GREEN TIMBER

# COMMUNITY FOREST STEWARDSHIP PLAN

| LANDOWNER: | City of Ironwood |
|---|---|
| **Address:** | 213 S. Marquette St.<br>Ironwood, MI 49938 |
| **Phone:** | (906) 932-5050 |
| **Signature:**<br><br>**Date:** | |

**LEGAL DESCRIPTION**

T. 47 N. – R. 47 W.
Portions of Sections 21, 22, 23, & 34
City of Ironwood, Gogebic County, Michigan
~458 Acres

**Green Timber Consulting Foresters, Inc.** • 11511 US Highway 41, Pelkie, MI 49958
(906) 353-8584 • info@greentimberforestry.com • GreenTimberForestry.com

**PREPARED BY** **Karl Ploeckelman**

**Signature of Plan Writer:** June 14th 2023

Karl Ploeckelman

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# SECTION I: MAPS AND INTRODUCTION

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## PROPERTY MAPS

- Locator Map
- Stands Maps x3
- Activities Maps x3
- Soils Maps x3
- Trail Maps x3

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# Ironwood Community Forest Property Locator
## T. 47 N. - R. 47 W.
## Portions of Sections 21, 22, 23 & 34
## Gogebic County, Michigan



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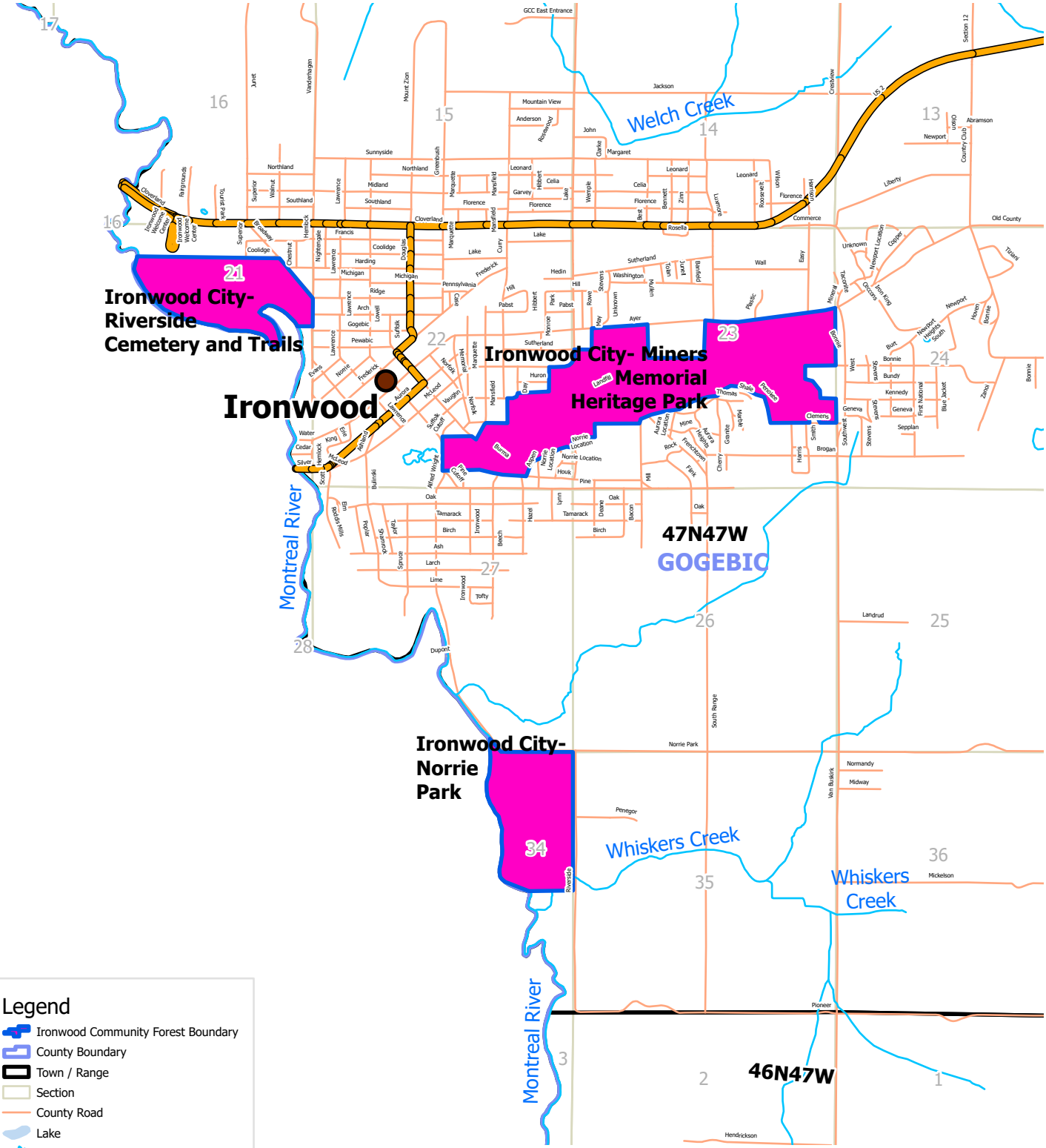


