLCOL	native	5	-5	forb	perennial	common water meal

Cemetery Complex Seeps	EOID 3093							
09/11/2018								
Other Notes:	Also 8/18/20							
Conservatism-Based Metrics:								
Total Mean C:	4.3							
Native Mean C:	4.7							
Total FQI:	55.9							
Native FQI:	58.7							
Adjusted FQI:	45.2							
% C value 0:	8.3							
% C value 1-3:	24.9							
% C value 4-6:	52.1							
% C value 7-10:	14.8							
Native Tree Mean C:	5.1							
Native Shrub Mean C:	3.7							
Native Herbaceous Mean C:	4.7							
Species Richness:								
Total Species:	169							
Native Species:	156	92.30%						
Non-native Species:	13	7.70%						
Species Wetness:								
Mean Wetness:	-0.4							
Native Mean Wetness:	-0.5							
Physiognomy Metrics:								
Tree:	18	10.70%						
Shrub:	17	10.10%						
Vine:	6	3.60%						
Forb:	87	51.50%						
Grass:	13	7.70%						
Sedge:	14	8.30%						
Rush:	1	0.60%						
Fern:	13	7.70%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	7	4.10%						
Perennial:	157	92.90%						
Biennial:	5	3%						
Native Annual:	7	4.10%						
Native Perennial:	145	85.80%						
Native Biennial:	4	2.40%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer nigrum; a. saccharum	Sapindaceae	ACENIG	native	4	3	tree	perennial	black maple
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Acer saccharum	Sapindaceae	ACESAU	native	5	3	tree	perennial	sugar maple

Adiantum pedatum	Pteridaceae	ADIPED	native	6	3	fern	perennial	maidenhair fern
Ageratina altissima; eupatorium rugosum	Asteraceae	AGEALT	native	4	3	forb	perennial	white snakeroot
Agrimonia gryposepala	Rosaceae	AGRGRY	native	2	3	forb	perennial	tall agrimony
Agrimonia pubescens	Rosaceae	AGRPUB	native	5	5	forb	perennial	soft agrimony
Agrostis gigantea	Poaceae	AGRGIG	non-native	0	-3	grass	perennial	redtop
Amphicarpaea bracteata	Fabaceae	AMPBRA	native	5	0	vine	annual	hog-peanut
Angelica atropurpurea	Apiaceae	ANGATR	native	6	-5	forb	perennial	purplestem angelica
Apios americana	Fabaceae	APIAME	native	3	-3	vine	perennial	groundnut
Apocynum cannabinum; a. sibiricum	Apocynaceae	APOCAN	native	3	0	forb	perennial	indian-hemp
Aquilegia canadensis	Ranunculaceae	AQUCAN	native	5	3	forb	perennial	wild columbine
Aralia nudicaulis	Araliaceae	ARANUD	native	5	3	forb	perennial	wild sarsaparilla
Aralia racemosa	Araliaceae	ARARAC	native	8	3	forb	perennial	spikenard
Arctium minus	Asteraceae	ARCMIN	non-native	0	3	forb	biennial	common burdock
Arisaema triphyllum	Araceae	ARITRI	native	5	0	forb	perennial	jack-in-the-pulpit
Asarum canadense	Aristolochiaceae	ASACAN	native	5	5	forb	perennial	wild-ginger
Asclepias exaltata	Apocynaceae	ASCEXA	native	6	5	forb	perennial	poke milkweed
Asclepias incarnata	Apocynaceae	ASCINC	native	6	-5	forb	perennial	swamp milkweed
Asimina triloba	Annonaceae	ASITRI	native	9	0	tree	perennial	pawpaw
Berberis thunbergii	Berberidaceae	BERTHU	non-native	0	3	shrub	perennial	japanese barberry
Berula erecta	Apiaceae	BERERE	native	10	-5	forb	perennial	water-parsnip
Bidens cernua	Asteraceae	BIDCER	native	3	-5	forb	annual	nodding beggar-ticks
Botrypus virginianus	Ophioglossaceae	BOTVIR	native	5	3	fern	perennial	rattlesnake fern
Brachyelytrum erectum	Poaceae	BRAERE	native	7	5	grass	perennial	long-awned wood grass
Bromus nottowayanus; b. pubescens	Poaceae	BRONOT	native	7	0	grass	perennial	satin brome
Campanulastrum americanum; campanula a.	Campanulaceae	CAMAME	native	8	0	forb	biennial	tall bellflower
Carex albursina	Cyperaceae	CXALBU	native	5	5	sedge	perennial	sedge
Carex bromoides	Cyperaceae	CXBROM	native	6	-3	sedge	perennial	sedge
Carex communis	Cyperaceae	CXCOMM	native	2	5	sedge	perennial	sedge
Carex gracillima	Cyperaceae	CXGRAA	native	4	3	sedge	perennial	sedge
Carex hirtifolia	Cyperaceae	CXHIRI	native	5	3	sedge	perennial	sedge
Carex hystericina	Cyperaceae	CXHYST	native	2	-5	sedge	perennial	sedge
Carex laxiflora	Cyperaceae	CXLAXF	native	8	0	sedge	perennial	sedge
Carex leptalea	Cyperaceae	CXLEPA	native	5	-5	sedge	perennial	sedge
Carex pedunculata	Cyperaceae	CXPEDU	native	5	3	sedge	perennial	sedge
Carex scabrata	Cyperaceae	CXSCAB	native	4	-5	sedge	perennial	sedge
Carex stipata	Cyperaceae	CXSTIP	native	1	-5	sedge	perennial	sedge
Carex stricta	Cyperaceae	CXSTRI	native	4	-5	sedge	perennial	sedge
Carpinus caroliniana	Betulaceae	CARCAO	native	6	0	tree	perennial	blue-beech
Carya cordiformis	Juglandaceae	CARCOR	native	5	0	tree	perennial	bitternut hickory
Caulophyllum thalictroides	Berberidaceae	CAUTHA	native	5	5	forb	perennial	blue cohosh

Celastrus orbiculatus	Celastraceae	CELORB	non-native	0	5	vine	perennial	oriental bittersweet
Celtis occidentalis	Cannabaceae	CELOCC	native	5	0	tree	perennial	hackberry
Chelone glabra	Plantaginaceae	CHEGLB	native	7	-5	forb	perennial	turtlehead
Cicuta maculata	Apiaceae	CICMAC	native	4	-5	forb	biennial	water hemlock
Cinna arundinacea	Poaceae	CINARU	native	7	-3	grass	perennial	wood reedgrass
Circaea canadensis; c. lutetiana	Onagraceae	CIRCAN	native	2	3	forb	perennial	enchanters-nightshade
Cirsium arvense	Asteraceae	CIRARV	non-native	0	3	forb	perennial	canada thistle
Cirsium muticum	Asteraceae	CIRMUT	native	6	-5	forb	biennial	swamp thistle
Clematis virginiana	Ranunculaceae	CLEVIR	native	4	0	vine	perennial	virgins bower
Collinsonia canadensis	Lamiaceae	COLCAN	native	8	0	forb	perennial	richweed
Cornus alternifolia	Cornaceae	CORALT	native	5	3	tree	perennial	alternate-leaved dogwood
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Cryptotaenia canadensis	Apiaceae	CRYCAN	native	2	0	forb	perennial	honewort
Cuscuta gronovii	Convolvulaceae	CUSGRO	native	3	-3	vine	annual	common dodder
Cypripedium parviflorum; c. calceolus	Orchidaceae	CYPPAR	native	5	0	forb	perennial	yellow lady-slipper
Cystopteris bulbifera	Cystopteridaceae	CYSBUL	native	5	-3	fern	perennial	bulblet fern
Deparia acrostichoides	Athyriaceae	DEPACR	native	6	0	fern	perennial	silvery spleenwort
Dryopteris carthusiana	Dryopteridaceae	DRYCAR	native	5	-3	fern	perennial	spinulose woodfern
Dryopteris goldiana	Dryopteridaceae	DRYGOL	native	10	0	fern	perennial	goldies woodfern
Dryopteris marginalis	Dryopteridaceae	DRYMAR	native	5	3	fern	perennial	marginal woodfern
Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive
Elymus hystrix; hystrix patula	Poaceae	ELYHYS	native	5	3	grass	perennial	bottlebrush grass
Elymus riparius	Poaceae	ELYRIP	native	8	-3	grass	perennial	riverbank wild-rye
Elymus villosus	Poaceae	ELYVIL	native	5	3	grass	perennial	silky wild-rye
Epilobium ciliatum	Onagraceae	EPICIL	native	3	-3	forb	perennial	willow-herb
Equisetum hyemale	Equisetaceae	EQUHYE	native	2	0	fern	perennial	scouring rush
Euonymus atropurpureus	Celastraceae	EUOATR	native	8	3	shrub	perennial	wahoo; burning-bush
Eupatorium perfoliatum	Asteraceae	EUPPER	native	4	-3	forb	perennial	boneset
Euthamia graminifolia	Asteraceae	EUTGRA	native	3	0	forb	perennial	grass-leaved goldenrod
Eutrochium maculatum; eupatorium m.	Asteraceae	EUTMAC	native	4	-5	forb	perennial	joe-pye-weed
Eutrochium purpureum; eupatorium p.	Asteraceae	EUTPUR	native	5	0	forb	perennial	green-stemmed joe-pye-weed
Festuca subverticillata; f. obtusa	Poaceae	FESSUB	native	5	3	grass	perennial	nodding fescue
Frangula alnus; rhamnus frangula	Rhamnaceae	FRAALN	non-native	0	0	shrub	perennial	glossy buckthorn
Fraxinus nigra	Oleaceae	FRANIG	native	6	-3	tree	perennial	black ash
Fraxinus pennsylvanica	Oleaceae	FRAPEN	native	2	-3	tree	perennial	red ash
Fraxinus quadrangulata	Oleaceae	FRAQUA	native	8	3	tree	perennial	blue ash
Galium circaezans	Rubiaceae	GALCIR	native	4	3	forb	perennial	white wild licorice

