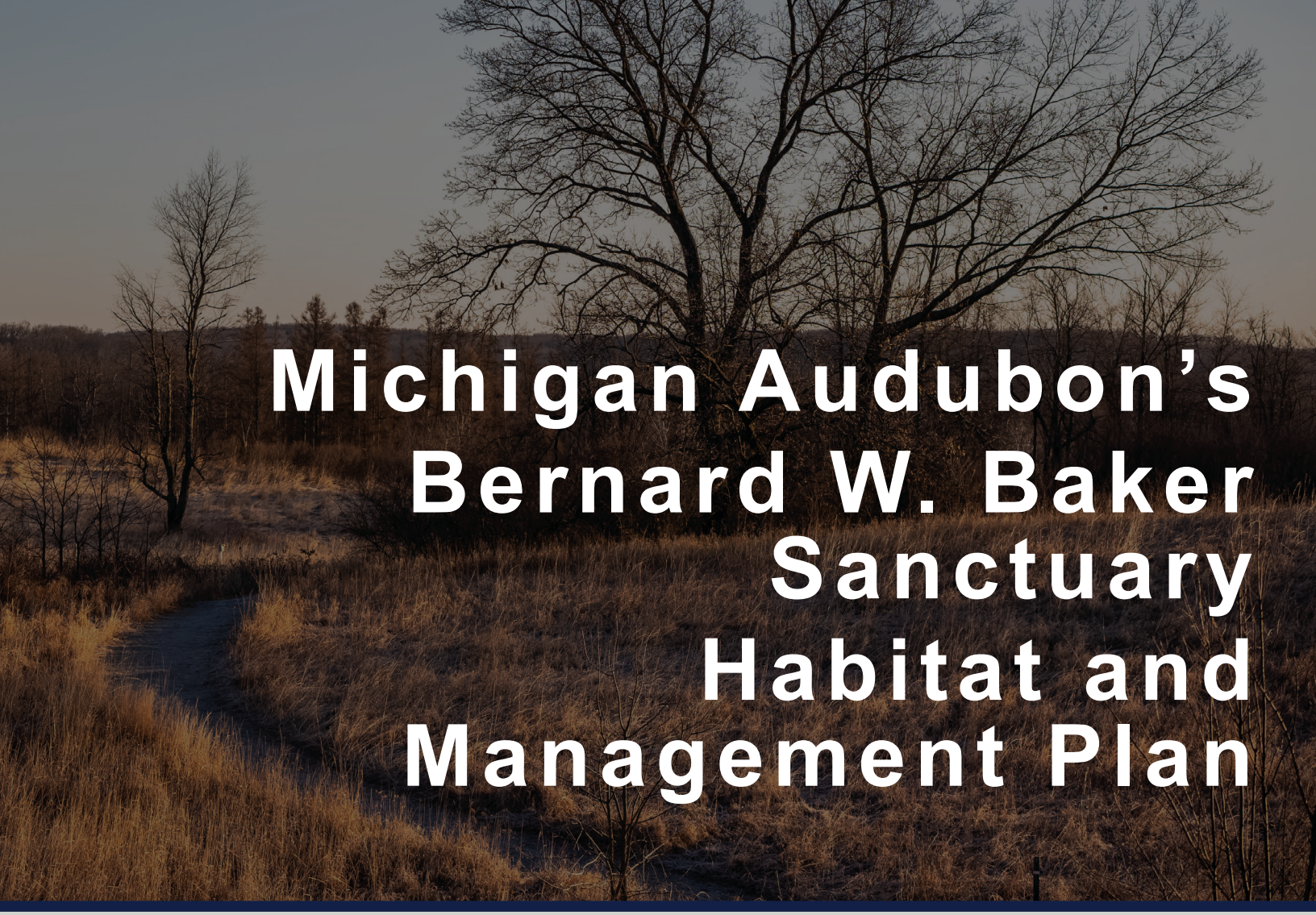

Michigan Audubon's Bernard W. Baker Sanctuary Habitat and Management Plan

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School for Environment and Sustainability
2022

Client: Michigan Audubon
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MICHIGAN audubon

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UNIVERSITY OF MICHIGAN

MARSHALL COMMUNITY FOUNDATION

TABLE OF CONTENTS

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We are grateful to the entire staff at Michigan Audubon for their unwavering commitment to this project, for their assistance in organizing events with volunteers, and for their steadfast determination to improve ecological function at Bernard W. Baker Sanctuary.

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CHAPTER 1: INTRODUCTION

1.1 Official Sanctuary Vision Statement

"The vision of Michigan Audubon's bird sanctuary network is to aid in the collective, collaborative preservation of native biological diversity and to secure the future of avian species and their habitats throughout the state of Michigan.

We abide by ecological best practices in our restorative management approach and utilize the organization's three pillars of Conservation, Education, and Research to meet our mission of connecting birds and people for the benefit of both at our 18 bird sanctuaries. Some of our sanctuaries are open to the public and others are maintained as habitat for at-risk species, such as the Cerulean Warbler.

We envision the realm of outdoor recreation, including birding, wildlife observation, hiking, and other non-consumptive activities, as a community that contributes and supports the protection, preservation, and appreciation of avian species and their native places while inspiring others to do the same."

- Michigan Audubon

1.2 Official Land Acknowledgement Statement

"Before Michigan Audubon purchased or received via donation the acreage that now comprises our network of bird and nature sanctuaries throughout the state, we acknowledge that this land is the ancestral, traditional, and contemporary Lands of the Anishinaabeg – Three Fires Confederacy of Ojibwe, Odawa, and Potawatomi – Indigenous peoples.

Michigan Audubon supports and actively advocates, through collaborative programs and projects involving wildlife and land conservation, for the sovereignty of Indigenous individuals and communities who live here now, and for those who were forcibly removed from their homeland. By offering this Land Acknowledgement, we affirm Indigenous sovereignty and hold our organizational policies and practices more accountable to the needs of American Indian and Indigenous peoples.

We honor the Anishinaabe and Indigenous Peoples' connection to this region, to the land itself, and to the balance, harmony, and intrinsic value of the living ecosystem. We offer an abundance of gratitude for the cherished opportunity to conserve these properties in perpetuity, and to care for them with respect, integrity, and best practices."

- Michigan Audubon

4
Bernard Baker Bird Santuary Management Plan

1.3 Overview and Goals

Bernard Baker Sanctuary encompasses 980 acres of protected land in Convis Township, Calhoun County in Michigan. It is located south of Bellevue and north of Marshall. The sanctuary contains several habitats including old fields, restored tallgrass prairie, and various forested wetlands. It also contains most of Big Marsh Lake and has been known as a refuge for at-risk avian species. It is an important location for migrating and nesting sandhill cranes and was established as North America's first refuge specifically for this species. Today, over 5,000 cranes stop at this location during fall migration.

The Michigan's Audubon's goals for this property are to conserve, restore, and maintain ecological function for native grassland, wetland, and forest communities, and to support species diversity, specifically focusing on threatened and endangered species. There are currently multiple areas of restoration concern in the sanctuary, primarily due to anthropogenic pressures. Ecologically responsible treatments to repair the landscape, such as prescribed fire, have been emphasized at this property. The sanctuary is visited annually by a large population of sandhill cranes and maintaining habitat for this species is a priority.

Additionally, Michigan Audubon has goals for visitor engagement related to maintaining or increasing quality of recreation, education, and research at this sanctuary.

1.4 History of Land and Michigan Audubon Organization

Indigenous Peoples

Baker Sanctuary is situated within the historical territory of the Potawatomi, or Bodewadmi, people. The Potawatomi are descendants of one of the great lineages of Indigenous Peoples in the Midwest: the Anishinaabeg or First Peoples (Nichols, 2021). The Anishinaabeg were at one time so numerous and their territory so expansive that they effectively split into multiple Tribal Nations. The Potawatomi, along with the Ojibwa of the Lake Superior region, the Mississauga of Manitoulin Island and Mississagi River, and the Ottawa of the Georgian Bay Region, are all joined in the "Council of the Three Fires" federation (Robyn, 2004).

The Potawatomi occupied a large expanse of arable land in southern Michigan and embraced farming along with hunting and fishing for subsistence. Their population grew to at least 6,000 by the seventeenth century, when they allied with the French as trading partners, and throughout the ensuing decades they were receptive to many changes caused by European settlement in the region. The Potawatomi continued to co-occupy their land with small numbers of white settlers throughout the eighteenth century, and despite high mortality from smallpox and other epidemics, by 1810 there were over forty Potawatomi settlements throughout the lower Great Lakes Region and their population had rebounded to pre-colonial numbers (Nichols, 2021).

During the early decades of the nineteenth century the relationship between the Potawatomi and the American settlers degraded and shifted, from relatively prosperous trading partnerships to episodes of violence and mistrust. Native Peoples were perceived as ignorant and exploitable, and their Traditional Knowledge was deemed entirely disposable. The tactics used by westward-moving Americans to coerce the Potawatomi to surrender not just their ancestral lands but also their language and traditions amounted to nothing less than cultural genocide, the legacy of which continues to this day (Robyn, 2004).

This period marks the beginning of large scale white American settlement of Michigan, when orchestrated violence against Native Peoples by local militias became commonplace. By 1818, with their nation significantly weakened, Potawatomi leaders agreed to sell the entirety of their land in Michigan to officials in the American government for a $5,000 annuity. Five years later they were forced to leave the region entirely. A handful of Potawatomi remained on small reservations in southern Michigan and an estimated two thousand individuals fled to Canada, but the group was by then functionally extirpated from the state (Nichols, 2021).

The situation further deteriorated for the Potawatomi and other Native Nations during the Jacksonian administration, when "Indian removal" was a top priority of the American government. After the War of 1812 western expansion was seen as the only true way to provide security to the young United States of America from the west. In 1830 President

Andrew Jackson signed the Indian Removal Act, and Indigenous Peoples from across the Eastern half of the country were pressured to relocate to reservations west of the Mississippi River (Nichols, 2021). This resulted in the large-scale expulsion of Indigenous Peoples from their ancestral lands, which severed them not just from their homes but from their previous way of life.

These crimes do not exist in a historical vacuum and their legacy continues to have an impact to this day. The Potawatomi Nation and others survived, but not without losing their rights to their homeland and sustaining losses to their historical and cultural identity. Their removal has had a lasting legacy on the land they once occupied, as widespread changes in land use adopted by American settlers during that period has resulted in the loss of natural communities, which has negatively impacted biodiversity in the landscape. White settlers removed the Potawatomi with violent and coercive tactics, and this is a permanent stain on the legacy of American expansion during this period.

Colonization by European settlers

The first settler of Township of Convis was Sanford Chaffee who came into the area in the spring of 1835. After Chaffee, there was such a rapid arrival of settlers that it warranted the organization of the township in 1837.

Following European settlement, much of this land was used for agriculture. Homesteaders were drawn to the landscape by its rich soils and rolling, open savanna. The first settlers of the area were farmers who cleared the lands of what little timber there was and farmed the open space. The upland areas were valued for farming, and the wetland systems, if not forested, were typically hunted, and hayed for marsh hay. Some of the farmers that settled into the township continued the practice of annually burning the marsh/wetland system and the uplands into the 1950s.

Specifically, the land that is now Bernard W. Baker Sanctuary was consolidated with land grant patents by Ephraim Follette, Horatio Hickok, and Leach S. Loomis in 1836. However, much of Big Marsh Lake and the surrounding areas lie on what was known as Swamp and Overflowed Lands. The heart of the marsh remained unsold until the state of Michigan assumed ownership via the Swamp Land Act of 1850. Under this act, states were encouraged to drain and reclaim swamp and overflowed lands mainly for agricultural development as the soils were fertile and proved to be the most productive farmlands. Fortunately, the unsold portion of Big Marsh Lake was not drained and cultivated; rather it was finally sold to Isaac C. Crary in 1868.

In 1882, Charles H. Freeman began acquiring portions of Big Marsh Lake. He eventually owned much of the marsh, and it was known by the locals as “Freeman Marsh”. Fourteen tax deeds were issued from 1857 to 1882 to the various owners of different portions of the marsh before Freeman acquired the majority ownership, indicating a certain amount of indifference and neglect. While this attitude may have caused some degradation to the marsh, it also may have protected it from development, allowing Sandhill Cranes to find sanctuary.

Beginning in 1893, William C. Yawkey began acquiring the land now owned by the Michigan Audubon Society. The land stayed in the Yawkey family until 1941 with the title being passed between six members of the family. In 1940, Bernard W. Baker and colleague Lawrence H. Walkinshaw first visited the property in search of the sandhill crane. In this visit, they noted the property contained the better part of “Big Marsh” where sandhill cranes nested annually in summer months, in turn, they obtained the property owners name and address from the local Township Treasurer. In the following months, Baker and Walkinshaw were appointed to a Crane Sanctuary Committee, their main task being to find a future Sandhill Crane refuge in southern Michigan. After exploring crane marshes throughout Calhoun and Jackson counties, they wrote to the Yawkey family in New York asking what their intentions might be with their property in Calhoun County. After a number of exchanges, the Yawkey family offered the property to Bernard W. Baker at a very reasonable rate to which he accepted and, in turn, presented it to the Michigan Audubon Society on October 1st, 1941.

Impact of Colonization on The Landscape

By the mid-nineteenth century nearly all of the historic oak savanna in the region, which occupied high-value, arable land, had been cleared and converted to agriculture. Additionally, areas containing saturated soil were drained so that they could also be put into production. Farmers grew row crops and grazed livestock on some upland sites. They also continued applying annual burn treatments to their fields as well as Big Marsh Lake. When Baker Sanctuary was established over 70 years ago nearly all management activities ceased, and the land was left undisturbed. This allowed the old fields to succeed to dense thickets of exotic species such as european buckthorn (*Rhamnus cathartica)*, autumn olive (*Elaeagnus umbellata*),and amur honeysuckle (*Lonicera maackii*).

History of Michigan Audubon Society

Michigan Audubon was founded in 1904 and is Michigan’s oldest conservation organization. It was established as a land preservation organization and advocacy group for better bird conservation practices in our state. At the time, the primary focus of members of Michigan Audubon was to secure protective legislation for birds because the millinery industry was harming songbird populations. Through the devotion of its conservation-minded founders, Michigan Audubon was recognized nationally for advocacy and education efforts.

Michigan Audubon Society Today

Since its establishment, Michigan Audubon has faithfully adhered to its mission of connecting birds and people for the benefit of both through conservation, education, and research. As an independent, member-based nonprofit organization, they conduct programming, advocacy, outreach, and stewardship on behalf of birds and the ecosystems they rely upon. There are 32 active local chapters which manage sanctuaries that are utilized for community outreach, education, and migratory bird counts. Much of this work is completed by a community of citizen scientists who volunteer to conduct data collection. Additionally, chapters educate thousands of bird watchers every year through a series of educational programs, events, and annual conferences.

Currently, the organization maintains 18 sanctuary properties throughout the state that together constitute nearly 4,000 acres of protected bird habitat. Bernard W. Baker Sanctuary is their second-largest property, and contains 980 acres of managed prairie, forest, and wetland. To protect as many species as possible, Michigan Audubon oversees the preservation of a variety of habitats in their sanctuaries, including rivers, lakes, marshes, bogs, fens, grasslands, hardwoods, and northern conifer forests. Each of their properties play a critical role in protecting Michigan native plants and animals, including both endangered and threatened species.

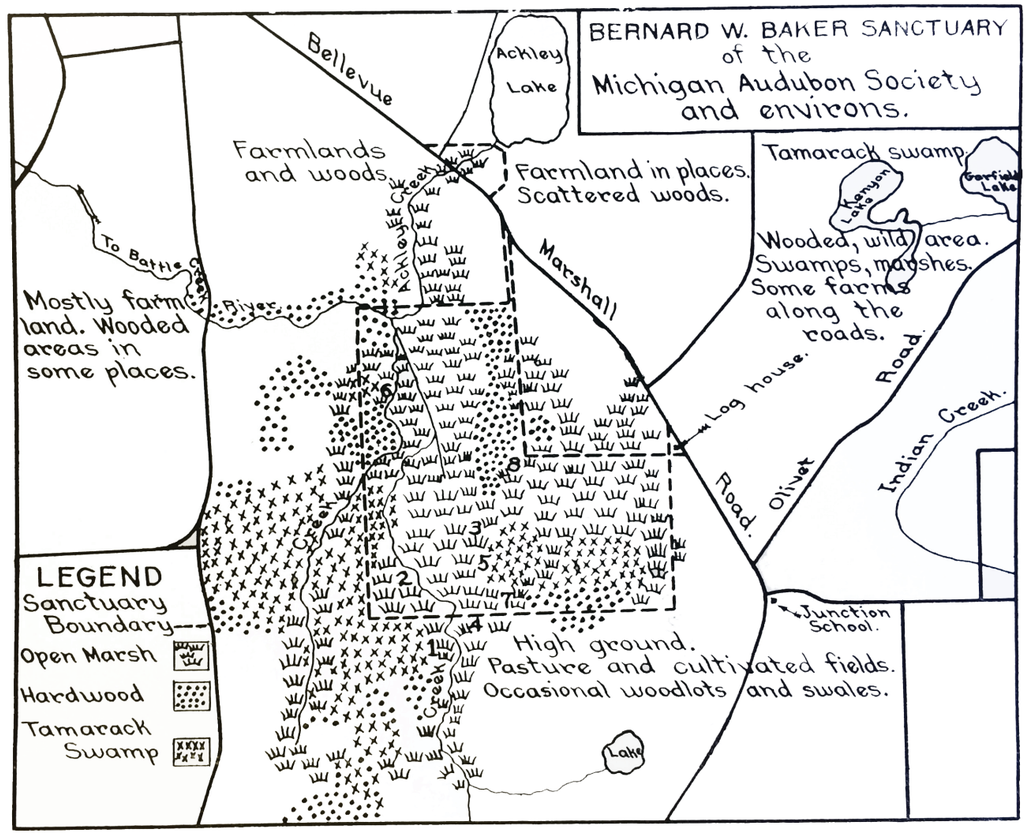


FIGURE 1.1 MAP OF THE NEW SANCTUARY AREA IN CONVIS TWP., CALHOUN COUNTY, MICHIGAN. DRAWN BY EDWARD M. BRIGHAM, JR., AND HIS ASSOCIATES FROM AN AERIAL PHOTOGRAPH OF THE AREA. 1941.

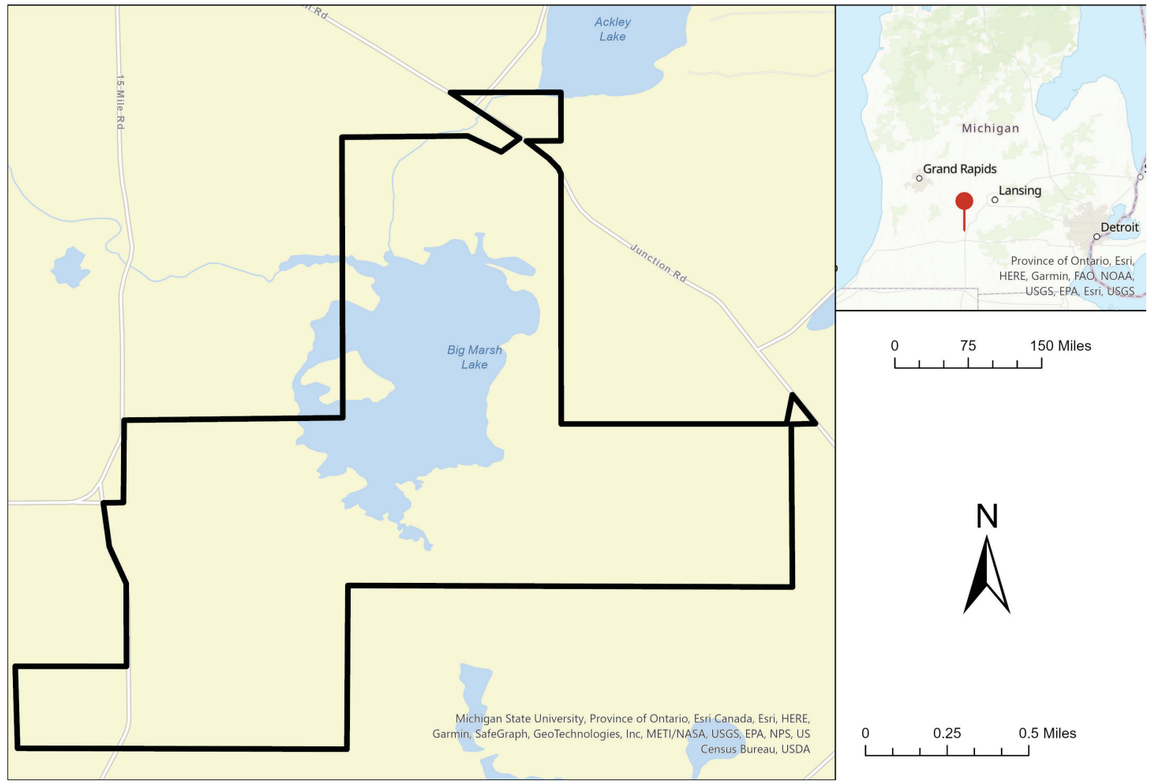


FIGURE 1.2 CURRENT PROPERTY EXTENT OF BERNARD W. BAKER BIRD SANCTUARY

Fossil Fuel Exploration

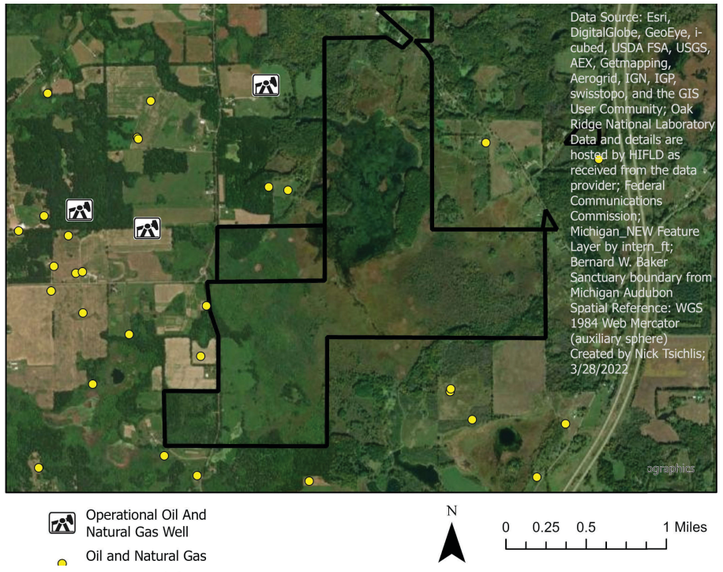


FIGURE 1.3 PROXIMITY OF OIL AND NATURAL GAS WELLS TO BAKER SANCTUARY

Michigan is rich in fossil fuel reserves, and more than 50,000 wells have been drilled in the state since 1925. The lower half of Michigan contains extensive sedimentary deposits that formed as organic matter compacted on an ancient seabed, and this rock contains porous pockets filled with oil and natural gas. It is for this reason that much of the extraction in the state has occurred in the southern half of the Lower Peninsula (Westbrook, 2005). The availability of these resources and their revenue potential has for decades inspired passionate debate amongst Michiganders. Politicians, land managers, and private entities have been forced to weigh ethical concerns regarding the impact of drilling on land, water, and wildlife against the short-term infusions of capital that could be used to stabilize budgets or to finance other ventures.

One of these disagreements occurred in 1975, when Mobil Oil propositioned Michigan Audubon to drill five exploratory wells within the boundaries of Baker Sanctuary. Michigan Audubon was running an annual $14,000 deficit and the offer, which guaranteed $100,000 per well, would have alleviated those concerns, and funded additional priorities. Opponents of drilling were adamant that any disturbance of the nesting cranes was too high of a price to pay, no matter how large the monetary reward was. When a proposal to ban all future fossil fuel extraction at Michigan Audubon properties came up for a vote in 1976 over 50% of the society's members voted for it, but this was less than the two thirds threshold required for it to be added to the organization's bylaws. Mobil Oil then withdrew its original offer (Anderson & Leal, 1991).

This was, however, not the end of the debate. Shortly after Mobil Oil rescinded its offer, Michigan Petroleum was granted access to Baker Sanctuary to explore and drill for oil. Permission was granted with stipulations that were intended to protect the habitat as a refuge for sandhill cranes. Michigan Petroleum was required to drill wells on a slant from a pad at least half a mile from Big Marsh Lake with equipment that was encased in high-efficiency mufflers to reduce sound pollution, and all fluids were contained on site. They were also required to finance studies of potential environmental problems that could result from their presence in the sanctuary. Michigan Audubon received royalties of $1 million from these activities, which concluded shortly thereafter (Anderson & Leal, 1991). There has been no fossil fuel exploration or extraction since that time.

1.5 Property Description

Context Within Regional Landscape

Bird Conservation Region

Designing resilient landscapes requires the synthesis of data from multiple sources. Specifically, it is important to understand how ecosystems are affected by anthropogenic activity, how these changes integrate within regional and national trends, and what the effects of these changes are on local populations native flora and fauna. The mission of the Michigan Audubon is intimately tied to the preservation of avian communities in North America, so they utilize a classification system consisting of Bird Conservation Regions (BCRs) in their literature, which are geographic areas that contain certain ecosystems and their associated avian species, and thus have similar management concerns. These regions have been designed and updated by the North American Bird Conservation Initiative (NABCI), an assemblage of scientific and academic professionals from the United States, Canada, and Mexico (North American Bird Conservation Initiative, 2000). They endeavor to stabilize the populations of native bird species by facilitating collaborations between nation states, governmental agencies, local governments, and engaged citizens on initiatives relevant to the restoration and conservation of ecosystems.

The NABCI aims to increase the effectiveness of conservation initiatives by encouraging the formation of biologically driven bird conservation partnerships, integrating those unions within a larger conservation community, and identifying financial resources available to those organizations (Wildlife Service. North American Waterfowl, & Wetlands Office, 2000). These goals are facilitated by the BCR framework, as nested ecoregions can be partitioned into smaller units for localized ecological planning or aggregated into larger regions to coordinate conservation throughout the range of a particular species. Additionally, because they are not affected by superficial state or national boundaries, it is possible to avoid certain bureaucratic entanglements and to focus on conservation (Bird Studies Canada and NABCI, 2014).

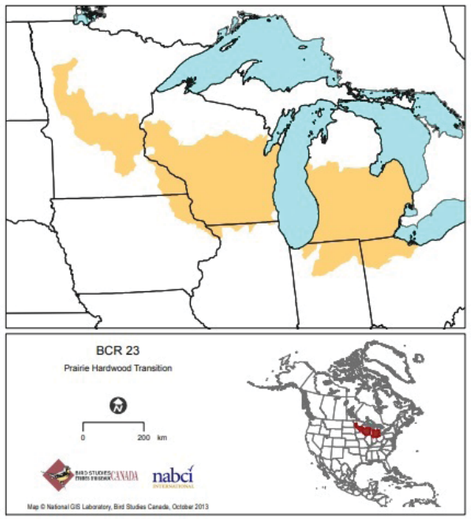


FIGURE 1.4 THE PRAIRIE-HARDWOOD TRANSITION ECOREGION COVERS A SIGNIFICANT PORTION OF THE UPPER MIDWEST (BIRD STUDIES CANADA AND NAVCI,

Baker Sanctuary is located within the Prairie-Transitional Forest Biome and is classified as Bird Conservation Region 23 – Prairie Hardwood Transition. Prior to European settlement, this BCR region was dominated by prairies to the west and south and oak forest to the north and east, with oak savanna inhabiting the transitional areas in-between. Past glacial activity is responsible for the numerous wetlands and shallow lakes that characterize this region, which provide crucial breeding grounds for native waterfowl (North American Bird Conservation Initiative, 2000).

This land has been heavily impacted by anthropogenic activity, and many forested upland patches have been reduced or eliminated. In Michigan, 16% of BCR 23 is currently classified as urban and 34% is in row crop production, a 50% reduction of the original suitable habitat for migratory species that traditionally depended on this environment for food and breeding sites (Pierce et al., 2014). The widespread loss of forest to urban cover and conventional agriculture as well as the fragmentation of remaining woodlands is an existential issue which threatens the stability of the populations of species that require large, undisturbed patches of high-quality habitat to reproduce successfully. Species that rely on specific cover types present in BCR 23 for breeding habitat include the cerulean warbler, wood thrush, eastern meadowlark, and others (U.S. Fish and Wildlife Service, 2021).

Birds are known to be excellent indicators of ecosystem health and stability due to their large-scale migrations that are far easier to track and record than the movements of other fauna. Since the 1970s, when large-scale monitoring became commonplace, there have been major documented decreases in bird populations. Studies reveal a net loss in total abundance of about 2.9 billion birds in North America, a 29% reduction from 50 years prior (Rosenberg et al., 2019). Currently, there are 99 threatened or endangered species in the United States alone, with 200 more nearing this classification.

Grassland species have experienced the largest proportional population loss compared with birds in forest and wetland biomes. Since 1970, grasslands in North America have lost an estimated 700 million breeding individuals from the populations of 31 species (Soulliere et al., 2020; Rosenberg et al., 2019). The causes of this are multifactorial and include widespread habitat loss, the expansion of conventional agricultural practices, and the disruption of migratory and breeding cycles due to climate change and other anthropogenic factors. The introduction of domesticated cats has also negatively impacted bird populations, and it is estimated that they kill between 1.3 and 4 billion

birds per year (Loss et al, 2013). The presence of feral cats and other predators can also negatively affect avian populations in non-lethal ways, as birds alter their behavior to mediate risk, and this can result in less foraging and lower fecundity (Bonnington et al., 2013). This is evident in the Prairie Hardwood Transition in Michigan, which 30 avian species of conservation concern utilize for either breeding grounds, a stopover, or as permanent residence (U.S. Fish and Wildlife Service, 2021). Baker Sanctuary, which is located within BCR 23, represents one of the few remaining undisturbed areas in southwestern Michigan that historically provided habitat for these species. Because of this, the site has significant potential to be a future hub of biodiversity in the region and a haven for a vibrant community of threatened species.

Climate Change

There is broad scientific consensus that the rapid, ongoing changes in global climate patterns are due to the anthropogenic release of carbon dioxide and other greenhouse gasses into the atmosphere, and that this will result in a global temperature increase between 1.5°C and 4.5°C within the next century (Albritton & Dokken, 2001). In 2019, global levels of carbon dioxide (CO_2) reached 410ppm, the highest of any period in the last two million years. Global methane (CH_4) and nitrous oxide (N_2O) levels are the highest they have been in the last 800,000 years. Because of this, global temperature has risen more since 1970 than any other 50-year period over the last 2,000 years (IPCC, 2021).

Warmer temperatures are expected to drive changes in the distribution of natural vegetation, and climate model simulations have predicted that there could be equivalent change in the next 200 to 500 years as there was in the previous 7,000 to 10,000 years. In the upper Midwest, the warmer temperatures will facilitate the encroachment of oaks into ecosystems that are now dominated by pine and spruce. Warmer temperatures will lead to drier sites with nutrient poor soils that will experience a higher frequency of fire, all of which will create a feedback loop that prevents succession and favors oak recruitment (Abrams, 1992). It is possible that along with increasing their frequency in the natural landscapes of the upper Midwest, oaks and other hardwoods will increase their range 500km to the north (Overpeck et al., 1991).

In addition to rising seasonal temperatures, Michigan is also predicted to experience a 5-10% increase in average annual precipitation (Kim et al., 2016). This will increase the frequency and severity of weather events and negatively impact the migration and reproductive cycles of numerous avian species that require stable conditions for food or breeding habitat. It will also disrupt the timing of the life cycles of many species which are interdependent, and together contribute to the resilience of their ecosystems (U.S. Environmental Protection Agency, 2016).

Another noticeable effect of rising global temperatures is a shift in the spring and fall migrations of many North American bird species. Warmer winters have catalyzed changes in the phenology of primary producers, which can cause trophic mismatches for many organisms that are dependent on multiple, specifically timed nutrient pulses throughout the year. In response, the timing of spring and fall migrations of many species has advanced, as they arrive early to access vital food sources and delay their return south due to warmer weather late in the season (Horton et al., 2020). For instance, migratory birds such as the sandhill crane are arriving earlier to the Midwest than 40 years ago (U.S. Environmental Protection Agency, 2016).

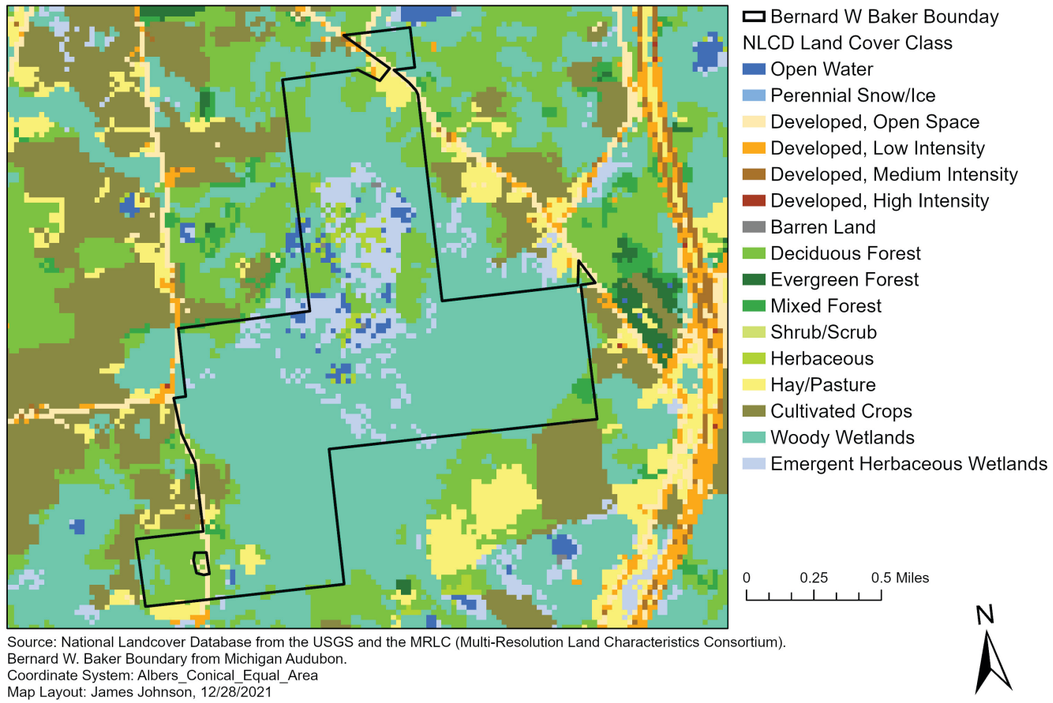
This change in timing can disrupt complex relationships in ecosystems when species react to warming at different rates. A migratory species may show up too early for its main food source to have sufficiently fruited and may not be able to find enough to eat. Because shifts in the phenology of flowering plants affects the timing of their nutrient pulses, the bulk of non-migratory fauna are affected as well. The widespread consequences of these changes on the interactions of flora and fauna have yet to be clarified, however it is certain that warming trends in global temperature are responsible for an increase in the frequency and severity of climate extremes, and that this will negatively impact ecosystem function (Butt et al., 2015).

Climate change caused by anthropogenic activity may also be responsible for recent evolutions in the morphology of many migrating bird species. It is understood that phenological changes of primary producers directly affect the seasonal nutritional and habitat needs of migrating species, and it has been observed that that many of these species have experienced body size decline over the past several decades. Therefore, it has been suggested that changes in body size are the result of the increase in global temperature. However, recent studies have determined that phenological shifts are not directly related to shifts in the morphology of birds. These findings produce more questions than answers, as widespread phenological and morphological changes continue to occur, and more research is necessary to determine what other factors are involved in the regulation of these traits (Zimova et al., 2021).

Conditions at Baker Sanctuary

Landcover

The National Land Cover Database (NLCD) shows, at a 30-meter spatial resolution, the surrounding land cover. The most abundant land cover around the sanctuary appears to be cultivated crops and woody wetlands. Inside the sanctuary, woody wetlands dominate the land cover present.

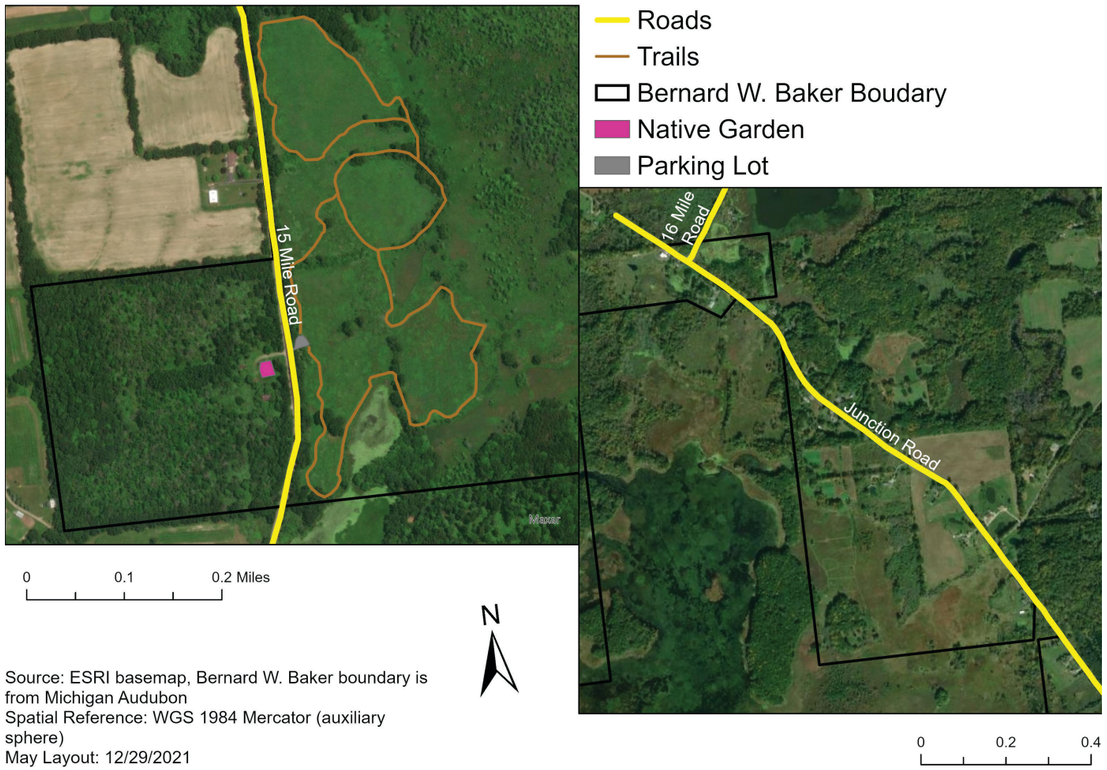


Source: National Landcover Database from the USGS and the MRLC (Multi-Resolution Land Characteristics Consortium).
Bernard W. Baker Boundary from Michigan Audubon.
Coordinate System: Albers_Conical_Equal_Area
Map Layout: James Johnson, 12/28/2021

Figure 1.5 NLCD land cover of and around Bernard W. Baker Sanctuary

Human Features/Impact

The human features/impacts present at the sanctuary are limited to the southwestern and northeastern corners of the property. In the northeastern corner, there are two roads, Junction Road and 16 Mile, which run up against the edge of the property. The southwestern corner of the property has the most human features. Here, the property includes a nearly two-mile trail system and a parking lot that is off 15 Mile Road. This road splits the sanctuary in two, where opposite the parking lot is a native show garden. This property still includes other buildings used for storage.