Legend
- Ironwood Community Forest Boundary
- County Boundary
- Town / Range
- Section
- County Road
- Lake
- Water Feature
- Highway

N

0 1 2 4 Miles

GREEN TIMBER

47N47W

# Ironwood Community Forest Property - Stands

Ironwood City- Miners Memorial Heritage Park

47N47W23

Portions of Sections 21, 22, 23

## Gogebic County, Michigan



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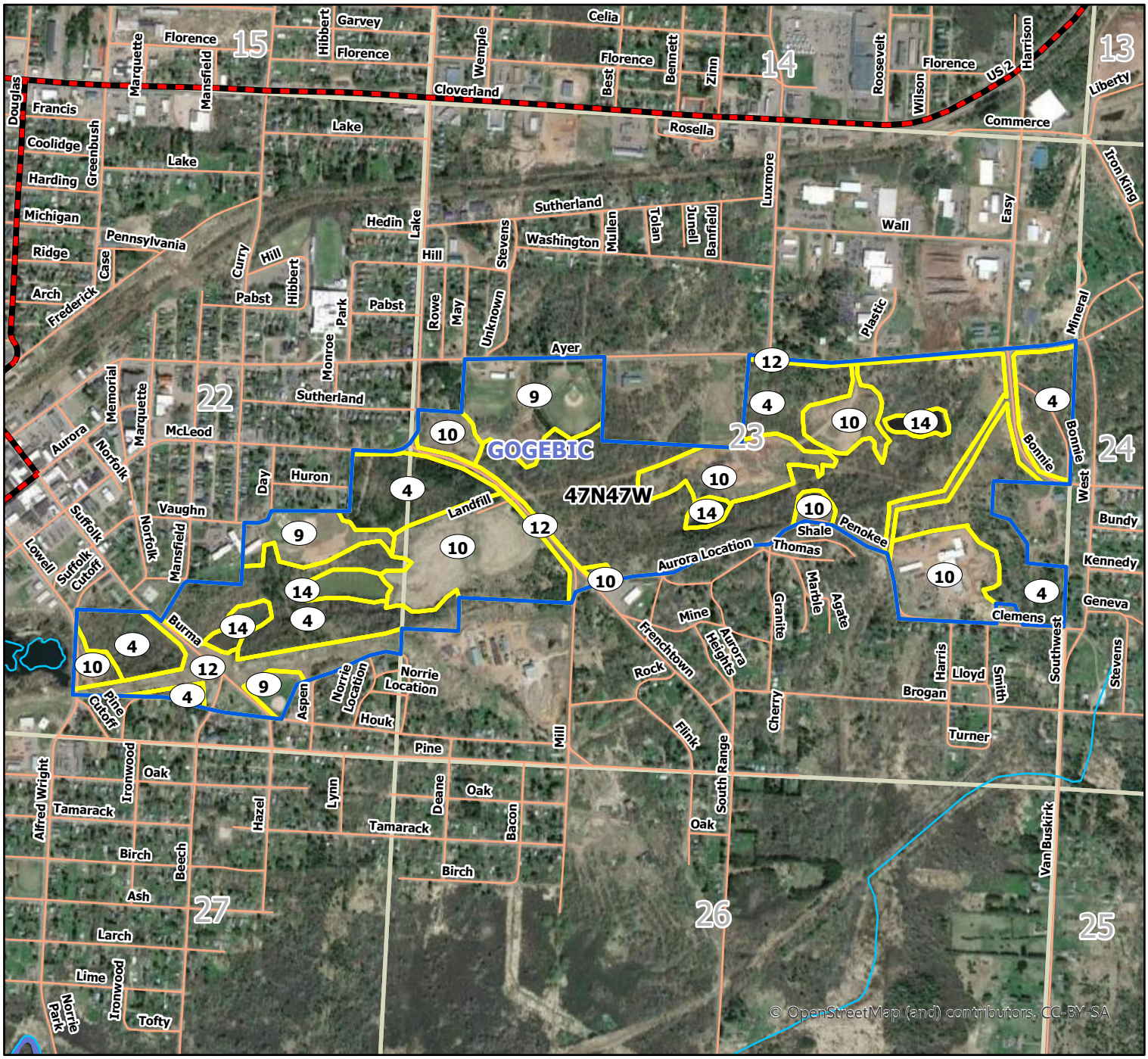