Galium triflorum	Rubiaceae	GALTRR	native	4	3	forb	perennial	fragrant bedstraw
Geum canadense	Rosaceae	GEUCAN	native	1	0	forb	perennial	white avens
Glyceria striata	Poaceae	GLYSTR	native	4	-5	grass	perennial	fowl manna grass
Helianthus decapetalus	Asteraceae	HELDEC	native	5	3	forb	perennial	pale sunflower
Hepatica americana	Ranunculaceae	HEPAME	native	6	5	forb	perennial	round-lobed hepatica
Homalosorus pycnocarpos	Diplaziopsidaceae	HOMPYC	native	10	0	fern	perennial	narrow-leaved spleenwort
Hydrastis canadensis	Ranunculaceae	HYDCAS	native	10	3	forb	perennial	goldenseal
Hylodesmum glutinosum; desmodium g.	Fabaceae	HYLGLU	native	5	5	forb	perennial	clustered-leaved tick-trefoil
Impatiens capensis	Balsaminaceae	IMPCAP	native	2	-3	forb	annual	spotted touch-me-not
Juglans nigra	Juglandaceae	JUGNIG	native	5	3	tree	perennial	black walnut
Juncus effusus	Juncaceae	JUNEFF	native	3	-5	rush	perennial	soft-stemmed rush
Lactuca biennis	Asteraceae	LACBIE	native	2	0	forb	biennial	tall blue lettuce
Laportea canadensis	Urticaceae	LAPCAN	native	4	-3	forb	perennial	wood nettle
Leersia oryzoides	Poaceae	LEEORY	native	3	-5	grass	perennial	cut grass
Leersia virginica	Poaceae	LEEVIR	native	5	-3	grass	perennial	white grass
Lilium michiganense	Liliaceae	LILMIC	native	5	-3	forb	perennial	michigan lily
Lindera benzoin	Lauraceae	LINBEN	native	7	-3	shrub	perennial	spicebush
Liriodendron tulipifera	Magnoliaceae	LIRTUL	native	9	3	tree	perennial	tulip tree
Lobelia siphilitica	Campanulaceae	LOBSIP	native	4	-3	forb	perennial	great blue lobelia
Lonicera morrowii	Caprifoliaceae	LONMOR	non-native	0	3	shrub	perennial	morrow honeysuckle
Lonicera tatarica	Caprifoliaceae	LONTAT	non-native	0	3	shrub	perennial	tartarian honeysuckle
Lycopus americanus	Lamiaceae	LYCAME	native	2	-5	forb	perennial	common water horehound
Lycopus uniflorus	Lamiaceae	LYCUNI	native	2	-5	forb	perennial	northern bugle weed
Lysimachia ciliata	Myrsinaceae	LYSCIL	native	4	-3	forb	perennial	fringed loosestrife
Lythrum salicaria	Lythraceae	LYTSAL	non-native	0	-5	forb	perennial	purple loosestrife
Maianthemum racemosum; smilacina r.	Convallariaceae	MAIRAC	native	5	3	forb	perennial	false spikenard
Maianthemum stellatum; smilacina s.	Convallariaceae	MAISTE	native	5	0	forb	perennial	starry false solomon-seal
Mentha canadensis; m. arvensis	Lamiaceae	MENCAS	native	3	-3	forb	perennial	wild mint
Mitella diphylla	Saxifragaceae	MITDIP	native	8	3	forb	perennial	bishops-cap
Morus rubra	Moraceae	MORRUB	native	9	3	tree	perennial	red mulberry
Muhlenbergia mexicana	Poaceae	MUHMEX	native	3	-3	grass	perennial	leafy satin grass
Muhlenbergia sylvatica	Poaceae	MUHSYL	native	8	-3	grass	perennial	woodland satin grass
Nasturtium officinale	Brassicaceae	NASOFF	native	4	-5	forb	perennial	watercress
Onoclea sensibilis	Onocleaceae	ONOSEN	native	2	-3	fern	perennial	sensitive fern
Osmunda cinnamomea	Osmundaceae	OSMCIN	native	5	-3	fern	perennial	cinnamon fern
Oxypolis rigidior	Apiaceae	OXYRIG	native	6	-5	forb	perennial	cowbane
Packera aurea; senecio a.	Asteraceae	PACAUR	native	5	-3	forb	perennial	golden ragwort

Panax quinquefolius	Araliaceae	PANQUI	native	10	5	forb	perennial	ginseng
Pedicularis lanceolata	Orobanchaceae	PEDLAN	native	8	-3	forb	perennial	swamp-betony
Persicaria punctata; polygonum p.	Polygonaceae	PERPUN	native	5	-5	forb	annual	smartweed
Persicaria virginiana; polygonum v.	Polygonaceae	PERVIR	native	4	0	forb	perennial	jumpseed
Pilea fontana	Urticaceae	PILFON	native	5	-3	forb	annual	bog clearweed
Pilea pumila	Urticaceae	PILPUM	native	5	-3	forb	annual	clearweed
Polymnia canadensis	Asteraceae	POLCAN	native	6	3	forb	perennial	leaf-cup
Polystichum acrostichoides	Dryopteridaceae	POLACR	native	6	3	fern	perennial	christmas fern
Populus deltoides	Salicaceae	POPDEL	native	1	0	tree	perennial	cottonwood
Prenanthes altissima	Asteraceae	PREALT	native	5	3	forb	perennial	tall white lettuce
Prunella vulgaris	Lamiaceae	PRUVUL	native	0	0	forb	perennial	self-heal
Pycnanthemum virginianum	Lamiaceae	PYCVIR	native	5	-3	forb	perennial	common mountain mint
Quercus rubra	Fagaceae	QUERUB	native	5	3	tree	perennial	red oak
Ranunculus hispidus	Ranunculaceae	RANHIS	native	5	0	forb	perennial	swamp buttercup
Ranunculus recurvatus	Ranunculaceae	RANREC	native	5	-3	forb	perennial	hooked crowfoot
Ribes cynosbati	Grossulariaceae	RIBCYN	native	4	3	shrub	perennial	prickly or wild gooseberry
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rubus allegheniensis	Rosaceae	RUBALL	native	1	3	shrub	perennial	common blackberry
Rubus occidentalis	Rosaceae	RUBOCC	native	1	5	shrub	perennial	black raspberry
Rudbeckia fulgida	Asteraceae	RUDFUL	native	9	-5	forb	perennial	black-eyed susan
Rudbeckia laciniata	Asteraceae	RUDLAC	native	6	-3	forb	perennial	cut-leaf coneflower
Rumex obtusifolius	Polygonaceae	RUMOBT	non-native	0	0	forb	perennial	bitter dock
Rumex verticillatus	Polygonaceae	RUMVER	native	7	-5	forb	perennial	water dock
Salix discolor	Salicaceae	SALDIS	native	1	-3	shrub	perennial	pussy willow
Sambucus canadensis	Adoxaceae	SAMCAN	native	3	-3	shrub	perennial	elderberry
Sanguinaria canadensis	Papaveraceae	SANCAA	native	5	3	forb	perennial	bloodroot
Sanicula odorata; s. gregaria	Apiaceae	SANODO	native	2	0	forb	perennial	black snakeroot
Schoenoplectus tabernaemontani; scirpus validus	Cyperaceae	SCHTAB	native	4	-5	sedge	perennial	softstem bulrush
Scirpus atrovirens	Cyperaceae	SCIATV	native	3	-5	sedge	perennial	bulrush
Smilax ecirrata	Smilacaceae	SMIECI	native	6	5	forb	perennial	upright carrion-flower
Solidago caesia	Asteraceae	SOLCAE	native	6	3	forb	perennial	bluestem goldenrod
Solidago canadensis	Asteraceae	SOLCAN	native	1	3	forb	perennial	canada goldenrod
Solidago gigantea	Asteraceae	SOLGIG	native	3	-3	forb	perennial	late goldenrod
Solidago patula	Asteraceae	SOLPAT	native	6	-5	forb	perennial	swamp goldenrod
Symphyotrichum lateriflorum; aster l.	Asteraceae	SYMLAT	native	2	0	forb	perennial	calico aster
Symphyotrichum novae-angliae; aster n.	Asteraceae	SYMNOV	native	3	-3	forb	perennial	new england aster
Symphyotrichum puniceum; aster p.	Asteraceae	SYMPUN	native	5	-5	forb	perennial	swamp aster