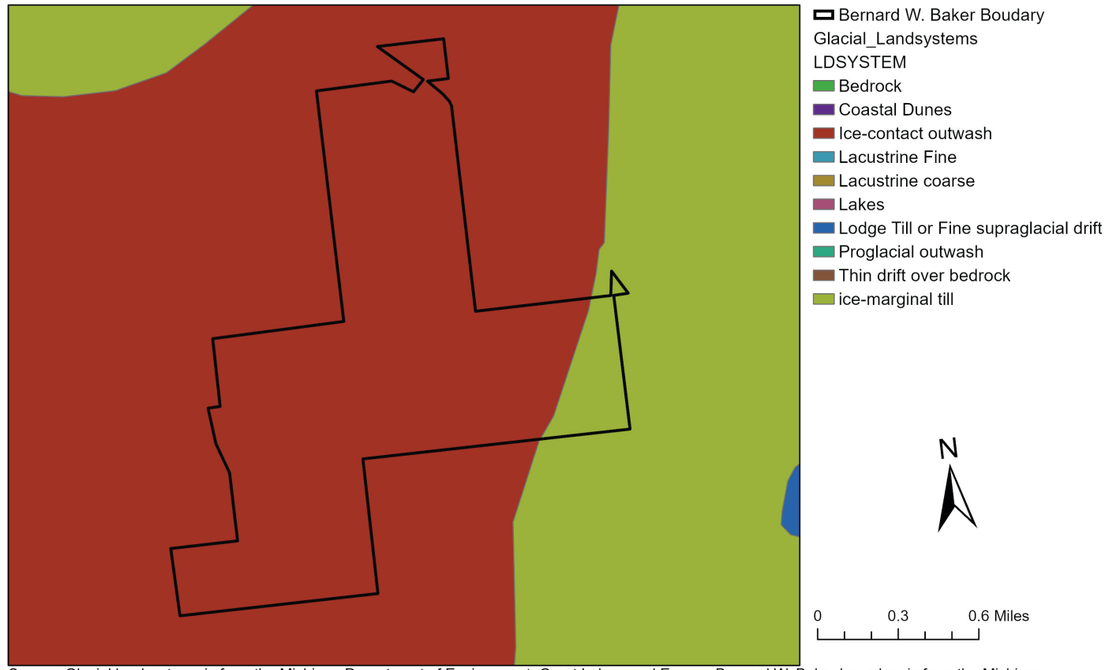


Source: ESRI basemap, Bernard W. Baker boundary is from Michigan Audubon
Spatial Reference: WGS 1984 Mercator (auxiliary sphere)
May Layout: 12/29/2021

Figure 1.6 Human Features and impacts

Geology

Bernard W. Baker sanctuary sits primarily on top of the Michigan formation. The eastern side of the sanctuary sits on the Bayport limestone and the Saginaw formation. The Michigan formation formed during the Mississippian period, the earlier part of the Carboniferous. This formation is composed of greenish gray and dark gray shale with beds of sandstone, limestone, dolostone, gypsum, and anhydrite mixed throughout (USGS, n.d., -b). The Bayport limestone is also from the Mississippian period. It is mostly made up of sandy yellow limestones, cross-bedded white sandstone, and some dolomite (USGS, n.d. -a). The Saginaw formation is dated to the Pennsylvanian period, the later part of the Carboniferous. This layer is made up of sandstone, shale, coal, and limestone that originated in water (USGS, n.d. -c).



Source: Glacial landsystems is from the Michigan Department of Environment, Great Lakes, and Energy. Bernard W. Baker boundary is from the Michigan Audubon.
Spatial Reference: WGS 1984
Map Layout: 12/29/2021

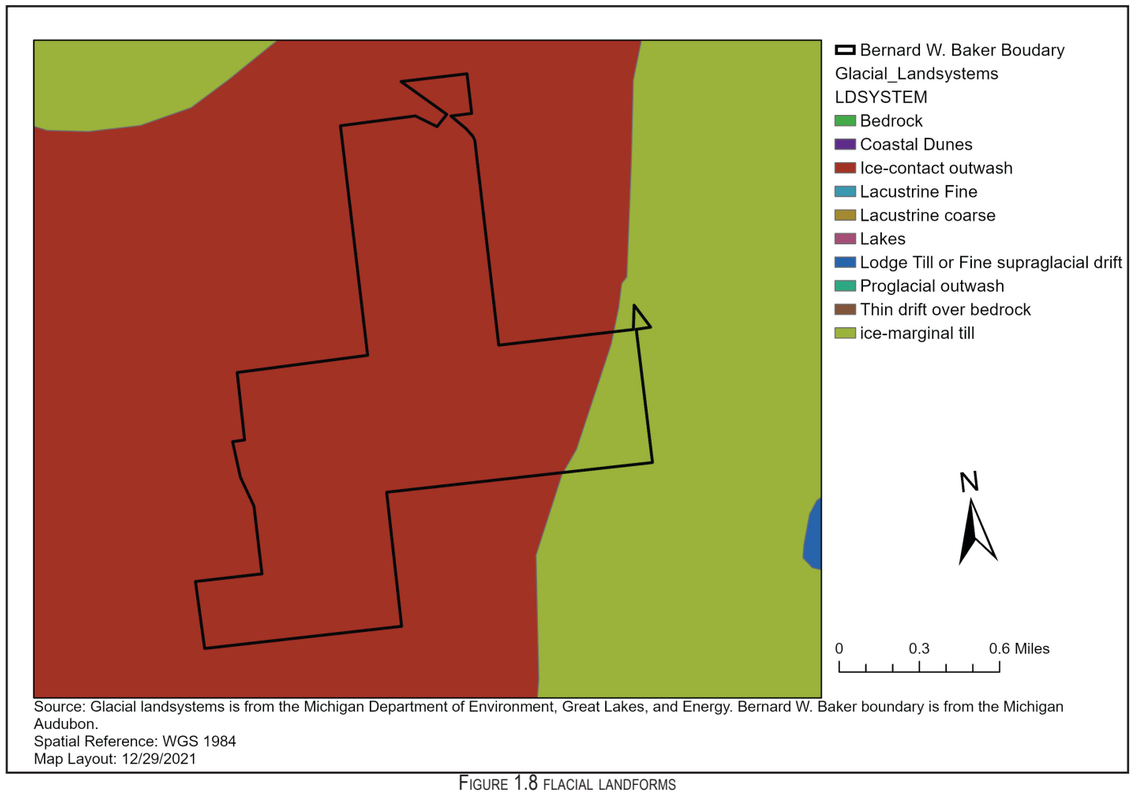
Figure 1.7 Geology

Bedrock geology of Bernard W. Baker sanctuary and surrounding area. The sanctuary is composed of the Michigan Formation, Bayport Limestone, and the Saginaw Formation.

Soils

The unique landscapes of the upper Midwest are the product of past glacial activity. Glacier ice covered the entirety of this region six times during the most recent ice age, and the parent material of the current soil was deposited during the most recent glacial maximum and subsequent oscillating advances and retreats of the Laurentide ice sheet between 15.5 and 10.0 ka. Glacial scour is responsible for the formation of the Great Lakes and other depressions, while other landscape features were created through processes of glacial retreat. The glacial outwash topography that encompasses the area of southeastern Michigan that contains Baker Sanctuary, punctuated by moraines as well as other ice contact features, is a product of the final glacial retreat that occurred 15.5 ka (Larson & Schaetzl, 2001).

Most of the soils at Baker Sanctuary are considered to be ice-contact outwash. On the eastside, a small part of the sanctuary is composed of ice-marginal till.



Source: Glacial landsystems is from the Michigan Department of Environment, Great Lakes, and Energy. Bernard W. Baker boundary is from the Michigan Audubon.
Spatial Reference: WGS 1984
Map Layout: 12/29/2021

Figure 1.8 flacial landforms

Glacial land systems of the Bernard W. Baker sanctuary and surrounding area. Ice-contact outwash comprises most of the sanctuary.

Current Climate

Data from the nearby Battle Creek Kellogg Airport suggests that Baker Sanctuary has experienced average annual precipitation of 33.15 inches per year from 1981-2010. Average annual precipitation is far lower in the winter months (4.99 inches) compared with spring (8.48 inches), summer (10.06 inches) and autumn (9.62 inches). The average yearly temperature during this time period was 48.2° F. The average winter temperature was 34° F, and the average summer temperature was 69.1° F. These temperatures place the sanctuary within USDA plant hardiness zone 5b (-15 to -10° F).

table 1.1.Annual and Seasonal Temperature and Precipitation averages for the Battle Creek Kellogg Airport, MI US USW00014815.

SEASON	PRECIP (IN)	MIN TMP (°F)	AVG TMP (°F)	MAX TMP (°F)
Annual	33.15	37.7	48.2	58.8
Winter	4.99	17.6	25.8	34
Summer	10.06	57.4	69.1	80.9
Spring	8.48	35.6	47.3	59
Autumn	9.62	39.9	50.3	60.8

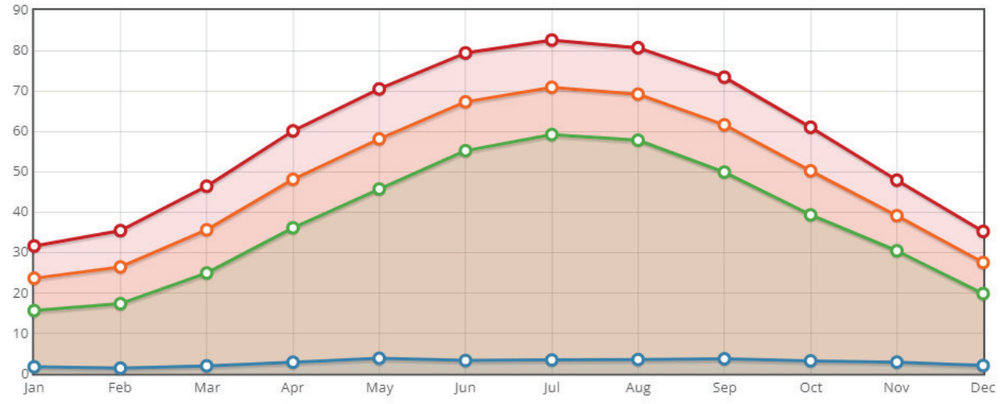
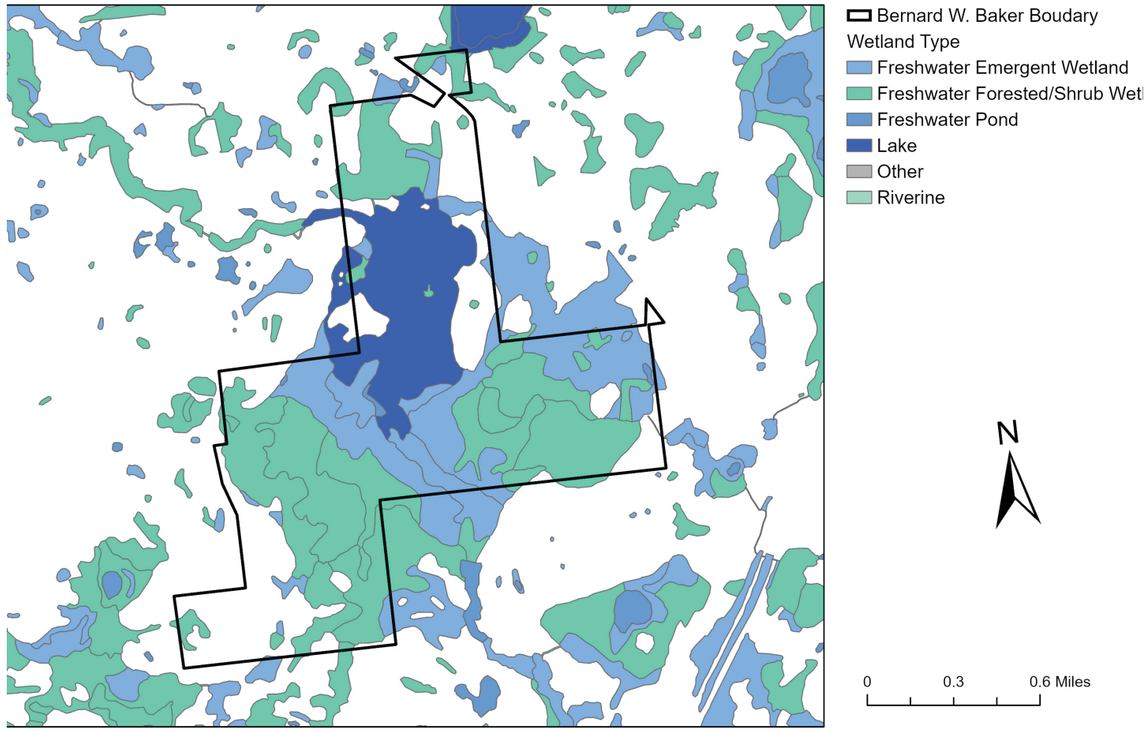


figure 1.9 Annual and Seasonal Temperature and Precipitation averages for the Battle Creek Kellogg Airport, MI US USW00014815. (National Centers for Environmental Information)

National Wetlands Inventory

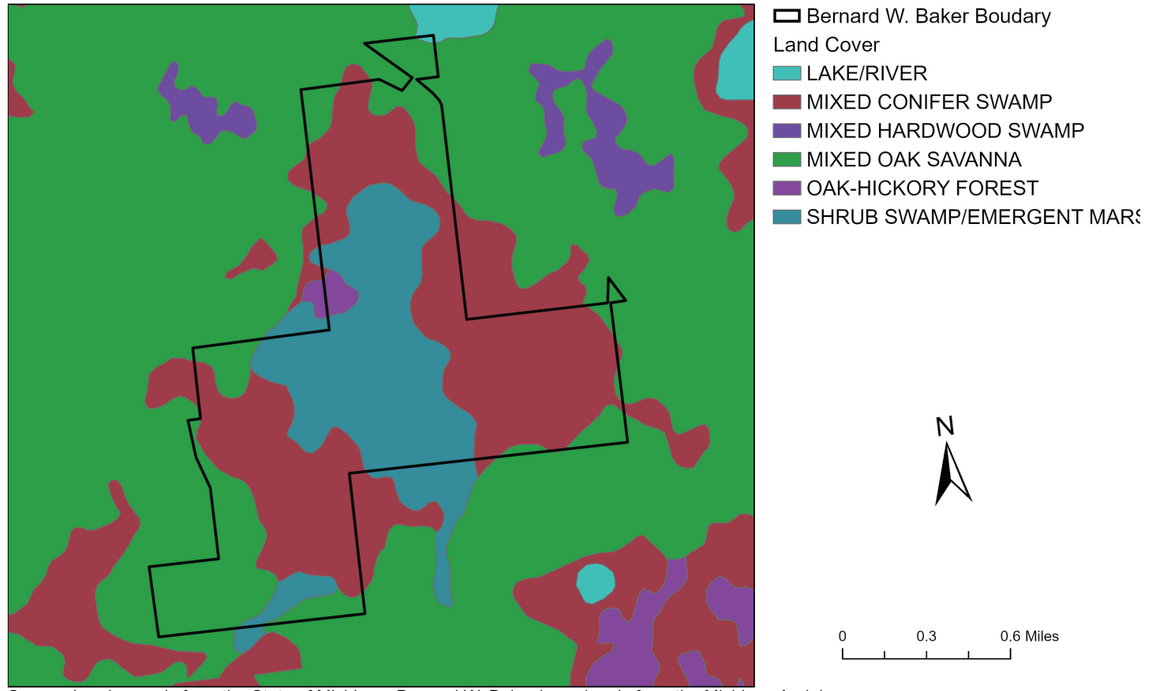
The latest wetlands inventory by the U.S. Fish and Wildlife service shows that most of the sanctuary is part of a wetland. Freshwater forested/shrub wetland and freshwater emergent wetland are the two kinds of wetland present.



ce: Wetland information from the National Wetlands Inventory by the U.S. Fish & Wildlife Service. Bernard W. Baker boundary from the Michigan Audubon.
al Reference: NAD_1983_Albers
Layout: 12/29/2021

FIGURE 1.10 WETLANDS OF BERNARD W. BAKER BIRD SANCTUARY

WETLANDS OF BERNARD W. BAKER SANCTUARY AND THE SURROUNDING AREA. THE WHITE SPACE INDICATES AREAS WHERE THERE IS NO WETLAND. THE SANCTUARY CONSISTS MOSTLY OF THREE TYPES OF WETLANDS.



Source: Land cover is from the State of Michigan. Bernard W. Baker boundary is from the Michigan Audubon
Spatial Reference: WGS 1984
Map Layout 12/29/2021

FIGURE 1.11 LAND COVER OF THE BERNARD W. BAKER SANCTUARY AREA CIRCA 1800.

Vegetation Circa 1800

The land that currently comprises Baker Sanctuary historically existed within a matrix of oak openings and wetlands that dominated the southeastern Michigan landscape throughout the postglacial period, beginning 15.5ka. The fire-adapted ecosystems that characterized this region developed on uneven glacial topography, and coarse-textured end moraine deposits functioned as sources of groundwater recharge for wetlands (Meyer et al., 2014). It has been estimated that between 11M and 13M hectares of oak openings existed in the Midwest prior to European settlement, however due to land use conversion for agriculture and other development only .02% remains today (Nuzzo, 1986).

The oak openings at Baker Sanctuary would have encircled the current boundaries of the preserve and given way to several palustrine natural communities in the interior lowlands. These were fire-dependent ecosystems, and fires occurred naturally and frequently here throughout the past 8,000 years, a period characterized by regional oak savanna dominance in southeastern Michigan (Winkler et al., 1986; Kost et al., 2007; Cohen, 2020). In addition, the Indigenous Peoples who occupied this land prior to European settlement actively managed annual fire treatments for millennia, which encouraged oak recruitment and contributed to open conditions in the landscape (Abrams & Nowacki, 2022; Wolf, 2004). Multiple investigations of the soils in the historical range of these oak dominated communities have revealed charcoal deposits, indicating that fire frequency was correlated with oak dominance (Szeicz & MacDonald, 1990; Winkler et al., 1986; Abrams, 1992). These fires would have periodically burned through the shrub swamp and emergent marsh wetland communities in the center of the sanctuary and reversed patterns of succession. Fires would also have allowed light to penetrate the conifer swamp, ensuring the recruitment of tamaracks and other shade-intolerant shrubs representative of that plant community.

Current Conditions

Baker Sanctuary is currently surrounded by a matrix of residential and agricultural properties (Calhoun County, 2021). The Kiwanis Club maintains another nature preserve to the north of the Isham Preserve. Big Marsh Farm, a 476-acre property located directly south of Baker Sanctuary, was also recently protected with a conservation easement in 2016 by the Southwest Michigan Land Conservancy (SWMLC staff with Larry Holcomb, 2017). Baker Sanctuary exists within a dynamic ecosystem that comprises several natural communities—habitats that contain groups of species that occur repeatedly together, interact with each other, and maintain ecological balance.

For the past three decades Michigan Audubon has endeavored to improve the quality of this landscape. Some old fields in areas of higher elevation have been restored to mesic prairie and dry-mesic southern forest, and now provide ecosystem services to support a diverse population of insects and other wildlife. These ecosystems are reminiscent of the oak savanna which historically dominated the upland areas of the site.

The palustrine group of natural communities that currently occupy other areas of the preserve include southern hardwood swamp, prairie fen, submergent marsh, emergent marsh, southern wet meadow, southern shrub-carr, and rich tamarack swamp. These wetlands function as a refuge and breeding ground for sandhill cranes. After nearing extinction in the early 1900's, populations of this species have rebounded consistently for 100 years, and currently there are approximately 90,000 that summer in the upper Midwest (Fox et al., 2019). Big Marsh Lake, the primary body of water in the Baker Sanctuary, has historically been a nesting location for sandhill cranes, and the Michigan Audubon Society intends to develop this location into a permanent, legally protected reserve for the migratory birds. These efforts will similarly improve habitat for other threatened animal species, such as the eastern massasauga rattlesnake, which prefers to seasonally migrate between open wetlands and upland vegetation with minimal canopy coverage (Bailey et al., 2012).

1.6 Natural Communities

When describing plant communities at a local scale the Michigan Audubon uses the Michigan Natural Features Inventory classification system described in A Field Guide to the Natural Communities of Michigan (Cohen et al., 2014).

The natural communities referenced in this document and their spatial proximity to one another are sourced from the management units detailed in Wildlife Conservation Plan for the Michigan Audubon Bernard W. Baker Sanctuary (Funke, 2013 p.63). Additional data was incorporated in 2015 with the inclusion of the natural communities of the Mabelle Isham Shagbark Preserve (Roake, 2016). The decision to continue to use these management units rather than to create a new map was influenced by the small amount of observable change to these natural community types over such a short time period. Aligning the management units with past management plans also preserves the ability of future land managers to connect past reports to this current one.

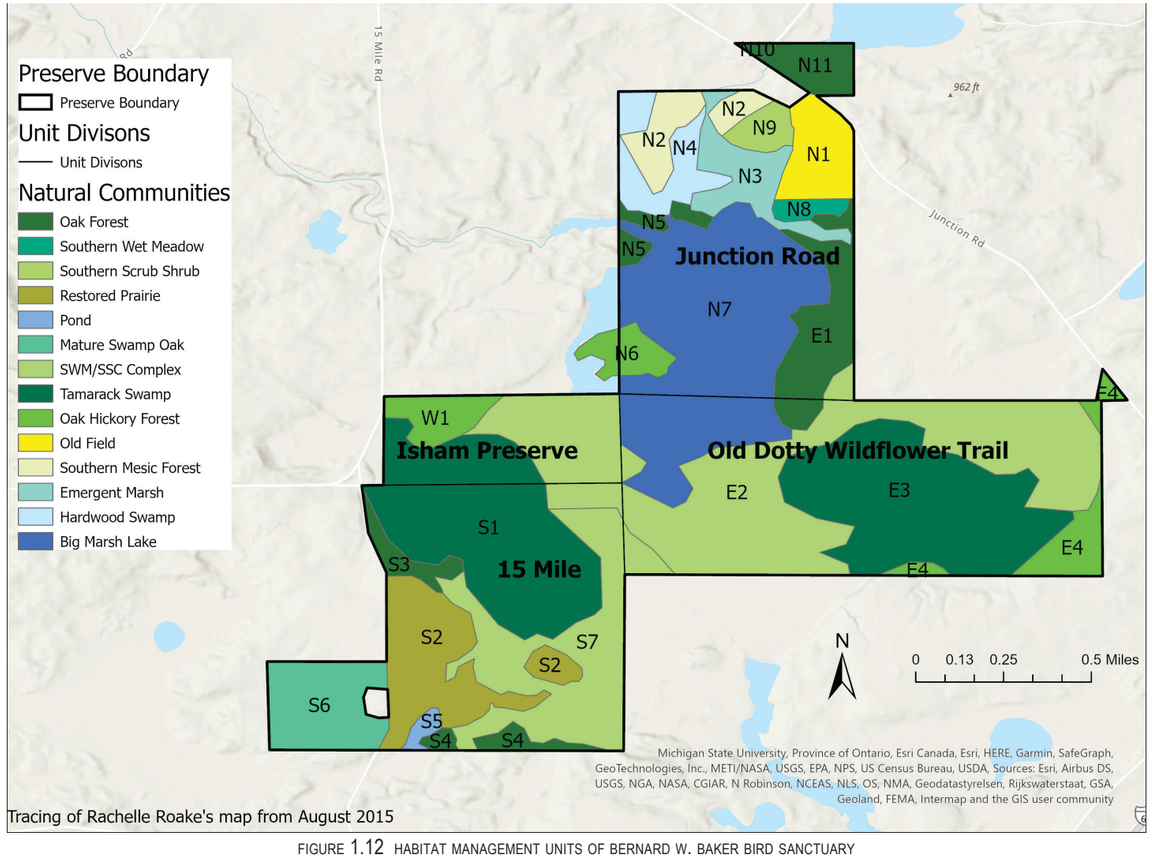


FIGURE 1.12 HABITAT MANAGEMENT UNITS OF BERNARD W. BAKER BIRD SANCTUARY

Dry- Mesic Southern Forest

In the sanctuary oak forest and oak-hickory forest are both considered to be dry-mesic southern forests. There are slight variations between the two but there is overlap in many species present and the management for both is similar. These forests are characterized by their semi-openness that is maintained through frequent fire. The canopy of the forest is typically dominated by white oak (*Quercus alba*) and black oak (*Quercus velutina*). Pignut (*Carya glabra*), shagbark (*C. ovata*), and bitternut (*C. cordiformis*) hickories are co-dominates in this system. Globally this ecosystem is considered secure but in Michigan it is considered vulnerable. A variety of invasive species threaten the native biodiversity of this ecosystem (Cohen et al. 2020).

Common bird species in this habitat include: white-breasted nuthatch (*Sitta carolinensis*), yellow-throated vireo (*Vireo flavifrons*), house wren (*Troglodytes aedon*), and a variety of woodpeckers such as red-headed woodpecker (*Melanerpes erythrocephalus*), red-bellied woodpecker (*Melanerpes carolinus*), hairy woodpecker (*Leuconotopicus villosus*), downy woodpecker (*Picoides pubescens*), and the pileated woodpecker (*Dryocopus pileatus*).

Rich Tamarack Swamp

The tamarack swamp is dominated by tamarack (*Larix laricina*) with other common trees such as black ash (*Fraxinus nigra*), yellow birch (*Betula alleghaniensis*), American elm (*Ulmus americana*), and red maple (*Acer rubrum*). poison sumac (*Toxicodendron vernix*), a shrub that causes rash, can also readily be found in this ecosystem. Globally this ecosystem is considered secure but considered vulnerable in Michigan. Invasive species and fluctuating hydrology are both concerns for this ecosystem (Cohen et al. 2020).

Common bird species in this habitat include: red-breasted nuthatch (*Sitta canadensis*), purple finch (*Haemorhous purpureus*), brown creeper (*Certhia americana*), winter wren (T*roglodytes hiemalis*) sharp-shinned hawk (*Accipiter striatus*), killdeer (*Charadrius vociferus*), American woodcock (*Scolopax minor*), black-billed cuckoo (*Coccyzus erythropthalmus*), eastern kingbird (*Tyrannus tyrannus*), eastern phoebe (*Sayornis phoebe*), alder flycatcher (*Empidonax alnorum*), northern flicker (*Colaptes auratus*), hairy woodpecker (*Leuconotopicus villosus*), and the downy woodpecker (*Picoides pubescens*).

Prairie Fen

Prairie fen is a wetland community dominated by sedges, grasses, and other graminoids that occurs on moderately alkaline organic soil and marl south of the climatic tension zone in southern Lower Michigan. Prairie fens occur where cold, calcareous, groundwater-fed springs reach the surface. The flow rate and volume of groundwater through a fen strongly influence vegetation patterning; thus, the community typically contains multiple, distinct zones of vegetation, some of which contain prairie grasses and forbs. This community is frequently found along small lakes and the upper reaches of streams and rivers. In this management unit, they are found surrounding Big Marsh Lake. Fires that would carry across oak savanna would often move into surrounding prairie fens, removing woody vegetation and maintaining the openness of this habitat. In addition, flooding as a result of bever dams were a common occurrence and converted prairie fens to pounds, marsh, or wet meadows.

Common bird species in this habitat include: red-winged blackbird (*Agelaius phoeniceus*), song sparrow (*Melospiza melodia*), yellow-bellied flycatcher (*Empidonax flaviventris*), Nashville warbler (*Leiothlypis ruficapilla*), American goldfinch (*Spinus tristis*), American woodcock (*Scolopax minor*), wilson's snipe (*Gallinago delicata*), alder flycatcher (*Empidonax alnorum*), and the willow flycatcher (*Empidonax traillii*).

Emergent Marsh

Emergent marshes are a wetland community that exists along lake and stream shores. This community is home to a large range of wetland species with water plantains (*Alisma spp.*), sedges (*Carex spp.*), rushes (*Eleocharis spp.* and *Schoenoplectus spp.*), and cattails (*Typha spp.*) being some of the more common ones. Globally this community is unranked and in Michigan it is considered secure. Threats to this community include invasive species, fluctuating water levels, and increased nutrient and sediment input (Cohen et al. 2020).

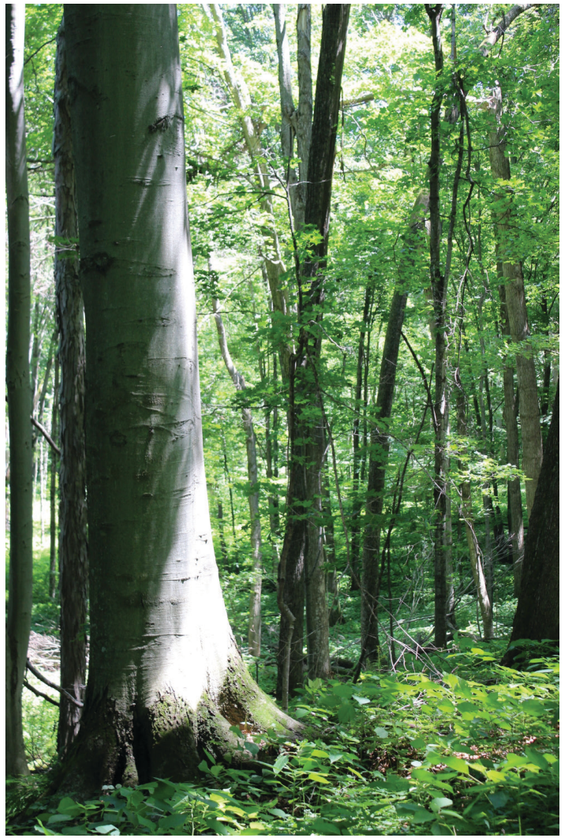
Common bird species in this habitat include: osprey (*Pandion haliaetus*), red-winged blackbird (*Agelaius phoeniceus*), belted kingfisher (*Megaceryle alcyon*), swamp sparrow (*Melospiza georgiana*), sandhill crane (*Grus canadensis*), great egret (*Ardea alba*), and various waterfowl such as the pied-billed grebe (*Podilymbus podiceps*), American wigeon (*Mareca americana*), ring-necked duck (*Aythya collaris*), mallard (*Anas platyrhynchos*), and the trumpeter swan (*Cygnus buccinator*).

Southern Mesic Forest

This plant community historically occurs adjacent to fire-dependent prairie, savanna, and oak forests, and would occasionally experience groundfire events. Patches are dominated by American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*). American elm (*Ulmus americana*) and ironwood (*Ostrya virginiana*) can commonly be found in the understory in this community.

Mesic southern forests are often located on end moraines and other land features with topographic complexity, which creates cooler and wetter microclimatic conditions at those sites. Because of this landscape heterogeneity, frequent fire and other large-scale disturbance events are not a major component in this ecosystem. Common disturbances include gap phase dynamics such as windthrow. Ice storms can play a key role in opening holes in the canopy that are often filled by slow growing shade-tolerant species (Cohen, 2004). Due to a lack of large-scale disturbance events, these forests develop a complex patchwork of plant communities of various ages filling gaps of assorted sizes, resulting in heterogeneity of the landscape. Threats to this natural community include encroachment by invasive species and overgrazing by deer. Globally this community ranges from imperiled to vulnerable and in Michigan it is vulnerable (Cohen et al. 2020).

Common bird species in this habitat include: cooper's hawk (*Accipiter cooperii*), red-shouldered hawk (*Buteo lineatus*), scarlet tanager (*Piranga olivacea*), black-throated green warbler (*Setophaga virens*), ovenbird (*Seiurus aurocapilla*), and the prothonotary warbler (*Protonotaria citrea*).



Southern Shrub-carr

A southern shrub-carr is a successional shrub community intermediate among a number of natural communities. Willows (*Salix spp.*), dogwoods (*Cornus spp.*), winterberry (*Ilex verticillata*), and bog birch (*Betula pumila*) are the common plant species found here. Due to the abundance of shrubs and late summer fruit, this community is important for many migrating and over wintering bird species. The main threat to this community is invasive species. In Michigan, this community has expanded in more recent times and is considered secure. This community can be a problem for communities surrounding it that are supposed to remain more open (Cohen et al. 2020).

Common bird species in this habitat include: common yellowthroat (*Geothlypis trichas*), American woodcock (*Scolopax minor*), ring-necked pheasant (*Phasianus colchicus*), willow flycatcher (*Empidonax traillii*), common grackle (*Quiscalus quiscula*), gray catbird (*Dumetella carolinensis*), cedar waxwing (*Bombycilla cedrorum*), yellow warbler (*Setophaga petechia*), song sparrow (*Melospiza melodia*), and swamp sparrow (*Melospiza georgiana*).

Big Marsh Lake

Big Marsh Lake covers the largest area in the Junction Unit. Lakes are usually classified based on their productivity. Based on the vegetative cover seen on the lake, it can be classified as either high productive eutrophic or mesotrophic. High productive eutrophic lakes are typically shallower and can support a large variety of plant growth. Mesotrophic lakes are usually deeper and are not as productive but still contain a large amount of vegetation (Michigan Clean Water Corps, 2008). The main threats to Big Marsh Lake include nutrient pollution from runoff and invasive species (Bhakta et al, 2017)

Common bird species in this habitat include: sandhill crane (*Grus canadensis*), great blue heron (*Ardea herodias*), bald eagle (*Haliaeetus leucocephalus*), great egret (*Ardea alba*), belted kingfisher (*Megaceryle alcyon*), American coot (*Fulica americana*), and various waterfowl such as the American black duck (*Anas rubripes*) and mallard (*Anas platyrhynchos*).

Old Field

Old fields are not a recognized natural community type. They typically exist on a successional spectrum between recently abandoned to mature woodland. Once a field has stopped being used for crop growth, annual grasses/forbs are the first to establish. Perennial growth/forbs generally follow, then shrubs, then young woodland (Sargent and Carter, 1999). In eastern North America, this progression is predictable and follows a generally repeatable pattern. Recent plant invasions can alter this pattern and the resulting community structure (Cramer et al. 2008).

Common bird species in this habitat include: wild turkey (*Meleagris gallopavo*), northern cardinal (*Cardinalis cardinalis*), red-winged blackbird (*Agelaius phoeniceus*), red-tailed hawk (*Buteo jamaicensis*), northern harrier (*Circus hudsonius*), American goldfinch (*Spinus tristis*), bobwhite (*Colinus virginianus*), eastern meadowlark (*Sturnella magna*), horned lark (*Eremophila alpestris*), bobolink (*Dolichonyx oryzivorus*), brown-headed cowbird (*Molothrus ater*), and the ruby-throated hummingbird (*Archilochus colubris*).

Restored Mesic Prairie

Most of the area surrounding the Meadow and Marshland Trail was once oak savannah before being homesteaded. Today, it is a restored mesic prairie and fallow farm fields. Years of fire suppression and inconsistent management methods have allowed many invasive species, especially old field species to proliferate. Mesic prairies are grasslands, typically characterized by dominating species of big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and indian grass (*Sorghastrum nutans*). They are locally ranked as critically imperiled. Fire plays a critical role in maintaining this plant community by suppressing woody vegetation and facilitating seed germination. Indigenous peoples were the main source of fire on the prairie and used it for a variety of purposes, such as making land more passable and improving hunting.

Common bird species in this habitat include: common yellowthroat (*Geothlypis trichas*), red-winged blackbird (*Agelaius phoeniceus*), bobolink (*Dolichonyx oryzivorus*), willow flycatcher (*Empidonax traillii*), eastern kingbird (*Tyrannus tyrannus*), field sparrow (S*pizella pusilla*), song sparrow (*Melospiza melodia*), yellow warbler (*Setophaga petechia*), and the American goldfinch (*Spinus tristis*).

Oak Savanna

Oak savannas are fire dependent savannas dominated by oaks, having 5-60% canopy, with or without a shrub layer. The scattered overstory is typically dominated by black oak (*Quercus velutina*) and white oak (*Q. alba*). The ground layer is mostly grasses and contains both grassland and forest species. They occur on well-drained sandy glacial outwash mostly on ridge tops, steep slopes, and flat sandplains. They are usually in bands surrounding prairie.

Fires characterized this habitat and typically occur during the spring, late summer, and fall. The now extinct passenger pigeon (*Ectopistes migratorius*) was likely a keystone species in oak ecosystems, roosting in oaks by the thousands. In addition, where large herbivores were abundant (like bison), grazing may have helped inhibit the succession of oak barrens to woodland or forest.

Common bird species in this habitat include: wild turkey (*Meleagris gallopavo*), mourning dove (*Zenaida macroura*), American woodcock (*Scolopax minor*), golden-winged warbler (*Vermivora chrysoptera*), blue jay (*Cyanocitta cristata*), black-capped chickadee (*Poecile atricapillus*), house wren (*Troglodytes aedon*), and a variety of woodpeckers such as the northern flicker (*Colaptes auratus*), red-bellied woodpecker (*Melanerpes carolinus*), red-headed woodpecker (*Melanerpes erythrocephalus*), hairy woodpecker (*Leuconotopicus villosus*), and the downy woodpecker (*Picoides pubescens*).

Southern Wet Meadow

Southern wet meadows are open, groundwater influenced wetlands. This ecosystem is dominated by tussock sedge (*Carex stricta*) which is responsible for the hummock and hollow structure of the community. Globally this community is secure but in Michigan it is considered vulnerable. Fluctuating water levels, invasive species, and uncontrolled woody plant growth are risks for this ecosystem (Cohen et al. 2020).

Common bird species in this habitat include: red-winged blackbird (*Agelaius phoeniceus*), swamp sparrow (*Melospiza georgiana*), American goldfinch (*Spinus tristis*), song sparrow (*Melospiza melodia*), and the eastern bluebird (*Sialia sialis*).

CHAPTER 2: MANAGEMENT GOALS

2.1 Conservation Values and Threats to these values

Migratory Patterns: Sandhill Crane

Baker Sanctuary is a breeding, migratory, and nesting site for Sandhill Cranes (*Antigone canadensis*). The sanctuary, specifically Big Marsh Lake, is the host site for Michigan's largest gathering of sandhill cranes each fall season. Accordingly, this site has become a popular viewing area to observe thousands of cranes during their migration. Cranes have become accustomed to people viewing them at a distance and therefore have adjusted their roost sites. However, people remain their biggest threat; namely people in unauthorized locations, discharging of firearms, and poaching.

Other Migratory Birds and Year-Round Residents

In addition to the Sandhill Crane, Baker Sanctuary is a major migratory stopover for numerous other migrating birds such as various waterfowl and diverse warblers. Further, the preserve is a year-round home to many bird species such as the northern cardinal (*Cardinalis cardinalis*), black-capped chickadee (*Poecile atricapillus*), white-breasted nuthatch (*Sitta carolinensis*), several woodpecker species, northern harrier (*Circus hudsonius*), and the state threatened trumpeter swan (*Cygnus buccinator*). The diverse habitat types required by these different bird species indicates the need to protect and maintain natural habitats. The main threat to this conservation value is changes in habitat over time, especially succession of fire-suppressed habitats that lead to lower biodiversity.