## Legend

- Ironwood Community Forest Boundary
- Type Boundary
- Highways
- Town and Range
- Sections
- City Streets / County Roads
- Water Features

| Stand_ID | Type | GIS_Acres |
|---|---|---|
| 9 | Open (a) | 28.3 |
| 10 | Open (b) | 60.0 |
| 12 | ROW | 24.4 |
| 14 | XW | 9.0 |
| 4 | Am5 | 143.5 |

0.00 0.13 0.25 Miles

GREEN TIMBER

47N47W

# Ironwood Community Forest Property - Stands

Ironwood City- Norrie Park

47N47W34

Portion of Section 34

## Gogebic County, Michigan

-NOT A SURVEY MAP-
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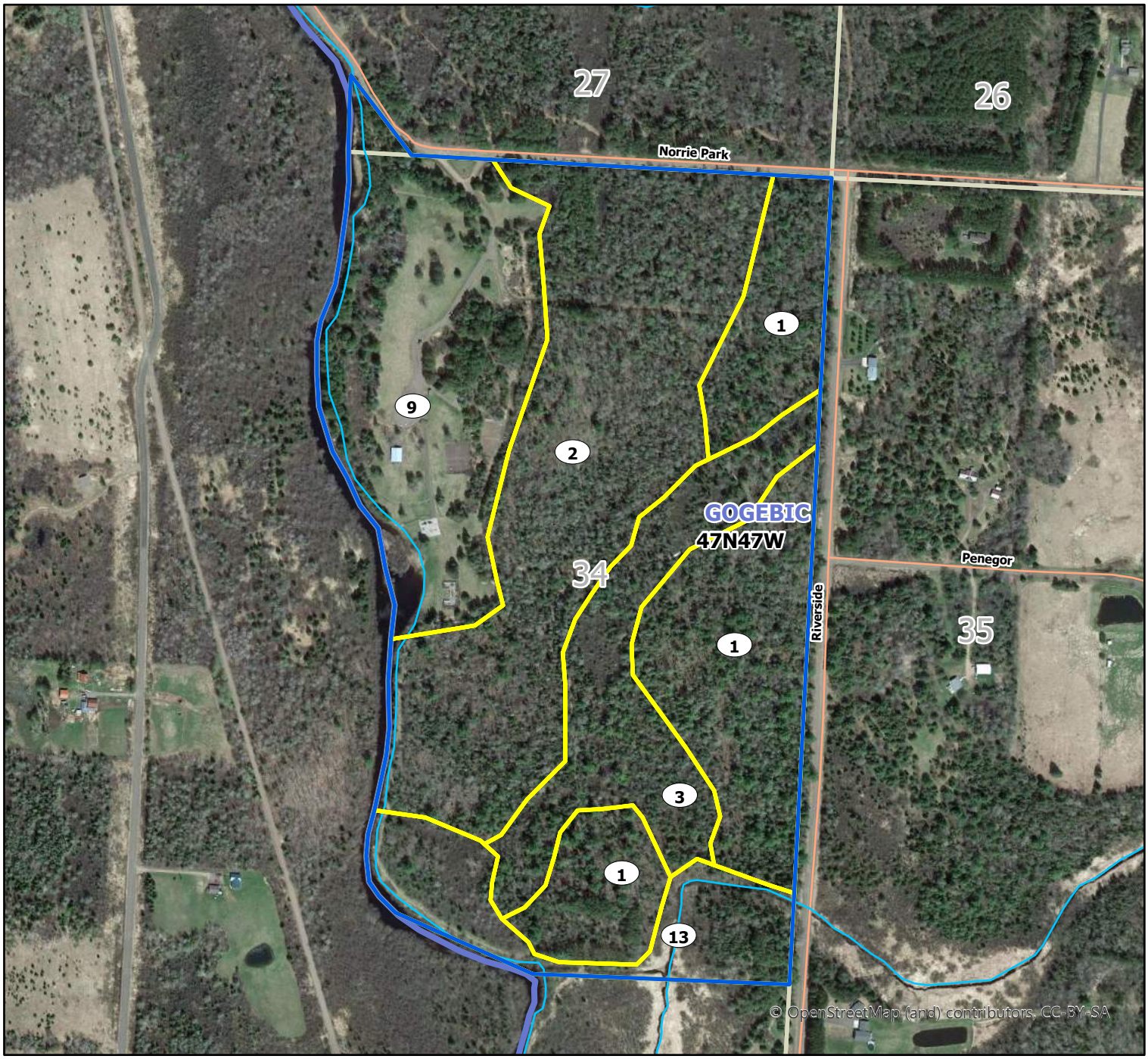


## Legend

- Ironwood Community Forest Boundary
- Type Boundary
- Town and Range
- Sections
- City Streets / County Roads
- Water Features

| Stand_ID | Type | GIS_Acres |
|---|---|---|
| 1 | Mw6-8 | 23.9 |
| 9 | Open (a) | 22.8 |
| 13 | XL | 8.3 |
| 2 | Ma6 | 31.1 |
| 3 | Qe5 | 12.4 |

