Calvin Ecosystem Preserve & Native Gardens
Land Management Plan

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Calvin Ecosystem Preserve
& Native Gardens

Table of Contents

List of Figures & Tables

PREFACE

This land management plan is a significant step for the Calvin Ecosystem Preserve and Native Gardens. Past strategic plans (1993 and 2009) have addressed land management in broad terms. The 1993 plan focused on protecting wildlife and native plant communities from excessive human use, and the 2009 plan expanded the scope of management to address invasive species and successional changes. Since the last plan, and with generous donor support, the preserve has hired a full-time land manager, Jen Howell, and increased the capacity for active management. The plan that follows is therefore the most expansive and detailed land management plan the preserve has produced in its 35-year history. It builds on decades of creative and dedicated work by Randy Van Dragt, the first preserve director, dozens of student staff members and volunteers, and several program managers, most recently Jeanette Henderson. Specifically, it builds on years of careful data collection and management achievements and sets out a comprehensive set of management objectives designed to meet the preserve's missional goals and demonstrate Calvin University's commitment to creation care.

This plan will guide land management for years to come, not as a static set of directives but as an adaptive framework. It will be reviewed on a regular basis and revised as needed based on physical conditions, use patterns, and resource availability. This document provides both a clear path forward and flexibility for adaptive management.

ACKNOWLEDGEMENTS

This plan for managing the lands and ecological communities of the Calvin Ecosystem Preserve and Native Gardens emerges 35 years after the original Ecosystem Preserve was established by, Calvin College in 1985. For much of its history management of the Preserve consisted of directing human use and allowing the Preserve lands, for decades subjected to intense agricultural use, to heal themselves with little human intervention. We have now reached a time when trends in the development of preserve lands require the more active guidance which this plan proposes.

After so many years, a plan like this does not spring to life *de novo* but emerges from a wealth of past practices and long study of the places that make up the Preserve. All those who observed and cared for this place have contributed to the plan, as have those inside and outside of the Calvin University community who have supported the Ecosystem Preserve and Native Gardens and made them possible. To all of you, we, the authors of the plan, are indebted and here acknowledge that this work is made possible by such a host of advisors, stewards, donors, administrators, researchers, and volunteers that we would surely leave out many if we attempted to acknowledge you each by name. But whether past or present student, faculty, board member, supporter, or staff, this work would not be what it is without you, and for your contributions we thank you.

OVERVIEW

Introduction

Calvin University (hereafter Calvin or University) is situated in Kent County, MI on ca. 400 contiguous acres of developed and undeveloped lands lying in the cities of Grand Rapids, East Grand Rapids, and Kentwood. The Calvin Ecosystem Preserve and Native Gardens (hereafter Ecosystem Preserve or Preserve) occupy ca. 104 acres (41.6 hectares) of the eastern portion of the Calvin campus with 28.5 acres located in Grand Rapids and 75.5 acres in Kentwood. The Preserve, created by the university in 1985, includes a diversity of habitats on a glaciated terrain, including mature deciduous forest, secondary forests of varying ages, abandoned agricultural fields now in secondary succession, and numerous ponds, intermittent streams, and wetlands. The Preserve is a facility of the university and is managed under direction of a university-appointed Advisory Board to meet the educational needs and conservation interests of the university and its surrounding community.

In consideration of the widespread degradation of creation that prevailed at the time of its inception, the Ecosystem Preserve was established to be "a small space where a continuing Sabbath holds sway. Here the land, the flora and the fauna are allowed to exist in a state of perpetual fallow, with humans present only to know, preserve, restore, and celebrate the intricate beauty and goodness of God's creation. The Preserve is both reality and symbol, declaring to those with ears to hear and eyes to see, that "the Earth is the Lord's and the fullness thereof" (Ps. 24:1)" (Preserve Master Plan, 1993). To this end, in 1985 Calvin University (then Calvin College) established the Ecosystem Preserve with a mission framed by the following goals:

- To preserve and restore within its boundaries:
  a. a variety of ecological communities characteristic of the West Michigan area, and
  b. those features of the site which are essential to maintaining the integrity of its ecosystems;
- To provide Calvin [University] with an academic resource for the support of such course and research activities as are specifically designed to study those features of God's creation found on the Preserve;
- To provide a passive re-creational resource for the Calvin [University] community, in the use of which appreciation of the natural features of the Preserve will be emphasized;
- To provide for the larger community, of which Calvin [University] is a part, a re-creational resource and center for environmental education;
- To help develop for the [university] a larger sense of its environmental footprint and its interactions with the surrounding landscape.

As noted in the preface, it is the purpose of this plan to provide a flexible guide to future management of the Preserve to preserve, restore, and maintain its natural features consistent with this mission.

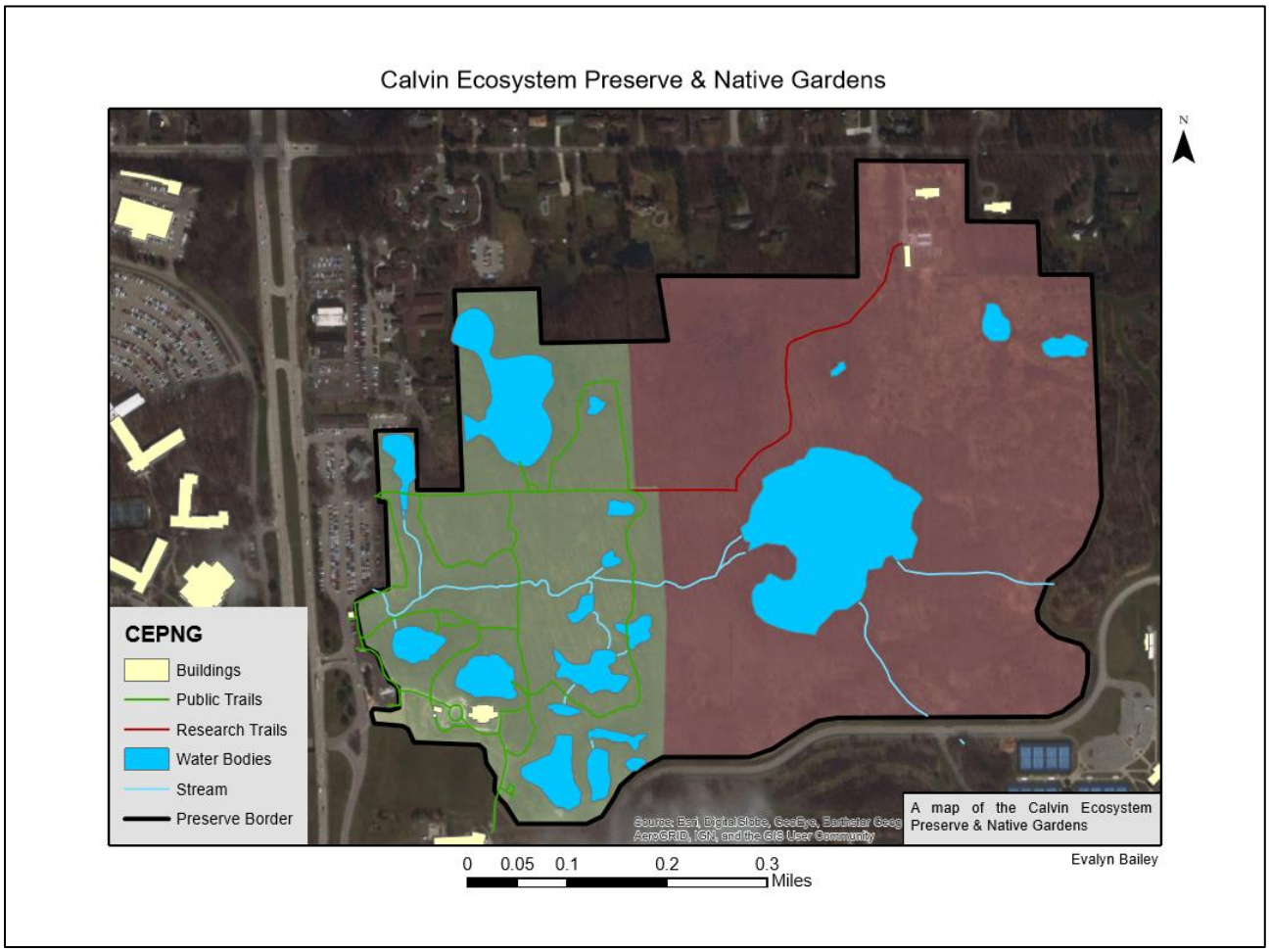

Figure 1: Contextual map of the Ecosystem Preserve.

This map shows the Ecosystem Preserve & Native Gardens in the context of the Calvin University campus and adjacent residential and commercial developments. The red area indicates the refuge/sanctuary portion of the Preserve. The green area represents the public portion of the Preserve.

Conservation Importance

Given the urbanized environment in which it is located, the Preserve is significant for what it contains, as well as for its restoration potential. Within its relatively small footprint, the Preserve contains both native forest on unplowed soils and contiguous second-growth stands on abandoned farmland. Its varied topography holds numerous small ponds and larger bodies of water with both open water and vegetative cover. This rich habitat diversity harbors 299 plant species, 206 of which are native to the area (Appendix J). Its native plant diversity gives

the Preserve a Floristic Quality Index (FQI) of 51.7. By Michigan standards (Herman, K., et al., 2001), areas with an FQI "registering in the 50s and higher are extremely rare and represent a significant component of Michigan's native biodiversity and natural landscapes." The Preserve's habitat diversity attracts a broad diversity of native fauna, particularly resident and migratory birds (179 species) and mammals (31 species). Appendix M lists all the vertebrate species that have been found on the Preserve. To support this floral and faunal diversity, it is of high conservation importance to maintain the quality of native preserve habitats in the face of pressures from human activity, opportunistic mammal species (e.g. white-tailed deer and raccoons), and invasive plant species.

Abandoned agricultural lands provide the opportunity for restoring additional valuable habitats, such as grassland. Extensive agriculture was historically conducted on much of the eastern half of the Preserve. Last tilled to grow corn in 1984 and 1985, farming was abandoned when Calvin purchased the land, and since then various successional communities have come and gone on the old farm fields. One of the richest periods of bird diversity on these lands was seen in the first five years after abandonment, when weedy grassland replaced the corn fields. After that period, woody species began to invade, and today large areas are dominated by shrubs and small trees, no longer an ideal habitat for grassland birds. With timely action, these abandoned agricultural lands still provide an opportunity to restore grassland to the Preserve, though maintaining grassland would require periodic burning, permission for which has been hard to obtain.

Given its situation in an increasingly urbanized landscape, the Preserve may also serve as a significant refuge for uncommon plant and animal species. As an example, the Preserve presently is home to two turtle species officially designated as of special concern in Michigan: Blanding's turtle (*Emidoidea blandingi*) and the Eastern box turtle (*Terrapene carolina*). In the Preserve, Blanding's turtles are largely confined to the area around North and Northwest ponds and are rarely seen on land except in late spring and early summer during mating and egg laying. Later, in summer and early fall, the occasional Blanding's turtle can be seen basking on a log in North Pond. By contrast, a somewhat larger population of box turtles is dispersed throughout much of the Preserve. Since 1986, preserve workers have captured box turtles as they encounter them, mapped the location of each capture, and uniquely marked each animal so that it can be identified when recaptured in the future. With each capture the animal's information is documented, and it is returned to the point of capture. Over the years a total of 45 different turtle have been captured and marked, and many of these have been recaptured more than once.

Each of these species shows evidence that its population, however low, is being maintained at viable levels. Hopefully, future management efforts will sustain the populations of each species

and permit their expansion in appropriate habitat. One factor that may be suppressing population growth for each of these turtles is the large population of raccoons that ranges the Preserve and exerts heavy egg predation on other more common species like the midland painted turtle (*Chrysemys picta*) and the common snapping turtle (*Chelydra serpentina*).

Educational Importance

As a facility of Calvin University, one purpose of the Ecosystem Preserve is to support the academic mission of the university. In establishing the Preserve, the university adopted the goal of using its natural features as a venue for course studies and research to the degree that such uses were consistent with conserving and restoring the native ecology of preserve lands. Since 1985 the Preserve has served formal courses as an outdoor laboratory or classroom, a subject for student projects, and a setting for research in a wide range of disciplines (art, biology, chemistry, education, sociology, and more).

Beyond the classroom, the Preserve provides practical experience for students with interests in environmental education and land management. For 25 years the Preserve has offered programs in environmental education for elementary schools and other groups during the academic year and in summer camps. The programs are conducted by Calvin students who are trained and supervised by the Preserve's program manager who is a trained environmental education professional. Involvement in these programs allows Calvin students to learn methods for applying their knowledge in a practical setting and to develop skills for outdoor education. Critically, the education programs also give students the opportunity to evaluate the extent of their interests in environmental education as a vocational choice.

Much of the care of the Preserve is also conducted by students. During the academic year, students monitor the use of the Preserve and help with light maintenance of preserve infrastructure. In the summer student crews are hired to conduct a variety of tasks dealing with heavier trail construction and maintenance, non-native plant control, botanical and zoological monitoring, garden maintenance and more. This work is done in such a way as to introduce the student workers to basic land management practice, and most students who participate in this less formal education develop skills sufficient to allow them to enter related employment elsewhere.

Beyond the formal curriculum, the Preserve also serves as a site for passive recreation and informal education for the university community and for the larger residential community surrounding the Calvin campus. For campus residents, the Preserve is a place to get away from the busy atmosphere of the campus and engage creation in ways less structured than those provided by the classroom. The Preserve is also open to the public during daylight hours and invites visitors to take advantage of interpretive materials available along the trails, in the

Bunker Interpretive Center (BIC), and in the newly created Venema Native Gardens. Programs for the public are also part of the Preserve's regular offerings.

The educational goal of the Preserve is to develop a greater appreciation of the creation by engaging visitors and program participants in the beauty and function of the creation. Experiential education is key to building this appreciation, but it also creates tensions with the goal of preserving natural features. Off-trail excursions are always a temptation for visitors and with that use comes the trampling of small plants, soil compaction and other adverse effects. This tension became particularly evident in 2020 when schools closed, and families were urged to stay home during the initial days of the COVID-19 pandemic. The significant increase in visitation during this period was accompanied by heavy off-trail traffic in areas that had seen little disturbance in previous years. This experience made evident the need for a preserve land management plan with strong conservation goals that strikes a balance between exploration and preservation. Land management in the Ecosystem Preserve, then, becomes an exercise in people management as well as ecosystem management.

Conservation Vision

Calvin University is a Christian, faith-based organization, rooted in that tradition of Reformed Christianity which places high value on creation. As such, the conservation vision of the Ecosystem Preserve is motivated by the biblical vision of "shalom" in which all creation flourishes to the degree that human cultural landscapes – homesteads, farms, cities, etc. -- exist in sustainable interaction with native ecosystems. In this vision the Creator is honored and glorified as both human and non-human elements of creation thrive in mutually supporting relationships. In pursuing its work of preservation, restoration, education, and research, the Preserve's goal is to shape within its boundaries a dynamic landscape in which native ecosystems with a diverse suite of appropriate species are encouraged to thrive alongside landscape elements – some historic, some novel – designed more to serve human purposes. Key to achieving this vision is the active preservation and restoration of historic West Michigan habitats and a commitment to assuring that any human use of the Preserve should produce minimum impact on preserve ecosystems, either locally or system wide. The value of this vision is evident in the attention given to the Preserve by the latest campus master planning effort in which the consultants took strong notice of the Preserve as a model for campus development and called for the Preserve to be protected and its elements to be extended to the larger campus (Campus Master Planning Concept Plan, 2014).

KEY CONSERVATION GOAL: Calvin University will restore and manage its Ecosystem Preserve lands to sustain functional native ecosystems with a diverse suite of appropriate native species.

This conservation vision for the Preserve property provides an overall touchstone for managing both the ecological features of the site and the ways in which human visitors interact with them. Maintaining the ecological integrity of the site is vital for upholding all five components of the Preserve's mission. Public use policies (Appendix B) and research protocols (Appendix C) have been developed to help sustain the property while also making it available for educational purposes as well as public use and enjoyment.

General Description of the Property

Drawn from 7 original parcels, the Ecosystem Preserve site is an irregularly shaped parcel of ca. 104 acres that occupies much of the northern half of the East Campus of Calvin University. The glacial origin of the Preserve appears to be that of a kettle moraine—an area which at one time was glacial gravels, clays, and sands intermixed with ice blocks of various sizes. The melting of these blocks left depressions, or "kettles," the largest of which on the Preserve is some 800 feet in diameter and now contains Kettle Swamp. Several other kettles, ranging from about 50 feet across to 300 feet across support other types of wetland communities ranging from shrub swamp to open ponds to wet meadows.

The native land cover is mixed deciduous forest and shrubland with the oldest forest stand in a central woodlot and younger stands of varying ages from 35 to 80 years old arrayed around the central forest. Farther from the center the east side of the Preserve is a mixture of shrubland and grassy opens growing on land last farmed in 1984 (Fields F and G) and 1985 (Fields C, D, and E). Dispersed through the rolling forested landscape are ponds and wetlands of varying sizes and an intermittent stream, Whiskey Creek, which is a tributary of Plaster Creek. The preserve headquarters and an associated greenhouse complex and nursery are located on the north margin at 3770 Lake Drive SE. The preserve education center, the Bunker Interpretive Center, is located at the southwest corner of the property just off East Beltline Avenue at 1750 East Beltline Avenue.

To assist in identifying and describing features and areas throughout this plan, we have divided the site into management units of various sizes (Fig.2). Most units reflect historic agricultural uses and are homogeneous in terms of vegetation and other site features. Unit boundaries typically correspond to landscape features (fence lines, roads) and vegetational changes. Names were chosen to denote the general location or dominant ecological community of the different units. Principle cultural features of the property are described in the map and tables found in Appendices E-I.

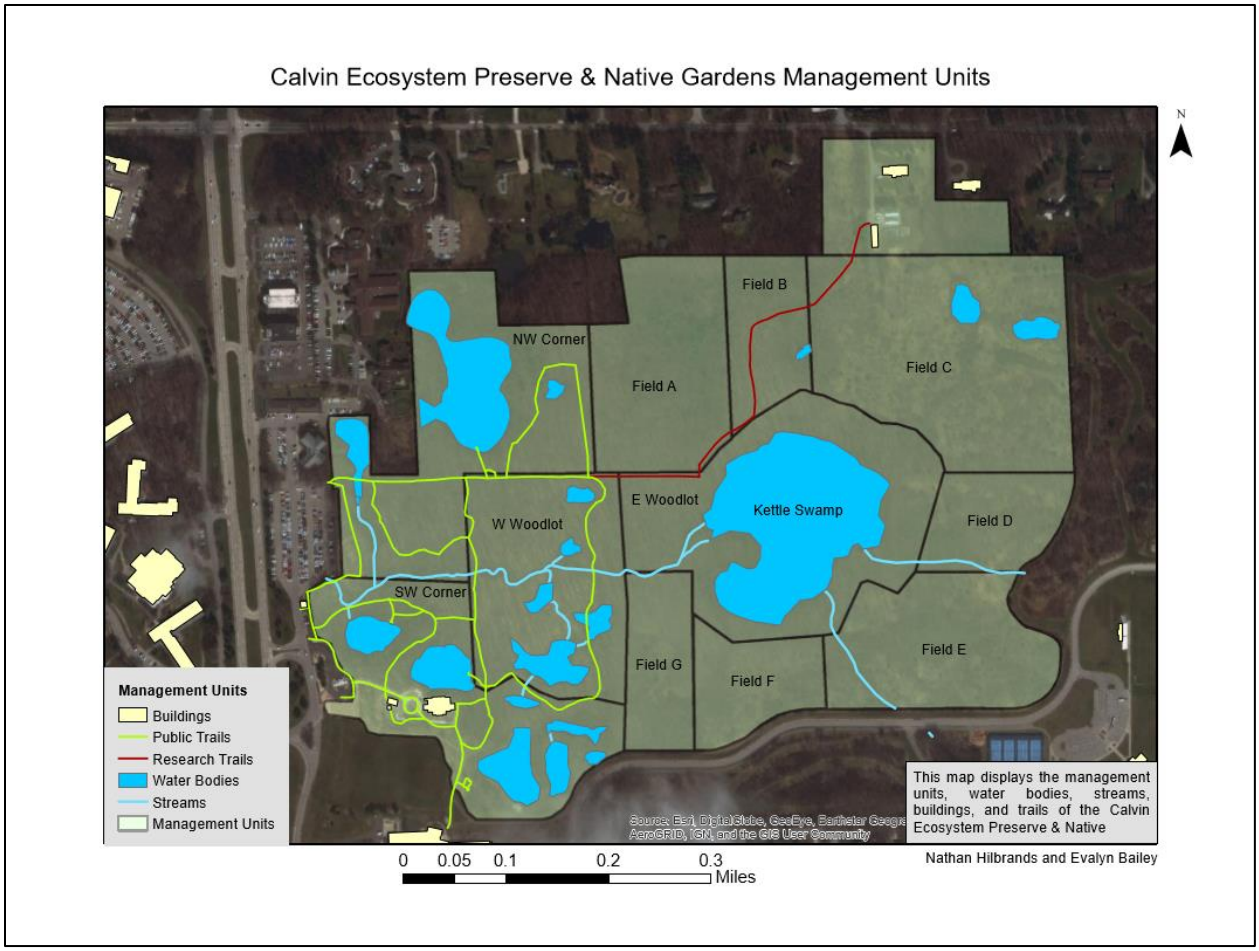

Figure 2: Map of the management units of the Ecosystem Preserve

Site History

Pre-Calvin Years

The Ecosystem Preserve site lies in section 2 of what was historically Kent County's Paris Township. Since its origin in 1831, the lands of the township were gradually annexed by urban centers until by 1969 and the establishment of the City of Kentwood all the historic township lands belonged to the municipalities of Grand Rapids, East Grand Rapids, and Kentwood. In the Preserve, the line between the cities of Grand Rapids and Kentwood runs north to south roughly along the line separating the public and refuge portions of the Preserve.

Prior to the advent of Euro-Americans and the large-scale conversion of the land to agriculture, the Calvin Preserve site was predominantly covered by forest, the species composition of which was largely determined by the nature of the underlying soil. Soils of the Preserve are moderately well drained, clay loams which in this area of Michigan favor a mature forest dominated by American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*).

Consistent with its glacial terrain, the forest was punctuated with small kettle ponds, swamps, and more open wetlands. This mixture of forest and wetland provided a wide range of resources for Native Americans, and, while archeological evidence of their presence on the preserve site is scant, some stone tools and arrow points have been found there (George Harper, personal communication).

Euro-American settlement of the preserve area began in the early 1800s and accelerated with the Michigan general land survey (early 1800s to 1850s) and the recognition of Michigan as a state in 1836. Kent County was organized in 1831, with Paris Township being the second named township in the county. Accounts of the township (Dillenbach and Leavitt, 1870) indicate that the early settlers lived a subsistence lifestyle and only slowly developed sufficient agricultural production to sell their surplus in Grand Rapids. Farms expanded in proportion to the felling of the forest to provide farmland. By the 1870's section 2 of Paris Township supported active farming that became more diverse as farmers were able to supply their products to the city.

When the first aerial photo was taken of the preserve area in 1938 (Fig, 3), the land was largely devoid of forest except for the small mature stand of trees presently at the heart of the Preserve and the adjacent woodland surrounding Kettle Swamp. At the time of that photo, the forest canopy was quite open indicating active harvest of trees for timber and firewood. Evidence of this use can be found in the fact that in the early 1980s stacks of split firewood could still be found on the wooded slope to the west of Kettle Swamp. Outside the forest remnant, the area within the present preserve boundary appears to have been extensively tilled and subjected to mixed agricultural uses, including pasture for cattle and horses, orchards, and the production of hay and grains. Photos taken in the 1950s show consolidation of land areas and some reduction in the diversity of agricultural land uses, the trend being mostly toward larger areas dedicated to cultivation of crops.

Creating the Calvin College Ecosystem Preserve

Calvin University (Calvin College before 2019) entered the larger landscape of the future Preserve in 1956 when it moved from its urban campus on Franklin Street to a farm property situated just across East Beltline Avenue from the preserve area. Established in 1876 to provide future leaders of the Christian Reformed Church (CRC) with a college education, Calvin had occupied several inner-city locations before building a campus on Franklin Street near the present Martin Luther King Park. By the early 1950's Calvin was a liberal arts college with an expanding enrollment that could not be adequately served at its Franklin Street location. In 1956 the leadership of the CRC decided to move the university to a site on the west side of the East Beltline between Burton St. and Lake Drive, known as "Knollcrest Farms." In 1962 Calvin Seminary held its first classes in its new facility on Burton St., while the university was building

its first classroom and library building and dormitories for its growing resident student population.

Figure 3: Aerial photo of the Ecosystem Preserve area as it appeared in 1938.
Three landmarks that define the center of the Preserve are North Pond (NP), South Pond (SP), and Kettle Swamp (KS). Some of the variety of land uses at the time of this photograph are pasture for livestock (PA), orchards (OR), and cultivation for crops (CF).

As the campus grew, the need for additional space for staging construction materials and residential parking became more pressing. To address this need, in 1964 the university purchased an 80-acre farm on the east side of the East Beltline at the corner of East Beltline Avenue and Burton Street. The farm belonged to William Kelly and at the time was used largely

for grazing livestock. At the north end of the property stood the mixed hardwood stand at the center of today's Preserve bounded by old pasture lands and several small ponds, including Whiskey and South Ponds. In the next few years, the university built a 2-acre parking lot (Parking Lot 13) at the northwest corner of the site, and to the south of Whiskey and South Ponds it developed disposal areas for clean construction waste from the campus and staging areas for excavation spoils. Most of these materials were used in the 1970'as fill for construction of the lacrosse field.

The woodlot on the W. Kelly land received little formal attention from the university during the 1960's. It served as a site for occasional biology fieldtrips and recreational outings by students, but it was not easily accessed, and traffic from the campus was low. In the mid-1970s several faculty members turned their attention to the woodlot, and the idea of forming the area into a campus preserve began to take shape. In 1974 Dr. Alan Gebben pursued the idea of using the area for long-term studies in forest structure and development by installing a fixed sampling grid in the woodlot nearly five acres in extent. He installed the grid with the help of senior biology student, John Ubels, who many years later joined the Calvin biology faculty, and the two of them censused all the trees in the grid greater than two inches in diameter, more than 700 trees total. This effort laid the baseline for a study of the development of this small forest that continues to this day.

The idea of creating a College forest preserve, however, seems to belong to two members of the Calvin English department, Drs. Kenneth Kuipers and George Harper, who as devoted anglophiles thought the Calvin University campus should have a forest reserve like many British universities. The idea of a establishing a preserve centered on the woodland gained momentum in the late 1970's when in 1977 it became part of the work of the first group of scholars assembled as the Calvin Center for Christian Scholarship (CCCS). The larger project of this inaugural CCCS team was the seminal volume on Christians and creation care entitled *Earthkeeping: Christian Stewardship of Natural Resources*. A smaller product was a proposal for the university to establish an "ecosystem preserve" that would include not only the northern part of the W. Kelly property but also contiguous lands to the north and east, none of which at the time were owned by the university.

In 1980 the university administration referred the CCCS proposal to an *ad hoc* committee chaired by Dr. Gebben. That committee returned a more fleshed-out proposal for the lands owned by the university and provided some estimate of the costs involved in developing a preserve that could be accessed by the college community. Creation of the Ecosystem Preserve became part of a proposal to the Angell Foundation of Muskegon, MI, and in 1985 funds were obtain from the foundation to open up the woodland with trails and other structures to allow visitors to fully appreciate this campus asset. At the same time, a parcel north of the university

land was purchased from a local farmer, George Van Elst, so that North Pond and Northwest Pond could be added to the preserve project.

Construction of the basic access infrastructure for the Preserve, took place during the summers of 1985 and 1986. In 1985 twelve college students under the direction of Professors Marvin Vander Wal and Randall Van Dragt installed the central trail loop in the woodland and a second loop to the west of the woodlot (Lowland Trail). In addition to 0.75 mi of wood-chipped trails, the 1985 team constructed overlooks on North and South Ponds, three bridges over Whiskey Creek, and a boardwalk across the small swamp created by spillover from Woods Pond 2. At that time, a single entrance to the trail system was provided at the northeast corner of Parking Lot 13. As part of the initial construction, portions of the external boundary of the Preserve and the boundary internal to the campus were fenced by a commercial contractor using inverted sheep fence (large openings on the bottom to allow passage of small animals). With this work complete, the Calvin College Ecosystem Preserve was dedicated and opened to visitors in October 1985.

In the summer of 1986, a team of four students working with Dr. Van Dragt completed the planned trail and fencing work that remained unfinished in 1985. This work created a south entrance to the trail system which emerged from the south edge of the forest and looped past South and Whiskey Pond to the access road to Parking Lot 13. Additional internal fences were erected to complete the physical separation between the public and future wildlife refuge portions of the Preserve.

Study of the configuration of the original Preserve over the 1985-86 academic year, made it clear that the Ecosystem Preserve had vital ties to lands to the east, particularly in the form of the water flow in Whiskey Creek. The creek originated offsite from Kettle Swamp and flowed across the Preserve to the main campus where it was impounded in the Seminary Pond. Since Kettle Swamp collected waters from more than 100 acres of land to the east of the original Preserve, development of those lands would influence water quality in the Preserve and on the main university campus. The committee overseeing the Preserve at the time petitioned the administration and Board of Trustees to purchase the farmland to the east, including Kettle Swamp. While the university was considering this proposal, a local retirement home obtained an option to buy the same property and submitted a plan to the City of Kentwood to develop an extensive retirement community on the land. The retirement community proposal generated significant resistance from local Kentwood residents, and when it became known that Calvin was interested in purchasing the land and dedicating a significant portion of it to greenspace, Kentwood turned down the retirement community proposal. Calvin then secured an option to purchase the property, which at the time was owned by Judge Joseph Kelly – brother of William Kelly mentioned earlier. In 1986-87 the University successfully raised the

funds to purchase the J. Kelly property which included farmland extending eastward from the 1985 Preserve to East Paris Avenue and north to the line of residences along Lake Drive. In addition to the Kelly property, the university purchased from Peter Cook a parcel of ca. 10 acres northwest of Kettle Swamp and contiguous with the northern portion of the J. Kelly farm (Fig. 2). With these purchases, the size of the Preserve expanded from the original 35 acres on the W. Kelly property to a total of ca. 125 acres. In 2009 the wildlife refuge created from these acquisitions was formally named the Paul and Caroline Buiten Wildlife Sanctuary in recognition of the role Paul Buiten played in raising the funds needed to create the reserve.

With the acquisition of these additional lands, university properties west and east of East Beltline Avenue totaled ca. 385 acres, more than 25% of which was in the Ecosystem Preserve. To oversee preserve lands and guide their development and use, the university in 1991 adopted a constitution for the governance of the Preserve, formed a preserve Governing Board, and appointed the first preserve director, Randall Van Dragt. The director and Governing Board over the next two years developed a preserve master plan that laid out guidelines for the development and use of the Preserve (Preserve Master Plan, 1993). The master plan embodied the conservation vision presented earlier in this document and laid out management strategies consistent with the preservation and education goals for the Preserve. That document has substantially shaped the development of the Preserve along with its management and use.

Changes in the Land

The configuration of the Preserve remained largely unchanged from 1987 to 1995. The preserve boundaries on the north and west were firmly established along development lines on the university campus and by residential properties along Lake Drive. During this period, the boundaries on the south and west within the City of Grand Rapids were defined by the developed portions of campus (athletic fields and the Knollcrest East apartments); on the east the residential properties along Observatory Ave defined the boundary. In the City of Kentwood, the south boundary was the limit of the J. Kelly property along Griggs Street and the east boundary was East Paris Avenue. It was understood during this period that some portions of the J. Kelly farm would eventually be used for campus development, but that until that time they would be managed as part of the Preserve.

In 1995 a neighbor, Helen Bunker, on the north preserve boundary helped the University purchase the 9-acre J. Kelly homestead on Lake Drive. The purchase included the Kelly home, one outbuilding and a 3-acre open field, the last undeveloped lot on the south side of Lake Drive between East Paris and East Beltline Avenues. In 1995 the former J. Kelly home was established as the preserve headquarters and research center.

In the twenty years following the 1987 purchase of the 134-acre Kentwood property, the old share-cropped corn fields that dominated much of the parcel soon began the process of ecological succession. Over the first four years the old fields developed into functional grasslands dominated by introduced agricultural weeds. Despite the plant composition of these grasslands, they attracted a variety of grassland wildlife, including birds like bobolinks and eastern meadowlarks. By year five, in the absence of fire, these grassy elements of the Preserve were being invaded by woody pioneer species from the surrounding wooded areas. At this time, the grassland birds left to be replaced by species that favor shrubby meadows, like indigo buntings and yellow warblers. As woody growth progressed, grassy open spaces constricted until by 2020 little open space remains. The remaining grassy areas are found in north and central parts of Field C and on the small sand prairie area in Field D. Maintaining and expanding these remaining grassy areas is of considerable conservation value for the Preserve.

In 1998 CU adopted a campus masterplan that envisioned a dramatic step in future campus development, the extension of the academic campus to the east side of East Beltline Avenue. Major elements of the plan included new academic buildings, a major conference center to serve the University, and new athletic facilities. To serve the new facilities and connect widely separated elements of the campus, a cross-campus road would be built to serve the new East Campus and connect it to East Paris Avenue.

Buildout of this plan began in 2000 and over the following four years produced extensive changes in the East Campus landscape. Near East Beltline Avenue, the De Vos Communication Center and the Prince Conference Center (PCC), and associated parking lots, were built on areas previously occupied by athletic fields and abandoned farmland. These new facilities were connected to the West Campus by Calvin's Crossing and to East Paris Avenue by a cross-campus road. On campus lands situated in Kentwood, south and east of Kettle Swamp, a campus cross-country course was created in the shrub dominated fields. As East Campus development was underway, the University entered an arrangement with the Grand Rapids Christian Schools to allow the schools to develop an athletic complex, now known as Gainey Field, on the southeast corner of the 1987 J. Kelly land purchase and an adjacent 15 acres to the south along East Paris Avenue. Gainey Field was completed in 2003, and the Christian Schools hold a long-term lease from the University on these lands. As development of the 1998 master plan proceeded, the boundaries of the Preserve necessarily contracted on the south and east, and the interface of the Preserve and the built campus changed considerably.

While the area of the Preserve decreased in the 1998 masterplan, the plan included several important elements that benefited the Preserve. First, the south and east boundaries of the Preserve were fixed to accommodate the new land uses and infrastructure described above. After considerable negotiation, those boundaries were established to enclose Kettle Swamp

and much of its watershed. In addition, since the red fox is the apex predator of the Preserve, the actual area encompassed by the new boundary was set at ca. 80 acres, the home range area needed to support a breeding pair of urban foxes. In 2003 when the cross-country course was constructed, the east and south preserve boundaries were formalized with a chain-link fence. The height of the fence was kept to 6 ft to allow deer to cross above the fence, and in constructing it, the fence material was drawn straight across landscape depressions to allow small wildlife to pass beneath it.

A second modification to the landscape that accompanied the buildout of the 1998 masterplan was not so much anticipated by the plan but arose from the necessity of dealing with runoff into the Preserve from the large parking lots associated with the DeVos Center and Prince Conference Center. Discharge into the Whiskey Creek watershed was mandated by Grand Rapids City regulations, but there was considerable concern that changes in runoff patterns and contaminants in the discharge would adversely affect the woodland ponds receiving the discharge.

To address the problem, a system of three connected treatment ponds (Figure 4) was installed to the east of the PCC to condition and store runoff until the system was full enough to discharge into the Preserve. In this system (Prince Ponds, or PP, 1, 2 and 3 from west to east), water enters PP 3 where it is stilled to allow sediments to drop out of the water before it flows to PP 2 and PP 1. PP 2 is relatively shallow and filled with macrophytes that can condition the water by removing contaminants. PP 1 is a deep retention pond designed to continue the water conditioning process and to store much of the volume of water the system receives. In periods of heavy melt or rainfall when stormwater input exceeds the volume of PP 2 and 1, a control structure at the north end of PP 1 discharges water first into two vernal pools, Woods Pond (WP) 3 and WP 5, and then, in case of added inputs, into WP 2 from which it can flow through a shallow extension of the pond to Whiskey Creek. This staged discharge was designed to simulate the normally slow filling of the Woods Ponds from the area to the south which was no longer possible due to the impermeable surfaces added in development. Unfortunately, the control structure located just inside the woodland edge at the north end of PP 1 developed a leak which prevents PP 1 from retaining its intended water volume when well filled. This, in turn, prevents the staged discharge from going into WP 3 and WP5 before WP2. The leak keeps WP 2 and the WP 2 extension perennially wet which has caused the death of numerous trees along the edge of the WP 2 extension due to a lack of soil oxygenation during the growing season. Efforts to correct the leak in the control structure have so far not been successful.

Despite the hydrologic challenge of controlling the output of the Prince Ponds, the ponds have brought additional habitat diversity to the Preserve which benefits a variety of wildlife. With

the construction of an observation dock on PP 1 in 2016, the ponds have also enhanced the educational exploration of aquatic habitats for school groups and casual visitors alike.

After the buildout of the 1998 masterplan on East Campus, the overall configuration of the Preserve went unchanged until 2017 when Calvin with funds from a longtime supporter, Thelma Venema, was able to secure a critical parcel on the north side of the Preserve. The 10-acre parcel was privately owned and extended south into the Preserve to North Trail, that is, deep into the heart of the Preserve. The full parcel was put on the development market in 2016 and was purchased by a neighboring landowner on Lake Drive, the Van Dries. In 2017 CU purchased the southern two-thirds of the property from the Van Dries, as part of the purchase arrangement deeded ca. 2 acres at the northwest corner of Field A to the Van Dries. The addition of this inholding pushed the boundary between the Preserve and adjacent residential lands ca. 500 feet to the north, far from the sensitive mature forest core. At the same time, it brought the entire shoreline of North Pond into the Preserve and added an additional pond, WP 7, and a small pine grove to the Preserve. The new addition became the Pine Grove management unit, and during the summer of 2017 a new trail loop, beginning and ending on North Trail, was built to allow visitors access to this interesting parcel.

The Bunker Interpretive Center and Venema Native Gardens

Another important feature of the 1998 masterplan was provision for the construction of an education center for the Preserve on the south shore of South Pond with a new main entrance to the preserve trail system. It was envisioned that the building would support both campus courses and outreach in environmental education to the surrounding community. Directed by then campus architect, Frank Gorman, planning for the building began in 2002, and by 2003, with considerable assistance from environmental science and engineering students, plans were in place for an interpretive center of ca 5,000 ft^2 surrounded by gardens of native plants reflecting native West Michigan ecosystems. A new parking lot was included to allow school busses to discharge students near the center. Funding for the nearly $2 M project was obtained from various foundations and individual philanthropists, including Ms. Helen Bunker and Ms. Thelma Venema. Construction was begun in late summer 2003 and was completed a year later. Named for the lead project donor and her husband, the Vincent and Helen Bunker Interpretive Center (BIC) was dedicated in the fall of 2004.