Symplocarpus foetidus	Araceae	SYMFOE	native	6	-5	forb	perennial	skunk-cabbage
Thalictrum dioicum	Ranunculaceae	THADIO	native	6	3	forb	perennial	early meadow-rue
Thelypteris palustris	Thelypteridaceae	THEPAL	native	2	-3	fern	perennial	marsh fern
Tilia americana	Malvaceae	TILAME	native	5	3	tree	perennial	basswood
Toxicodendron vernix	Anacardiaceae	TOXVER	native	6	-5	shrub	perennial	poison sumac
Typha latifolia	Typhaceae	TYPLAT	native	1	-5	forb	perennial	broad-leaved cat-tail
Typha Ã—glauca	Typhaceae	TYPGLA	non-native	0	-5	forb	perennial	hybrid cat-tail
Ulmus americana	Ulmaceae	ULMAME	native	1	-3	tree	perennial	american elm
Urtica dioica	Urticaceae	URTDIO	native	1	0	forb	perennial	stinging nettle
Uvularia grandiflora	Convallariaceae	UVUGRA	native	5	5	forb	perennial	bellwort
Verbena hastata	Verbenaceae	VERHAS	native	4	-3	forb	perennial	blue vervain
Vernonia missurica	Asteraceae	VERMIS	native	4	0	forb	perennial	missouri ironweed
Viburnum lentago	Adoxaceae	VIBLEN	native	4	0	shrub	perennial	nannyberry
Viburnum trilobum; v. opulus	Adoxaceae	VIBTRI	native	5	-3	shrub	perennial	american highbush-cranberry
Vitis riparia	Vitaceae	VITRIP	native	3	0	vine	perennial	river-bank grape

Cemetery Complex Ridge	EOID 6892							
09/11/2018								
Other Notes:	Also 8/18/20; 4/23/21							
Conservatism-Based Metrics:								
Total Mean C:	4.6							
Native Mean C:	5							
Total FQI:	43.4							
Native FQI:	45.6							
Adjusted FQI:	48.3							
% C value 0:	6.7							
% C value 1-3:	18							
% C value 4-6:	57.3							
% C value 7-10:	18							
Native Tree Mean C:	5.2							
Native Shrub Mean C:	3							
Native Herbaceous Mean C:	5.1							
Species Richness:								
Total Species:	89							
Native Species:	83	93.30%						
Non-native Species:	6	6.70%						
Species Wetness:								
Mean Wetness:	2.5							
Native Mean Wetness:	2.4							
Physiognomy Metrics:								
Tree:	18	20.20%						
Shrub:	10	11.20%						
Vine:	5	5.60%						
Forb:	41	46.10%						
Grass:	5	5.60%						
Sedge:	5	5.60%						
Rush:	0	0%						
Fern:	5	5.60%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	1	1.10%						
Perennial:	86	96.60%						
Biennial:	2	2.20%						
Native Annual:	1	1.10%						
Native Perennial:	81	91%						
Native Biennial:	1	1.10%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Acer saccharum	Sapindaceae	ACESAU	native	5	3	tree	perennial	sugar maple
Actaea pachypoda	Ranunculaceae	ACTPAC	native	7	5	forb	perennial	dolls-eyes

Adiantum pedatum	Pteridaceae	ADIPED	native	6	3	fern	perennial	maidenhair fern
Alliaria petiolata	Brassicaceae	ALLPET	non-native	0	3	forb	biennial	garlic mustard
Allium burdickii; a. tricoccum	Alliaceae	ALLBUR	native	7	3	forb	perennial	wild leek
Arisaema triphyllum	Araceae	ARITRI	native	5	0	forb	perennial	jack-in-the-pulpit
Asarum canadense	Aristolochiaceae	ASACAN	native	5	5	forb	perennial	wild-ginger
Asimina triloba	Annonaceae	ASITRI	native	9	0	tree	perennial	pawpaw
Athyrium filix-femina	Athyriaceae	ATHFIL	native	4	0	fern	perennial	lady fern
Berberis thunbergii	Berberidaceae	BERTHU	non-native	0	3	shrub	perennial	japanese barberry
Botrypus virginianus	Ophioglossaceae	BOTVIR	native	5	3	fern	perennial	rattlesnake fern
Brachyelytrum erectum	Poaceae	BRAERE	native	7	5	grass	perennial	long-awned wood grass
Bromus nottowayanus; b. pubescens	Poaceae	BRONOT	native	7	0	grass	perennial	satin brome
Carex albursina	Cyperaceae	CXALBU	native	5	5	sedge	perennial	sedge
Carex communis	Cyperaceae	CXCOMM	native	2	5	sedge	perennial	sedge
Carex hitchcockiana	Cyperaceae	CXHITC	native	5	5	sedge	perennial	sedge
Carex laxiculmis	Cyperaceae	CXLAXC	native	8	3	sedge	perennial	sedge
Carex rosea; c. convoluta	Cyperaceae	CXROSE	native	2	5	sedge	perennial	curly-styled wood sedge
Carpinus caroliniana	Betulaceae	CARCAO	native	6	0	tree	perennial	blue-beech
Carya cordiformis	Juglandaceae	CARCOR	native	5	0	tree	perennial	bitternut hickory
Caulophyllum thalictroides	Berberidaceae	CAUTHA	native	5	5	forb	perennial	blue cohosh
Celastrus orbiculatus	Celastraceae	CELORB	non-native	0	5	vine	perennial	oriental bittersweet
Celtis occidentalis	Cannabaceae	CELOCC	native	5	0	tree	perennial	hackberry
Circaea canadensis; c. lutetiana	Onagraceae	CIRCAN	native	2	3	forb	perennial	enchanters-nightshade
Collinsonia canadensis	Lamiaceae	COLCAN	native	8	0	forb	perennial	richweed
Conopholis americana	Orobanchaceae	CONAME	native	10	5	forb	perennial	squaw-root
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Dioscorea villosa; dioscorea villosa	Dioscoreaceae	DIOVIL	native	4	0	forb	perennial	wild yam
Dryopteris carthusiana	Dryopteridaceae	DRYCAR	native	5	-3	fern	perennial	spinulose woodfern
Elymus hystrix; hystrix patula	Poaceae	ELYHYS	native	5	3	grass	perennial	bottlebrush grass
Elymus villosus	Poaceae	ELYVIL	native	5	3	grass	perennial	silky wild-rye
Euonymus obovatus	Celastraceae	EUOOBO	native	5	3	shrub	perennial	running strawberry-bush
Eurybia macrophylla; aster m.	Asteraceae	EURMAC	native	4	5	forb	perennial	big-leaved aster
Fagus grandifolia	Fagaceae	FAGGRA	native	6	3	tree	perennial	american beech
Festuca subverticillata; f. obtusa	Poaceae	FESSUB	native	5	3	grass	perennial	nodding fescue
Fraxinus americana	Oleaceae	FRAAME	native	5	3	tree	perennial	white ash
Fraxinus nigra	Oleaceae	FRANIG	native	6	-3	tree	perennial	black ash
Galearis spectabilis; orchis s.	Orchidaceae	GALSPE	native	10	3	forb	perennial	showy orchis
Galium circaezans	Rubiaceae	GALCIR	native	4	3	forb	perennial	white wild licorice
Geranium maculatum	Geraniaceae	GERMAC	native	4	3	forb	perennial	wild geranium
Geum canadense	Rosaceae	GEUCAN	native	1	0	forb	perennial	white avens

Hydrastis canadensis	Ranunculaceae	HYDCAS	native	10	3	forb	perennial	goldenseal
Hydrophyllum appendiculatum	Boraginaceae	HYDAPP	native	7	3	forb	biennial	great waterleaf
Hylodesmum glutinosum; desmodium g.	Fabaceae	HYLGLU	native	5	5	forb	perennial	clustered-leaved tick-trefoil
Hylodesmum nudiflorum; desmodium n.	Fabaceae	HYLNUD	native	7	5	forb	perennial	naked tick-trefoil
Laportea canadensis	Urticaceae	LAPCAN	native	4	-3	forb	perennial	wood nettle
Leonurus cardiaca	Lamiaceae	LEOCAR	non-native	0	5	forb	perennial	motherwort
Lindera benzoin	Lauraceae	LINBEN	native	7	-3	shrub	perennial	spicebush
Liriodendron tulipifera	Magnoliaceae	LIRTUL	native	9	3	tree	perennial	tulip tree
Osmorhiza claytonii	Apiaceae	OSMCLI	native	4	3	forb	perennial	hairy sweet-cicely
Ostrya virginiana	Betulaceae	OSTVIR	native	5	3	tree	perennial	ironwood; hop-hornbeam
Panax quinquefolius	Araliaceae	PANQUI	native	10	5	forb	perennial	ginseng
Parthenocissus quinquefolia	Vitaceae	PARQUI	native	5	3	vine	perennial	virginia creeper
Persicaria virginiana; polygonum v.	Polygonaceae	PERVIR	native	4	0	forb	perennial	jumpseed
Phlox divaricata	Polemoniaceae	PHLDIV	native	5	3	forb	perennial	wild blue phlox
Pilea pumila	Urticaceae	PILPUM	native	5	-3	forb	annual	clearweed
Polygonatum pubescens	Convallariaceae	POLPUB	native	5	5	forb	perennial	downy solomon seal
Polymnia canadensis	Asteraceae	POLCAN	native	6	3	forb	perennial	leaf-cup
Polystichum acrostichoides	Dryopteridaceae	POLACR	native	6	3	fern	perennial	christmas fern
Populus grandidentata	Salicaceae	POPGRA	native	4	3	tree	perennial	big-tooth aspen
Potentilla simplex	Rosaceae	POTSIM	native	2	3	forb	perennial	old-field cinquefoil
Prenanthes altissima	Asteraceae	PREALT	native	5	3	forb	perennial	tall white lettuce
Prunus serotina	Rosaceae	PRUSER	native	2	3	tree	perennial	wild black cherry
Quercus alba	Fagaceae	QUEALB	native	5	3	tree	perennial	white oak
Quercus rubra	Fagaceae	QUERUB	native	5	3	tree	perennial	red oak
Quercus velutina	Fagaceae	QUEVEL	native	6	5	tree	perennial	black oak
Ribes cynosbati	Grossulariaceae	RIBCYN	native	4	3	shrub	perennial	prickly or wild gooseberry
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rubus flagellaris	Rosaceae	RUBFLA	native	1	3	shrub	perennial	northern dewberry
Rubus occidentalis	Rosaceae	RUBOCC	native	1	5	shrub	perennial	black raspberry
Rubus pensilvanicus	Rosaceae	RUBPEN	native	2	3	shrub	perennial	dewberry
Sambucus racemosa	Adoxaceae	SAMRAC	native	3	3	shrub	perennial	red-berried elder
Sanguinaria canadensis	Papaveraceae	SANCAA	native	5	3	forb	perennial	bloodroot
Sanicula odorata; s. gregaria	Apiaceae	SANODO	native	2	0	forb	perennial	black snakeroot
Sassafras albidum	Lauraceae	SASALB	native	5	3	tree	perennial	sassafras
Smilax hispida; s. tamnoides	Smilacaceae	SMIHIS	native	5	0	vine	perennial	bristly greenbrier
Symphyotrichum lateriflorum; aster l.	Asteraceae	SYMLAT	native	2	0	forb	perennial	calico aster