0.00 0.13 0.25 Miles

GREEN TIMBER

47N47W

# Ironwood Community Forest Property - Stands

Ironwood City- Riverside Cemetery and Trails

47N47W21

Portion of Section 21

## Gogebic County, Michigan

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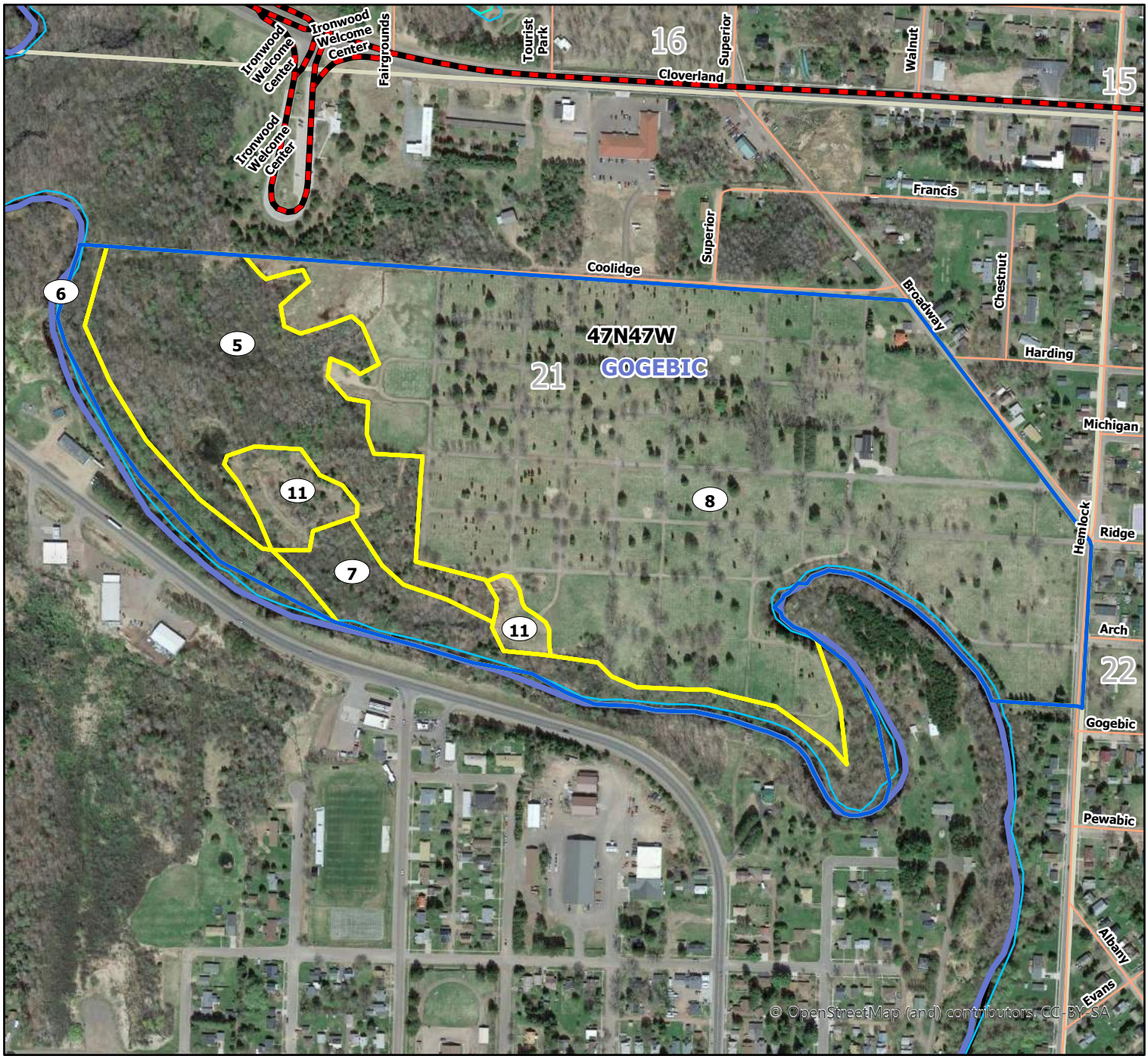


## Legend

- Ironwood Community Forest Boundary
- Type Boundary
- Highways
- Town and Range
- Sections
- City Streets / County Roads
- Water Features

| Stand_ID | Type | GIS_Acres |
|---|---|---|
| 11 | Open (c) | 3.1 |
| 5 | Ma5 | 16.1 |
| 6 | E8 | 3.5 |
| 7 | E4 | 7.8 |
| 8 | Cemetary | 64.4 |