Consistent with the environmental preservation goals of the Preserve, the BIC was designed to meet LEED (Leadership in Energy and Environmental Design) building standards established by the US Green Building Council (USGBC). The College sought LEED certification for the project, and in 2005 the BIC was granted LEED Gold Certification from the USGBC. At the time, the BIC was only the second building in Grand Rapids to receive LEED gold certification. Features that contributed to the granting of LEED certification are shown in Appendix J.

Consistent with the 2003 plan for the BIC, the grounds were planted in species native to West Michigan. The gardens were originally designed with the educational goal of introducing visitors to many of the native herbaceous and woody plants that are common to the grasslands and open woodlands of the region. Since the native gardens would demand little watering, they contributed significantly to the BIC's LEED certification. Many of the species selected for the gardens, however, were tall grass prairie species, and after more than a decade of settling into the BIC landscape, their seasonal growth was lush and increasingly out of scale with the limited space around the BIC.

In 2017 the preserve Governing Board approved a proposal to remodel the native gardens around the BIC. With funding support from Thelma Venema, a new garden was designed to feature native plants of smaller stature in massed plantings that would make them more effective in teaching visitors their identification and functions on the land. In addition to new plantings the walks and other hardscape features of the gardens were upgraded, and two small buildings were added for support of educational activities and the care of the gardens. The new Venema Plaza and Native Gardens were completed and dedicated in Spring, 2019. In addition to the new gardens, parking for the facility was expanded to accommodate more cars and provide easier access to the BIC and the Native Gardens. The layout of the gardens is shown in Figure 4, and the species they contain are listed in Appendix K.

Figure 4: Map of the Ecosystem Preserve's native garden beds

Figure 5: The Bunker Interpretive Center surrounded by newly renovated native garden beds

Summary

A timeline of the development of the Ecosystem Preserve is given in Appendix A. As of 2020, the overall configuration of the Ecosystem Preserve is largely established in relation to surrounding residential, commercial and University properties. The challenge for the University and the Preserve is to adopt management policies and practices that will promote the flourishing of Preserve ecosystems and the species they contain in a constantly changing environment.

Public Use

From the outset the Ecosystem Preserve was seen by those shaping it as a service to the larger community of southeast Grand Rapids, particularly to the formal education community but also to casual visitors. In the mid-1980s the greater Grand Rapids area was served by only two

nature centers that were open to the public and provided a full program for environmental education. Blandford Nature Center on Grand Rapids' west side served primarily the Grand Rapids Public School system. Howard Christensen Nature Center in northern Kent County served the Kent Intermediate School District. At the time there was no nearby nature center to serve the southeast side of Grand Rapids, and it seemed evident that a Calvin Preserve could help fill that void, and the founding mission statement explicitly pointed in that direction.

While a nearby nature center could clearly benefit the surrounding community, it seemed that inviting the community to visit, enjoy, and learn from a Calvin Preserve also would bear returns for the University in at least two ways. First, this outreach to the community could help build connections between the University and our neighbors. Second, deliberately involving Calvin students with a broader visiting public would expand their college experience and hone skills in serving the public, especially in environmental education for youth and adults. In the hope of serving the community and reaping the benefits of that interaction, the Preserve has been open to the public free of charge since it was first dedicated.

Bringing in large numbers of visitors, not only from the College community but from the surrounding area as well, can threaten the very features important for conservation and education. Early visits to Blandford Nature Center were very informative as to the impacts large numbers of visitors can have, especially in the form of school classes. Major issues are trampling of off-trail areas leading to the destruction of vegetation and the compaction of soils, especially near trails. Heavy exposure to human activity can be stressful to some wildlife, so that high visitor traffic and certain uses potentially had the effect of keeping away the very creatures that some visitors come to see, like birds. In additional to incidental damages, there was also the occasional damage caused by deliberate vandalism, which often occurred at night. With challenges such as these in mind, the preserve Governing Board in 1993 approved the above mentioned master plan for the use and future development of the Preserve (Preserve Master Plan, 1993), which specified ways of meeting the conservation goals of the Preserve once its woodlands and wetlands were opened to much higher levels of human traffic. The plan made many recommendations concerning public use of the Preserve that are still in effect (enforcing the daily limiting of access to daylight hours being the only exception), but in general it affirmed and stipulated five management elements that have played a significant role in shaping public use of the Preserve:

- The Preserve will be divided into a public portion centered on the woodland trails and pond overlooks and a wildlife refuge or sanctuary area which would encompass the eastern portion of the Preserve. The need for this structure was anticipated in the original Preserve layout when an internal fence was installed just east of the trail system

to separate these areas. Two gates in that fence allow access to the sanctuary for research and management activity.

- Public access would be restricted to daylight hours, the period between 7:00 am and dusk. Outside of that time frame the main preserve entrances would be locked, and campus security personnel would open and close the main gates at the specified times.

- Recreational use will be restricted to passive (ie. non-athletic) activities, such as "creative writing, photography, reading, painting and drawing, meditation, bird-watching nature study or even the simple quiet enjoyment of the natural setting" (Ecosystem Preserve Master Plan, 1993). More active forms of recreation, such as running, biking, skiing, snowshoeing, were forbidden since they were judged to cause greater general disturbance and held the potential for damage to sensitive areas when pursued off the established trails.

- Scheduling of groups will be controlled to hold the number of people on the trails to 50 at any one time, a total of 100 over the course of the day, and a limit of 300 in any one week. These figures were based on the level of casual use observed over the five years preceding the 1993 plan and the level of demand that might be expected if the Preserve were to offer a significant environmental education program.

- Visits by formal groups are always to be conducted by preserve personnel, and the number of visitors per group ideally limited to 12 individuals.

As preserve use increases and diversifies, it is likely that these measures will continue to provide useful guidelines for managing use.

Since the 1993 plan was published, visitation has steadily increased and diversified among both individuals and groups. Casual visitors in the early days of the Preserve came largely from the university community, and annual visitation was limited to a few thousand per year. As the Preserve has become more widely known in the surrounding community, casual visitation has risen to more than 7,000 visits per year as of 2019, and in the spring of 2020, during the COVID-19 lockdown in Michigan, visitation on an annualized basis likely exceeded 10,000, much of which came in the form of family visits. Accurate numbers for 2020 are difficult to arrive at since the preserve stewards who normally record such numbers were unable to be on the trails. It is clear, however, that the increased use levels in Spring, 2020 led to considerably more off-trail activity and trampling of habitat features.

The educational potential of the Preserve has been steadily developed and enhanced by the addition of formal and informal programs, the addition of new trails and pond overlooks, the construction of the Bunker Interpretive Center (2004), and the installation of the Venema Plaza and Native Gardens. In addition to providing outdoor and indoor classrooms for many University courses, the Preserve has served elementary classes (pre-K to 3) from across the Grand Rapids area during the school year and an expanded range of elementary and middle school students in summer camps. The Preserve offers its own programs for adults and serves as a venue for meetings and programs of other groups, like River City Wild Ones and Michigan Bluebird Society.

Consistent with its original vision Calvin University is working to maintain opportunities for public benefit in its preservation, restoration, and management of the Ecosystem Preserve. Future management will continue to assure access to the trails and wetland overlooks that draw visitors to the site. CU is committed to ongoing habitat protection and restoration, which over time will enhance the health and integrity of the ecosystems comprising this diverse landscape.

Adjacent Lands & Landscape Connections

As indicated in Figure 6, the Preserve is situated in a widely developed but diverse landscape to which it is ecologically connected. The area which contains the Calvin East Campus, including the Preserve, measures ca. 0.75 mi on each side with the boundaries defined by three four-lane streets on the east, west and south, and a much less trafficked two-lane drive on the north. Within this partial section, the Preserve is bounded largely by college lands, mostly consisting of athletic fields and the cross-country course. The shrubland that contains the cross-country course is a strong habitat buffer for the Preserve's wildlife sanctuary on its east and south margins, and while the fence construction along these margins allows wildlife to pass between the Preserve and campus buffer, it quite effectively limits human entry. To the south of the cross-country buffer, the 40-acre Keyhill residential development has an open boundary with the campus and many members of that community use the East Campus lands, including the Preserve, for recreation.

The most active interface of the Preserve with university East Campus lands is along the south and west sides extending from the Prince water treatment ponds to the Youngsma Center north of Parking Lot 13. This margin comprises the south and west boundaries of the public portion of the Preserve and contains five entrances to the trail system, the BIC, and the Venema Plaza and Native Gardens. Given the campus development and lack of natural habitat outside of this margin and the heavy human traffic along it, little wildlife movement is observed across this edge.

Figure 6: The Ecosystem Preserve seen in its larger landscape context
Except to the north the preserve area is bounded by busy streets and extensive development. The north margin of the preserve is more porous to the natural wetlands and woodlands of the Reeds Lake swamp area east of the East Beltline, which hold a lower density of human development.

The north margin of the Preserve is by far its most porous to animal movement, allowing wildlife to move between the Preserve and the relatively wild habitats of the Reeds Lake swamp to the north. On the north, the Preserve abuts large, mostly wooded residential properties lining the south side of Lake Drive. Similar development exists on the north side of Lake Drive. Because of its wooded character, the segment of Lake Drive between the East Beltline Avenue and East Paris Avenue is a state-designated Natural Beauty Road. This designation encourages road managers and residents to leave the margins of the road naturally vegetated, and this has produced narrow wooded corridors across Lake Drive at various points. These corridors and the relatively light traffic on Lake Drive encourage larger wildlife to move between the Preserve and the Reeds Lake swamp, effectively increasing the amount of habitat available to them by more than a factor of two. Student studies of wildlife movement across Lake Drive using trail cameras demonstrate that deer use these corridors, and the tree line just to the east of the Preserve House is one of the most active. If large animals move throughout the larger landscape along this boundary, it is likely that smaller animals do so as well, thus keeping their populations from becoming isolated in the Preserve.

Since the north margin of the Preserve is unfenced, it allows not only passage of wildlife but also human trespass directly from residential properties or through the open preserve parcel that contains the Preserve House. Much of the entry along this margin consists of innocent exploration by neighborhood families and their friends and may cause no greater impact than brief disturbance to wildlife. In other cases, however, the impacts may be more at odds with the conservation goals of the Preserve. The most conspicuous of this sort of unsanctioned activity is hunting, particularly for deer. Since the establishment of the Preserve, there have been recurring periods when hunters have entered the sanctuary without permission to bait deer, set up camera traps, and hunt. In 2016 two preserve workers came upon a hunter in a blind along the cross-country trail loop, who was about to take down a magnificent 10-point white-tail buck with a crossbow. When confronted, the hunter with weak protest packed up and left. This particular deer had been a hunting season resident of the Preserve for several years, and he had been seen on the Preserve several times that season. After the crossbow hunter was challenged by the students, that buck was not seen again. We suspect the hunter returned sometime later and took out that animal. We have not posted the north margin of the Preserve for many years out of deference to our neighbors. Perhaps posting should be reconsidered.

Maintaining biological corridors between small natural areas is seen as essential in maintaining the biological diversity of each area in the network. When small natural areas or preserves become isolated, their uncommon or rare species may be extirpated by random events, and in their isolation such rare members are not likely to repopulate an area from which they were lost. To the degree possible, every effort should be made to nurture corridors spaces along

Lake Drive so that the Preserve can maintain connections between its populations and those farther north.

ECOLOGICAL & CULTURAL FEATURES

Geology, Topography, Soils, and Climate

The land surface features of Kent County, Michigan are composed of glacial drift and morainal deposits created during the Wisconsinan glacial period, the latest glaciations of the Pleistocene in the Great Lakes basin. The county lies in an area where the Michigan and Saginaw lobes of the Wisconsinan ice sheet met. That confluence produced the complex morainal systems that shaped much of the county's irregular topography, as seen on a small scale in the Preserve. (Figure 7). Dating of wood from the lowest sediments of North Pond indicate the area was likely ice free by 13,250 years BCE. County-wide, the composition of deposits in these systems varies from gravels to fine clays, and it is from these materials that most of the soils of the county have been formed (Soil Survey of Kent County, Michigan, 1986).

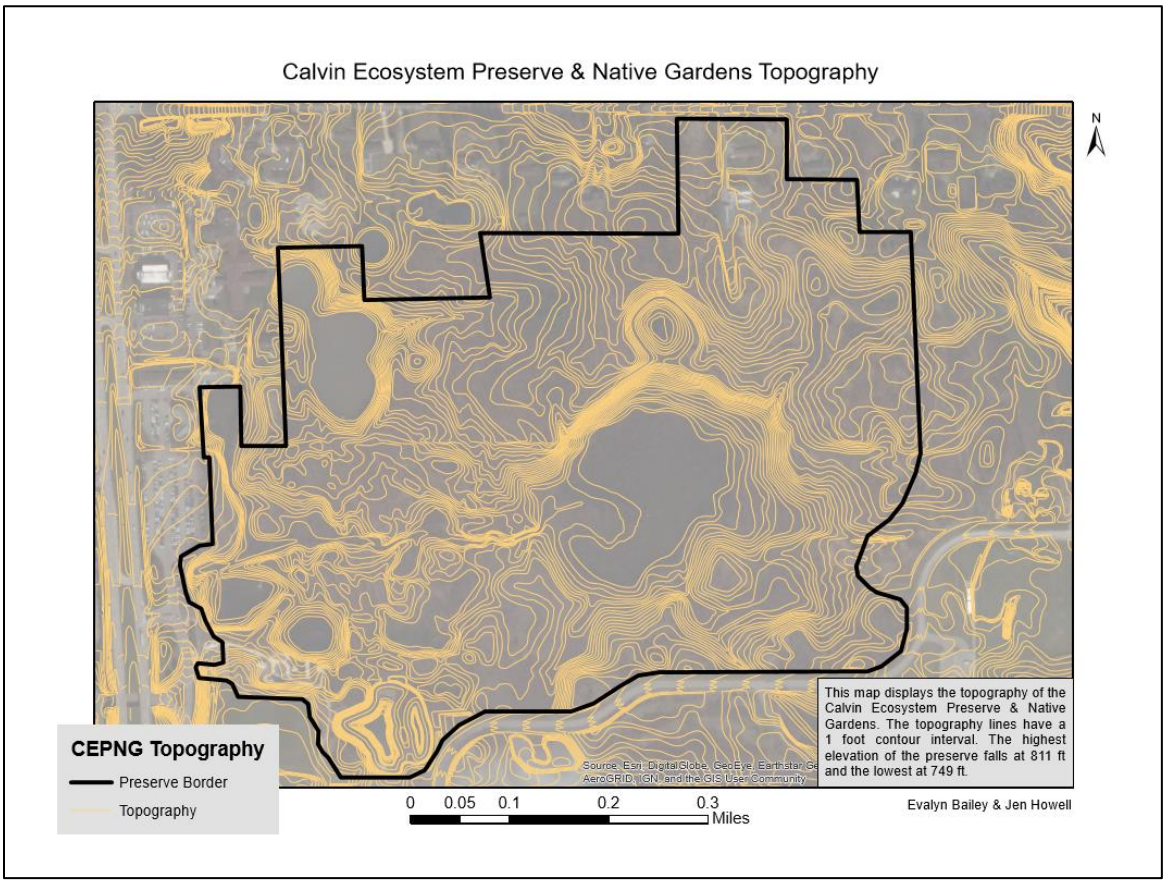

Figure 7: Topographical map of the Ecosystem Preserve

The Preserve lies near the center of the county in an area where two of the physiographic regions represented in the county meet. The first is a broad till plain extending northward from the south county line to approximately Reeds Lake. In that area the till plain meets a second physiographic region in the form of the morainal ridges that flank the Grand River as it flows northward into the Grand Rapids area. The topography of the Preserve reflects both eroded morainal ridges and till plain made irregular by kettle lakes and ponds formed by the melt of ice blocks left in the drift as the last ice sheet retreated. Consistent with the morainal contribution to the land, the Preserve shows modest topographic relief with several high points in excess of 800 ft above sea level near the Preserve House on Lake Drive, a sharp drop to 769 ft at Kettle Swamp, and a low point of 763 ft at Whiskey Pond. The third physiographic region found in Kent County, glacial outwash plain, is not prominently represented in the Preserve (Soil Survey of Kent County, Michigan, 1986).

Surface drainage in the Preserve is dominated by the large kettle depressions containing Kettle Swamp and North Pond. Kettle Swamp is the source of Whiskey Creek which, as it flows west across the Preserve, picks up both runoff from the forest flanking the stream and a perennial outflow from Buttonbush Pond. After leaving the Preserve, Whiskey Creek flows through the Calvin campus and from there south to become a major tributary of Plaster Creek.

North Pond drains a large portion of the north side of the Preserve including land in the Pine Grove unit and Fields A and B. Historically lacking a surface outflow, it was tied to preserve hydrology only through ground water. However, an actively maintained farm culvert installed before the 1930's to connect North Pond to Buttonbush Pond drained much spring and early summer runoff into Buttonbush Pond and from there to Whiskey Creek. After the Preserve was established, the mouth of the farm culvert was kept open until 1987, after which time it was allowed to fill. Soon the outflow in the culvert was greatly reduced, and by 1990 the flow to Buttonbush Pond had largely ceased. Despite the blockage, however, the culvert appears to continue to leak a small amount of water to a small seep at the northeast corner of Buttonbush Pond.

Reflecting their mixed glacial origins and landscape positions, most of the soils of the Preserve belong to clay or silt loams higher in the landscape and wet loams or mucks along drainage channels and in ponds and other wetlands. Upland soils differ somewhat in their properties depending on slope. Soils influence by the ponding of water are mostly level to undulating and show little slope to influence their properties. The soils mapped on the Preserve are described below and are shown in Figure 7. (Soil Survey of Kent County, Michigan, 1986).

Upland soils of the Preserve are predominantly mapped as Perrinton loam which in the Preserve occurs on slopes varying from 2 to 18%. It is a generally well-drained soil found on side slopes of knolls and ridges. The upper layer is 17-20 inches of brown clay loam underlain

by 19 inches of firm clay loam subsoil. This soil is suited to cultivation, but due to its clay content, it tends to compact when worked. On steep slopes it is susceptible to erosion, and in that context is better suited to pasture and woodland cover where perennial plants can control erosion. Historically, Perrinton loam soils on the Preserve were used for crops (especially corn), pasture, orchards, and woodland. Naturally occurring mature forest on this soil tends to be mixed deciduous forest dominated by American beech and sugar maple.

Perrinton loam soils may contain inclusion of sandy loams, commonly classed as Oakville, Tustin, or Rimer soils. The 1-2 acres of unusually sandy soil in the southwest corner of Field D may be such an inclusion, likely of Rimer soil. The extent and composition of this sandy soil needs further study.

In the northeast corner of the Preserve is an area of several acres of Blount loam which surrounds two small wetlands in that area. This soil also occurs on the west margin of Kettle Swamp. Blount loam soils are typically poorly drained clay loam soils on side slopes of low knobs and ridges or drainageways between ridges. The topsoil layer is a dark brown loam about 7 inches thick underlain by 16 inches of a lighter yellow to brown clay loam. Like Perrinton loam this soil can be cultivated but is susceptible to compaction and is, thus, better used to support pasture and forest. Within the preserve boundary, the Blount loam soil in the northeast corner was cultivated to grow corn, but water retention on the site during the growing season typically reduced the harvest in this area (R. Van Dragt, personal observations). After the Preserve was established, water was encouraged to collect in the two wet depressions, and they now support small, marshy ponds. The Blount loam soils on the Kettle Swamp margin have been perennially forested.

To the east and west of Kettle Swamp extend deposits of Wallkill silt loam, a poorly drained soil associated with flood plains and the margins of organic soils adjacent to uplands. In this soil the topsoil is a very dark brown silt loam about 12 inches deep. The subsoil consists of a lighter gray silt loam. Except where it is well drained, the soil is unsuitable for agriculture and is covered with shrubland or forest. With drainage the soil can be cultivated, as was the case to the east of Kettle Swamp where the Wallkill loam was cultivated along with the surrounding Perrinton loam for corn. Wallkill loam deposits on the west side of the swamp have been perennially covered in forest.

In Kettle Swamp and on shallow areas around North and Northwest Ponds, Houghton muck soils can be found. This organic soil is characteristic of landscape positions that retain water, such as bogs, drainageways, and various potholes or kettles. The surface layer is a black muck about 7 inches deep below which lighter colored muck layers extend to a depth of about 60 inches. On level terrain runoff is slow or ponded, as in Kettle Swamp where the dominant vegetation consists of water-tolerant shrubs and trees. On shallow slopes around open water

Houghton muck (79) is seasonally inundated and often supports shallow water emergent plants like cattails (*Typha* sp.) and pondweeds (*Persicaria* sp.). When drained, Houghton muck is well suited to vegetable crops, but within the preserve boundary there is no evidence the muck soils were ever used in this way. By contrast, the extensive muck soils on the eastern extreme of the Reeds Lake swamp between Lake Drive and Cascade Road were drained and used extensively for vegetable farming (George Harper, personal communication).

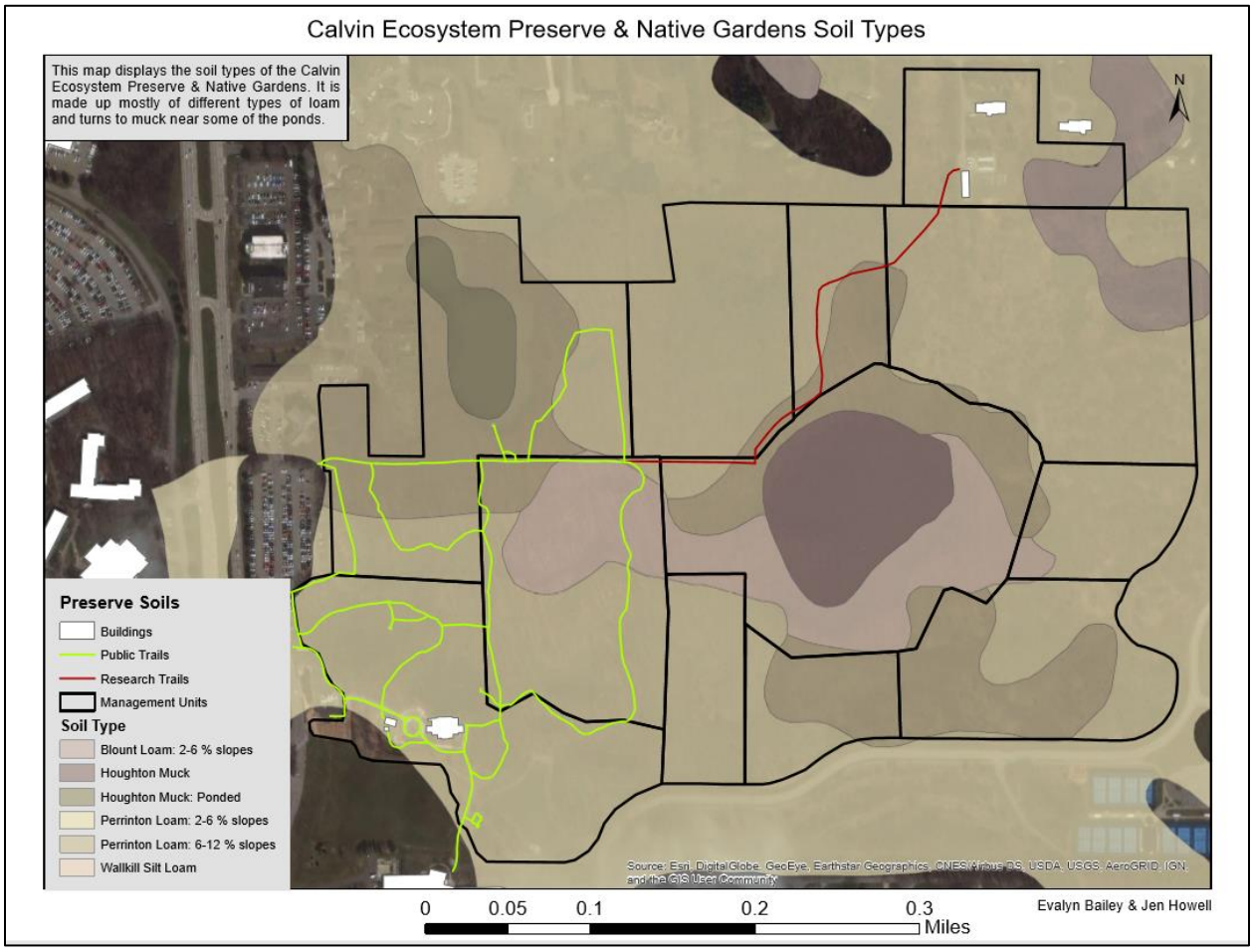

Figure 8: Soil types of the Ecosystem Preserve

With regard to climate, the Grand Rapids area in West Michigan is considered to experience a warm, humid continental climate somewhat modified by airflow over the Great Lakes, particularly Lake Michigan (U.S. Climate Data, 2020). This climate is shaped by cold, dry arctic air masses in winter and warm moist air from the Gulf of Mexico in summer. In both seasons passage of the dominant air mass over Lake Michigan influences both the temperature and moisture content of the air relative to continental lands to the west, adding moisture

throughout the year, while warming northwesterly airflow in winter and cooling southwesterly flow in summer. The result is a more temperate continental climate for the Grand Rapids area compared to regions at similar latitude to the west of Lake Michigan. Despite lake influences there exist two climate zones in Michigan's lower peninsula, a cooler region to the north and a warmer region to the south where Grand Rapids is found. The boundary between these climatic regions is known as the climate tension zone, and it extends roughly from Muskegon in the west to Saginaw Bay on the east.

Grand Rapids experiences an average annual precipitation of 38.27 inches and total annual snowfall of 76 inches, which falls between October and April. Daily high temperatures range from an average of 31° F in January to 81° F in August. Daily lows vary from 18° F in January to 61° F in August.

As is occurring globally, the climate of West Michigan is changing. Though climate change is unlikely to demonstrate dramatic effects within the scope of this plan, some effects are already noticeable and may become more evident in the near future. In coming decades, the major climate trends projected for western Michigan include increased annual mean temperature, increased heat wave severity, increased annual humidity and precipitation, increased length of drought periods between rain events, increased severity of storm events, degraded water quality and degraded air quality (U.S. Climate Resilience Tool Kit, 2020).

In combination these changes may noticeably affect the physical and ecological features of the Preserve in ways that challenge conservation goals and demand management attention. For example, heavier precipitation will increase flooding, erosion, and water quality degradation. Climate change may subject species once common to the area to stresses that challenge their health and survival. This might be expected for northern tree species now living at the southern end of their range. Weakened and dead trees subjected to more extreme storms will create safety hazards that will demand more careful monitoring. Overall, the existing biodiversity of the Preserve will be under challenge from both environmental change and the added advantage climate change can give to invasive species. Given the array of potential effects that attend climate change, careful consideration of potential climate change impacts should be undertaken to anticipate future needs and to help direct future research.

Ecological Features

As has been noted earlier, the Ecosystem Preserve encompasses 104 acres (41.6 hectares) of largely undeveloped lands on the Calvin University campus. Of that land 44 acres (17.6 hectares) are open to the public and include over 1 mile of hiking trails. Another 60 acres (24 hectares), the Buiten Wildlife Sanctuary, is maintained as a wildlife reserve and research area to which visitor access is restricted. Due to their topographic relief, diverse soils, and varied land

use history, both public and reserve areas contain a variety of terrestrial, aquatic, and transitional biological communities (Fig. 9), which are described generally in this section and treated in greater detail in the section on biological communities that follows.

Conspicuous among the terrestrial communities are the mixed hardwood forest remnants along the northern edge and at the core of the Preserve. The more prominent of these is the 5-acre (2 hectare) mixed hardwood forest encircled by the Preserve's main trail. Wood cores and ring counts in fallen trees indicate the oldest trees in this woodland exceed 125 years of age, some of the oldest being sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and red oak (*Quercus rubra*). The sugar maple and American beech are considered the climax species in a mature woodlot of this type because they can propagate in the shade of the canopy of an old forest. The red oak cannot propagate successfully under a full forest canopy, and, thus, their presence represents periods in the history of the woodland when the canopy was opened, likely in association with tree harvest. In 1974, when the central forest was first censused, the 1206 trees counted represented 23 species). The same count in 2014 accounted for 1183 individuals belonging to 21 species (Knott, 2014). Overall, the forest has become less diverse over its first 45 years, with the importance of sugar maple and American beech increasing and that of red oak and white ash (*Fraxinus americanus*) declining.

As agricultural fields adjacent to the Preserve's forest remnants were fallowed and then abandoned, ecological succession quickly established transitional wooded areas dominated initially by shrubs and tree seedlings and saplings to be replaced within a decade or two by young forest stands. Among the earliest areas to experience this succession from old field to secondary forest, are those bordering the Preserve's mature forest on the west and north. Notable among these is the woodlot of Field B. Aerial photos indicate this area to be one of the earliest to have been fallowed before the Preserve was established. A survey of the Field B woods in 2012 (Ortwine-Boes, 2012) showed that along with other early successional species its southern half contained numerous sugar maples 40 years old or older that were of a size sufficient for tapping. In contrast, younger secondary stands are found on the south and east of the mature woodlot and the woodland margin of Kettle Swamp. Though many tree and shrub species are represented in these stands, a dominant species in most areas, as in Field B, is sugar maple. All of these transition forest stands establish at the cost of open grassland, and if grassland is to be maintained, particularly within the Buiten Wildlife Sanctuary, it will require removal of young forest stands.

Over the years stands of dry mesic prairie and sand prairie have been created in the transitional area between the Preserve and Native Gardens and the academic and athletic areas to the south and west. This management plan addresses those created habitats and envisions

creating or restoring similar prairie elements to parts of Fields C, D and E in the Buiten Wildlife Sanctuary.

Scattered across both portions of the Preserve, though largely associated with its established woodlands, are both naturally occurring and created aquatic habitats. The most conspicuous of these is Kettle Swamp, an extensive, inundated shrub swamp, dominated by buttonbush (*Cephalanthus occidentalis*) and willows (*Salix* sp.). The swamp is enclosed in a margin of mature trees that line the walls of the kettle occupied by the swamp and are continuous with the forest at the core of the Preserve. Swamp elements also occur along the drainage channel from Woods Pond 2 and in the Whiskey Creek flood plain. Naturally occurring open waters include 3 small vernal pools and 10 larger ponds the most prominent of which is North Pond. Two additional ponds are found in the northeast corner of Field C in shallow depressions that formed when natural drainage to Kettle Swamp was blocked by creation of the university's cross-country course. The smaller of these is often overgrown with herbaceous vegetation and takes the form of emergent marsh. Finally, between the Prince Conference Center and the margin of the preserve forest are three created ponds, the Prince ponds, which receive and treat the runoff from impervious surfaces around the conference center before it flows into the Preserve. These water bodies are described more fully in Appendix D.

Several intermittent drainage channels collect and conduct water through the Preserve. From its source in Kettle Swamp, Whiskey Creek flows ca. 1,775 ft (538 m) to its point of entry into Whiskey Pond, from which it continues its flow under East Beltline Avenue to the CU west campus. Just before it enters Whiskey Pond, Whiskey Creek receives a tributary that originates from Buttonbush Pond and flows 250 ft (76 m) to its confluence with Whiskey Creek. In addition to draining overflow from Buttonbush Pond, this tributary also receives overflow from the Whiskey Creek Bioswale during heavy rain and melt events. Clearly defined channels conduct surface runoff into North Pond (one channel from fields A and B) and into Kettle Swamp (six channels from fields A through G). In most cases these are natural erosion channels, though in several cases existing channels were excavated by farmers to increase their flow.

Cultural Features

Vestiges from Agriculture and Other Land Uses

Prior to establishment of the Ecosystem Preserve the land which it is now occupies had undergone 150 years of development consistent with use patterns familiar to the Euro-American settlers who came to the area, many from New England. Though settlement proceeded slowly eventually much of the present preserve land was cleared of forest and

dedicated to small-scale agricultural. To support such use, after the forest was removed, fields were plowed and fenced, and drainage was installed. What remains of this early activity is described in Appendix F. The most conspicuous landscape features from early agricultural days are drainage channels and treed fence rows.

The efforts of early farmers to dry the land for tilling most commonly took the form of ditches dug to enhance natural erosion channels or create new pathways for runoff. Some of these channels have become overgrown and inconspicuous while others remain active, such as the erosion channel at the northwest corner of Kettle Swamp which drains portions of Field A and a second which drains into the northeast corner of North Pond from the Pine Grove unit and the north parts of Fields A and B. These channels continue to erode soil from adjacent lands which contributes to some degradation of water quality, especially in North Pond.

Over the years, stone and wire fences used to delineate land uses provided linear spaces with plenty of sunshine and little land use disturbance. In those spaces deciduous trees could germinate and grow and over time achieve considerable stature, while those that attempted to establish away from the fences were eliminated by grazing, cutting, or plowing. Old representatives of the fence row trees still create conspicuous colonnades within the Preserve's mature woodlot and at some of its margins. Among these trees several of the red oaks and sugar maples within the woodlot have been cored and their ages shown to exceed 125 years. These old fence rows stand as a testimony to Euro-American agricultural influences and are useful in illuminating vestiges of Euro-American influence.

Trails and Infrastructure

Central to fulfilling the mission of the Preserve is the ability for visitors and preserve personnel to access various parts of the Preserve with as little disturbance to preserve ecosystems as possible. To provide that support, the Preserve has 1.7 miles of surfaced trails throughout the public portion of the Preserve and 0.27 miles of trail giving access to the Buiten Wildlife Sanctuary and the preserve facilities on Lake Drive. The original preserve construction in 1985 and 1986 created 0.95 miles of public trails; the rest has been added as new lands and facilities have been added to the Preserve. The original trail system had two access points, one on the northeast corner of Parking Lot 13 and the other at the south end of the same parking lot near the Gatehouse. Today there are five access points, the original two plus one from the Prince Conference Center, one that accesses Whiskey Pond Trail, and a third leading to the trail crossing the preserve bioswale at the southeast corner of Parking Lot 13.

The objective of the original trail was to provide access to the signature ecosystems of the Preserve while causing as little disturbance as possible in their construction and use. As a result, the trail was laid out in two loops, one around the edges of the mature woodland and

the other around a lowland meadow to the west of the woodland in the process of secondary succession. The trail itself consisted of a deep bed of woodchips contained between formal borders of treated 2x4 lumber. The trail width varied from 5 to 6 feet, generally wide enough for two people to walk comfortably side-by-side. The trail was leveled and given a consistent surface (woodchips) to allow ease of walking for people of all ages. To encourage visitors to stay on the trail, the formal edging was used to clearly establish the contrast between visitor travel space and the natural spaces beyond.

In addition to leaving large blocks of habitat as undisturbed as possible, the path of the trail was laid out to accomplish several effects, including:

- Protecting sensitive plant and other landscape features, like erodible slopes,
- Fitting the trail to the natural horizontal and vertical contours of the habitats, meaning few straight lines, except on North Trail,
- Assuring that new discoveries could be continually uncovered as the visitor moves along the trails, meaning few straight lines,
- Assuring that no trees would be removed that were greater than 4" in diameter at chest height, and
- Approaching as closely as possible to conspicuous water bodies.

The main trail needed to cross Whiskey Creek or its tributary in three places as well as the small swamp created by the annual overflow of Woods Pond 2. Three bridges were built to ford the streams and a 140-foot boardwalk was constructed across the swamp. These structures are all 5 feet wide to match the trail width, but that width is limiting to utility vehicles like golf carts. As a result, a golf cart cannot be used to carry visitors of limited mobility on the branch of the Buttonbush Bridge leading to Lowland Trail or across West Bridge.

To access two of the more interesting ponds on the woodland edge, construction of the original trail included a large overlook on both North and South Ponds. These overlooks can accommodate visitor groups or classes of about 24. The overlook on South Pond was placed on the east side of the pond and the North Pond overlook among surrounding trees to shade the overlooks for morning bird watching.

As the original trails were added to over the years with major trails to Whiskey Pond and through the Pine Grove unit, the formal trail design was maintained though the trail edging of dimensional lumber was replaced with the trunks of small trees collected in secondary forest areas where mortality among American elm and white ash has been high. Other trails added around the BIC and from the BIC to the Prince Conference Center and Prince Pond dock, have been hard surfaced to allow for heavier traffic and to conform to university standards for campus walks. In 2001 the wood chips on steep portions of the preserve trails were replaced

with crushed concrete to allow easier passage for visitors using wheelchairs. In designing the BIC and its surrounding trails, the travel surface of the BIC trails, the BIC itself, and the approach to the South Pond overlook were maintained at the same level so that wheelchair users have complete access to the BIC, the Venema Native Gardens, and South Pond.

Built components of the trail system have held up remarkably well in the 35 years since they were installed. However, the edging of the original trails is deteriorating and as a result in many places needs replacement. Two of the bridges have required maintenance over the years due to storm damage. The supports beneath the decks of the pond overlooks have been replaced due to deterioration of the lumber and vandalism. The condition of these structures should be carefully examined each year, but overall, they should last well into the future.

The trails and built structures associated with the trails are described more fully in Appendices G and H.

Buildings

At the outset the management and educational work of the Ecosystem Preserve operated out of an open motorcycle shed at the north end of Parking Lot 13 that extended from the northwest corner of the lot eastward to a point that today includes the drive into the Youngsma Building lot. After several years in this rude facility, preserve personnel secured use of a small building at the south entrance of Parking Lot 13 to supplement the motorcycle shed.

The smaller building had originally been built to accommodate students who served as parking lot "guards," occupying the building at night to deter theft from cars kept in the lot. Because of this use, it was known for many years as the "guard shack." A garage bay was added to the guard shack in 1994 when the motorcycle shed was removed from the lot. That bay served as equipment storage during the inclement months and as a "nature center" for educational outreach from spring to fall. Today the building is called the "gatehouse" and provides storage for larger maintenance equipment and for field equipment for faculty and students working on the Preserve.

In 1995 Calvin acquired 9 acres and a 2,100 ft^2 house at 3770 Lake Drive to use as the preserve headquarters, research center, and maintenance center for the Wildlife Sanctuary. The building became known as the Preserve House, and in addition to preserve-related functions, provided office space to Au Sable Institute in the early 2000s. Beginning in 1998, the Preserve began to develop a nursery on a portion of the property as a plant propagation center and nursery. The beginning of that process was installation of a production greenhouse, which was followed by two smaller greenhouses for development and seasonal storage of propagated plants. Outdoor growth space was added along with the greenhouses, and in 2020 tens of thousands of plants were raised for restoration and sale at this facility. Today the nursery

facility serves both the Preserve and another Calvin organization, Plaster Creek Stewards, which is actively involved in restoring a major southeast Grand Rapids stream, Plaster Creek.

The other major center on the Ecosystem Preserve is the Bunker Interpretive Center and the Venema Plaza and Gardens. A gold-certified LEED building (Appendix H), the BIC provides workspace for personnel, display spaces for visitors, and educational spaces for Calvin classes and other programming. Though the BIC was closed for an extended period in 2020-21 because of the COVID-19 outbreak, it promises to continue as an exciting center for environmental education in the years ahead.