Natural Habitats

The preserve is home to many other wildlife as well such as the state threatened blanchard's cricket frog (*Acris blanchardi*) and blanding's turtle (*Emydoidea blandingii*), and the federally threatened eastern massasauga rattlesnake (*Sistrurus catenatus*). It is crucial to preserve and maintain the various habitat types within the Baker Sanctuary, not only for 200+ bird species that have been recorded here but for all the species that rely on them. Threats to these natural habitats include changes in habitat over time and loss of biodiversity. This can be caused by human activity and pervasive non-native plant species such as autumn olive (*Elaeagnus umbellata*). It will be crucial to preserve and restore the native flora of the area in order to support the bird, pollinator, and the other wildlife populations that rely on the Baker Sanctuary for food and refuge.

See section 3.2.2 for the flora found at Baker Sanctuary that are of conservation concern.
See section 2.7 for a complete list of the bird species found at Baker Sanctuary.
See section 3.2.1 for the bird species found at Baker Sanctuary that are of conservation concern Natural Habitats.

2.2 SWOT Analysis

The purpose of performing a SWOT analysis is to create a unified overview of the current state of an organization. This is a valuable exercise for strategic and operational planning, marketing, and other tasks related to the future of an enterprise. To plan for a productive future, it is important to assess the current state of the organization without bias and to identify both positive and negative trends that could affect future prospects for growth.

The four components of this acronym are strengths, weaknesses, opportunities, and threats. Strengths are intended to be built upon, weaknesses are to be addressed, opportunities are to be invested in, and threats are to be monitored. The strengths and weaknesses categories are meant to be written from an internal perspective. These are things which can be directly impacted by employees of the organization. Conversely, opportunities and threats are intended to be written from an external perspective and are items that can be influenced but cannot be directly impacted (Leigh, 2009).

Strengths

- Large, contiguous land area surrounded primarily by rural residential zoning.
- Reasonable degree of communication with landowners adjacent to property.
- Attitudes of nearby community members are complementary to those of Michigan Audubon; they recognize the value in preserving and improving the integrity of the sanctuary.
- The primary water body, Big Marsh Lake, remains undisturbed and protected.
- High Avian Species Diversity.
- Reasonably High FQI Scores.
- Developed trails attract visitors and are accessible to those with limited mobility.
- There exists a small network of dedicated volunteers.
- The sanctuary is reasonably isolated yet located near several population centers.
- Partnerships with the University of Michigan and other educational institutions will continue to contribute to positive future outcomes.
- The annual migration and nesting of sandhill cranes in Big Marsh Lake endows the sanctuary with a visible, charismatic species that can generate interest and potential funding opportunities.
- Significant potential of the sanctuary to provide habitat for other state and federally listed floral and faunal species.
- Michigan Audubon is a well-known and respected organization.

WEAKNESSESS

- Limited communication and coordination with the Kiwanis Club, which owns a section of Big Marsh Lake.
- Community engagement with local schools, youth groups, and other organizations is an untapped resource.
- Multiple projects and priorities but limited funding.
- Intermittent past management has created a situation where previous progress is being lost.
- Defined restoration plans for multiple areas within the preserve would help future managers carry the restoration initiatives forward.
- Encroachment by invasive woody species into partially restored habitats inhibits the establishment of native species.
- Lack of sufficient parking facilities and other infrastructure necessary to accommodate tours and school trips.
- Current signage is insufficient with many items in need of repair or replacement.
- Bird blinds are dilapidated, and some trails have overgrown due to neglect.
- Current high deer population is negatively impacting oak recruitment and the diversity of native herbaceous vegetation.
- No on-site accommodation for a property manager to oversee restoration progress and be a security presence on the land.

Threats

- Poaching, trespassing, and larceny of trees continues to be a major ongoing issue.
- The lack of an endowment makes management challenging.
- Persistent transmission of pathogens from foot traffic can negatively affect wildlife in the preserve.
- The deer population is inherently unstable and prone to large fluctuations in mortality.
- Encroachment of exotic woody species imperils the partially restored oak savanna.
- There are no receptacles for refuse in the sanctuary.
- The sanctuary exists as an island surrounded by a heavily anthropogenically-altered landscape.
- Edge effects are apparent and non-native species are prevalent.
- There is persistent noise pollution from large vehicles on 15 Mile Rd. to the West and on Interstate 69 to the East.
- Light pollution from a nearby landfill may affect avian migratory patterns and other communications.
- Road salt contamination is a possible issue for small bodies of water near the edges of the preserve.
- Climate change can and will alter annual temperature and precipitation regimes.
- Could potentially decrease habitat and affect migratory patterns of threatened species.
- Could favor recruitment of non-native woody and herbaceous flora.
- Court of public opinion can be fickle; may be influenced by unrelated issues and misinformation

OPPORTUNITIES

- Several habitat restoration projects could be easily initiated.
- The physical characteristics of the landscape are well understood by Michigan Audubon.
- Many potential opportunities to work with students from primary schools to the graduate level.
    - o Twenty colleges are located within fifty miles of the sanctuary
    - o There are many local high schools where partnerships with students can be cultivated
- Potential to initiate land conservation programs with local landowners and enhance the impact of the preserve.
- Increasing national focus on climate goals may present new avenues for funding.

2.3 Public Benefit

Baker Sanctuary holds a variety of specific programming coordinated by Audubon staff, such as CraneFest, monthly hikes, and outreach programs. The almost two mile long Meadow and Marshland Trail is off 15 Mile Road between T Drive North and Q Drive North. It is mowed in the summer and offers season-round recreation in hiking, cross-country skiing, and wildlife viewing.

The native plant display garden off 15 Mile Road across the parking lot for the Meadow and Marshland Trails offers opportunities for visitors to learn about native plant species that both support birds and look beautiful in home gardens. A pathway and seating area through the garden allow visitors to rest and restore.

The sanctuary is committed to expanding education and outreach components to reach and serve communities historically underrepresented in outdoor spaces.

2.4 Overall Goals and Objectives for Sanctuary

GOAL 1: BAKER SANCTUARY MAINTAINS AND ENHANCES NATURAL COMMUNITIES THROUGH ADAPTIVE MANAGEMENT STRATEGIES

Objective 1: Remove invasives

Objective 2: Remove non-conforming trees (Black Walnut within 15 Mile Mgmt. Unit)

Objective 3: Replace natural plant components

Monitoring: Frequency and abundence of invasives, non-conforming, natural plant components; FQA; FQI: Point Counts, Censuses

Outcome: Abundance and frequency of invasive species within management units decreases

Outcome: FQA scores increase; FQI Score increases

Outcome: Recognition of restoration efforts

Outcome: Sanctuary is used as a training center for habitat restoration

Outcome: Birds, native to natural communities, return and/or increase in species and number

Objective 4: Sanctuary attracts a wide diversity of birds for breeding and as a migratory stopover

Monitoring: Point-Count seasonal surveys

Objective 5: Native Plant Garden supports native bird and pollinator species and provides educational opportunities to visitors

Monitoring: Visitor Counts

Outcome: Garden is used as an example of planting design methods that support wildlife and look beautiful in residential areas.

GOAL 2: SANCTUARY IS A BREEDING, MIGRATORY, AND NESTING SITE FOR SANDHILL CRANES

Objective 1: Monitor water level in Big Marsh Lake to maximize for stopover habitat for cranes

Monitoring: Water level recordings

Outcome: 5000+ Sandhill Cranes observed

Objective 2: Visitor participation and outreach increases surrounding crane specific events such as Cranefest

Monitoring: Surveys; customer counts, evaluations

Objective 3: Keep a diverse mix of water and nesting sites

Monitoring: Number of nesting pairs

GOAL 3: INCREASE DIVERSITY AND CAPACITY OF VOLUNTEER MANAGEMENT AND VISITOR ENGAGEMENT.

Objective 1: Develop engagement and outreach strategies with local schools, youth groups, and other organizations, prioritizing communities historically underrepresented in natural sciences and conservation.

Monitoring: Perform appropriate evaluations chosen during the planning process to monitor methods.

Outcome: Volunteer capacity increases, specifically participants for consistent stewardship, nest box monitoring, and bird counts

Outcome: Connections and relationships established with local youth groups, and other organizations.

2.5 Management Strategies and the Evaluation of Natural Systems

Adaptive Management

Actively managing disturbance-adapted ecosystems to increase their resilience to climate change is integral to their preservation and can have a positive effect on species richness. This typically involves treatments that are intended to increase biodiversity, encourage drought-tolerant species, and reduce tree density. However, while the scientific discipline of restoration ecology is emerging as a vital resource, there exists only a limited number of studies on the success of various restoration treatments, and many additional proposed protocols are novel and untested.

To address this challenge, an adaptive management framework is often utilized to implement management objectives while simultaneously developing a greater understanding of underlying ecosystem dynamics and other species interactions. The adaptive management approach, in which management strategies are informed and altered by concurrent research and data collection, is instrumental to the management of these partially understood landscapes (Williams, 2011). This framework enables managers of natural systems to identify knowledge gaps and address new problems continually as part of a cycle (Cawson & Muir, 2008). By utilizing this approach, it is possible to experimentally reduce previous management activities, test new approaches, and monitor the relative successes of these new regimes.

The Prairie-Hardwood Transition zone of southwestern Michigan has been heavily impacted by anthropogenic activity in the last 200 years. Ongoing conservation efforts to restore fragments of this previously vibrant landscape mosaic have utilized an adaptive management approach to incrementally improve species diversity and improve habitat resilience. Similarly, principles of adaptive management were utilized in this report, which includes a comprehensive plan intended to transform degraded ecosystems to high quality, resilient landscapes, increase the diversity of native biota, and provide suitable habitat for threatened wildlife species.

Reintroducing Tallgrass Prairie to Degraded Land

A byproduct of two centuries of agricultural intensification in the upper Midwest is the existence of a patchwork of scattered remnant farm fields in the region. These often occur in locations that were previously farmed at a smaller scale by European settlers but are not suitable to the industrial farm practices which currently dominate the landscape. These fields present an opportunity for restoration to a prior condition or a new stable state that will increase species richness and improve other ecological characteristics of the land.

Due to its fertility and rolling topography, land that supports prairie and savanna is frequently desired for farming, and decades of agricultural intensification have nearly extirpated these ecosystems from the Midwest. By the mid-eighteenth century most of the tallgrass prairie, a plant community that was historically present in the oak opening matrix at Baker Sanctuary, had been destroyed as land was converted to other uses. The removal of fire and other regenerative processes further degraded remaining prairie fragments and accelerated their demise (Gardner, 2011, Samson & Knopf, 1994). The loss of these open ecosystems has been devastating for the ecology of the region. Hundreds of grasses and forbs native to these ecosystems are either endangered or threatened, and grassland birds have experienced some of the largest declines of any group of species in North America (Samson & Knopf, 1994).

There is a growing recognition of the impacts of large-scale land use conversion and abuse both in academic circles and in the public, which has generated interest in the restoration of old fields to sites resembling prairies of the past. Prairie restorations increase the abundance and diversity of native pollinator communities and multiple studies show that newly restored sites are rapidly colonized with native insects. Therefore, they are becoming an integral component of conservation strategies for threatened species (Tonietto et al., 2017; Rowe & Holland, 2013). The rehabilitation of each specific site is dependent on its pre-colonial ecotype, land use history, current condition, and predicted impacts of climate change. These factors make every restoration unique and influence management decisions that dictate the cultural, mechanical, biological, and chemical alterations to the landscape.

The first step in facilitating a successful restoration is site evaluation. It is important to reveal the extent of the ecological degradation at the site and to identify targets which may need specific treatments. At Baker Sanctuary, the old fields were abandoned nearly 70 years ago, so there have been significant changes to these sites brought on by patterns of succession. Sites with more recent historical agricultural use may require mechanical treatments to remove roads, alleviate soil compaction, or to grade the landscape when it has been excavated or terraced (Pannebaker et al., 2017). After repairs to the landscape have been completed the next priority is removing the exotic and invasive grasses, forbs, and other unwanted woody vegetation. This can be accomplished through a variety of methods including but not limited to mowing grasses, brush-hogging established woody vegetation, implementing prescribed burn regimens, and the application of herbicides via foliar spray or the cut-and-pour method. The unique characteristics of each individual site dictate the order, intensity, and timing of these treatments (Pannebaker et al., 2017; Phillips-Mao, 2017).

An integral component of prairie restoration is the reintroduction and establishment of native herbaceous plant species, so the acquisition of appropriate seeds and seed mixes is crucial to the success of these projects. Attention must be given to the origin of seeds to ensure there is adequate and appropriate genetic diversity amongst the species being reintroduced. Seeds may be broadcast into bare soil following a controlled burn or injected into the soil via a seed drill if germination and establishment are determined to be challenging at a site (Pannebaker et al., 2017; Phillips-Mao, 2017). After initial reestablishment of a restored prairie, it is often necessary to continue annual treatments to remove exotic and invasive species, followed by continued efforts to improve the floral diversity of the landscape through seed dispersal. It is common for these efforts to include the harvesting of native seeds from nearby areas and the propagation of those seeds in a controlled environment. A robust monitoring program can ensure that temporary improvements to the landscape become permanent and that future problems are swiftly identified (Pannebaker et al., 2017).

The Importance of Fire to the Maintenance of Oak Communities

Oak savanna ecosystems were common throughout the Prairie-Hardwood Transition prior to European colonization and featured large oaks surrounded by herbaceous vegetation (Anderson, 1998). Much of the remaining oak savanna habitat in southeastern Michigan has been degraded by anthropogenic activity, lost to land use conversion, or diminished by succession. This has catalyzed the loss or fragmentation of numerous species populations associated with the prairie-forest border adjacent to oak forests (Reinhardt et al., 2017).

Oak savannas have historically supported diverse floral and faunal communities throughout the Midwest and were maintained with frequent fires to control the growth of woody understory species by Indigenous Peoples. Due to their importance, restoring extant fragments of oak savanna has become a top priority for conservation managers in the region. Decades of fire suppression and agricultural conversion has shifted the species composition and spatial dynamics of these ecosystems, and they require multi-year restoration regimes to create habitat favorable to the diverse wildlife that they previously supported (Dey et al., 2017).

Restoring oak savanna to ecologically appropriate sections of Baker Sanctuary is a focus of this management plan because this ecosystem is included in the Prairie Hardwood Transition that supports 30 avian species of concern. Temperate grasslands and savannas are some of the most endangered habitats in the world, with approximately only one percent of oak savannah in the US remaining (Reinhardt et al., 2017). Restoration of this land to provide quality natural communities through the control of invasive species, the protection of native species, and the renewal of annual prescribed fire and mowing regimens will improve its resilience. Furthermore, because studies have indicated that singular, low heat burns alone are not enough to permanently shift vegetative dynamics in these communities, pursuing change through an adaptive management framework will be necessary to elucidate which techniques may be combined to produce effective results (Bassett et al., 2020).

Monitoring Natural Communities

When managing a site, it is important to identify ecosystem attributes that indicate whether the site is “healthy.” This can help determine how much management is needed or when to manage a site. In the United States the USDA and the US Forest Service have a Forest Health Monitoring (FHM) and Forest Inventory Analysis (FIA) program that is designed to monitor the status and changing conditions of forests around the U.S. This program measures the crown condition, tree mortality, tree damage, soil condition, downed woody material, vegetation structure and diversity, lichen communities, and ozone injury (Tkacz et al., 2008). Detailed information regarding this protocol can be found at https://www.fia.fs.fed.us/ and also at https://www.fs.fed.us/foresthealth/protecting-forest/forest-health-monitoring/index.shtml . These methods can be time consuming and expensive to perform but can provide detailed data about forest health.

Another way to monitor the health of a site is to look for key species, whose presence or absence can be a reliable indicator of ecosystem change. Rare plants and animals require certain conditions to exist that are not present in degraded ecosystems or at sites that have lost important habitat due to anthropogenic activity (US Forest Service). The selection of key species must be site specific, reflective of its current and desired floral composition, and incorporated into a long-term restoration framework (Coulloudon et al., 1999). This requires specific knowledge of the species’ traits, to be able to identify it. These can be learned relatively easily by anyone making it a low cost, somewhat time consuming monitoring tool.

The Michigan Department of Environment, Great Lakes, and Energy has a wetland monitoring and assessment strategy for the state of Michigan that uses a three-tiered approach. This involves a landscape assessment using remote sensing, a rapid assessment using simple field indicators, and an intensive site assessment (Michigan Department of Environmental Quality (MDEQ) Water Resources Division, 2015). The United States Environmental Protection Agency (EPA) also has a monitoring and evaluation strategy for wetlands. These types of monitoring programs can provide a great deal of information about the health of an ecosystem but come at the expense of many field hours, equipment, and money. A simple monitoring

Another method used to evaluate the health of ecosystems in the Great Lakes region is the Floristic Quality Assessment (FQA), which allows for objective, quantitative judgements regarding the quality of sites through a standardized and repeatable process (Milburn, 2007). It removes subjective bias by assigning all native plant species within a region a coefficient of conservation (C) number and is designed to supplement other habitat assessment strategies. Plant communities have evolved as assemblages of species in ecosystems with varying disturbance regimes, and as a result they exhibit a diverse array of survival strategies to overcome negative impacts to their environment. Some species have evolved with characteristics that allow them to colonize low-quality environments, while others require pristine, undisturbed habitats. The C-value of each species reflects its fidelity to undisturbed natural environments as well as its tolerance to pollution and environmental degradation (Wilhelm & Masters, 1995).

The C-values assigned to each species range from zero to ten, with all non-native species automatically receiving a zero. Species that are unaffected by anthropogenic change are assigned a low C-value, from zero to four, and those with the highest fidelity towards their natural environments are rated from seven to ten. While there is inherently a level of subjectivity in any assessment of ecosystem health, the assignment of C-values to individual species and the associated Floristic Quality Index calculation utilized in thi areas. C-values are assigned collaboratively by a committee of academic professionals in each state that FQA protocols have been established, ensuring that they can be used to reliably assess the ecological condition of any site in any represented region (Herman et al., 2001). Ecologists, field botanists, and other professionals with similar backgrounds can easily use this methodology to compare sets of sites to one another and track changes to the same site over time. This can be useful when setting conservation priorities, planning restoration projects, and monitoring the health of restored sites (Milburn, 2007; Wilhelm & Masters, 1995).

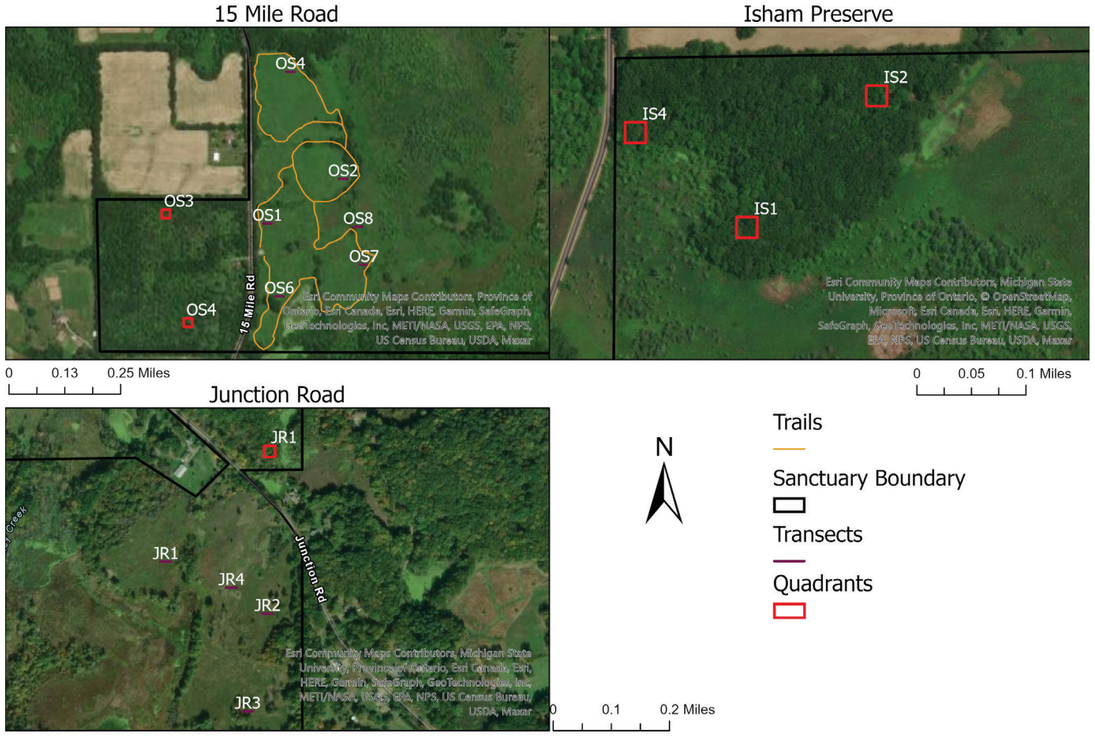


FIGURE 2.1 VEGETATION MONITORING LOCATIONS

SITE SELECTION AND MONITORING METHODS UTILIZED IN THIS REPORT

Floristic surveys were conducted on four consecutive days in July, from 7-15-2021 to 7-18-2021 at Baker Sanctuary by a team of master's students. Survey points were created in ArcGIS by establishing 100ft² grids and then using a random number generator to pick a point within them. Point count locations from previous monitoring activities were used on the western half of the preserve, in the 15 Mile parcel. Care was taken to ensure that the grids were located within only one habitat type and that the resulting transect would not cross between plant communities. Time and budgetary limitations limited the surveys to three of the four subdivisions of the sanctuary, and data was collected from the 15 Mile Road, Junction Road, and Isham parcels. The Old Doty Wildlife Trail was the least accessible area of the preserve, and no surveys were conducted in this unit.

In the 15 Mile Road area, observations from these surveys were combined with random meander surveys conducted throughout the fall and summer to produce a species list for each of those three observed parcels. An FQA analysis was performed to determine species richness and to provide a greater understanding of the current conditions in each parcel, and that data is included in the appendix portion of this report.

Cover Class	Range of Cover	Midpoint of Rage
1	Trace – 5%	2.5%
2	6 – 25%	15.0%
3	26 – 50%	37.5%
4	51 – 75%	62.5%
5	76 – 95%	85.0%
6	96 – 100%	97.5%

FIGURE 2.2 THE DAUBENMIRE METHOD CATEGORIZES OCULAR COVER ESTIMATES INTO SIX CLASSES.

Frequency sampling surveys were conducted in the grassland and wetland sites using the Daubenmire method protocol described in Coulloudon et al. (1999 p. 55). Survey of this

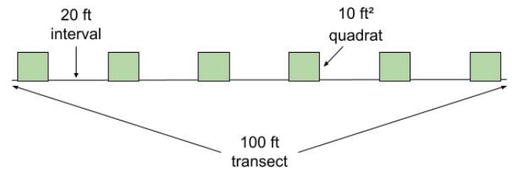


FIGURE 2.3 DIAGRAM OF DAUBENMIRE METHOD

type are suitable for measuring canopy cover, frequency, and composition by canopy cover (Coulloudon et al., 1999). In this analysis all grasslands and wetlands were assessed using a linear study design. Six 10ft² quadrats were placed at 20ft intervals along a 100ft transect which was randomly extended from each point location. All species present within each quadrant were identified and percent cover was determined by estimating the range of cover of each species within each individual quadrant according to the Daubenmire method.

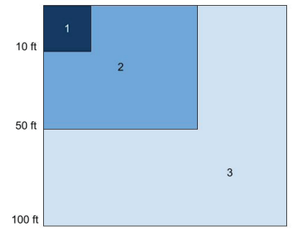
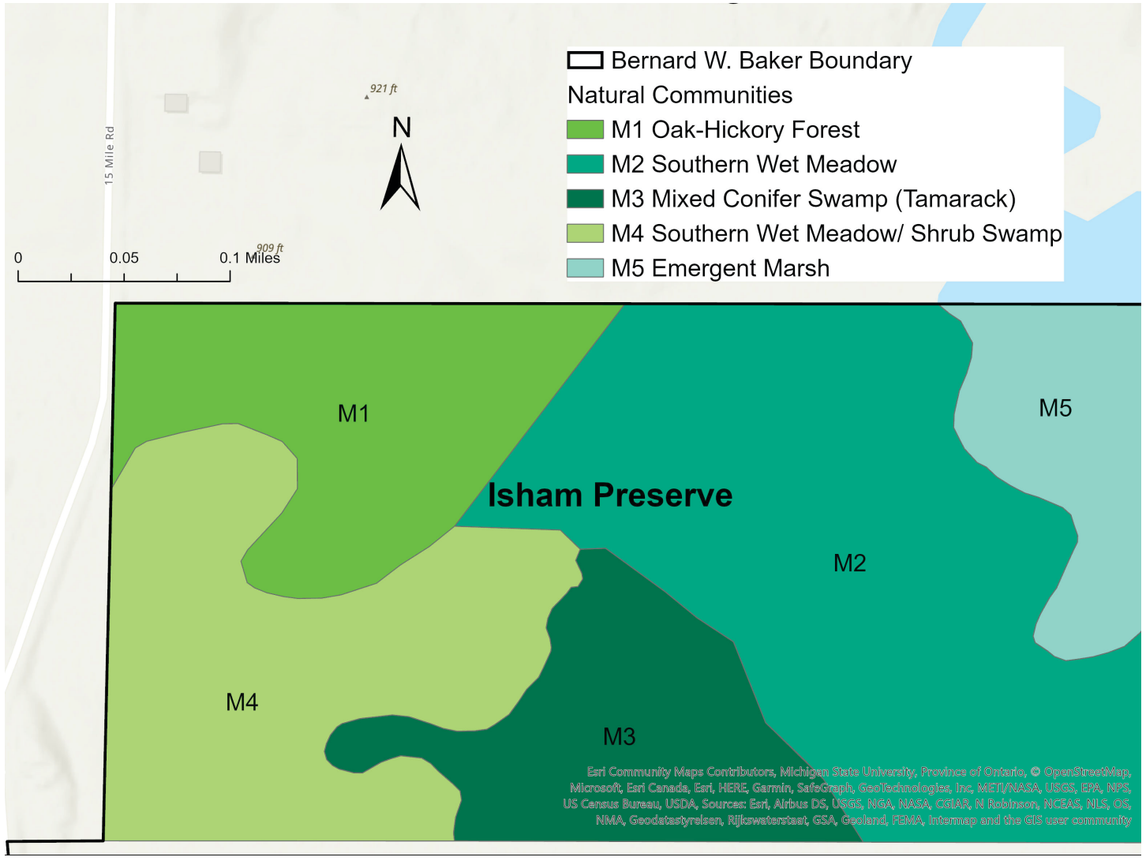


FIGURE 2.4 DIAGRAM OF NESTED PLOT FREQUENCY METHOD

Survey points in forested locations with a closed canopy were assessed using the nested frequency method described in Coulloudon et al. (1999 p.37). Data collected using this survey method is used to measure frequency, basal cover, and general cover categories such as litter (Coulloudon et al., 1999). Frequency data collected using this method is dependent on plot size, as larger quadrats will more likely contain key species. Additionally, the data is only useful in measuring sensitivity to change if recorded frequency data is between 20% and 80%. To enable the discussion of frequency change over time, it is important to select an adequate plot size so that the recorded frequency in sampled quadrants will not produce data with a recorded frequency of <10% or >90%. In this study, three nested quadrats with sizes of 10ft², 50ft², and 100ft² were used. Each plant species recorded within the sampling area was given a number corresponding to the smallest plot it was present within because a plant located within the smallest nested plot is also within the larger plots as well.

2.6 Habitat Management

2.6.1 Isham Preserve



The Isham preserve comprises four main ecosystems, oak-hickory forest, tamarack swamp, southern wet meadow/shrub swamp and emergent marsh.

Specific Property Goals

- Decrease non-native species prevalence
- Increase native plant cover where possible
- Promote oak regeneration by maintaining open understory conditions in oak hickory forest
- Monitor water levels in wetlands
- Monitor nutrient inputs in wetlands
- Gain a better understanding of what organisms are utilizing these communities
- Monitor deer populations
- Reduce deer numbers as needed to maintain healthy ecosystems

Current Conditions

Currently the oak hickory forest has an open understory due to recent management of the area. The nested plot surveys in the area showed mature trees with few saplings in the area. The surveys also showed that the area has few non-native species present. Out of the 56 species recorded, only 12 are considered non-native. An FQA of the area gave a floristic quality index (FQI) of 26.7. This indicates a site of high vegetative quality. Observed non-native species include garlic mustard (*Alliaria petiolata*), *Carex sylvatica*, orchard grass (*Dactylis glomerata*), autumn olive (*Elaeagnus umbellata*), common ivy (*Hedera helix*), Timothy grass (*Phleum pratense*), broadleaf plantain (*Plantago major*), black locust (*Robinia pseudoacacia*), multiflora rose (*Rosa multiflora*), bitter dock (*Rumex obtusifolius*), common speedwell (*Veronica officinalis*), and periwinkle (*Vinca minor*).

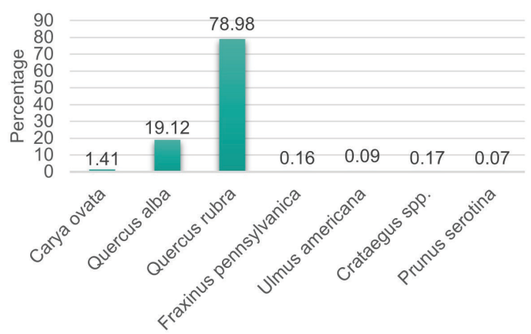


FIGURE 2.4 RELATIVE DOMINANCE: ISHAM PRESERVE NESTED PLOT (IS1)

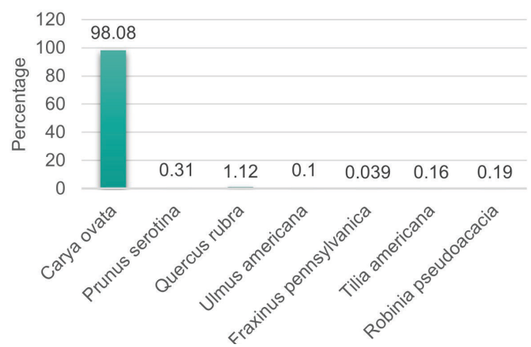


FIGURE 2.5 RELATIVE DOMINANCE: ISHAM PRESERVE NESTED PLOT (IS2)

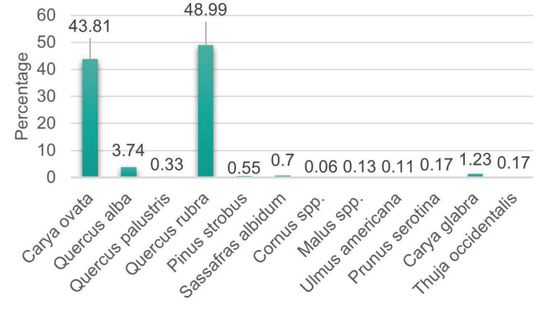
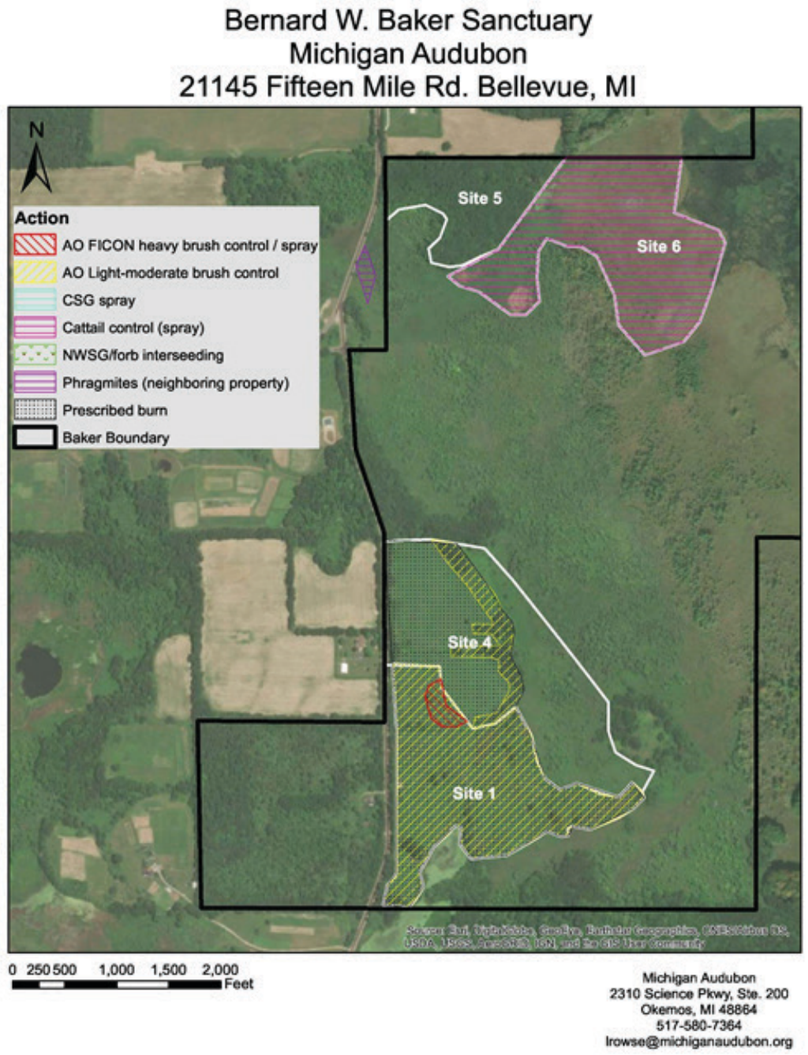


FIGURE 2.6 RELATIVE DOMINANCE: ISHAM PRESERVE NESTED PLOT (IS4)

Management History



Based on the map above, sites 5 and 6 are places where proposed management was to take place in the Isham preserve. Site 6 is where cattail control was suggested inside part of the wetland area. Unable to confirm if this happened. Site 5 is the location of the oak-hickory forest and where a prescribed burn was used to clear out the understory of the forest. This was confirmed to have happened. Also, just outside the preserve, a small section of phragmites was to be removed. This was proposed in hopes of preventing it from spreading into the wetlands in the preserve. It is unknown if this removal took place.

Management Strategies/Objective

In the oak-hickory forest the management strategy involves the promotion of the regeneration of oaks. This can be achieved through the removal (mechanical and/or chemical) of understory species that prevent the regrowth of oaks. After the understory has been opened, infrequent fires can be used to keep the regrowth of unwanted species at bay. Once the forest understory has been opened, a new problem that arises is overgrazing of deer on young saplings. This can be managed through culling of deer populations or by creating barriers that prevent deer from getting to the saplings. Large, extensive barriers can be used to prevent deer from getting into the oak-hickory forest or small barriers can be used on individual saplings to prevent browsing. Whichever solution or combination of solutions is used for deer control depends on the resources and the goals of the sanctuary (Lee, 2007).

There are 3 types of wetlands in the Isham preserve: emergent marsh, southern wet meadow, and rich tamarack swamp. The management recommendations are similar for each so they will be treated as one wetland. The main management strategy in the wetlands should be to protect the hydrology of the area. Nutrient runoff in rainwater from neighboring agriculture fields should be limited as much as possible. Wetlands are also subject to degradation from non-native species. As such the removal of these species will help keep native ecosystems healthy (Cohen, 2020; Kost 2010). In the rich tamarack swamp specifically, red maple (*Acer rubrum*) can eventually out compete tamaracks for light, eventually changing the composition of the plant community. This can be avoided through removal of red maples. In the southern wet meadow, fire, except in times of drought, can be used to maintain open conditions (Kost, 2010).

TABLE 2.1 ISHAM PRESERVE QUALITY SITE INDICATORS/OUTCOMES

Organism/Character-istic	Current Conditon	Evalutaion Method	Desired Condition
Oak-Hickory Forest Overall Plant Species	Total: 58 Total Mean C: 3.5 Total FQI: 26.7	Nested Plots	Greater native diver-sity Less non-native spe-cies
Oak- Hickory Forest Non-native Species	Total: 12 (20.7%)	Nested Plots	≤ 5% of total species
Oak- Hickory Forest C value 7-10	12.1% of total mean C value *Aureolaria flava* *Aureolaria virginica* *Blephilia Hirsute* *Eutrochium fisulosum* *Lespedeza hirta* *Quercus palustris* *Tiarella cordifolia*	Nested Plots	Increase abundance to 20 - 25%
Oak- Hickory Forest Dominant Canopy Species	*Carya glabra* *Carya ovata* *Quercus alba* *Quercus palustris* *Quercus rubra*	Nested Plots	Promote understory growth to replace old-er growth
Wetlands Emergent Marsh, Southern Wet Mead-ow, Rich Tamarack Swamp	Unknown Assumed to have non-native species	Nested Plots or Tran-sects	Maintain healthy water levels and quality. ≤ 5% of total species being non-native.