Taraxacum officinale	Asteraceae	TAROFF	non-native	0	3	forb	perennial	common dandelion
Thalictrum dioicum	Ranunculaceae	THADIO	native	6	3	forb	perennial	early meadow-rue
Thalictrum thalictroides; anemonella t.	Ranunculaceae	THATHA	native	8	3	forb	perennial	rue-anemone
Tilia americana	Malvaceae	TILAME	native	5	3	tree	perennial	basswood
Toxicodendron radicans	Anacardiaceae	TOXRAD	native	2	0	vine	perennial	poison-ivy
Trillium grandiflorum	Trilliaceae	TRIGRA	native	5	3	forb	perennial	common trillium
Uvularia grandiflora	Convallariaceae	UVUGRA	native	5	5	forb	perennial	bellwort
Viola canadensis	Violaceae	VIOCAN	native	5	3	forb	perennial	canada violet
Viola pubescens	Violaceae	VIOPUB	native	4	3	forb	perennial	yellow violet
Viola sororia	Violaceae	VIOSOR	native	1	0	forb	perennial	common blue violet
Vitis aestivalis	Vitaceae	VITAES	native	6	3	vine	perennial	summer grape

Whitman Lake Woods EOID 3628								
07/14/2020								
Other Notes:	Combined from lists generated for Whitman Woods West, Central, East (stand 38), East (stand 55), and NE Annex (Stand 36)							
Conservatism-Based Metrics:								
Total Mean C:	4							
Native Mean C:	4.5							
Total FQI:	57.7							
Native FQI:	60.5							
Adjusted FQI:	42							
% C value 0:	15.4							
% C value 1-3:	20.7							
% C value 4-6:	49.5							
% C value 7-10:	14.4							
Native Tree Mean C:	4.7							
Native Shrub Mean C:	3.9							
Native Herbaceous Mean C:	4.6							
Species Richness:								
Total Species:	208							
Native Species:	181	87%						
Non-native Species:	27	13%						
Species Wetness:								
Mean Wetness:	2.6							
Native Mean Wetness:	2.5							
Physiognomy Metrics:								
Tree:	20	9.60%						
Shrub:	26	12.50%						
Vine:	11	5.30%						
Forb:	113	54.30%						
Grass:	17	8.20%						
Sedge:	8	3.80%						
Rush:	2	1%						
Fern:	11	5.30%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	6	2.90%						
Perennial:	196	94.20%						
Biennial:	6	2.90%						
Native Annual:	4	1.90%						
Native Perennial:	173	83.20%						
Native Biennial:	4	1.90%						

Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Acer saccharum	Sapindaceae	ACESAU	native	5	3	tree	perennial	sugar maple
Achillea millefolium	Asteraceae	ACHMIL	native	1	3	forb	perennial	yarrow
Actaea pachypoda	Ranunculaceae	ACTPAC	native	7	5	forb	perennial	dolls-eyes
Adiantum pedatum	Pteridaceae	ADIPED	native	6	3	fern	perennial	maidenhair fern
Agrimonia gryposepala	Rosaceae	AGRGRY	native	2	3	forb	perennial	tall agrimony
Agrimonia pubescens	Rosaceae	AGRPUB	native	5	5	forb	perennial	soft agrimony
Agrimonia rostellata	Rosaceae	AGRROS	native	8	3	forb	perennial	beaked agrimony
Agrostis gigantea	Poaceae	AGRGIG	non-native	0	-3	grass	perennial	redtop
Agrostis perennans	Poaceae	AGRPER	native	5	3	grass	perennial	autumn bent
Alliaria petiolata	Brassicaceae	ALLPET	non-native	0	3	forb	biennial	garlic mustard
Amelanchier arborea	Rosaceae	AMEARB	native	4	3	tree	perennial	juneberry
Amelanchier laevis	Rosaceae	AMELAE	native	4	5	tree	perennial	smooth shadbush
Amphicarpaea bracteata	Fabaceae	AMPBRA	native	5	0	vine	annual	hog-peanut
Anemone quinquefolia	Ranunculaceae	ANEQUI	native	5	3	forb	perennial	wood anemone
Anemone virginiana	Ranunculaceae	ANEVIR	native	3	3	forb	perennial	thimbleweed
Antennaria parlinii	Asteraceae	ANTPAL	native	2	5	forb	perennial	smooth pussytoes
Apocynum androsaemifolium	Apocynaceae	APOAND	native	3	5	forb	perennial	spreading dogbane
Aralia nudicaulis	Araliaceae	ARANUD	native	5	3	forb	perennial	wild sarsaparilla
Aralia racemosa	Araliaceae	ARARAC	native	8	3	forb	perennial	spikenard
Arisaema triphyllum	Araceae	ARITRI	native	5	0	forb	perennial	jack-in-the-pulpit
Asclepias exaltata	Apocynaceae	ASCEXA	native	6	5	forb	perennial	poke milkweed
Asplenium platyneuron	Aspleniaceae	ASPPLA	native	2	3	fern	perennial	ebony spleenwort
Athyrium filix-femina	Athyriaceae	ATHFIL	native	4	0	fern	perennial	lady fern
Aureolaria flava	Orobanchaceae	AURFLA	native	8	5	forb	perennial	smooth false foxglove
Aureolaria virginica	Orobanchaceae	AURVIR	native	10	5	forb	perennial	downy false foxglove
Berberis thunbergii	Berberidaceae	BERTHU	non-native	0	3	shrub	perennial	japanese barberry
Boechera canadensis; arabis c.	Brassicaceae	BOECAN	native	7	5	forb	biennial	sickle-pod
Botrypus virginianus	Ophioglossaceae	BOTVIR	native	5	3	fern	perennial	rattlesnake fern
Brachyelytrum erectum	Poaceae	BRAERE	native	7	5	grass	perennial	long-awned wood grass
Bromus pubescens	Poaceae	BROPUB	native	5	3	grass	perennial	canada brome
Campanula rotundifolia	Campanulaceae	CAMROT	native	6	3	forb	perennial	harebell
Carex blanda	Cyperaceae	CXBLAN	native	1	0	sedge	perennial	sedge
Carex cephalophora	Cyperaceae	CXCEPP	native	3	3	sedge	perennial	sedge
Carex digitalis	Cyperaceae	CXDIGI	native	5	5	sedge	perennial	sedge
Carex gracillima	Cyperaceae	CXGRAA	native	4	3	sedge	perennial	sedge
Carex pensylvanica	Cyperaceae	CXPENS	native	4	5	sedge	perennial	sedge
Carex rosea; c. convoluta	Cyperaceae	CXROSE	native	2	5	sedge	perennial	curly-styled wood sedge
Carex sparganioides	Cyperaceae	CXSPAR	native	5	3	sedge	perennial	sedge