When the BIC was constructed, the land around it was landscaped in native species. As noted earlier, after a dozen years the original native gardens outgrew their surroundings, and the decision was made to install new plantings to better fit the scale of the space and better help visitors learn to identify specific native species with valuable ecological functions that can be used in home landscaping. To complement the educational goals for the new gardens and to provide support for the maintenance of the gardens, two new buildings were added to the BIC grounds as part of the gardens. The first is an education and volunteer support building called the Gardener's Cottage. This building was built to reflect the style of the BIC and is heated and well insulated to allow for year-round use. The second building, the Glasshouse, is a small green house used to display native species and to serve as a point of sale for plants offered through the Preserve. These buildings were dedicated as part of the Venema Native Gardens in May 2019.

Summary descriptions of the buildings of the Preserve can be found in Appendix I. The layout and plant diversity of the Venema Native Gardens are shown in Figure 4 and Appendix K respectively.

NATURAL COMMUNITIES AND THEIR MANAGEMENT

To more effectively manage the 104-acre preserve, the land manager found it helpful to divide the landscape into 10 distinct natural community types (Figure 9). A natural community is defined as "an assemblage of interacting plants, animals, and other organisms that repeatedly occur under similar environmental conditions across the landscape and is predominantly structured by natural processes rather than modern anthropogenic disturbances" (Cohen et al, 2020). The natural community classification used to identify habitats in the preserve are consistent with the classification system developed by the Michigan Natural Features Inventory. This particular natural community classification system is based on a combination of data derived from statewide and regional surveys, ecological sampling and data analysis, literature review, and expert assessment. Being able to associate a name with a distinct area in the

preserve will ultimately allow the land manager to communicate effectively about the preserve's distinct natural areas and how to best care for them.

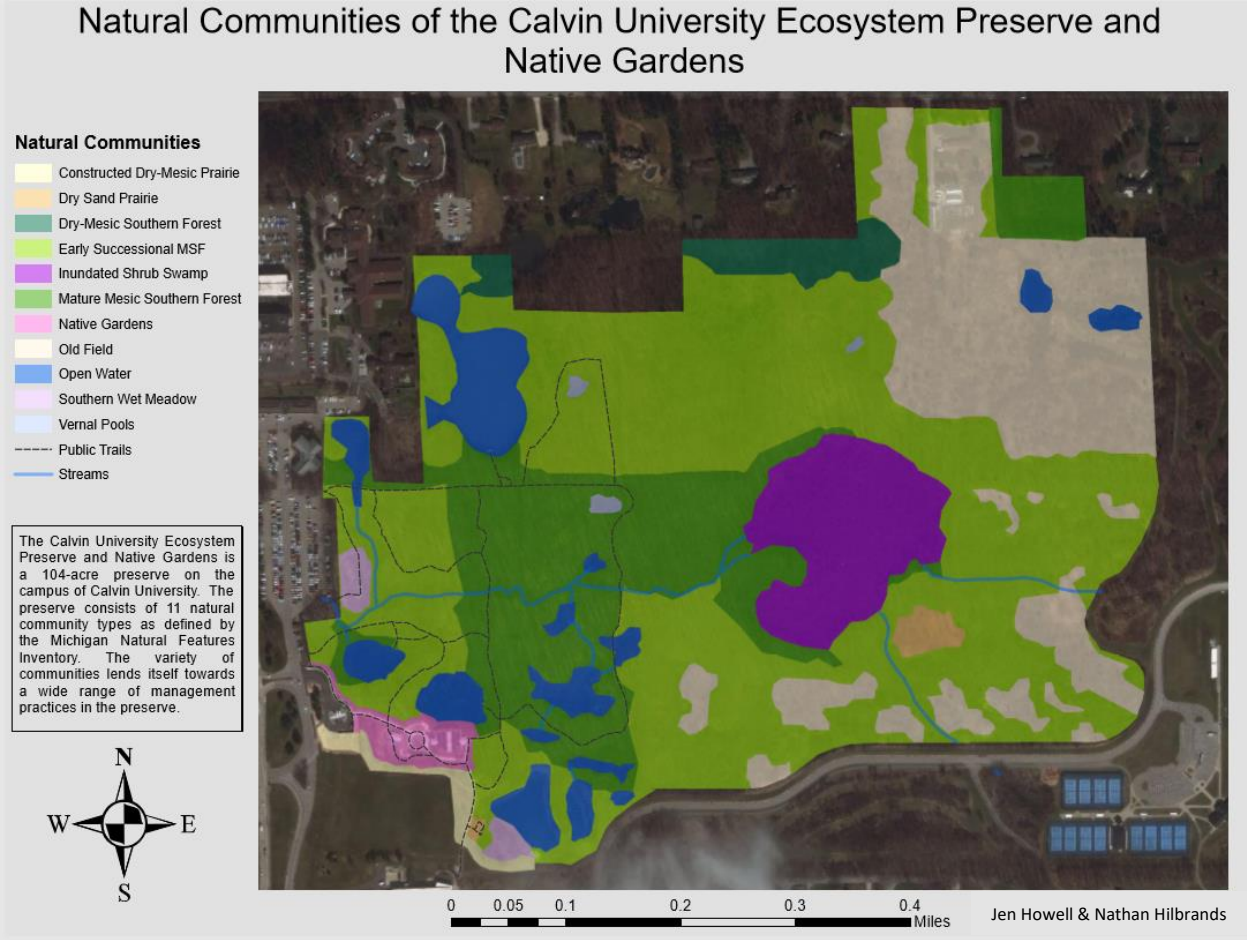

Figure 9: Map of the natural communities of the Ecosystem Preserve

Dry-mesic Southern (Oak-hickory) Forest

Figure 10: Example of Oak-Hickory Forest in the Ecosystem Preserve

Description: Dry-mesic southern forests are oak-dominated, fire-dependent forests that typically occur south of the climatic tension zone in Michigan's lower peninsula (Lee, J.G. 2007).

A. Location: northern portion of Field A, B, western edge of Field C & North Pond Field
B. Area: Approximately 7.5 acres
C. History: A portion of the second growth forest has minimal human impact since it is located within the Buiten Wildlife Sanctuary and is not open to the public. Most of this natural community was formerly agricultural fields.

Soils: Soils are typically sandy loam or loam with a slightly acidic to neutral pH.

Vegetation: The canopy layer generally is dominated or co-dominated by white oak (*Quercus alba*) and black oak (*Quercus velutina*), with white oak being the more frequent dominant. Red oak (*Q. rubra*) can occur as a canopy codominant, especially where soils and topographic position favor less droughty conditions such as north- to east-facing slopes and footslopes. Hickories such as pignut hickory (*Carya glabra*), shagbark hickory (*C. ovata*), and bitternut hickory (*C. cordiformis*) are often canopy co-dominants. Prevalent canopy associates may include red maple (*Acer rubrum*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), Hill's oak [*Quercus ellipsoidalis*, basswood (*Tilia americana*), and sassafras (*Sassafras albidum*). Prevalent species of the subcanopy include red maple, hickories, alternate-leaved dogwood (*Cornus alternifolia*), flowering dogwood (*C. florida*), ironwood (*Ostrya virginiana*), cherries (*Prunus* spp.), and sassafras. Characteristic shrubs include serviceberries (*Amelanchier* spp.), witch hazel (*Hamamelis virginiana*), and choke cherry (*Prunus virginiana*). In fire-suppressed systems, mesophytic trees and shrubs are often dominant in the subcanopy and shrub layers. Typical herbaceous species include doll's eyes (*Actaea pachypoda*), hog peanut (*Amphicarpaea bracteata*), jack-in-the-pulpit (*Arisaema triphyllum*), northern shorthusk [*Brachyelytrum aristosum (B. erectum* of Voss*)],* hairy woodland brome (*Bromus pubescens*), white bear sedge (*Carex albursina*), rosy sedge [*C. radiata (C. rosea* of Voss*)*], enchanter's nightshade [*Circaea canadensis (C. lutetiana* of Voss)], spotted coral-root (*Corallorhiza maculata*), pointed-leaf tick-trefoil (*Hylodesmum glutinosum*), naked-flower tick-trefoil (*H. nudiflorum*), fragrant bedstraw (*Galium triflorum*), black snakeroot (*Sanicula*

marilandica), bristly greenbrier (*Smilax hispida*), large-flowered bellwort (*Uvularia grandiflora*), and downy yellow violet (*Viola pubescens*) (Lee, J.G. 2007).

Wildlife: Several rare plants and animals such as the state special concern Cooper's hawk (*Accipeter cooperii*) and Eastern box turtle (*Terrapene c. carolina*) are known to be found in dry-mesic southern forests. MNFI recognizes 43 rare species (Lee, J.G. 2007). In addition, many common wildlife species utilize the habitat afforded by dry-mesic southern forests and rely on the production of acorn masts [See Courteau et al. 2006) for complete lists].

Current Status and Threats: In spite of the historical logging and grazing pressures that took place on this site, the dry-mesic southern forest has a moderate native plant and animal diversity and community-structure. The preserve's dry-mesic southern forest habitat is currently degraded by the presence of invasive plants, heavy browsing by white-tailed deer and turkey, off-trail trampling of vegetation, and the presence of pests and pathogens. While historical presence of Dutch Elm's Disease is unknown, there is significant damage (numerous dead ash trees) resulting from the presence of emerald ash borers. In addition, Beech Bark Disease was detected the summer of 2019. Invasive plants include common buckthorn (which constitutes over ½ of the overall shrub composition), glossy buckthorn, privet, multiflora rose and Japanese barberry. This habitat type has insufficient interior habitat for large woodland bird species and lacks a historical fire regime to act as a natural and desirable disturbance.

Goals/Objectives (Desired Future Condition):

- To preserve the ecological integrity of the old growth forest habitats by minimizing the impacts of human activities and invasive plants and animals.
- To encourage natural succession and support key plant functional groups-specifically oak regeneration
- To maintain a healthy and viable white-tailed deer population. The 100-acre preserve should be able to adequately support only 3-4 deer (Tilghman, 1989).
- To maintain and enhance biodiversity

Management Strategies:

A. Introduce Rx fire (if permissible by City of Kentwood) to promote oak regeneration, deter succession of shade-tolerant and invasive species, and keep oak pathogens and insect pests under control.
B. Capitalize on student intern research projects to improve species inventories and monitoring efforts of known rare species (i.e. box turtles, Blandings turtles, green herons, pileated woodpeckers, Cooper's hawks, etc.)

C. Active monitoring, mapping, and control of invasive plant species such as: (garlic mustard (*Alliaria petiolata*), black swallow-wort (*Vincetoxicum nigrum*), white swallow-wort (*V*. *rossicum*), Oriental bittersweet (*Celastrus orbiculatus*), common buckthorn (*Rhamnus cathartica*), autumn olive (*Elaeagnus umbellata*), Eurasian honeysuckles (*Lonicera morrowii*, *L. japonica*, *L. maackii*, *L. tatarica*, *L*. x*bella*, and *L. xylosteum*), and multiflora rose (*Rosa multiflora*).
D. Selective harvesting/girdling of invasive and/or non-native trees (i.e. red maple in oak-hickory forest & Scotch pine)
E. Implement a quality deer management program to reduce detrimental effects of deer over-browsing and introduction/spread of invasive weed seeds.
    a. Determine actual deer herd size (and compare to DNR recommendation of 21 deer per square mile)
    b. Install deer exclosures to determine the impact of deer herbivory while encouraging spring ephemeral populations and regeneration of old growth forest.
F. Limit fragmentation (edge disturbance) to prevent invasion of invasive species and support interior-dependent native species
G. Introduction of native seed and plugs/saplings historically characteristic of West Michigan Dry-Mesic Southern Forest habitat.
H. Prevent insect and pathogen outbreak by regularly monitoring (Eyes on the Forest) and treating individual outbreaks quickly (early detection rapid response).
I. Leave large tracts of forest habitat unharvested and unfragmented to allow for natural processes such as fire, windthrow, insect outbreaks, senescence, pathogens, etc. to operate unhindered. This will also limit nest predation by edge species.
J. Retain large diameter snags, coarse woody debris, and old living trees to maximize forest continuity.
K. Limit anthropogenic disturbances (i.e. off-trail hiking, introduction/spread of invasive species, unauthorized collections, etc.) by improving/increasing interpretive signage to encourage appropriate use of the property.

<u>Quality Site Indicators</u>:

A. Maintained or increased biodiversity as evident by annual/regular species diversity monitoring efforts (i.e. tree census, small mammal survey, breeding bird survey, etc.).
    1. Presence of woodland specialist bird species in woodlands (i.e. wood thrushes, red-eyed vireos, ovenbirds, scarlet tanagers, flycatchers, warblers, etc.)
    2. Presence of healthy/stable breeding bird populations
    3. High diversity of tree species (including oak saplings)

4. Plant biodiversity and floristic quality similar to undisturbed natural areas.

B. Relative absence of invasive plants and animals
C. Ecologically balanced red maple population
D. Presence of fine fuels (i.e. Pennsylvania sedge) and oak leaf litter
E. Ecologically balanced white-tail deer population and turkey populations with minimal signs of over-browsing and over-harvesting of acorns
F. The presence of fine fuels (i.e. Pennsylvania sedge) and abundant oak leaf litter (with reduced maple leaf litter) in oak-hickory forest.
G. Presence of snags and mature, healthy trees.

Mature Mesic Southern (Beech-Maple) Forest

Description: Mesic southern forests are beech- and sugar maple-dominated communities typically found on rolling topography (Cohen, J.G. 2004).

A. Location: East Woodlot & West Woodlot and a fringe surrounding Kettle Swamp (small portion of Fields A, B, C, D, E, F, & G)
B. Area: Approximately 25 acres
C. History: Historical photographs from 1938 suggest that portions of this site were historically an agricultural field (i.e. crop cultivation or pasture with possible orchard) but there is no evidence that the area currently occupied by mature forest was ever completely cleared or tilled. The portion located within the Buiten Wildlife Sanctuary has minimal human impact as that portion of the property is not open to the public. This forest has potential to become a sugar bush. As of 2012, there are 31 sugar maple trees with a dbh > 10 inches. Dominant shrubs include common buckthorn, glossy buckthorn and silky dogwood.

Figure 11: Example of mature Beech-Maple Forest in the Ecosystem Preserve

Soils: The soils in this habitat are typically well-drained Perrinton loam with high water holding capacity and high nutrient and soil organism content (deep leaf litter). Areas having this soil type are most often associated with cultivated crops, orchards, pastures, or woodlands.

Vegetation: Principal dominants of the canopy are American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*), which together often make up over 80% of the canopy composition. Canopy associates include bitternut hickory (*Carya cordiformis*), white ash

(*Fraxinus americana*), tulip tree (*Liriodendron tulipifera*), white oak (*Quercus alba*), red oak (*Q. rubra*), and basswood (*Tilia americana*). American elm (*Ulmus americana*) and ironwood (*Ostrya virginiana*) are common in the subcanopy. Sugar maple is the overwhelming dominant within the understory layer and often the ground layer. American beech, elm, and ironwood are also common saplings. Common shrub species include pawpaw (*Asimina triloba*), musclewood (*Carpinus caroliniana*), alternate-leaved dogwood (*Cornus alternifolia*), flowering dogwood (*Cornus florida*), leatherwood (*Dirca palustris*), witch hazel (*Hamamelis virginiana*), spicebush (*Lindera benzoin*), American fly honeysuckle (*Lonicera canadensis*), prickly gooseberry (*Ribes cynosbati*), red elderberry (*Sambucus racemosa*), and maple-leaved arrow-wood (*Viburnum acerifolium*). Common vines include Virginia creeper (*Parthenocissus quinquefolia*), green briar (*Smilax* spp.), and poison ivy (*Toxicodendron radicans*). The ground flora is characterized by a prevalence of spring ephemerals, high diversity, and high degree of compositional similarity across its range. Common ground flora include spring beauty (*Claytonia virginica*), cut-leaved toothwort (*Cardamine concatenata*), squirrel corn (*Dicentra canadensis*), Dutchman's breeches (*D. cucullaria*), white trout lily (*Erythronium albidum*), yellow trout lily (*E. americanum*), false rue anemone (*Enemion biternatum*), doll's eyes (*Actaea pachypoda*), jack-in-the-pulpit (*Arisaema triphyllum*), wild ginger (*Asarum canadense*), blue cohosh (*Caulophyllum thalictroides*), wild geranium (*Geranium maculatum*), sharp-lobed hepatica (*Hepatica acutiloba*), Virginia waterleaf (*Hydrophyllum virginianum*), may apple (*Podophyllum peltatum*), bloodroot (*Sanguinaria canadensis*), common trillium (*Trillium grandiflorum*), large-flowered bellwort (*Uvularia grandiflora*), maidenhair fern (*Adiantum pedatum*), wild leek (*Allium tricoccum*), sedges (*Carex albursina* and *C*. *plantaginea*), enchanter's nightshade [*Circaea canadensis (C. lutetiana* of Voss*)]*, beech drops (*Epifagus virginiana*), and running strawberry bush (*Euonymus obovata*) (Cohen, J.G. 2004).

Wildlife: Several state special concern raptor species frequently nest in mesic forest: Northern goshawk (*Accipiter gentilis*) and Cooper's hawk (*Accipiter cooperii*). This community also supports the state threatened red-shouldered hawk (*Buteo lineatus*) and provides summer nesting habitat for many neotropical migrants/forest interior obligates such as the black-throated green warbler (*Dentdroica virens*), scarlet tanager (*Piranga olivacea*) and ovenbird (*Seiurus aurocappilus*) (Cohen, J.G. 2004).

Temporary pools within mesic southern forest provide crucial habitat for native reptiles and amphibians such as the state endangered small-mouthed salamander (*Ambystoma texanum)*, the state special concern Eastern box turtle (*Terrapene c. carolina*) and gray ratsnake (*Pantherophis spiloides*), as well as other more common species such as the spotted salamander (*Ambystoma maculatum*), blue-spotted salamander (*Ambystoma laterale*), chorus

frog (*Psuedacris laterale*), wood frog (*Rana sylvatica*), gray tree frog (*Hyla versicolor*) and American toad (*Bufo americanus*) (Cohen, J.G. 2004).

Current Status and Threats: This habitat has moderate native plant and animal diversity and community structure. The maturing beech-maple forest is in fair condition having a robust native plant diversity at all levels from ground to canopy. Threats include the presence of invasive plants (i.e. common buckthorn, glossy buckthorn, multiflora rose, privet and Japanese barberry), and heavy browsing pressure from deer and turkeys. Forest pests (i.e. emerald ash borers) and pathogens are present. There is insufficient interior habitat to support large woodland bird species.

Goals/Objectives (Desired Future Condition):

- To preserve the ecological integrity of the old growth beech-maple forest habitat by minimizing the impacts of human activities and invasive plants and animals.
- To maintain and enhance ecological biodiversity
- To encourage natural forest succession and key plant functional groups (i.e. woodland spring ephemeral wildflowers)
- To maintain healthy and viable white-tailed deer population: The 100 acre preserve should be able to adequately support only 3-4 deer (Tilghman, 1989).

Management Strategies:

A. Active monitoring, mapping, and control of invasive plants: garlic mustard (*Alliaria petiolata*), Dame's rocket (*Hesperis matronalis*), Oriental bittersweet (*Celastrus orbiculatus*), Eurasian honeysuckles (*Lonicera morrowii*, *L. japonica*, *L. maackii, L. tatarica*, *L.* x*bella*, and *L. xylosteum*), Japanese barberry (*Berberis thunbergii*), common buckthorn (*Rhamnus cathartica*), glossy buckthorn (*Frangula alnus*), multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), and common privet (*Ligustrum vulgare*).
B. Capitalize on student intern research projects to improve species inventories and monitoring efforts of known rare species (i.e. box turtles, Blandings turtles, green herons, pileated woodpeckers, Cooper's hawks, etc.)
C. Leave large tracts unharvested and unfragmented to allow natural processes to operate unhindered and to limit nest predation by edge species.
    1. Maintain dead wood in form of snags, stumps, and fallen logs for cavity nesters, salamanders, macroinvertebrates, and decomposers.
D. Reduce fragmentation and edge disturbance to accommodate interior forest obligate species such as neotropical migratory birds [i.e. black-throated green warbler

(*Dendroica virens*), scarlet tanager (*Piranga olivacea*), and ovenbird (*Seiurus aurocapillus*)]

1. Reducing forest fragmentation will also reduce predation by edge species and nest parasitism

E. Implement a quality deer management program to reduce detrimental effects of deer over-browsing and introduction/spread of invasive weed seeds.
    1. Determine actual deer herd size (and compare to DNR recommendation of 21 deer per square mile)
    2. Install deer exclosures to determine the impact of deer herbivory while encouraging spring ephemeral populations and regeneration of old growth forest.
F. Preserve vernal pools as critical habitat for reptiles and amphibians
G. Monitor for pests and pathogens such as Dutch elm disease, beech bark disease, emerald ash borer, etc. (Eyes on the Forest) and treat new infestations in a timely manner (early detection rapid response).
H. Limit anthropogenic disturbances (i.e. off-trail hiking, introduction/spread of invasive species, unauthorized collections, etc.) by improving/increasing interpretive signage to encourage appropriate use of the property.
I. Introduce native plant species well adapted to the site conditions and historically characteristic of Mesic Southern Forest habitat.
    1. Basswood and American beech to shady understory
    2. Tulip polar to sunnier sites
    3. Silky dogwood, downy arrowwood, and maple-leaved viburnum

<u>Quality Site Indicators</u>:

A. Plant biodiversity and floristic quality that is similar to undisturbed natural areas (determined by annual/routine monitoring efforts and observation)
B. Healthy and stable populations of breeding birds. Specifically, the presence of woodland specialist bird species such as wood thrushes, red-eyed vireos, ovenbirds, scarlet tanagers, flycatchers, warblers, etc.
C. Diverse population of spring ephemeral wildflowers
D. Presence of beech and sugar maple seedlings
E. Ecologically balanced deer population
F. Healthy, intact vernal pools
G. Relative absence of invasive plants and animals

Early Successional Mesic-Southern Forest

Figure 12: Example of early successional Beech-Maple Forest in the Ecosystem Preserve

Description: Mesic southern forests are beech- and sugar maple-dominated communities typically found on rolling topography (Cohen, J.G. 2004).

A. Location: North Pond unit, BIC/SW corner, West Preserve and majority of Fields A, B, F, & G (excluding fringe around Kettle Swamp)
B. Area: Approximately 35 acres
C. History: Until the mid-1960s, Fields A and B were historically farmed as hayfield and pasture, respectively. The tree canopy in Fields A and B were well established by the mid-1990s. Fields F and G were in corn production until 1984 and remained a meadow until early 1990s. The portion of early successional mesic-southern forest located within the Buiten Wildlife Sanctuary has minimal human impact as that portion of the property is not open to the public. Dominant shrubs include common buckthorn, glossy buckthorn and silky dogwood.

Soils: The soils in this habitat are typically well-drained Perrinton loam with high water holding capacity and high nutrient and soil organism content (deep leaf litter).

Vegetation: Principal dominants of the canopy are a variety of tree and shrub species that are generally fast growing, intolerant of shade, and spread rapidly. Early successional mesic southern forest habitat in the preserve has succeeded out of fallow agricultural fields and typically consists of 50% shrubs, seedlings (trees < 1 inch dbh) and sapling-sized trees (1-5 inch dbh). This young forest type may have as many as 450 woody stems per acre. During the earlier stages of succession, species composition tends to consist of short-lived and/or pioneer species such as dogwoods (*Cornus sp*.), wild black cherry (*Prunus serotina*), American elm *(Ulmus americana*), and ironwood (*Ostrya virginiana)*. Over time this habitat type should succeed into mature mesic southern forest dominated by mature American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) trees which together often make up over 80% of the canopy composition. Over time, canopy associates often include bitternut hickory (*Carya cordiformis*), white ash (*Fraxinus americana*), tulip tree (*Liriodendron tulipifera*), white oak (*Quercus alba*), red oak (*Q. rubra*), and basswood (*Tilia americana*). American elm (*Ulmus americana*) and ironwood (*Ostrya virginiana*) are common in the subcanopy. Sugar maple is the overwhelming dominant within the understory layer and often the ground layer. American beech, elm, and ironwood are also common saplings. Common shrub species include pawpaw (*Asimina triloba*),

musclewood (*Carpinus caroliniana*), alternate-leaved dogwood (*Cornus alternifolia*), flowering dogwood (*Cornus florida*), leatherwood (*Dirca palustris*), witch hazel (*Hamamelis virginiana*), spicebush (*Lindera benzoin*), American fly honeysuckle (*Lonicera canadensis*), prickly gooseberry (*Ribes cynosbati*), red elderberry (*Sambucus racemosa*), and maple-leaved arrow-wood (*Viburnum acerifolium*). Common vines include Virginia creeper (*Parthenocissus quinquefolia*), green briar (*Smilax* spp.), and poison ivy (*Toxicodendron radicans*).

Wildlife: Several state special concern raptor species frequently nest in mesic southern forest: Northern goshawk (*Accipiter gentilis*) and Cooper's hawk (*Accipiter cooperii*). This community also supports the state threatened red-shouldered hawk (*Buteo lineatus*) and provides summer nesting habitat for many neotropical migrants/forest interior obligates such as the black-throated green warbler (*Dentdroica virens*), scarlet tanager (*Piranga olivacea*) and ovenbird (*Seiurus aurocappilus*) (Cohen, J.G. 2004).

Temporary pools within mesic southern forest provide crucial habitat for native reptiles and amphibians such as the state endangered small-mouthed salamander (*Ambystoma texanum)*, the state special concern Eastern box turtle (*Terrapene c. carolina*) and gray ratsnake (*Pantherophis spiloides*), as well as other more common species such as the spotted salamander (*Ambystoma maculatum*), blue-spotted salamander (*Ambystoma laterale*), chorus frog (*Psuedacris laterale*), wood frog (*Rana sylvatica*), gray tree frog (*Hyla versicolor*) and American toad (*Bufo americanus*) (Cohen, J.G. 2004).

Current Status and Threats: This habitat has moderate native plant and animal diversity and community structure. The maturing beech-maple forest is in fair condition having a robust native plant diversity at all levels from ground to canopy. Threats include the presence of invasive plants (i.e. common buckthorn, glossy buckthorn, multiflora rose, privet and Japanese barberry), and heavy browsing pressure from deer and turkeys. Forest pests (i.e. emerald ash borers) and pathogens such as Beech Bark Disease are present. There is currently insufficient interior habitat to support large woodland bird species.

Goals/Objectives (Desired Future Condition):

- To preserve the ecological integrity of the early successional beech-maple forest habitat by minimizing the impacts of human activities and invasive plants and animals.
- To maintain and enhance ecological biodiversity
- To limit native bird nest predation by edge species and nest parasites
- To encourage natural forest succession and key plant functional groups (i.e. woodland spring ephemeral wildflowers)

- To maintain healthy and viable white-tailed deer population: The 100-acre preserve should be able to adequately support only 3-4 deer (Tilghman, 1989).

Management Strategies:

A. Active monitoring, mapping, and control of invasive plants: garlic mustard (*Alliaria petiolata*), Dame's rocket (*Hesperis matronalis*), Oriental bittersweet (*Celastrus orbiculatus*), Eurasian honeysuckles (*Lonicera morrowii*, *L. japonica*, *L. maackii, L. tatarica*, *L.* x*bella*, and *L. xylosteum*), Japanese barberry (*Berberis thunbergii*), common buckthorn (*Rhamnus cathartica*), glossy buckthorn (*Frangula alnus*), multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), and common privet (*Ligustrum vulgare*).
B. Capitalize on student intern research projects to improve species inventories and monitoring efforts of known rare species (i.e. box turtles, Blandings turtles, green herons, pileated woodpeckers, Cooper's hawks, etc.)
C. Leave large tracts unharvested and unfragmented to allow natural processes to operate unhindered and to limit nest predation by edge species and nest parasites.
D. Maintain large diameter snags, stumps and coarse woody debris to hasten old growth conditions while creating habitat for cavity nesters, salamanders, macroinvertebrates, and decomposers.
E. Reduce fragmentation and edge disturbance to accommodate interior forest obligate species such as neotropical migratory birds [i.e. black-throated green warbler (*Dendroica virens*), scarlet tanager (*Piranga olivacea*), and ovenbird (*Seiurus aurocapillus*)]
F. Reducing forest fragmentation will also reduce predation by edge species and nest parasitism
G. Implement a quality deer management program to reduce detrimental effects of deer over-browsing and introduction/spread of invasive weed seeds.
    a. Determine actual deer herd size (and compare to DNR recommendation of 21 deer per square mile)
    b. Install deer exclosures to determine the impact of deer herbivory while encouraging spring ephemeral populations and regeneration of old growth forest.
H. Preserve vernal pools as critical habitat for reptiles and amphibians
I. Monitor for pests and pathogens such as Dutch elm disease, beech bark disease, emerald ash borer, etc. (Eyes on the Forest) and treat new infestations in a timely manner (early detection rapid response). Limit anthropogenic disturbance to reduce the possibility of future invasive species establishment

J. Introduce native plant species well adapted to the site conditions and Mesic Southern Forest habitat
    a. Basswood and American beech to shady understory
    b. Tulip polar to sunnier sites
    c. Silky dogwood, downy arrowwood, and maple-leaved viburnum

Quality Site Indicators:

A. Transition towards old growth mesic-southern (beech-maple) forest with mature trees and healthy understory including spring ephemeral wildflowers.
    1. Plant biodiversity and floristic quality that is similar to undisturbed natural areas (determined by annual/routine monitoring efforts and observation)
B. Healthy and stable populations of breeding birds. Specifically, the presence of woodland specialist bird species such as wood thrushes, red-eyed vireos, ovenbirds, scarlet tanagers, flycatchers, warblers, etc.
C. Presence of early successional tree saplings
D. Ecologically balanced deer population
E. Healthy, intact vernal pools
F. Relative absence of invasive plants and animals

Vernal pools (Ephemeral ponds)

Description: Vernal pools are small, isolated wetlands that occur in forested settings throughout Michigan. Vernal pools experience cyclic periods of water inundation and drying, typically filling with water in the spring or fall and drying during the summer or in drought years (Thomas et. Al. 2010). According to Thomas et al. (2010), Vernal pools can be distinguished from true ponds or other wetland types because they must meet the following criteria:

Figure 13: Example of a vernal pool in the Ecosystem Preserve.

- Flooded long enough and frequently enough and dried out long enough and frequently enough to harbor flora and/or fauna that have specialized adaptations or life cycles for coping with both inundation and water drawdown. Notably, permanent fish populations do not occur in vernal pools.
- Small enough and/or shaded enough that recognized open-structure natural community types (see Kost et al. 2007) such as submergent marsh, emergent marsh, southern wet meadow, wet prairie, and so forth, do not become established

- Lack permanent surface water connection to other water bodies.

A. Location: Of the 13 ponds found in the preserve, only 3 are considered true ephemeral ponds. All 3 (Woods Pond 1, 6 & 7) are located north of Whiskey Creek.
B. Area: 0.20 acres
C. History: Historically, the preserve had five well-defined vernal pools that lacked connections to other surface waters, particularly those containing fish; these were Woods Pond 1,3,4,5 and 6. Woods Pond 4 was incorporated into the construction of the Prince Ponds and no longer exists. Woods Pond 1, 3, 5 and 6 showed classic vernal pool biota and seasonal development until the mid-2000s, when connections to the large Prince Pond introduced fish to Woods Pond 3 and 5 and those ponds began to hold water more permanently. Fish are still absent from Woods Pond 1 and 6. Woods Pond 7 also lacks fish and was added to the Ecosystem Preserve in 2017 when additional property (Pine Grove Trail area) was acquired.

   Woods Pond 2 is a broad depression that in the early years of the preserve behaved much like a vernal pool, though it was connected to other surface waters. Before the construction of Prince Ponds, this pond received occasional input from Woods Pond 3 and 5 when they overfilled. As today, at times of high water, Woods Pond 2 fills broadly across its northern edge into the swamp area traversed by the East Trail boardwalk. From there water finds its way through a shallow channel to Whiskey Creek. Flow in this channel and standing water in the swamp typically dried in summer until the discharge control structure from the Prince Ponds began to leak resulting in year-round flow through the swamp. In a Spring 1990 study, when that channel was flowing quite freely, central mudminnows were observed migrating up the channel and into the swamp beyond.

Soils: Typically, mineral soil underlain by an impermeable layer of clay. May be covered by a layer of interwoven fibrous roots and dead leaves.

Vegetation: Plants that grown in vernal pools are often tolerant of flooding, soil saturation, and drought. In Michigan, vernal pools are typically found within mesic southern forest habitat and can be ringed by: black ash (*Fraxinus nigra*), red ash (*Fraxinus pennsylvanica*), swamp white oak (*Quercus bicolor*), pin oak (*Quercus palustris*), bur oak (*Quercus macrocarpa*), black gum (*Nyssa sylvatica*), cottonwood (*Populus deltoides*), silver maple (*Acer saccharinum*), red maple (Acer rubrum), American elm (*Ulmus americana*), white pine (*Pinus strobus*), hemlock (*Tsuga canadensis*), northern white-cedar (*Thuja occidentalis*), and willow (*Salix spp.).*

The shrub component may include speckled alder [*Alnus incana (A. rugosa* of Voss)], buttonbush (*Cephalanthus occidentalis*), winterberry (*Ilex verticillata*), highbush cranberry [*Viburnum trilobum (V. opulus* of Voss)], highbush blueberry (*Vaccinium corymbosum),* dogwood (*Cornus spp*.), and willow (*Salix spp*.). Common herbaceous species may include: small duckweed (*Lemna minor*), jewelweed (*Impatiens capensis*), iris (*Iris spp*.), clearweed (*Pilea pumila*), marsh marigold (*Caltha palustris*), skunk cabbage (*Symplocarpus foetidus*), sensitive fern (*Onoclea sensibilis*), blue-joint grass (*Calamagrostis canadensis*), rushes *(Juncus spp*.), and sedges (*Carex spp*., including but not limited to *C. tuckermanii, C. squarrosa, C. bromoides, C. lupulina, C. lupuliformis,* and *C. muskingumensis*) (Thomas et al. 2010).

Wildlife: Though relatively small, vernal pools provide critical habitat for many plants and animals, including rare species and species with specialized adaptations for coping with variable hydroperiods. Invertebrates comprise the majority of animal, species, and biomass in vernal pools (Calhoun and deMaynadier 2008). Invertebrate groups commonly associated with vernal pools include fairy shrimp, clam shrimp, tadpole shrimp, seed shrimp (ostracods), copepods, water fleas (cladocerans), isopods and amphipods, springtails (Collembola), crayfish, worms, flatworms, leeches, rotifers and sponges, mollusks such as snails and fingernail clams, arachnids such as water mites and spiders, and aquatic insects such as caddisflies, aquatic beetles, dragonflies and damselflies, water bugs, true flies and mosquitoes (Eriksen and Belk 1999, Coburn 2004, Williams 2006).

Approximately 35 amphibian species breed in or utilize vernal pools (Johnson 1998). The amphibian species most dependent on ephemeral ponds in Michigan are: wood frogs (*Lithobates sylvaticus* [*Rana sylvatica*]), spotted salamanders (*Ambystoma maculatum*), blue-spotted salamanders (*Ambystoma laterale*) and hybrid complex, marbled salamanders (*Ambystoma opacum*, state endangered), and smallmouth salamanders (*Ambystoma texanum*, state endangered) (Harding 1997, Crother 2008). These species can be considered obligate or indicator vernal pool species (Ontario Vernal Pool Association 2010). Other amphibian species in Michigan that commonly breed in vernal pools but also can breed in other wetlands (i.e., facultative vernal pool species) include the eastern tiger salamander (*Ambystoma tigrinum*), western chorus frog (*Pseudacris triseriata*), boreal chorus frog (*Pseudacris maculata*), spring peeper (*Pseudacris crucifer*), gray treefrog (*Hyla versicolor*), Cope's gray treefrog (*Hyla chrysoscelis*), American toad (*Anaxyrus americanus* [*Bufo americanus*]), and Fowler's toad (*Anaxyrus fowleri* [*Bufo woodhousei fowleri*]) (Harding 1997, Ontario Vernal Pool Association 2010).

In Michigan, bird species that have often been observed using vernal pools or have high potential for using these habitats include wood duck (*Aix sponsa*), great blue heron (*Area*

herodias), mallard (*Anas platyrhynchos*), American black duck (*Anas rubripes*), eastern screech owl (*Megascops asio*), barred owl (*Strix varia*), wild turkey (*Meleagris gallopavo*), American woodcock (*Scolopax minor*), blackcapped chickadees (*Poecila atricapillus*), and warblers (Colburn 2004, Calhoun and deMaynadier 2008). A significant percentage of mammal species that occur in northeastern North America also utilize vernal pools (Calhoun and deMaynadier 2008). These include the little brown bat (*Myotis lucifugus*), big brown bat (*Eptesicus fuscus*), water shrew (*Sorex palustris*), masked shrew (*S. cinereus*), smoky shrew (*S. fumeus*), short-tailed shrew (*Blarina brevicauda*), star-nosed mole (*Condylura cristata*), meadow vole (*Microtus pennsylvanicus*), white-footed mouse (*Peromyscus leucopus*), woodland jumping mouse (*Napaeozapus insignis),* raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), mink (*Mustela vison*), white-tailed deer (*Odocoileus virginianus*), and moose (*Alces alces,* state special concern).

Current Status and Threats: In general, vernal pools have been declining in North America at an alarming rate. Many of these pools have been drained, filled, destroyed, or degraded by agricultural activities and urban development. In the Ecosystem Preserve the water quality in the vernal pools is indicative of stable natural process. While the ponds have characteristic biota, some ponds are exhibiting changing fauna and breeding conditions. Heavy predation of herps by raccoons and skunks limits recruitment.

Goals/Objectives (Desired Future Condition):

- Better understand location, condition, and hydrology of all vernal pools.
- Maintain and enhance macroinvertebrate and herpetofauna biodiversity
- Protect and enhance water quality

Management Strategies:

A. Properly identify and map all vernal pools on the preserve property
B. Minimize activities that disturb or compact soils or minimize tree canopies near vernal pools (especially in March through July).
    1. Limit off-road vehicle use near ponds
C. Retain sources of food and shelter by leaving trees and branches that fall naturally into pools.
D. Maintain a buffer of native forest vegetation around vernal pools to protect them from land use activities and alterations to water quality (Calhoun and deMaynadier 2008).
E. Maintain connections between vernal pools and other wetlands so that animals may disperse between scattered vernal pools and wetlands.

F. Maintain good water quality by minimizing the use of herbicides or other chemicals immediately adjacent to vernal pools. Use only wetland-approved herbicides.
G. Monitoring and prompt/sustained control of all invasive species such as autumn olive, reed canary grass, garlic mustard, glossy buckthorn, etc. that threated diversity and community structure
H. Encourage natural predators of raccoon and skunks to reduce predation of herps.
I. Limit habitat fragmentation by maintaining as much natural cover, wetland area, and drainage connection as possible between groups of vernal pools and between vernal pools and other wetlands so that animals may continue to disperse between scattered wetlands (Calhoun and deMaynadier 2008).
J. Limit anthropogenic disturbances (i.e. social trails along pond edges to accommodate frog collection/observation) by improving/increasing interpretive signage to encourage appropriate use of the property.