TABLE 2.2 ISHAM PRESERVE MAJOR MANAGEMENT TASK CALENDER

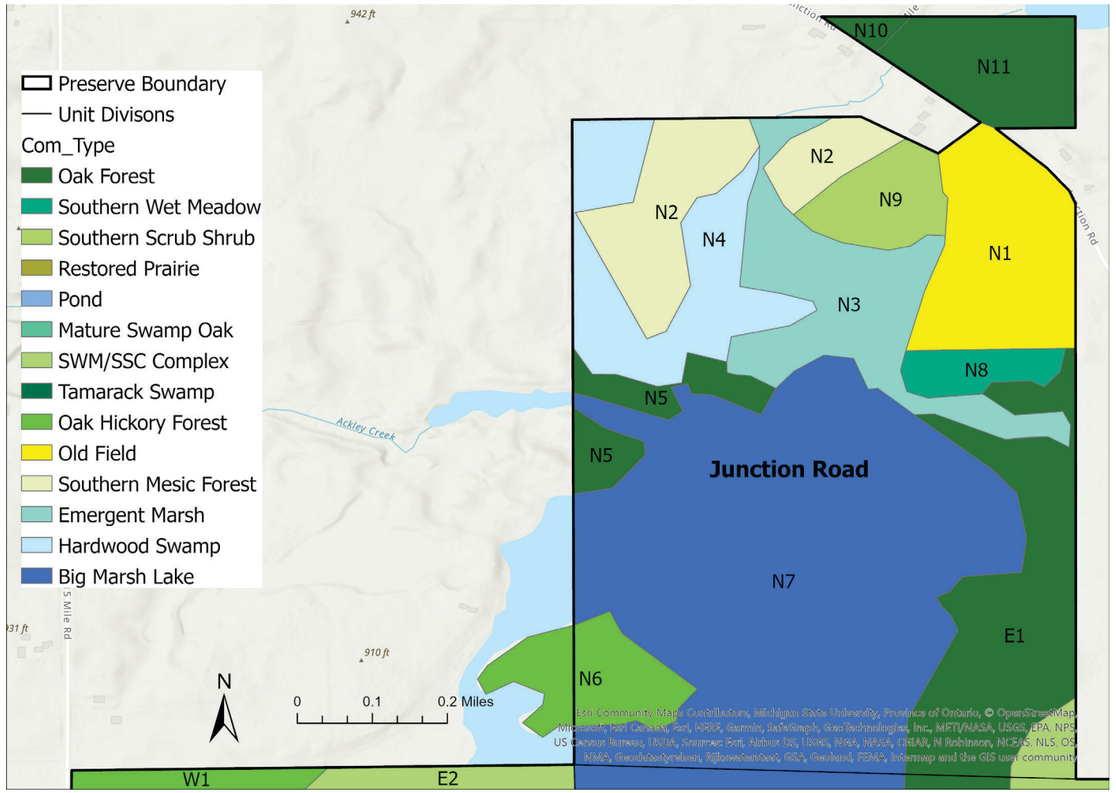
Year	Task	Time of Year
0	Site Evaluation	Summer
1	Chemical treatment of small-medium populations of invasive and undesirable woody vegetation. (*Elaeagnus umbellata*, *Rosa multiflora*, *Rhamnus cathartica*). • Stump Cut—Cut stem 2" above ground and immediately apply herbicide to the cross-section of the stem.	Late summer into fall
2	Prescribed Burn • Spring burns target woody species (such as *Rosa multiflora*, *Elaeagnus umbellata*, and *Rhamnus cathartica*) and cool season grasses such as *Phleum pratense* and *Poa pratensis*. • SWM/SSC: once every 3 years • Oak hickory: once every 5-10 yrs	Alternating between Spring and Fall
2-3	Reintroduction and establishment of native herbaceous plant species– plant and interseed with native grasses and shrubs Determine seeding rate from instructions provided by seed supplier	Fall
Annually	Monitor and control deer population in oak hickory community	All
Annually	Groundwater monitoring using the MiRAM methodology detailed in the "State of Michigan Wetland Monitoring and Assessment Strategy" (Michigan Department of Environmental Quality (MDEQ) Water Resources Division, 2015)	All

This unit contains several small to medium clusters of autumn olive and multiflora rose. An integrated method is suggested to control these species. Stump-cut, performed in the late summer-early fall consists of cutting the stem about 2" above the ground and immediately applying herbicide. This method is also referred to as 'Cut-and-Squirt'. Annual follow-up is required to control both species. In addition, monitoring of 20' from the population is recommended for Multiflora Rose specifically.

A late spring/early summer prescribed burn (Mid to late May) will severely damage the leafed out woody species, including autumn olive. In addition, a late spring burn targets cool-season grasses such as timothy and Kentucky bluegrass and allows native grass species the ability to out-compete these plants. These low-intensity prescribed-fires should be administered to the old field/prairie system every two to three years. However, it is good practice to alternate prescribed burns between the spring and fall seasons. This provides balance to the ecosystem, as repeated annual spring burns can negatively affect the abundance of native early season grasses and forbs.

Following a controlled burn (and at times, the chemical removal of woody species) the reintroduction and establishment of native plant species is crucial. This can be accomplished by broadcasting seeds over bare soil or injecting them into the ground. After the initial year of habitat management, it is important to perform annual site evaluations to determine what species are present and their abundance as well as to determine the effectiveness of the removal treatments.

2.6.2 JUNCTION ROAD



The Junction Road parcel contains plant communities that are connected through patterns of succession and are representative of the dynamic ecosystems present at Baker Sanctuary. This land was subject to significant anthropogenic manipulation prior to its incorporation as a preserve. Past farming and grazing practices, as well as other land use changes, have altered the successional and hydrological processes in a sizable portion of the Junction Road parcel. This catalyzed the loss of native biodiversity and encouraged the proliferation of invasive graminoids, forbs, and shrubs.

Soil texture and structure, topography, and cyclical environmental processes affect the characteristics of each site and influence species composition (Jenny, 1980). For this reason, we have grouped certain habitat types within this parcel to better represent the management decisions for each. From this point, Junction Road will be divided into 'Mesic Upland' representing the oak and oak hickory forests, and 'wetlands and old f ield', which accounts for the ecotone between the forests and Big Marsh Lake. Plant communities present in the mesic upland portions of this section of the preserve include oak forest, oak forest/wetland, southern mesic forest, and an oak hickory island. The wetlands contain emergent marsh, southern wet meadow, shouthern shrub scrub (southern shrub-carr), hardwood swamp, emergent marsh, and southern wet meadow plant communities. Big Marsh Lake is located at the center of the Junction Road unit.

Specific Property Goals

- Decrease abundance and frequency of non-native species.
- Increase native species plant cover.
- Gain a better understanding of what organisms are utilizing these communities.
- Maintain open conditions to support oak regeneration in forested subunits.
- Reintroduce natural disturbance regimes such as fire and other mechanical, biological, and chemical treatments to the landscape.
- Prevent dramatic fluctuations in water levels in wetlands by limiting the amount of additional nutrients and sediment from runoff of surrounding areas.
- Monitor the water levels in wetlands using the MiRAM methodology.
- Monitor and control deer populations to prevent overgrazing.

Wetlands and Old Field of Junction Road

Current Condition

The 'wetlands and old field' communities of Junction Road consist of old field, southern scrub-carr, and southern wet meadow. Old field is a generally drier habitat than southern wet meadow and southern shrub-carr, and is typically a mixture of grasses, forbs, shrubs, and weeds. The species composition of old fields is dependent on a variety of factors including the characteristics of the site, the land use history, the ecological composition of the surrounding landscape, and the type of management that occurred after initial abandonment.

Southern wet meadow, a groundwater-influenced community, is a sedge-dominated wetland. Its community structure and species composition are influenced by natural and anthropogenic processes including seasonal flooding, flooding by beaver, and fire. Southern shrub-carr, a shrub-dominated wetland, typically occurs on saturated organic soils within depressions of a variety of landforms. The species composition and community structure of this natural community is influenced by natural and anthropogenic processes such as fluctuating water levels, flooding beaver, and windthrow.

Of the four transect site surveys that were conducted in the Junction Road unit, two were in old field communities. According to the surveys, the old field communities had a combined total of 47 plant species with 16 being non-native. Of the 16 total non-native species discovered in the two old field communities, two species, timothy grass (*Phleum pratense*) and Kentucky bluegrass (*Poa pratensis*), were in at least 75% of the surveyed quadrants.

One of the four transect site surveys that was conducted in the Junction Road unit was in a southern shrub-carr community. According to this survey, the southern shrub-carr contained 33 identifiable plant species with 13 being non-native. The most common non-native species in the southern shrub-carr were Kentucky bluegrass (*Poa pratensis*) and multiflora rose (*Rosa multiflora*), which were present in 100% of the surveyed quadrants. Further, autumn olive (*Elaeagnus umbellata*), timothy grass (*Phleum pratense*), and cow parsley (*Anthriscus sylvestris*) were present in at least 50% of the surveyed quadrants.

The last of the four transect site surveys conducted in the Junction Road unit was an emergent marsh/wet meadow community. This habitat type contained 30 plant species with nine being non-native. Of the nine total non-native species found in the emergent marsh/wet meadow community, Kentucky bluegrass (*Poa pratensis*) is by far the most prevalent and was in 100% of the surveyed quadrants. Purple coneflower (*Echinacea purpurea*), the second most prevalent, was found in 67% of the surveyed quadrants.

TABLE 2.3 JUNCTION ROAD TRANSECTS DOMINANT PLANT SPECIES (2021)

Junction Road Transect	JR2 + JR3	JR1	JR4
Natural Community	Old field	Southern shrub-carr	Emergent marsh / wet meadow
Species Composition	47 total species 16 non-native	33 total species 13 non-native	30 total species 9 non-native
Species present in 100% of surveyed quadrats	*Phleum pratense* and *Poa pratensis*	*Poa pratensis* and *Rosa multiflora*	*Poa pratensis*
Species present in >75% of quadrats	*Phleum pratense* and *Poa pratensis*	—	—
Species present in >50% of quadrats	—	*Elaeagnus umbellata, Phleum pratense,* and *Anthriscus sylvestris*	*Echinacea purpurea*

The floral inventory assessment for the entire Junction Road unit includes a combined total of 67 species, with 50 native species and the remaining 17 being non-native. This translates to an FQI score of 22.1, indicating that the vegetative quality of this site could be improved. However, it is important to note this assessment combined the surveys from all the habitat types of Junction Road. Compiling a fully comprehensive floral inventory assessment of each habitat type within the different units of Baker Sanctuary will require additional time and resources that were not available to produce this report.

While the FQI score indicates that there is average vegetative quality for Junction Road, it is important to note not only the presence of plant species but also their richness. This is better represented by the individual transect site surveys done within the specific communities in each unit of Baker Sanctuary. According to the transect surveys conducted in the open field and wetland communities, non-native species represent 30-40% of the total species present. Additionally, many of the non-native species present have a high abundance in their associated transects, indicating the possible displacement of native plant species.

Management History

The management history of Junction Road is separated based on the habitat type. Appropriately, there is an extensive management history of the old field communities. In the pre-settlement era, the areas of what is now old field were oak savanna habitat. After settlement, they were converted to agricultural fields of either or both row crops/forage/hay. Agriculture continued until the 1940s when Michigan Audubon acquired the land. There were no known management practices of the old field communities from that time until 2012 when Baker Sanctuary was

was professionally surveyed. Based on this survey, the recommended management of the old field communities are listed in the table below.

TABLE 2.4 2013 MANAGEMENT RECOMMENDATIONS FOR THE OLD FIELD COMMUNITIES WITHIN JUNCTION ROAD

Date	Task	Time of Year	Performed by
Year			
2012-13	Evaluate Site	Fall	RM/TF
2014	Bulldoze/grub autumn olive	Late Winter/Spring	Contractor
	Spot treat random Autumn Olive	Late Winter/Spring	SC/Volunteers
	Herbicide Brome Grass	Spring	Contractor
	Prescribed Burn	Fall	Contractor
	Interseed with native grasses	Late Fall	Contractor
	Plant native Shrubs	Lake Fall	SC/Volunteers
2015	Thin out tree lines of red maple, walnut	Mid-winter	SC/DC/Volunteers (firewood)
	Mow	Early Fall	Contractor
	Burn	Late Fall	Contractor

There is less known about the management history for the southern shrub-carr and southern wet meadow communities. However, the survey completed in 2013, outlines the management practices necessary for these community types in the following table.

Management Strategies / Objective

TABLE 2.5 2013 MANAGEMENT RECOMMENDATIONS FOR THE SOUTHERN SHRUB-CARR AND SOUTHERN WET MEADOW COMMUNITIES WITHIN JUNCTION ROAD

Date	Task	Time of Year	Performed by
Year			
2013	Evaluate Site	Fall	RM/TF
	Mechanical Removal	Winter	RM/Volunteers
	Chemical Treatment	Summer	RM
	Prescibed Fire	Fall	Burn Crew
	Plant Seeds/shrubs	Winter-Spring	RM/Volunteers

The old field, southern wet meadow, and southern shrub-carr sections of the Junction Road parcel are adjacent and comprise the northeastern corner of Baker Sanctuary. The old field shares its western border with a road that delineates the eastern edge of the preserve. It also borders an emergent marsh to the west and south. The southern wet meadow is located directly below the old field and functionally exists as the gradient between the old field and emergent marsh. The southern shrub-carr plant community borders the western edge of the old field and provides a similar buffer from the emergent marsh. It is likely that the loss of historical disturbance regimes catalyzed its succession from southern wet meadow and without action it will likely succeed to a tamarack or hardwood swamp, which both exist nearby and comprise a sizable portion of Baker Sanctuary north of Big Marsh Lake (White, 1965).

The old fields at Baker Sanctuary were farmed for nearly a century prior to abandonment when the land was donated to Michigan Audubon. Similarly, to the old fields which exist in the 15 Mile unit, a long-term restoration goal in the Junction Road parcel is the establishment of a tallgrass restoration prairie which will support high levels of diversity and contribute to the overall ecosystem function of the protected land.

The southern wet meadow is located directly to the south of the old field and has a similar current species composition. It is likely that a portion of the old field was also southern wet meadow prior to European settlement, and that it existed as part of a dynamic complex of wetland natural communities that together encompassed the perimeter of Big Marsh Lake. These plant communities experienced frequent disturbances from fire and seasonal water level fluctuations, which kept them free from encroaching shrub-carr and encouraged the establishment of shade intolerant species. Southern wet meadow ecosystems were viewed as excellent for agriculture by European settlers and have been nearly extirpated from Michigan as a result of land use conversion. Because of their value to regional biodiversity, they are often the focus of restoration efforts that include the reintroduction of fire to the landscape and the protection of nearby sites that influence the hydrology of the ecosystem (Kost, 2001).

Similarly, the site containing southern shrub-carr is directly west of the old field and was likely a southern wet meadow that was invaded by shrubs due to the historical loss of fire to the landscape. While southern shrub-carr is a valuable natural community that supports an abundance of native plant species, it has invaded other plant communities such as southern wet meadow, which are now far rarer. To ameliorate this, restoration efforts sometimes focus on removing the woody vegetation via prescribed burns and setting back succession to an earlier stable state (Cohen, 2020; Kost 2010).

Southern wet meadow and southern shrub-carr exist within a matrix of wetland ecotones with emergent marsh and southern hardwood swamp in the Junction Road unit. These four wetland plant communities share common attributes, which makes their management recommendations similar, so they will be

combined in this report. In addition to these specific recommendations regarding southern wet meadow and southern shrub-carr, these four natural communities are sensitive to pollution from agricultural runoff and other anthropogenic sources, and they respond negatively to hydraulic manipulations of any kind. It is imperative that runoff from nearby developed sites is contained and other nearby lands which impact the hydrology are protected from development. Southern hardwood swamps and emergent marshes experience infrequent fire events, but more so when they are located adjacent to fire-dependent ecosystems (Cohen, 2020; Kost 2010). Fragmentation of hardwood swamps has caused an invasion of non-native vegetation which negatively affects community structure and function, and mechanical removal is recommended in these instances. Deer populations must be monitored and controlled, as overbrowsing has a deleterious effect on the recruitment of herbaceous and woody vegetation. Other woody debris such as rotting logs and dead standing wood should be left in place, as they build structural complexity in the ecosystem and provide habitat or substrate suitable for numerous species (Slaughter, 2009).

TABLE 2.6 JUNCTION ROAD WETLANDS AND OLD FIELD QUALITY SITE INDICATORS/ OUTCOME

Organism/ Characteristic	Current Condition	Evaluation Method	Desired Condition
Invasive Plants	Present; <25% *Elaeagnus umbellata* *Rosa multiflora* *Rubus occidentalis* *Acer rubrum*	Presence/ Absence	Absent; 5%
Plant Species	# observed species: 68 Total MeanC: 2.7 Native Mean C: 3.6 Total FQI: 22.1	Nested Plot	# observed species: >200 Total MeanC: >4 Native Mean C: >4 Total FQI: >35
C-Value 7-10 *Tiarella cordifolia*	*Present*	Nested Plot Site Survey	Increase abundance of high quality native species
Dominant Canopy Species: *Prunus serotina* *Quercus spp.* *Ulmus americana* *Acer rubrum*	Relative Dominance: *Prunus serotina*: 17.86% *Quercus ellipsoidalis*: 53.11% *Ulmus americana*: 10.97% *Quercus rubra*: 5.16% *Acer rubrum*: 9.97% Other: 2.93%	*Nested Plot Site Survey*	Maintain and preserve current conditions
Notable Species: *Dichanthelium oligosanthes* *Carex pensylvanica* *Onoclea sensibilis* *Bromus ciliatus* *Symphyotrichum oolentangiense*	Present	Nested Plot Site Survey	Increase abundance and encourage establishment of complimentary species

TABLE 2.7 OLD FIELD MANAGEMENT TASK CALENDER

Year	Task	Time of Year
1	Site Evaluation	Summer
2-3* *Adaptability for repeated process	Chemical treatment of small-medium populations of invasive and undesirable woody vegetation. (*Elaeagnus umbellata* and *Rosa multiflora*). -Stump Cut—Cut stem 2" above ground and immediately apply herbicide to the cross-section of the stem.	Late Summer-Early Fall (July-September)
4	Prescribe Burn Mid-Spring burn targets control of cool season grasses such as *Phleum pratense* and *Poa pratensis.* ** Mowing as close to the ground as possible is sufficient in managing old fields if burning is not available.*	Alternating Spring & Fall
5	Reintroduction and establishment of native herbaceous plant species– plant and interseed with native grasses and shrubs ** Determine seeding rate from instructions provided by seed supplier*	Late Fall
6	Site Evaluation	Spring/Summer
7-9	Continue management of non-native species through mechanical, chemical, and prescribed burn.	Spring/Fall
10	Site Evaluation	Spring/Summer

This unit contains several small to medium clusters of autumn olive and multiflora rose. An integrated method is suggested to control these species. Stump-cut, performed in the late summer-early fall consists of cutting the stem about 2” above the ground and immediately applying herbicide. This method is also referred to as ‘Cut-and-Squirt’. Annual follow-up is required to control both species. In addition, monitoring of 20’ from the population is recommended for multiflora rose specifically.

For larger populations, mowing/brush hogging followed by foliar spray is suggested. For autumn olive specifically, mowing alone is not an adequate process of removal, as it will result in a regrowth of smaller stems. The regrowth should be chemically treated with a foliar spray July-September, after bird nesting season.

A late spring/early summer prescribed burn (Mid to late May) will severely damage the leafed out woody species, including autumn olive. In addition, a late spring burn targets cool-season grasses such as Timothy and Kentucky bluegrass and allows native grass species the ability to out-compete these plants.

These low-intensity prescribed-fires should be administered to the old field/prairie system every two to three years. However, it is good practice to alternate prescribed burns between the spring and fall seasons. This provides balance to the ecosystem, as repeated annual spring burns can negatively affect the abundance of native early season grasses and forbs.

Mowing the old field/prairie might be suggested to reduce fuel and ensure a low-intensity fire. However, the Burn Plan constructed by a certified burn boss may not include mowing in the weeks leading up to a controlled burn.

Following a controlled burn (and at times, the chemical removal of woody species) the reintroduction and establishment of native plant species is crucial. This can be accomplished by broadcasting seeds over bare soil or injecting them into the ground. After the initial year of habitat management, it is important to perform annual site evaluations to determine what species are present and their abundance as well as to determine the effectiveness of the removal treatments.

TABLE 2.8 SSC/SWM MANAGEMENT TASK CALENDER

Year	Task	Time of Year
1	Site Evaluation	Summer
2-3* *Adaptability for repeated process	Chemical treatment of small-medium populations of invasive and undesirable woody vegetation. (*Elaeagnus umbellata* and *Rosa multiflora*). -Stump Cut—Cut stem 2” above ground and immediately apply herbicide to the cross-section of the stem.	Late Summer-Early Fall (July-September)
4	Prescribe Burn Mid-Spring burn targets control of cool season grasses such as *Phleum pratense* and *Poa pratensis*. ** Mowing as close to the ground as possible is sufficient in managing old fields if burning is not available.*	Alternating Spring & Fall
3-4	Reintroduction and establishment of native herbaceous plant species– plant and interseed with native grasses and shrubs	Winter-spring
Annually	Groundwater monitoring using the MiRAM methodology detailed in the “State of Michigan Wetland Monitoring and Assessment Strategy” (Michigan Department of Environmental Quality (MDEQ) Water Resources Division, 2015)	All

These habitat management methods are similar and less extensive than those of the old field community. If needed, refer to the above paragraph for further explanation of each task.

Mesic Uplands of Junction Road

Current Condition

The surveyed 'mesic uplands' communities include an oak and oak hickory forest habitat.

These drier forests are commonly found south of Michigan's tension zone on porous, loose-textured soils. These forests have an open canopy that admits considerable sunlight to the forest floor year-round. The understory of this mesic upland community consists of woody and non-woody vegetation with few saplings. According to the nested plot surveys, the understory consisted of a total of 41 species, with ten being non-native. Some of the most common native plant species include *Vitis riparia* (riverbank grape), *Fragaria virginiana* (Virginia strawberry), *Achillea millefolium* (yarrow), *Carex pensylvanica* (Pennsylvania sedge), and *Rubus allegheniensis* (common blackberry).

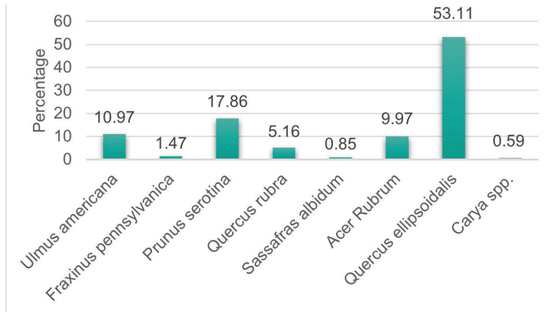
The most common non-native species that are present in the understory of this mesic upland community are *Elaeagnus umbellata* (autumn olive), *Rosa multiflora* (multiflora rose), *Berberis spp.* (Japanese barberry), V*eronica officinalis* (common speedwell), and *Geum urbanum* (wood avens). Species richness and diversity values were determined based on their plot prevalence. The species listed as the most common were present in every plot within the nested plot. Further, based on the nested plot survey, the saplings that were present in the mesic upland understory include *Sassafras albidum, Fraxinus pennsylvanica, Carya spp., Acer rubrum, Juniperus virginiana, Ulmus americana, Quercus rubra, and Quercus alba.* However, it is important to note the *Ulmus americana, Quercus rubra,* and *Quercus alba* were the least prevalent sapling species that were identified in this community possibly indicating a shift in forest type.

TABLE 2.9 SPECIES COMPOSITION OF JUNCTION ROAD UNIT (2021)

Nested Plot JR1 (50 total species)	Native	Non-native
Number of Species	41	9
Present in 100% of nested plots	*Vitis riparia, Fragaria virginiana, Achillea millefolium, Carex pensylvanica, Rubus allegheniensis*	*Elaeagnus umbellata,Rosa multiflora, Berberis thunbergii, Veronica officinalis, Geum urbanum*
Saplings	*Sassafras albidum, Fraxinus pennsylvanica, Carya spp., Acer rubrum, Juniperus virginiana, Ulmus americana, Quercus rubra, Quercus alba*	

As mentioned in the 'Wetlands and Old Field' community above, the floral inventory assessment for the entire Junction Road unit shows a combined total of 67 species in the Junction Road plots with 50 species being native and the remaining 17 being non-native. An FQA analysis of this list produced an FQI score of 22.1, indicating a site of reasonable vegetative quality. Again, it is important to note this assessment combined the surveys from all the habitat types of Junction Road, including four transects and one closed-canopy nested plot. Additional time and resources are required to create a fully comprehensive floral inventory assessment of each habitat type within the different units of Baker Sanctuary.

Also, it is important to note that the FQI score does not include any canopy data from the forest communities. The survey of the overstory of nested plot JR1 reveals a total of 53 trees consisting of eight different species. Native species include American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), black cherry (*Prunus serotina*), red oak (*Quercus rubra*), sassafras (*Sassafras albidum*), Red Maple (*Acer rubrum*), northern pin oak (*Quercus ellipsoidalis*), and hickory (*Carya spp.*). The two most common tree species are *Ulmus americana* and *Quercus ellipsoidalis*, with 13 and 10 trees, respectively. The two least common trees in the overstory of the mesic upland community are *Sassafras albidum* and the unidentified Carya species.



FFIGURE 2.6 RELATIVE DOMINANCE: JUNCTION ROAD NESTED PLOT (JR4)

Management History

There were no known management practices of the mesic upland communities until 2012 when Baker Sanctuary was professionally surveyed

TABLE 2.10 2013 MANAGEMENT RECOMMENDATIONS FOR THE MESIC UPLAND COMMUNITIES WITHIN JUNCTION ROAD

Date	Task	Time of Year	Performed by
Year			
2012	Evaluate Site	Fall	RM/TF
	Mechanical Removal	Winter	RM/Volunteers
	Chemical Treatment	Summer	RM
	Prescibed Fire	Fall	Burn Crew
	Plant Seeds/shrubs	Winter-Spring	RM/Volunteers

Management Strategies/Objectives

Several parcels located near the perimeter of the Junction Road property contain forested natural communities. These patches exist along a mesic gradient that is driven by topography and proximity to Big Marsh Lake. The northwest corner contains a patch of southern mesic forest surrounded by a hardwood swamp, the southwest corner contains an oak-hickory island that extends into Big Marsh Lake, and the northeast and southeast corners are dominated by oak forests in mesic soils with varying elevations and gradients. Due to logistical issues as well as time and budgetary constraints the oak-hickory island and most of the oak forests were not observed for this study and no surveys were conducted at these locations. The one oak forest parcel that was observed is disconnected from the rest of the preserve by Junction Road and anthropogenic development.

Because the natural communities' boundaries within the preserve were defined in multiple management plans within the last ten years, we reasonably conclude that current conditions in these forested patches are like those descriptions. The oak-hickory island is a dry-mesic southern forest, and management should reflect the goals associated with improving biodiversity in that ecosystem. Similarly, management of the oak forest should be oriented towards the restoration of either dry-mesic southern forest or southern mesic forest paradigms, depending on the unique characteristics of each patch. Each forest fragment must be analyzed for its physiological properties and species composition to determine the correct management strategy moving forward.

As previously discussed in the Isham Preserve section, the principal focus of dry-mesic

forest management is increasing oak recruitment. This is historically a fire-dependent ecosystem, where periodic ground fires removed unwanted woody vegetation and promoted oak regeneration. In a post fire paradigm those species must be removed mechanically or with the application of herbicides. Additionally, deer densities should be monitored and controlled to encourage the establishment of herbaceous and woody understory vegetation. Over browsing by deer can have a negative impact on the richness and diversity of native forbs and catalyze changes to the structure of the ecosystem (Augustine, 1998).

The mesic southern forest portions of the Junction Road parcel are larger than the other forested areas and spread throughout the northeastern and southeastern corners. When managing these fragments to improve biodiversity generally it is prudent to leave sites undisturbed whenever possible. It is also important not to remove downed woody debris, snags, and other organic matter of varying size and age to mimic the old growth conditions of larger patches (Kost, 2007). Most parcels currently exist within a dense agricultural matrix and suffer from anthropogenic degradation and invasions of non-native flora and fauna, so it is often necessary to monitor site conditions and remove unwanted woody vegetation. This ecosystem is heavily impacted by deer browsing, and many native species will be eliminated from the landscape if deer populations are not carefully managed.

TABLE 2.11 JUNCTION ROAD MESIC UPLANDS QUALITY SITE INDICATORS /OUTCOME

Organism/ Characteristic	Current Condition	Evaluation Method	Desired Condition
Invasive Plants	Present; <25% *Elaeagnus umbellata* *Rosa multiflora* *Rubus occidentalis* *Acer rubrum*	Presence/ Absence	Absent; 5%
Plant Species	# observed species: 68 Total MeanC: 2.7 Native Mean C: 3.6 Total FQI: 22.1	Nested Plot	# observed species: >200 Total MeanC: >4 Native Mean C: >4 Total FQI: >35
C-Value 7-10 *Tiarella cordifolia*	*Present*	Nested Plot Site Survey	Increase abundance of high quality native species
Dominant Canopy Species: *Prunus serotina* *Quercus spp.* *Ulmus americana* *Acer rubrum*	Relative Dominance: *Prunus serotina*: 17.86% *Quercus ellipsoidalis*: 53.11% *Ulmus americana*: 10.97% *Quercus rubra*: 5.16% *Acer rubrum*: 9.97% Other: 2.93%	*Nested Plot Site Survey*	Maintain and preserve current conditions
Notable Species: *Dichanthelium oligosanthes* *Carex pensylvanica* *Onoclea sensibilis* *Bromus ciliatus* *Symphyotrichum oolentangiense*	Present	Nested Plot Site Survey	Increase abundance and encourage establishment of complimentary species

TABLE 2.12 MESIC UPLAND TASK CALENDER

Year	Task	Time of Year
1	Site Evaluation	Summer
1-2	Mechanical removal of large populations of invasives and non-native woody vegetation, specifically: *Elaeagnus umbellata, Rubus occidentalis, Acer rubrum, Rosa multiflora*	Winter
3* *Adaptability for repeated process	Chemical treatment of: Small-medium populations of invasive and undesirable woody vegetation. - Stump Cut—Cut stem 2" above ground and immediately apply herbicide to the cross-section of the stem. Large populations of invasive and undesirable woody vegetation. - Foliar spray *Berberis thunbergii:* A systemic herbicide can provide control in a single step	Late Summer-Early Fall (July-September)
4	Prescribe Burn: - Target woody species (such as *Rosa multiflora, Berberis thunbergii*, and *Elaeagnus umbellata)*. - Infrequent - Maintain once every 5-10 years	Spring
5-6	Reintroduction and establishment of native herbaceous plant species in areas of invasive wood removal. – plant and inter-seed with native grasses and shrubs. * *Determine seeding rate from instructions provided by seed supplier*	Winter/Spring
Annually	Monitor and control deer population	All

In order to properly manage a mesic upland plant community, it is necessary to conduct a site evaluation to determine what plant species are present. In this mesic upland community, autumn olive (*Elaeagnus umbellata*), black raspberry (*Rubus occidentalis*), red maple (*Acer rubrum*), and multiflora rose (*Rosa multiflora*), and Japanese barberry (*Berberis thunbergii*) are present. An integrated method is suggested for these species, and autumn olive, black raspberry, red maple, and multiflora rose should be mechanically removed, followed by a chemical treatment.

For small to medium populations stump-cut, , performed in the late summer-early fall consists of cutting the stem about 2” above the ground and immediately applying herbicide. This method is also referred to as ‘Cut-and-Squirt’. Annual follow-up is required to control both species. In addition, monitoring of 20’ from the population is recommended for multiflora rose specifically.

For larger populations, mowing/brush hogging followed by foliar spray is suggested. For autumn olive specifically, mowing alone is not an adequate process of removal, as it will result in a regrowth of smaller stems. The regrowth should be chemically treated with a foliar spray July-September, after bird nesting season. Japanese barberry can follow these treatments; however, a systemic herbicide could provide control in a single step.

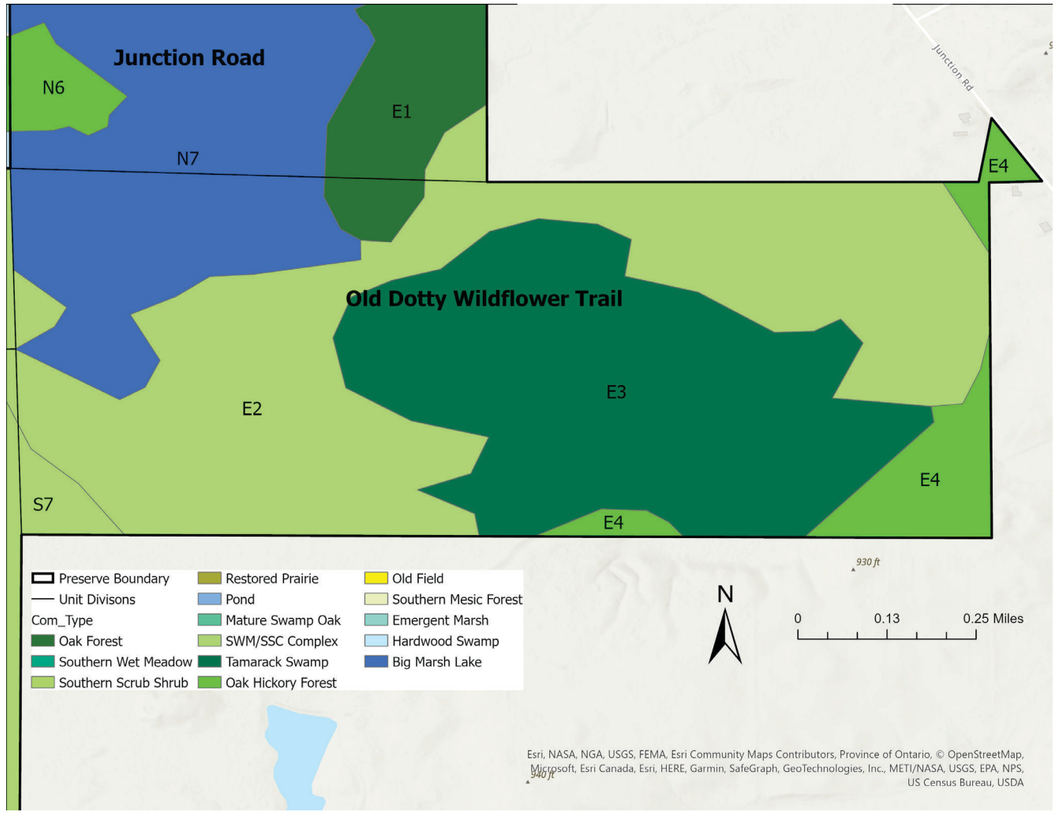
As previously mentioned, prescribed fire is required at less frequent intervals in mesic upland habitat than in grassland or prairie habitat. It is recommended that low-intensity surface fires be spread once every five to ten years. Oaks have evolved with adaptations that make them successful at surviving fire such as the ability to resprout due to their large root system, their formation of root collar buds belowground, and their thick bark. Fire is necessary in these habitat types to control the density of the forest. Without fire, trees that cannot survive fire, and other woody plants, begin growing in and invading the oak forests. As the trees become denser, the canopy will begin to close which will affect forest succession because oaks cannot regrow under a closed canopy. However, in established oak forests, it is important to administer low-intensity surficial fires on a rather limited basis. As mentioned in the ‘management strategies/objectives’ section, in order to improve biodiversity in mesic southern forest fragments, there needs to be minimal site disturbance as well as retaining downed woody debris, snags, and other organic matter.

Lastly, to maintain and restore an oak forest community, there needs to be the reintroduction and establishment of native plant species. This can be accomplished by either seeding or planting native vegetation in the understory of this mesic upland community.

The current conditions of the hardwood swamp, oak-hickory island, oak-hickory forest, and Big Marsh Lake located in the Junction Road Unit is unknown. Time and resources prevented vegetative sampling of these areas. An assumption that can be made based on the broader context of natural areas in this region is that non-native/ invasive species are present in the wetlands. To what extent they are present is unknown.

Further, there are several patches of the same natural communities within Junction Road unit. Due to the lack of time, resources, and the difficulty of accessing many of these patches, we were unable to survey each individual habitat patch. However, we can make broad assumptions about the habitat composition and structure based on the data collected from the surveyed patches of the same habitat type.

2.6.3 OLD DOTY WILDFLOWER TRAIL



The Old Doty Wildflower Trail (ODWT) occupies the southwest portion of Baker Sanctuary and is similar in composition to the Junction Road parcel. Its northeastern and southeastern corners are higher in elevation and contain oak hickory forest. These patches are closely related to the other areas of oak and oak hickory forest that occupy the perimeter of the entire preserve and are representative of the plant communities that historically comprised Baker Sanctuary. Additionally, the tip of the oak forest from the eastern edge of the Junction Road parcel extends south into the ODWT as a forested peninsula surrounded by wetlands. When moving from the edges of the parcel towards the middle the elevation gradient drops, and the bulk of the interior of the ODWT is comprised of a matrix of tamarack swamp, southern wet meadow, and southern shrub carr. Big Marsh Lake protrudes into the parcel from its northern boundary and makes up a significant portion of the eastern half of the ODWT.

The ODWT is the least accessible of the four parcels in the preserve. There are no connecting trails or boardwalks with the 15 Mile parcel to the west, and it is separated from the Junction Road and Isham Preserve units by Big Marsh Lake. It is named in honor of Iva Dotty, a generous benefactor who grew up in Battle Creek. She had envisioned the creation of a wildflower garden in the area, and in 1963 she came to an agreement with Michigan Audubon to develop one within Baker Sanctuary (Funke, 2013). A boardwalk trail was constructed and then renovated in the 1990’s, but it fell into disrepair and was largely removed. The only evidence of the trail on Junction Road is a small pavilion. This site was once a principal attraction of Baker Sanctuary and has significant potential for recreational development. However, infrastructure improvements would be necessary to ensure public safety at this entrance.

Specific Property Goals

- Increase native species diversity and reduce the presence of non-native flora
- Improve the function of the natural communities and preserve the health of the site
- Gain a better understanding of what organisms are utilizing these communities
- Open conditions should be maintained to support oak regeneration in the forested subunits
- Reintroduce natural disturbance regimes such as fire and other mechanical, biological, and chemical treatments to the landscape
- Prevent dramatic fluctuations in water levels in wetlands to limit the amount of additional nutrients and sediment from runoff of surrounding areas
- Monitor the water levels in wetlands
- Monitor and control deer populations to prevent overgrazing

Additionally, a long-term goal of Michigan Audubon is to improve the facilities at the Junction Road entrance to the preserve and to reestablish the Dotty Wildflower Trail boardwalk. The most recent botanical survey for this parcel, conducted in 2000, indicated that the area of the ODWT near the defunct boardwalk contained 291 species with an FQI of 61.96, and thus was an extremely high-quality site at the time. Reopening this entrance to the preserve would allow visitors to view and interact with this incredible diversity and could stimulate community engagement.

Current Condition

As mentioned previously, ODWT is the least accessible of all the units of Baker Sanctuary. Due to accessibility, time, and resources, we were unable to survey any part of this unit. All the following data is from the 2013 Wildlife Conservation Plan by Thomas Funke and the botanical survey done in 2000 by Benjamin Smith of Albion College. We can make assumptions about the current community composition and structure of ODWT based on the surrounding habitats, past management practices, and our acquired ecological knowledge. However, due to the lack of data, our knowledge and recommendations will be quite broad.

According to the 2000 botanical survey of ODWT, 36% of the identified plant species received a C-value between 0 to 2; 43% of the identified plant species received a c-value between 3 to 5; 16% of the identified plant species received a C-value between 6 to 8; and 5% of the identified plant species received a C-value between 9 to 10.

Based on the previous botanical survey, it appears ODWT is a high-quality habitat based on the high species richness, the relatively small proportion of non-native species present, and the relatively high occurrence of species with mid-to-high C-values. Unfortunately, there is no data that indicates which species were in each management unit. Due to this lack of information, it is difficult to know or predict the state of each natural community. From the 2000 botanical survey, we can see that invasive species are present, however, we do not have the data to access the abundance or the exact location of those invasive species. Further, it is important to keep in mind that the botanical survey was conducted 22 years ago, and the Wildlife Conservation Plan was conducted 10 years ago. While we can make recommendations based on assumptions about the quality of ODWT, it is possible these will not align with the actual current conditions of ODTW.

Management History

The southern hardwood swamp or tamarack swamp was most likely used for agricultural production in the past. However, there has been no active management of this habitat since the establishment of the Michigan Audubon. The only type of interference with this unit has been the botanical survey conducted in 2000 by Benjamin Smith, a site evaluation in 2012 by Thomas Funke, and yearly monitoring for pests since 2012.