Carex swanii	Cyperaceae	CXSWAN	native	4	3	sedge	perennial	sedge
Carpinus caroliniana	Betulaceae	CARCAO	native	6	0	tree	perennial	blue-beech
Carya glabra	Juglandaceae	CARGLA	native	5	3	tree	perennial	pignut hickory
Celastrus orbiculatus	Celastraceae	CELORB	non-native	0	5	vine	perennial	oriental bittersweet
Celtis occidentalis	Cannabaceae	CELOCC	native	5	0	tree	perennial	hackberry
Chimaphila maculata	Ericaceae	CHIMAC	native	8	5	shrub	perennial	spotted wintergreen
Cinna arundinacea	Poaceae	CINARU	native	7	-3	grass	perennial	wood reedgrass
Circaea canadensis; c. lutetiana	Onagraceae	CIRCAN	native	2	3	forb	perennial	enchanters-nightshade
Clinopodium vulgare	Lamiaceae	CLIVUL	native	3	5	forb	perennial	wild-basil
Collinsonia canadensis	Lamiaceae	COLCAN	native	8	0	forb	perennial	richweed
Comandra umbellata	Santalaceae	COMUMB	native	5	3	forb	perennial	bastard-toadflax
Coreopsis tripteris	Asteraceae	CORTRP	native	7	0	forb	perennial	tall coreopsis
Cornus alternifolia	Cornaceae	CORALT	native	5	3	tree	perennial	alternate-leaved dogwood
Cornus florida	Cornaceae	CORFLO	native	8	3	tree	perennial	flowering dogwood
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Corylus americana	Betulaceae	CORAMA	native	5	3	shrub	perennial	hazelnut
Dactylis glomerata	Poaceae	DACGLO	non-native	0	3	grass	perennial	orchard grass
Danthonia spicata	Poaceae	DANSPI	native	4	5	grass	perennial	poverty grass; oatgrass
Dendrolycopodium dendroideum; lycopodium d.	Lycopodiaceae	DENDEN	native	5	3	fern	perennial	tree clubmoss
Desmodium paniculatum	Fabaceae	DESPAN	native	4	3	forb	perennial	panicled tick-trefoil
Desmodium perplexum; d. paniculatum	Fabaceae	DESPER	native	5	5	forb	perennial	tick-trefoil
Dianthus armeria	Caryophyllaceae	DIAARM	non-native	0	5	forb	annual	deptford pink
Dichanthelium dichotomum; panicum d.	Poaceae	DICDIC	native	7	0	grass	perennial	panic grass
Dichanthelium latifolium; panicum l.	Poaceae	DICLAT	native	5	3	grass	perennial	broad-leaved panic grass
Dioscorea villosa; dioscorea villosa	Dioscoreaceae	DIOVIL	native	4	0	forb	perennial	wild yam
Dryopteris carthusiana	Dryopteridaceae	DRYCAR	native	5	-3	fern	perennial	spinulose woodfern
Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive
Elymus hystrix; hystrix patula	Poaceae	ELYHYS	native	5	3	grass	perennial	bottlebrush grass
Epipactis helleborine	Orchidaceae	EPIHEL	non-native	0	0	forb	perennial	helleborine
Erigeron annuus	Asteraceae	ERIANN	native	0	3	forb	biennial	daisy fleabane
Erigeron pulchellus	Asteraceae	ERIPUL	native	5	3	forb	perennial	robins-plantain
Euonymus alatus	Celastraceae	EUOALA	non-native	0	5	shrub	perennial	winged euonymus

Eupatorium sessilifolium	Asteraceae	EUPSES	native	10	5	forb	perennial	upland boneset
Euphorbia corollata	Euphorbiaceae	EUPCOR	native	4	5	forb	perennial	flowering spurge
Eurybia macrophylla; aster m.	Asteraceae	EURMAC	native	4	5	forb	perennial	big-leaved aster
Euthamia graminifolia	Asteraceae	EUTGRA	native	3	0	forb	perennial	grass-leaved goldenrod
Fagus grandifolia	Fagaceae	FAGGRA	native	6	3	tree	perennial	american beech
Festuca subverticillata; f. obtusa	Poaceae	FESSUB	native	5	3	grass	perennial	nodding fescue
Fragaria virginiana	Rosaceae	FRAVIR	native	2	3	forb	perennial	wild strawberry
Frangula alnus; rhamnus frangula	Rhamnaceae	FRAALN	non-native	0	0	shrub	perennial	glossy buckthorn
Fraxinus americana	Oleaceae	FRAAME	native	5	3	tree	perennial	white ash
Fraxinus pennsylvanica	Oleaceae	FRAPEN	native	2	-3	tree	perennial	red ash
Galium aparine	Rubiaceae	GALAPA	native	0	3	forb	annual	annual bedstraw
Galium boreale	Rubiaceae	GALBOR	native	3	0	forb	perennial	northern bedstraw
Galium circaezans	Rubiaceae	GALCIR	native	4	3	forb	perennial	white wild licorice
Galium lanceolatum	Rubiaceae	GALLAN	native	4	5	forb	perennial	yellow wild licorice
Galium triflorum	Rubiaceae	GALTRR	native	4	3	forb	perennial	fragrant bedstraw
Gaylussacia baccata	Ericaceae	GAYBAC	native	7	3	shrub	perennial	huckleberry
Geranium maculatum	Geraniaceae	GERMAC	native	4	3	forb	perennial	wild geranium
Geum canadense	Rosaceae	GEUCAN	native	1	0	forb	perennial	white avens
Hackelia virginiana	Boraginaceae	HACVIR	native	1	3	forb	biennial	beggars lice
Hamamelis virginiana	Hamamelidaceae	HAMVIR	native	5	3	shrub	perennial	witch-hazel
Helianthus divaricatus	Asteraceae	HELDIV	native	5	5	forb	perennial	woodland sunflower
Helianthus strumosus	Asteraceae	HELSTR	native	4	5	forb	perennial	pale-leaved sunflower
Hepatica americana	Ranunculaceae	HEPAME	native	6	5	forb	perennial	round-lobed hepatica
Heuchera americana	Saxifragaceae	HEUAME	native	8	3	forb	perennial	alum root
Hieracium caespitosum	Asteraceae	HIECAE	non-native	0	5	forb	perennial	king devil
Hieracium gronovii	Asteraceae	HIEGRO	native	5	5	forb	perennial	hairy hawkweed
Hieracium pilosella	Asteraceae	HIEPIA	non-native	0	5	forb	perennial	mouse-ear hawkweed
Hieracium scabrum	Asteraceae	HIESCA	native	3	5	forb	perennial	rough hawkweed
Hylodesmum glutinosum; desmodium g.	Fabaceae	HYLGLU	native	5	5	forb	perennial	clustered-leaved tick-trefoil
Hylodesmum nudiflorum; desmodium n.	Fabaceae	HYLNUD	native	7	5	forb	perennial	naked tick-trefoil
Hypericum perforatum	Hypericaceae	HYPPER	non-native	0	5	forb	perennial	common st. johns-wort
Impatiens capensis	Balsaminaceae	IMPCAP	native	2	-3	forb	annual	spotted touch-me-not
Juncus tenuis	Juncaceae	JUNTEN	native	1	0	rush	perennial	path rush
Krigia biflora	Asteraceae	KRIBIF	native	5	3	forb	perennial	false dandelion
Laportea canadensis	Urticaceae	LAPCAN	native	4	-3	forb	perennial	wood nettle
Lathyrus venosus	Fabaceae	LATVEN	native	8	0	vine	perennial	veiny pea
Lespedeza hirta	Fabaceae	LESHIR	native	7	5	forb	perennial	hairy bush-clover

Lespedeza violacea; l. intermedia	Fabaceae	LESVIO	native	7	5	forb	perennial	bush-clover
Lindera benzoin	Lauraceae	LINBEN	native	7	-3	shrub	perennial	spicebush
Lonicera japonica	Caprifoliaceae	LONJAP	non-native	0	3	vine	perennial	japanese honeysuckle
Lonicera maackii	Caprifoliaceae	LONMAA	non-native	0	5	shrub	perennial	amur honeysuckle
Lonicera morrowii	Caprifoliaceae	LONMOR	non-native	0	3	shrub	perennial	morrow honeysuckle
Luzula multiflora	Juncaceae	LUZMUL	native	5	3	rush	perennial	common wood rush
Lysimachia lanceolata	Myrsinaceae	LYSLAN	native	9	0	forb	perennial	lance-leaved loosestrife
Lysimachia quadrifolia	Myrsinaceae	LYSQUL	native	8	3	forb	perennial	four-leaved loosestrife
Maianthemum canadense	Convallariaceae	MAICAN	native	4	3	forb	perennial	canada mayflower
Maianthemum racemosum; smilacina r.	Convallariaceae	MAIRAC	native	5	3	forb	perennial	false spikenard
Mitchella repens	Rubiaceae	MITREP	native	5	3	forb	perennial	partridge-berry
Monotropa uniflora	Ericaceae	MONOUN	native	5	3	forb	perennial	indian-pipe
Muhlenbergia tenuiflora	Poaceae	MUHTEN	native	8	5	grass	perennial	slender satin grass
Onoclea sensibilis	Onocleaceae	ONOSEN	native	2	-3	fern	perennial	sensitive fern
Osmorhiza claytonii	Apiaceae	OSMCLI	native	4	3	forb	perennial	hairy sweet-cicely
Osmunda cinnamomea	Osmundaceae	OSMCIN	native	5	-3	fern	perennial	cinnamon fern
Osmunda claytoniana	Osmundaceae	OSMCLN	native	6	0	fern	perennial	interrupted fern
Parthenocissus quinquefolia	Vitaceae	PARQUI	native	5	3	vine	perennial	virginia creeper
Pedicularis canadensis	Orobanchaceae	PEDCAN	native	10	3	forb	perennial	wood-betony
Persicaria virginiana; polygonum v.	Polygonaceae	PERVIR	native	4	0	forb	perennial	jumpseed
Phryma leptostachya	Phrymaceae	PHRLEP	native	4	3	forb	perennial	lopseed
Phytolacca americana	Phytolaccaceae	PHYAME	native	2	3	forb	perennial	pokeweed
Pilea pumila	Urticaceae	PILPUM	native	5	-3	forb	annual	clearweed
Poa compressa	Poaceae	POACOM	non-native	0	3	grass	perennial	canada bluegrass
Poa languida	Poaceae	POALAN	native	6	5	grass	perennial	bluegrass
Poa pratensis	Poaceae	POAPRA	non-native	0	3	grass	perennial	kentucky bluegrass
Podophyllum peltatum	Berberidaceae	PODPEL	native	3	3	forb	perennial	may-apple
Polygonatum biflorum	Convallariaceae	POLBIF	native	4	3	forb	perennial	solomon-seal
Polygonatum pubescens	Convallariaceae	POLPUB	native	5	5	forb	perennial	downy solomon seal
Potentilla simplex	Rosaceae	POTSIM	native	2	3	forb	perennial	old-field cinquefoil
Prenanthes alba	Asteraceae	PREALB	native	5	3	forb	perennial	white lettuce
Prunella vulgaris	Lamiaceae	PRUVUL	native	0	0	forb	perennial	self-heal
Prunus avium	Rosaceae	PRUAVI	non-native	0	5	tree	perennial	sweet cherry
Prunus serotina	Rosaceae	PRUSER	native	2	3	tree	perennial	wild black cherry
Prunus virginiana	Rosaceae	PRUVIR	native	2	3	shrub	perennial	choke cherry
Pteridium aquilinum	Dennstaedtiaceae	PTEAQU	native	0	3	fern	perennial	bracken fern