Quality Site Indicators:

A. Relative absence of aggressive weeds
B. Absence of fish species
C. Seasonally fluctuating water levels and intact hydrologic cycle (duration, size, temporal pattern of inundation, drying, and water-depth change pattern generally consistent over time)
D. Presence (and evidence of breeding) of obligate (indicator vernal pool) species such as: fairy shrimp (*Branchinecta lynchi*), wood frog (*Lithobates sylvaticus*), spotted salamander (*Ambystoma maculatum*), blue-spotted salamander (*Ambystoma laterale*) and hybrid complex, marbled salamander (*Ambystoma opacum*, state endangered), and smallmouth salamander (*Ambystoma texanum*, state endangered) (Harding, 1997).
E. Diverse populations of invertebrates (i.e. crustaceans, worms, copepods, rotifers, mollusks, arachnids, aquatic insects, etc.)

Open Water

Description: The glacial origin of the preserve appears to be that of a kettle moraine—an area which at one time was glacial gravels, clays, and sands intermixed with ice blocks of various sizes. The melting of these blocks left depressions or "kettles" ranging from about 50 feet across to 300 feet across. These kettles became ponds and are classified as open water habitat in the preserve along with the constructed Prince Ponds and Whiskey Creek. A map and history of open water habitats of the Ecosystem Preserve is located in Appendix D.

A. Location: The open water communities of Calvin's Ecosystem Preserve include: South Pond, Prince Ponds, N Pond, NW Pond, Whiskey Pond, Buttonbush Pond, Woods Pond 2,3 & 5 & Whiskey Creek.
B. Area: 4.8 acres
C. History:

Figure 14: Example of open water habitat in the Ecosystem Preserve

1. South Pond: Unlike North, NW, Whiskey and Buttonbush Ponds, South Pond has no surface connections to the other ponds in the area. This small pothole, which provides a strong reference point for the BIC and native gardens, appears to fill only from direct rainfall and runoff from its small immediate watershed (including the Venema Plaza and native gardens), while water loss consists largely of evaporation since its basis consists of heavy clay. Since the 1990's, the pond has held standing water throughout most years, but in hot, dry summers, evaporation sufficiently exceeds rainfall and runoff and the pond dries. In those years, the exposed floor of the pond eventually develops a cover of wetland grasses and other vegetation tolerant of hydric soils. Throughout its history, occasional summer drying and winter kill due to oxygen starvation beneath a solid ice cover have kept fish populations from establishing in this pond. After construction of the Prince Pond system, populations of black bullheads (*Ictalurus melas*) have occasionally established but do not over-winter. This pond has been recorded as up to 4 m deep.

2. Prince Ponds: This series of three interconnected ponds was created as part of the East Campus development in 2000 and 2001. These wetland retention ponds were designed to hold and condition runoff from the Prince Conference Center parking lot before discharging it into the preserve. The series of ponds begins with a settlement pond (PP3) near the cross-campus road on the east, which collects incoming storm water and stills it to allow larger suspended sediments to settle from the flow. From the settlement pond water drains via a culvert to the second pond (PP2), which is shallow with abundant macrophytes. After flowing the full length of the small pond from north to south, water moves through a small stand of cattails (*Typha sp*.) to the large Prince pond (PP1) which reaches a depth of 3-4 m over much of its center and contains a volume many times that of the other ponds. The large Prince Pond also receives water from the roof of the Prince Conference Center through a drain that empties into the pond near the observation dock on the south end of the pond.

The purpose of these three ponds is to retain water and allow time for sediments and contaminants to settle out of the water before the water enters the preserve. In 2020 a student employee learned that a neighbor purposely stocked the pond with bluegills for their personal fishing enjoyment. Prince Pond is the only pond in the preserve that contains bluegill.

3. North & NW Ponds: In the spring of 1985, as plans for the Ecosystem Preserve were taking form, Calvin College purchased from George Van Elst, a local resident on Lake Drive, a 10-acre parcel north of, and adjacent to, the mature woodlot, which would soon be the heart of the preserve. Nearly half of the 10-acre parcel was occupied by two seasonal ponds, the larger subsequently named North Pond and the smaller Northwest Pond. Each of these ponds filled with water during the winter, but saw their standing water replaced by vegetation over the course of the summer.

   By August summer vegetation in the heavily shaded NW Pond consisted largely of pondweeds (*Polygonom sp.*), while the larger, more exposed North Pond, inside its shrubby border, was dominated by a broad band of cattails around the edge and tall stands of grass in the interior of each half of the pond. There is an abandoned culvert (once maintained by the former owner) separating the two ponds allowing them to re-establish themselves as isolated water bodies. As water levels increased, first the grasses in the center of the pond and then the cattail border disappeared.

   By the summer of 1990 North Pond was free of emergent vegetation but for buttonbush (*Cephalanthus occidentalis*) stands that had established in the years of summer drying. Eventually, even these water-tolerant shrubs succumbed to the deeper waters so that the North Pond today is largely free of emergent vegetation. The buttonbush stands supported a Green Heron rookery for many years, even after deeper summer waters were established. The rookery disappeared about 2005. As water levels rose in North Pond, it became evident that the two ponds were formerly joined by a shallow ditch, which historically had drained much of the volume of NW Pond along with that of North Pond. Once a more elevated summer water level was established (mid-1990's) the two ponds had become permanently confluent. Over time, rising water levels in both ponds have significantly expanded the collective surface area. North Pond is typically 3 meters deep while NW Pond is typically 2 m deep. While NW Pond has a fairly solid bottom, the surface sediments at the bottom of North Pond are largely unconsolidated in each of its two sub-basins, making precise depth measurements difficult to obtain. An extensive probing of North Pond sediments confirmed the two-pot-hole nature of the basin

and established the original depth of the basins at approximately 10 m. A palynological study produced several wood samples that were radiocarbon dated to 13,250 BP. This suggests that the waters of North Pond could be confluent with the local water table and the rising volume of water in the pond could increase its recharge raising its level as well.

4. Buttonbush Pond: Situated just east of the Youngsma Building, Buttonbush Pond was named for the buttonbush shrubs that line much of its perimeter. Long supplied by water from North Pond, Buttonbush Pond has retained standing water continuously since the Ecosystem Preserve was established. Input to the pond from North Pond appears as a spring or seep where the culvert from North Pond empties into the Buttonbush Pond basin at its northeast corner. Though springtime discharge was quite noticeable in the early years of the preserve, it is presently much reduced because of the filling of the culvert; however, it continues year-round under pressure from the higher water levels in North Pond. When flow into the pond is at its maximum, the pond discharges to the south by way of a small, intermittent tributary of Whiskey Creek.

   Overall, Buttonbush Pond is among the bodies of standing water least changed since the preserve was established. Immediately to the east of the pond is a small inholding belonging to Hope Network. In the past, this parcel was used as a dump for landscaping materials, and from the plant debris deposition there small populations of Japanese Knotweed (*Reynoutria japonica)* and common reed (*Phragmites australis*) have become established near the shore of the pond. Annual efforts to eradicate these invasive plants have limited their spread, but they return with regularity. Calvin has spoken with Hope Network about the problem and they allow preserve staff to treat these two species. Hope Network has plans to build a utility building on this site. If this happens, the construction may eliminate the invasive plant populations, however, construction will need to be watched carefully to assure that construction does not cause them to spread.

5. Whiskey Pond: The name for Whiskey Pond, as for Whiskey Creek which drains into it, appears to derive from the brown hue of the tannin-stained waters carried by the stream from Kettle Swamp and the larger woodland through which it flows. In addition to direct rainfall, runoff from its immediate watershed and ground water inputs (including a seep on the east margin near the observation deck), Whiskey Pond received significant flow from much of the rest of the preserve by way of

Whiskey Creek and its preserve tributaries. Occupying the lowest elevation in the preserve, the pond serves as the preserve discharge point by way of a large stormwater culvert on the west margin of the pond. The culvert carries Whiskey Creek across the East Beltline to the west campus where it flows to the Seminary Pond and from there south of campus to its eventual junction with Plaster Creek. Like Buttonbush Pond, Whiskey Pond is rimmed with stands of buttonbush, which provide rich cover for a variety of birds commonly drawn to waterside habitats. In summer the pond is typically covered with duckweed (*Lemna minor*) which provides cover for frogs, tadpoles and fish and habitat for large populations of macroinvertebrates that are a favored prey of mallards and wood ducks that frequent the pond.

6. Woods Pond 2,3, & 5: Historically, the preserve had five well-defined vernal pools that lacked connections to other surface waters, particularly those containing fish; Woods Pond 1,3,4,5, & 6. Woods Pond 4 was incorporated into the construction of the Prince Ponds and no longer exists. Woods Pond 1 and 6 are currently classified as a true ephemeral pond/vernal pool. The remaining (Woods Pond 2,3 & 5) showed classic biota and seasonal development until the mid-2000s, when connections to the large Prince Pond brought fish to Woods Pond 3 and 5 and all the ponds began to hold water progressively later into the summer—causing them to lose their status as ephemeral ponds.

   Woods Pond 2 is a broad depression that in the early years of the preserve behaved much like a vernal pool, though it was connected to other surface waters. Before the construction of the Prince Ponds, this pond received occasional input from Woods Pond 3 and 5 when they overfilled. Currently, at times of high water, Woods Pond 2 spills broadly across its northern edge into the swamp area traversed by the East Trail boardwalk. From there water finds its way through a shallow channel to Whiskey Creek. Flow in this channel and standing water in the swamp typically dry in summer until the discharge control structure from the Prince Ponds began to leak resulting in year-round flow through the swamp.

7. Whiskey Creek: a tributary to Plaster Creek, Whiskey Creek supplies water to three prominent overflow areas. Two of these are just to the west of East Bridge. The basins of these areas produce pond-like conditions when the stream's flow expands in the spring. Fish, particularly central mud minnows, migrate up the stream in spring and may explain why ambystomatid salamanders (spotted and blue-spotted salamanders) have not been observed breeding there. Sediment/pollutant load was

decreased in 2012 when the Whiskey Creek Bioswale was installed. The Bioswale reduced erosion, sediment, and chemical inputs that accumulated on the surface of the adjacent 2-acre parking lot.

Current Status and Threats: With the exception of Prince Pond that has been artificially stocked with bluegills by an unauthorized neighbor and is routinely fished by neighbors, these aquatic resources are not heavily used by the general public (no fishing, swimming, etc.) and appear to be in a healthy state with minimal signs of human impact and water quality indicative of stable natural processes. Issues include a dense population of Eurasian milfoil in Prince Pond, seasonally dense populations of duckweed in Whiskey Pond and excessive nutrient loading in North Pond. Water levels in the Prince Ponds are undesirably low due to a leak in the discharge control structure. Most of the wetlands lie in clay-filled depressions and depend very little on ground water for refilling. Most are filled by runoff from fall and winter precipitation on adjacent upland habitat.

Goals/Objectives (Desired Future Condition):

- To contribute to the overall preservation of the greater watershed.
- To preserve the ecological integrity of open water habitats by minimizing the impacts of human activities and invasive plants and animals.
    - To reduce invasive plants in and adjacent to ponds
    - To maintain and enhance macroinvertebrate and herpetofauna biodiversity
    - To protect and enhance water quality
    - To address heavy nutrient loading into North Pond
    - To contain and/or eliminate the Eurasian milfoil population in Prince Pond.
    - To discourage fishing activities that could increase spread throughout pond systems
    - To determine and fix source of leak in Prince Ponds.

Management Strategies:

A. Monitor and control of aquatic invasive species at each of the open water habitats
B. Capitalize on student intern research projects to improve species inventories and monitoring efforts of rare, invasive and recently introduced species (i.e. Blandings turtles, green herons, bluegill, Eurasian watermilfoil, etc.)
C. Limit habitat fragmentation by maintaining as much natural cover and drainage connection as possible between ponds/wetland areas.
D. Repair water level/drainage issues of Prince Ponds
E. Better understand the drivers of eutrophication in North Pond (potential long-term research project)

F. Address heavy nutrient loading and dying vegetation in N/NW ponds
G. Address duckweed issue in Whiskey Pond to encourage waterfowl and turkey usage.
H. Introduce native plants historically characteristic of West Michigan as necessary (i.e. Prince Pond shoreline restoration project)
I. Limit anthropogenic disturbances (i.e. fishing, fish stocking, swimming, etc.) by improving/increasing interpretive signage to encourage appropriate use of the property.

Quality Site Indicators:

A. Relative absence of aggressive weeds
B. Diversity of pollution sensitive macroinvertebrates and fish species
C. Intact hydrology
D. Presence of nesting aquatic birds such as mallard ducks, wood ducks and green herons.
E. Restored water depths in Prince Ponds

Inundated Shrub Swamp (Kettle Swamp)

Description: The glacial origin of the preserve appears to be that of a kettle moraine—an area which at one time was glacial gravels, clays, and sands intermixed with ice blocks of various sizes. The melting of these blocks left depressions or "kettles" the largest of which is some 800 feet in diameter (what is now called Kettle Swamp and classified as Inundated Shrub Swamp). This habitat occupies a kettle hole depression surrounded by mesic southern forest. An inundated shrub swamp is successionally intermediate between open emergent marsh and swamp forest (Slaughter et al. 2010). Water often pools for prolonged periods of time due to the impermeable clay layer in the soil profile, which limits tree establishment.

Figure 15: Example of an Inundated Shrub Swamp in the Ecosystem Preserve.

A. Location: Fairly centrally located within the Buiten Wildlife Sanctuary. Primarily located in the East Woodlot and Fields D and F but portions also exist in Field B, C and E.
B. Area: 7.8 acres (340,450 ft^2)
C. History: Agricultural tiles (now disintegrated) once drained Field C between Woods Pond 6 and Kettle Swamp. A significant portion of the water entering the Preserve's aquatic systems comes from the watershed of Kettle Swamp. Once filled, the swamp overflows

into an intermittent stream which drains across the Preserve and connects with several other ponds. Because of the substantial input to the Preserve's hydrology from the watershed of the Kettle Swamp, it is important that the integrity of this management unit be maintained.

Soils: Relatively shallow Houghton muck over clay. Organic soil profile tends to be more acidic than mineral portions. Although soils typically remain inundated throughout the year (due to underlying permeable clay), the upper soil layers may become dry in mid to late summer and during periods of persistent drought.

Vegetation: Inundated shrub swamps are characterized by a dominance of buttonbush (*Cephalanthus occidentalis*) which typically represents more than 50% of the shrub cover. This community is often surrounded by a shallow moat of open water ringed by a thin band of wetland trees. Research suggests that a minimum water depth of 0.5 m (20 inches) is needed for successful maintenance of buttonbush populations.

In addition to buttonbush, other common species in the shrub layer of inundated shrub swamps include willows (i.e., *Salix bebbiana* and *S*. *discolor*), red-osier dogwood [*Cornus sericea (C. stolonifera* of Voss*)]*), silky dogwood (*C*. *amomum*), winterberry (*Ilex verticillata*), black chokeberry (*Aronia prunifolia*), swamp dewberry (*Rubus hispidus*), and swamp rose (*Rosa palustris*). Shrub cover can range from 40 to 90%, with an average of 70%. Often a scattered tree canopy is also present and may include maples (i.e., *Acer rubrum*, *A*. *saccharinum*, and *A*. *saccharum*), yellow birch (*Betula alleghaniensis*), musclewood (*Carpinus caroliniana*), ashes (i.e., *Fraxinus nigra* and *F*. *pennsylvanica*), black walnut (*Juglans nigra*), oaks (i.e., *Quercus bicolor* and *Q*. *palustris*), black willow (*Salix nigra*), and American elm (*Ulmus americana*). In a survey of 13 inundated shrub swamps in southern Michigan, tree overstory cover ranged from 5 to 60%, with an average cover of 23% (Slaughter et al. 2010).

Although the amount of ground cover can vary greatly both within and among inundated shrub swamps, the herbaceous layer is typically sparse due to frequent and prolonged flooding. The ground flora may contain species such as short-awned foxtail (*Alopecurus aequalis*), swamp milkweed (*Asclepias incarnata*), common beggar ticks (*Bidens frondosa*), false nettle (*Boehmeria cylindrica*), sedges (*Carex stricta*, *C*. *intumescens*, *C*. *retrorsa*, *C*. *radiata*, *C. lacustris, and C. crinita),* water hemlock (*Cicuta bulbifera*), goldthread (*Coptis trifolia*), spinulose woodfern (*Dryopteris carthusiana*), jewelweed (*Impatiens capensis*), southern blue flag (*Iris virginica*), rattlesnake grass (*Glyceria canadensis*), small duckweed (*Lemna minor*), common water horehound (*Lycopus americanus*), northern bugle weed (*L. uniflorus*), tufted loosestrife (*Lysimachia thyrsiflora*), Canada mayflower (*Maianthemum canadense*), sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinnamomea*), Virginia chain-fern (*Woodwardia virginica*),

reed canary grass (*Phalaris arundinacea*), clearweed (*Pilea pumila*), puccinellia (*Torreyochloa pallida*), mad-dog skullcap (*Scutellaria lateriflora*), water parsnip (*Sium suave*), bur-reeds (*Sparganium* spp.), skunk cabbage (*Symplocarpus foetidus*), and starflower (*Trientalis borealis*).

A narrow band of lowland deciduous trees often occurs at the periphery of inundated shrub swamp. Characteristic species include red maple (*Acer rubrum*), silver maple (*A. saccharinum*), musclewood (*Carpinus caroliniana*), black ash (*Fraxinus nigra*), green ash (*F. pennsylvanica*), black gum (*Nyssa sylvatica*), cottonwood (*Populus deltoides*), swamp white oak (*Quercus bicolor*), pin oak (*Q. palustris*), black willow (*Salix nigra*), and American elm (*Ulmus americana*). Poison-ivy (*Toxicodendron radicans*) is a common vine growing on the trees that ring inundated shrub swamp. Occasionally, a scattered tree canopy occurs within the wetland basin itself (Kost et al. 2007). In addition to lowland hardwoods, species characteristic of adjacent upland forests may also be represented. Several shrubs that are tolerant of moist but not inundated conditions also occur in the forest edge. Among these are silky dogwood (*Cornus amomum*), gray dogwood (*C. foemina*), and red-osier dogwood (*C. stolonifera*).

Wildlife: Inundated shrub swamp provides important habitat for a variety of animal species. Standing water provides critical breeding habitat for invertebrates, a critical part of the food source for herptiles such as the american toad (*Bufo americanus*), bullfrog (*Rana catesbeiana*), gray treefrog (*Hyla versicolor*), green frog (*Rana clamitans melanota*), northern leopard frog (*Rana pipiens*), and wood frog (*Rana sylvatica*) (Roe et al. 2004). Other herptiles that utilize inundated shrub swamp include the state endangered smallmouth salamander (*Ambystoma texanum*), the state threatened spotted turtle (*Clemmys guttata*), and the state special concern Blanding's turtle (*Emydoidea blandingii*) and eastern box turtle (*Terrapene c. carolina*). This is also preferred habitat for the state species of concern, the black-crowned night-heron (*Nycticorax nycticorax*).

The flowers of buttonbush are an attractive nectar source for day-flying lepidopterans, including silver-spotted skipper (*Epargyreus clarus*), tawny-edged skipper (*Polites themistocles*), monarch (*Danaus plexippus*), bronze copper (*Lycaena hyllus*), pearl crescent (*Phyciodes tharos*), red admiral (*Vanessa atalanta*), and black swallowtail (*Papilio polyxenes*) (Tooker et al. 2002). Buttonbush nutlets, which persist through winter, are consumed by ducks and other waterfowl (Snyder 1991).

Current Status and Threats: The kettle swamp is fairly difficult to traverse and is therefore not heavily used by researchers. Being located in the sanctuary portion of the preserve protects it from use by the general public. Kettle Swamp appears to be in a healthy state with no obvious signs of human impact outside of student research activity and small dump sites along the

perimeter. The swamp consists of stable water levels and includes a mix of native shrub and tree vegetation. Status is good but vulnerable to non-native invasive plants surrounding. Kettle Swamp has historically and continues to serve as the headwaters of Whiskey Creek

Goals/Objectives (Desired Future Condition):

- Maintain the natural hydrology and natural cycles found within the system
- Protect and enhance water quality
- Encourage key plant functional groups
- Maintain healthy and viable white-tailed deer population

Management Strategies:

A. Maintain a well-established upland buffer of natural communities to maintain natural hydrology and reduce nutrient, chemical and sediment loading from water-run-off from inappropriate sources.
B. Monitoring and prompt/sustained control of all invasive species such as autumn olive, reed canary grass, garlic mustard, glossy buckthorn, etc. that threated diversity and community structure.
C. Capitalize on student intern research projects to improve species inventories and monitoring efforts of known rare species (i.e. box turtles, Blandings turtles, green herons, pileated woodpeckers, Cooper's hawks, etc.)
D. Allow prescribed fire of associated upland habitat to spread into wetland area but do not force forest into buttonbush depressions that are resistant to burning due to inundation and insufficient fuel.
E. Maintain and monitor wood duck nest boxes.
F. Introduce native plants historically characteristic of West Michigan Inundated Shrub Swamp habitat into the management unit.
G. Encourage regeneration of adjacent old growth forest by implementing a Quality Deer Management Program.
H. Clean small dump sites along perimeter

Quality Site Indicators:

A. Robust breeding populations of amphibians and reptiles
B. Relative absence of aggressive weeds
C. Intact hydrology
D. Presence of healthy buttonbush population
E. Absence of dump sites/trash

(Constructed) Dry-Mesic (Tallgrass) Prairie

(& Old Fields to Be Converted to DMP)

Figure 16: Example of constructed Tallgrass Prairie habitat in the Ecosystem Preserve.

Description: Dry-mesic prairie is a native grassland community dominated by big bluestem (*Andropogon gerardii*), little bluestem [*Schizachyrium (Andropogon) scoparium],* and Indian grass (*Sorghastrum nutans*) that occurs on sandy loam or loamy sand on level to slightly sloping sites of glacial outwash, coarse-textured end moraines, and glacial till plain (Kost, 2004). The community represents the stands of open grassland that occurred within the historic oak openings. In the early to mid-1800s, the southern Lower Peninsula supported approximately 60,500 acres (Comer et al. 1995) of upland prairie, which included pockets of dry-mesic prairie, mesic prairie, mesic sand prairie, dry sand prairie, and hillside prairie. The Michigan Natural Features Inventory database currently includes 11 occurrences of dry-mesic prairie, which range in size from 2 to 15 acres and total 62 acres. It appears that less than 1% of the original upland prairie remains intact (Kost, 2004).

A. Location: The tallgrass prairie habitat is located immediately south of the Bunker Interpretive Center. Over time (as funding allows) it may also include approximately 20 acres of old field habitat located primarily in Field C but also in Fields D, E, and F.
B. Area:
    1. BIC Constructed Prairie (including Prince Pond Shoreline Restoration project plantings) = 1.48 acres (64,469 ft^2).
    2. Old Field = 22.2 acres
C. History:
    1. BIC Constructed Prairie: This small and somewhat isolated constructed prairie habitat is currently being extensively managed. It was severely degraded during the installation of the native garden project in Summer/Fall 2018. This area will likely see a mild to moderate amount of disturbance created by the general public during educational programs and during the field/research season. This management unit is managed on a routine basis (i.e. invasive plant removal, prescribed fire, seed collection, mowing, etc.).
    2. Old Field: This habitat was created by past human activities such as farming and grazing and shows signs of human settlement. This area was sharecropped in

corn until 1984. This management unit is among the lowest quality areas of the preserve due, in part, to heavy encroachment of shrubs and the presence of invasive plants.

Soils: Dry-mesic prairie occurs primarily on level to slightly sloping sites of glacial outwash or coarse-textured end moraines on glacial outwash (Chapman 1984). Soils are typically sandy loam or occasionally loamy sand with pH ranging from 5.2 to 6.7 (ave. pH 5.8) and water retaining capacity of 43 to 94% (ave. 55%) (Chapman 1984).

Vegetation: Unfortunately, no detailed ecological study of dry-mesic prairie was completed in Michigan before the nearly total demise of the community. What information is available comes from written descriptions of oak openings by early European settlers and from studies of small prairie remnants. Chapman (1984) completed a study of 66 prairie and savanna remnants in southern Lower Michigan, thirteen of which he classified as dry-mesic prairie (Kost, 2004).

Dry-mesic prairie supports a dense to moderately dense growth of low to medium vegetation with very little bare ground (Chapman 1984). The community is dominated by big bluestem, little bluestem, and Indian grass, which can occur in varying degrees of dominance to one another.

The following table of dry-mesic prairie plants was compiled from Chapman's (1984) study of thirteen dry-mesic prairie remnants in southern Lower Michigan and includes only species occurring in more than half the sites he studied:

SCIENTIFIC NAME	**COMMON NAME**
Grasses and Sedges	
Andropogon gerardii	big bluestem
Carex pensylvanica	Pennsylvania sedge
Schizachyrium (Andropogon) scoparium	little bluestem
Sorghastrum nutans	Indian grass
Forbs	
Achillea millefolium	yarrow
Anemone cylindrica	thimbleweed
Antennaria parlinii	smooth pussytoes
Asclepias syriaca	common milkweed
Asclepias tuberosa	butterfly weed
Comandra umbellate	bastard toadflax
Desmodium canadense	showy tick-trefoil
Desmodium illinoense	prairie tick-trefoil

Desmodium marilandicum	small-leaved tick-trefoil
Erigeron strigosus	daisy fleabane
Euphorbia corollata	flowering spurge
Fragaria virginiana	wild strawberry
Helianthus occidentalis	western sunflower
Hieracium longipilum	long-bearded hawkweed
Lactuca canadensis	tall lettuce
Lespedeza capitata	round-headed bush-clover
Lithospermum canescens	hoary puccoon
Maianthemum (Smilacina) racemosum	false spikenard
Monarda fistulosa	wild bergamot
Potentilla simplex	old field cinquefoil
Ratibida pinnata	yellow coneflower
Rudbeckia hirta	black-eyed susan
Solidago juncea	early goldenrod
Solidago nemoralis	old field goldenrod
Solidago rigida	stiff goldenrod
Solidago speciosa	showy goldenrod
Symphyotrichum (Aster) laeve	smooth aster
Symphyotrichum (Aster) oolentangiensis	prairie heart-leaved aster
*Symphyotrichum (Aster) pilosum**	hairy aster
Tradescantia ohiensis	common spiderwort
Shrubs	
Ceanothus americanus	New Jersey tea
Rosa carolina	pasture rose
Rubus flagellaris	northern dewberry
Salix humilis	prairie willow

* indicator species for dry-mesic prairie in Michigan (Chapman, 1984)

Wildlife:

Grassland Birds: Henslow's sparrow (*Ammodramus henslowii*) (E), grasshopper sparrow (*Ammodramus savannarum*) (SC), short-eared owl (*Asio flammeus*) (E), long-eared owl (*Asio otus*) (T), northern harrier (*Circus cyaneus*) (SC), migrant loggerhead shrike (*Laniusludovicianus migrans*) (E), dickcissel (*Spiza americana*) (SC), western meadowlark (*Sturnella neglecta*) (SC), and barn owl (*Tyto alba*) (E).

Insects: blazing star borer (*Papaipema beeriana*) (SC), phlox moth (*Schinia indiana*) (E), leadplant flower moth (*Schinia lucens*) (E), red-legged spittlebug (*Prosapia ignipectus*) (SC), Sprague's pygarctia (*Pygarctia spraguei*) (SC), American burying beetle (*Nicrophorus*

americanus) (X/LE), pinetree cricket (*Oecanthus pini*) (SC), and regal fritillary (*Speyeria idalia*) (E).

Mammals: prairie vole (*Microtus ochrogaster*) (E).

Reptiles: eastern massasauga (*Sistrurus c. catenatus*) (SC and Federal Candidate Species), gray ratsnake (*Pantherophis spiloides*) (SC), and eastern box turtle (*Terrapene c. carolina*) (SC). Spotted turtle (*Clemmys guttata*) (T) and Blanding's turtle (*Emydoidea blandingii*) (SC) may nest in dry-mesic prairie when it occurs adjacent to wetlands (Kost, 2004).

Current Status and Threats:

1. BIC Constructed Prairie: Severely degraded during native garden project. Invasive species include: spotted knapweed, curly dock, sweet white clover, Canada thistle, bull thistle, teasel, multiflora rose, oxeye daisy, etc.
2. Old Field: This moderately degraded habitat is currently succeeding into dry mesic southern forest in the absence of fire as a disturbance agent. Woody encroachment from gray dogwoods, hawthorns, cherry and cedar trees makes this area generally insufficient for grassland bird nesting habitat. The most threatening invasive plants include spotted knapweed and autumn olive. This habitat exists in the sanctuary portion of the preserve and experiences minimal human disturbance outside of minimal vegetation trampling that takes place during routine summer research projects.

Goals/Objectives (Desired Future Condition):

1. BIC Constructed Prairie:

- To preserve and enhance the ecological diversity of the site by minimizing the impacts of human activities and invasive plants and animals.
- To expand current, fragmented prairie habitat towards BIC parking lot and Prince Conference Center.
- To increase the plant diversity of constructed prairie habitats over time so that they more closely resemble naturally occurring tallgrass prairie habitat.
- Use as native seed bank for other restoration efforts (i.e. sand lens project)

2. Old Field:

- To preserve and enhance the ecological diversity of the site by minimizing the impacts of human activities and invasive plants and animals.
- Over time, 20 acres of current old field habitat will be converted to tallgrass prairie habitat by removing encroaching woody vegetation and planting the site with grass and

wildflower species native to Michigan. Whenever feasible, only local genotype seed will be introduced into this site.

- To increase the plant diversity of the constructed prairie over time so that it more closely resembles naturally occurring prairie habitat.
- To create sufficiently large and undisturbed areas of grassland habitat to support the breeding of grassland specialized bird species.

Management Strategies:

A. Introducing frequent prescribed fire (if permissible by City of Kentwood) or mowing to protect and enhance plant species diversity and to prevent the encroachment of trees and shrubs
B. Monitoring and prompt/sustained control of all invasive species and brush that threated diversity and community structure
C. Capitalize on student intern research projects to improve species inventories and monitoring efforts of known rare species (i.e. box turtles, native pollinators, grassland birds, etc.)
D. Possible removal of select trees to remove predator perches and to reduce habitat fragmentation making the habitat potentially more suitable to native grassland birds.
E. Administering a Quality Deer Management program to control the density of white-tail deer that pose a threat to the forb diversity within the constructed prairie habitat.
F. Allow lowland portions to Old Field areas to naturally succeed into dry-mesic southern forest
G. Manually remove (brush hog w/ follow-up cut-stump herbicide application) woody vegetation in upland areas (all invasive shrubs and possibly some native trees/shrubs if undesirable shading becomes an issue)
H. Create corridors between constructed prairie habitats to better accommodate grassland species such as Henslow's and grasshopper sparrows that require up to 20 acres of contiguous prairie habitat.
    a. Avoid fragmentation of existing grasslands and maximize interior grassland habitat by avoiding long, narrow plantings which increase edge habitat.
    b. Re-introduce native plants appropriate to site conditions (See list recommended by Chapman (1984) and characteristic of remnant tallgrass prairie habitat.
I. Limit anthropogenic disturbances (i.e. off-trail hiking, disk golfing, dog walking, etc.) by improving/increasing interpretive signage to encourage appropriate use of the property.

Quality Site Indicators:

A. Substantial fuel to carry fire
B. Presence of prairie indicator species

C. Change in dominance of ant species from carpenter (Camponotus) and woodland (Aphaenogaster) ants to prairie (Formica) ants.
D. Relative absence of woody species and aggressive weeds
E. Diversity of flora and fauna characteristic of remnant tallgrass prairie habitat
F. Increasing diversity of native pollinators over time
G. Presence of native grassland specialist bird species (i.e. bluebirds, grasshopper sparrows, Henslow's sparrows, savannah sparrows, eastern meadowlarks, dickcissels, bobolinks, etc.)
H. Increase in presence of meadow voles over time

Dry Sand Prairie

Figure 17: Example of constructed Dry Sand Prairie habitat in the Ecosystem Preserve

Description: Dry sand prairie is a native grassland community dominated by little bluestem [Schizachyrium (*Andropogon scoparium*), big bluestem (*Andropogon gerardii*) and Pennsylvania sedge (*Carex pensylvanica*) that occurs on loamy sands primarily on well drained to excessively well drained, sandy glacial outwash plains and lakebeds (Kost, 2004). Historically, the largest areas of dry sand prairie occurred in Crawford and Newaygo counties, with each supporting approximately 5,000 acres of dry grassland. Today, in northern Lower Michigan, the community is known from 16 element occurrences that range in size from 6 to 77 acres and total 540 acres (Kost, 2004). Today, no remnant dry sand prairie exists in Kent County, MI.

A. Location:
    1. Sand Lens (Field E)
    2. Constructed Sand Prairie (On upland western shore of Prince Pond)
B. Area:
    1. Sand Lens: 0.45 acre
    2. Constructed Sand Prairie: 0.05 acre
C. History:
    1. Sand Lens: Along slope in Field D (SE of Kettle Swamp). First pioneer species were mosses, distinct soil type (currently undetermined but sandy). Vegetation is sandy prairie species.
    2. Constructed Sand Prairie: In 2005 Calvin mounted a touring exhibition, entitled "The Lost City of Petra," at the Prince Conference Center (PCC). This expansive exhibit took over much of the meeting space at the PCC and included outdoor

displays on the life of today's Bedouin people, who live in the area of Petra, and an archeological exploration area, which became the current "sand prairie."

The archeological exploration area was created by filling a depression on the southwest corner of the large Prince Pond with numerous dump truck's loads of sand. The sand was leveled and compacted, and then a backhoe was used to cut shallow trenches through the sand. Numerous "artifacts" were laid out in the trenches by Neil Bearling (5th grade teacher from Ada Christian), and the trenches were refilled. This layout welcomed hundreds of elementary students to conduct their own "digs" in a manner used by professional archeologists, including mapping the artifacts on a site map and recording the depths at which their artifacts were found. It was a very popular part of school visits to the Petra exhibit.

When the Petra exhibit ended, the question arose of what to do with all the sand in the exploratory area. It was decided that instead of trying to remove the sand and restore the area to local vegetation we would use the sand to create a dune planting where we could display plants common to Lake Michigan dunes. Initial plantings included not only species specific to the dunes (e.g. Pitcher's thistle, wormwood) but also species common to the dunes and Michigan sand prairies (e.g. little bluestem, switch grass, showy goldenrod). As time passed, sand prairie species have proven more persistent, and it is those species that today form the plant community of this display.

Soils: Loamy sands on well-drained to excessively well-drained sandy glacial outwash. In a study of dry sand prairie in Newaygo County, Hauser (1953) found that the community historically occurred on soils labeled Sparta Sandy Loam. These soils are loose, well-drained, acidic, unconsolidated and have very little organic matter content (Hauser, 1953).

Vegetation: Unfortunately, no detailed ecological study of dry sand prairie was completed in Michigan before the community experienced significant alterations due to farming, fire suppression, and conversion to pine plantations (Kost, 2004). However, Chapman (1984) completed a study of 66 prairie and savanna remnants in Lower Michigan and six were classified as dry sand prairie. The vegetation of dry sand prairie is typically tow to medium height and somewhat sparse with patches of bare soil common (Chapman, 1984). Common species of dry sand prairies in southern and western Lower Michigan includes the following species: little bluestem [*Schizachyrium (Andropogon) scoparium*], Pennsylvania sedge (*Carex pensylvanica*), and big bluestem (*Andropogon gerardii*) (Chapman, 1984). Other common

species include: New Jersey tea (*Ceanothus americanus*), flowering spurge (*Euphorbia corollata*), wild strawberry (*Fragaria virginiana*), long-bearded hawkweed (*Hieracium longipilum*), old field goldenrod (*Solidago nemoralis*), smooth pussytoes (*Antennaria parlinii*), wormwood (*Artemisia campestris*), butterfly weed (*Asclepias tuberosa*), prairie heart-leaved aster [*Symphyotrichum (Aster) oolentangiense*], poverty grass (*Danthonia spicata)*, common rockrose (*Crocanthemum canadense*), rough blazing star (*Liatris aspera*), wild lupine (*Lupinus perennis*), panic grass (*Dichanthelium oligosanthes*), northern dewberry (*Rubus flagellaris*), black-eyed Susan (*Rudbeckia hirta*), early goldenrod (*Solidago juncea*), and common spiderwort (*Tradescantia ohiensis*) (Chapman, 1984).

Wildlife: ants (genus *Formica*) are important for soil aeration. CEP sand prairie habitat will be too small and isolated to support rare sand prairie animals such as Henslow's sparrow, Grasshopper sparrow, Wood turtle, Karner Blue butterflies, prairie voles, etc.

Grassland birds: Henslow's sparrow *(Ammodramus henslowii*) (E), grasshopper sparrow (*Ammodramus savannarum*) (SC), short-eared owl (*Asio flammeus*) (E), long-eared owl (*Asio otus*) (T), migrant loggerhead shrike (*Lanius ludovicianus migrans)* (E), dickcissel (*Spiza americana*) (SC), western meadowlark (*Sturnella neglecta)* (SC), and barn owl (*Tyto alba*) (E).

Insects: secretive locust (*Appalachia arcana*) (SC), dusted skipper (*Atrytonopsis hianna*) (SC), Persius duskywing (*Erynnis p. persius*) (T), Ottoe skipper (*Hesperia ottoe*) (T), frosted elfin (*Incisalia irus*) (T), Great Plains spittlebug *(Lepyronia gibbosa)* (SC), Karner blue (*Lycaeides melissa samuelis*) (T, LE), blazing star borer (*Papaipema beeriana*) (SC), redlegged spittlebug (*Prosapia ignipectus*) (SC), Sprague's pygarctia (*Pygarctia spraguei*) (SC), grizzled skipper (*Pyrgus wyandot*) (SC), phlox moth (*Schinia indiana*) (E), and regal fritillary (*Speyeria idalia*) (E).

Mammals: prairie vole (*Microtus ochrogaster*) (E).

Reptiles: eastern massasauga (*Sistrurus c. catenatus*) (SC and Federal Candidate Species), gray rat snake (*Pantherophis spiloides*) (SC), and eastern box turtle (*Terrapene c. carolina*) (SC). Spotted turtle (*Clemmys guttata*) (T), wood turtle (*Glyptemys insculpta*) (SC), and Blanding's turtle (*Emydoidea blandingii*) (SC).

Current Status and Threats:

1. Sand Lens: Naturally occurring "sand lens" prairie in Field E is in fair condition and supports a rather robust and diverse population of plants characteristic of sand prairie. It is mildly degraded due to succession into dry-mesic southern forest and

presence of invasive plants. It also creates insufficient grassland bird nesting habitat because of its limited size.