TABLE 2.13 MANAGEMENT HISTORY FOR THE SWM/SSC COMPLEX COMMUNITY OF ODWT

Date	Task	Time of Year	Performed by
Year			
2013	Evaluate Site	Fall	RM/TF
	Mechanical Removal	Winter	RM/Volunteers
	Chemical Treatment	Summer	RM
	Prescibed Fire	Fall	Burn Crew
	Plant Seeds/shrubs	Winter-Spring	RM/Volunteers

TABLE 2.14 MANAGEMENT HISTORY FOR THE OAK HICKORY FOREST COMMUNITY OF ODWT.

Year			
2012	Evaluate Site	Fall	RM/TF
2012-14	Mechanical Removal/Chainsaw Cherry, Red Maple, Walnut, elm	Winter	RM/Volunteers
2013	Chemical Treatment, Basal Bark-Cut Stump AO, HS	Summer	RM/SC
2015	Prescribed Fire	Fall	Burn Crew
2016	Plant Seeds/shrubs	Winter-Spring	RM/Volunteers
2013	Foliar spray Phragmites	Fall	SC

Management Strategies / Objectives

Forested Uplands

The oak and oak-hickory forest portions of the ODWT exist as small peninsulas that penetrate the interior wetland complex from the corners of the parcel. Similarly, to the other oak-dominated forests at Baker Sanctuary, the primary management objective for these patches is to promote the regeneration of oaks. This can be achieved by minimizing the presence of shade-tolerant tree species such as red maple (*Acer rubrum*) and black cherry (*Prunus serotina*) via mechanical and chemical removal methods (Lee, 2007). Additionally, non-native shrubs and forbs must be manually removed because certain invasive species, such as European buckthorn (*Rhamnus cathartica*) and garlic mustard (*Alliaria petiolata*), alter the nutrient conditions of the soils they occupy. Sites containing these species are more mesic, have an elevated pH, and have higher N and C pools than non-invaded sites (Heneghan et al., 2006). Due to the ability of these species to alter the soil characteristics and nutrient fluxes of sites they occupy; their presence may have legacy effects on the land years after their removal. Therefore, it is imperative that their frequency be diminished in the forested sections of the ODWT and elsewhere at Baker Sanctuary.

Following these treatments, open conditions should be maintained through infrequent, low-temperature ground fires. The presettlement forests of this region were dominated by fire-tolerant oak species, and the frequency and intensity of those fires dictated the development of oak forests on many upland sites (Abrams,1992). Reinitiating a fire regime in these wooded patches would therefore encourage oak recruitment, remove accumulated debris, and create conditions conducive to the reestablishment of the diverse native woody and herbaceous flora that historically occupied ground-level niches in this ecosystem. Furthermore, deer populations in Baker Sanctuary must be monitored and controlled, as their foraging of ground layer floral species can have devastating effects on their ability to compete and reproduce.

Wetlands

The majority of the ODWT contains a matrix of wetlands that includes southern wet meadow, southern shrub carr, and tamarack swamp natural communities, and together they comprise the ecotone that connects the oak and oak hickory forests with Big Marsh Lake. Because these habitats require similar conditions to continue to exist in a stable state, it is possible to group them together in the context of management recommendations.

Protection of nearby groundwater recharge areas and preservation of regional hydrology is the most important action to the preservation of this wetland complex. Variations in surface water inputs can cause fluctuations of groundwater levels, and pollution from agriculture and other anthropogenic activity can swiftly degrade these wetland habitats (Kost, 2001). These are groundwater-dependent plant communities that rely on calcareous seepage, and alterations to this ecosystem process would result in reduced species richness and diversity throughout the site. Additionally, similarly to the oak and oak hickory forest patches, maples and non-native woody vegetation must be mechanically and chemically removed from the wetland complex. An increase in the dominance of hardwood tree species in the tamarack swamp would shade out the shade-intolerant tamaracks and virtually eliminate their recruitment capacity. Migratory birds also rely on the fruit from the native shrub layer of the tamarack swamp, and a side effect of increased canopy coverage from maples is the reduction of the frequency of those species and the loss of a key nutrient pool in the ecosystem (Kost, 2010).

Woody vegetation alters the structure of southern wet meadow and catalyzes succession to southern shrub-carr, and this process is

regimes are removed from sedge-dominated wetlands, native and non-native shrubs such as willows and dogwoods colonize the space, and over time this rare plant community is reduced and eventually eliminated. Historically, fire has been the principal disturbance in this ecosystem, as the duff would burn without damaging the saturated peatland beneath it. In the period immediately following European settlement these fields were mowed yearly for hay, which had a similar effect on woody species but negatively impacted species diversity (Curtis, 1959).

Reintroducing fire to this natural community would help it to recover its vegetational structure and increase the relative dominance of graminoids while not affecting the richness or diversity of the system. However, it is important to utilize fire as just one of several tools for this task, as established woody vegetation will not be affected by these cool season burns. Additionally, late-successional prairie species may take up to twenty years to reestablish, so a long-term treatment and monitoring plan must be maintained (Kost, 2001).

Each of these three wetland communities, as well as the oak uplands, evolved with fire as a natural component of the landscape, and all of them are suffering the effects of fire suppression. Future management strategies must reflect this reality, and cool-season burns should be designed so that they move through the landscape from the oak peninsulas and down through the topographic gradient to Big Marsh Lake.

TABLE 2.15 OLD DOTY WILDFLOWER QUALITY SITE INDICATORS/OUTCOME

Organism /Characteristic	Current Condition	Evaluation Method	Desired Condition
Invasive Plants	Present; Estimated Saturation >25% *Umbellata elaeagnus* *Rosa multiflora* *Rhamnus cathartica* *Phleum pratense*	Random Meander Survey of areas immediately adjacent to the trail	Absent; <5%
Plant Species (circa 2000)	>291 Species C=1057 Avg C=3.63 FQI = 61.96, "Significantly Biodiverse"	Transect Site Survey, Random Meander Survey	# observed species: >50 Sum C>200 Avg C >4 FQI >35
C-Value 10 (circa 2000)	*Agalinis gattingeri* *Agalinis skinneriana* *Agropyron dasystachyum* *Agropyron spicatum* *Carex disperma* *Cypripedium candidum* *Filipendula rubra* *Hydrastis canadensis* *Hypoxis hirsuta* *Polemonium reptans* *Ranunculus flabellaris* *Saxifraga pensylvanica*	Random Meander Survey of areas immediately adjacent to the trail	Increase abundance of high quality native species
Species of SWM/SSC	Unknown	Transect Site Survey, Random Meander Survey	*Carex stricta* *Calamagrostis canadensis* *Bromus ciliatus* *Dasiphora fruticosa* *Larix Laricina* *Betula pumila*
Oak Hickory Forest Overstory	Unknown	Transect Site Survey, Random Meander Survey	Canopy coverage 5-60%; Dominated by: *Quercus velutina,* *Quercus alba,* *Carya glabra,* *Carya ovata*

TABLE 2.16 OLD DOTY WILDFLOWER TASK CALENDER

Year	Task	Time of Year
0	Site Evaluation	Summer
1	Mechanical removal of non-native and non-conforming trees and shrubs Reduce basal area and canopy coverage (*Acer rubrum* and *Prunus serotina*)	Late Winter/Early Spring (Nov-Feb)
1* *Repeated treatment is often necessary	Chemical treatment of *Phragmites australis* in oak-hickory community **Do not chemically treat if near open water**	Late Summer/Early Fall
2-3*	Chemical treatment of small-medium populations of invasive and undesirable woody vegetation. (*Elaeagnus umbellata*, *Rosa multiflora*, *Rhamnus cathartica*). -Stump Cut — Cut stem 2" above ground and immediately apply herbicide to the cross-section of the stem.	Late Spring/Summer
2-3	Reintroduction and establishment of native herbaceous plant species– plant and interseed with native grasses and shrubs *Determine seeding rate from instructions provided by seed supplier*	Fall
4	Prescribed Burn - Spring burns target woody species (such as *Elaeagnus umbellata*, *Rosa multiflora*, *Rhamnus cathartica)* and cool season grasses such as *Phleum pratense* and *Poa pratensis*. - SWM/SSC: once every 3 years - Oak Hickory: once every 5-10 yrs	Alternate between Spring and Fall
Annually	Monitor and control deer population in oak hickory community	All
Annually	Groundwater monitoring using the MiRAM methodology detailed in the "State of Michigan Wetland Monitoring and Assessment Strategy" (Michigan Department of Environmental Quality (MDEQ) Water Resources Division, 2015)	All

In order to properly manage a mesic upland plant community, it is necessary to conduct a site evaluation to determine what plant species are present. In this mesic upland community, autumn olive (*Elaeagnus umbellata*), multiflora rose (*Rosa multiflora*), and European buckthorn (*Rhamnus cathartica*), are present. An integrated method is suggested for these species, and should be mechanically removed, followed by a chemical treatment. To promote oak regeneration, mechanical removal of red maple (*Acer rubrum*) and black cherry (*Prunus serotina*) is performed in the late winter with the other invasive woody species.

For small to medium populations stump-cut can be performed in the late summer-early fall and consists of cutting the stem about 2” above the ground and immediately applying herbicide. This method is also referred to as ‘Cut-and-Squirt’. Annual follow-up is required to control both species. In addition, a monitoring area that extends to 20’ from the population is recommended for multiflora rose specifically.

For larger populations, mowing or brush hogging followed by foliar spray is suggested. For autumn olive specifically, mowing alone is not an adequate process of removal, as it will result in a regrowth of smaller stems. The regrowth should be chemically treated with a foliar spray July-September, after bird nesting season. Japanese barberry can follow these treatments; however, a systemic herbicide could provide control in a single step.

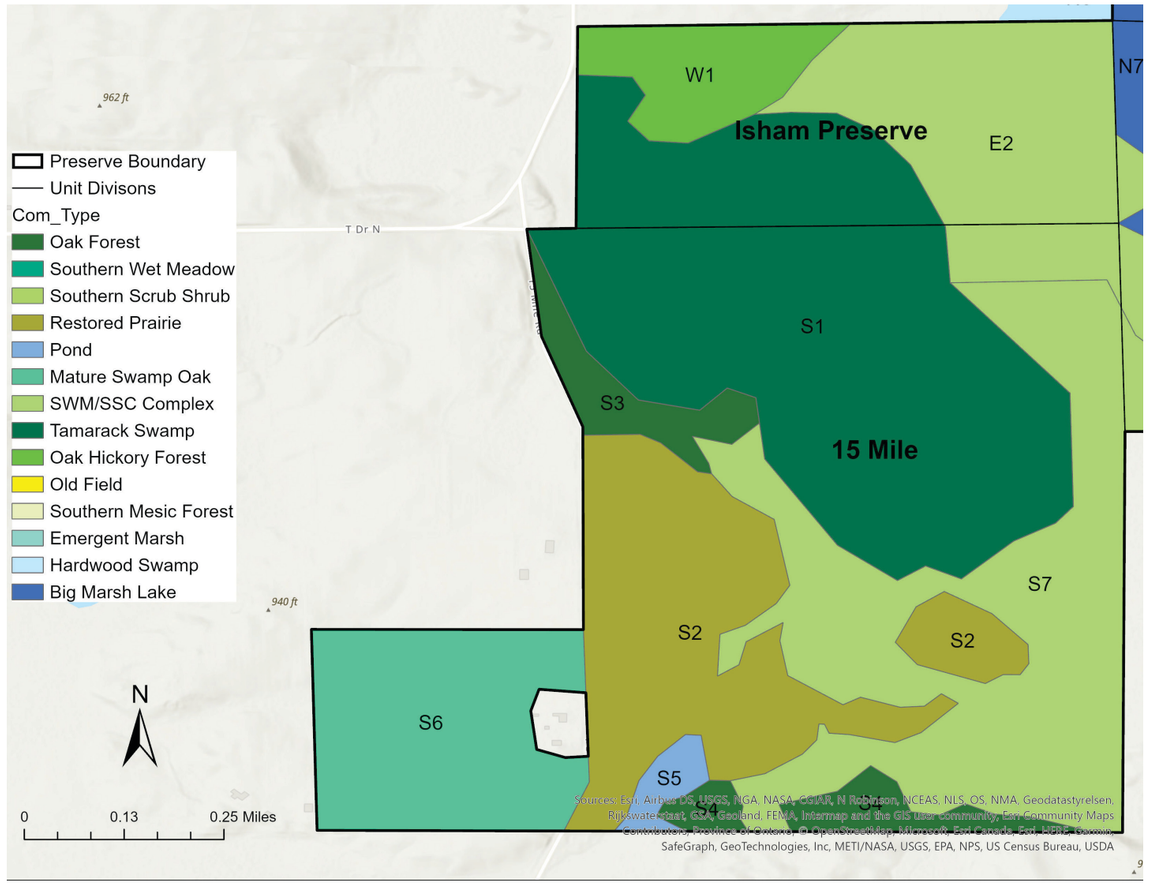
Where phragmites is present in the oak-hickory natural community in this unit, it should be chemically treated with a foliar spray in the late summer and may need to be repeatedly treated throughout the year. Chemical treatment is not recommended for populations in or around water.

Within the SWM/SSC a late spring/early summer prescribed burn (mid to late May) will severely damage the leafed out woody species, including autumn olive. In addition, a late spring burn targets cool-season grasses- such as Timothy and Kentucky bluegrass, and aggressive invasives like Phragmites- and allows native species the ability to out-compete these plants. These low-intensity prescribed-fires should be administered to the SWM/SSC system every two to three years. However, it is good practice to alternate prescribed burns between the spring and fall seasons. This provides balance to the ecosystem, as repeated annual spring burns can negatively affect the abundance of native early season grasses and forbs.

Prescribed fire is required at less frequent intervals in mesic upland habitat than in grassland or prairie habitat. It is recommended that low-intensity surface fires be spread once every five to ten years.

Lastly, the reintroduction and establishment of native plant species is implemented through seeding or planting native vegetation. This is completed in the understory of mesic uplands and in open spaces within wetlands.

2.6.4 15 MILE



The 15 Mile Management Unit contains multiple plant communities and is the most accessible portion of the sanctuary, supporting a majority of the recreation activities through almost two miles of trails that are used for hiking and wildlife viewing. This unit is dominated by grassland communities, specifically southern wet meadow and restored prairie. Wetland communities include tamarack swamp and pond. Finally, in the upland sites, oak forest is present.

The communities within the 15 Mile Unit are all strongly impacted by fire regimens to maintain natural composition. Habitat types were condensed to facilitate a continuity of management across these habitats whose natural processes influence each other’s. From this point, 15 Mile will be categorized into grassland (restored prairie, southern wet meadow, oak forest), and wetlands (tamarack swamp, pond, and oak swamp).

Observations collected during 2021 plant surveys were only collected in restored prairie, southern wet meadow, and oak swamp.

Specific Property Goals

- Increase native species diversity and reduce the presence of non-native flora.
- Woody species that do not contribute to plant community quality should be removed from the grassland and oak forests. This includes species such as black walnut (*Juglans nigra*) and black cherry (*Prunus serotina*).
- Particularly in the restored mesic prairie, remove wooded field edge that divides the habitat into four sections.
- Improve the function of the natural communities and preserve the health of the site.
- Gain a better understanding of what organisms are utilizing these communities.
- Open conditions should be maintained to support oak regeneration in the forested subunits.
- Reintroduce natural disturbance regimes such as fire and other mechanical, biological, and chemical treatments to the landscape.
- Prevent dramatic fluctuations in water levels in wetlands to limit the amount of additional nutrients and sediment from runoff of surrounding areas.
- Monitor the water levels in wetlands.
- Monitor and control deer populations to prevent overgrazing.

Grasslands of 15 Mile

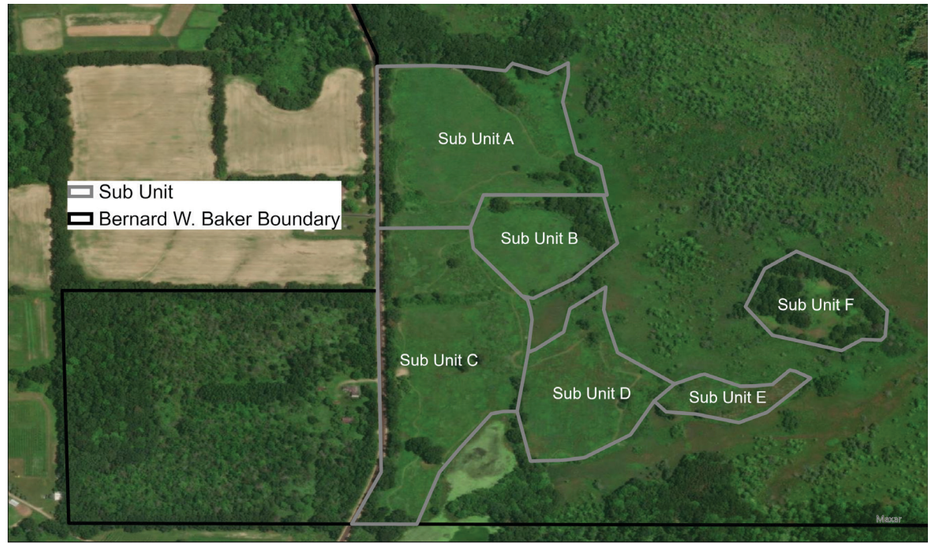
Current Conditions

These habitat types were combined due to their strong interactions with each other and fire. Michigan Natural Inventories suggests the following for management of oak forests "The burning of this habitat should happen when adjacent communities, like southern wet meadows, prairie fen, and mesic prairies, are burned in this management unit." Oak forests and the restored mesic prairie that surrounded most of the Meadow and Marshland Trail, are generally dryer than the southern wet meadow. Data collection only occurred in southern wet meadow and restored prairie habitat types. Surveys for these grassland sites resulted in a total species richness of 111 species, with approximately 76% being native, and 24% being non-native invasive species (NNIS). A FQA of this unit has a FQI of 31.6, indicating a site of high vegetative quality. Species documented during surveys are found in Appendix I. Bird species documented during point-count surveys are described in section 2.7.

Management History

A prescribed burn took place in the northwestern oak forest in the early 2000's, and the SWM/SSC complex has experienced fire along the margins it shares with the restored prairie unit. The restored prairie by far has the most extensive management history within the 15 Mile Road Unit. It was converted from an oak savanna for agricultural uses sometime after 1835 and farmed until the Michigan Audubon took possession in the mid 1950's. The marsh and some of the surrounding upland areas were burned regularly, most likely yearly, from prehistoric times up until the late 1950's. Sometime in the 1950's – 1960's, autumn olive was planted in the area. Since the burning has subsided, trees and shrub growth invaded the marsh and surrounding uplands. The previous owner of the prairie had created five separate sections using fences, and the entire area was essentially free of trees. Since this point, tree lines grew in creatingfive or six small grasslands.

Prior to a tree removal project in 2013, 1200 trees under 14" in diameter and an unknown number of trees over 14" in diameter were counted. Historically, this area was home to many grassland birds but with the tree invasion, the sensitive birds have disappeared. Active management started in 1998 on the following subunits:



Sources: Sub units traced from map from Michigan Audubon. Bernard W. Baker boundary from the Michigan Audubon.
Spatial Reference: WGS 1984

N

0 0.07 0.15 Miles

FIGURE 2.7 SUB-UNITS IN THE 15 MILE UNIT PARCEL

Sub-Unit A "Walkinshaw Loop"

Fall 2010

- Prescribed Burn

Sub-Unit B "Bluebird Loop"

Spring 1998

- Prescribed burn
- No-till planting (Big Bluestem, little bluestem, Indian Grass, Switch Grass, forbs unk.)
- Herbicide Applied

Spring 2001

- Brome Grass chemically treated

Sub-Unit C "Main Trail West"

- At some point in the past, this was burned and planted. Dates and species unknown.

Sub-Unit D "Main Trail East"

Spring 1998

- Prescribed burn
- Herbicided
- Plowed/disked
- Dragged
- Mechanical broadcast seeded (plant list unknown)

Sub-Unit E "Cattail Loop"

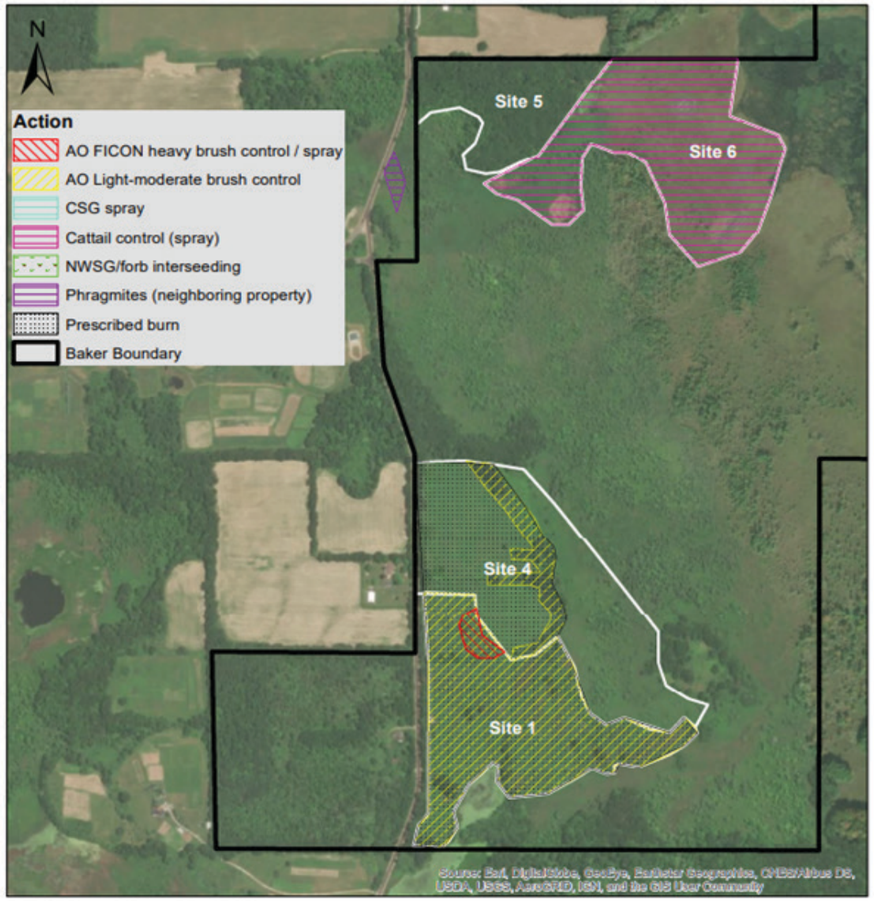
Spring 1998

- Entire unit prescribed burn
- 1⁄2 unit hand raked, hand seeded, cultipack
- 1⁄2 unit no treatment
- At some point plants were transplanted into this unit.

Sub-Unit F "Coyote Island"

- No management.

Bernard W. Baker Sanctuary
Michigan Audubon
21145 Fifteen Mile Rd. Bellevue, MI



Michigan Audubon
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Management Strategies / Objective

The single most important tool for management of these grassland habitats is fire. Reintroduction of a rotating fire schedule removes heavy overstory's of woody species and increases overall grass and forb diversity. For the restored mesic prairie and oak forest, it should be burned annually to assist the integrated management of autumn olive in this habitat type. SWM/SSC should be burned once every three years. This alternation reduces the impact on fire sensitive species and provides refugia for animals. This method is believed to enhance bird diversity. Oak forests are to be burned when adjacent communities are burned. Prescribed burns should be used to transition from oak forests in the northwest back to oak savannas with less than 35% canopy coverage in the southeast where the restored prairie starts.

An integrated method is suggested to control autumn olive (*Umbellata elaeagnus*). Due to the large population within this management unit, mowing/brush hogging followed by foliar spray is suggested. Mechanical removal can be used as a first step and is done in the late winter/ early spring while plants are dormant. Smaller stems can be cut with 'brush hogs' and larger stems can be cut with forestry cutters. Mowing alone is not an adequate process of removal, as it will result in a regrowth of smaller stems. The regrowth should be chemically treated with a foliar spray July-September, after bird nesting season. An effective herbicide solution for autumn olive is a combination of glyphosate and triclopyr with 0.5-1% of an appropriate non-ionic surfactant since glyphosate alone is an ineffective foliar treatment for this species.

This process should be repeated annually, and follow-up treatments should take place no sooner than six weeks after initial application.

A late spring/early summer prescribed burn (Mid to late May) will severely damage the leafed out woody species, including autumn olive.

TABLE 2.17 15 MILE GRASSLANDS QUALITY SITE INDICATORS / OUTCOME

Organism /Characteristic	Current Condition	Evaluation Method	Desired Condition
Invasive Plants	27 non-native species present; 24% *Umbellata elaeagnus* present in nearly half of survey sites in the 15 Mile parcel	Transect Site Survey	Absent; <5% Decreased *Umbellata elaeagnus* presence, contained to identified areas
Plant Species	# Observed Species: 111 Total Mean C: 3 Native Mean C: 4 Total FQI: 31.6 *Prunus serotina* and *Juglans nigra* are the common trees around the restored prairie, both are non-conforming and alter the soil chemistry	Transect Site Survey	Maintain and improve native species dominance; # Observed Species: ≥ 111 Total Mean C: ≥4 Native Mean C: >4 Total FQI: ≥35 *Prunus serotina* and *Juglans nigra* ≤1 per acre; Increase grassland species to >30% saturation in the restored prairie
C-Value 7-10	10.8% of species *Baptisia lactea* *Coreopsis lanceolata* *Coreopsis tripteris* *Dasiphora fruticosa; potentilla f.* *Decodon verticillatus* *Juncus acuminatus* *Lespedeza hirta* *Liriodendron tulipifera* *Piptatherum pungens; oryzopsis p.* *Rudbeckia fulgida*	Transect Site Survey	Increased abundance of species with a C value of ≥7
Fire Presence	Fire suppressed communities; oak forest transitioned from oak savanna with fire suppression	Site Survey	Fire dependant communities; Re-introduced fire regime; NW oak forest transitioning to an oak savanna with 10-15% max canopy coverage where it meets the prairie, regularly burned with surrounding communities; 25-35% canopy coverage within oak forests

TABLE 2.18 15 MILE GRASSLANDS MANAGEMENT TASK CALENDER

Year	Task	Time of Year
0	Site Evaluation	Summer
1-2	Mechanical removal of non-native and non-conforming trees and shrubs, reduce basal area and canopy coverage (*Elaeagnus umbellata, Juglans nigra* and *Prunus serotina)*	Late Winter/Early Spring (Nov-Feb)
3* *Adaptability for repeated process	Chemical treatment for regrowth of *Elaeagnus umbellata* -Foliar spray	Late Summer/Early Fall (Most effective July-Sept)
4	Prescribed Burn - Targets woody species (such as *Rosa multiflora*) - Mesic Prairie & Oak Forest: 1-3 years - After 2023, Marshall Native Garden should also be burned at this time. - SWM/SSC: Once every 3 years	Late Spring-Early Summer
5-6	Reintroduction and establishment of native herbaceous plant species in areas of invasive wood removal – plant and interseed with native grasses and shrubs *Determine seeding rate from instructions provided by seed supplier*	Mid Summer-Early Fall
6	Site Evaluation	Spring/Summer
7-9	Continue management of non-native species through mechanical, chemical, and prescribed burn. Non-native control– mechanical removal or herbicide Treatment for any unwanted vegetation	

WETLANDS OF 15 MILE

Current Conditions

These habitats were combined due to their defining hydrology. The only habitat type within this category that nested understory data was collected in was the oak swamp. However, a change to the previous naming of management units is suggested given that the dominant species within our survey was American elm (*Ulmus americana*) with a relative dominance of 100%. The non-native species present within all plots include smooth brome (*Bromus inermis*), wood avens (*Geum canadense*), cow parsley (*Anthriscus sylvestris*), multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), and timothy grass (*Phleum pratense*). In addition, there has been a small stand of *Phragmites* reported near this unit.

Best guesses for current conditions of tamarack swamp and pond natural communities within the 15 Miles Unit are like those found within these natural communities in other units, such as Ishman. A 2016 report describes this natural community to be a conifer dominated swamp. (Roake, 2016).

Management History

The wetland communities in the 15 Mile unit have very little past management in comparison to the grassland communities. A dike and water control structure were installed at the pond at some point, and over 50 years ago the oak swamp and riparian forest was subject to livestock grazing. However, the tamarack swamp has no past management.

Management Strategies / Objective

The management strategies for these habitats have been described in previous sections, namely 2.6.2 Junction Road. In summary, management and conservation of surrounding upland communities is the most important factor in maintaining hydrology, water quality, and habitat diversity. Invasive species establishment is fostered by development and are controlled through an integrated management strategy, using a wetland safe chemical treatment. Specifically for oak swamps, the best method to maintain biodiversity is to leave large tracts unmanaged to allow natural processes like windthrow and flooding to occur. For the emergent marsh that is surrounded by fire dependent grasslands, prescribed burning should include this habitat to facilitate seed establishment. In the tamarack swamp specifically, the removal of red maple (*Acer rubrum*) may be necessary as they eventually out compete tamaracks for light.

These communities are also generally threatened by garlic mustard (*Alliaria petiolata*), reed canary grass (*Phalaris arundinacea*), reed (*Phragmites australis subsp. australis*), autumn olive (*Elaeagnus umbellata*), multiflora rose (*Rosa multiflora*), and glossy buckthorn (*Frangula alnus*). An integrated management strategy is suggested to reduce presence of these invasive species, using a wetland safe chemical treatment.

TABLE 2.19 15 MILE WETLANDS QUALITY SITE INDICATORS/OUTCOME

Organism /Characteristic	Current Condition	Evaluation Method	Desired Condition
Invasive Plants	Small stand of invasive *Phragmites* reported near property	Transect	Absence of *Phragmites* and other invasive species; <5%
Plant Species	Current conditions in the tamarack swamp and pond are unknown due to lack of sampling in the area; Based on the surrounding areas, it is assumed non-native and invasive species are also present, to an unknown extent; Oak swamp dominated by *Ulmus americana*	Transect	# Observed Species: ≥ 50 (per management unit) Total Mean C: ≥4 Native Mean C: >4 Total FQI: ≥35 Decrease canopy coverage; Diverse riparian trees and shrubs in oak wamp
Pond	Berm and water control structure controlling the water height and flow	Meander Survey	Maintain and protect water control structures; Seasonal flooding; Maintain water level to encourage shallow pond and submergent marsh habitats grading into the uplands

TABLE 2.20 15 MILE OAK FOREST MANAGEMENT TASK CALENDER

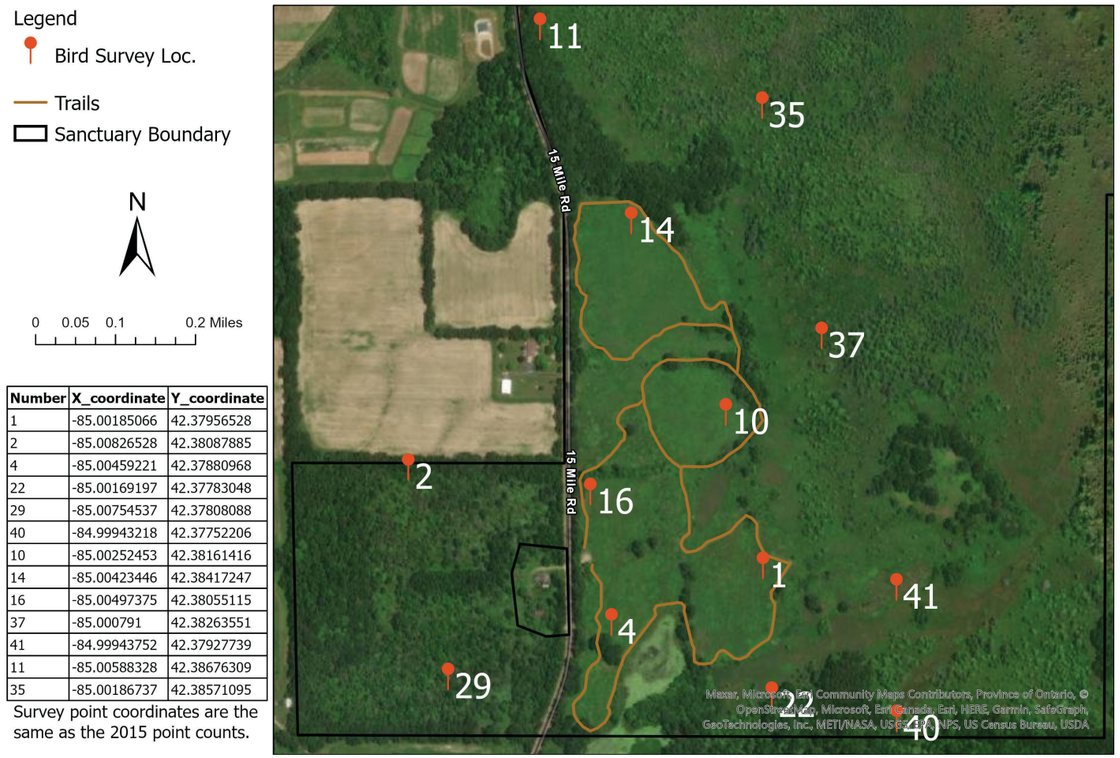
Year	Task	Time of Year
1	Site Evaluation	Summer
2-3* *Adaptability for repeated process	Chemical treatment of small-medium populations of invasive and undesirable woody vegetation. (*Elaeagnus umbellata* and *Rosa multiflora*). -Stump Cut—Cut stem 2" above ground and immediately apply herbicide to the cross-section of the stem.	Late Summer-Early Fall (July-September)
3	Mowing of cool-season non-native grasses *(Bromus inermis, Phleum pratense)*	Mid-Late Spring
3-4	Reintroduction and establishment of native herbaceous plant species– plant and interseed with native grasses and shrubs *Determine seeding rate from instructions provided by seed supplier*	Winter-Spring
Annually	Groundwater monitoring using the MiRAM methodology detailed in the "State of Michigan Wetland Monitoring and Assessment Strategy" (Michigan Department of Environmental Quality (MDEQ) Water Resources Division, 2015 Site Evaluations	Mid Summer-Early Fall

This unit contains several small to medium clusters of autumn olive and multiflora rose. An integrated method is suggested to control these species. Stump-cut, performed in the late summer-early fall consists of cutting the stem about 2" above the ground and immediately applying herbicide. This method is also referred to as 'Cut-and-Squirt'. Annual follow-up is required to control both species. In addition, monitoring of 20' from the population is recommended for multiflora roses specifically.

Because fires are rarely present in this area, and invasives like smooth brome are hard to control by burning, mowing close to the ground (even to the soil) in this natural community is required to manage these invasive species.

Following a mowing (and at times, the chemical removal of woody species) the reintroduction and establishment of native plant species is crucial. This can be accomplished by broadcasting seeds over bare soil or injecting them into the ground. After the initial year of habitat management, it is important to perform annual site evaluations to determine what species are present and their abundance as well as to determine the effectiveness of the removal treatments.

2.7 Bird Data



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4	-85.00459221	42.37880968
22	-85.00169197	42.37783048
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40	-84.99943218	42.37752206
10	-85.00252453	42.38161416
14	-85.00423446	42.38417247
16	-85.00497375	42.38055115
37	-85.000791	42.38263551
41	-84.99943752	42.37927739
11	-85.00588328	42.38676309
35	-85.00186737	42.38571095

Survey point coordinates are the same as the 2015 point counts.

FIGURE 2. 8 2021 POINT-COUNT SURVEY LOCATIONS

Bird Surveys

To get a better understanding of which bird species are using the sanctuary during breeding season a point count survey was conducted from end of May to beginning of June of 2021. The survey was conducted by three students; Douglas Noe, Esha Biswas, and Danielle Goodwin; at the University of Michigan, who are skilled birders. They were given a set of coordinate points, GPS device, and recording sheet. Two of them recorded bird sightings in the morning hours right after sunrise and one recorded bird sightings in the afternoon right before sunset. The survey area focused on the restored Meadow and Marshlands trail area in the 15 Mile unit of the preserve. Our contact with the Michigan Audubon for this project at the time, requested focus on this area because of possible future projects that would have benefited from this information.

In total 528 individuals were recorded across 13 different GPS points. A total of 44 samples were taken or about 3 visits per GPS point. Out of the 68 unique species recorded, red-winged blackbirds (*Agelaius phoeniceus*) were observed the most with 76 total individuals observed followed by field sparrow (*Spizella pusilla*) and common yellowthroat (*Geothlypis trichas*) with 59 observations each. The common yellowthroat (*Geothlypis trichas*) was observed in the most sampling units, 38.

TABLE 2.21 2021 POINT-COUNT SURVEY SPECIES LIST

Bird Survey Data

Species	Abundance	Frequency	Species	Abundance	Frequency
Agelaius phoeniceus	76	37	*Meleagris gallopavo*	2	1
Aix sponsa	6	4	*Melospiza georgiana*	10	4
Anas platyrhynchos	5	4	*Molothrus ater*	15	5
Antigone canadensis	27	16	*Myiarchus crinitus*	7	4
Ardea herodias	7	3	*Passerina cyanea*	6	4
Baeolophus bicolor	18	9	*Pheucticus ludovicianus*	11	3
Bombycilla cedrorum	2	2	*Pipilo erythrophthalmus*	2	2
Branta canadensis	4	4	*Poecile atricapillus*	1	1
Cardinalis cardinalis	51	22	*Polioptila caerulea*	2	1
Cathartes aura	4	3	*Quiscalus quiscula*	14	8
Chaetura pelagica	2	1	*Sayornis phoebe*	4	3
Charadrius vociferus	1	1	*Scolopax minor*	1	1
Colaptes auratus	9	7	*Setophaga fusca*	1	1
Contopus virens	25	11	*Setophaga petechia*	44	29
Corvus brachyrhynchos	18	11	*Setophaga pinus*	3	2
Cyanocitta cristata	29	17	*Setophaga virens*	1	1
Cygnus buccinator	8	4	*Sialia sialis*	9	7
Cygnus olor	2	1	*Sitta carolinensis*	14	9
Dryobates pubescens	14	7	*Spinus tristis*	23	14
Dryocopus pileatus	7	3	*Spizella pusilla*	59	29
Dumetella carolinensis	37	24	*Sturnus vulgaris*	40	4

To get a better understanding of how well this survey captures the diversity of this area, a Species-richness Prediction and Diversity Estimation (SpadeR) was run using R software. The R software package that was used was created by Chao et al (2015) and uses abundance data and incidence data to compute various biodiversity indices. The results of this computation suggest that our surveys were comprehensive, though there was an upward limit of 20 species that may not have been observed.