Pyrola elliptica	Ericaceae	PYRELL	native	6	3	forb	perennial	large-leaved shinleaf
Quercus alba	Fagaceae	QUEALB	native	5	3	tree	perennial	white oak
Quercus rubra	Fagaceae	QUERUB	native	5	3	tree	perennial	red oak
Quercus velutina	Fagaceae	QUEVEL	native	6	5	tree	perennial	black oak
Ranunculus abortivus	Ranunculaceae	RANABO	native	0	0	forb	perennial	small-flowered buttercup
Ranunculus recurvatus	Ranunculaceae	RANREC	native	5	-3	forb	perennial	hooked crowfoot
Rhamnus cathartica	Rhamnaceae	RHACAT	non-native	0	0	tree	perennial	common buckthorn
Ribes cynosbati	Grossulariaceae	RIBCYN	native	4	3	shrub	perennial	prickly or wild gooseberry
Rosa carolina	Rosaceae	ROSCAR	native	4	3	shrub	perennial	pasture rose
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rubus allegheniensis	Rosaceae	RUBALL	native	1	3	shrub	perennial	common blackberry
Rubus flagellaris	Rosaceae	RUBFLA	native	1	3	shrub	perennial	northern dewberry
Rubus occidentalis	Rosaceae	RUBOCC	native	1	5	shrub	perennial	black raspberry
Rubus pensilvanicus	Rosaceae	RUBPEN	native	2	3	shrub	perennial	dewberry
Rumex acetosella	Polygonaceae	RUMACL	non-native	0	3	forb	perennial	sheep sorrel
Rumex crispus	Polygonaceae	RUMCRI	non-native	0	0	forb	perennial	curly dock
Rumex obtusifolius	Polygonaceae	RUMOBT	non-native	0	0	forb	perennial	bitter dock
Sambucus racemosa	Adoxaceae	SAMRAC	native	3	3	shrub	perennial	red-berried elder
Sanicula canadensis	Apiaceae	SANCAS	native	8	3	forb	biennial	black snakeroot
Sanicula marilandica	Apiaceae	SANMAR	native	4	3	forb	perennial	black snakeroot
Sassafras albidum	Lauraceae	SASALB	native	5	3	tree	perennial	sassafras
Scrophularia lanceolata	Scrophulariaceae	SCRLAN	native	5	3	forb	perennial	early figwort
Smilax ecirrata	Smilacaceae	SMIECI	native	6	5	forb	perennial	upright carrion-flower
Smilax hispida; s. tamnoides	Smilacaceae	SMIHIS	native	5	0	vine	perennial	bristly greenbrier
Smilax lasioneura	Smilacaceae	SMILAS	native	5	5	vine	perennial	carrion-flower
Solidago caesia	Asteraceae	SOLCAE	native	6	3	forb	perennial	bluestem goldenrod
Solidago gigantea	Asteraceae	SOLGIG	native	3	-3	forb	perennial	late goldenrod
Solidago hispida	Asteraceae	SOLHIS	native	3	5	forb	perennial	hairy goldenrod
Solidago juncea	Asteraceae	SOLJUN	native	3	5	forb	perennial	early goldenrod
Solidago rugosa	Asteraceae	SOLRUG	native	3	0	forb	perennial	rough-leaved goldenrod
Solidago speciosa	Asteraceae	SOLSPE	native	5	5	forb	perennial	showy goldenrod
Solidago ulmifolia	Asteraceae	SOLULM	native	5	5	forb	perennial	elm-leaved goldenrod
Sphenopholis intermedia	Poaceae	SPHINT	native	4	0	grass	perennial	slender wedgegrass
Sphenopholis nitida	Poaceae	SPHNIT	native	8	5	grass	perennial	shining wedgegrass
Symphyotrichum cordifolium; aster c.	Asteraceae	SYMCOR	native	4	5	forb	perennial	heart-leaved aster
Symphyotrichum laeve; aster l.	Asteraceae	SYMLAE	native	5	3	forb	perennial	smooth aster

Symphyotrichum lateriflorum; aster l.	Asteraceae	SYMLAT	native	2	0	forb	perennial	calico aster
Symphyotrichum urophyllum; aster sagittifolius	Asteraceae	SYMURO	native	2	5	forb	perennial	arrow-leaved aster
Taenidia integerrima	Apiaceae	TAEINT	native	8	5	forb	perennial	yellow-pimpernel
Thalictrum dioicum	Ranunculaceae	THADIO	native	6	3	forb	perennial	early meadow-rue
Thalictrum thalictroides; anemonella t.	Ranunculaceae	THATHA	native	8	3	forb	perennial	rue-anemone
Thelypteris noveboracensis	Thelypteridaceae	THENOV	native	5	0	fern	perennial	new york fern
Tilia americana	Malvaceae	TILAME	native	5	3	tree	perennial	basswood
Torilis japonica	Apiaceae	TORJAP	non-native	0	3	forb	annual	hedge-parsley
Toxicodendron radicans	Anacardiaceae	TOXRAD	native	2	0	vine	perennial	poison-ivy
Tradescantia ohiensis	Commelinaceae	TRAOHI	native	5	3	forb	perennial	common spiderwort
Trillium grandiflorum	Trilliaceae	TRIGRA	native	5	3	forb	perennial	common trillium
Urtica dioica	Urticaceae	URTDIO	native	1	0	forb	perennial	stinging nettle
Uvularia grandiflora	Convallariaceae	UVUGRA	native	5	5	forb	perennial	bellwort
Vaccinium angustifolium	Ericaceae	VACANG	native	4	3	shrub	perennial	low sweet blueberry
Vaccinium myrtilloides	Ericaceae	VACMYR	native	4	-3	shrub	perennial	canada blueberry
Verbascum thapsus	Scrophulariaceae	VERTHA	non-native	0	5	forb	biennial	common mullein
Verbena urticifolia	Verbenaceae	VERURT	native	4	0	forb	perennial	white vervain
Veronica officinalis	Plantaginaceae	VEROOF	non-native	0	3	forb	perennial	common speedwell
Veronicastrum virginicum	Plantaginaceae	VERVIR	native	8	0	forb	perennial	culvers-root
Viburnum acerifolium	Adoxaceae	VIBACE	native	6	5	shrub	perennial	maple-leaved viburnum
Viburnum lentago	Adoxaceae	VIBLEN	native	4	0	shrub	perennial	nannyberry
Viburnum trilobum; v. opulus	Adoxaceae	VIBTRI	native	5	-3	shrub	perennial	american highbush-cranberry
Vicia americana	Fabaceae	VICAME	native	5	3	vine	perennial	american vetch
Viola pubescens	Violaceae	VIOPUB	native	4	3	forb	perennial	yellow violet
Viola sororia	Violaceae	VIOSOR	native	1	0	forb	perennial	common blue violet
Vitis aestivalis	Vitaceae	VITAES	native	6	3	vine	perennial	summer grape
Vitis riparia	Vitaceae	VITRIP	native	3	0	vine	perennial	river-bank grape
Zizia aurea	Apiaceae	ZIZAUR	native	6	0	forb	perennial	golden alexanders

Saddleback Woodland EOID 23953								
08/10/2020								
Other Notes:	Most of list reflects 2019 survey (date not recorded), some 6/18/20 survey by Lincoln							
Conservatism-Based Metrics:								
Total Mean C:	4.8							
Native Mean C:	5.1							
Total FQI:	44.8							
Native FQI:	46.2							
Adjusted FQI:	49.5							
% C value 0:	5.7							
% C value 1-3:	19.5							
% C value 4-6:	51.7							
% C value 7-10:	23							
Native Tree Mean C:	4.7							
Native Shrub Mean C:	4							
Native Herbaceous Mean C:	5.3							
Species Richness:								
Total Species:	87							
Native Species:	82	94.30%						
Non-native Species:	5	5.70%						
Species Wetness:								
Mean Wetness:	3.2							
Native Mean Wetness:	3.3							
Physiognomy Metrics:								
Tree:	11	12.60%						
Shrub:	14	16.10%						
Vine:	1	1.10%						
Forb:	37	42.50%						
Grass:	14	16.10%						
Sedge:	9	10.30%						
Rush:	1	1.10%						
Fern:	0	0%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	3	3.40%						
Perennial:	84	96.60%						
Biennial:	0	0%						
Native Annual:	3	3.40%						
Native Perennial:	79	90.80%						
Native Biennial:	0	0%						
Species:								