2. Constructed Sand Prairie: Constructed and actively managed and is in relatively good condition with high native plant diversity. This site is too small and isolated to be grassland bird nesting habitat.

Goals/Objectives (Desired Future Condition):

- To preserve and enhance the ecological diversity of the site by minimizing the impacts of human activities and invasive plants and animals.
- To increase the plant diversity so that they more closely resemble naturally occurring dry sand prairie
- To establish sites as native seed banks for dry sand prairie indicator species and rare (state threatened and special concern) plant species such as pale agoseris (*Agoseris glauca*), lead plant (*Amorpha canescens*), prairie-smoke (*Geum triflorum*), rattlesnake master (*Eryngium yuccifolium*), etc.
- To eliminate all woody encroachment from both sites

Management Strategies:

A. Keep open with frequent Rx fire which will suppress weeds and encourage species diversity by promoting native seed germination and seedling establishment, increasing plant nutrients, and encouraging flowering and seed set. Burn on a rotating schedule and preserve refugia for fire-intolerant insect species.
B. Capitalize on student intern research projects to improve species inventories and monitoring efforts of known rare species and recently introduced invasive species (i.e. brown knapweed).
C. Control brush (cut-stump herbicide application)
D. Manage invasive species (i.e. spotted knapweed (*Centaurea maculosa*), common St. John's-wort (*Hypericum perforatum*), autumn olive *(Elaeagnus umbellata*), multiflora rose (*Rosa multiflora*), common buckthorn (*Rhamnus cathartica*), Eurasian honeysuckles (*Lonicera maackii, L. morrowii, L. tatarica, L. x bella*.), and black locust (*Robinia pseudoacacia*). Also control sweet white clover (*Melilotus abla*), Canada thistle (*Cirsium arvense)* and bull thistle (*C. vulgare*), curly dock (*Rumex crispus*), sheep sorrel (*Rumex acetosella*), orange hawkweed (*Hieracium aurantiacum*) and Canada bluegrass (*Poa compressa*).
E. Avoid fragmentation of these small, isolated management units and maximize interior grassland habitat by avoiding long, narrow plantings which increase edge habitat.

F. Reintroduce appropriate native vegetation (characteristic of dry sand prairie habitat) since small, isolated prairie remnants (and constructed prairies) are subject to reduced gene flow.

Quality Site Indicators:

A. Substantial fuel to carry fire
B. Presence of dry prairie indicator species: wormwood *(Artemisia campestris),* slender sand sedge [*Cyperus lupulinus (C. filiculmis* of Voss)], rough blazing star (*Liatris aspera*), and wild lupine (*Lupinus perennis*)
C. Relative absence of woody and invasive species
D. Presence of native soil mixing animals (i.e. prairie ants, moles, mice, skunks, etc.)

Southern Wet Meadow (Whiskey Creek Bioswale)

Description: This constructed habitat most closely resembles Southern Wet Meadow (or Sedge Meadow) habitat. It is generally an open, sedge-dominated wetland.

Figure 18: Example of Southern Wet Meadow habitat (constructed Whiskey Creek Bioswale) in the Ecosystem Preserve

A. Location: SW Corner east of Parking Lot 13
B. Area: 0.25 acre (10,500 ft^2)
C. History: The preserve's s-shaped, multi-tiered bioswale was designed in 2012 (319 contract) to prevent stormwater runoff from a 2.5 acre parking lot (Lot 13) from discharging uncontrolled directly to an existing stream, wetland, and pond complex system at the headwaters of Whiskey Creek, a large, highly urbanized tributary to Plaster Creek. The stormwater that discharges from this parking lot carries sediment and pollutants from the parking lot and causes erosion. The bioswale is 25 feet wide, 420 feet long, and 1 to 2 feet deep, providing a treatment volume of 21,000 ft^3. The bio swale increases the stormwater runoff flow path from 50 feet (previous) to 420 feet (a 90% increase) and can treat runoff for rainfall events between 2 and 3 inches (the majority of rain events within a given year). To accommodate stormwater flows larger than the treatment volume, a reinforced spillway was constructed at the end of the bioswale. In addition, a low flow discharge slowly dissipates bio swale water through a perforated riser and outlet pipe to ensure that the bioswale adequately empties after a rain event so that it is ready for the next rain event. The Whiskey Creek Bioswale project was funded in part through

Michigan Department of Environmental Quality's Nonpoint Source Program by the United States Environmental Protection Agency.

Soils: Typically organic soil such as muck and peat (Curtis 1959)

Vegetation: This natural area is typically dominated by tussock sedge (Carex stricta). Other sedges that commonly occur in southern wet meadow include: Carex aquatilis, C. comosa, C. bebbii, C. hystericina, C. lacustris, C. pellita (*C. lanuginose* of Voss), C. lasiocarpa, C. prairea, C. rostrata, C. sartwellii, C. stipata and C. vulpinoidea. Although most of the associated sedge species tend to be randomly interspersed, *Carex lacustris* often occurs in dense patches. The most dominant grass species in southern wet meadow is blue joint grass (*Calamagrostis canadensis*). Other common grasses include: fringed brome (*Bromus ciliatus*), fowl manna grass (*Glyceria striata*), marsh wild timothy (*Muhlenbergia glomerata),* leafy satin grass (*Muhlenbergia mexicana*), and fowl meadow grass (*Poa palustris*) (Kost, M. A. 2001).

Wildlife: Rare animal species associated with southern wet meadow include: swamp metalmark (*Calephelis mutica*, state special concern), Mitchell's satyr butterfly (*Neonympha m. mitchellii*, federal and state endangered), eastern massasauga (*Sistrurus c. catenatus*, state special concern), Blanding's turtle (*Emydoidea blandingii*, state special concern), spotted turtle (*Clemmys guttata*, state threatened), marsh wren (*Cistothorus palustris*, state special concern), northern harrier (*Circus cyaneus*, state special concern), short eared owl (*Asio flammeus*, state endangered), and American bittern (*Botaurus lentiginosus*, state special concern) (Kost 2001).

Current Status and Threats: The bioswale on the Preserve is not heavily used by the general public and appears to be in a relatively healthy state with no obvious signs of human impact outside of light student research activity, the minimal introduction of non-native plants, and the accumulation of trash. Is used to "absorb" nutrient additions and contamination from surface (parking lot) run-off. Forbs were introduced by Plaster Creek Stewards in 2017.

Goals/Objectives (Desired Future Condition):

- Maintain bioswale functionality (maintain intact hydrology, protect and enhance water quality in Whiskey Creek, Plaster Creek, etc.).
- Preserve site hydrology
- Maintain and enhance biodiversity that is primarily native
- The bioswale will specifically be managed to encourage key plant functional groups

Management Strategies:

A. Keep open with frequent Rx fire which will suppress weeds and encourage species diversity by promoting native seed germination and seedling establishment, increasing plant nutrients, and encouraging flowering and seed set. Burn on a rotating schedule and preserve refugia for fire-intolerant insect species.
B. Avoid surface water inputs from drainage ditches and agricultural fields and protect groundwater recharge areas by maintaining native vegetation types in the uplands adjacent to the community.
C. Reintroduce appropriate native vegetation characteristic of sedge meadow habitat since small, isolated wetland habitats are subject to reduced gene flow.
D. Clear drainage area so debris does not inhibit the flow of water into the overflow drain. Monitor riprap at mouth to ensure water entering the bioswale is not causing erosion. Clear check dams of debris
E. Active monitoring, mapping and control of non-native/invasive plants (i.e. glossy & common buckthorn, oxeye/shasta daisy, periwinkle, Japanese hedge parsley and exotic cool season grasses such as reed canary grass.
F. Capitalize on student intern research projects to improve species inventories and monitoring efforts of known rare and/or desirable species.
G. Actively manage/eliminate poison ivy along trails.
H. Limit anthropogenic disturbances (i.e. off-trail hiking, introduction/spread of invasive species, unauthorized collections, etc.) by improving/increasing interpretive signage to encourage appropriate use of the property.

Quality Site Indicators:

A. Substantial fuel to carry fire
B. Presence of sedge meadow indicator species (i.e. *Carex stricta*, Carex lacustris, blue joint grass, swamp aster, joe pye weed, common boneset, northern bugleweed, great water dock, marsh bellflower, and tufted loosestrife).
C. Relative absence of woody and invasive species such as common/glossy buckthorn, autumn olive, narrow-leaved cattails, phragmites, and purple loosestrife.

(Constructed) Native Gardens

Description & History: The native gardens were initiated in 2016, with a substantial donation from a long-time supporter of the preserve. At that time, Wes Landon, landscape architect, was hired to help staff reimagine the space. After a site assessment and much consideration, a plan was approved, and construction began in June 2018. The Calvin Ecosystem Preserve & Native Gardens now has a demonstration garden containing various types of native habitats to provide inspiration for people planting at home, additional paths to roam and views of South Pond, a

small gardeners cottage in which Calvin student employees (stewards) and volunteers can work, and a small greenhouse in which to display and sell native plants.

Building a garden from the ground up is no small feat. The summer and fall of 2018 were spent rescuing native plants from the existing garden, clearing the area, adjusting slopes, amending soil, laying sidewalks, placing irrigation, blowing mulch and planting. The execution of this project is the result of immense efforts made by preserve staff and Calvin's exceptional Physical Plant staff and contractors. In addition, 176 wonderful volunteers donated 444 hours of time to help us install nearly 30,000 native plants (representing well over 200 species which are listed in Appendix I) to complete the natural part of this project. Twenty-one garden beds (Figure 4) have been constructed-each with a different themed habitat for demonstration purposes. Some of these themes include tall and shortgrass prairie, oak savannah, pollinator garden, cottage garden, spring ephemeral garden, shoreline stabilization demonstration, etc.

In 2019 and 2020 over 10,000 additional native plants were planted in a less formal manner on the outskirts of the native gardens to extend the native garden beds. The Prince Pond Shoreline Restoration project consists of over 8,000 native plant plugs and this planting was extended northeastward to include a Monarch Garden that ultimately makes the prairie planting contiguous with the sand prairie habitat. Details about these prairie expansion projects along with details about soil type, vegetation, specific management goals and management strategies can be found in the Native Garden Management Plan (link will be provided here when maps are updated and link is included on Preserve's website).

A. Location: Area surrounding and adjacent to the Bunker Interpretive Center (Figure 4)
B. Area:1.48 acres (64,469 ft^2) of formally planted garden beds

Figure 19: Example of a native garden bed in the Ecosystem Preserve

Soils: In numerous instances, the soil in each garden bed has been amended to suit the growing needs of the plants introduced to the garden bed.

Vegetation: In general, each garden bed consists of plants with native Michigan genotype. See the Native Garden Management Plan for detailed plant lists and planting plans of each garden bed. (link provided above). Appendix K includes the general list of species planted into the native gardens.

Current Status and Threats: The native garden beds have been actively managed since their introduction in 2018. Routine watering, weeding, mulching, etc. have resulted in high quality native plant demonstration beds. The weed species most common to the Native Gardens include:

- Purslane
- Henbit
- Mugwort
- Velvetleaf
- Dandelion
- Crab grass
- White clover
- Sweet white (& yellow) clover
- Nutsedge
- Creeping Charlie
- Poison ivy
- Lambs quarter
- Yellow rocket
- Smartweed
- Foxtail
- Canada thistle
- Bull thistle
- Musk thistle
- Black medic
- Curly dock
- Fleabane
- Chickweed
- Ragweed
- Garlic mustard
- Spotted knapweed
- Common buckthorn
- Glossy buckthorn

Goals/Objectives/Management Strategies: The purpose of the native gardens is to install a cohesive set of garden spaces that will:

- Familiarize visitors with native plants and communities of West Michigan
- Demonstrate aesthetic possibilities for incorporating native plants in residential and commercial landscapes
- Display representative habitats that were originally present in Michigan
- Increase the effectiveness of educational spaces surrounding the Bunker Interpretive Center
- Provide partnership opportunities (i.e. installation and maintenance of garden beds and educational outreach programs) with local organizations

Implementation of Land Management Plan

Table 1: Resource needs, timeline, budget and priority of land management strategies

Land Management Strategy	Resource Needs	Work Plan /Timeline	Budget	Priority
Introduce Rx fire to promote oak regeneration, deter succession of shade-tolerant and invasive species, and keep oak pathogens and insect pests under control. Obtain permission to burn before converting 22 acre shrubland to prairie	Permission from City of Kentwood, contract with Rx burn crew, grant support (in lieu of burn at FIL?)	Once every 5 years	Approximately $7,000	1 (dependent upon Kentwood approval)
Active monitoring, mapping, and control of invasive plant species	Stewardship staff, herbicide, work gloves, boots, eye protection, GPS unit, yard waste bags, loppers	Immediate and ongoing	Herbicide (upland and wetland): $465; safety equipment: $260; GPS unit/software: (estimate from Jason Van Horn); misc tools: $325	1
Selecting harvesting/girdling of red maples where prevalent in Oak Hickory habitat	Stewardship staff, herbicide and titration bottles, safety equipment	Pending status of ability to Rx burn; If red maples limit success of Rx burning	Herbicide: $165; Supplies: $120	3
Selective harvesting/girdling Scotch Pine trees	Stewardship staff, herbicide and titration bottles	As time allows	See above	3
Implement a quality deer management program to encourage forest regeneration	Sanctuary only, hunters to provide own tree stands, safety straps, etc. Land manager to manage; discuss publicity issues with board of directors	ASAP	Staff time	2
Install deer exclosures to protect native saplings and rare forbs & help justify QDM program	Stewardship staff, Lumber and fencing at least 8 ft tall, labor to install	Optional: if deemed necessary to help justify deer mgmt. program	$1400 for 2 exclosures; staff time	2 (optional)
Replace infrastructure (trail edging, boardwalks, bridges and observation decks) as necessary	Lumber, hardware, stewardship staff	Immediate/as needed/on-going	Staff time; treated lumber: 2X4X8: $4.70; 4X4X8: $7.40; 6X16 deck boards:	1 (as needed)

			$10.50; 5 lb deck screws: $24; hacksaw blades: $14. Engineering required for observation deck replacement	
Limit fragmentation/edge disturbance to prevent invasion of invasive species and support interior-dependent native species	Passive management	Immediate & on-going	$0; staff time	1
Introduction of native seed and plugs/saplings	Plants propagated in greenhouse with seed collected on site and stewardship staff	Immediate & on-going	Pots: $50 (can be reused); staff time	2
Prevent insect and pathogen outbreak by regularly monitoring and treating individual outbreaks quickly (early detection rapid response)	Stewardship staff and potential application of pesticides	Immediate & on-going	Staff time; possible pesticide treatments (tbd)	1
Leave large tracts of forest habitat unharvested and unfragmented to allow for natural processes to operate unhindered	Passive management -Only address downed trees that are safety hazards or impede foot traffic on trails	Immediate & on-going	$0; staff time	1
Limit anthropogenic disturbance to reduce the possibility of future invasive species establishment and spread	Stewardship staff to enforce preserve rules	Immediate & on-going	$0; staff time	1
Retain large diameter snags, coarse woody debris and old living trees to maximize forest continuity	Passive management	Immediate & on-going	$0; staff time	1
Preserve vernal pools as critical habitat for reptiles and amphibians	Stewardship staff to control invasive plants and monitor for run-off	Immediate & on-going	Staff time	1
Monitor and control of aquatic invasive species at each of the open water habitats	Wetland approved herbicide; stewardship staff	Immediate & on-going	Staff time; AquaNeat herbicide: $80	1
Limit habitat fragmentation by maintaining as much natural cover and drainage connection as	Passive management; some drain maintenance	As needed & on-going	$0; staff time	2

possible between ponds and wetland areas				
Repair water level/drainage issues of Prince Ponds	Contracted excavator work?	ASAP	Staff time and/or Kentwood Excavator's	2
Better understand the drivers of eutrophication in North Pond	Student researchers	Possible long-term research project	Staff and student researcher time: equipment needs tbd	2
Address duckweed issue in Whiskey Pond	Mechanical harvesting by stewardship staff; reduction in nutrient inputs	As staffing & time allow	Staff time	3
Maintain and enhance macroinvertebrate and herpetofauna biodiversity in open water habitats	Passive management; stewardship staff to monitor for disease; possible treatments	Immediate & on-going	Staff time	1
Maintain a well-established upland buffer of natural communities to maintain natural hydrology of Prince Pond and reduce nutrient, chemical and sediment loading from water-run-off from inappropriate sources.	Introduction of native plants grown by staff by seed collected on grounds	Installation is immediate and in progress; on-going maintenance	Native plants grown in-house (pots: $50). Staff and volunteer time	1
Maintain and monitor wood duck nest boxes	Stewardship staff and replacement lumber/hardware	As staffing and time allows	Replacement lumber & hardware: approximately $40/box (x2)	3
Clean dump sites along perimeter of Kettle Swamp	Stewardship staff	As staffing and time allows	Staff time to remove and scrap metal	3
Manual or mechanical removal of woody vegetation in upland areas to convert up to 22 contiguous acres of open habitat suitable to native grassland birds	Stewardship staff for long-term maintenance, contractor to remove brush and apply herbicide, installation of prairie species (seed)	ASAP-may be funding limited. The longer we wait, the bigger the problem	Staff time and grant required to hire contractor. Rough estimate = planting: $350/acre X 22 acres = $7,700 plus brush removal @ $1,400/acre (approximately $31,000)	1
Allow lowland portions of Old Field areas to naturally succeed into dry-mesic southern forest	Passive and active management; stewardship staff; native shrubs/trees grown in greenhouse	Immediate and on-going	Staff time for selective vegetation management; cost of native plant propagation (approximately $50 for pots)	1

	by seeds collected on site			
Create corridors between constructed prairie habitats to better accommodate grassland species	Stewardship staff and prairie plants grown in greenhouse by seeds collected on site	As staffing and funding allow	Staff time; $50 pots	2
Avoid fragmentation of existing grasslands and maximizing interior grassland habitat by avoiding long, narrow plantings which increase edge habitat	Thoughtful planning	As staffing and funding allow	$0; staff time	2
Control brush in open habitats (cut-stump herbicide application)	Stewardship staff, herbicide, loppers	Immediate and on-going	Staff time; herbicide: $60	1
Avoid surface water inputs from drainage ditches and agricultural fields and protect groundwater recharge areas by maintaining native vegetation types in the uplands adjacent to each community.	Thoughtful planning and coordination with neighbors	Immediate & on-going	Staff time	1
Clear drainage area of bioswale so debris does not inhibit the flow of water into the overflow drain. Monitor riprap at mouth to ensure water entering the bioswale is not causing erosion. Clear check dams of debris	Stewardship staff	Immediate & on-going	Staff time	1
Control poison ivy along hiking trails.	Stewardship staff and herbicide	Immediate & on-going	Staff time; herbicide: $30/year	1

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APPENDICES

APPENDIX A: A Brief Historical Timeline of the Calvin Ecosystem Preserve & Native Gardens

1964 Calvin College purchases the 80-acre William Kelly farm at the intersection of Burton Street and East Beltline Avenue across the East Beltline from the college campus.

1974 Dr. Ken Kuipers of the English Department shares with a few colleagues an idea to create a nature preserve in the old woods behind the East Beltline parking lot (Parking Lot 13) built on the William Kelly land.

1977-78 The first study group of the Calvin Center for Christian Scholarship meets to consider Christian stewardship of natural resources. One product of that group is a proposal for a nature preserve to include the woods and ponds at the northeast corner of campus property east of the East Beltline. The proposal includes a vision for incorporating into a future preserve lands to the east of campus property owned by Judge Joseph Kelly.

1979-80 An *ad hoc* college committee evaluates the CCCS proposal and recommends the creation of a campus nature preserve to include the wild 35 or so acres at the northeast corner of campus land east of the Beltline.

1983-84 A second *ad hoc* committee is charged with creating a detailed proposal for an Ecosystem Preserve. The proposal investigates possible programs for the preserve, develops a set of goals for the preserve project, and lays out, a plan for an Ecosystem Preserve.

1984 Calvin College receives a grant from the William Angell Foundation of Muskegon, MI (funds derived from the sale to the federal government of North Manitou Island) which provides funding for development of Ecosystem Preserve infrastructure.

1985 During the summer a team of 12 Calvin College students under direction of Marvin Vander Wal of the Engineering Department and Randy Van Dragt of the Biology Department installs most of the trail system, three bridges and two pond overlooks. The preserve encompasses approximately 35-40 acres.

The Calvin College Ecosystem Preserve is dedicated in October 1985.

1986 An *ad hoc* oversight committee for the Preserve is formed and urges purchase of the Kelly land to the east of the newly created Ecosystem Preserve to protect the watershed supplying water to the Preserve.

In the summer of 1986, the trail system originally planned for the Ecosystem Preserve is

completed.

1987 The college purchases parcels from Joseph Kelly and Peter Cook in Kentwood to the east of the newly created preserve, and the area surrounding the swamp at the head of Whiskey Creek is incorporated into the preserve. The preserve grows to about 125 acres.

1991 The constitution (formulated by the *ad hoc* committee established in 1986) for the Ecosystem Preserve is adopted, and the position of Preserve Director is created. Randy Van Dragt is appointed preserve director, and the first Governing Board is formed under the terms of the preserve constitution.

1993 The first master plan for the preserve is created and adopted by the Governing Board.

1995 In the fall of the year the first environmental education program is offered for area schools. Calvin College students are recruited and trained to teach the units of the program.

With the help of Mrs. Helen Bunker the house and land at 3770 Lake Drive SE and an adjacent 3-acre lot are added to the Preserve. Both properties lie on the northern boundary of the Preserve. The house is set up to serve as the headquarters for the Ecosystem Preserve.

1999 A half-time preserve Program Manager position is created. Cheryl Hoogewind is hired to fill the position and to coordinate the educational outreach programs of the Preserve.

A new campus masterplan (produced by an *ad hoc* Campus Planning Committee which included the preserve director) is adopted by the college. The plan includes a proposed interpretive center on the southern edge of the Preserve and a new boundary for the Ecosystem Preserve relative to proposed campus development east of the East Beltline. The preserve shrinks to about 90 acres.

2000 In the summer of 2000 under direction of Cheryl Hoogewind, four one-week summer camp sessions are offered for the first time.

2001 In the spring, construction begins on Gainey Field, the Prince and De Vos buildings, the cross-campus road and the treatment pond system.

Key funding toward the interpretive center is obtained from Mrs. Helen Bunker.

2002-03 Planning of the Bunker Interpretive Center is undertaken with input from campus and outside stakeholders. The decision is made to focus program for this building on education and outreach rather than research. Support of research program is assigned

to the Preserve House on Lake Drive. The decision is made to design the interpretive center according to LEED (Leadership in Energy and Environmental Design) guidelines.

Construction of the Bunker Interpretive Center begins in September 2003.

2004 Construction of the interpretive center is completed. On September 10, the Bunker Interpretive Center (BIC) is dedicated. The first educational programs are offered in the new facility that fall.

2005 The Bunker Interpretive Center receives LEED Gold certification from the US Green Building Council.

The college receives two generous endowments from Mrs. Helen Bunker, one to support and extend the programs of the Ecosystem Preserve and the second to support maintenance of the BIC.

2007 Jeanette Henderson is hired to replace Cheryl Hoogewind as full-time Preserve Program Manager.

2009 The wildlife refuge portion of the Preserve is formally renamed as the "Paul and Caroline Buiten Wildlife Sanctuary" in honor of Paul Buiten's leading the Calvin annual campaign that raised the funds to acquire this part of the Preserve.

The Ecosystem Preserve Governing Board and staff take on stewardship responsibilities for stewardship of the Flat Iron Lake Nature Preserve, a 68-acre nature preserve in Oakfields Township, Kent County donated to Calvin College by alumni Fritz and Carol Rottman.

2010 The College celebrates the 25th Anniversary of the Ecosystem Preserve.

2017 A four-acre inholding on the north margin of the Preserve is purchased and incorporated into the Preserve. The land purchase is made possible through a donation from a long-time preserve supporter, Thelma Venema, and a small land exchange with the sellers. A new length of trail, the Pine Grove Trail, is installed in the new addition by the summer steward crew.

The original preserve constitution is replaced by a new set of bylaws approved by the Ecosystem Preserve Governing Board and the college.

The full-time position of preserve Land Manager is created and funded for three years by a grant from Thelma Venema. Jen Howell is hired to fill the position.

With funding support from Thelma Venema, plans are developed to renovate the gardens around the BIC and to replace the BIC parking area. The gardens are to feature native plants in a semi-formal garden arrangement and to include two new buildings, a small support building and a display greenhouse.

2018	Much of the new BIC garden infrastructure and plantings is installed, and the parking lot replacement is roughed in.
2019	Installation of the Venema Native Gardens and the parking lot renovation are completed. The Venema Native Gardens are dedicated on May 11, 2019.
	Restoration of the wooded area at the southwest corner of the large Prince Pond is begun.
	After serving as preserve Director for 28 years, Randy Van Dragt retires.
2020	Dr. Jamie Skillen of the Calvin GEO department becomes the new director of the Ecosystem Preserve.
	Preserve programming is largely shut down beginning in March due to the COVID-19 pandemic.

APPENDIX B: Public Use Policies of the Ecosystem Preserve

Calvin Ecosystem Preserve & Native Gardens
Public Use Policies
Updated 4/21/2020

Missional Goals of CEPNG

The Calvin Ecosystem Preserve & Native Gardens conserves, restores and interprets native ecosystems to inspire people to value and protect the wonder of creation. Specifically, the preserve aims to:

A. Preserve and restore within their boundaries: 1) a variety of ecological communities characteristic of the West Michigan area and 2) those features of each site which are essential to maintaining the integrity of its ecosystems;
B. Provide Calvin University with academic resource for the support of courses and research activities as are designed to study the natural features of each preserve;
C. Provide a resource for the refreshment and renewal of members of the Calvin University community who visit the preserves. In the use of both preserves, appreciation of their natural features, including their resiliencies and fragilities, will be emphasized.
D. Provide for the West Michigan public a recreational resource (as described in II.C.) and a center for environmental education. (This element of purpose applies only to the Ecosystem Preserve, since the FIL preserve is not open to the general public.)

Use of the Bunker Interpretive Center, Venema Plaza, and preserve trails must be consistent with these goals. While use and preservation of a natural area can often conflict, the following rules and regulations ensure that the preserve can serve as many user groups as possible- particularly the wildlife that call this special place home. Please enjoy the preserve while being respectful of the following public use policies.

Preserve Public Use Policies

- **Guests must stay on trails and out of water bodies.**
    - Staying on designated trails helps to ensure guest safety, the preservation of sensitive plants and animals, and prevents the introduction of invasive species.

- **Trails are for hikers only. No running, biking, cross-country skiing or motorized vehicles.**

- These activities alter wildlife behavior, contribute to trail erosion and can create safety hazards for more passive trail users (i.e. birders, small children, researchers, etc.)

- **Dogs are not welcome-leashed, carried, or otherwise.**
  - Dogs are viewed as predators by smaller animals and as a potential bite risk for other guests. Keeping dogs at home makes the preserve less threatening to wildlife, increases wildlife sightings and generally improves the outdoor experience for guests.

- **The removal, disturbance or introduction of any plant, animal, or mineral is prohibited.**
  - Please leave what you find and allow others the opportunity of discovery. Exceptions are made only for formal research projects authorized by the Preserve Director. Feeding or releasing wild animals to the preserve may introduce disease to the property and may otherwise alter and negatively affect the balance of the ecosystem. Very few relocated animals actually survive.

- **Avoid interfering with research projects and educational programs.**
  - Students are hard at work conducting valuable research in the preserve. Please do not interfere by removing or tampering with their research equipment. Please also be respectful of educational program taking place in the preserve and/or Venema Plaza.

- **Smoking, consuming alcoholic beverages, and littering in the preserve are prohibited.**
  - The preserve is a part of the Calvin University campus and the same rules apply in this outdoor setting.

APPENDIX C: Research Protocols of the Ecosystem Preserve

Calvin Ecosystem Preserve & Native Gardens

Research Protocols

Updated 10/8/2020

Research in the Preserve

The Calvin Ecosystem Preserve & Native Gardens and Flat Iron Lake Nature Preserves are living laboratories for Calvin faculty and students to conduct field research, which greatly enhances our knowledge and improves our management. It also provides Calvin students with important, practical experience conducting scientific research. Research is strongly encouraged in the preserve. While exploring the preserves, please be mindful of the research protocols listed below.

Research Protocols

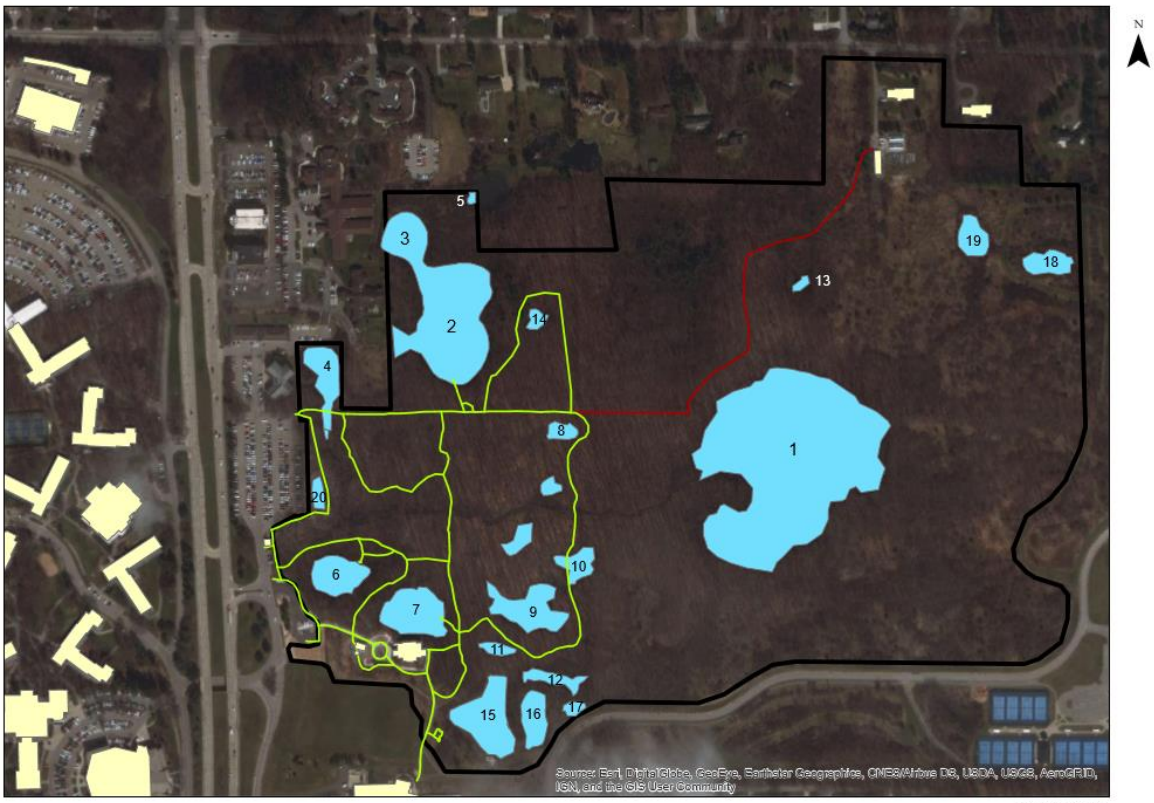
Researchers whose work abides by the preserves public use policies (see below) may self-register (https://calvin.edu/ecosystem-preserve/resources/academics/teaching-research-outdoors/) and may begin immediately. Researchers are asked to share their research data and conclusions with the preserve staff in a final research report (https://calvin.edu/ecosystem-preserve/documents/field-research/research%20summ%20form-fill.pdf). Research that requires exceptions to any of the public use rules is prohibited unless approved by the preserve Director, Dr. Jamie Skillen. Please submit an Application for Research for review (https://forms.office.com/Pages/ResponsePage.aspx?id=uUljdRAGAUuReypKwQ35R9-eTQWGU2pNoJbeSajqfQBUQlk2QVM5V1VXNjhYSFYwRzhRMDFNRlUyMy4u).

Researcher Expectations

- In addition to filing a research application, researchers are responsible for obtaining any and all appropriate university, state or federal permits required for their research.
- Researchers should use proper personal safety equipment when handling dangerous tools or chemicals.
- Research equipment (i.e. boots, waders, watercraft, water sampling equipment, etc.) that has been used outside of the ecosystem preserve must be properly cleaned before being introduced into the preserve.
    - Ideally, all research equipment should be cleaned at the location of last use before being moved to a new location. If this is not possible, equipment should be cleaned behind the Gardener's Cottage BEFORE being introduced to the preserve's natural areas. Ask Jen Howell (Land Manager) or Jamie Skillen (Director) for the access code to the Gardener's Cottage.
    - To properly clean equipment, remove all debris (soil, mud, plant particles, etc.) and disinfect equipment with a 10% bleach solution and allow to completely dry before using in the preserve.
    - Research equipment borrowed from the preserve must not leave the preserve without written consent from the Preserve Director.

APPENDIX D: Map and History of the Open Waters of the Ecosystem Preserve

History and size of the principle open waters and wetlands of the Calvin University Ecosystem Preserve. Several of the ponds have become more persistent on an annual basis over the history of the Preserve, and the persistence history columns reflect those changes. The descriptions of seasonal persistence are as follows: permanent = surface waters present year-round most years; seasonal = surface waters present much of the year except the summer and early fall; ephemeral = open water present primarily winter and spring, basins filling with fall rains and spring melt; intermittent = dry much of the year but filling during heavy rains or quick melts.



Evalyn Bailey

# on Map	Wetland/Pond	Size hectares (acres)	Geology	History of Seasonal Persistence 1986	2000	2019
1	Kettle Swamp	3.16 (7.89)	Kettle	Seasonal	Permanent	Permanent
2	North Pond	0.88 (2.21)	Potholes (2)	Seasonal	Permanent	Permanent
3	Northwest Pond	0.21 (0.51)	Pothole	Seasonal	Permanent	Permanent
4	Buttonbush Pond	0.21 (0.51)	Pothole	Permanent	Permanent	Permanent
5	Van Drie Pond	0.11 (0.27)	Pothole	Permanent	Permanent	Permanent
6	Whiskey Pond	0.25 (0.63)	Pothole	Seasonal	Permanent	Permanent
7	South Pond[a]	0.29 (0.71)	Pothole	Seasonal	Seasonal[a]	Permanent[a]
8	Woods Pond 1	0.04 (0.11)	Pothole	Seasonal	Seasonal	Seasonal
9	Woods Pond 2	0.24 (0.61)	Pothole	Seasonal	Seasonal	Permanent
10	Woods Pond 2 Extension	0.05 (0.13)	Pothole	Seasonal	Seasonal	Seasonal
11	Woods Pond 3[b]	0.04 (0.11)	Pothole	Seasonal	Seasonal	Permanent
N/A	Woods Pond 4[c]	---	Pothole	Seasonal	Seasonal	---
12	Woods Pond 5[b]	0.12 (0.31)	Pothole	Seasonal	Seasonal	Permanent
13	Woods Pond 6	0.04 (0.09)	Pothole	Seasonal	Seasonal	Seasonal
14	Woods Pond 7	0.03 (0.07)	Pothole	Seasonal	Seasonal	Permanent
15	Prince Pond 1[d]	0.30 (0.75)	Constructed	---	---	Permanent
16	Prince Pond 2[d]	0.10 (0.25)	Constructed	---	---	Seasonal
17	Prince Pond 3[d]	0.03 (0.08)	Constructed	---	---	Ephemeral
18	Cross-Country Pd	0.14 (0.34)	Depression	Ephemeral	Seasonal	Permanent
19	Field C Pond	0.02 (0.06)	Depression	Ephemeral	Seasonal	Seasonal
20	Lot 13 Bioswale[e]	0.10 (0.25)	Constructed	---	---	Intermittent

Notes:

a. South Pond has become more persistent over time, drying completely only 3 years since 2000.

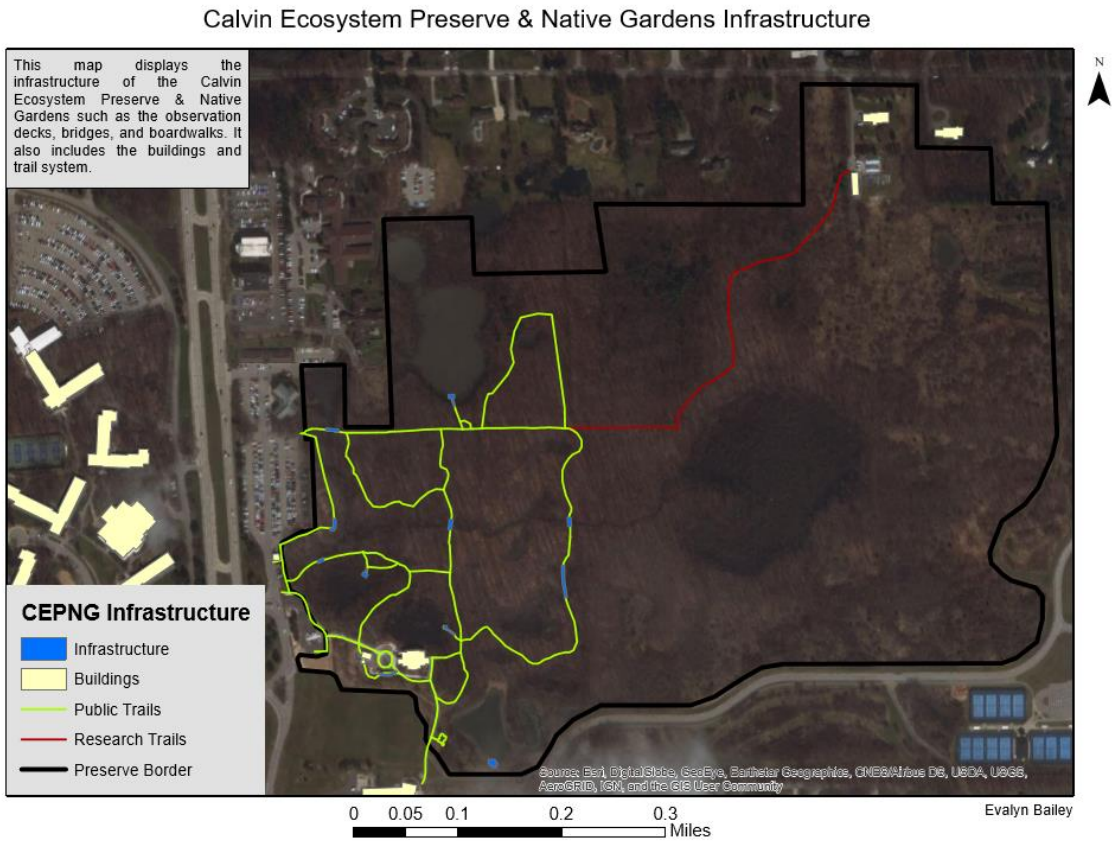
b. Both Woods Ponds 3 and 5 were classic vernal pools until the construction of the Prince Ponds, and since then have held water much of the year.

c. Woods Pond 4 was a shallow vernal pool in the south woodland margin prior to 2001 when it was replaced by Prince Ponds 2 and 3.

d. The three Prince Ponds are a series of water treatment ponds that begins with a settlement pond (Prince Pond 3), a shallow treatment pond with submerged and emergent vegetation (Prince Pond 2), and a deep (3-4 m in center) storage pond (Prince Pond 1), which by design may discharge excess water accumulation into the Preserve.

e. This intermittent wetland was created in 2014 to detain and treat runoff from the adjacent Parking Lot 13 before it discharges into Whiskey Creek.