TABLE 2.22 2021 SPECIES RICHNESS PREDICTION AND DIVERSITY ESTIMATORS

Abundance Based				
Model	Estimate	s.e.	95% Lower	95% Upper
Homogeneous	71.333	2.22	69.017	78.928
Homogeneous (MLE)	68	0.006	68	68.018
Chao1 (Chao, 1984)	76.991	6.785	70.412	101.52
Chao1-bc	75.326	5.673	69.912	96.071
iChao1 (Chiu et al. 2014)	78.991	4.614	72.99	92.21
ACE (Chao & Lee, 1992)	75.663	4.63	70.568	90.867
ACE-1 (Chao & Lee, 1992)	77.205	5.905	70.913	97.089
1st order jackknife	79.988	4.895	73.552	93.883
2nd order jack-knife	83.988	8.473	74.03	110.393
Incidence Based				
Model	Estimate	s.e.	95% Lower	95% Upper
Homogeneous	72.76	2.75	69.663	81.629
Chao1 (Chao, 1984)	80.216	8.282	71.66	108.775
Chao1-bc	78.261	7.061	71.029	102.767
iChao1 (Chiu et al. 2014)	81.953	5.91	74.293	98.934
ACE (Chao & Lee, 1992)	78.122	5.472	71.752	95.307
ACE-1 (Chao & Lee, 1992)	80.175	7.03	72.255	102.839
1st order jackknife	82.659	5.384	75.3	97.437
2nd order jack-knife	88.586	9.186	76.93	115.458

Homogeneous Model: This model assumes that all species have the same abundances or discovery probabilities. See Eq. (2.3) of Chao and Lee (1992) or Eq. (7a) of Chao and Chiu (2016b).

Homogeneous (MLE): An approximate maximum likelihood estimates under homogeneous model. See Eq. (1.1) and Eq. (1.2) of Chao and Lee (1992) or Eq. (3) of Chao and Chiu (2016b).

Chao1 (Chao, 1984): This approach uses the numbers of singletons and doubletons to estimate the number of undetected species because undetected species information is mostly concentrated on those low frequency counts; see Chao (1984), and Chao and Chiu (2012, 2016a, b).

Chao1-bc: A bias-corrected form for the Chao1 estimator; see Chao (2005) or Eq. (6b) of Chao and Chiu (2016b).

iChao1: An improved Chao1 estimator; see Chiu et al. (2014).

ACE (Abundance-based Coverage Estimator): A non-parametric estimator proposed by Chao and Lee (1992) and Chao, Ma and Yang (1993). The observed species are separated as rare and abundant groups; only data in the rare group is used to estimate the number of undetected species. The estimated CV of the species in rare group characterizes the degree of heterogeneity among species discovery probabilities. See Eq. (2.14) in Chao and Lee (1992) or Eq. (7b) of Chao and Chiu (2016b).

ACE-1: A modified ACE for highly heterogeneous communities when CV of the entire dataset > 2 and species richness > 1000. See Eq. (2.15) in Chao and Lee (1992).

1st order jackknife: It uses the number of singletons to estimate the number of undetected species; see Burnham and Overton (1978).

2nd order jackknife: It uses the numbers of singletons and doubletons to estimate the number of undetected species; see Burnham and Overton (1978).

95% Confidence interval: A log-transformation is used for all estimators so that the lower bound of the resulting interval is at least the number of observed species. See Chao (1987).

eBird Data

eBird is a powerful documenting tool that collects data on bird distribution, abundance, habitat use, and trends through checklists uploaded by birders around the world. The goal of eBird is not only to power new data-driven approaches to science, conservation, and education but also to make birding more rewarding by offering several tools in order to provide the most current and useful information to birding communities.

On eBird, Bernard W. Baker Sanctuary is observed as an intermediate hotspot with a total of 158 observed species from 290 uploaded checklists. The oldest available checklist is from October 23, 2015; however, this only accounts for 200 of the 290 total checklists. While the checklists dated before October 23, 2015, are inaccessible, the data that are obtainable are invaluable as they provide consistent information about the bird species that are present at Baker Sanctuary throughout the past seven years.

Specifically, for the eBird analysis of Baker Sanctuary, 180 checklists were analyzed. This includes all available checklists from October 2015 to present while excluding duplicate checklists from multiple persons outings. From the 180 checklists, 162 bird species have been observed at the eBird location of 'Bernard W. Baker Sanctuary- Meadow and Marshland Trail within the 15 Mile Unit. The available checklists were individually input into a spreadsheet where the species, number of sightings, and month of sighting were recorded. For information regarding the abundance of a specific species, eBird 'bird observations bar charts' were utilized.

With this eBird data, we are not only able to see what species are present at the sanctuary but also when they are present and how frequently each species is sighted. This gives information about which species are using Baker Sanctuary during migration, breeding, or over-wintering. This is then further used to inform more specific conservation and management strategies for the sanctuary. Also, it allows managers to make an educated guess about the species richness and abundance at the sanctuary at specific times of the year. Using these data, the Michigan Audubon can prioritize specific management strategies for bird species that are considered rare, of a conservation concern, or of special importance. For instance, the sandhill crane (*Antigone canadensis*) is observed at Baker Sanctuary in all months of the year. However, the abundance of sandhill cranes is not evenly distributed throughout the year. Their abundance is steadily low throughout most of the year but reaches a drastic peak in October.

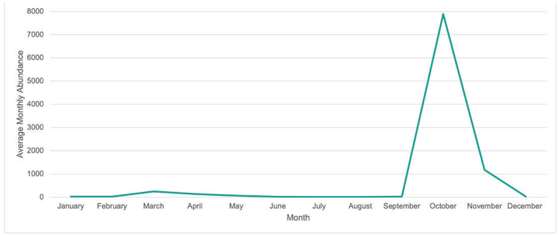


FIGURE 2. 9 AVERAGE COUNT OF SANDHILL CRANES BY MONTH

October experiences the largest abundance of sandhill cranes by a factor of eight and the month November experiences the second highest abundance of sandhill cranes. From this, it can be inferred that sandhill cranes use Baker Sanctuary as a stopping ground during their fall migration which occurs from mid to late October to late November. With this knowledge, Michigan Audubon can better adjust management strategies that will continue to promote Baker Sanctuary as a key staging area for sandhill crane populations. Further, this information can be used for grant proposals in order to fund future projects that can benefit sandhill cranes as well as the other bird species that are dependent on Baker Sanctuary.

Figure 2.9 displays the monthly averaged abundance of sandhill cranes from eBird checklists. While eBird averaged abundances can reveal migratory and behavioral patterns of specific bird species, it is important to note abundance is very difficult to estimate with eBird data due to possible repetition in counts. For instance, an eBirder might record 200 sandhill cranes on October 1st and another eBirder might record 200 sandhill cranes on October 2nd. It is likely these will be the same birds but they are being counted twice. For this reason, eBird abundance should be taken cautiously and only used to give an idea of sandhill crane migratory patterns. However, in this case, it is accepted that sandhill crane abundance is much larger in the fall season, notably October and November, in southern Michigan than any other time of year due to fall migration. Furthermore, an annual standardized count of the Eastern Population Sandhill Cranes was conducted on November 5th, 2021 at Baker Sanctuary per the request of the U.S. Fish and Wildlife Service. During this official count, 3,106 sandhill cranes were recorded from 4:30pm to 7:15pm. These official counts give additional evidence and information of the actual sandhill crane abundance at Baker Sanctuary as well as for the population as a whole.

TABLE 2.23 MONTHLY BIRD SPECIES COMPOSITION OF BAKER SANCTUARY

Bird Species	Sightings	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Empidonax alnorum (Alder Flycatcher)	7					X	X						
Anas rubripes (American Black Duck)	3				X						X		
Fulica americana (American Coot)	3										X		
Corvus brachyrhynchos (American Crow)	114	X	X	X	X	X	X	X		X	X	X	X
Spinus tristis (American Goldfinch)	106	X	X	X	X	X	X	X	X	X	X	X	X
Falco sparverius (American Kestrel)	8			X	X	X	X	X				X	
Setophaga ruticilla (American Redstart)	5					X					X		
Turdus migratorius (American Robin)	109		X	X	X	X	X	X	X	X	X	X	X
Spizelloides arborea (American Tree Sparrow)	44	X	X	X	X						X	X	X
Mareca americana (American Wigeon)	2										X		
Scolopax minor (American Woodcock)	5				X	X	X				X		
Haliaeetus leucocephalus (Bald Eagle)	15		X	X	X	X					X	X	X
Icterus galbula (Baltimore Oriole)	32					X	X	X					
Riparia riparia (Bank Swallow)	1					X							
Hirundo rustica (Barn Swallow)	31				X	X	X	X	X				
Setophaga castanea (Bay-breasted Warbler)	1									X			

Megaceryle alcyon (Belted Kingfisher)	19		X	X	X	X	X		X	X	X		X
Coccyzus erythropthalmus (Black-billed Cuckoo)	5					X	X						
Poecile atricapillus (Black-capped Chick-adee)	98	X	X	X	X	X	X	X	X	X	X	X	X
Setophaga caerulescens (Black-throated Blue Warbler)	1									X			
Setophaga virens (Black-throated Green Warbler)	4					X				X	X		
Setophaga fusca (Blackburnian Warbler)	2					X				X			
Setophaga striata (Blackpoll Warbler)	5					X				X	X		
Cyanocitta cristata (Blue Jay)	125	X	X	X	X	X	X	X	X	X	X	X	X
Polioptila caerulea (Blue-gray Gnatcatcher)	6				X	X	X		X	X			
Vireo solitarius (Blue-headed Vireo)	1										X		
Spatula discors (Blue-winged Teal)	4				X	X				X			
Vermivora cyanoptera (Blue-winged Warbler)	13				X	X	X						
Dolichonyx oryzivorus (Bobolink)	1									X			
Certhia americana (Brown Creeper)	6		X	X		X					X	X	
Toxostoma rufum (Brown Thrasher)	19				X	X	X	X		X	X		
Molothrus ater (Brown-headed Cowbird)	34			X	X	X	X	X				X	
Bucephala albeola (Bufflehead)	3			X	X								
Branta hutchinsii (Cackling Goose)	2	X	X										
Branta canadensis (Canada Goose)	71	X	X	X	X	X	X		X	X	X	X	X
Thryothorus ludovicianus (Carolina Wren)	5					X	X	X		X			
Bombycilla cedrorum (Cedar Waxwing)	40					X	X	X	X	X	X	X	X

Setophaga pensylvanica (Chestnut-sided Warbler)	4					X	X	X					
Chaetura pelagica (Chimney Swift)	9					X	X	X			X		
Spizella passerina (Chipping Sparrow)	39				X	X	X	X			X		
Spizella pallida (Clay-colored Sparrow)	2									X	X		
Gallinula galeata (Common Gallinule)	2					X							
Quiscalus quiscula (Common Grackle)	29			X	X	X	X	X	X		X		
Mergus merganser (Common Merganser)	1				X								
Geothlypis trichas (Common Yellowthroat)	63				X	X	X	X	X	X	X		
Accipiter cooperii (Cooper's Hawk)	6				X						X	X	
Junco hyemalis (Dark-eyed Junco)	34	X	X	X	X						X	X	X
Nannopterum auritum (Double-crested Cormorant)	1					X							
Dryobates pubescens (Downy Woodpecker)	80	X	X	X	X	X	X	X		X	X	X	X
Sialia sialis (Eastern Bluebird)	114	X	X	X	X	X	X	X	X	X	X	X	X
Tyrannus tyrannus (Eastern Kingbird)	27					X	X	X	X				
Sturnella magna (Eastern Meadowlark)	3				X		X						
Sayornis phoebe (Eastern Phoebe)	52			X	X	X	X	X	X	X	X		
Pipilo erythrophthalmus (Eastern Towhee)	27				X	X	X	X	X	X	X		
Contopus virens (Eastern Wood-Pewee)	31					X	X	X	X	X	X		
Sturnus vulgaris (European Starling)	24			X	X	X	X			X	X	X	
Hesperiphona vespertina (Evening Grosbeak)	1										X		
Falco sp. (Falcon sp.)	1										X		
Spizella pusilla (Field Sparrow)	77			X	X	X	X	X	X	X	X		

Passerella iliaca (Fox Sparrow)	8			X							X	X	
Mareca strepera (Gadwall)	1										X		
Aquila chrysaetos (Golden Eagle)	1										X		
Regulus satrapa (Golden-crowned Kinglet)	8			X	X						X		
Vermivora chrysoptera (Golden-winged Warbler)	2					X							
Ammodramus savannarum (Grasshopper Sparrow)	1						X						
Dumetella carolinensis (Gray Catbird)	60					X	X	X	X	X	X		
Catharus minimus (Gray-cheeked Thrush)	1										X		
Ardea herodias (Great Blue Heron)	32		X	X	X	X	X	X	X	X	X		
Myiarchus crinitus (Great Crested Flycatcher)	24					X	X	X	X	X			
Ardea alba (Great Egret)	4									X	X		
Butorides virescens (Green Heron)	10					X	X	X		X			
Anas carolinensis (Green-winged Teal)	5				X					X	X		
Leuconotopicus villosus (Hairy Woodpecker)	24		X		X	X	X	X		X	X	X	X
Catharus guttatus (Hermit Thrush)	7			X	X						X		
Larus smithsonianus (Herring Gull)	6		X		X						X	X	
Lophodytes cucullatus (Hooded Merganser)	7			X	X								
Eremophila alpestris (Horned Lark)	2										X		
Haemorhous mexicanus (House Finch)	14		X	X		X		X		X	X	X	X
Passer domesticus (House Sparrow)	8	X	X		X	X	X						X
Troglodytes aedon (House Wren)	45				X	X	X	X	X	X	X		
Passerina cyanea (Indigo Bunting)	34					X	X	X	X		X		

Charadrius vociferus (Killdeer)	25			X	X	X	X	X		X	X		
Empidonax minimus (Least Flycatcher)	8					X							
Melospiza lincolnii (Lincoln's Sparrow)	8					X					X		
Setophaga magnolia (Magnolia Warbler)	1									X			
Anas platyrhynchos (Mallard)	59		X	X	X	X	X		X	X	X	X	X
Zenaida macroura (Mourning Dove)	86	X	X	X	X	X	X	X	X	X	X	X	X
Geothlypis philadelphia (Mourning Warbler)	1					X							
Cygnus olor (Mute Swan)	2					X				X			
Leiothlypis ruficapilla (Nashville Warbler)	6					X				X	X		
Cardinalis cardinalis (Northern Cardinal)	104	X	X	X	X	X	X	X	X	X	X	X	X
Colaptes auratus (Northern Flicker)	74	X	X	X	X	X	X	X	X	X	X	X	X
Circus hudsonius (Northern Harrier)	6				X			X			X		
Mimus polyglottos (Northern Mockingbird)	1						X						
Setophaga americana (Northern Parula)	4					X							
Anas acuta (Northern Pintail)	2										X		
Stelgidopteryx serripennis (Northern Rough-winged Swallow)	3				X	X		X					
Spatula clypeata (Northern Shoveler)	2				X						X		
Contopus cooperi (Olive-sided Flycatcher)	1										X		
Leiothlypis celata (Orange-crowned Warbler)	4									X	X		
Icterus spurius (Orchard Oriole)	4					X	X						
Pandion haliaetus (Osprey)	1			X									
Seiurus aurocapilla (Ovenbird)	1										X		

Setophaga palmarum (Palm Warbler)	6					X					X		
Podilymbus podiceps (Pied-billed Grebe)	2										X	X	
Dryocopus pileatus (Pileated Woodpecker)	43	X	X	X	X	X	X	X		X	X	X	X
Spinus pinus (Pine Siskin)	2										X		
Setophaga pinus (Pine Warbler)	1									X			
Protonotaria citrea (Prothonotary Warbler)	1						X						
Haemorhous purpureus (Purple Finch)	3										X		X
Progne subis (Purple Martin)	1						X						
Melanerpes carolinus (Red-bellied Woodpecker)	115	X	X	X	X	X	X	X	X	X	X	X	X
Sitta canadensis (Red-breasted Nuthatch)	1									X			
Vireo olivaceus (Red-eyed Vireo)	14					X	X		X	X			
Melanerpes erythrocephalus (Red-headed Woodpecker)	17	X	X	X	X	X	X			X	X	X	
Phasianus colchicus (Ring-necked Pheasant)	1					X							
Buteo lineatus (Red-shouldered Hawk)	5		X	X									
Buteo jamaicensis (Red-tailed Hawk)	56	X	X	X	X	X	X	X	X	X	X	X	X
Agelaius phoeniceus (Red-winged Blackbird)	108		X	X	X	X	X	X		X	X	X	
Larus delawarensis (Ring-billed Gull)	24		X	X	X						X	X	X
Aythya collaris (Ring-necked Duck)	2				X						X		
Phasianus colchicus (Ring-necked Pheasant)	8					X	X	X					
Pheucticus ludovicianus (Rose-breasted Grosbeak)	25					X	X	X	X	X	X		

Corthylio calendula (Ruby-crowned Kinglet)	8				X	X					X		
Archilochus colubris (Ruby-throated Hummingbird)	6					X		X	X	X			
Euphagus carolinus (Rusty Blackbird)	4				X						X		
Antigone canadensis (Sandhill Crane)	113	X	X	X	X	X	X	X	X	X	X	X	X
Passerculus sandwichensis (Savannah Sparrow)	3				X		X						
Piranga olivacea (Scarlet Tanager)	12					X	X			X	X		
Cistothorus stellaris (Sedge Wren)	6					X	X						
Accipiter striatus (Sharp-shinned Hawk)	2							X			X		
Plectrophenax nivalis (Snow Bunting)	1		X										
Tringa solitaria (Solitary Sandpiper)	1							X					
Melospiza melodia (Song Sparrow)	114	X	X	X	X	X	X	X	X	X	X	X	X
Actitis macularius (Spotted Sandpiper)	1									X			
Catharus ustulatus (Swainson's Thrush)	2					X					X		
Melospiza georgiana (Swamp Sparrow)	32				X	X	X	X	X	X	X	X	
Leiothlypis peregrina (Tennessee Warbler)	7					X				X	X		
Tachycineta bicolor (Tree Swallow)	67			X	X	X	X	X	X				
Cygnus buccinator (Trumpeter Swan)	79	X	X	X	X	X	X	X	X	X	X		
Baeolophus bicolor (Tufted Titmouse)	74	X	X	X	X	X	X	X	X	X	X	X	X
Cathartes aura (Turkey Vulture)	103			X	X	X	X	X	X	X	X	X	
Catharus fuscescens (Veery)	4					X							
Pooecetes gramineus (Vesper Sparrow)	1						X						
Vireo gilvus (Warbling Vireo)	15					X	X	X		X			
Sitta carolinensis (White-breasted Nuthatch)	103	X	X	X	X	X	X	X	X	X	X	X	X

Zonotrichia leucophrys (White-crowned Sparrow)	15										X		
Zonotrichia albicollis (White-throated Sparrow)	20			X						X	X	X	
Meleagris gallopavo (Wild Turkey)	15		X	X	X	X	X	X			X		
Empidonax traillii (Willow Flycatcher)	13					X	X	X	X				
Gallinago delicata (Wilson's Snipe)	4				X								
Cardellina pusilla (Wilson's Warbler)	1									X			
Troglodytes hiemalis (Winter Wren)	4									X	X		
Aix sponsa (Wood Duck)	39			X	X	X	X	X	X	X	X		
Hylocichla mustelina (Wood Thrush)	15					X	X	X		X			
Setophaga petechia (Yellow Warbler)	44				X	X	X	X					
Empidonax flaviventris (Yellow-bellied Flycatcher)	3					X					X		
Sphyrapicus varius (Yellow-bellied Sapsucker)	3									X	X		
Coccyzus americanus (Yellow-billed Cuckoo)	6					X	X						
Icteria virens (Yellow-breasted Chat)	10					X	X	X					
Setophaga coronata (Yellow-rumped Warbler)	8				X	X				X	X		
Vireo flavifrons (Yellow-throated Vireo)	21				X	X	X	X		X			

There are many bird species such as the northern cardinal (*Cardinalis cardinalis*), white-breasted nuthatch (*Sitta carolinensis*), blue jay (*Cyanocitta cristata*), black-capped chickadee (*Poecile atricapillus*), etc. that use the sanctuary year-round. While their abundance may vary month by month, these species keep a relatively constant presence.

Bird Seasonality

By looking at Table 2.23, we are not only able to see when certain bird species utilize Baker Sanctuary, but we can also see patterns in bird seasonality of Michigan. The tables below display bird seasonality in all of Michigan with an emphasis on southern Michigan, particularly within Bernard W. Baker Sanctuary.

TABLE 2.24 SPRING BIRD ACTIVITY IN MICHIGAN

Month	When	What	Why	Note
March	Early	Red-winged Blackbird (*Agelaius phoeniceus*)	Arrival for breeding season	
	Early to Mid	American Robin (*Turdus migratorius*)	Arrival for breeding season	Will also over-winter in MI
	All	Waterfowl	Arrival for breeding season	
	Mid to Late	American Woodcock (*Scolopax minor*)	Arrival for breeding season	
	Late	Tree Swallow (*Tachycineta bicolor*), Killdeer (*Charadrius vociferus*), Wilson's Snipe (*Gallinago delicata*), Eastern Phoebe (*Sayornis phoebe*)	Arrival for breeding season	
April	Mid	Sparrows, Kinglets (*Regulus spp.*), Blue-gray Gnatcatcher (*Polioptila caerulea*), Yellow-rumped Warbler (*Setophaga coronata*)	Arrival for breeding season	
	All	Waterfowl	Arrival for breeding season	
	Mid to Late	Raptors (*Falconiformes spp.*), Ruby-throated Hummingbird (*Archilochus colubris*)	Arrival for breeding season	
	Late	American Tree Sparrows (*Spizelloides arborea*)	Northward departure for breeding season	
	Late	Least Flycatcher (*Empidonax minimus*)	Arrival for breeding season	
May	Early to Mid	Warblers: Yellow Warbler (*Setophaga petechia*), Chestnut-sided Warbler (*S. pensylvanica*), Black-throated Green Warbler (*S. virens*), American Redstart (*S. ruticilla*) Thrushes: Wood Thrush (*Hylocichla mustelina*), Veery (*Catharus fuscescens*)	Arrival for breeding season	

For instance, the first indicators of spring, the red-winged blackbird (*Agelaius phoeniceus*) and American robin (*Turdus migratorius*), are first sighted in February (Thompson, Spring). This is followed by the arrival of various waterfowl as the ice breaks up on the Great Lakes in late February and early March (Thompson, Spring). This can be easily seen by analyzing waterfowl with many sightings at Baker Sanctuary such as the mallard (*Anas platyrhynchos*) and wood duck (*Aix sponsa*) who are first sighted in February and March. The official beginning of spring in late March is marked by the arrival of several other birds including the killdeer (*Charadrius vociferus*), tree swallow (*Tachycineta bicolor*), and eastern phoebe (*Sayornis phoebe*) (Thompson, Spring). The beginning of April experiences a noticeable increase in migrant arrivals such as golden (*Regulus satrapa*) and ruby-crowned kinglets (R. calendula), Wilson's snipe (*Gallinago delicata*), blue-gray gnatcatchers (*Polioptila caerulea*), yellow-rumped warbler (*Setophaga coronata*), and various sparrows such as the chipping sparrow (*Spizella passerina*) and swamp sparrow (*Melospiza georgiana*) (Thompson, Spring). Oftentimes, late April in Michigan is when spring raptor migration reaches its peak, however, the location of Baker Sanctuary is not ideal as many migration lines are farther north, such as at the Straits of Mackinac, or east toward the Detroit River Hawk Watch. Fortunately, Baker Sanctuary is far enough south that several raptors are year-round residents such as the red-tailed hawk (*Buteo jamaicensis*), cooper's hawk (*Accipiter cooperii*), bald eagle (*Haliaeetus leucocephalus*), northern harrier (*Circus hudsonius*), and sharp-shinned hawk (*Accipiter striatus*) although sightings of certain raptors seem to be infrequent and unpredictable at the sanctuary. Lastly, the end of April marks the departure of the American tree sparrow as it migrates northward for breeding season.

Interestingly, the eBird data from Baker Sanctuary corresponds well with Michigan's migration patterns. May is the peak of migration throughout the state which is supported by the eBird data as the month of May has the highest number of species sightings at Baker Sanctuary. The figure below displays the average number of species sightings at Baker Sanctuary for each month while controlling for the number of checklists.

FIGURE 2.10 BIRD SIGHTINGS BY MONTH

Throughout the month of May, many birds migrate to Michigan for breeding season. Such birds include many warblers, cuckoos, and flycatchers such as the yellow warbler (*Setophaga petechia*), chestnut-sided warbler (*S. pensylvanica*), black-throated green warbler (*S. virens*), American redstart (*S. ruticilla*), yellow (*Coccyzus americanus*) and black-billed cuckoo (*C. erythropthalmus*), willow flycatcher (*Empidonax traillii*), yellow-bellied flycatcher (*Empidonax flaviventris*), and great-crested flycatcher (*Myiarchus crinitus*) (Thompson, Spring). This migration continues until June although with much less vigor.

TABLE 2.25 SUMMER BIRD ACTIVITY IN MICHIGAN

Month	When	What	Why	Note
June	Early to Mid	Black (*Coccyzus erythropthalmus*) and Yellow-billed Cuckoo (*C. americanus*), Olive-Sided (*Contopus cooperi*) and Yellow-bellied Flycatcher (*Empidonax flaviventris*)	Late migrators to breeding grounds	
	All	Mourning Dove (*Zenaida macroura*), Downy Woodpecker (*Dryobates pubescens*), Red-bellied Woodpecker (*Melanerpes carolinus*), Black-capped Chickadee (*Poecile atricacpillus*), Tufted Titmouse (*Baeolophus bicolor*), White-breasted Nuthatch (*Sitta carolinensis*), House Finch (*Haemorhous mexicanus*), American Goldfinch (*Spinus tristis*), Blue Jay (*Cyanocitta cristata*), Song Sparrow (*Melospiza melodia*), Indigo Bunting (*Passerina cyanea*), Northern Cardinal (*Cardinalis cardinalis*)	Common summer and year-round residents	
July	All	American Goldfinch (*Spinus tristis)*	Nesting	
August	Early to Mid	Warblers: Yellow (*Setophaga petechia*), Blackburnian (*Setophaga fusca*), Blue-winged (*Vermivora cyanoptera*); Empidonax flycatchers and Eastern Kingbird (*Tyrannus tyrannus*); Yellow (*Coccyzus americanus)* and Black-billed Cuckoo (*C. erythropthalmus*); Yellow-breasted Chat (*Icteria virens*); Ruby-throated Hummingbird (*Archilochus colubris*); First migrant thrushes	Departure for wintering grounds	
	Late	Swallows: Barn Swallow (*Hirundo rustica*), Northern Rough-winged (*Stelgidopteryx serripennis*), Tree Swallow (*Tachycineta bicolor*); Ruby-throated Hummingbird (*Archilochus colubris*); Raptors (*Falconiformes*) and Nighthawks (*Chordeiles spp.*); Warbling Vireo (*Vireo gilvus*); Blue-winged Teal (*Spatula discors*)	Departure for winter-ing grounds	Some raptors over-winter at Baker

The end of spring and beginning of summer marks the decline and end of spring migration for many birds. A few species still may be migrating such as some waterfowl and late migrant songbirds such as the yellow (*Coccyzus americanus*) and black-billed cuckoo (*C. erythropthalmus*), some flycatchers, and a few warblers (Thompson, Summer). During the summer, it is common for sightings to decline as many of the songbirds breed north of the reserve and many resident breeders are busy tending to their young (Thompson, Summer). However, common species seen during summer months are mourning doves (*Zenaida macroura*), downy woodpeckers (*Picoides pubescens*), red-bellied woodpeckers (*Melanerpes carolinus*), black-capped chickadees (*Poecile atricapillus*), tufted titmouses (*Baeolophus bicolor*), white-breasted nuthatches (*Sitta carolinensis*), house finches (*Haemorhous mexicanus*), American goldfinches (*Spinus tristis*), blue jays (*Cyanocitta cristata*), song sparrows (*Melospiza melodia*), indigo buntings (*Passerina cyanea*), and northern cardinals (*Cardinalis cardinalis*) (Thompson, Summer).

Fall bird migration tends to begin in August with many songbirds beginning to migrate in early to mid-August including several warblers such as the yellow (*Setophaga petechia*) and blackburnian (*S. fusca*), Empidonax flycatchers, and warbling vireos (*Vireo gilvus*) (Thompson, Summer). By mid-August, first migrants of many species begin their journey such as thrushes and common nighthawks (*Chordeiles minor*) that typically increase in numbers by the end of the month. Further, several species begin their migration in late August and into September such as several species of swallows, waterfowl, and raptors (Thompson, Summer).

TABLE 2.26 FALL BIRD ACTIVITY IN MICHIGAN

Month	When	What	Why	Note
September	All	Warblers, Vireos, Thrushes, Waterfowl, Hawks, and Ruby-throated Hummingbird (*Archilochus colubris*)	Peak Fall Migration	Waterfowl more common on Great Lakes
	Late	Blue Jay (*Cyanocitta cristata*)	Fall Migration	
October	Early	American Tree Sparrow (*Spizelloides arborea*), Snow Bunting (*Plectrophenax nivalis*), Dark-eyed Junco (*Junco hyemalis)*, Evening Grosbeak (*Coccothraustes vespertinus)*, Pine Siskin (*Spinus pinus*), House Finch (*Haemorhous mexicanus*), etc.	Arrival of wintering birds	
	Early	Sharp-shinned Hawk (*Accipiter striatus*)	Peak Fall Migration	
	Mid	Cooper's Hawk (*Accipiter cooperii)*	Peak Fall Migration	
	Mid to Late	Nashville (*Leiothlypis ruficapilla*), Orange-crowned (*L. celata*), Yellow-rumped (*Setophaga coronata*), Black-throated Blue (*S. caerulescens*), and Blackpoll (*S. striata*)	Only Warblers still present in MI; Orange-crowned Warbler peak	
	Late	Sparrows: White-throated (*Zonotrichia albicollis*), White-crowned sparrow (*Z. leucophrys*), Song (*Melospiza melodia*), Swamp (*M. georgiana*); Kinglets (*Regulus spp.*), Brown Creeper (*Certhia americana*), Horned Larks (*Eremophila alpestris*), and migrant American Goldfinches (*Spinus tristis*)	Fall Migration	
	Late	Raptors: Red-shouldered Hawk (*Buteo lineatus*), Red-tailed Hawk (*B. jamaicensis*), and Golden Eagle (*Aquila chrysaetos*)	Fall Migration	
	All	Waterfowl: American Black Duck (*Anas rubripes*), American Wigeon (*Mareca americana*), Gadwall *(Mareca strepera),* Trumpeter Swan (*Cygnus buccinator*), etc.	Fall Migration	More common on Great Lakes
	All	Hawks: Northern Harrier (*Circus hudsonius*), Bald Eagle (*Haliaeetus leucocephalus*)	Peak Fall Migration	
November	All	Snow Buntings (*Plectrophenax nivalis*), American Tree Sparrow (*Spizelloides arborea*), Crossbills (*Loxia spp.*), and Grosbeaks (*P. ludovicianus*), and Northern Finches (*Colaptes auratus*)	Continued arrival of wintering birds	

In September, fall migration for many bird species is well underway. Many warblers, vireos, and thrushes reach their migration peak during September (Thompson, Fall). Ruby-throated hummingbirds (*Archilochus colubris*) will continue their migration out of Michigan with very few remaining by the end of the month (Thompson, Fall). The migration of waterfowl also begins around this time; however, this is better viewed in large bodies of water such as the Great Lakes. Similarly, hawk migration also begins in September, however, as mentioned before this is better viewed in northern locations such as the Straits of Mackinac and eastern locations such as the Detroit River Hawk Watch.

The beginning of October is when wintering birds begin to arrive in southern Michigan. These birds include snow buntings (*Plectrophenax nivalis*), American tree sparrow (*Spizelloides arborea*), and dark-eyed juncos (*Junco hyemalis*) (Thompson, Fall). The migration of warblers and thrushes is still underway in October. Some of the more common warblers to see during this time of the year include the Nashville (*Leiothlypis ruficapilla*), orange-crowned (*L. celata*), yellow-rumped (*Setophaga coronata*), black-throated blue (*S.caerulescens*), and the blackpoll (*S. striata*) (Thompson, Fall). Interestingly, the orange-crowned warbler reaches its population peak in October (Thompson, Fall). By the end of the month, additional wintering birds begin to arrive such as white-throated (*Zonotrichia albicollis*) and white-crowned sparrows (*Z. leucophrys*), kinglets (Regulus sp.), brown creepers (*Certhia americana*), horned larks (*Eremophila alpestris*), migrant American goldfinches (*Spinus tristis*), as well as “winter finches” that include pine siskins (*Spinus pinus*) and evening grosbeaks (Coccothraustes vespertinus) (Thompson, Fall).

While Baker Sanctuary does not experience the great hawk migration as other parts of the state do, there is still evidence of a hawk migration underway. In October, the species diversity of migrating hawks is the greatest in Michigan. This can be seen at Baker Sanctuary as eight out of the ten present hawk species have been sighted in the month of October including the bald eagle (*Haliaeetus leucocephalus*), Cooper’s hawk (*Accipiter cooperii*), golden eagle (*Aquila chrysaetos*), northern harrier (*Circus hudsonius*), red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*B. jamaicensis*), sharp-shinned hawk (*Accipiter striatus*), and a falcon species (*falco spp*.). The only exceptions are the osprey (*Pandion haliaetus*) and American kestrel (*Falco sparverius*). The chart 2.7.4 below displays the abundance of five raptor species in Baker Sanctuary. It can be easily seen that there is an increase in raptor species diversity in the month of October.

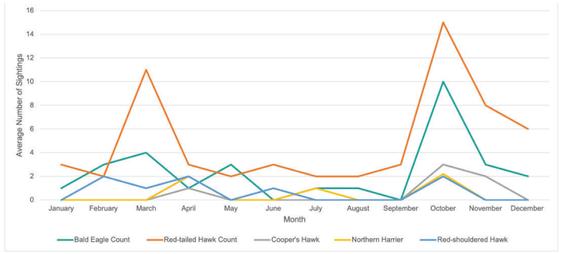


FIGURE 2. 11 ABUNDANCE OF FIVE RAPTOR SPECIES IN BAKER SANCTUARY SINCE 2015

Each hawk species has slightly different migration patterns as sharp-shinned hawks reach peak migration by early October, Cooper’s hawks reach peak migration in mid-October, and red-tailed and red-shouldered hawks reach peak migration by late October (Thompson, Fall). The latter half of October is usually marked by the arrival of the first golden eagle which has only ever been sighted at Baker Sanctuary one time in the past seven years.

Bird sightings at Baker Sanctuary vary greatly throughout the year. May has the highest number of sightings with 101 different species and October has the second highest number of sightings with 99 different species sightings. These peaks in activity are due to migrations. For instance, May is the peak month for spring migration while October is the peak month for fall migration. For instance, there is much overlap of bird species at Baker Sanctuary during the month of October. There are still remnants of warblers, vireos, and thrushes from the breeding season, there are outgoing and incoming blue jays, there are migrating waterfowl and raptors, as well as incoming overwintering birds. During this time of year, there tends to be an increase in species diversity as rarities and vagrant birds are more common (Thompson, Fall). For instance, 37% of the species that have been sighted in only one month have been sighted in October. This can be compared with 22% of the species that have been sighted in only one month have been sighted in May, 17% in September, 5% in April, and so on. Further, of the bird species that have only been recorded at Baker Sanctuary on three or less instances, 49% have been in the months of September and October.

TABLE 2.27 WINTER BIRD ACTIVITY IN MICHIGAN

Month	When	What	Why	Note
December	All	Late migrating songbirds- American Pipits (*Anthus rubescens*), Horned Larks (*Eremophila alpestris*), Snow Buntings (*Plectrophenax nivalis*)	Fall Migration	
	All	Winter finches: Pine Siskin (*Spinus pinus*), Purple Finch (*Haemorhous purpureus*), migrant American Goldfinch (*Spinus tristis*), House Finch (*Haemorhous mexicanus*), etc.	Late arrival of wintering birds	
	All	Wintering Waterfowl	Present	More common on Great Lakes
January	Mid	Winter Finches	Irruption Year-continued arrival of wintering birds	Very late arrival
February	All	Gulls and Wintering Waterfowl	Most Present	
	Mid to Late	Mourning Dove (*Zenaida macroura*)	Initiation of breeding season	
	Late	Horned Lark (*Eremophila alpestris*), Northern Harrier (*Circus hudsonius*), Red-winged Blackbirds (male) (*Agelaius phoeniceus*), American Robins (*Turdus migratorius*)	Arrival of first migrants	

Winter is the least active season for birds at Baker Sanctuary. Specifically, January has the lowest species diversity with only 23 sighted species, December is the second lowest in terms of species diversity with only 29 species sighted, and February has the third lowest species diversity count with only 37 species sighted.

In December, there might be late migrating songbirds such as American pipits (*Anthus rubescens*), horned larks (*Eremophila alpestris*), and snow buntings (*Plectrophenax nivalis*) (Thompson, Winter). Additionally, it is not uncommon to observe a raptor as a few late migrants might come through Baker Sanctuary. There might be a sighting of waterfowl on Big Marsh Lake as large numbers are present on the Great Lakes until they become completely frozen over (Thompson, Winter). Further, there might be sightings of “winter finches” as in irruption years they may not reach southern Michigan until later in the month or even early January (Thompson, Winter). Throughout the month of December, several wintering birds will take up residence in the area such as dark-eyed juncos (*Junco hyemalis*), American tree sparrow (*Spizelloides arborea*), American goldfinches (*Spinus tristis*), or even a raptor like the cooper’s hawk (*Accipiter cooperii*) (Thompson, Winter).

As mentioned above, January at Baker Sanctuary has the least amount of birding activity than the rest of the year due to having the coldest temperatures and much snowfall. During the month, the most common birds that can be seen are wintering gulls flying high in the sky and waterfowl. However, it seems as though Baker Sanctuary does not experience many waterfowl possibly due to the inland location. By mid-February, the initiation of breeding season begins for certain species such as the mourning dove (*Zenaida macroura*) (Thompson, Winter). By the end of the month, first migrants

of species can be seen such as the northern harrier (*Circus hudsonius*), horned lark (*Eremophila alpestris*), American robins (*Turdus migratorius*), and male red-winged blackbirds (*Agelaius phoeniceus*) (Thompson, Winter).

eBird Rare or Uncommon Birds of Baker Sanctuary

Table 2.7.6 below lists species observed at Baker Sanctuary on three or fewer instances since 2015. The species, number of sightings, month of sighting(s), and when they are expected at Baker Sanctuary are listed. The range of each species comes from The National Audubon Society and the Cornell Lab of Ornithology.