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Actaea pachypoda	Ranunculaceae	ACTPAC	native	7	5	forb	perennial	dolls-eyes
Agrimonia pubescens	Rosaceae	AGRPUB	native	5	5	forb	perennial	soft agrimony
Agrostis perennans	Poaceae	AGRPER	native	5	3	grass	perennial	autumn bent
Amphicarpaea bracteata	Fabaceae	AMPBRA	native	5	0	vine	annual	hog-peanut
Apocynum androsaemifolium	Apocynaceae	APOAND	native	3	5	forb	perennial	spreading dogbane
Asclepias exaltata	Apocynaceae	ASCEXA	native	6	5	forb	perennial	poke milkweed
Aureolaria pedicularia	Orobanchaceae	AURPED	native	7	5	forb	annual	annual false foxglove
Brachyelytrum erectum	Poaceae	BRAERE	native	7	5	grass	perennial	long-awned wood grass
Bromus pubescens	Poaceae	BROPUB	native	5	3	grass	perennial	canada brome
Carex albursina	Cyperaceae	CXALBU	native	5	5	sedge	perennial	sedge
Carex blanda	Cyperaceae	CXBLAN	native	1	0	sedge	perennial	sedge
Carex cephalophora	Cyperaceae	CXCEPP	native	3	3	sedge	perennial	sedge
Carex grisea; c. amphibola	Cyperaceae	CXGRIS	native	3	0	sedge	perennial	sedge
Carex laxiflora	Cyperaceae	CXLAXF	native	8	0	sedge	perennial	sedge
Carex pensylvanica	Cyperaceae	CXPENS	native	4	5	sedge	perennial	sedge
Carex rosea; c. convoluta	Cyperaceae	CXROSE	native	2	5	sedge	perennial	curly-styled wood sedge
Carex sparganioides	Cyperaceae	CXSPAR	native	5	3	sedge	perennial	sedge
Carex swanii	Cyperaceae	CXSWAN	native	4	3	sedge	perennial	sedge
Carya glabra	Juglandaceae	CARGLA	native	5	3	tree	perennial	pignut hickory
Ceanothus americanus	Rhamnaceae	CEAAME	native	8	5	shrub	perennial	new jersey tea
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Corylus americana	Betulaceae	CORAMA	native	5	3	shrub	perennial	hazelnut
Cryptotaenia canadensis	Apiaceae	CRYCAN	native	2	0	forb	perennial	honewort
Danthonia spicata	Poaceae	DANSPI	native	4	5	grass	perennial	poverty grass; oatgrass
Desmodium glabellum; d. paniculatum	Fabaceae	DESGLA	native	5	5	forb	perennial	tick-trefoil
Desmodium paniculatum	Fabaceae	DESPAN	native	4	3	forb	perennial	panicled tick-trefoil
Desmodium rotundifolium	Fabaceae	DESROT	native	8	5	forb	perennial	round-leaved tick-trefoil
Dichanthelium dichotomum; panicum d.	Poaceae	DICDIC	native	7	0	grass	perennial	panic grass
Dichanthelium implicatum; panicum i.	Poaceae	DICIMP	native	3	0	grass	perennial	panic grass
Dichanthelium latifolium; panicum l.	Poaceae	DICLAT	native	5	3	grass	perennial	broad-leaved panic grass
Dichanthelium oligosanthes; panicum o.	Poaceae	DICOLI	native	5	3	grass	perennial	panic grass
Dichanthelium sphaerocarpon; panicum s.	Poaceae	DICSPH	native	5	3	grass	perennial	round-fruited panic grass

Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive
Euphorbia corollata	Euphorbiaceae	EUPCOR	native	4	5	forb	perennial	flowering spurge
Eurybia macrophylla; aster m.	Asteraceae	EURMAC	native	4	5	forb	perennial	big-leaved aster
Festuca subverticillata; f. obtusa	Poaceae	FESSUB	native	5	3	grass	perennial	nodding fescue
Frangula alnus; rhamnus frangula	Rhamnaceae	FRAALN	non-native	0	0	shrub	perennial	glossy buckthorn
Galium boreale	Rubiaceae	GALBOR	native	3	0	forb	perennial	northern bedstraw
Galium circaezans	Rubiaceae	GALCIR	native	4	3	forb	perennial	white wild licorice
Galium lanceolatum	Rubiaceae	GALLAN	native	4	5	forb	perennial	yellow wild licorice
Galium pilosum	Rubiaceae	GALPIL	native	6	5	forb	perennial	hairy bedstraw
Gaylussacia baccata	Ericaceae	GAYBAC	native	7	3	shrub	perennial	huckleberry
Geranium maculatum	Geraniaceae	GERMAC	native	4	3	forb	perennial	wild geranium
Helianthus divaricatus	Asteraceae	HELDIV	native	5	5	forb	perennial	woodland sunflower
Hepatica americana	Ranunculaceae	HEPAME	native	6	5	forb	perennial	round-lobed hepatica
Hylodesmum glutinosum; desmodium g.	Fabaceae	HYLGLU	native	5	5	forb	perennial	clustered-leaved tick-trefoil
Hylodesmum nudiflorum; desmodium n.	Fabaceae	HYLNUD	native	7	5	forb	perennial	naked tick-trefoil
Krigia biflora	Asteraceae	KRIBIF	native	5	3	forb	perennial	false dandelion
Ligustrum vulgare	Oleaceae	LIGVUL	non-native	0	3	shrub	perennial	common privet
Linum virginianum	Linaceae	LINVIR	native	9	0	forb	perennial	slender yellow flax
Liriodendron tulipifera	Magnoliaceae	LIRTUL	native	9	3	tree	perennial	tulip tree
Lonicera morrowii	Caprifoliaceae	LONMOR	non-native	0	3	shrub	perennial	morrow honeysuckle
Luzula multiflora	Juncaceae	LUZMUL	native	5	3	rush	perennial	common wood rush
Lysimachia lanceolata	Myrsinaceae	LYSLAN	native	9	0	forb	perennial	lance-leaved loosestrife
Lysimachia quadrifolia	Myrsinaceae	LYSQUL	native	8	3	forb	perennial	four-leaved loosestrife
Maianthemum racemosum; smilacina r.	Convallariaceae	MAIRAC	native	5	3	forb	perennial	false spikenard
Muhlenbergia tenuiflora	Poaceae	MUHTEN	native	8	5	grass	perennial	slender satin grass
Osmorhiza longistylis	Apiaceae	OSMLON	native	3	3	forb	perennial	smooth sweet-cicely
Ostrya virginiana	Betulaceae	OSTVIR	native	5	3	tree	perennial	ironwood; hop-hornbeam
Paronychia canadensis	Caryophyllaceae	PARCAN	native	8	5	forb	annual	tall forked chickweed
Piptochaetium avenaceum; stipa a.	Poaceae	PIPAVE	native	10	3	grass	perennial	black oatgrass

Poa sylvestris	Poaceae	POASYL	native	8	0	grass	perennial	woodland bluegrass
Podophyllum peltatum	Berberidaceae	PODPEL	native	3	3	forb	perennial	may-apple
Polygonatum pubescens	Convallariaceae	POLPUB	native	5	5	forb	perennial	downy solomon seal
Populus grandidentata	Salicaceae	POPGRA	native	4	3	tree	perennial	big-tooth aspen
Potentilla simplex	Rosaceae	POTSIM	native	2	3	forb	perennial	old-field cinquefoil
Prunus serotina	Rosaceae	PRUSER	native	2	3	tree	perennial	wild black cherry
Quercus alba	Fagaceae	QUEALB	native	5	3	tree	perennial	white oak
Quercus rubra	Fagaceae	QUERUB	native	5	3	tree	perennial	red oak
Quercus velutina	Fagaceae	QUEVEL	native	6	5	tree	perennial	black oak
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rubus allegheniensis	Rosaceae	RUBALL	native	1	3	shrub	perennial	common blackberry
Rubus occidentalis	Rosaceae	RUBOCC	native	1	5	shrub	perennial	black raspberry
Sambucus racemosa	Adoxaceae	SAMRAC	native	3	3	shrub	perennial	red-berried elder
Sassafras albidum	Lauraceae	SASALB	native	5	3	tree	perennial	sassafras
Scrophularia lanceolata	Scrophulariaceae	SCRLAN	native	5	3	forb	perennial	early figwort
Smilax ecirrata	Smilacaceae	SMIECI	native	6	5	forb	perennial	upright carrion-flower
Solidago caesia	Asteraceae	SOLCAE	native	6	3	forb	perennial	bluestem goldenrod
Sphenopholis nitida	Poaceae	SPHNIT	native	8	5	grass	perennial	shining wedgegrass
Symphyotrichum oolentangiense; aster o.	Asteraceae	SYMOOL	native	4	5	forb	perennial	prairie heart-leaved aster
Thalictrum thalictroides; anemonella t.	Ranunculaceae	THATHA	native	8	3	forb	perennial	rue-anemone
Tilia americana	Malvaceae	TILAME	native	5	3	tree	perennial	basswood
Tradescantia ohiensis	Commelinaceae	TRAOHI	native	5	3	forb	perennial	common spiderwort
Vaccinium angustifolium	Ericaceae	VACANG	native	4	3	shrub	perennial	low sweet blueberry
Viburnum acerifolium	Adoxaceae	VIBACE	native	6	5	shrub	perennial	maple-leaved viburnum
Viola pedata	Violaceae	VIOPET	native	9	5	forb	perennial	birdfoot violet