APPENDIX E: Map of the Cultural Features of the Ecosystem Preserve



APPENDIX F: History of Vestiges of Land Use Before the Establishment of the Ecosystem Preserve

Cultural features of the Ecosystem Preserve the origins of which precede the establishment of the Preserve. Since many of these features were in place well before the Preserve was set aside, reliable dating is not available in most cases. Abbreviations: cardinal compass directions (E, W, N, S, NE, SE, SW, NW); trail (Tr), pond (Pd), bridge (Br), field (Fld), between (btwn); through (thru).

Feature	Location	Origin	Purpose
Rock boundary/ fence	Btwn Pine Grove parcel & Fld A; north margin of Flds A & B; btwn Flds C & D.	European agricultural practice – field clearing for agriculture.	Stones removed from field for tilling & piled along fence boundaries to create fences for grazing animals.
Wire fence – barbed wire & electric	West & north margins of mature woodlot.	European agricultural practice over many years – barbed wire & electric.	Define areas & control movements of grazing animals. Evidences – wire protruding from fence row trees, metal posts, electric insulators.
Fence tree row	Btwn Pine Grove parcel & Fld A; thru woodlot to S preserve boundary; btwn Flds C & D.	Fence rows developed along rock and metal fences.	Trees growing in immediate fence rows not cleared leaving prominent rows of mature trees, which today provide conspicuous boundary markers.
Farm utility trail (two-tracks)	From the NW edge of Kettle Swamp to NW corner of mature woodlot (along route of N Tr); from SW corner of woodlot to Whiskey Cr.	Appear to be longstanding utility trails for movement of farm wagons. Full extend of original trails not clear due to land use changes.	Created to connect wood land and adjoining fields to farmsteads to the east and south. Used for timber removal and, perhaps, crop and hay removal. May also have been used to move cattle or horses between grazing areas.
Field A Trail	Meandering trail in present sanctuary running from N Tr extension to S boundary of residential property on Lake Dr.	Cross-country skiing & snowmobiling.	Created prior to 1985 by area resident on whose property the trail ends. Resident maintained trail with permission of the former owner of Fld A and for several years with Calvin's permission.
Ditch	N margin of Pine Grove unit; along boundaries of Fld E with Flds D & F	Construction & enhance-ment of drainage channels to N Pd and Kettle Swamp	To drain lands of standing water to permit cultivation
Earth works – excavation deposit (fill)	Along boundary between Pine Grove unit & Fld A	Unknown; given plant growth on and around the deposit of soil it appears to have been there for some time	Might be a pile of waste fill from a local construction project

Earth works – ditch spoils pile	Along ditches in Pine Grove parcel & Fld E	Excavated materials from ditch construction	Spoils piles reflect the removed fill generated by ditch construction left in place along the ditches involved.
Earth works -- Field C borrow pit	Linear depression extending S of Preserve House greenhouse	Construction of Preserve House, approximately 1968.	Soils removed from this area used to raise elevation for construction of Preserve House
Earth works – the mossy ridge	This shallow ridge runs for 30—40 m along the boundary of Flds A & B.	Ridge represents the soil thrown from the edge plow furrow the last time the field was tilled	Area subsoils when brought to the surface by plowing or tree-spading (see "bomb craters") provide poor growth substrate for most plants except mosses
"Bomb crater"	Circular depressions found among the trees on the SW margin of the mature woodlot.	Depressions are result of removal of shrubs and small trees in the 1960's by "tree spades." Plants used in Calvin campus landscaping.	"Craters" are 1—2 m diameter depressions about ½ m deep often surrounded by a moss-covered ring of slightly elevated soil. They contain organic forest debris but little living plant diversity except mosses. About a score of these depressions can be readily identified.
Dump	Two sites in the woodland margin E and SE of Kettle Swamp	Longstanding refuse deposit sites	Out of the way site for deposit non-combustible household and agricultural refuse. The more northerly site consists mostly of rolls of sheep-fencing wire.
ATT long distance line vault –	In the Buiten Sanctuary along-side the old 2-track that runs from Kettle Swamp to N Tr. Marked by two manhole covers in the hillside.	Installed by ATT; date of construction unknown	Used to service two long distance lines (500 transmission pairs each) connecting Ionia and Grand Rapids. Structure functional until early 1990's when it was abandoned. Cables were cut inside the structure in late 2000's & the structure again mothballed.

APPENDIX G: History of Ecosystem Preserve Trails.

The prominent trails constructed at the time of and since the establishment of the Ecosystem Preserve in 1985. *Abbreviations: cardinal compass directions (E, W, N, S, NE, SE, SW, NW); trail (Tr), pond (Pd), bridge (Br), field (Fld), Bunker Interpretive Center (BIC), between (btwn); through (thru).*

Trail Element	Description	Origin	Length & Width (ft)	Purpose/Comments
North Trail	Nearly straight trail extending from N preserve entrance to Kettle Swamp. Portion extending into Buiten Sanctuary not developed.	Developed in 1985 as part of original preserve construction.	993 5	Entrance to the preserve & N segment of the main trail loop within the preserve woodlot. Much of trail follows old farm wagon road (Table XX). From Buttonbush Bridge E, trail surfaced with crushed concrete for chair access.
East Trail	Curves S off N Tr & meanders thru E part of woodlot to intersection with S Woods Tr.	Developed in 1985 as part of original preserve construction.	919 5	E leg of the main woodland trail loop. Includes E Bridge over Whiskey Cr. and boardwalk over Woods Pond 2 Extension.
South Woods Trail	S leg of the wood-land trail loop, ex-tending from S end of E Tr to inter-section with W Tr.	Developed in 1985 as part of original preserve construction.	483 5	Traverses high ground btwn WP 3 & 5 to the S and WP 2 to the N. Past W Tr an extension of S Woods Tr (32 ft long) leads to S Pond Overlook.
South Sanctuary Entrance Trail	Extends from inter-section of E and S Woods trails to S gate into Sanctuary	Built in 1988 to access S entrance to Sanctuary.	99 Footpath of irregular width	Connects the main trail loop with the S entrance to the Sanctuary.
West Trail	Connects the W end of S Woods Tr with N Tr.	Developed in 1985 as part of original preserve construction	831 4	The W N-S leg of the main woodland trail loop. Includes W Bridge & connections with Meadow & Ashwood trails.
Lowland Trail	A trail that loops btwn the E end of Buttonbush Bridge and West Tr.	Developed in 1985 as part of original preserve construction	580 4	Originally a trail thru an old hay field undergoing secondary succession. Now passes through secondary woodland.
South Field Trail	Trail thru the forest edge beginning at intersection of S Woods and W trails that extends to Prince Center Tr.	Developed in 1986 as part of original trail plan.	310 6	Originally connected the wood-land trail loop with the W margin of the preserve. Much of W part incorporated into Native Gardens with construction of BIC.

Whiskey Creek Trail	Extends from the Native Gardens Entrance Walk to W parking lot trail.	Constructed in 2001	862 5	Built to provide access to Whiskey Pd & an entrance to the trails from parking lot 13. Includes Whiskey Pd bridge. W 126 ft surfaced in crushed concrete
Whiskey Pond Dock Approach Trail	A short loop from Whiskey Pd Tr to Whiskey Pd dock.	Added to Whiskey Pd Tr in 2001	170 6	Built to facilitate access to Whiskey Pd dock. Surfaced in crushed concrete for chair access.
Ashwood Trail	Connects Whiskey Pond Tr with West Tr.	Build in XXXX	145 5	A short connector between W and Whiskey Pd Tr to enhance education programs.
N Parking Lot Trail	Wood-chipped trail along W preserve margin, extending from Parking Lot 13 to connection with S Parking Lot Trail.	Originally installed in 1986; as part of S Fld Tr.	136 5	Connects the gatehouse & Parking Lot 13 to the S Parking Lot Tr which leads to the Native Gardens and BIC. The segment of S Fld Tr to which it originally connected was eliminated with BIC construction.
S Parking Lot Trail	Concrete walk along E margin of BIC parking lot from S edge of lot to junction with N Parking Lot Tr.	Installed with the remodeling of BIC parking lot in 2018	247 10	Directs foot traffic from the BIC parking lot and N Parking Lot Trail to the Entrance Walk into the Venema Native Gardens
BIC Entrance Walk	Concrete campus walk extending from BIC parking lot to the Venema Gardens Circle Walk.	Installed in 2018 as part of the construction of the native gardens	216 10	Broad concrete walk leading to the circle walk at the center of the Venema Native Gardens. and around BIC. It surrounds the ornamental paved circle at the center of the Venema Native Gardens
Venema Native Gardens Circle Walk	Concrete walk surrounding the ornamental paved plaza at center of Venema Native Gardens.	Installed in 2018 as part of the construction of the native gardens.	185 10	Provides focus for the center of Venema Native Gardens & connects with several garden paths as well as a route thru the gardens to trails of the Ecosystem Preserve.
South Gardens Walk	Extends between the Circle Walk & Prince Center Trail.	Installed in 2018 as part of the construction of the native gardens.	140 10	Conducts pedestrian traffic from the Circle Walk to trails E of the BIC that lead into the Ecosystem Preserve.
Prince Center Trail	Paved campus walk connecting BIC to Prince Conference Center.	Installed with construction of BIC in 2004.	383 8	Connects pedestrian traffic between the Prince Conference Center & BIC. Leads from BIC to Prince Pond Trail and the Prince Pond dock.

Prince Pond Trail	Paved campus walk connecting Prince Trail to cross-campus road.	Installed in 2017 following construction of Prince Pond dock.	295 8	Skirts the S margin of the largest of the Prince ponds, providing access to the Prince Pond dock and an exit from the Preserve to the cross-campus road. S branch to Prince Pd Tr 83 ft long.
Pine Grove Trail	Wood-chipped trail in the Pine Grove unit, which travels a loop its two connections with N Trail	2017. Much of the work completed in 2017 following purchase of the Pine Grove unit.	993 Varied width but averages 8 ft	Wood-chipped trail with edging of small fallen tree trunks that begins and ends on N Trail. It takes walkers near the two special features of this unit, the pine grove above N Pond and Woods Pond 7.
Bioswale Trail	Connects N Parking Lot Tr to N Tr. Runs on E & S edges of Preserve Bioswale.	Constructed during the summer of	648 5	Installed to support access to the bioswale for educational purposes.
Cross-country Trail Loop	Loop extension of the Calvin cross-country trail connected for competition to the main trail thru two gates in the E boundary fence.	Installed along with the rest of the cross-country course in 2003	732 30	This athletic trail is used only during cross-country competitions. A short-cut across the loop & outside the Preserve is used for practice.
Sanctuary Trail	Meandering foot path passing from the greenhouse area on Lake Dr., thru the W part of the Preserve House parcel & Flds A, B, & C to the Sanctuary portion of North Trail.	Trail initially established in 1996 after acquisition of the Preserve House.	1,416 Footpath of irregular width: 1.5–2.5	Connects the Preserve House area with northern Sanctuary areas & the trails of the public preserve trails.
Sand Prairie Trail	Narrow footpath creating a loop thru the sand prairie btwn Prince Center Tr and the large Prince Pd	Installed in 2009 as part of creation of sand prairie garden.	166 Footpath of Irregular Width 2 - 3	Provides visitor access a sand prairie garden installed on a sand ledge above the large Prince Pd, just E of the Prince Center Tr

APPENDIX H: History of Ecosystem Preserve Bridges and Overlooks

The main bridges and overlooks that facilitate movement though the preserve and provide viewing access for education and aesthetic enjoyment. *Abbreviations: cardinal compass directions (E, W, N, S, NE, SE, SW, NW); trail (Tr), pond (Pd), bridge (Br), field (Fld), between (btwn); through (thru).*

Structure	Location	Origin	Length (ft)	Width (ft)	Notes
Buttonbush Bridge	Begins just inside N preserve entrance & crosses Button-bush Pd tributary to Whiskey Cr.	1985 – part of original preserve construction	152.5	5	Bridge divides at E end with one branch leading to N Tr and other to Meadow Tr.
East Bridge	Carries E Tr across Whiskey Cr just E of Whiskey Cr flood-plain ponds.	1985 -- part of original preserve construction	83	5	S 20 ft of suspended deck re-placed in 2012 after treefall.
East Trail Boardwalk	Carries E Tr across meandering extension of WP2.	1985 -- part of original preserve construction	142	5	Footings of some deck supports are unstable & occasionally need leveling, last done in 2002.
West Bridge	Carries W Tr across Whiskey Cr near W edge of mature woodlot.	1985 -- part of original preserve construction	92	5	Angle at N end of bridge prevents a conventional golf cart from crossing bridge.
Whiskey Pond Bridge	Part of Whiskey Pd Tr; crosses Whiskey Cr just above its entry to Whiskey Pd.	2001 -- part of construction of Whiskey Pd Tr.	49	5	
Bioswale Bridge – bridge deck	Carries Bioswale Tr over the outflow of the Whiskey Cr bioswale.	2016 -- part of construction of Bioswale Tr.	16.2	5	Bridge provides elevated deck for interpretive signage about the bioswale. S approach is
Bioswale Bridge – N approach	Walk off the Bioswale Br deck, slightly angled to NE to follow curve of bioswale.	2017 -- part of construction of Bioswale Tr.	16.5	5	
Bioswale Bridge – S approach	Sharply angled walk connecting S end of Bioswale Br deck to Bioswale Tr.	Finished in 2018 -- part of construction of Bioswale Tr.	26	Irregular (5–7)	Built in three segments to fit bridge to site and to improve accessibility. Includes level landing with room to add seating.

North Pond Overlook – deck	Built on steep wall of kettle that holds S half of N Pd.	1985 -- part of original preserve construction	11.75	15.25	Built to provide elevated vista of the largest body of water in the Preserve. Originally built on dry land, the bases of the supports have been submerged since 1990.
North Pond Overlook – approach	Joins N Pd deck to upper edge of wall of kettle.	1985 -- part of original preserve construction.	46	5	Built to provide gentle access to N Pd deck without need for stairs.
South Pond Overlook – deck	On E wall of small kettle containing S Pd.	1985 -- part of original preserve construction.	14.8	11.8	Built to provide elevated vista of one of most biologically rich bodies of water in the Preserve. Faces W to provide good morning vantage for bird watching.
South Pond Overlook – approach	Built to connect overlook deck to the westward extension of South Woods Tr.	1985 -- part of original preserve construction.	39	5	Built in three segments to fit overlook to site and improve accessibility.
Whiskey Pond Dock – Floating dock	Sited on NE bank of Whiskey Pd with its own access trail connected to Whiskey Pd Tr.	2001 – des-tination for Whiskey Pond Tr.	12	16	Built to provide an observation & sampling deck near surface of pond.
Whiskey Pond Dock – Landing deck	Onshore point of access to Whiskey Pd dock.	2002 – added to provide safer approach to dock.	8.5	14.5	Built to improve the access point to the dock and to provide seating near the dock.
Whiskey Pond Dock – gangway	Connects the onshore deck to the floating dock.	2001 -- replaced older ramp from shore to dock.	12	4.5	Added to provide access to the dock from the landing and to tether the dock to the shoreline.
Prince Pond Dock – deck	Built at S end of large Prince Pond to enrich use of transition zone between Preserve & built campus.	2016 – deck built & use began.			Overall configuration that of 2 overlapping rectangles, each about XXXXX. Southerly rectangle provides seating all around while northerly allows exploration of the pond.
Prince Pond Dock -- approach	Fixed gangway connecting Prince Pd dock to shoreline	2016 – deck built & use began.	8	8	
Venema Natïve Gardens Boardwalk	Boardwalk wraps around the south edge of the rain-garden component of the Native Gardens.	2018 -- part of remodel-ing of the Native Gardens at the BIC.	79	5	Boardwalk is strong aesthetic component of the Gardens and carries the outer garden trail over a seepage zone generated from the athletic field to the S.

APPENDIX I: History of Ecosystem Preserve Buildings

Buildings within the Ecosystem Preserve boundaries that directly or indirectly serve the mission of the Preserve. *Abbreviations: cardinal compass directions (E, W, N, S, NE, SE, SW, NW); Prince Pond (PP), Woods Pond (WP); Bunker Interpretive Center (BIC), Prince Conference Center (PCC); Trail (Tr), Pond (Pd), Bridge (Br), Field (Fld); between (btwn); through (thru).*

Building	Location	Origin	Approx. Size (ft^2)	Purpose/Comments
Bunker Interpretive Center	On the SE corner of the Preserve at 1750 East Beltline Ave SE, Grand Rapids, MI 49546, in transition btwn built campus & Preserve.	Opened in 2004.	5100	Built as part of the 1998 campus master plan. This LEED gold-rated building serves as the center for the Preserve's educational programs.
Gardener's Cottage	1750 East Beltline Ave, Grand Rapids, MI 49546.	Built in 2018 as part of the Venema Native Gardens.	361	Supports the many aspects of developing & supporting Venema Native Gardens.
Glasshouse	Part of Venema Native Gardens at 1750 East Beltline Ave, Grand Rapids, MI 49546.	Built in 2018 as part of the Venema Native Gardens.	215	Provides space for display & sale of native plants featured in the Venema Native Gardens.
Gatehouse	Situated on Parking Lot 13 near its S entrance.	Original "office" built in early 1970s. Garage added in 1994.	520	Original building served as a "guard shack" to protect cars in Parking Lot 13. Garage bay & new roof added later to house Preserve equipment. Served as "nature center" from 1995 to 2004.
Preserve House (aka Ecosystem Preserve Study Center)	On the N side of Preserve at 3770 Lake Drive SE, Grand Rapids, MI 49546.	Built in 1968; acquired by Calvin University in 1995.	4272	Originally built as residence for family of local judge, Joseph Kelly. Bought by Calvin U. in 1995 to serve as main office & research center for the Ecosystem Preserve. Square footage includes main floor, basement & garage.
Equipment Storage Out-building	On grounds of Preserve House.	Built in 1969.	128	Storage for grounds & field equipment.
Lake Drive Greenhouse	On grounds of Preserve House.	Built in 1998.	2550	Originally built as Biology Dept. specimen & research green-house, has become largely a native plant production facility for the Ecosystem Preserve & Plaster Creek Stewards.
Lake Drive Cold Frames (2)	On grounds of Preserve House.	N cold frame built in 2012, S in 2018.	960 each	Unheated greenhouses to support native plant production, largely for Plaster Creek Stewards.

APPENDIX J: LEED Gold Certification for the Bunker Interpretive Center

The Bunker Interpretive Center was built following guidelines of the U. S. Green Building Council developed for their LEED (Leadership in Energy and Environmental Design) certification program[1]. Numerous environmentally sensitive features incorporated into its design secured LEED Gold Certification for the Bunker Interpretive Center in 2005. Design features that move the building closer to the goal of sustainability include:

- Locating the interpretive center on an old college land fill--no native habitat disturbed
- Filtering and detaining area runoff in South Pond—reduced load on area storm sewers; assured filling of South Pond
- Using existing parking for building visitors--no addition of impermeable surfaces that promote runoff
- Low impact building materials used wherever possible (certified lumber, ceramic tile and carpeting made with recycled materials, paints low in volatile organic compounds)—reduced resource use, reduced habitat loss, reduced pollution
- Low impact construction practices (chipping vegetation cleared on site and using chips for landscaping, separating construction wastes for recycling, minimizing construction footprint)—protect habitat, reduce materials use, prevent pollution
- Passive lighting and automated passive cooling—reduced energy usage
- Computerized environmental control system with occupancy sensors—reduced energy use
- Radiant heating system (hot water heat in the floor)—reduced energy use, more comfortable environment
- Heavily insulated walls and ceilings; partially earth-bermed south wall—reduced energy use
- Photovoltaic power system (14 KW; supplies about half of the building's annual electricity needs)—reduced energy use; energy production from a renewable source
- Water conservation strategies
    1. Gray water treatment system—reduced waste water & pollution
    2. Composting toilets—reduced waste water & pollution
    3. Landscaping which needs no irrigation (or fertilizer)—reduced water & pollution
- Landscaping with native species--enhances the surrounding natural community; conserves water; reduces nutrient pollution from fertilizer use
- Low level exterior lighting to reduce light pollution—prevents lighting interference with nocturnal animals
- Ample shading--reduced heat island effect

APPENDIX K: List of Species Planted in Native Garden Beds

Forbs				
Scientific Name	**Common Name**		**Scientific Name**	**Common Name**
Actaea pachypoda	Doll's Eyes, White baneberry		*Erythronium americanum*	Yellow Trout Lily
Allium cernuum	Nodding Wild Onion		*Eupatorium maculatum*	Joe Pye Weed
Amorpha canescens	Leadplant		*Eupatorium perfoliatum*	Boneset
Anemone canadensis	Canada Anemone		*Eupatorium purpureum*	Woodland Joe-pye, Sweet Joe-pye Weed
Anemone cylindrica	Thimbleweed		*Euphorbia corollata*	Flowering Spurge
Anemone virginiana	Tall Thimbleweed, Tall Anemone		*Filipendula rubra*	Queen of the Prairie
Antennaria plantaginifolia	Pussytoes		*Fragaria virginiana*	Wild Strawberry
Aquilegia canadensis	Wild Columbine, Columbine		*Gentiana andrewsii*	Bottled Gentian, Closed Bottle Gentian
Aralia racemosa	Spikenard		*Geranium maculatum*	Wild Geranium
Arisaema dracontium	Green Dragon		*Geum triflorum*	Prairie Smoke
Arisaema triphyllum	Jack in the Pulpit		*Helenium autumnale*	Sneezeweed
Artemisia campestris	Wormwood		*Heliopsis helianthoides*	False Sunflower
Asarum canadense	Wild Ginger		*Hepatica acutiloba*	Spring Beauty
Asclepias exaltata	Poke Milkweed		*Heuchera americana*	Alumroot
Asclepias incarnata	Swamp Milkweed		*Heuchera richardsonii*	Prairie Alumroot
Asclepias syriaca	Common Milkweed		*Hibiscus moscheutos*	Swamp Hibiscus
Asclepias tuberosa	Butterflyweed		*Hydrophyllum virginiannum*	Virginia Waterleaf
Asclepias verticillata	Whorled Milkweed		*Iris virginica*	Southern Blue Flag, Virginia Iris
Symphyotrichum (Aster) cordifolium	Heart-Leaved Aster		*Jeffersonia diphylla*	Twinleaf
Aster laevis	Smooth Aster		*Lespedeza capitata*	Round Headed Bush Clover
Eurybia(Aster) macrophylla	Big Leaf Aster		*Liatris aspera*	Rough Blazingstar
Symphyotrichum (Aster) novae-angliae	New England Aster		*Liatris scariosa*	Northern Blazingstar
Aster oolentangiensis	Sky Blue Aster, Prairie Heart-Leaved Aster		*Liatris spicata*	Marsh Blazingstar
Baptisia bracteata	Cream False Indigo		*Lilium michiganense*	Michigan Lily
Baptisia lacteta	White Wild Indigo, White False Indigo		*Lobelia cardinalis*	Cardinal Flower
Campanula americana	Tall Bellflower		*Lobelia siphilitica*	Great Blue Lobelia
Campanula rotundifolia	Harebell		*Lupinus perennis*	Wild Blue Lupine, Lupine
Senna (Cassia) hebecarpa	Wild Senna		*Lysimachia ciliata*	Fringed Loosestrife, Fringed Yellow Loosestrife
Caulophyllum thalictroides	Blue Cohosh		*Maianthemum racemosu*	False Solomon Seal
Chelone glabra	Turtlehead		*Maianthemum stellatum*	Starry Solomon Seal
Coreopsis lanceolata	Lance Leaf Coreopsis, Sand Tickseed		*Mertensia virginica*	Virginia Bluebells
Coreopsis palmata	Prairie Coreopsis, Stiff Coreopsis		*Mitella diphylla*	Bishop's Cap
Coreopsis tripteris	Tall Coreopsis		*Monarda fistulosa*	Wild Bergamot, Bergamot, Beebalm
Dalea purpurea	Purple Prairie Clover		*Monarda punctata*	Spotted Beebalm, Horsemint, Dotted Mint
Echinacea pallida	Pale Purple Coneflower		*Packera (Senecio) aurea*	Golden Ragwort
Echinacea purpurea	Purple Coneflower		*Parthenium integrifolium*	Wild Quinine
Eryngium yuccifolium	Rattlesnake Master		*Penstemon digitalis*	Foxglove, Beard-tongue, Smooth Penstemon
Penstemon hirsutus	Hairy beard-tongue		*Sisyrinchium angustifolium*	Blue-eyed Grass
Phlox divaricata	Woodland Phlox		*Solidago caesia*	Bluestem Goldenrod
Phlox pilosa	Prairie Phlox		*Solidago flexicaulis*	Zig Zag Goldenrod
Physostegia virginiana	Obedient Plant		*Solidago juncea*	Early Goldenrod
Podophyllum peltatum	Mayapple		*Solidago ohioensis*	Ohio Goldenrod

Polemonium reptans	Jacob's Ladder		*Solidago riddellii*	Riddell's Goldenrod
Polygonatum biflorum	Solomon's Seal		*Solidago rigida*	Stiff Goldenrod
Pycnanthemum virginianum	Mountain Mint		*Solidago speciosa*	Showy Goldenrod
Ranunculus hispida	Swamp Buttercup		*Stylophorum diphyllum*	Celandine/Wood Poppy
Ratibida pinnata	Yellow Coneflower		*Thalictrum dasycarpum*	Tall Meadow Rue
Rudbeckia fulgida	Orange Coneflower		*Tiarella cordifolia*	Foamflower
Rudbeckia hirta	Black-eyed Susan		*Tradescantia ohiensis*	Ohio Spiderwort
Rudbeckia triloba	Brown-eyed susan		*Trillium grandiflorum*	Trillium
Ruellia humilis	Wild Petunia		*Uvularia grandiflora*	Bellwort
Oenothera biennis	Evening Primrose		*Verbena hastata*	Blue Vervain
Sanguinaria canadensis	Bloodroot		*Verbena stricta*	Hoary Vervain
Scrophularia marilandica	Late Figwort		*Veronia missurica*	Ironweed
Silphium integrifolium	Rosinweed		*Veronicastrum virginicum*	Culver's Root
Silphium laciniatum	Compass Plant		*Zizea aurea*	Golden Alexander
Silphium perfoliatum	Cup Plant			
Silphium terebinthinaceum	Prairie Dock			

Graminoids

Scientific Name	Common Name		Scientific Name	Common Name
Acorus americanus	Sweet Flag		*Carex sparganioides*	Woodland sedge
Adropogon gerardii	Big Bluestem		*Carex sprengelii*	Sprengel's Sedge
Bouteloua curtipendula	Sideoats Grama		*Carex stricta*	Tussock sedge
Carex bicknellii	Bicknell's Sedge		*Carex vulpinoidea*	Fox Sedge
Carex blanda	Wood sedge		*Danthonia spicata*	Poverty Oat Grass
Carex brevior	Plains Oval Sedge		*Diarrhena obovata*	Beakgrass
Carex cephalophora	Oval Headed Sedge		*Dichanthelium oligosanthes*	Panic Grass
Carex deweyana	Dewey's Sedge		*Elymus hystrix (Hystrix patula)*	Bottlebrush grass
Carex eburnea	Ivory Sedge, Bristle-leaved Sedge		*Eragrostis spectabilis*	Purple Lovegrass
Carex gracillima	Graceful Sedge		*Koeleria macrantha*	Junegrass
Carex grayi	Gray's Sedge, Bur Sedge		*Panicum virgatum*	Switchgrass
Carex hystericina	Porcupine Sedge		*Schizachyrium scoparium*	Little Bluestem
Carex muskingumensis	Palm Sedge		*Scripus atrovirens*	Green Bullrush
Carex pensylvanica	Pennsylvania Sedge		*Sorghastrum nutans*	Indiangrass
Carex plantaginea	Plantain Leaved Sedge		*Sporobolus heterolepis*	Prairie Dropseed
Carex rosea	Golden Star Sedge			

Ferns

Scientific Name	Common Name		Scientific Name	Common Name
Adiantum pedatum	Maidenhair Fern		*Dryopteris sp.*	Wood Fern
Asplenium platyneuron	Ebony Spleenwort Fern, Spleenwort Fern		Dryopteris clintoniana	Cliton's Wood Fern
Asplenium trichomanes	Maidenhair Spleenwort		*Matteuccia struthiopteris*	Ostrich Fern
Athyrium felix-femina	Lady Fern		*Onoclea sensibilis*	Sensitive Fern
Athyrium felix-mas			*Osmunda cinnamomea*	Cinnamon Fern
Athyrium thelipteris	Northern Marsh Fern		*Osmunda regalis*	Royal Fern
Dennstaedtia punctilobula	Hayscented Fern		*Polystichum acrostichoides*	Christmas Fern

Shrubs & Vines

Scientific Name	Common Name		Scientific Name	Common Name
Aronia melanocarpa	Black Chokeberry		*Physocarpus opulifolius*	Ninebark
Aronia prunifolia	Purple Chokeberry		*Potentilla fruticosa*	Shrubby Cinquefoil
Ceanothus americanus	New Jersey Tea		*Prunus virginiana*	Chokecherry
Clematis virginiana	Virgin's Bower, Wild Clematis		*Rhus aromatica*	Fragrant Sumac
Cornus foemina	Gray Dogwood		*Rhus typhina*	Staghorn Sumac
Cornus sericea	Red-stemmed Dogwood, Red-osier		*Sambucus canadensis*	Common Elderberry, American Elderberry
Diervilla lonicera	Northern Bush Honeysuckle		*Viburnum lentago*	Nannyberry

Euonymus atropurpureus	Wahoo		*Viburnum prunifolium*	Black Haw
Ilex verticillata	Michigan Holly		*Viburnum trilobum*	Highbush Cranberry
Lindera benzoin	Spicebush		*Hamamelis virginiana*	American Witchhazel
Trees				
Scientific Name	**Common Name**		**Scientific Name**	**Common Name**
Abies fraseri	Fraser Fir		*Liriodendron tulipifera*	Tulip Tree
Acer saccharinum	Silver Maple		*Nyssa sylvatica*	Black Gum
Acer saccharum	Sugar Maple		*Populus sp.*	Cottonwood sp.
Acer sp.	Maple sp.		*Prunus americana*	Wild Plum
Amelanchier laevis	Serviceberry, Juneberry, Smooth Shadblow		*Prunus pensylvanica*	Fire Cherry, Pin Cherry
Betula papyrifera	Paper Birch, White Birch, Canoe Birch		*Prunus serotina*	Wild Black Cherry
Betula sp.	Birch sp.		*Prunus serotina*	Wild Black Cherry
Carpinus caroliniana	Blue Beech		*Quercus macrocarpa*	Bur Oak
Celtis occidentalis	Hackberry		*Salix sp.*	Willow sp.
Cercis canadensis	Redbud		*Sambucus racemosa*	Red Elderberry
Cornus alternifolia	Alternate-Leaved Dogwood, Pagoda Dogwood		*Sassafras albidum*	Sassafras
Cornus florida	Flowering Dogwood, Florida Dogwood		*Staphylea trifolia*	Bladdernut
Hamamelis virginiana	Witchhazel		*Zanthoxylum americanum*	Prickly Ash
Juniperus virginiana	Red cedar			

APPENDIX L: Plant Species Inventory of the Ecosystem Preserve

(Updated 9/15/2020)

PLANTS					
Genus	Species	Synonym	Common Name	General Classification	Coefficient of Conservatism
Adiantum	pedatum		Maidenhair Fern	Fern	
Asplenium	platyneuron		Ebony Spleenwort Fern, Spleenwort Fern	Fern	
Asplenium	trichomanes		Maidenhair Spleenwort	Fern	
Athyrium	felix-mas	Dryopteris Felix-mas	Male Fern	Fern	
Athyrium	filix-femina		Lady Fern	Fern	
Athyrium	thelipteris		Northern Marsh Fern	Fern	
Dryopteris	carthusiana		Spinulose Wood Fern	Fern	
Dryopteris	clintoniana		Cliton's Wood Fern	Fern	
Matteuccia	struthiopteris		Ostrich Fern	Fern	
Onoclea	sensibilis		Sensitive Fern	Fern	
Osmunda	regalis		Royal Fern	Fern	
Osmundastrum	cinnamomea		Cinnamon Fern	Fern	
Polystichum	acrostichoides		Christmas Fern	Fern	
Abutilon	theophrasti		Velvetleaf	Forb	
Achillea	millefolium		Yarrow	Forb	
Acorus	americanus	Acorus calamus	Sweet flag	Forb	
Actaea	pachypoda		Doll's Eyes, White Baneberry	Forb	
Actaea	rubra		Red Baneberry	Forb	
Agastache	nepetoides		Giant Yellow Hyssop	Forb	
Agrimonia	gryposepala		Tall Agrimony	Forb	
Alliaria	petiolata		Garlic Mustard	Forb	
Allium	cernuum		Nodding Wild Onion	Forb	
Allium	tricoccum		Wild Leek	Forb	
Allium	vineale		Field Garlic	Forb	
Amaranthus	retroflexus		Rough Amaranth	Forb	
Ambrosia	artemisiifolia		Common ragweed	Forb	
Anaphalis	margaritacea		Pearly everlasting	Forb	

Anemone	canadensis		Canada Anemone	Forb	
Anemone	cylindrica		Thimbleweed	Forb	
Anemone	multifida		Red Anemone	Forb	
Anemone	quinquefolia		Wood Anemone	Forb	
Anemone	virginiana		Tall Thimbleweed	Forb	
Angelica	atropurpurea		Angelica	Forb	
Antennaria	howelli		Small pussytoes	Forb	
Antennaria	neglecta		Cat's foot, Field pussytoes	Forb	
Antennaria	parlinii		Smooth pussytoes	Forb	
Antennaria	sp.			Forb	
Anticlea	elegans	Zigadenus glaucus	White Camas	Forb	
Apocynum	androsaemifolium		Spreading dogbane	Forb	
Aquilegia	canadensis		Wild Columbine	Forb	
Aralia	nudicaulis		Wild sarsparilla	Forb	
Aralia	racemosa		Spikenard	Forb	
Arctium	minus		Common burdock	Forb	
Arenaria	serpyllifolia		Thyme-leaved sandwort	Forb	
Arisaema	dracontium		Green Dragon	Forb	
Arisaema	triphyllum		Jack-in-the-pulpit	Forb	
Arnoglossum	atriplicifolium	Cacalia atriplicifolia	Pale Indian Plantain	Forb	
Artemisia	campestris		Wormwood	Forb	
Artemisia	vulgaris		Mugwort	Forb	
Asarum	canadense		Wild Ginger	Forb	
Asclepias	amplexicaulis		Clasping Milkweed	Forb	
Asclepias	exaltata		Poke Milkweed	Forb	
Asclepias	hirtella		Tall Green Milkweed	Forb	
Asclepias	incarnata		Swamp milkweed, Rose milkweed	Forb	
Asclepias	purpurascens		Purple Milkweed	Forb	
Asclepias	sullivantii		Prairie Milkweed	Forb	
Asclepias	syriaca		Common Milkweed	Forb	
Asclepias	tuberosa		Butterfly Milkweed	Forb	
Asclepias	verticillata		Whorled Milkweed	Forb	
Asclepias	virdiflora		Green Milkweed	Forb	

Baptisia	lactea	Baptisia alba (L.) Vent. var. macrophylla (Larisey) Isely	White False Indigo	Forb	
Baptisia	leucophaea	Baptisia bracteata Elliot var. leucophaea (Nutt.)	Cream Wild Indigo	Forb	
Baptisia	tinctoria		Yellow Wild Indigo	Forb	
Barbarea	vulgaris		Yellow rocket	Forb	
Berteroa	incana		Hoary alyssum	Forb	
Bidens	cernua		Nodding bur-marigold	Forb	
Bidens	connata		Purple stemmed Tickseded	Forb	
Bidens	coronatus		Tall swamp-marigold	Forb	
Bidens	frondosa		Beggar-ticks	Forb	
Bidens	trichosperma		Tickseed Sunflower	Forb	
Blephilia	ciliata		Downy Wood Mint	Forb	
Blephilia	hirsuta		Hairy Wood Mint	Forb	
Boehmeria	cylindrica		False Nettle	Forb	
Brickellia	eupatorioides	Kuhnia eupatorioides	False boneset	Forb	
Caltha	palustris		Yelllow Marsh Marigold	Forb	
Calystegia	sepium		Hedge bindweed	Forb	
Campanula	americana		Tall Bellflower	Forb	
Campanula	rotundifolia		Harebell	Forb	
Cardamine	bulbosa		Spring Cress	Forb	
Caulophyllum	thalictroides		Blue Cohosh	Forb	
Centaurea	jacea		Brown knapweed	Forb	
Centaurea	maculosa	stoebe	Spotted knapweed	Forb	
Cerastium	fontanum		Mouse-ear chickweed	Forb	
Chamerion	angustifolium		Fireweed	Forb	
Chelone	glabra		Turtlehead	Forb	
Chenopodium	album		Lambsquarters	Forb	
Chrysanthemum	leucanthemum		Ox-eye daisy	Forb	
Cichorium	intybus		Chicory	Forb	
Cicuta	maculata		Water hemlock	Forb	
Circaea	lutetiana	Circaea canadensis	Enchanter's nightshade	Forb	
Cirsium	arvense		Canada thistle	Forb	

Cirsium	muticum		Marsh thistle	Forb	
Cirsium	vulgare		Bull thistle	Forb	
Claytonia	virginica		Spring beauty	Forb	
Conopholis	americana		Squawroot	Forb	
Conyza	canadensis		Horseweed	Forb	
Coreopsis	lanceolata		Lance Leaf Coreopsis, Sand Tickseed	Forb	
Coreopsis	palmata		Prairie Coreopsis	Forb	
Coreopsis	tripteris		Tall Coreopsis	Forb	
Cuscuta	gronovii		Common dodder	Forb	
Cypripedium	acaule		Pink Lady Slipper	Forb	
Cypripedium	calceolus		Yellow Lady Slipper	Forb	
Cypripedium	reginae		Showy Lady Slipper	Forb	
Dalea	purpurea		Purple Prairie Clover	Forb	
Daucus	carota		Wild carrot	Forb	
Dentaria	laciniata		Cut-leaved toothwort	Forb	
Desmodium	canadense		Showy tick-trefoil	Forb	
Desmodium	nudiflorum		Naked-flowered tick trefoil	Forb	
Desmodium	obtusum		Stiff tick-trefoil	Forb	
Desmodium	paniculatum		Panicled tick trefoil	Forb	
Dianthus	armeria		Deptford pink	Forb	
Dicentra	canadensis		Squirrel Corn	Forb	
Dicentra	cucullaria		Dutchman's Breeches	Forb	
Dipsacus	fullonum		Common teasel	Forb	
Dodecatheon	meadia		Shooting Star	Forb	
Doellingeria	umbellata	Aster umbellatus	Flat-topped aster	Forb	
Echinacea	pallida		Pale Purple Coneflower	Forb	
Echinacea	purpurea		Purple Coneflower	Forb	
Epifagus	virginiana		Beech drops	Forb	
Epipactis	helleborine		Helleborine Orchid	Forb	
Erigeron	annuus		Annual fleabane	Forb	
Erigeron	philadelphicus		Marsh fleabane	Forb	
Erigeron	strigosus		Daisy fleabane	Forb	
Eryngium	yuccifolium		Rattlesnake Master	Forb	