TABLE 2.28 SPECIES OBSERVED AT BAKER SANCTUARY ON THREE OR FEWER INSTANCES SINCE 2015

Species	Number of Sightings	Month of Sighting	Species Range
Riparia riparia (Bank Swallow)	1	May	Range encompasses Baker during breeding season
Setophaga castanea (Bay-breasted Warbler)	1	September	Range encompasses Baker during migration
Setophaga caerulescens (Black-throated Blue Warbler)	1	September	Range encompasses Baker during migration
Vireo solitarius (Blue-headed Vireo)	1	October	Range encompasses Baker during migration
Dolichonyx oryzivorus (Bobolink)	1	September	Range encompasses Baker during breeding season
Mergus merganser (Common Merganser)	1	April	Range encompasses Baker in winter
Phalacrocorax auritus (Double-crested Cormorant)	1	May	Range encompasses Baker during migration
Coccothraustes vespertinus (Evening Grosbeak)	1	October	Range encompasses Baker in winter
Mareca strepera (Gadwall)	1	October	Range encompasses Baker during migration
Aquila chrysaetos (Golden Eagle)	1	October	Range encompasses Baker during migration
Ammodramus savannarum (Grasshopper Sparrow)	1	June	Range encompasses Baker during breeding season
Catharus minimus (Gray-cheeked Thrush)	1	October	Range encompasses Baker during migration
Setophaga magnolia (Magnolia Warbler)	1	September	Range encompasses Baker during migration
Geothlypis philadelphia (Mourning Warbler)	1	May	Range encompasses Baker during breeding season
Mimus polyglottos (Northern Mockingbird)	1	June	Range encompasses Baker year-round
Contopus cooperi (Olive-sided Flycatcher)	1	October	Range encompasses Baker during migration
Pandion haliaetus (Osprey)	1	March	Range encompasses Baker during breeding season
Seiurus aurocapilla (Ovenbird)	1	October	Range encompasses Baker during breeding season
Setophaga pinus (Pine Warbler)	1	September	Range encompasses Baker during breeding season
Protonotaria citrea (Prothonotary Warbler)	1	June	Range encompasses Baker during breeding season
Progne subis (Purple Martin)	1	June	Range encompasses Baker during breeding season
Sitta canadensis (Red-breasted Nuthatch)	1	September	Range encompasses Baker in winter
Phasianus colchicus (Ring-necked Pheasant)	1	May	Range encompasses Baker year-round
Plectrophenax nivalis (Snow Bunting)	1	February	Range encompasses Baker in winter
Tringa solitaria (Solitary Sandpiper)	1	July	Range encompasses Baker during migration
Actitis macularius (Spotted Sandpiper)	1	September	Range encompasses Baker during breeding season
Pooecetes gramineus (Vesper Sparrow)	1	June	Range encompasses Baker during breeding season
Cardellina pusilla (Wilson's Warbler)	1	September	Range encompasses Baker during migration
Mareca americana (American Wigeon)	2	October	Range encompasses Baker during migration
Setophaga fusca (Blackburnian Warbler)	2	May & September	Range encompasses Baker during migration
Branta hutchinsii (Cackling Goose)	2	January & February	Range encompasses Baker during winter (scarce)
Spizella pallida (Clay-colored Sparrow)	2	September & October	Range encompasses Baker during migration
Gallinula galeata (Common Gallinule)	2	May	Range encompasses Baker during breeding season
Vermivora chrysoptera (Golden-winged Warbler)	2	May	Range encompasses Baker during breeding season
Eremophila alpestris (Horned Lark)	2	October	Range encompasses Baker year-round
Cygnus olor (Mute Swan)	2	May & September	Range encompasses Baker year-round
Riparia riparia (Bank Swallow)	1	May	Range encompasses Baker during breeding season
Setophaga castanea (Bay-breasted Warbler)	1	September	Range encompasses Baker during migration
Setophaga caerulescens (Black-throated Blue Warbler)	1	September	Range encompasses Baker during migration
Vireo solitarius (Blue-headed Vireo)	1	October	Range encompasses Baker during migration
Dolichonyx oryzivorus (Bobolink)	1	September	Range encompasses Baker during breeding season
Mergus merganser (Common Merganser)	1	April	Range encompasses Baker in winter

Phalacrocorax auritus (Double-crested Cormorant)	1	May	Range encompasses Baker during migration
Coccothraustes vespertinus (Evening Grosbeak)	1	October	Range encompasses Baker in winter
Mareca strepera (Gadwall)	1	October	Range encompasses Baker during migration
Aquila chrysaetos (Golden Eagle)	1	October	Range encompasses Baker during migration
Ammodramus savannarum (Grasshopper Sparrow)	1	June	Range encompasses Baker during breeding season
Catharus minimus (Gray-cheeked Thrush)	1	October	Range encompasses Baker during migration
Setophaga magnolia (Magnolia Warbler)	1	September	Range encompasses Baker during migration
Geothlypis philadelphia (Mourning Warbler)	1	May	Range encompasses Baker during breeding season
Mimus polyglottos (Northern Mockingbird)	1	June	Range encompasses Baker year-round
Contopus cooperi (Olive-sided Flycatcher)	1	October	Range encompasses Baker during migration
Pandion haliaetus (Osprey)	1	March	Range encompasses Baker during breeding season
Seiurus aurocapilla (Ovenbird)	1	October	Range encompasses Baker during breeding season

Most bird species whose range encaompasses Baker during a specific time of year largely align with the month(s) they were sighted. For instance, the blackburnian warbler (*Setophaga fusca*) is considered common at Baker Sanctuary during times of migration which aligns with the two instances this species was sighted at Baker– once in May and once in September. Furthermore, it is interesting to note that 61% of these birds with three or fewer sightings have been sighted in either September and/or October. As mentioned previously, rarities and vagrant birds are more common during this time of the year due to the sheer amount of bird activity that occurs during this time.

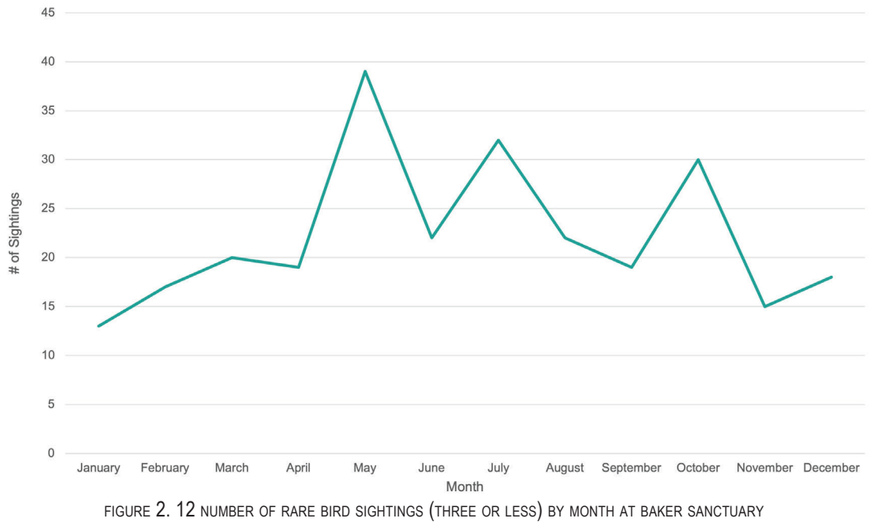


FIGURE 2. 12 NUMBER OF RARE BIRD SIGHTINGS (THREE OR LESS) BY MONTH AT BAKER SANCTUARY

Influences of eBird Data

While eBird provides a wealth of invaluable information, there are certain things to keep in mind when analyzing the data. Firstly, the bird sightings need to be addressed. The most sighted bird at Baker Sanctuary is the blue jay with 125 sightings since 2015 and the second most sighted bird at Baker is the red-bellied woodpecker (*Melanerpes carolinus*) with 115 sightings in the same timeframe. While this information is significant, it is important to keep in mind possible bias. The blue jay (C*yanocitta cristata*) and the red-bellied woodpecker are both quite distinguishable and easily identifiable. These species may have been sighted more than other species because of these factors, while cryptic species abundances tend to be under-estimated when using ebird data. It is also important to note possible bias for diurnal species. Bird activity that coincides with human activity is more likely to have been recorded. For instance, according to eBird, there has never been an owl or nightjar sighted at Baker Sanctuary, however, there are almost certainly owls and nightjars at the Sanctuary

It is also important to note bird sightings based on seasonality. On eBird, May and October appear to experience the highest species diversity at Baker Sanctuary, however, this could be due to increased visitations of birders. While there is almost certainly higher species diversity during migration, it may be exaggerated by more people actively birding. Additionally, increased birder activity during the migratory periods likely produces seasonality in the abundance estimates of non-migratory birds. Conversely, winter is the season with the fewest ebird checklists, and this corresponds to low estimates of species diversity. These things are almost certainly associated with each other.

Finally, it is important to keep in mind that eBird is a citizen science dataset. As mentioned previously, while the information eBird collects is invaluable, the quality of the data is contingent on the skills of the birders, which vary greatly among observers. This could introduce error through misidentification or miscalculations with abundance estimates, and failure to observe rare species. For example, there have been 27 species observed at Baker Sanctuary just once since 2015 with many considered rare in this area. So, while we take note of these rare species and include them in our data, it is important to regard them carefully.

CHAPTER 3: RECOMMENDATIONS

3.1 Restoration 10 Year Plan

The following represents recommendations for Michigan Audubon to facilitate the improvement and expansion of diverse, high-quality habitat, and to increase community engagement and volunteer capacity at Baker Sanctuary. Decision making was prioritized through extensive literature review, analysis of monitoring results, and a thorough examination of past management practices at this site.

Priority 1: 15 Mile Road

Restoration phases are organized into restoration phases for oak forest and phases for grasslands. This differs from previous sections to allow flexibility in restoration implementation that can be responsive to funding availability. Ideally, if finances allow, these habitats should have these recommendations applied to them simultaneously.

However, this may differ due to a Burn Plan implemented by a certified Burn Boss, who may burn one habitat type to leave refuge for flora and fauna.

Phase 1:

A. Restoration: Grasslands (restored prairie/SWM/SSC)

a. Implement proper mechanical and/or chemical treatment following the schedule outlined within 2.6 of invasive and undesirable woody species.

b. Coordinate a prescribed burn (and future regime) with a certified Burn Boss.

c. Coordinate vegetation sampling conducted by qualified individuals following the schedule outlined within 2.6.4.

i. Add sampling sites and collect data within tamarack swamp and pond natural communities.

Phase 2:

A. Restoration: Oak Forests

a. Implement proper mechanical and/or chemical treatment following the schedule outlined within 2.6.4 of invasive species.

b. Coordinate a prescribed burn (and future regime) with a certified Burn Boss.

c. Coordinate vegetation sampling conducted by qualified individuals following the schedule outlined within 2.6.4.

Phase 3:

A. Manage and Enhance: Marshall Native Garden

a. Follow the specific management plan outlined.

b. Design and install permanent interpretive signage, focusing on function and form of native plants.

c. Plan and contract installation of 15’ wide gravel drive and lot for a minimum of five parking spaces.

Phase 4:

A. Expand and Enhance: Visitor Experience

a. Design and build new wayfinding signage that includes a trail map.

b. Update kiosk structure and posted materials.

c. Design and implement interpretive signage, focusing on restoration practices, citizen science (bird box monitoring), and key species listed in 3.2.

Priority 2: Junction Road

Phase 1:

B . Restoration: Grasslands (old field /SWM/SSC)

a. Implement proper mechanical and/or chemical treatment following the schedule outlined within 2.6.2 of invasive and undesirable woody species.

b. Coordinate a prescribed burn (and future regime) with a certified Burn Boss.

c. Coordinate vegetation sampling conducted by qualified individuals following the schedule outlined within 2.6.2.

Phase 2:

B. Restoration: Forests and wetland habitat

a. Implement groundwater monitoring system using MiRAM methodology for wetland habitats

b. Implement proper mechanical and/or chemical treatment following the schedule outlined within 2.6.2 of invasive and undesirable woody species.

c. Coordinate a prescribed burn (and future regime) with a certified Burn Boss.

d. Coordinate vegetation sampling conducted by qualified individuals following the schedule outlined within 2.6.2.

Phase 3:

B. Monitor and Manage: Big Marsh Lake

a. Implement monitoring regimen of aquatic organisms to determine health of lake

b. Implement water testing regimen in order to track nutrient levels (nitrogen, phosphorus, etc.)

c. Management as needed

Phase 4:

B. Expand: Visitor Experience

a. Design and install wildflower viewing trail and entrance system

b. Design and install kiosk structure to include map of trail system and relevant plant/bird material

c. Design and implement interpretive signage, focusing on restoration practices, citizen science (bird box monitoring), and key species listed in 3.2.

Priority 3: Isham

Phase 1:

C. Restoration: Oak Forest

a. Implement proper mechanical and/or chemical treatment following the schedule outlined within 2.6.1 of invasive and undesirable woody species.

b. Coordinate a prescribed burn (and future regime) with a certified Burn Boss.

c. Coordinate vegetation sampling conducted by qualified individuals following the schedule outlined within 2.6.1.

Phase 2:

C. Restoration: Wetlands

a. Implement groundwater monitoring system using MiRAM methodology

b. Implement proper mechanical and/or chemical treatment following the schedule outlined within 2.6.1 of invasive and undesirable woody species.

c. Coordinate a prescribed burn (and future regime) with a certified Burn Boss.

d. Coordinate vegetation sampling conducted by qualified individuals following the schedule outlined within 2.6.1.

Phase 3:

C. Monitor and Manage: Big Marsh Lake

a. Implement monitoring regimen of aquatic organisms to determine health of lake

b. Implement water testing regimen in order to track nutrient levels (nitrogen, phosphorus, etc.)

c. Management as needed

Phase 4:

C. Expansion and Enhancement: Visitor Experience

a. Coordinate and plan strategy to connect Meadow and Marshland Trails within the 15 Miles Unit to trails within the Isham Unit.

b. Design and install interpretive signage within the Isham trails, focusing on the story of the former landowner Mabelle Isham and of significant habitats within the unit.

c. Plan and install sandhill crane viewing area within sight of Big Marsh Lake

Priority 4: old doty wildflower trail

Phase 1:

D. Restoration: Wetlands

a. Implement groundwater monitoring system using MiRAM methodology

b. Implement proper mechanical and/or chemical treatment following the schedule outlined within 2.6.3 of invasive and undesirable woody species.

c. Coordinate a prescribed burn (and future regime) with a certified Burn Boss.

d. Coordinate vegetation sampling conducted by qualified individuals following the schedule outlined within 2.6.3.

Phase 2:

D. Revitalize: Visitor Experience

a. Coordinate efforts to reinstall the Wildflower Trail.

b. Design and install interpretive signage along trails focusing on key species in this unit.

c. Install entrance signs and improve visibility and recognition of property.

d. Improve entrance visibility.

e. Restore and update infrastructure and materials of shelter.

Priority 5: Maintaining Ecosystem Resilience

E. Cultivate relationships with nearby landowners, including the Kiwanis Club, to coordinate matching goals related to the health of Baker Sanctuary.

a. Contact community members and conduct surveys to assess their current level of interaction with Baker Sanctuary and their desires for its future

b. Coordinate future management of the deer population with neighbors who have property directly adjacent to the preserve

E. Plan future extension of wetland monitoring program to ensure the resilience of Big Marsh Lake and its associated wetlands

E. Long-term monitoring activities in prairie and forest habitats are to be focused on enhancing and retaining native species diversity

a. Continued spot treatment of all habitat types to reduce cover and frequency undesirable species

b. Prescribed burns at intervals to simulate natural conditions

E. Continue to conduct outreach within the community to strengthen awareness of the mission of Michigan Audubon and to maintain an active volunteer network

a. Contact local schools and other clubs and organizations to educate about the motivations behind the ongoing restoration activities at Baker Sanctuary

b. Maintain an active volunteer list and coordinate volunteer days for future initiatives

3.2 Species at Risk

3.2.1 Birds

The following table lists the bird species that are both present at Baker Sanctuary and are of conservation concern in the state of Michigan. According to the Michigan Natural Features Inventory, there are no endangered bird species that have been recorded at Baker Sanctuary. However, there are eight bird species that are listed as endangered whose range either encompasses Baker Sanctuary or is within a proximity. These birds include the Henslow's sparrow (*Ammodramus henslowii*), short-eared owl (*Asio flammeus*), peregrine falcon (*Falco peregrinus*), loggerhead shrike (*Lanius ludovicianus*), king rail (*Rallus elegans*), prairie warbler (*Setophaga discolor*), Kirtland's warbler (*Setophaga kirtlandii*), and the barn owl (*Tyto alba*). It is important to take these bird species into consideration given their conservation status and proximity to Baker Sanctuary. As previously stated, bird surveys and eBird data should be regarded as approximations of species richness and abundance. It is also important to keep in mind the possible bias of eBird data as certain conspicuous, well-known, or diurnal species may be represented to a larger degree than inconspicuous or nocturnal species. As a result, Baker Sanctuary should be regarded as a possible refuge for these endangered bird species even though this data signifies, they have no presence there.

The species listed as 'endangered', as well as the species listed as 'threatened', are protected under the Endangered Species Act of the State of Michigan (Part 365 of PA 451, 1994 Michigan Natural Resources and Environmental Protection Act). The species listed as 'special concern' are of concern because of declining or relict populations in Michigan, however, they are not legally protected. These species will be closely monitored resulting in either the species being moved to threatened/endangered status if their populations continue to decline or off the list completely if their population numbers increase. The 'special concern' status is very important because it is a transitional period. If a species listed as 'special concern' is given the protection needed, before reaching dangerously low population levels, it is possible it would be able to maintain adequate numbers of self-sustaining populations within Michigan.

TABLE 3.1 BIRD SPECIES OF CONSERVATION CONCERN THAT ARE PRESENT AT BAKER SANCTUARY

Species	State Status	eBird Sightings	Habitat
Haliaeetus leucocephalus (Bald Eagle)	Special Concern	15	Typically nest in forested areas adjacent to large bodies of water, staying away from heavily developed areas when possible. Prefer to perch in tall, mature coniferous or deciduous trees that afford a wide view of the surroundings.
Gallinula galeata (Common Gallinule)	Threatened	2	Use freshwater and brackish marshes, ponds, and lakes that have a mix of submerged, floating, and emergent aquatic vegetation and are open water year-round. Will also use artificial aquaculture ponds, rice fields, sewage lagoons, and urban stormwater retention ponds.
Ammodramus savannarum (Grasshopper Sparrow)	Special Concern	1	Common in overgrown pastures and hayfields with waist-high grasses. Breeds in open grasslands, prairies, hayfields, and pastures, typically with some bare ground.
Circus hudsonius (Northern Harrier)	Special Concern	6	Breeding in large, undisturbed tracts of wetlands and grasslands with low, thick vegetation. They breed in freshwater and brackish marshes, lightly grazed meadows, old fields, tundra, dry upland prairies, drained marshlands, high-desert shrubsteppe, and riverside woodlands. Winter in a range of habitats.
Pandion haliaetus (Osprey)	Special Concern	1	Almost any expanse of shallow, fish-filled water, including rivers, lakes, reservoirs, lagoons, swamps, and marshes. Nesting habitat must include an adequate supply of accessible fish
Protonotaria citrea (Prothonotary Warbler)	Special Concern	1	Breed in flooded bottomland forests, wooded swamps, and forests near lakes and streams while avoiding forest patches smaller than about 250 acres or forest borders less than 100 feet wide. Winter in mangrove swamps or tropical dry forest and wooded areas near streams.
Melanerpes erythrocephalus (Red-headed Woodpecker)	Special Concern	17	Breed in deciduous woodlands with oak or beech, groves of dead or dying trees, river bottoms, burned areas, recent clearings, beaver swamps, orchards, parks, farmland, grasslands with scattered trees, forest edges, and roadsides. During the start of the breeding season they move from forest interiors to forest edges or disturbed areas.

The following table lists the bird species that are present in Baker Sanctuary that are in steep decline nationally. According to the parameters of the MSU table above, these species would be considered of “special concern.” As previously mentioned, the goal with identifying species whose populations are rapidly declining is to address the causes of those declines and offer solutions before population declines become irreversible.

This table includes species from three different sources. The first source is ‘State of the Birds’ reports from the North American Bird Conservation Initiative– one report is from 2019 (most recent) outlining America’s birds that are in steep decline and a 2014 report listing common birds that are in steep decline. The latter report states their goal “of keeping common species common” by analyzing long-term monitoring surveys of North American bird populations for evidence of sharp declines among species that have always been numerous. According to the Cornell Lab of Ornithology, these early warning signs may be clues that a habitat is in trouble. The NABCI compiles their list of bird populations in decline with regard to habitat which, in turn, gives information about those habitat types. For instance, the 2019 State of the Birds report emphasizes grassland birds as having suffered the steepest losses with a population decline of 53% since 1970. This is followed by shorebirds that have suffered population declines of 37% since 1974 and forest birds with population losses of 22% since 1970.

The second source is from the National Audubon report “North American bird species undergoing the greatest population declines from 1966 to 2003. These population declines were measured by the Breeding Bird Survey which is done by volunteers across North America and is coordinated and analyzed by the U.S. Geological Survey at the Patuxent Wildlife Research Center.

The third source is from the Michigan Audubon website in which the organization highlights two species of conservation concern: the chimney swift and purple martin. The Michigan Audubon Society emphasizes the steep declines the chimney swift has suffered over recent decades due to loss of man-made nesting and roosting structure, insecticide use, and habitat loss in their wintering grounds in South America. Further, while the global population of purple martins is stable, Michigan’s populations of purple martins have been experiencing consistent, steep population declines since 1966 due to lack of properly sited and managed nesting structures. The Michigan Audubon Society “efforts are focused on outreach, education, on-the-ground conservation, and research to increase awareness for chimney swifts and purple martins and slow or reverse the population declines they have experienced across the state.”

Additionally, there are bird species experiencing steep declines that are common to Michigan whose range includes Baker Sanctuary, however, have not been recorded at Baker Sanctuary. As previously noted, it is important to regard the bird surveys and eBird data tentatively as there could be bias toward certain species that may be well-known or diurnal. Michigan’s bird species in steep decline whose range encompasses Baker Sanctuary are the black tern, Brewer’s blackbird, Cape May warbler, cerulean warbler, common nighthawk, greater scaup, horned grebe, Kirtland’s warbler, lesser yellowlegs, loggerhead shrike, northern bobwhite, purple gallinule, rusty blackbird, short-eared owl, snow bunting, and the snowy owl. These bird species occupy Michigan for varied reasons including breeding, wintering, and migration. Of these 16 declining bird species, only three, the Kirtland warbler, loggerhead shrike, and the purple gallinule, are considered rare in the part of their range that includes Baker Sanctuary.

TABLE 3.2 BIRD SPECIES IN STEEP DECLINE THAT ARE PRESENT AT BAKER SANCTUARY

Species	Population Decline since ~1970’s	eBird Sightings	Habitat
Scolopax minor (American Woodcock)	30%	5	Nest in young, shrubby, deciduous forests, old fields, and mixed forest-agricultural-urban areas. They display in forest openings and old fields in the springtime, and they often use clearings for roosting in the summer.
Icterus galbula (Baltimore Oriole)	44%	32	Breed in leafy deciduous trees, but not in deep forests, prefer open woodland, forest edge, river banks, and small groves of trees. Well adapted to human settlement and often feed and nest in parks, orchards, and backyards
Riparia riparia (Bank Swallow)	>50%	1	Breed in open lowland areas near bodies of water.
Setophaga striata (Blackpoll Warbler)	88%	5	Breed mainly in spruce and tamarack forests in Canada’s boreal forests, but also young stands of evergreens and alder or willow thickets. During migration they stop over in evergreen and deciduous forests.
Dolichonyx oryzivorus (Bobolink)	50%	1	Common in hayfields and meadows as well as marshes in migration. marshes. Breed in damp meadows and natural prairies with dense growth of grass and weeds and a few low bushes
Chaetura pelagica (Chimney Swift)	>50%	9	Open areas, usually near urban or residential areas. Nest and roost in traditional brick chimneys with open caps.
Quiscalus quiscula (Common Grackle)	>50%	29	Agricultural fields, feedlots, city parks, and suburban lawns. Also common in open habitats including woodland, forest edges, meadows, and marshes.
Junco hyemalis (Dark-eyed Junco)	44%	34	Breed in forests at elevations ranging from sea level to >11,000 feet. They are often found in coniferous forests but can also be seen in deciduous forests. During winter and on migration they use a wider variety of habitats including open woodlands, fields, roadsides, parks, and gardens.
Sturnella magna (Eastern Meadowlark)	26%	3	Most common in native grasslands and prairies, but also occur in pastures, hayfields, agricultural fields, airports, and other grassy areas.
Spizella pusilla (Field Sparrow)	69%	77	Shrubby grasslands or overgrown, weedy fields.
Larus smithsonianus (Herring gull)	>50%	6	Along coastal shorelines, feeding on beaches, or squabbling at refuse dumps. Winter near any large open space near water

Eremophila alpestris (Horned Lark)	>50%	2	Open country with very short or no vegetation, including bare agricultural fields. Breed in short grassland, short-stature sage shrubland, desert, and even alpine and arctic tundra.
Anas acuta (Northern Pintail)	63%	2	Nest in seasonal wetlands, croplands, grasslands, wet meadows, and shortgrass prairies. Forage in nearby shallow wetlands, lakes, and ponds. Common in wetlands, ponds, lakes, bays, tidal marshes, and flooded agricultural fields in the non-breeding season
Spinus pinus (Pine Siskin)	>50%	2	Prefer evergreen or mixed evergreen and deciduous forests with open canopies. Can also be seen in weedy fields, scrubby thickets, or backyards and gardens.
Progne subis (Purple Martin)	N/A	1	Towns, farms, semi-open country near water. Breeds in any kind of semi-open area where nest sites are provided, especially near a pond or river.
Contopus cooperi (Olive-sided Flyctacher)	73%	1	Olive-sided Flycatchers breed mostly in the boreal forest. Also found in forests of spruce, fir, Douglas-fir, hemlock, western redcedar, and tamarack or larch. Nest in openings or edges in the forest. Common in meadows, rivers and streams, partially logged areas, recent burns, beaver ponds, bogs, and muskegs.
Agelaius phoeniceus (Red-winged Blackbird)	40%	108	Breeding in wet places like fresh or saltwater marshes and rice paddies or in drier places like sedge meadows, alfalfa fields, and fallow fields. Occasionally nest in wooded areas along waterways. In fall and winter, they congregate in agricultural fields, feedlots, pastures, and grassland.
Euphagus carolinus (Rusty Blackbird)	~90%	4	Wet areas such as flooded woods, swamps, marshes and the edges of ponds.
Plectrophenax nivalis (Snow Bunting)	38%	1	Breeds on rocky tundra. Winters in open weedy and grassy fields and along shores of lakes and oceans. Often concentrates on shorelines where debris piles up along the edge from wave or wind action.
Cardellina pusilla (Wilson's Warbler)	>50%	1	Breed in mountain meadows and thickets near streams, especially those with willows and alders, along the edges of lakes, bogs, and aspen stands. During migration they use woodlands, suburban areas, desert scrub, and shrubby areas near streams.
Hylocichla mustelina (Wood Thrush)	50%	15	Found mainly in damp deciduous woodlands. Breeds in the understory of woodlands, mostly deciduous but sometimes mixed.

(The Cornell Lab of Ornithology, 2014; NABCI, 2019 & National Audubon Society, 2007 & Michigan Audubon, 2022)

Birds of Significance

The goal of Michigan Audubon's sanctuaries is to protect natural habitats in order to protect Michigan native plants and animals, including both endangered and threatened species. While the organization protects a variety of southern Michigan's flora and fauna, the overall purpose is to protect bird species that rely on their sanctuaries for shelter and resources throughout the year. Baker Sanctuary aims to aid in the protection and conservation of sandhill cranes. In fact, Bernard W. Baker Sanctuary, being a well-known host site for Michigan's largest gathering of sandhill cranes each fall, was North America's first bird sanctuary dedicated to the conservation of these birds.

Sandhill cranes are considered as a species of low concern as their populations have increased by about 4.5% per year between the years of 1966 and 2014 (Cornell Lab of Ornithology). However, as with any species, it is important to monitor their population numbers on a regular basis in order to avoid irreversible damage, particularly as efforts to open a hunting season for sandhill cranes are gaining traction in the state. Notably, sandhill crane populations recover slowly due to them mating for life as well as each breeding pair typically only having one chick that survives to fledging (Cornell Lab of Ornithology). While this a significant factor to consider when analyzing the conservation of sandhill cranes, the future of this bird is mainly determined by the fate of their habitat (Cornell Lab of Ornithology). It is important to conserve wetlands in staging and wintering areas where large migratory flocks congregate such as Big Marsh Lake in Baker Sanctuary. A few key features of staging areas include shallow water for roosting, high visibility, limited human disturbance, and ample foraging areas (Krapu). Foraging areas are of particular importance due to staging being "accompanied by physiological conditioning of the birds for migration and reproduction" (Krapu). For example, fat levels of cranes increased from about 8% of body weight in late winter in west Texas to 23% at departure from a staging area in Saskatchewan in late April (Krapu). In general, most foraging occurs primarily on agricultural lands in the vicinity of staging areas where cereal grains and invertebrates account for a major part of the sandhill cranes nutrition. However, in the past century it is the expansion of agricultural development that has greatly altered sandhill crane staging areas. Thus, it is important for organizations such as the Michigan Audubon to recognize and conserve suitable habitat in these key staging areas in order to promote the vitality of sandhill crane populations.

3.2.2 Flora

In the floristic quality index, the C value or coefficient of conservatism gives an idea of the quality of the plant. A high number, 9 or 10, represents many rare or endangered species or species that require high-quality natural habitats (We Conserve PA, 2019). This is a good place to start when looking at species that are at risk in the sanctuary. All of these were identified by amateurs and should be confirmed by more experienced personnel.

TABLE 3.3 FLORAL SPECIES AT RISK

Species	C value	State Status	Habitat	Location Observed
Aureolaria virginica	10	Not listed	Oak openings, sandy oak and oak-hickory savanna	IS1
Baptisia lactea	9	Special Concern	Prairies or similar dry open areas	JR4
Coreopsis palmata	9	Threatened	Prairies and associated roadsides and railroads	JR4
Eryngium yuccifolium	10	Threatened	Prairies, wet meadows, open borders of marshes and swamps	JR4
Liriodendron tulipifera	9	Not listed	Rich deciduous forests	OS6
Piptatherum pungens; oryzopsis p.	9	Not listed	Sandy dry forests and savannas on dunes and plains	OS3, OS4, OS6, IS2
Rudbeckia fulgida	9	Not listed	Fens, sedge meadows, calcareous springy banks, riverside swamps, meadows, and other wet ground.	Off of trail
Silphium perfoliatum	10	Threatened	River banks and prairie-like openings in floodplain forests; sedge meadows and marshes	Near Parking lot off trail
Tiarella cordifolia	9	Not listed	Deciduous and mixed forests, often in wet hallows; swamps	IS2, JR1

(Reznicek et al., 2011 and Michigan State University)

3.3 Monitoring

Necessary steps for the implementation of a robust monitoring program:

- Identify and train volunteers to monitor conditions in specific locations within the preserve
- Conduct a survey of the boundaries of the preserve as well as the habitat management units so that existing data can be updated
- Implement a yearly monitoring schedule

Monitoring Activity Summary

- General monitoring tasks include observing boundaries, corners, signage, and trail conditions
- Monitoring for conservation values involves recording observations in species lists as well as natural disturbances and ongoing restoration efforts
- Monitoring for hazards such as vandalism, safety hazards, encroachment, and unauthorized use are vital for the preservation of the health of the preserve

Point Count Method of Monitoring Avian Species

Population size is a reliable indicator of the health of avian species and many surveying methods have been developed to estimate populations. The most widely implemented of these are unlimited distance point counts, which are modified for specific situations. These observations are recorded at predetermined counting stations and are a reasonable compromise between the effort necessary to obtain the data and the precision and accuracy of observations (Ralph et al., 1995). Point counts are versatile and can be adapted to a variety of habitat types in all seasons and in other unique circumstances, making them useful for integration into regional and national efforts to understand current trends in avian populations.

Monitoring avian population changes at Baker Sanctuary will be conducted using the 10-minute point count protocol described in Managing and Monitoring Birds Using Point Counts: Standards and Applications (Ralph et al., 1995). Point count locations will be predetermined prior to field work. They will not be within 150m of each other to preserve the independence of observations and will not be located near the boundaries between habitat types. Data collection activities must account for the seasonality of migratory bird populations, and the timing of monitoring activities will be structured to provide the most accurate representation of avian populations in the preserve. Surveys during the breeding season should be emphasized. Tentative observation windows are as follows:

Spring: May 12 - 31

Summer: June 14 - 29

Fall: October 1 - 15

Winter: January 1 – 14

Data from monitoring initiatives will be invaluable in determining current avian populations at Baker Sanctuary, tracking changes in avian species richness and abundance, and assessing the efficacy of the restoration efforts detailed in this management plan. Point count data will also be analyzed by Michigan Audubon staff and will be input into eBird to contribute to global citizen science initiatives.

Transect Monitoring of Vegetative Species

Monitoring protocols that evaluate floral diversity are essential to the success of restoration efforts. Field data collected from robust monitoring programs allows ecologists and field managers to quantitatively observe trends in floral diversity and empowers them to make sound recommendations. Recommendations can be incorporated into an adaptive management framework for decision making so that the success of past management decisions can be evaluated and changes to long-term management plan can be made as needed (Cawson & Muir, 2008).

Vegetative monitoring will be conducted using frequency sampling surveys according to the protocols suggested in Coulloudon et al. (1999, p.37). Transects will originate at the existing avian point-count locations as well as at randomly determined points throughout Baker Sanctuary according to the restoration objectives of Michigan Audubon. Frequency is defined as how often a species is present within a given sampling area, and frequency data can clarify abundance and distribution questions as well as track changes in population dynamics over time (Caratti, 2006). This sampling method also measures basal cover, or the percentage of the ground that is occupied by vegetation (Coulloudon et al., 1999). The precise location of future survey points will be reflective of the determined monitoring objectives. The specific frequency methods utilized, whether they be quadrats arranged on a transect or nested quadrats, should be determined based on the habitat type being surveyed. Once transects are established, they should be actively monitored seasonally for one year. Subsequent surveys will be conducted every 1-3 years, as well as the year following any treatments to the land. Additional species observations may be made by visitors to the preserve with the iNaturalist app or emailed directly to Michigan Audubon.

3.4 Community Engagement

External Signage

Given the location of the sanctuary, roadside advertising is recommended to increase awareness of those in the area. Below is a list of nearby attractions that people visit from all over the state, and the routes and exits they would take to get to the sanctuary. By advertising near or at these locations, the target audience is more likely to be reached, and increase visitation of the sanctuary.

Attractions

Cornwell's Turkeyville - 18935 15 1/2 Mile Rd, Marshall, MI 49068

- Closest attraction in the area. Offerings include a restaurant, gift shop, ice cream parlor, dinner theatre, as well as classes and events every weekend, which frequently include flea markets.
- Camp Turkeyville RV Resort down the road, with 176 camper sites. This would be a good location for a road sign, or even potentially advertising within the RV resort.

If possible, partnering with Turkeyville to advertise the existence of the sanctuary and the new native garden. People visit Turkeyville to enjoy natural and rural areas, so sanctuary advertising would be reaching a key potential visitor demographic. This would be a wise location for a sign for the sanctuary, which is less than 2.5 miles away, ~5 minutes by car, and would require minimal directions from Turkeyville.

TTCM Bellevue Campground - Baseline Rd, Bellevue Township, MI 49021

- 4.3 miles, 8 minutes

Sherwood Forest Campground - 5563A Sherwood Hwy, Olivet, MI 49076

- 8.2 miles, 12 minutes

Marshall City Hall - 323 W Michigan Ave, Marshall, MI 49068

- 8.3 miles, 13 minutes

Olivet College - 320 S Main St, Olivet, MI 49076

- 9 miles, 11 minutes

FireKeepers Casino Hotel - 11177 E Michigan Ave, Battle Creek, MI 49014

- 10.1 miles, 15 minutes

Routes to the Sanctuary

East: Jackson, Ann Arbor, Detroit, MI. The sanctuary is roughly 7 miles away from Exit 110 on I-94 W. Signage for the 110 exits, or along the west bound highway prior to the exit, is recommended to inform drivers of the sanctuary.

West: Kalamazoo, MI. - Exit 108 on I-94 E, 8.5 miles, 10 minutes.

North: Lansing, MI. - Exit 48 on I-69 S. 8 miles, 10 minutes.

Exiting Butterfield Highway (78): 4 miles, 6 minutes

South: Fort Wayne, IN. - Exit 42 on I- 69 N. 3.5 miles, 6 minutes.

Interpretive Signage

Signs along the trails within the Baker Sanctuary should utilize technology such as QR codes, which allows people quick access to a webpage by using a device connected to the internet. This will allow for more information to be shared compared to printing on a physical sign, which also means any changes to information can be done remotely, without a need for a new sign, but can also include links for community participation. Connections to Ebird are also a wise use for trail signage, allowing visitors access to “hotspots”, while encouraging community involvement in bird identification.

QR codes could also be placed near key conservation areas or plants and used to provide links, or a webpage designed specifically for the area. By giving visitors basic identification information for species (flora or fauna), this will increase the engagement while at the site, and help with community participation in Ebird sightings.

Another option for the QR codes would be to show the plant (or area) throughout different seasons (while flowering, fruiting, dropping leaves, winter conditions, etc.) while also providing basic identification characteristics. This might encourage more visits year-round.

iNaturalist

iNaturalist is an online social network of people sharing biodiversity information to help each other learn about nature.

It's also a *crowdsourced species identification system* and an *organism occurrence recording tool*. You can use it to record your own observations, get help with identifications, collaborate with others to collect this kind of information for a common purpose, or access the observational data collected by iNaturalist users.

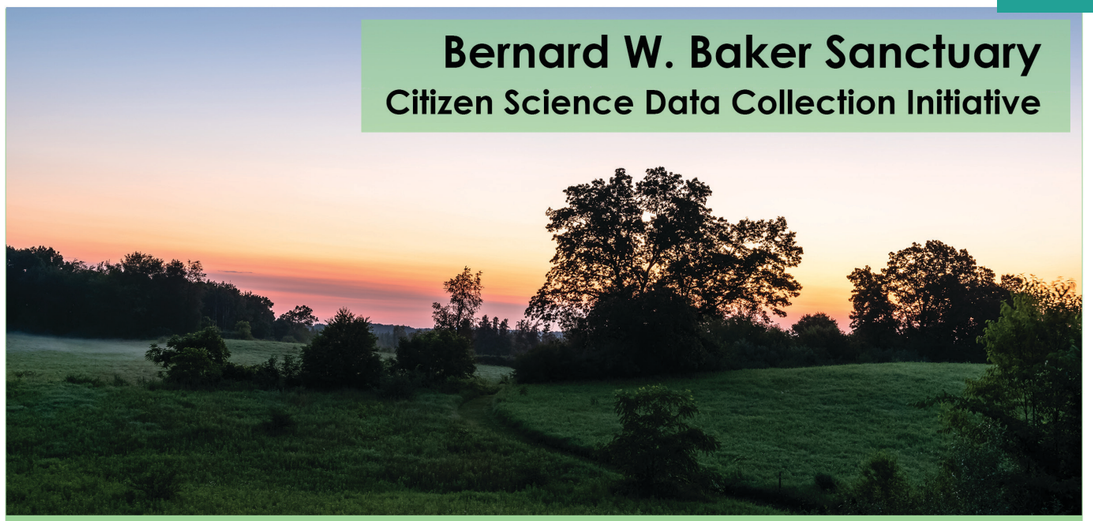
What Are Observations?

An observation records an encounter with an individual organism at a particular time and location. This includes encounters with a living or dead organism or signs like tracks or nests.