Range 13 Barrens EOID 23951								
06/12/2020								
Other Notes:	Also Crataegus sp.							
Conservatism-Based Metrics:								
Total Mean C:	4.2							
Native Mean C:	4.7							
Total FQI:	36.1							
Native FQI:	38.5							
Adjusted FQI:	44.7							
% C value 0:	9.5							
% C value 1-3:	29.7							
% C value 4-6:	36.5							
% C value 7-10:	24.3							
Native Tree Mean C:	4.4							
Native Shrub Mean C:	3.9							
Native Herbaceous Mean C:	4.8							
Species Richness:								
Total Species:	74							
Native Species:	67	90.50%						
Non-native Species:	7	9.50%						
Species Wetness:								
Mean Wetness:	3.5							
Native Mean Wetness:	3.5							
Physiognomy Metrics:								
Tree:	8	10.80%						
Shrub:	13	17.60%						
Vine:	0	0%						
Forb:	29	39.20%						
Grass:	15	20.30%						
Sedge:	8	10.80%						
Rush:	1	1.40%						
Fern:	0	0%						
Bryophyte:	0	0%						
Duration Metrics:								
Annual:	0	0%						
Perennial:	70	94.60%						
Biennial:	4	5.40%						
Native Annual:	0	0%						
Native Perennial:	64	86.50%						
Native Biennial:	3	4.10%						
Species:								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Achillea millefolium	Asteraceae	ACHMIL	native	1	3	forb	perennial	yarrow

Agrostis scabra; a. hyemalis	Poaceae	AGRSCA	native	4	0	grass	perennial	ticklegrass
Amorpha canescens	Fabaceae	AMOCAN	native	8	5	shrub	perennial	lead-plant
Antennaria neglecta	Asteraceae	ANTNEG	native	3	5	forb	perennial	cats foot
Antennaria parlinii	Asteraceae	ANTPAL	native	2	5	forb	perennial	smooth pussytoes
Asclepias tuberosa	Apocynaceae	ASCTUB	native	5	5	forb	perennial	butterfly-weed
Asclepias viridiflora	Apocynaceae	ASCVIR	native	8	5	forb	perennial	green milkweed
Berberis thunbergii	Berberidaceae	BERTHU	non-native	0	3	shrub	perennial	japanese barberry
Brachyelytrum erectum	Poaceae	BRAERE	native	7	5	grass	perennial	long-awned wood grass
Carex cephalophora	Cyperaceae	CXCEPP	native	3	3	sedge	perennial	sedge
Carex gracillima	Cyperaceae	CXGRAA	native	4	3	sedge	perennial	sedge
Carex laxiculmis	Cyperaceae	CXLAXC	native	8	3	sedge	perennial	sedge
Carex muehlenbergii	Cyperaceae	CXMUEH	native	7	5	sedge	perennial	sedge
Carex pensylvanica	Cyperaceae	CXPENS	native	4	5	sedge	perennial	sedge
Carex rosea; c. convoluta	Cyperaceae	CXROSE	native	2	5	sedge	perennial	curly-styled wood sedge
Carex swanii	Cyperaceae	CXSWAN	native	4	3	sedge	perennial	sedge
Carex tonsa; c. rugosperma	Cyperaceae	CXTONS	native	5	5	sedge	perennial	sedge
Carya glabra	Juglandaceae	CARGLA	native	5	3	tree	perennial	pignut hickory
Ceanothus americanus	Rhamnaceae	CEAAME	native	8	5	shrub	perennial	new jersey tea
Centaurea stoebe; c. maculosa	Asteraceae	CENSTO	non-native	0	5	forb	biennial	spotted knapweed
Cornus florida	Cornaceae	CORFLO	native	8	3	tree	perennial	flowering dogwood
Corylus americana	Betulaceae	CORAMA	native	5	3	shrub	perennial	hazelnut
Danthonia spicata	Poaceae	DANSPI	native	4	5	grass	perennial	poverty grass; oatgrass
Desmodium marilandicum	Fabaceae	DESMAR	native	7	5	forb	perennial	small-leaved tick-trefoil
Desmodium paniculatum	Fabaceae	DESPAN	native	4	3	forb	perennial	panicled tick-trefoil
Desmodium rotundifolium	Fabaceae	DESROT	native	8	5	forb	perennial	round-leaved tick-trefoil
Dichanthelium depauperatum; panicum d.	Poaceae	DICDEP	native	4	5	grass	perennial	panic grass
Dichanthelium dichotomum; panicum d.	Poaceae	DICDIC	native	7	0	grass	perennial	panic grass
Dichanthelium implicatum; panicum i.	Poaceae	DICIMP	native	3	0	grass	perennial	panic grass
Dichanthelium oligosanthes; panicum o.	Poaceae	DICOLI	native	5	3	grass	perennial	panic grass
Dichanthelium sphaerocarpon; panicum s.	Poaceae	DICSPH	native	5	3	grass	perennial	round-fruited panic grass
Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive
Elymus hystrix; hystrix patula	Poaceae	ELYHYS	native	5	3	grass	perennial	bottlebrush grass

Euphorbia corollata	Euphorbiaceae	EUPCOR	native	4	5	forb	perennial	flowering spurge
Festuca subverticillata; f. obtusa	Poaceae	FESSUB	native	5	3	grass	perennial	nodding fescue
Fragaria virginiana	Rosaceae	FRAVIR	native	2	3	forb	perennial	wild strawberry
Galium pilosum	Rubiaceae	GALPIL	native	6	5	forb	perennial	hairy bedstraw
Hieracium gronovii	Asteraceae	HIEGRO	native	5	5	forb	perennial	hairy hawkweed
Hylodesmum nudiflorum; desmodium n.	Fabaceae	HYLNUD	native	7	5	forb	perennial	naked tick-trefoil
Juncus tenuis	Juncaceae	JUNTEN	native	1	0	rush	perennial	path rush
Juniperus virginiana	Cupressaceae	JUNVIR	native	3	3	tree	perennial	red-cedar
Lactuca canadensis	Asteraceae	LACCAN	native	2	3	forb	biennial	tall lettuce
Lespedeza capitata	Fabaceae	LESCAP	native	5	3	forb	perennial	round-headed bush-clover
Lespedeza hirta	Fabaceae	LESHIR	native	7	5	forb	perennial	hairy bush-clover
Lespedeza violacea; l. intermedia	Fabaceae	LESVIO	native	7	5	forb	perennial	bush-clover
Liatris aspera	Asteraceae	LIAASP	native	4	5	forb	perennial	rough blazing-star
Lonicera morrowii	Caprifoliaceae	LONMOR	non-native	0	3	shrub	perennial	morrow honeysuckle
Lupinus perennis	Fabaceae	LUPPER	native	7	5	forb	perennial	wild lupine
Lysimachia lanceolata	Myrsinaceae	LYSLAN	native	9	0	forb	perennial	lance-leaved loosestrife
Muhlenbergia tenuiflora	Poaceae	MUHTEN	native	8	5	grass	perennial	slender satin grass
Piptochaetium avenaceum; stipa a.	Poaceae	PIPAVE	native	10	3	grass	perennial	black oatgrass
Poa compressa	Poaceae	POACOM	non-native	0	3	grass	perennial	canada bluegrass
Poa pratensis	Poaceae	POAPRA	non-native	0	3	grass	perennial	kentucky bluegrass
Prunus serotina	Rosaceae	PRUSER	native	2	3	tree	perennial	wild black cherry
Quercus alba	Fagaceae	QUEALB	native	5	3	tree	perennial	white oak
Quercus velutina	Fagaceae	QUEVEL	native	6	5	tree	perennial	black oak
Rhus copallina	Anacardiaceae	RHUCOP	native	3	5	shrub	perennial	winged sumac
Rosa carolina	Rosaceae	ROSCAR	native	4	3	shrub	perennial	pasture rose
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rubus allegheniensis	Rosaceae	RUBALL	native	1	3	shrub	perennial	common blackberry
Rubus flagellaris	Rosaceae	RUBFLA	native	1	3	shrub	perennial	northern dewberry
Rubus pensilvanicus	Rosaceae	RUBPEN	native	2	3	shrub	perennial	dewberry
Sanicula canadensis	Apiaceae	SANCAS	native	8	3	forb	biennial	black snakeroot
Sassafras albidum	Lauraceae	SASALB	native	5	3	tree	perennial	sassafras
Schizachyrium scoparium; andropogon s.	Poaceae	SCHSCO	native	5	3	grass	perennial	little bluestem
Solidago altissima	Asteraceae	SOLALT	native	1	3	forb	perennial	tall goldenrod
Solidago juncea	Asteraceae	SOLJUN	native	3	5	forb	perennial	early goldenrod
Solidago nemoralis	Asteraceae	SOLNEM	native	2	5	forb	perennial	old-field goldenrod
Solidago rugosa	Asteraceae	SOLRUG	native	3	0	forb	perennial	rough-leaved goldenrod

Solidago speciosa	Asteraceae	SOLSPE	native	5	5	forb	perennial	showy goldenrod
Turritis glabra; arabis g.	Brassicaceae	TURGLA	native	3	5	forb	biennial	tower mustard
Vernonia missurica	Asteraceae	VERMIS	native	4	0	forb	perennial	missouri ironweed
Zanthoxylum americanum	Rutaceae	ZANAME	native	3	3	shrub	perennial	prickly-ash