Erythronium	americanum		Yellow Trout Lily	Forb	
Eupatorium	altissimum		Tall Boneset	Forb	
Eupatorium	perfoliatum		Boneset	Forb	
Euphorbia	corollata		Flowering Spurge	Forb	
Eurybia	macrophylla	Aster macrophyllus	Big Leaf Aster	Forb	
Euthamia	caroliniana	Euthamia remota	Slender Goldentop	Forb	
Euthamia	graminifolia	Solidado graminifolia	Grass-leaved goldenrod	Forb	
Eutrochium	maculatum	Eupatorium maculatum	Joe-pye weed	Forb	
Eutrochium	purpureum	Eupatorium purpureum	Woodland Joe-pye, Sweet Joe-pye Weed	Forb	
Filipendula	rubra		Queen of the Prairie	Forb	
Fragaria	virginiana		Wild Strawberry	Forb	
Frasera	carolinersis		American Columbo	Forb	
Galium	aparine		Bedstraw	Forb	
Gentiana	alba		Cream Gentian	Forb	
Gentiana	andrewsii		Bottle Gentian	Forb	
Gentianopsis	crinata		Fringed Gentian	Forb	
Geranium	maculatum		Wild Geranium	Forb	
Geum	aleppicum		Yellow Avens	Forb	
Geum	canadense		White avens	Forb	
Geum	fragarioides	Waldsteinia fragarioides	Barren strawberry	Forb	
Geum	laciniatum		Rough avens	Forb	
Geum	triflorum		Prairie Smoke	Forb	
Glechoma	hederacea		Ground ivy	Forb	
Hackelia	virginiana		Beggar's Lice, Virginia Stickseed	Forb	
Helenium	autumnale		Sneezeweed	Forb	
Helianthus	annuus		Garden sunflower	Forb	
Helianthus	decapetalus		Pale sunflower	Forb	
Helianthus	divaricatus		Woodland sunflower	Forb	
Helianthus	giganteus		Tall sunflower	Forb	
Helianthus	hirsutus		Hairy sunflower	Forb	
Helianthus	maximiliani		Maximillan's sunflower	Forb	
Helianthus	mollis		Downy Sunflower	Forb	

Helianthus	occidentalis		Western Sunflower	Forb	
Helianthus	strumosus		Pale-Leaved Sunflower	Forb	
Helianthus	tuberosus		Jerusalem artichoke	Forb	
Heliopsis	helianthoides		False Sunflower	Forb	
Hepatica	acutiloba		Spring Beauty, Sharp-Lobed Hepatica	Forb	
Hepatica	americana		Round -lobed Hepatica	Forb	
Heracleum	maximum		Cow parsnip	Forb	
Heuchera	americana		Alumroot	Forb	
Heuchera	richardsonii		Prairie Alumroot	Forb	
Hibiscus	moscheutos		Swamp Hibiscus, Swamp Rose Mallow	Forb	
Hieracium	aurantiacum		Orange hawkweed	Forb	
Hieracium	caespitosum		King-devil	Forb	
Hydrophyllum	appendiculatum		Great waterleaf	Forb	
Hydrophyllum	virginiannum		Virginia Waterleaf	Forb	
Hypericum	ascyron		Great St. Johnswort	Forb	
Hypericum	perforatum		Common St. John's-wort	Forb	
Impatiens	capensis		Spotted touch-me-not	Forb	
Impatiens	pallida		Pale Jewelweed	Forb	
Iris	versicolor		Wild Blue Flag	Forb	
Iris	virginica		Southern Blue Flag	Forb	
Jeffersonia	diphylla		Twinleaf	Forb	
Lactuca	serriola		Prickly lettuce	Forb	
Laportea	canadensis		Wood Nettle	Forb	
Lathyrus	latifolius		Everlasting pea	Forb	
Lemna	minor		Small duckweed	Forb	
Lemna	trisulca		Star duckweed	Forb	
Lemna	turionifera			Forb	
Leonurus	cardiaca		Motherwort	Forb	
Lepidium	campestre		Field cress	Forb	
Lespedeza	capitata		Round Headed Bush Clover	Forb	
Lespedeza	hirta		Hairy bush-clover	Forb	
Lespedeza	virginica		Slender Bush clover	Forb	

Leucanthemum	vulgare		ox-eye daisy	Forb	
Liatris	aspera		Rough Blazingstar	Forb	
Liatris	cylindracea		Cylindrical Blazingstar	Forb	
Liatris	scariosa		Northern Blazingstar	Forb	
Liatris	spicata		Marsh Blazingstar	Forb	
Lilium	michiganense		Michigan Lily	Forb	
Lilium	philadelphicum		Wood Lily	Forb	
Lobelia	cardinalis		Cardinal Flower	Forb	
Lobelia	siphilitica		Great Blue Lobelia	Forb	
Lonicera	morrowii		Morrow's Honeysuckle	Forb	
Ludwigia	alternifolia		Bushy Seedbox	Forb	
Lupinus	perennis		Wild Blue Lupine	Forb	
Lycopus	americanus		Water Horehound, American Bugleweed	Forb	
Lycopus	uniflorus		Northern Bugleweed	Forb	
Lysimachia	ciliata		Fringed Yellow Loosestrife	Forb	
Lysimachia	quadriflora		Whorled Loosestrife	Forb	
Lythrum	salicaria		Purple loosestrife	Forb	
Maianthemum	canadense		Canada Mayflower	Forb	
Maianthemum	racemosum	Smilacina racemosa	False Solomon’s seal, False Spikenard	Forb	
Maianthemum	stellatum	Smilacina stellata	Starry Solomon's seal	Forb	
Malva	neglecta		Common mallow; cheeses	Forb	
Malva	rotundifolia		Round-leaved mallow	Forb	
Medicago	lupulina		Black medic	Forb	
Medicago	sativa		Alfalfa	Forb	
Melilotus	alba		White sweet-clover	Forb	
Melilotus	officinalis		Yellow sweet-clover	Forb	
Mertensia	virginica		Virginia Bluebells	Forb	
Mimulus	ringens		Monkey flower	Forb	
Mitella	diphylla		Bishop's Cap	Forb	
Monarda	fistulosa		Wild Bergamot, Beebalm	Forb	
Monarda	punctata		Horse mint, Spotted Beebalm,	Forb	
Monotropa	uniflora		Indian pipe	Forb	

Nasturtium	microphyllum		Watercress	Forb	
Nepeta	cataria		Catnip	Forb	
Nymphaea	odorata		American White Water Lily	Forb	
Oenothera	biennis		Common Evening Primrose	Forb	
Oenothera	fruticosa		Sundrops	Forb	
Oenothera	villosa		Evening primrose	Forb	
Opuntia	humifusa		Prickly pear cactus	Forb	
Oxalis	fontana		Yellow wood-sorrel	Forb	
Oxalis	stricta		Common yellow wood-sorrel	Forb	
Packera	aurea	Senecio aurea	Golden Ragwort	Forb	
Packera	obovata	Senecio obovata	Round-leaved Ragwort	Forb	
Parnassia	glauca		Grass-of- Parnassus	Forb	
Parthenium	integrifolium		Wild Quinine	Forb	
Pedicularis	canadensis		Wood Betony	Forb	
Peltandra	virginica		Green Arrow Arum	Forb	
Penstemon	digitalis		Foxglove Beard-tongue	Forb	
Penstemon	hirsutus		Hairy Beard-tongue	Forb	
Persicaria	amphibia		Water Smartweed	Forb	
Persicaria	hydropiperoides		Swamp Smartweed	Forb	
Persicaria	virginiana		Jumpseed	Forb	
Phlox	divaricata		Woodland Phlox	Forb	
Phlox	pilosa		Prairie Phlox	Forb	
Physostegia	virginiana		Obedient Plant	Forb	
Pilea	pumila		Clearweed	Forb	
Plantago	lanceolata		English plantain	Forb	
Plantago	major		Common plantain	Forb	
Plantago	rugelii		Red-stalked plantain	Forb	
Podophyllum	peltatum		Mayapple	Forb	
Polemonium	reptans		Jacob's Ladder	Forb	
Polygonatum	biflorum		Solomon's Seal	Forb	
Polygonum	amphibian		Water Smartweed	Forb	
Polygonum	aviculare		Knotweed	Forb	

Polygonum	hydropiper		Water-pepper	Forb	
Polygonum	pensylvanicum		Pinkweed	Forb	
Polygonum	persicaria		Smartweed (Lady's thumb)	Forb	
Polygonum	sp			Forb	
Polygonum	virginianum		Jumpseed	Forb	
Pontederia	cordata		Pickerel Weed	Forb	
Potentilla	anserina		Sliverweed	Forb	
Potentilla	argentea		Silvery cinquefoil	Forb	
Potentilla	norvegica		Rough cinquefoil	Forb	
Potentilla	recta		Rough-fruited cinquefoil	Forb	
Potentilla	simplex		Common cinquefoil	Forb	
Prenanthes	alba		White Lettuce	Forb	
Prenanthes	altissima		Tall White Lettuce, Tall Rattlesnakeroot	Forb	
Prunella	vulgaris		Self-heal	Forb	
Pycnanthemum	virginianum		Mountain Mint	Forb	
Ranunculus	abortivus		Small-Flowered Buttercup	Forb	
Ranunculus	acris		Common buttercup	Forb	
Ranunculus	fascicularis		Early Buttercup	Forb	
Ranunculus	hispida		Swamp buttercup	Forb	
Ranunculus	recurvatus		Hooked crowfoot	Forb	
Ranunculus	sceleratus		Cursed crowfoot	Forb	
Ratibida	pinnata		Yellow Coneflower, Grayhead coneflower	Forb	
Rhexia	viginica		Meadow Beauty	Forb	
Rorippa	palustris		Yellow cress	Forb	
Rudbeckia	fulgida		Orange Coneflower	Forb	
Rudbeckia	hirta		Black-eyed Susan	Forb	
Rudbeckia	laciniata		Cut-leaved coneflower, Green-headed Coneflower	Forb	
Rudbeckia	triloba		Brown-eyed susan	Forb	
Ruellia	humilis		Wild Petunia	Forb	
Rumex	acetosella		Sheepsorrell	Forb	
Rumex	crispus		Curly dock	Forb	
Rumex	orbiculatus		Great water dock	Forb	

Sagittaria	latifolia		Common Arrowhead	Forb	
Sanguinaria	canadensis		Bloodroot	Forb	
Saururus	cernuus		Lizards tail	Forb	
Scrophularia	lanceolata		Early Figwort	Forb	
Scrophularia	marilandica		Late Figwort	Forb	
Scutellaria	lateriflora		Mad dog skullcap	Forb	
Senna	hebecarpa	Cassia hebecarpa	Wild Senna	Forb	
Silene	pratensis		White campion	Forb	
Silphium	integrifolium		Rosin Weed	Forb	
Silphium	laciniatum		Compass Plant	Forb	
Silphium	perfoliatum		Cup Plant	Forb	
Silphium	terebinthinaceum		Prairie Dock	Forb	
Sisyrinchium	angustifolium		Blue-eyed Grass	Forb	
Solanum	carolinense		Horse nettle	Forb	
Solidago	altissima		Tall goldenrod	Forb	
Solidago	caesia		Bluestem Goldenrod	Forb	
Solidago	canadensis		Canada goldenrod	Forb	
Solidago	flexicaulis		Zig Zag Goldenrod	Forb	
Solidago	gigantea		Late Goldenrod	Forb	
Solidago	juncea		Early Goldenrod	Forb	
Solidago	nemoralis		Gray Goldenrod, Old Field Goldenrod	Forb	
Solidago	ohioensis		Ohio Goldenrod	Forb	
Solidago	patula		Swamp Goldenrod	Forb	
Solidago	riddellii		Riddell's Goldenrod	Forb	
Solidago	rigida		Stiff Goldenrod	Forb	
Solidago	rugosa		Rough-leaved Goldenrod	Forb	
Solidago	simplex		Gilman’s goldenrod	Forb	
Solidago	speciosa		Showy Goldenrod	Forb	
Sparganium	chlorocarpum		Green fruited bur-reed	Forb	
Spirodela	polyrhiza		Great duckweed	Forb	
Stellaria	longifolia		Longleaf Starwort	Forb	
Stylophorum	diphyllum		Wood Poppy, Celandine Poppy	Forb	

Symphyotrichum	cordifolium	Aster cordifolius	Heart-Leaved Aster	Forb	
Symphyotrichum	cordifolium x	Aster cordifolius	Aster Hybrid- Dave Warner's Aster	Forb	
Symphyotrichum	firmum	Aster firmus	Smooth swamp aster	Forb	
Symphyotrichum	laeve	Aster laevis	Smooth aster	Forb	
Symphyotrichum	lanceolatum		Panicled aster	Forb	
Symphyotrichum	lateriflorum	Aster lateriflorus	Calico aster	Forb	
Symphyotrichum	novae-angliae	Aster novae-angilae, Virgulus novae-angliae	New England aster	Forb	
Symphyotrichum	oolentangiense	Aster oolentanigiensis	Prairie heart-leaved aster	Forb	
Symphyotrichum	pilosum	Aster pilosus		Forb	
Symphyotrichum	pilosus		Frost Aster, Hairy aster	Forb	
Symphyotrichum	puniceum	Aster puniceus	Swamp aster	Forb	
Symphyotrichum	urophyllum	Aster sagittifolius	Arrow-leaved aster	Forb	
Symplocarpus	foetidus		Skunk cabbage	Forb	
Taraxacum	officinale		Common Dandelion	Forb	
Tephrosia	virginiana		Goat's Rue	Forb	
Teucrium	canadense		Wood sage	Forb	
Thalictrum	dasycarpum		Purple Meadow Rue, Tall Meadow Rue	Forb	
Thalictrum	dioicum		Early Meadow Rue	Forb	
Thalictrum	thalictroides	Anemonella thalictroides	Rue Anemone	Forb	
Tiarella	cordifolia		Foamflower	Forb	
Torilis	japonica		Hedge-Parsley	Forb	
Tradescantia	ohiensis		Ohio Spiderwort	Forb	
Tragopogon	dubius		Goats beard	Forb	
Trifolium	hybridum		Alsike clover	Forb	
Trifolium	pratense*		Red clover	Forb	
Trillium	grandiflorum		Common trillium	Forb	
Triosteum	aurantiacum		Horse-Gentian	Forb	
Typha	latifolia		Broad-leaved cattail	Forb	
Urtica	dioica*		Stinging nettle	Forb	
Uvularia	grandiflora		Large Flower Bellwort	Forb	
Verbascum	blattaria*		Moth mullein	Forb	
Verbascum	thapsus		Common mullein	Forb	

Verbena	hastata		Blue Vervain	Forb	
Verbena	stricta		Hoary Vervain	Forb	
Vernonia	missurica		Missouri ironweed	Forb	
Veronica	officinalis		Common Speedwell	Forb	
Veronica	serpyllifolia		Thymeleaf Speedwell	Forb	
Veronicastrum	virginicum		Culver's root	Forb	
Vicia	cracca*		Tufted vetch	Forb	
Vicia	tetrasperma		Sparrow Vetch	Forb	
Vicia	villosa*		Hairy vetch	Forb	
Viola	pedata		Bird's Foot Violet	Forb	
Viola	pedatifida		Praire Violet	Forb	
Viola	pubescens		Smooth yellow violet	Forb	
Viola	sagittata		Arrow-leaved Violet	Forb	
Viola	sororia		Common Blue Violet	Forb	
Wolffia	columbiana		Common watermeal	Forb	
Zizia	aurea		Golden Alexander	Forb	
Agropyron	smithii		Smith's wheat grass	Grass	
Agrostis	gigantea		Redtop	Grass	
Agrostis	stolonifera		Creeping bent	Grass	
Alopecurus	aequalis		Short-awned foxtail	Grass	
Andropogon	gerardii		Big bluestem	Grass	
Andropogon	virginicus		Broom sedge	Grass	
Anthoxanthum	hirtum		Sweet Grass	Grass	
Anthoxanthum	repens		Quack grass	Grass	
Aristida	purpurascens		Three awned grass	Grass	
Bouteloua	curtipendula		Sideoats Grama	Grass	
Brachyelytrum	erectum		Long-Awned Wood Grass, Bearded Shorthusk	Grass	
Bromus	ciliatus		Fringed brome grass	Grass	
Bromus	inermis		Smooth brome	Grass	
Bromus	kalmii		Prairie Brome	Grass	
Bromus	latiglumis		Ear-leaved brome	Grass	
Bromus	pubescens		Canada brome	Grass	
Cinna	arundinacea		Wood reed grass	Grass	

Dactylis	glomerata		Orchard grass	Grass	
Danthonia	spicata		Poverty Oat grass	Grass	
Diarrhena	obovata		Beakgrass	Grass	
Digitaria	sanguinalis		Hairy crab grass	Grass	
Echinochloa	crusgalli		Barnyard grass	Grass	
Echinochloa	muricata		Barnyard grass	Grass	
Elymus	canadensis		Canada wild-rye	Grass	
Elymus	hystrix	Hystrix patula	Bottlebrush grass	Grass	
Elymus	riparius		Riverbank wild-rye	Grass	
Elymus	villosus		Silky Wild Rye	Grass	
Elymus	virginicus		Virginia wild-rye	Grass	
Eragrostis	pectinacea		Love grass	Grass	
Eragrostis	poaeoides		Low love grass	Grass	
Eragrostis	spectabilis		Purple Lovegrass	Grass	
Festuca	obtusa	Festuca subverticillata	Nodding fescue	Grass	
Glyceria	septentriondis		Floating manna grass	Grass	
Glyceria	striata		Graceful Grass	Grass	
Koeleria	macrantha		Junegrass	Grass	
Leersia	oryzoides		Cut grass	Grass	
Panicum	capillare		Witch grass	Grass	
Panicum	virgatum		Switchgrass	Grass	
Phleum	pratense		Timothy grass	Grass	
Poa	compressa		Canada bluegrass	Grass	
Poa	pratensis		Kentucky bluegrass	Grass	
Schizachyrium	scoparium		Little Bluestem	Grass	
Setaria	viridis		Green foxtail	Grass	
Sorghastrum	nutans		Indiangrass	Grass	
Spartina	pectinata		Prairie cord grass	Grass	
Sphenopholis	intermedia		Slender wedgegrass	Grass	
Sphenopholis	sp.			Grass	
Sporobolus	heterolepis		Prairie Dropseed	Grass	
Tridens	flavus		Purpletop	Grass	
Juncus	acuminatus		Sharp-fruited rush	Rush	

Juncus	dudleyi		Dudley's Rush	Rush	
Juncus	effusus		Soft-stemmed rush	Rush	
Juncus	tenuis		Path rush	Rush	
Scirpus	cyperinus		Woolgrass	Rush	
Scripus	atrovirens		Green Bulrush	Rush	
Carex	arctata		Drooping Woodland Sedge	Sedge	
Carex	bicknellii		Bicknell's Sedge	Sedge	
Carex	blanda		Wood sedge, Common woodland Sedge	Sedge	
Carex	brevior		Plains Oval Sedge	Sedge	
Carex	bromoides		Brome-Like Sedge	Sedge	
Carex	brunnescens		Brownish Sedge	Sedge	
Carex	cephalophora		Oval Headed Sedge, Oval leaf Sedge	Sedge	
Carex	comosa		Bristly Sedge	Sedge	
Carex	crinita		Fringed Sedge	Sedge	
Carex	deweyana		Dewey's Sedge	Sedge	
Carex	eburnea		Ivory Sedge, Bristle-leaved Sedge	Sedge	
Carex	gracillima		Graceful Sedge	Sedge	
Carex	grayi		Gray's Sedge, Bur Sedge	Sedge	
Carex	grisea		Woodland Grey Sedge	Sedge	
Carex	hystericina		Porcupine Sedge, Bottlebrush Sedge	Sedge	
Carex	intumescens		Bladder Sedge	Sedge	
Carex	lacustris		Common Lake Sedge	Sedge	
Carex	laxiflora		Broad-Looseflorwer Sedge	Sedge	
Carex	leptonervia		Nerveless Woodland Sedge	Sedge	
Carex	lupilina		Hop Sedge	Sedge	
Carex	lurida		Sallow sedge	Sedge	
Carex	muhlenbergii		Sand bracted sedge	Sedge	
Carex	muskingumensis		Palm Sedge	Sedge	
Carex	pensylvanica		Pennsylvania Sedge	Sedge	
Carex	plantaginea		Plantain-leaved sedge	Sedge	
Carex	prairea		Prairie sedge	Sedge	
Carex	prasina		Drooping Sedge	Sedge	

Carex	radiata		Eastern Star Sedge	Sedge	
Carex	retrorsa		Retrose Sedge, Knotsheath Sedge	Sedge	
Carex	rosea		Golden Star Sedge, Rosy Sedge	Sedge	
Carex	scabrata		Easter rough Sedge	Sedge	
Carex	sparganioides		Woodland sedge, Bur reed Sedge	Sedge	
Carex	sprengelii		Sprengel's sedge, Long Beaked Sedge	Sedge	
Carex	stipata		Awlfruit Sedge	Sedge	
Carex	stricta		Tussock sedge	Sedge	
Carex	swanii		Swan's Sedge	Sedge	
Carex	tenera		Quill Sedge, Remote Sedge	Sedge	
Carex	tribuloides		Blunt broom Sedge	Sedge	
Carex	tuckermanii		Tuckerman's Sedge	Sedge	
Carex	vulpinoidea		Fox Sedge	Sedge	
Cyperus	odoratus		Umbrella sedge	Sedge	
Eleocharis	erythropoda		Spike-rush	Sedge	
Eleocharis	obtusa		Spike-rush	Sedge	
Alnus	incana	Alnus rugosa	Speckled alder	Shrub	
Amorpha	canescens		Leadplant	Shrub	
Arctostaphylos	uva-ursi		Bearberry	Shrub	
Aronia	melanocarpa		Black Chokeberry	Shrub	
Aronia	prunifolia		Purple chokeberry	Shrub	
Beberis	thunbergii		Japanese Barberry	Shrub	
Ceanothus	americanus		New Jersey Tea	Shrub	
Cephalanthus	occidentalis		Buttonbush	Shrub	
Chimaphila	maculata		Wintergreen	Shrub	
Cornus	amomum		Silky dogwood	Shrub	
Cornus	foemina		Gray Dogwood	Shrub	
Cornus	racemosa	Cornus foemina ssp. racemosa	Gray Dogwood	Shrub	
Cornus	rugosa		Round-Leaved Dogwood	Shrub	
Cornus	sericea	Cornus stolonifera	Red-stemmed Dogwood, Red-osier dogwood	Shrub	
Corylus	americana		American hazelnut	Shrub	
Dasiphora	fruticosa	Potentilla fruticosa	Shrubby Cinquefoil	Shrub	

Diervilla	lonicera		Northern Bush Honeysuckle	Shrub	
Dirca	palustris		Leatherwood	Shrub	
Elaeagnus	umbellata		Autumn Olive	Shrub	
Euonymus	alatus		Burning Bush	Shrub	
Euonymus	atropurpureua		Wahoo	Shrub	
Euonymus	obovatus		Running Strawberry Bush	Shrub	
Frangula	alnus		Glossy Buckthorn	Shrub	
Hamamelis	virginiana		American Witchhazel	Shrub	
Hypericum	kalmianum		Kalm's St. John's Wort	Shrub	
Hypericum	prolificum		Shrubby St John's Wort	Shrub	
Ilex	verticillata		Michigan Holly, Winterberry	Shrub	
Ligustrum	vulgare		Common privet	Shrub	
Lindera	benzoin		Spicebush	Shrub	
Lonicera	tatarica		Tartarian honeysuckle	Shrub	
Myrica	gale		Sweet Gale	Shrub	
Myrica	pensylvanica		Bayberry	Shrub	
Physocarpus	opulifolius		Ninebark	Shrub	
Privet	sp.			Shrub	
Prunus	virginiana		Chokecherry	Shrub	
Rhamnus	frangula		Glossy buckthorn	Shrub	
Rhus	aromatica		Fragrant Sumac	Shrub	
Rhus	copallina		Winged Sumac	Shrub	
Rhus	glabra		Smooth sumac	Shrub	
Rhus	typhina		Staghorn Sumac	Shrub	
Ribes	americanum		Wild Black Current	Shrub	
Ribes	cynosbati		Prickly Gooseberry	Shrub	
Rosa	carolina		Pasture rose	Shrub	
Rosa	multiflora		Multiflora rose	Shrub	
Rosa	palustris		Swamp Rose	Shrub	
Rosa	setigera		Prairie Rose	Shrub	
Rubus	allegheniensis		Common blackberry	Shrub	
Rubus	flagellaris		Northern dewberry	Shrub	
Rubus	hispidus		Swamp dewberry	Shrub	

Rubus	occidentalis		Black raspberry	Shrub	
Rubus	strigosus		Red rasperry	Shrub	
Salix	exigua		Sandbar willow	Shrub	
Sambucus	canadensis		Black Elderberry	Shrub	
Sambucus	racemosa		Red Elderberry	Shrub	
Spiraea	alba		Meadowsweet	Shrub	
Spiraea	tomentosa		Stepplebush	Shrub	
Staphylea	trifolia		Bladdernut	Shrub	
Straphylea	trifolia		Bladdernut	Shrub	
Toxidendron	vernix		Poison sumac	Shrub	
Vaccinium	angustifolium		Lowbush Blueberry	Shrub	
Viburnum	acerifolium*		Maple Leaf viburnum	Shrub	
Viburnum	dentatum		Northern arrowwood, Smooth arrowwood	Shrub	
Viburnum	lentago		Nannyberry	Shrub	
Viburnum	opulus		Geulder Rose	Shrub	
Viburnum	prunifolium		Black Haw	Shrub	
Viburnum	trilobum		Highbush Cranberry	Shrub	
Zanthoxylum	americanum		Prickly Ash	Shrub	
Abies	fraseri		Fraser Fir	Tree	
Acer	ginnala		Amur Maple	Tree	
Acer	negundo		Box elder	Tree	
Acer	platanoides		Norway maple	Tree	
Acer	rubrum		Red maple	Tree	
Acer	saccharinum		Silver maple	Tree	
Acer	saccharum		Sugar maple	Tree	
Acer	sp.		Maple sp.	Tree	
Amelanchier	arborea		Juneberry	Tree	
Amelanchier	laevis		Serviceberry, Juneberry, Smooth Shadblow	Tree	
Asimina	triloba		Paw Paw	Tree	
Betula	papyrifera		Paper Birch, White Birch, Canoe Birch	Tree	
Betula	pumila		Bog birch	Tree	
Betula	sp.		Birch sp.	Tree	

Carpinus	caroliniana		Blue Beech	Tree	
Carya	ovata		Shagbark hickory	Tree	
Carya	cordiformis		Bitternut Hickory	Tree	
Celtis	occidentalis		Hackberry	Tree	
Cercis	canadensis		Redbud	Tree	
Cornus	alternifolia		Alternate-Leaved Dogwood, Pagoda Dogwood	Tree	
Cornus	florida		Flowering Dogwood, Florida Dogwood	Tree	
Crataegus	sp.		Hawthorn	Tree	
Diospyros	virginiana		American Persimmon	Tree	
Fagus	grandifolia		American beech	Tree	
Fraxinus	americana		American ash (white)	Tree	
Fraxinus	nigra		Black Ash	Tree	
Fraxinus	pennsylvanica		Green Ash	Tree	
Gaylussacia	baccata		Huckleberry	Tree	
Gingko	biloba		Gingko	Tree	
Gymnocladus	dioicus		Kentucky Coffee Tree	Tree	
Juglans	cinerea		Butternut	Tree	
Juglans	nigra		Black walnut	Tree	
Juniperus	virginiana		Red cedar	Tree	
Liriodendron	tulipifera		Tulip Tree	Tree	
Malus	pumila		Common apple	Tree	
Morus	rubra		Red mulberry	Tree	
Nyssa	sylvatica		Black Gum	Tree	
Ostrya	virginiana		Ironwood	Tree	
Pinus	strobus		White pine	Tree	
Pinus	sylvestris		Scots pine	Tree	
Platanus	occidentalis		Sycamore	Tree	
Populus	deltoides		Cottonwood	Tree	
Populus	grandidentata		Big-toothed aspen	Tree	
Populus	tremuloides		Trembling aspen	Tree	
Prunus	americana		Wild Plum	Tree	
Prunus	avium		Sweet Cherry	Tree	

Prunus	pensylvanica		Fire Cherry, Pin Cherry	Tree	
Prunus	serotina		Wild black cherry	Tree	
Ptelea	trifoliata		Hop tree	Tree	
Quercus	alba		White oak	Tree	
Quercus	bicolor		Swamp white oak	Tree	
Quercus	macrocarpa		Bur Oak	Tree	
Quercus	muehlenbergii		Chinkapin Oak	Tree	
Quercus	palustris		Pin Oak	Tree	
Quercus	rubra		Red oak	Tree	
Quercus	veluntia		Black Oak	Tree	
Rhamnus	cathartica		Common buckthorn	Tree	
Robinia	pseudocacia		Black locust	Tree	
Salix	babylonica		Weeping willow	Tree	
Salix	nigra		Black willow	Tree	
Salix	petiolaris		Meadow Willow	Tree	
Salix	sp.		Willow sp.	Tree	
Sassafras	albidum		Sassafras	Tree	
Thuja	occidentalis		White Cedar	Tree	
Tilia	americana		American basswood	Tree	
Ulmus	americana*		American elm	Tree	
Ulmus	rubra		Slippery Elm	Tree	
Celastrus	scandens		American Bittersweet	Vine	
Clematis	virginiana		Wild Clematis, Virgin's Bower	Vine	
Clematis	occidentalis		Purple Clematis	Vine	
Dioscorea	villosa		Wild Yam	Vine	
Echinocystis	lobata		Wild Cucumber	Vine	
Lonicera	dioca		Red Honeysuckle	Vine	
Menispermum	canadense		Moonseed	Vine	
Parthenocissus	quinquefolia		Virginia creeper	Vine	
Polygonum	convolvulus		Bindweed	Vine	
Solanum	dulcamara		Devil's nightshade	Vine	
Toxicodendron	radicans	Rhus radicans	Poison ivy	Vine	
Vitis	riparia*		Riverbank grape	Vine	

APPENDIX M: Vertebrate Species Inventory of the Ecosystem Preserve

Mammals		
Scientific Name	**Common Name**	**Order**
Didelphis virginiana	Virginia opossum	Didelphimorphia (American opossums)
Sorex cinereus	Masked shrew	Soricomorpha (insectivores)
Blarina brevicauda	Northern short-tailed shrew	Soricomorpha (insectivores)
Scalopus aquaticus	Eastern mole	Soricomorpha (insectivores)
Condylura cristata	Star-nosed mole	Soricomorpha (insectivores)
Sorex monticolus	Montane shrew	Soricomorpha (insectivores)
Sorex fumeus	Smoky shrew	Soricomorpha (insectivores)
Sorex hoyi	Pigmy shrew	Soricomorpha (insectivores)
Eptesicus fuscus	Big brown bat	Chiroptera (bats)
Myotis lucifugus	Little brown bat	Chiroptera (bats)
Felis catus	Domestic cat	Carnivora (Carnivores)
Procyon lotor	(Northern) Raccoon	Carnivora (Carnivores)
Mustela nivalis	Least weasel	Carnivora (Carnivores)
Mustela frenata	Long-tailed weasel	Carnivora (Carnivores)
Neovison vison	American mink	Carnivora (Carnivores)
Mephites mephites	Striped skunk	Carnivora (Carnivores)
Vulpes vulpes	Red fox	Carnivora (Carnivores)
Urocyon cinereoargenteus	Gray fox	Carnivora (Carnivores)
Canis latrans	Coyote	Carnivora (Carnivores)
Canis lupus famoliaris	Domestic dog	Carnivora (Carnivores)
Tamias striatus	Eastern chipmunk	Rodentia (rodents)
Tamiasciurus hudsonicus	Red squirrel	Rodentia (rodents)
Sciurus niger	Eastern fox squirrel	Rodentia (rodents)
Glaucomys volans	Southern flying squirrel	Rodentia (rodents)
Glaucomys sabrinus	Northern flying squirrel	Rodentia (rodents)
Sciurus carolinensis	Eastern gray squirrel	Rodentia (rodents)

Spermophilus tridecemlineatus	Thirteen-lined ground squirrel	Rodentia (rodents)
Marmota monax	Woodchuck	Rodentia (rodents)
Peromyscus maniculatus	Deer mouse	Rodentia (rodents)
Peromyscus leucopus	White-footed mouse	Rodentia (rodents)
Microtus pennsylvanicus	Meadow vole	Rodentia (rodents)
Zapus hudsonius	Meadow-jumping mouse	Rodentia (rodents)
Sylvilagus floridanus	Eastern cottontail	Lagomorpha (Hares, Pikas, & Rabbits)
Odocoileus virginianus	White-tailed deer	Artiodactyla (even-toed ungulates)

Birds (179 species)

Scientific Name	Common Name	Order	Family
Acanthis flammea	Common redpoll	Passeriformes (Perching Birds)	Fringillidae
Accipiter cooperii	Cooper's hawk	Falconiformes (diurnal birds of prey)	Accipitridae (Eagles, Hawks, & Kites)
Accipiter striatus	Sharp-shinned hawk	Accipitriformes	Accipitridae (Eagles, Hawks, & Kites)
Acititis macularius	Spotted sandpiper	Charadriiformes (Waders, Gulls & Auks)	Scolopacidae (Sandpipers, Snipes, & relatives)
Agelaius phoeniceus	Red-winged blackbird	Passeriformes (Perching Birds)	Icteridae (Blackbirds)
Aix sponsa	Wood duck	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)
Anas crecca	Green winged teal (common teal)	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)
Anas discors	Blue-winged teal	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)
Anas platyrhynochos	Mallard	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)
Anas rubripes	American black duck	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)
Anthus rubescens	American pipit	Passeriformes (Perching Birds)	Motacillidae
Archilochus colubris	Ruby-throated hummingbird	Apodiformes (Swifts & Hummingbirds)	Trochilidae (Hummingbirds)
Ardea alba	Great egret	Pelecaniformes	Ardeidae (Herons)
Ardea herodias	Great-blue heron	Ciconiiformes (Storks & relatives)	Ardeidae (Herons)
Asio otus	Long-eared owl	Strigiformes (Owls)	Strigidae (typical owls)
Bombycilla cedrorum	Cedar waxwing	Passeriformes (Perching Birds)	Bomycillidae (Waxwings)
Bonasa umbellus	Ruffed grouse	Galliformes	Phasianidae
Branta canadensis	Canada goose	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)
Bubo virginianus	great-horned owl	Strigiformes (Owls)	Strigidae (typical owls)
Bucephala albeola	Bufflehead	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)

Buteo jamaicensis	Red-tailed hawk	Falconiformes (diurnal birds of prey)	Accipitridae (Eagles, Hawks, & Kites)
Buteo lagopus	Rough-legged hawk	Accipitriformes	Accipitridae (Eagles, Hawks, & Kites)
Buteo lineatus	Red-shouldered hawk	Accipitriformes	Accipitridae (Eagles, Hawks, & Kites)
Buteo platypterus	Broad-winged hawk	Accipitriformes	Accipitridae (Eagles, Hawks, & Kites)
Butorides virescens	Green heron	Ciconiiformes (Storks & relatives)	Ardeidae (Herons)
Calidris minutilla	Least sandpiper	Charadriiformes (Waders, Gulls & Auks)	Scolopacidae (Sandpipers, Snipes, & relatives)
Cardellina canadensis	Canada warbler	Passeriformes (Perching Birds)	Parulidae
Cardinalis cardinalis	Northern cardinal	Passeriformes (Perching Birds)	Cardinalidae (Cardinal, Grosbeaks, and relatives)
Carduelis tristis	American goldfinch	Passeriformes (Perching Birds)	Fringillidae (True Finches)
Carpodacus mexicanus	House finch	Passeriformes (Perching Birds)	Fringillidae (True Finches)
Carpodacus purpureus	Purple finch	Passeriformes (Perching Birds)	Fringillidae (True Finches)
Cathartes aura	Turkey vulture	Falconiformes (diurnal birds of prey)	Cathartidae (New World vultures & condors)
Catharus fuscescens	Veery	Passeriformes (Perching Birds)	Turdidae (Thrushes)
Catharus guttatus	Hermit thrush	Passeriformes (Perching Birds)	Turdidae (Thrushes)
Catharus minimus	Gray-cheeked thrush	Passeriformes (Perching Birds)	Turdidae (Thrushes)
Catharus ustulatus	Swainson's thrush	Passeriformes (Perching Birds)	Turdidae (Thrushes)
Certhia americana	Brown creeper	Passeriformes (Perching Birds)	Certhiidae (Creepers)
Chaetura pelagica	Chimney swift	Apodiformes (Swifts & Hummingbirds)	Apodidae (swifts)
Charadrius vociferous	Killdeer	Charadriiformes (Waders, Gulls & Auks)	Charadriidae (Lapwigs & Plovers)
Chordeiles minor	Common nighthawk	Caprimulgiformes (nightbirds)	Caprimulgidae (Nightjars, Nighthawks, & relatives)
Circus cyaneus	Northern harrier	Falconiformes (diurnal birds of prey)	Accipitridae (Eagles, Hawks, & Kites)
Coccyzus americanus	Yellow-billed cuckoo	Cuculiformes (Cuckoos)	Cuculidae (Cuckoos, Roadrunners, & relatives)
Coccyzus erythrophthalmus	Black-billed cuckoo	Cuculiformes (Cuckoos)	Cuculidae (Cuckoos, Roadrunners, & relatives)
Colaptes auratus	Northern flicker	Piciformes (Woodpeckers & relatives)	Picidae (Woodpeckers)
Columba livia	Rock pigeon (common pigeon)	Columbiformes (Doves & Pigeons)	Columbidae (Doves & Pigeons)
Contopus virens	Eastern wood pewee	Passeriformes (Perching Birds)	Tyrannidae (Tyrant Flycatchers)
Corvus brachyrhynchos	American crow	Passeriformes (Perching Birds)	Corvidae (Crows & Jays)
Cyanocitta cristata	Blue jay	Passeriformes (Perching Birds)	Corvidae (Crows & Jays)
Cygnus buccinator	Trumpeter swan	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)
Cygnus olor	Mute swan	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)
Dendoicia fusca	Blackburnian warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Dendroica caerulencens	Black-throated blue warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)