Tips & Tricks

- Upload multiple photos from different perspectives to make your find easier to identify
- Take clear photos close-up to show the entire organism
- Ensure that your GPS location services are on to document an accurate location
- Check your account after you upload observations to see how the community helped to identify what you found

Join the Bernard W. Baker Sanctuary Project and contribute to a growing database!

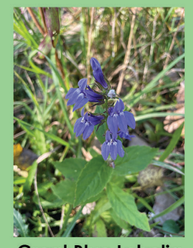


Bernard W. Baker Sanctuary
Citizen Science Data Collection Initiative

Become a citizen scientist!

Join a free, interactive community of botanists, ecologists, and nature lovers

Butterfly Weed
Asclepias tuberosa



Great Blue Lobelia
Lobelia siphilitica

Smooth Blue Aster
Symphyotrichum laeve

Missouri Ironweed
Vernonia missurica

Highbush Cranberry
Viburnum trilobum

It's Easy!

Find plants like these at Baker Sanctuary!

1. Download the iNaturalist app and create an account
2. Join the project “Bernard W. Baker Sanctuary” by scanning this QR code:
3. Upload your observations of plants and other wildlife

iNaturalist

MICHIGAN audubon

SCHOOL FOR ENVIRONMENT AND SUSTAINABILITY
UNIVERSITY OF MICHIGAN

Baker Sanctuary is on eBird!

Help Michigan Audubon collect information that will be used to make informed management decisions

What is ebird?

It is a website that stores and provides data on bird abundance and distribution across the globe. With an eBird account, free to everyone, you can share observations with Michigan Audubon and with the world's largest birding community.

Join the fun!

1. Download the eBird app
2. Make an account
3. Start a checklist and select the hotspot:
"Bernard W. Baker Sanctuary-- Meadow and Marshland Trail"
4. Record birds as you see them!

iPhone Android

TheCornellLab of Ornithology

MICHIGAN audubon

SCHOOL FOR ENVIRONMENT AND SUSTAINABILITY
UNIVERSITY OF MICHIGAN

See a bird?

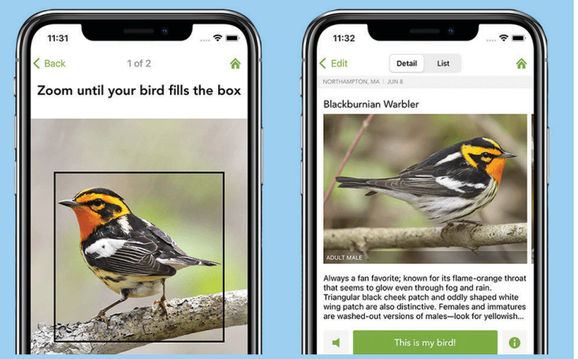
Identify it with Merlin Bird ID

Use photos to ID birds! Great for Kids!

TheCornellLab Merlin

How many birds will you find?

1. Download the app
2. Take a photo
3. Click "Identify"



Over 90% accurate!

TheCornellLab of Ornithology

MICHIGAN audubon

SCHOOL FOR ENVIRONMENT AND SUSTAINABILITY
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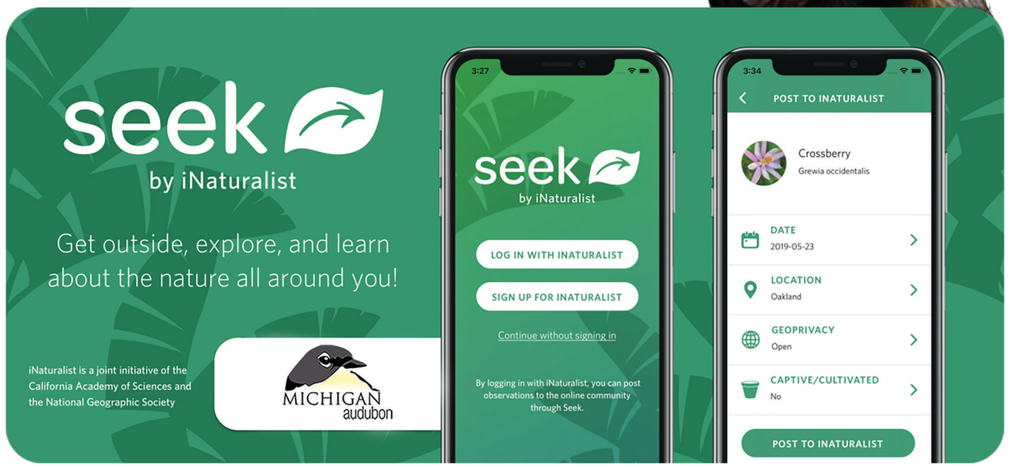
Get Out And Explore Nature With Free Apps!

The amazing Seek camera instantly identifies living plants, animals, and insects

Participate in challenges and earn badges

Kid-friendly and fun for families

What will you find?



APPENDIX

Baker Sanctuary 15 Mile Road Floral Inventory Assessment		
21145 15 Mile Rd, Bellevue, MI 49021		
Survey Dates:	7/15/2021 - 7/19/2021; 9/19/2021; 9/25/2021; 9/28/2021; 2/6/2022	
FQA DB Region:	Michigan	
FQA DB Publication Year:	2014	
FQA DB Description:	Reznicek, A.A., M.R. Penskar, B.S. Walters, and B.S. Slaughter. 2014. Michigan Floristic Quality Assessment Database. Herbarium, University of Michigan, Ann Arbor, MI and Michigan Natural Features Inventory, Michigan State University, Lansing, MI. http://michiganflora.net	
Practitioner:	Nick Tsichlis, Megan Livingston, James Johnson, Jenna Happach, Catherine Watts	
Latitude:		
Longitude:		
Weather Notes:	Sunny and warm.	
Duration Notes:		
Community Type Notes:		
Other Notes:	Due to thick brush, only two of the three nested plots in this section were observed. The plots were similar in species richness, so we believe the two plots surveyed are sufficient to understand the composition of the unit; OS2 Notes: Transect on a slope; OS8 Notes: Lowland next to wetland; Frequecy Scale: 1: 1-5%, 2: 6-25%, 3: 26-50%, 4: 51-75%, 5: 76-94%, 6: 95-100%	
Private/Public:	Public	
Conservatism-Based Metrics:		
Total Mean C:	3	
Native Mean C:	4	
Total FQI:	31.6	
Native FQI:	36.7	
Adjusted FQI:	34.8	
% C value 0:	27	
% C value 1-3:	33.3	
% C value 4-6:	28.8	
% C value 7-10:	10.8	
Native Tree Mean C:	4.1	
Native Shrub Mean C:	3.9	

Baker Sanctuary 15 Mile Road Floral Inventory Assessment		
Native Herbaceous Mean C:	3.9	
Species Richness:		
Total Species:	111	
Native Species:	84	75.70%
Non-native Species:	27	24.30%
Species Wetness:		
Mean Wetness:	1.6	
Native Mean Wetness:	1.1	
Physiognomy Metrics:		
Tree:	17	15.30%
Shrub:	15	13.50%
Vine:	3	2.70%
Forb:	61	55%
Grass:	9	8.10%
Sedge:	3	2.70%
Rush:	1	0.90%
Fern:	2	1.80%
Bryophyte:	0	0%
Duration Metrics:		
Annual:	4	3.60%
Perennial:	99	89.20%
Biennial:	8	7.20%
Native Annual:	1	0.90%
Native Perennial:	80	72.10%
Native Biennial:	3	2.70%

Baker Sanctuary 15 Mile Road Floral Inventory Assessment

Scientific Name	Family	Acronym	Native?	C	W	Physiog-nomy	Duration	Common Name
Abutilon theoph-rasti	Malvace-ae	ABUTHE	non-na-tive	0	3	forb	annual	velvet-leaf
Acer rubrum	Sapinda-ceae	ACERUB	native	1	0	tree	perennial	red maple
Achillea millefo-lium	Asterace-ae	ACHMIL	native	1	3	forb	perennial	yarrow
Agrimonia gry-posepala	Rosace-ae	AGRGRY	native	2	3	forb	perennial	tall agrimony
Agrimonia pu-bescens	Rosace-ae	AGRPUB	native	5	5	forb	perennial	soft agrimony
Alliaria petiolata	Brassica-ceae	ALLPET	non-na-tive	0	3	forb	biennial	garlic mustard
Andropogon gerardii	Poaceae	ANDGER	native	5	0	grass	perennial	big bluestem
Anthriscus syl-vestris	Apiaceae	ANTSYL	non-na-tive	0	5	forb	biennial	false chervil
Apocynum cannabinum; a. sibiricum	Apocyna-ceae	APOCAN	native	3	0	forb	perennial	indian-hemp
Asclepias syri-aca	Apocyna-ceae	ASCSYR	native	1	5	forb	perennial	common milk-weed
Asclepias tu-berosa	Apocyna-ceae	ASCTUB	native	5	5	forb	perennial	butterfly-weed
Asplenium platyneuron	Asplenia-ceae	ASPPLA	native	2	3	fern	perennial	ebony spleen-wort
Baptisia lactea	Fabace-ae	BAPLAC	native	9	3	forb	perennial	white false indigo
Berberis thun-bergii	Berberi-daceae	BERTHU	non-na-tive	0	3	shrub	perennial	japanese bar-berry
Bromus ciliatus	Poaceae	BROCIL	native	6	-3	grass	perennial	fringed brome
Bromus inermis	Poaceae	BROINE	non-na-tive	0	5	grass	perennial	smooth brome
Carex vulpi-noidea	Cypera-ceae	CXVULP	native	1	-5	sedge	perennial	sedge
Carya ovata	Juglan-daceae	CAROVA	native	5	3	tree	perennial	shagbark hick-ory
Cichorium inty-bus	Asterace-ae	CICINT	non-na-tive	0	3	forb	perennial	chicory
Cirsium vulgare	Asterace-ae	CIRVUL	non-na-tive	0	3	forb	biennial	bull thistle
Coreopsis lance-olata	Asterace-ae	CORLAN	native	8	3	forb	perennial	sand coreopsis

Baker Sanctuary 15 Mile Road Floral Inventory Assessment

Scientific Name	Family	Acronym	Native?	C	W	Physiog-nomy	Duration	Common Name
Coreopsis tripteris	Asterace-ae	CORTRP	native	7	0	forb	perennial	tall coreopsis
Cornus foemina	Cornace-ae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Crataegus flu-viatilis; c. apio-morpha	Rosace-ae	CRAFLU	native	4	5	tree	perennial	hawthorn
Dasiphora fruti-cosa; potentilla f.	Rosace-ae	DASFRU	native	8	-3	shrub	perennial	shrubby cinque-foil
Daucus carota	Apiaceae	DAUCAR	non-na-tive	0	5	forb	biennial	queen-annes-lace
Decodon verticil-latus	Lythrace-ae	DECVER	native	7	-5	shrub	perennial	whorled or swamp loose-strife
Desmodium canadense	Fabace-ae	DESCAD	native	3	0	forb	perennial	showy tick-tre-foil
Desmodium glabellum; d. paniculatum	Fabace-ae	DESGLA	native	5	5	forb	perennial	tick-trefoil
Dichanthelium oligosanthes; panicum o.	Poaceae	DICOLI	native	5	3	grass	perennial	panic grass
Doellingeria um-bellata; aster u.	Asterace-ae	DOEUMB	native	5	-3	forb	perennial	flat-topped white aster
Echinacea pur-purea	Asterace-ae	ECHPUA	non-na-tive	0	5	forb	perennial	purple coneflow-er
Elaeagnus um-bellata	Elaeag-naceae	ELAUMB	non-na-tive	0	3	shrub	perennial	autumn-olive
Erigeron annuus	Asterace-ae	ERIANN	native	0	3	forb	biennial	daisy fleabane
Eryngium yucci-folium	Apiaceae	ERYYUC	native	10	0	forb	perennial	rattle-snake-master
Euthamia gram-inifolia	Asterace-ae	EUTGRA	native	3	0	forb	perennial	grass-leaved goldenrod
Eutrochium mac-ulatum; eupatori-um m.	Asterace-ae	EUTMAC	native	4	-5	forb	perennial	joe-pye-weed
Fagus grandi-folia	Fagace-ae	FAGGRA	native	6	3	tree	perennial	american beech
Fragaria virgin-iana	Rosace-ae	FRAVIR	native	2	3	forb	perennial	wild strawberry
Fraxinus penn-sylvanica	Oleaceae	FRAPEN	native	2	-3	tree	perennial	red ash

Baker Sanctuary 15 Mile Road Floral Inventory Assessment

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Galium pilosum	Rubiaceae	GALPIL	native	6	5	forb	perennial	hairy bedstraw
Geum urbanum	Rosaceae	GEUURB	non-native	0	5	forb	perennial	avens
Helianthus divaricatus	Asteraceae	HELDIV	native	5	5	forb	perennial	woodland sunflower
Hypericum perforatum	Hypericaceae	HYPPER	non-native	0	5	forb	perennial	common st. johns-wort
Ilex verticillata	Aquifoliaceae	ILEVER	native	5	-3	shrub	perennial	michigan holly
Impatiens capensis	Balsaminaceae	IMPCAP	native	2	-3	forb	annual	spotted touch-me-not
Juglans nigra	Juglandaceae	JUGNIG	native	5	3	tree	perennial	black walnut
Juncus acuminatus	Juncaceae	JUNACU	native	8	-5	rush	perennial	sharp-fruited rush
Juniperus virginiana	Cupressaceae	JUNVIR	native	3	3	tree	perennial	red-cedar
Lespedeza hirta	Fabaceae	LESHIR	native	7	5	forb	perennial	hairy bush-clover
Leucanthemum vulgare; chrysanthemum leucanthemum	Asteraceae	LEUVUL	non-native	0	5	forb	perennial	ox-eye daisy
Liriodendron tulipifera	Magnoliaceae	LIRTUL	native	9	3	tree	perennial	tulip tree
Lonicera maackii	Caprifoliaceae	LONMAA	non-native	0	5	shrub	perennial	amur honeysuckle
Maclura pomifera	Moraceae	MACPOM	non-native	0	3	tree	perennial	osage-orange
Monarda fistulosa	Lamiaceae	MONFIS	native	2	3	forb	perennial	wild-bergamot
Onoclea sensibilis	Onocleaceae	ONOSEN	native	2	-3	fern	perennial	sensitive fern
Oxalis stricta; o. fontana	Oxalidaceae	OXASTR	native	0	3	forb	perennial	yellow wood-sorrel
Panicum virgatum	Poaceae	PANVIR	native	4	0	grass	perennial	switch grass
Parthenium integrifolium; p. hispidum	Asteraceae	PARINT	non-native	0	5	forb	perennial	wild quinine
Parthenocissus quinquefolia	Vitaceae	PARQUI	native	5	3	vine	perennial	virginia creeper

Baker Sanctuary 15 Mile Road Floral Inventory Assessment

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Persicaria maculosa; polygonum persicaria	Polygonaceae	PERMAC	non-native	0	0	forb	annual	ladys-thumb
Phleum pratense	Poaceae	PHLPRA	non-native	0	3	grass	perennial	timothy
Phytolacca americana	Phytolaccaceae	PHYAME	native	2	3	forb	perennial	pokeweed
Picea glauca	Pinaceae	PICGLA	native	3	3	tree	perennial	white spruce
Pinus resinosa	Pinaceae	PINRES	native	6	3	tree	perennial	red pine
Piptatherum pungens; oryzopsis p.	Poaceae	PIPPUN	native	9	5	grass	perennial	rice-grass
Prunella vulgaris	Lamiaceae	PRUVUL	native	0	0	forb	perennial	self-heal
Prunus serotina	Rosaceae	PRUSER	native	2	3	tree	perennial	wild black cherry
Pseudognaphalium obtusifolium; gnaphalium o.	Asteraceae	PSEOBT	native	2	5	forb	biennial	old-field balsam
Quercus alba	Fagaceae	QUEALB	native	5	3	tree	perennial	white oak
Quercus rubra	Fagaceae	QUERUB	native	5	3	tree	perennial	red oak
Ratibida pinnata	Asteraceae	RATPIN	native	4	5	forb	perennial	yellow coneflower
Rhamnus cathartica	Rhamnaceae	RHACAT	non-native	0	0	tree	perennial	common buckthorn
Rhus typhina	Anacardiaceae	RHUTYP	native	2	3	shrub	perennial	staghorn sumac
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rosa palustris	Rosaceae	ROSPAL	native	5	-5	shrub	perennial	swamp rose
Rubus alleghaniensis	Rosaceae	RUBALL	native	1	3	shrub	perennial	common blackberry
Rubus occidentalis	Rosaceae	RUBOCC	native	1	5	shrub	perennial	black raspberry
Rudbeckia fulgida	Asteraceae	RUDFUL	native	9	-5	forb	perennial	black-eyed susan
Rudbeckia hirta	Asteraceae	RUDHIR	native	1	3	forb	perennial	black-eyed susan

Baker Sanctuary 15 Mile Road Floral Inventory Assessment

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Rudbeckia triloba	Asteraceae	RUDTRI	native	5	3	forb	biennial	three-lobed coneflower
Sambucus canadensis	Adoxaceae	SAMCAN	native	3	-3	shrub	perennial	elderberry
Sassafras albidum	Lauraceae	SASALB	native	5	3	tree	perennial	sassafras
Schizachyrium scoparium; andropogon s.	Poaceae	SCHSCO	native	5	3	grass	perennial	little bluestem
Scirpus atrocinctus; s. cyperinus	Cyperaceae	SCIATC	native	5	-5	sedge	perennial	wool-grass
Scirpus cyperinus	Cyperaceae	SCICYP	native	5	-5	sedge	perennial	wool-grass
Silene latifolia; s. pratensis	Caryophyllaceae	SILLAT	non-native	0	5	forb	annual	white campion
Silphium perfoliatum	Asteraceae	SILPER	native	10	-3	forb	perennial	cup plant
Solanum carolinense	Solanaceae	SOLCAR	non-native	0	3	forb	perennial	horse-nettle
Solidago altissima	Asteraceae	SOLALT	native	1	3	forb	perennial	tall goldenrod
Solidago canadensis	Asteraceae	SOLCAN	native	1	3	forb	perennial	canada goldenrod
Solidago gigantea	Asteraceae	SOLGIG	native	3	-3	forb	perennial	late goldenrod
Sorghastrum nutans	Poaceae	SORNUT	native	6	3	grass	perennial	indian grass
Symphyotrichum cordifolium; aster c.	Asteraceae	SYMCOR	native	4	5	forb	perennial	heart-leaved aster
Symphyotrichum drummondii	Asteraceae	SYMDRU	native	5	5	forb	perennial	drummonds aster
Symphyotrichum lateriflorum; aster l.	Asteraceae	SYMLAT	native	2	0	forb	perennial	calico aster
Symphyotrichum novae-angliae; aster n.	Asteraceae	SYMNOV	native	3	-3	forb	perennial	new england aster
Symphyotrichum pilosum; aster p.	Asteraceae	SYMPIL	native	1	3	forb	perennial	hairy aster

Baker Sanctuary 15 Mile Road Floral Inventory Assessment

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Symphyotrichum urophyllum; aster sagittifolius	Asteraceae	SYMURO	native	2	5	forb	perennial	arrow-leaved aster
Taraxacum officinale	Asteraceae	TAROFF	non-native	0	3	forb	perennial	common dandelion
Toxicodendron radicans	Anacardiaceae	TOXRAD	native	2	0	vine	perennial	poison-ivy
Toxicodendron vernix	Anacardiaceae	TOXVER	native	6	-5	shrub	perennial	poison sumac
Trifolium pratense	Fabaceae	TRIPRA	non-native	0	3	forb	perennial	red clover
Typha angustifolia	Typhaceae	TYPANG	non-native	0	-5	forb	perennial	narrow-leaved cat-tail
Ulmus americana	Ulmaceae	ULMAME	native	1	-3	tree	perennial	american elm
Urtica dioica	Urticaceae	URTDIO	native	1	0	forb	perennial	stinging nettle
Verbascum thapsus	Scrophulariaceae	VERTHA	non-native	0	5	forb	biennial	common mullein
Vernonia gigantea	Asteraceae	VERGIG	native	3	0	forb	perennial	tall ironweed
Vernonia missurica	Asteraceae	VERMIS	native	4	0	forb	perennial	missouri ironweed
Viburnum opulus	Adoxaceae	VIBOPU	non-native	0	-3	shrub	perennial	european highbush-cranberry
Vitis riparia	Vitaceae	VITRIP	native	3	0	vine	perennial	river-bank grape

Baker Sanctuary Isham Preserve Floral Inventory Assessment		
21145 15 Mile Rd, Bellevue, MI 49021		
Survey Dates:	7/15/2021 - 7/19/2021	
FQA DB Region:	Michigan	
FQA DB Publication Year:	2014	
FQA DB Description:	Reznicek, A.A., M.R. Penskar, B.S. Walters, and B.S. Slaughter. 2014. Michigan Floristic Quality Assessment Database. Herbarium, University of Michigan, Ann Arbor, MI and Michigan Natural Features Inventory, Michigan State University, Lansing, MI. http://michiganflora.net	
Practitioner:	Nick Tsichlis, James Johnson, Megan Livingston, Catherine Watts, Jenna Happach	
Latitude:		
Longitude:		
Weather Notes:		
Duration Notes:		
Community Type Notes:		
Other Notes:	(IS4) Road through plot 2 and plot 3; (IS4) Polypore fungus in plot 1; (Is1) Q2 near vernal pool; (IS2) road through plot 1 and plot 2; (IS2) Plot 3 had "chicken coop" within & was adjacent to Big Marsh	
Private/Public:	Public	
Conservatism-Based Metrics:		
Total Mean C:	3.5	
Native Mean C:	4.4	
Total FQI:	26.7	
Native FQI:	29.8	
Adjusted FQI:	39.2	
% C value 0:	22.4	
% C value 1-3:	22.4	
% C value 4-6:	43.1	
% C value 7-10:	12.1	
Native Tree Mean C:	3.9	
Native Shrub Mean C:	3	
Native Herbaceous Mean C:	4.8	
Species Richness:		
Total Species:	58	
Native Species:	46	79.30%

Baker Sanctuary Isham Preserve Floral Inventory Assessment		
Non-native Species:	12	20.70%
Species Wetness:		
Mean Wetness:	2.3	
Native Mean Wetness:	2.1	
Physiognomy Metrics:		
Tree:	14	24.10%
Shrub:	6	10.30%
Vine:	5	8.60%
Forb:	26	44.80%
Grass:	5	8.60%
Sedge:	2	3.40%
Rush:	0	0%
Fern:	0	0%
Bryophyte:	0	0%
Duration Metrics:		
Annual:	2	3.40%
Perennial:	55	94.80%
Biennial:	1	1.70%
Native Annual:	2	3.40%
Native Perennial:	44	75.90%
Native Biennial:	0	0%

Baker Sanctuary Isham Preserve Floral Inventory Assessment

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Achillea millefolium	Asteraceae	ACHMIL	native	1	3	forb	perennial	yarrow
Alliaria petiolata	Brassicaceae	ALLPET	non-native	0	3	forb	biennial	garlic mustard
Amphicarpaea bracteata	Fabaceae	AMPBRA	native	5	0	vine	annual	hog-peanut
Apocynum cannabinum; a. sibiricum	Apocynaceae	APOCAN	native	3	0	forb	perennial	indian-hemp
Arisaema triphyllum	Araceae	ARITRI	native	5	0	forb	perennial	jack-in-the-pulpit
Aureolaria flava	Orobanchaceae	AURFLA	native	8	5	forb	perennial	smooth false foxglove
Aureolaria virginica	Orobanchaceae	AURVIR	native	10	5	forb	perennial	downy false foxglove
Blephilia hirsuta	Lamiaceae	BLEHIR	native	8	3	forb	perennial	wood mint
Bromus pubescens	Poaceae	BROPUB	native	5	3	grass	perennial	canada brome
Carex pensylvanica	Cyperaceae	CXPENS	native	4	5	sedge	perennial	sedge
Carex sylvatica	Cyperaceae	CXSYLV	non-native	0	3	sedge	perennial	sedge
Carya glabra	Juglandaceae	CARGLA	native	5	3	tree	perennial	pignut hickory
Carya ovata	Juglandaceae	CAROVA	native	5	3	tree	perennial	shagbark hickory
Dactylis glomerata	Poaceae	DACGLO	non-native	0	3	grass	perennial	orchard grass
Dichanthelium latifolium; panicum l.	Poaceae	DICLAT	native	5	3	grass	perennial	broad-leaved panic grass
Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive
Elymus hystrix; hystrix patula	Poaceae	ELYHYS	native	5	3	grass	perennial	bottlebrush grass
Erigeron philadelphicus	Asteraceae	ERIPHI	native	2	0	forb	perennial	philadelphia fleabane
Eurybia macrophylla; aster m.	Asteraceae	EURMAC	native	4	5	forb	perennial	big-leaved aster

Baker Sanctuary Isham Preserve Floral Inventory Assessment

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Eutrochium fistulosum; eupatorium f.	Asteraceae	EUTFIS	native	8	-3	forb	perennial	hollow-stemmed joe-pye-weed
Fragaria virginiana	Rosaceae	FRAVIR	native	2	3	forb	perennial	wild strawberry
Fraxinus pennsylvanica	Oleaceae	FRAPEN	native	2	-3	tree	perennial	red ash
Geranium maculatum	Geraniaceae	GERMAC	native	4	3	forb	perennial	wild geranium
Hedera helix	Araliaceae	HEDHEL	non-native	0	3	vine	perennial	english ivy
Hepatica americana	Ranunculaceae	HEPAME	native	6	5	forb	perennial	round-lobed hepatica
Lespedeza hirta	Fabaceae	LESHIR	native	7	5	forb	perennial	hairy bush-clover
Melampyrum lineare	Orobanchaceae	MELLIN	native	6	3	forb	annual	cow-wheat
Monotropa uniflora	Ericaceae	MONOUN	native	5	3	forb	perennial	indian-pipe
Parthenocissus quinquefolia	Vitaceae	PARQUI	native	5	3	vine	perennial	virginia creeper
Persicaria virginiana; polygonum v.	Polygonaceae	PERVIR	native	4	0	forb	perennial	jumpseed
Phleum pratense	Poaceae	PHLPRA	non-native	0	3	grass	perennial	timothy
Pinus strobus	Pinaceae	PINSTR	native	3	3	tree	perennial	white pine
Plantago major	Plantaginaceae	PLAMAJ	non-native	0	3	forb	perennial	common plantain
Podophyllum peltatum	Berberidaceae	PODPEL	native	3	3	forb	perennial	may-apple
Polygonatum pubescens	Convallariaceae	POLPUB	native	5	5	forb	perennial	downy solomon seal
Prenanthes crepidinea	Asteraceae	PRECRE	native	6	0	forb	perennial	nodding rattlesnake root
Prunella vulgaris	Lamiaceae	PRUVUL	native	0	0	forb	perennial	self-heal
Prunus serotina	Rosaceae	PRUSER	native	2	3	tree	perennial	wild black cherry
Quercus alba	Fagaceae	QUEALB	native	5	3	tree	perennial	white oak

Baker Sanctuary Isham Preserve Floral Inventory Assessment

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Quercus palustris	Fagaceae	QUEPAL	native	8	-3	tree	perennial	pin oak
Quercus rubra	Fagaceae	QUERUB	native	5	3	tree	perennial	red oak
Ribes cynosbati	Grossulariaceae	RIBCYN	native	4	3	shrub	perennial	prickly or wild gooseberry
Robinia pseudoacacia	Fabaceae	ROBPSE	non-native	0	3	tree	perennial	black locust
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rubus occidentalis	Rosaceae	RUBOCC	native	1	5	shrub	perennial	black raspberry
Rumex obtusifolius	Polygonaceae	RUMOBT	non-native	0	0	forb	perennial	bitter dock
Sassafras albidum	Lauraceae	SASALB	native	5	3	tree	perennial	sassafras
Symphyotrichum cordifolium; aster c.	Asteraceae	SYMCOR	native	4	5	forb	perennial	heart-leaved aster
Thuja occidentalis	Cupressaceae	THUOCC	native	4	-3	tree	perennial	arbor vitae
Tiarella cordifolia	Saxifragaceae	TIACOR	native	9	3	forb	perennial	foamflower
Tilia americana	Malvaceae	TILAME	native	5	3	tree	perennial	basswood
Toxicodendron radicans	Anacardiaceae	TOXRAD	native	2	0	vine	perennial	poison-ivy
Ulmus americana	Ulmaceae	ULMAME	native	1	-3	tree	perennial	american elm
Vaccinium angustifolium	Ericaceae	VACANG	native	4	3	shrub	perennial	low sweet blueberry
Veronica officinalis	Plantaginaceae	VEROOF	non-native	0	3	forb	perennial	common speedwell
Vinca minor	Apocynaceae	VINMIN	non-native	0	5	shrub	perennial	periwinkle
Vitis riparia	Vitaceae	VITRIP	native	3	0	vine	perennial	river-bank grape

Baker Sanctuary Junction Road Floral Inventory Assessment

21145 15 Mile Rd, Bellevue, MI 49021		
Survey Dates:	7/15/2021 - 7/19/2021	
FQA DB Region:	Michigan	
FQA DB Publication Year:	2014	
FQA DB Description:	Reznicek, A.A., M.R. Penskar, B.S. Walters, and B.S. Slaughter. 2014. Michigan Floristic Quality Assessment Database. Herbarium, University of Michigan, Ann Arbor, MI and Michigan Natural Features Inventory, Michigan State University, Lansing, MI. http://michiganflora.net	
Practitioner:	Nick Tsichlis, James Johnson, Catherine Watts, Megan Livingston, Jenna Happach	
Latitude:		
Longitude:		
Weather Notes:		
Duration Notes:		
Community Type Notes:		
Other Notes:		
Large wetland/swamp backs up to Plot 3, Silty clay soil, Fungus throughout quadrant: Jellybaby, chantrelle, crown-tip coral, phallus; JR1 (transect) Notes: Wet Meadow; JR2 (transect) Notes: Wet Meadow; JR3 (transect) notes: Wetland; JR4 (transect) notes: Rattlesnake master near Q5"		
Private/Public:	Public	
Conservatism-Based Metrics:		
Total Mean C:	2.7	
Native Mean C:	3.6	
Total FQI:	22.1	
Native FQI:	25.5	
Adjusted FQI:	31.1	
% C value 0:	28.4	
% C value 1-3:	32.8	
% C value 4-6:	31.3	
% C value 7-10:	7.5	
Native Tree Mean C:	3.2	

Baker Sanctuary Junction Road Floral Inventory Assessment		
Native Shrub Mean C:	3.8	
Native Herbaceous Mean C:	3.7	
Species Richness:		
Total Species:	67	
Native Species:	50	74.60%
Non-native Species:	17	25.40%
Species Wetness:		
Mean Wetness:	1.7	
Native Mean Wetness:	1	
Physiognomy Metrics:		
Tree:	9	13.40%
Shrub:	9	13.40%
Vine:	3	4.50%
Forb:	30	44.80%
Grass:	7	10.40%
Sedge:	6	9%
Rush:	1	1.50%
Fern:	2	3%
Bryophyte:	0	0%
Duration Metrics:		
Annual:	2	3%
Perennial:	61	91%
Biennial:	4	6%
Native Annual:	1	1.50%
Native Perennial:	48	71.60%
Native Biennial:	1	1.50%

Baker Sanctuary Junction Road Floral Inventory Assessment								
Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Acer rubrum	Sapindaceae	ACERUB	native	1	0	tree	perennial	red maple
Achillea millefolium	Asteraceae	ACHMIL	native	1	3	forb	perennial	yarrow
Alliaria petiolata	Brassicaceae	ALLPET	non-native	0	3	forb	biennial	garlic mustard
Andropogon gerardii	Poaceae	ANDGER	native	5	0	grass	perennial	big bluestem
Anthriscus sylvestris	Apiaceae	ANTSYL	non-native	0	5	forb	biennial	false chervil
Apocynum cannabinum; a. sibiricum	Apocynaceae	APOCAN	native	3	0	forb	perennial	indian-hemp
Asplenium platyneuron	Aspleniaceae	ASPPLA	native	2	3	fern	perennial	ebony spleenwort
Baptisia lactea	Fabaceae	BAPLAC	native	9	3	forb	perennial	white false indigo
Berberis thunbergii	Berberidaceae	BERTHU	non-native	0	3	shrub	perennial	japanese barberry
Bromus ciliatus	Poaceae	BROCIL	native	6	-3	grass	perennial	fringed brome
Bromus inermis	Poaceae	BROINE	non-native	0	5	grass	perennial	smooth brome
Carex aurea	Cyperaceae	CXAURE	native	3	-3	sedge	perennial	sedge
Carex blanda	Cyperaceae	CXBLAN	native	1	0	sedge	perennial	sedge
Carex pensylvanica	Cyperaceae	CXPENS	native	4	5	sedge	perennial	sedge
Carex swanii	Cyperaceae	CXSWAN	native	4	3	sedge	perennial	sedge
Carex vulpinoidea	Cyperaceae	CXVULP	native	1	-5	sedge	perennial	sedge
Cerastium glomeratum	Caryophyllaceae	CERGLO	non-native	0	3	forb	annual	chickweed
Chamaecrista fasciculata; cassia chamaecrista	Fabaceae	CHAFAS	native	2	3	forb	annual	partridge-pea
Coreopsis lanceolata	Asteraceae	CORLAN	native	8	3	forb	perennial	sand coreopsis
Coreopsis palmata	Asteraceae	CORPAT	native	9	5	forb	perennial	prairie coreopsis

Baker Sanctuary Junction Road Floral Inventory Assessment

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Cornus foemina	Cornaceae	CORFOE	native	1	0	shrub	perennial	gray dogwood
Dasiphora fruticosa; potentilla f.	Rosaceae	DASFRU	native	8	-3	shrub	perennial	shrubby cinquefoil
Desmodium canadense	Fabaceae	DESCAD	native	3	0	forb	perennial	showy tick-trefoil
Dichanthelium oligosanthes; panicum o.	Poaceae	DICOLI	native	5	3	grass	perennial	panic grass
Dioscorea villosa; dioscorea villosa	Dioscoreaceae	DIOVIL	native	4	0	forb	perennial	wild yam
Echinacea purpurea	Asteraceae	ECHPUA	non-native	0	5	forb	perennial	purple coneflower
Elaeagnus umbellata	Elaeagnaceae	ELAUMB	non-native	0	3	shrub	perennial	autumn-olive
Erigeron annuus	Asteraceae	ERIANN	native	0	3	forb	biennial	daisy fleabane
Fragaria virginiana	Rosaceae	FRAVIR	native	2	3	forb	perennial	wild strawberry
Fraxinus pennsylvanica	Oleaceae	FRAPEN	native	2	-3	tree	perennial	red ash
Galium pilosum	Rubiaceae	GALPIL	native	6	5	forb	perennial	hairy bedstraw
Geum urbanum	Rosaceae	GEUURB	non-native	0	5	forb	perennial	avens
Hypericum perforatum	Hypericaceae	HYPPER	non-native	0	5	forb	perennial	common st. johns-wort
Ilex verticillata	Aquifoliaceae	ILEVER	native	5	-3	shrub	perennial	michigan holly
Juncus tenuis	Juncaceae	JUNTEN	native	1	0	rush	perennial	path rush
Leucanthemum vulgare; chrysanthemum leucanthemum	Asteraceae	LEUVUL	non-native	0	5	forb	perennial	ox-eye daisy
Monarda fistulosa	Lamiaceae	MONFIS	native	2	3	forb	perennial	wild-bergamot
Onoclea sensibilis	Onocleaceae	ONOSEN	native	2	-3	fern	perennial	sensitive fern
Panicum virgatum	Poaceae	PANVIR	native	4	0	grass	perennial	switch grass
Parthenium integrifolium; p. hispidum	Asteraceae	PARINT	non-native	0	5	forb	perennial	wild quinine
Parthenocissus quinquefolia	Vitaceae	PARQUI	native	5	3	vine	perennial	virginia creeper

Baker Sanctuary Junction Road Floral Inventory Assessment

Scientific Name	Family	Acronym	Native?	C	W	Physiognomy	Duration	Common Name
Pastinaca sativa	Apiaceae	PASSAT	non-native	0	5	forb	biennial	wild parsnip
Phleum pratense	Poaceae	PHLPRA	non-native	0	3	grass	perennial	timothy
Podophyllum peltatum	Berberidaceae	PODPEL	native	3	3	forb	perennial	may-apple
Prunella vulgaris	Lamiaceae	PRUVUL	native	0	0	forb	perennial	self-heal
Prunus serotina	Rosaceae	PRUSER	native	2	3	tree	perennial	wild black cherry
Quercus alba	Fagaceae	QUEALB	native	5	3	tree	perennial	white oak
Quercus ellipsoidalis; q. coccinea	Fagaceae	QUEELL	native	4	5	tree	perennial	hills oak
Quercus rubra	Fagaceae	QUERUB	native	5	3	tree	perennial	red oak
Rosa multiflora	Rosaceae	ROSMUL	non-native	0	3	shrub	perennial	multiflora rose
Rubus occidentalis	Rosaceae	RUBOCC	native	1	5	shrub	perennial	black raspberry
Rudbeckia hirta	Asteraceae	RUDHIR	native	1	3	forb	perennial	black-eyed susan
Sassafras albidum	Lauraceae	SASALB	native	5	3	tree	perennial	sassafras
Schizachyrium scoparium; andropogon s.	Poaceae	SCHSCO	native	5	3	grass	perennial	little bluestem
Scirpus cyperinus	Cyperaceae	SCICYP	native	5	-5	sedge	perennial	wool-grass
Spiraea alba	Rosaceae	SPIALB	native	4	-3	shrub	perennial	meadowsweet
Symphyotrichum oolentangiense; aster o.	Asteraceae	SYMOOL	native	4	5	forb	perennial	prairie heart-leaved aster
Taraxacum officinale	Asteraceae	TAROFF	non-native	0	3	forb	perennial	common dandelion
Thuja occidentalis	Cupressaceae	THUOCC	native	4	-3	tree	perennial	arbor vitae
Tiarella cordifolia	Saxifragaceae	TIACOR	native	9	3	forb	perennial	foamflower
Toxicodendron radicans	Anacardiaceae	TOXRAD	native	2	0	vine	perennial	poison-ivy
Trifolium repens	Fabaceae	TRIREP	non-native	0	3	forb	perennial	white clover
Ulmus americana	Ulmaceae	ULMAME	native	1	-3	tree	perennial	american elm

Baker Sanctuary Junction Road Floral Inventory Assessment								
Scientific Name	Family	Acronym	Native?	C	W	Physi-ogno-my	Duration	Common Name
Vernonia missurica	Asterace-ae	VERMIS	native	4	0	forb	perennial	missouri iron-weed
Veronica officinalis	Plantag-inaceae	VEROOF	non-na-tive	0	3	forb	perennial	common speedwell
Viburnum lentago	Adoxac-eae	VIBLEN	native	4	0	shrub	perennial	nannyberry
Vitis riparia	Vitaceae	VITRIP	native	3	0	vine	perennial	river-bank grape

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