Dendroica castanea	Bay-breasted warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Dendroica coronata	Yellow-rumped warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Dendroica magnolia	Magnolia warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Dendroica palmarum	Palm warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Dendroica pensylvanica	Chestnut-sided warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Dendroica petechia	Yellow warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Dendroica striata	Blackpoll warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Dendroica tigrina	Cape May warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Dendroica virens	Black-throated green warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Dolichonyx oryzivorus	Bobolink	Passeriformes (Perching Birds)	Icteridae (Blackbirds)
Dryocopus pileatus	Pileated woodpecker	Piciformes (Woodpeckers & relatives)	Picidae (Woodpeckers)
Dumetella carolinensis	Gray catbird	Passeriformes (Perching Birds)	Mimidae (Mocking birds & Thrashers)
Egretta caerulea	Little blue heron	Ciconiiformes (Storks & relatives)	Ardeidae (Herons)
Empidonax alnorum	Alder flycatcher	Passeriformes (Perching Birds)	Tyrannidae (Tyrant Flycatchers)
Empidonax flaviventris	Yellow-bellied flycatcher	Passeriformes (Perching Birds)	Tyrannidae (Tyrant Flycatchers)
Empidonax minimus	Least flycatcher	Passeriformes (Perching Birds)	Tyrannidae (Tyrant Flycatchers)
Empidonax traillii	Willow flycatcher	Passeriformes (Perching Birds)	Tyrannidae (Tyrant Flycatchers)
Empidonax virescens	Acadian flycatcher	Passeriformes (Perching Birds)	Tyrannidae (Tyrant Flycatchers)
Eremophila alpestris	Horned lark	Passeriformes (Perching Birds)	Alaudidae (Larks)
Euphagus carolinus	Rusty blackbird	Passeriformes (Perching Birds)	Icteridae (Blackbirds)
Falco columbarius	Merlin	Falconiformes (diurnal birds of prey)	Falconidae (Falcons)
Falco peregrinus	Peregrine falcon	Falconiformes (diurnal birds of prey)	Falconidae (Falcons)
Falco sparverius	American kestrel	Falconiformes (diurnal birds of prey)	Falconidae (Falcons)
Fulica americana	American coot	Gruiformes	Rallidae
Galliango gallinago	Wilson's snipe (common snipe)	Charadriiformes (Waders, Gulls & Auks)	Scolopacidae (Sandpipers, Snipes, & relatives)
Gavia immer	Common loon	Gaviiformes	Gaviidae
Geothlypis philadelphia	Mourning warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Geothlypis trichas	Common yellowthroat	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Grus canadensis	Sandhill crane	Gruiformes (Crane-like Birds)	Gruidae (Cranes)
Haliaeetus leucocephalus	Bald eagle	Accipitriformes	Accipitridae (Eagles, Hawks, & Kites)
Hirundo rustica	Barn swallow	Passeriformes (Perching Birds)	Hirundinidae (Swallows)
Hylocichla mustelina	Wood thrush	Passeriformes (Perching Birds)	Turdidae (Thrushes)
Icterus galbula	Baltimore oriole	Passeriformes (Perching Birds)	Icteridae (Blackbirds)

Icterus spurius	Orchard oriole	Passeriformes (Perching Birds)	Icteridae (Blackbirds)
Junco hyemalis	Dark-eyed junco	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Lanius borealis	Northern shrike	Passeriformes (Perching Birds)	Laniidae
Larus argentatus	Herring gull	Charadriiformes (Waders, Gulls & Auks)	Laridae (Gulls,Terns, & Skimmers)
Larus delawarensis	Ring-billed gull	Charadriiformes (Waders, Gulls & Auks)	Laridae (Gulls,Terns, & Skimmers)
Larus philadelphia	Bonaparte's gull	Charadriiformes (Waders, Gulls & Auks)	Laridae (Gulls,Terns, & Skimmers)
Leiothlypis celata	Orange-crowned warbler	Passeriformes (Perching Birds)	Parulidae
Lophodytes cucullatus	Hooded merganser	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)
Loxia leucoptera	White-winged crossbill	Passeriformes (Perching Birds)	Fringillidae
Mareca americana	American wigeon	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)
Mareca strepera	Gadwall	Anseriformes (Swans, Geese & Ducks)	Anatidae (Ducks, Geese, and Swans)
Megaceryle alcyon	Belted kingfisher	Coraciiformes (Kingfishers & rleatives)	Alcedinidae (Kingfishers)
Melanerpes carolinus	Red-bellied woodpecker	Piciformes (Woodpeckers & relatives)	Picidae (Woodpeckers)
Melanerpes erythrocephales	Red-headed woodpecker	Piciformes (Woodpeckers & relatives)	Picidae (Woodpeckers)
Meleagris gallopavo	Wild turkey	Galliformes (Pheasants, Partridges & Quail)	Phasianidae (Turkeys, Grouse, Phesants, & Partridges)
Melospiza georgiana	Swamp sparrow	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Melospiza lincolnii	Lincoln's sparrow	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Melospiza melodia	Song sparrow	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Miniotilta varia	Black-and-white warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Molothrus ater	Brown-headed cowbird	Passeriformes (Perching Birds)	Icteridae (Blackbirds)
Myiarchus crinitus	Great-crested flycatcher	Passeriformes (Perching Birds)	Tyrannidae (Tyrant Flycatchers)
Nyctanassa violacea	Yellow-crowned night heron	Ciconiiformes (Storks & relatives)	Ardeidae (Herons)
Nycticorax nycticorax	Black-crowned night heron	Ciconiiformes (Storks & relatives)	Ardeidae (Herons)
Oporornis agilis	Connecticut warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Otus asio	Eastern screech owl	Strigiformes (Owls)	Strigidae (typical owls)
Pandion haliaetus	Osprey	Accipitriformes	Pandionidae
Parkesia motacilla	Louisiana waterthrush	Passeriformes (Perching Birds)	Parulidae
Parkesia noveboracensis	Northern waterthrush	Passeriformes (Perching Birds)	Parulidae
Parus atricapillus	Black-capped chickadee	Passeriformes (Perching Birds)	Paridiae (Chickadees & Titmice)
Parus bicolor	Tufted titmouse	Passeriformes (Perching Birds)	Paridiae (Chickadees & Titmice)
Passer domesticus	House sparrow	Passeriformes (Perching Birds)	Passeridae (Old World Sparrows)

Passerculus sandwichensis	Savannah sparrow	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Passerella iliaca	Fox sparrow	Passeriformes (Perching Birds)	Passerellidae
Passerina cyanea	Indigo bunting	Passeriformes (Perching Birds)	Cardinalidae (Cardinal, Grosbeaks, and relatives)
Phalacrocorax auritus	Double-crested cormorant	Suliformes	Phalacrocoracidae
Phasianus colchicus	Ring-necked (Common) pheasant	Galliformes (Pheasants, Partridges & Quail)	Phasianidae (Turkeys, Grouse, Phesants, & Partridges)
Pheucticus ludovicianus	Rose-breasted grosbeak	Passeriformes (Perching Birds)	Cardinalidae (Cardinal, Grosbeaks, and relatives)
Picoides pubescens	Downy woodpecker	Piciformes (Woodpeckers & relatives)	Picidae (Woodpeckers)
Picoides villosus	Hairy woodpecker	Piciformes (Woodpeckers & relatives)	Picidae (Woodpeckers)
Pipilo erythrophthalmus	Eastern towhee	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Piranga olivacea	Scarlet tanager	Passeriformes (Perching Birds)	Genera Incertae Sedis (12:69)
Plectrophenax nivalis	Snow bunting	Passeriformes (Perching Birds)	Calcariidae
Podilymbus podiceps	Pied-billed grebe	Podicipediformes (Grebes)	Podicipedidae
Polioptila caerulea	Blue-grey gnatcatcher	Passeriformes (Perching Birds)	Poliopilidae (Gnatcatchers)
Pooecetes gramineus	Vesper sparrow	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Porzana carolina	Sora	Gruiformes (Crane-like Birds)	Rallidae (Coots, Rails, & relatives
Progne subis	Purple martin	Passeriformes (Perching Birds)	Hirundinidae (Swallows)
Protonotaria citrea	Prothonotary warbler	Passeriformes (Perching Birds)	Parulidae
Quiscalus quiscula	Common grackle	Passeriformes (Perching Birds)	Icteridae (Blackbirds)
Rallus limicloa	Virginia rail	Gruiformes (Crane-like Birds)	Rallidae (Coots, Rails, & relatives
Regulus calendula	Ruby-crowned kinglet	Passeriformes (Perching Birds)	Reguliidae (Kinglets)
Regulus satrapa	Golden-crowned kinglet	Passeriformes (Perching Birds)	Reguliidae (Kinglets)
Riparia ripaira	Bank swallow	Passeriformes (Perching Birds)	Hirundinidae (Swallows)
Saynoris phoebe	Eastern phoebe	Passeriformes (Perching Birds)	Tyrannidae (Tyrant Flycatchers)
Scolopax minor	American woodcock	Charadriiformes (Waders, Gulls & Auks)	Scolopacidae (Sandpipers, Snipes, & relatives)
Seiurus aurocapilla	Ovenbird	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Setophaga americana	Northern parula	Passeriformes (Perching Birds)	Parulidae
Setophaga pinus	Pine warbler	Passeriformes (Perching Birds)	Parulidae
Setophaga ruticilla	Common redstart	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Setophaga rutiilla	American redstart	Passeriformes (Perching Birds)	Parulidae
Sialia sialis	Eastern bluebird	Passeriformes (Perching Birds)	Turdidae (Thrushes)
Sitta canadensis	Red-breasted nuthatch	Passeriformes (Perching Birds)	Sittidae (Nuthatches)
Sitta carolinensis	White-breasted nuthatch	Passeriformes (Perching Birds)	Sittidae (Nuthatches)

Sphyrapicus varius	Yellow-bellied sapsucker	Piciformes (Woodpeckers & relatives)	Picidae (Woodpeckers)
Spinus pinus	Pine siskin	Passeriformes (Perching Birds)	Fringillidae
Spizella arborea	American tree sparrow	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Spizella pallida	Clay-colored sparrow	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Spizella passerina	Chipping sparrow	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Spizella pusilla	Field sparrow	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Stelgidopteryx serripennis	Northern rough-winged swallow	Passeriformes (Perching Birds)	Hirundinidae (Swallows)
Strix varia	Barred owl	Strigiformes (Owls)	Strigidae (typical owls)
Sturnella magma	Eastern meadowlark	Passeriformes (Perching Birds)	Icteridae (Blackbirds)
Sturnus vulgaris	European starling	Passeriformes (Perching Birds)	Sturnidae (Starlings)
Tachycineta bicolor	Tree swallow	Passeriformes (Perching Birds)	Hirundinidae (Swallows)
Toxostoma rufum	Brown thrasher	Passeriformes (Perching Birds)	Mimidae (Mocking birds & Thrashers)
Tringa flavipes	Lesser yellowlegs	Charadriiformes (Waders, Gulls & Auks)	Scolopacidae (Sandpipers, Snipes, & relatives)
Tringa solitaria	Solitary sandpiper	Charadriiformes (Waders, Gulls & Auks)	Scolopacidae (Sandpipers, Snipes, & relatives)
Troglodytes aedon	House wren	Passeriformes (Perching Birds)	Troglodytidae (Wrens)
Troglodytes hiemalis	Winter wren	Passeriformes (Perching Birds)	Troglodytidae (Wrens)
Turdus migratorius	American robin	Passeriformes (Perching Birds)	Turdidae (Thrushes)
Tyrannus tyrannus	Eastern kingbird	Passeriformes (Perching Birds)	Tyrannidae (Tyrant Flycatchers)
Vermivora peregrina	Tennessee warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Vermivora pinus	Blue-winged warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Vermivora ruficapilla	Nashville warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Vireo bellii	Bell's vireo	Passeriformes (Perching Birds)	Vireonidae (Vireos)
Vireo flavifrons	Yellow-throated vireo	Passeriformes (Perching Birds)	Vireonidae (Vireos)
Vireo gilvus	Warbling vireo	Passeriformes (Perching Birds)	Vireonidae (Vireos)
Vireo olivaceus	Red-eyed vireo	Passeriformes (Perching Birds)	Vireonidae (Vireos)
Vireo philadelphicus	Philadephia vireo	Passeriformes (Perching Birds)	Vireonidae (Vireos)
Vireo solitarius	Blue-headed (Solirary) vireo	Passeriformes (Perching Birds)	Vireonidae (Vireos)
Wilsonia pusilla	Wilson's warbler	Passeriformes (Perching Birds)	Parulidaea (New World Warblers)
Zenaida macroura	Mourning dove	Columbiformes (Doves & Pigeons)	Columbidae (Doves & Pigeons)
Zonotrichia albicollis	White-throated sparrow	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)
Zonotrichia leucophrys	White-crowned sparrow	Passeriformes (Perching Birds)	Emberizidae (Buntings, American Sparrows, & Relatives)

Reptiles		
Scientific Name	**Common Name**	**Order**
Chelydra serpentina	Common snapping turtle	Testudines
Emydoidea blandingi	Blanding's turtle	Testudines
Terrapene carolina	Eastern (Common) box turtle	Testudines
Chrysemys picta	Painted turtle	Testudines
Trachemys scripta elegans	Red-eared slider	Testudines
Sternotherus odoratus	Musk turtle	Testudines
Thamnophis	Eastern (Common) garter snake	Squamata
Lampropeltis triangulum	Eastern milk snake	Squamata
Storeria dekayi	Northern brown snake	Squamata

Amphibians		
Scientific Name	**Common Name**	**Order**
Bufo americanus	American Toad	Anura (Frogs & Toads)
Hyla versicolor	Gray Treefrog	Anura (Frogs & Toads)
Pseudacris crucifer	Spring Peeper	Anura (Frogs & Toads)
Pseudacris triseriata	Western Chorus Frog	Anura (Frogs & Toads)
Rana clamitans	Green Frog	Anura (Frogs & Toads)
Rana pipiens	Northern Leopard Frog	Anura (Frogs & Toads)
Rana sylvatica	Wood Frog	Anura (Frogs & Toads)
Rana catasbeina	Bullfrog	Anura (Frogs & Toads)
Ambystoma laterale	Blue-spotted Salamander	Caudata (Salamanders)
Ambystoma maculatum	Spotted Salamander	Caudata (Salamanders)

Fish		
Scientific Name	**Common Name**	**Order**
Umbra limi	Central Mudminnow	Esociformes
Pimephales promelas	Fathead Minnow	Cypriniformes
Lepomis macrochirus	Bluegill	Perciformes
Ameiurus natalis	Bullhead	Siluriformes

APPENDIX N: Invertebrate Species Inventory of the Ecosystem Preserve

This data was collected within the native garden habitat between July 14, 2020 and July 21, 2020 and will be updated yearly as new species are identified.

Class	Order	Suborder	Family	Common Name	Genus	Species	Date
Insecta	Diptera	Nematocera	Tipulidae	Crane fly	Tipula	Oleracea	7/14/2020
Insecta	Diptera	Brachycera	Syrphidae		Baccha	Elongata	7/14/2020
Insecta	Diptera	Brachycera	Tabanidae		Tabanus	Atratus	7/14/2020
Insecta	Lepidoptera		Tineidae	Common Clothes moth	Tineola	Bisselliella	7/14/2020
Insecta	Diptera	Nematocera	Culicidiae	Mosquito	Anepheles	Quadrimaculatus	7/14/2020
Insecta	Hymenoptera	Apocrita	Halictidae	Sweet Bee	Agapostemon	Virescens	7/14/2020
Insecta	Diptera	Cyclomhaphous	Syrphidae	Flower fly	Toxomerus	Marginatus	7/14/2020
Insecta	Hymenoptera	Apocrita	Megachilidae	Mason Bee	Osmia	Spp.	7/14/2020
Insecta	Hymenoptera	Apocrita	Ichneumonidae		Rhyssa	Lineolata	7/14/2020
Insecta	Diptera	Brachycera	Empididae	Dance fly	Empis	Spp.	7/14/2020
Insecta	Orthoptera	Caelifera	Arcididae	Carolina locust	Dissosteira	Carolina	7/15/2020
Insecta	Coleoptera	Polyphaga	Cantharidae	Soldier Beetle	Chauliognathus	Spp.	7/15/2020
Insecta	Diptera	Cycorrhapha	Tachinidae	Early Tachinid Fly	Epalpus	Signifer	7/15/2020
Insecta	Diptera	Nematocera	Culicidiae	Elephant Mosquito	Toxorhynchites	Rutilus	7/15/2020
Insecta	Hymenoptera	Apocrita	Braconidae	Braconid Wasp	Cotesia	Spp.	7/14/2020
Insecta	Coleoptera	Polyphaga	Lampyridae		Ellychnia	corrura	7/14/2020
Arachnida	Araneae		Lycosidae	Wolf Spider	Pardosa	Spp.	7/20/2020
Insecta	Lepidoptera		Nymphalidae		Chlosyne	Gorgone	7/21/2020
Insecta	Lepidoptera		Erebidae		Lymantria	Dispar	7/21/2020
Insecta	Lepidoptera		Pieridae		Pieris	Rapae	7/21/2020
Insecta	Odonada		Libellulidae		Pachyoipax	Longipemis	7/21/2020
Insecta	Hymenoptera	Apocrita	Ichneumonidae		Megarhyssa	Spp.	7/21/2020
Insecta	Diptera		Tabanidae		Tabanus	Quinqueuittatus	7/21/2020
Insecta	Hemiptera	Auchenorohyncha	Cicadellidae		Gyphonana	Octolineta	7/21/2020
Insecta	Hymenoptera		Halictidae		Augochlara	Pura	7/21/2020
Insecta	Coleoptera		Cantharidae		Ichaulignathus	Spp.	7/21/2020
Insecta	Lepidoptera		Nymphalidae		Nymphalis	Antipoa	7/20/2020
Insecta	Coleoptera		Scarabaeidae	Japanese Beetle	Popillia	Japonica	7/20/2020
Gastropoda	Coleoptera		Arionidae	Garden slug	Arion	Distinctuv	7/20/2020
Insecta	Orthoptera	Caelifera	Arionidae	Spurthroated Grasshopper	Melanuplus	Spp.	7/20/2020
Insecta	Hymenoptera	Apocrita	Apidae		Bombus	Spp.	7/14/2020
Insecta	Diptera	Cyclorrhapha	Calliphoridae		Lucilia	Servicata	7/14/2020
Insecta	Diptera	Cyclorrhapha	Sarcophagidae		Sarcophaga	Spp.	7/14/2020

Insecta	Diptera	Cyclorrhapha	Muscidae		Musca	Domestica	7/14/2020
Insecta	Diptera	Nematocera	Simuliidae		Simulium	Spp.	7/14/2020
Insecta	Diptera	Brachycera	Tabanidae		Chrysops	Spp.	7/14/2020
Insecta	Hymenoptera	Apocrita	Vespidae		Vesipula	Pennsylvanica	7/14/2020
Insecta	Hymenoptera	Apocrita	Chrysididae		Chrysura	Pacifica	7/14/2020
Insecta	Hymenoptera	Apocrita	Gasteruptidae	Apocritan wasps			7/14/2020
Insecta	Homoptera	Auchennorhyncha	Cicadellidae	leaf hoppers	Fieberiella	Florri	7/14/2020
Insecta	Diptera	Cyclorrhapha	Tephritidae	Fruit Fly	Rhageletis	Pomenella	7/14/2020
Insecta	Diptera	Sciapodinea	Dolichepudidne	Long legged fly	Landylostglus		7/14/2020
Insecta	Hymenoptera	Apocrita	Sphecidae		Chalybion	Californicum	7/14/2020
Insecta	Hymenoptera	Apocrita	Carcinellidae		Sphex	Ichneumeneus	7/15/2020
Insecta	Coleoptera	Polyphaga	Libellulidae		Colemegilla	Macultat	7/15/2020
Insecta	Odonada	Anisoptera	Apidae		Libellulla	Pulchella	7/15/2020
Insecta	Hymenoptera	Apocrita	Apidae		Apis	Mellifera	7/15/2020
Insecta	Hymenoptera	Apocrita	Formicidae	Black Carpenter Ant	Xylocopa	Spp.	7/15/2020
Insecta	Hymenoptera	Apocrita	Gryllidae	House Cricket	Camponotus	Pennsylvanicus	7/15/2020
Insecta	Orthoptera	Ensifera	Phalangiidae	Harvestman	Acheta	Domesticus	7/14/2020
Chelicerata	Opiliones		Libellulidae	Blue Dasher	Phalaagium	Opilid	7/20/2020
Insecta	Odonata		Geophilidae	Coil Centipede	Pachydiplay	Longipeanis	7/20/2020
Chilopda	Diptera		Paradorosomatidae		Arenophilus	Bipunctecups	7/20/2020
Diplopoda	Polydesmida				Oxidus	Gracilis	7/20/2020
Insecta	Lepidoptera		Arctiidae	Fall Webworm	Hyphantria	Cunea	7/20/2020
Insecta	Orthoptera	Ensifera	Gryllidae	Field Cricket	Gryllus	Pennsylvanicus	7/20/2020
Insecta	Odonada	Anisoptera	Libellulidae		Perithemis	Tenera	7/20/2020
Insecta	Hymenoptera	Apocrita	Vespidae		Polistes	Dominulus	7/20/2020
Insecta	Odonada	Zygoptera	Lestidae		Enallagma	Spp.	7/21/2020
Insecta	Coleptera	Polyphaga	Chrysomelidae		Plagiodera	Versicolora	7/21/2020
Insecta	Hemiptera	Auchenorrhypicha	Cicadellidae		Gyponana	Spp.	7/21/2020
Insecta	Coleptera	Polyphaga	Lampyridae		Photinis	Pyralis	7/21/2020
Insecta	Hymenoptera	Apocrita	Halictidae		Augochlora	Pura	7/21/2020
Insecta	Neuroptera	Planipennia	Chrysopidae		Chrysopa	Spp.	7/21/2020
Insecta	Hemiptera	Gymnocerata	Lygaeidae				7/21/2020
Insecta	Hymenoptera	Apocrita	Sphecidae		Ammophila	Spp.	7/21/2020
Insecta	Lepidoptera		Geometridae		Tetracts	Cachexiata	7/21/2020
Insecta	Odonada	Zygoptera	Coenagrianidea		Ischnura	Vecticalis	7/21/2020
Insecta	Hymenoptera	Apocrita	Icheneumoidae				7/21/2020

APPENDIX O: Invasive Plant Control Priorities of the Ecosystem Preserve

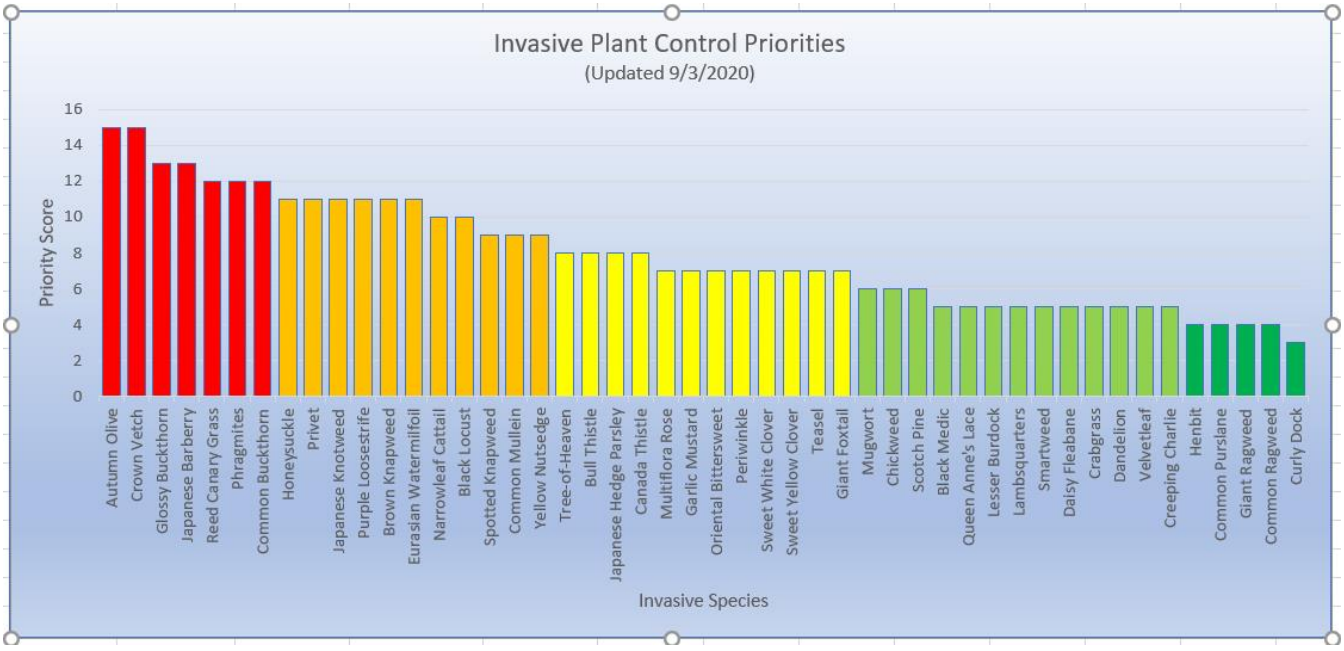
Scientific Name	Common Name	Location	I-Rank	Ecological Impact	Current Distribution & Abundance	Trend in Distribution & Abundance	Management Difficulty	Priority Score
Rhamnus cathartica	Common Buckthorn	Forest habitat	High/Medium	High/Medium	High	High	Medium/ Low	12
Frangula alnus	Glossy Buckthorn	Forest habitat with saturated soils	High/Medium	High	High	Medium	Medium	13
Lonicera tatarica	Honeysuckle	Forest habitat	High/Medium	Medium	High	High/Medium	Medium	11
Eleagnus umbellata	Autumn Olive	Open fields succeeding to forest (Field C and field west of Preserve House)	High	High	High	High/Medium	Low	15
Berberis thunbergii	Japanese Barberry	Forest habitat	High/Med	High/Medium	High	Medium/Low	Low	13
Ailanthus altissima	Tree-of-Heaven	Near Prince Pond, Gainey Field compost, possibly west of PH	Medium	Medium/Low	High	Medium/Low	Medium/ Low	8
Rosa multiflora	Multiflora Rose	forest habitat; large population near fence that separates preserve from sanctuary (north)	Medium/Low	Low	High	Medium/Low	Low	7
Alliaria petiolata	Garlic Mustard	Prince Pond and garden beds	High/Medium	Medium/Low	High	High/Medium	Medium	7
Celastrus orbiculata	Oriental Bittersweet	individuals throughout forest habitat: one at Bunker; one near eastern edge of preserve adjacent to fencing	High/Medium	Medium/Low	High	High/Medium	Medium	7
Centaurea biebersteinii	Spotted Knapweed	prairie and open field habitats	High/Medium	High/Medium	High	High/Medium	High	9
Polygonum cuspidatum	Japanese Knotweed	Home Network boundary	High/Medium	High/Medium	High	Medium	Medium	11
Cirsium arvense	Canada Thistle	Prairie and open field habitats	High/Medium	Medium	High	Medium/Low	High/Medium	8
Cirsium vulgare	Bull Thistle	prairie and garden beds	Medium/Low	Medium/Low	High/Medium	Medium/Low	Medium/ Low	8
Artemisia vulgaris	Mugwort	garden beds		Medium/Low			High/Med	6

Rumex crispus	Curly Dock	prairie and garden beds	Low/Insignificant	Low/Insig	Medium	Low	Medium	3
Coronilla varia	Crown Vetch	Flat Iron Lake prairie	High	High	High	Medium	Low	15
Arctium minus	Lesser Burdock	garden beds	Medium	Low	Medium	Medium	Medium	5
Typha angustifoolia	Narrowleaf Cattail	Prince Pond (likely other pond edges)	High/Medium	High/Medium	High	Medium/Low	High/Medium	10
Verbascum thapsus	Common Mullein	prairie and garden beds	Medium	Medium/Low	High	Medium	Low	9
Lythrum salicaria	Purple Loosestrife	ponds (Field C in particular)	High	High	High	High	High	11
Phalaris arundinacea	Reed Canary Grass	South Pond	High	High	High	Medium	High/Medium	12
Myriophyllum spicatum	Eurasian Watermilfoil	Prince Pond	High	High	High	High	High	11
Phragmites australis	Phragmites	Not yet confirmed on preserve but along Lake Drive	High	High	High	High	High/Medium	12
Vinca minor	Periwinkle	bioswale & along sanctuary trail at top of kettle swamp		Medium/Low			Medium	7
Torilis japonica	Japanese Hedge Parsley	Forest edges: near Gatehouse and bioswale		Medium/Low			Medium/Low	8
Chenopodium album	Lambsquarters	garden beds		Insignificant			Low	5
Polygonum pensylvanicum	Smartweed	garden beds		Low/Insig			Low	5
Erigeron strigosus	Daisy Fleabane	garden beds and prairies		Insignificant			Low	5
Stellaria media	Chickweed	garden beds	Low	Low	Medium	Low	Medium/Low	6
Pinus sylvestris	Scotch Pine	Fields A & B	Medium/Low	Medium/Low	Medium/Low	Low	High/Med	6
Digitaria sanguinalis	Crabgrass	garden beds and edge of prairies along sidewalks	Low/Insignificant	Low	Medium	Low	Low	5
Robinia pseudoacacia	Black Locust	Gainey compost	High/Medium	High/Medium	High	Medium/Low	High/Medium	10
Taraxacum officinale	Dandelion	garden beds		Insignificant			Low	5
Abutilon theophrasti Medicus	Velvetleaf	garden beds and disturbed areas	Medium/Low	Low	High	Medium/Low	Medium	5
Lamium amplexicaule	Henbit	garden beds		Insignificant			Medium/Low	4
Melilotus albus	Sweet White Clover	prairie and garden beds		Medium			High	7

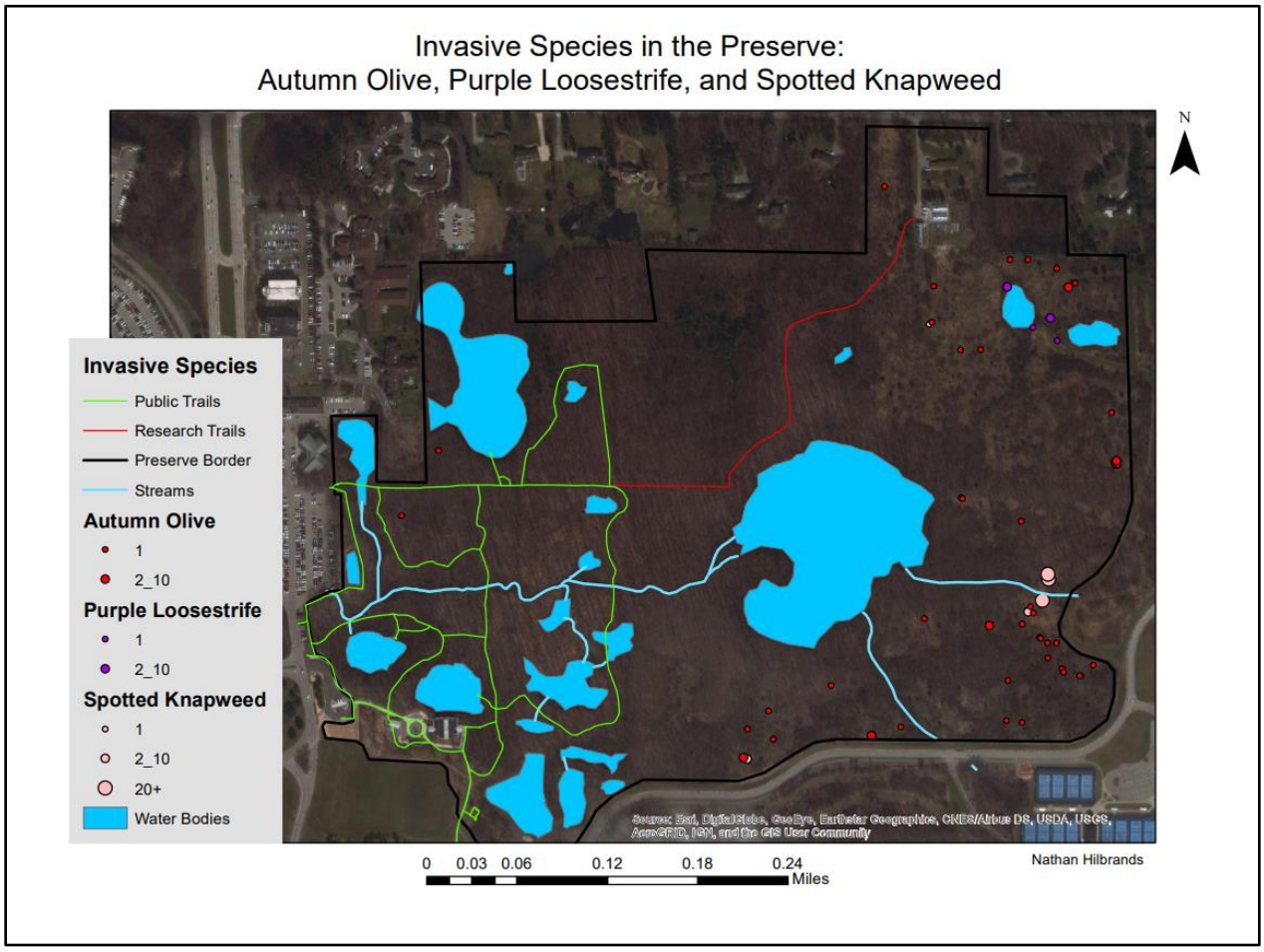
Melilotus officinalis	Sweet Yellow Clover	prairie and garden beds: lots between prairie and Prince Pond shoreline		Medium			High	7
Pilea nummulariifolia	Creeping Charlie	garden beds: lots between garden and Prince Pond next to groundhog burrow		Low			Medium	5
Daucus carota	Queen Anne's Lace	prairie and garden beds	Low	Insignificant	High	Low	Medium	5
Dipsacus sylvestris	Teasel	prairie		Low			Low	7
Cyperus esculentus	Yellow Nutsedge	garden beds and disturbed areas adjacent to sidewalks in full sun		Medium			Medium	9
Medicago lupulina	Black Medic	garden beds	Medium	Low	Medium	Medium	Medium	5
Portulaca oleracea	Common Purslane	garden beds		Insignificant			Medium/ Low	4
Ambrosia trifida	Giant Ragweed	garden beds and prairie edges		Insignificant			Medium/ Low	4
Ambrosia artemisiifolia	Common Ragweed	garden beds		Insignificant			Medium/ Low	4
Setaria faberi	Giant Foxtail	disturbed prairie edges and newly established garden beds		Medium/Low			Medium	7
Centaurea jacea*	Brown Knapweed	South of Kettle Swamp	Medium	High/Med	Low	Low	High/Medium	11
*Ligustrum vulgare**	Privet	Pine Grove Trail, E of Preserve House, Northern property boundary	High/Medium	High/Med	Med/Low	Med/Low	High/Med	11

*= discovered 2020

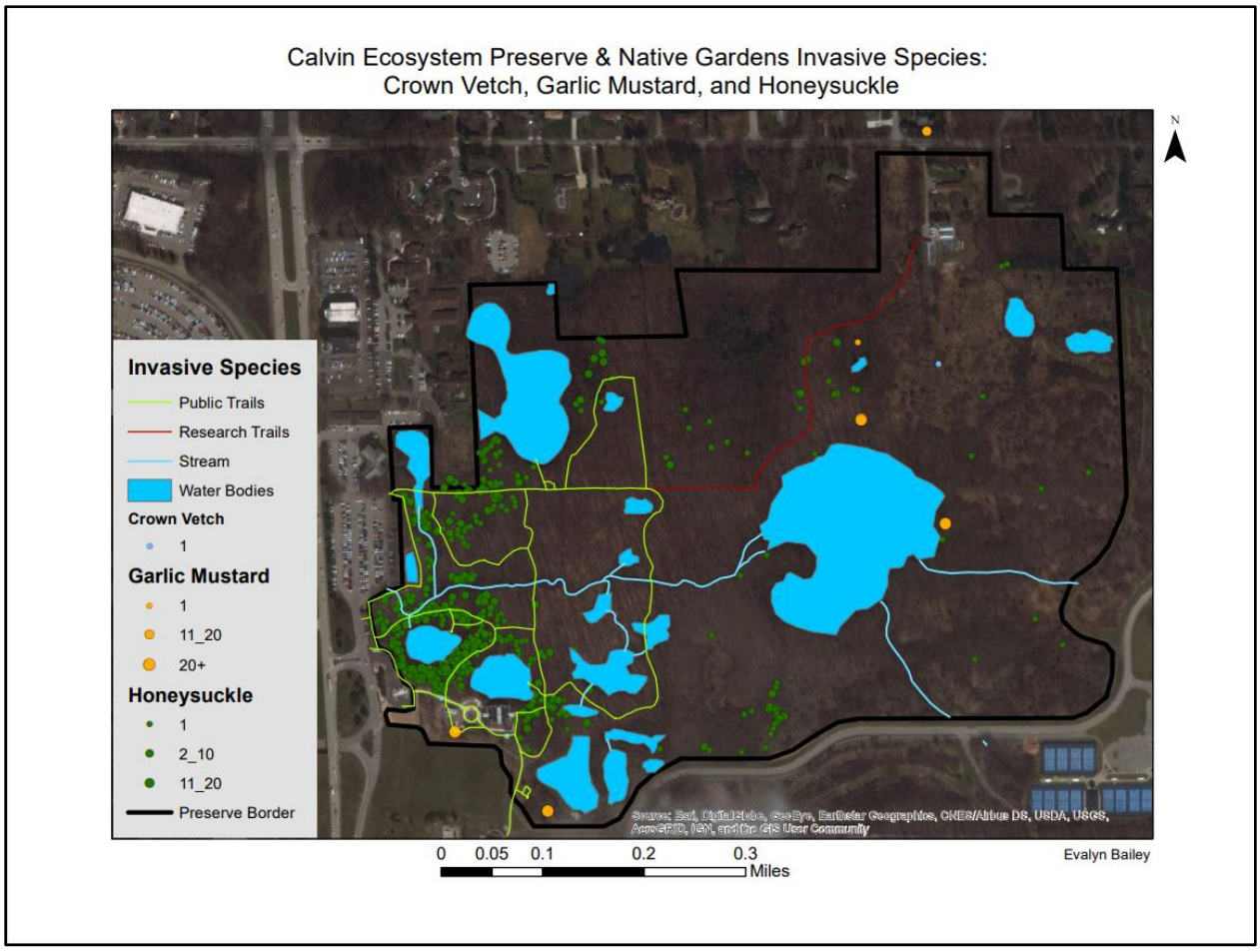
APPENDIX P: Graph of Invasive Plant Control Priorities of the Ecosystem Preserve



APPENDIX Q: Map of Autumn Olive, Purple Loosestrife and Spotted Knapweed Populations



APPENDIX R: Map of Crown Vetch, Garlic Mustard and Honeysuckle Populations



APPENDIX S: Map of Japanese Barberry and Common Privet Populations