0.00 0.13 0.25 Miles

GREEN TIMBER

47N47W

# Ironwood Community Forest Property - Activities

Ironwood City- Miners Memorial Heritage Park

47N47W23

Portions of Sections 21, 22, 23

## Gogebic County, Michigan

Date Saved: 7/31/2023
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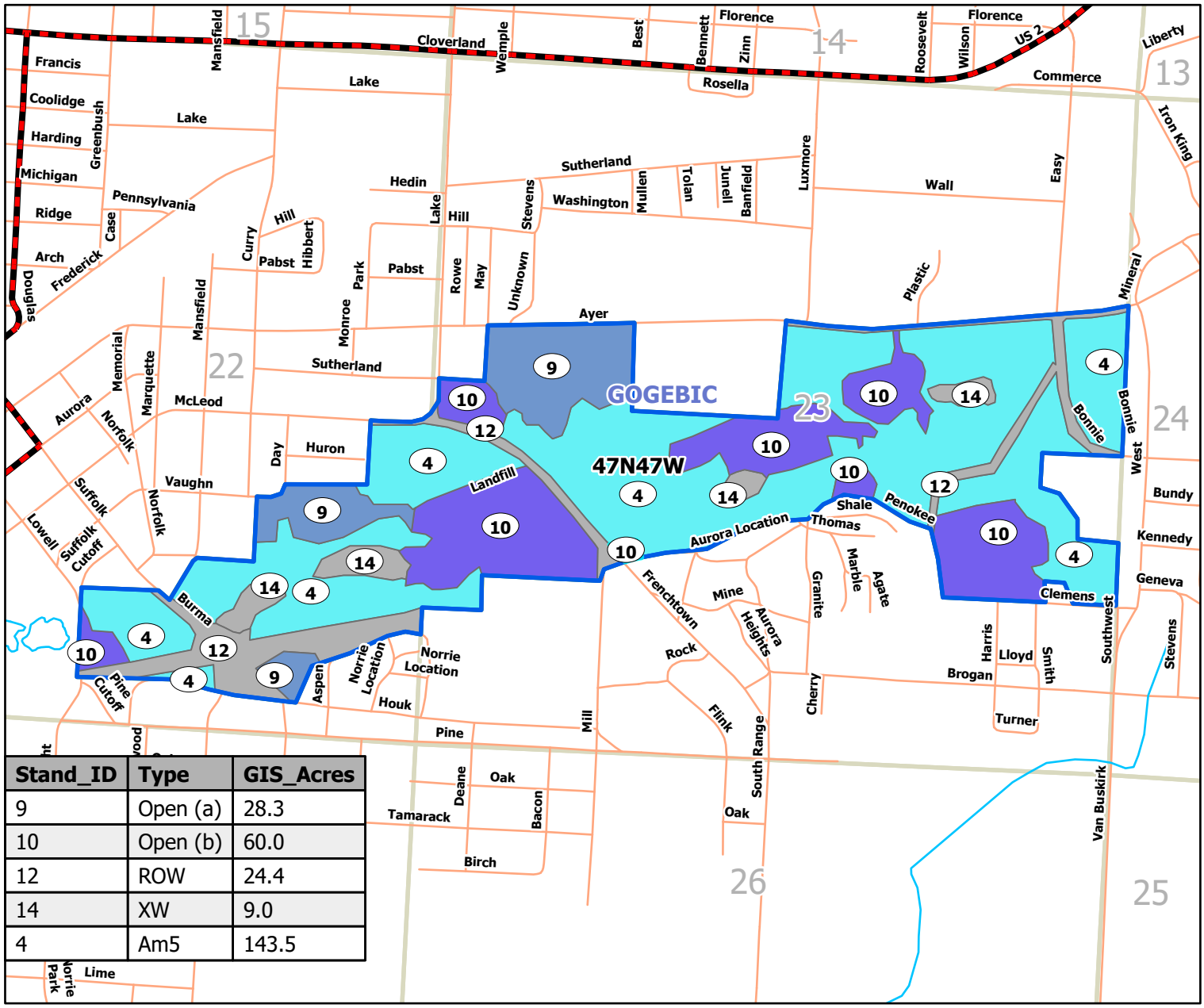



| Stand_ID | Type | GIS_Acres |
|---|---|---|
| 9 | Open (a) | 28.3 |
| 10 | Open (b) | 60.0 |
| 12 | ROW | 24.4 |
| 14 | XW | 9.0 |
| 4 | Am5 | 143.5 |

## Legend

- Ironwood Community Forest Boundary
- Type Boundary
- Highways
- Town and Range
- Sections
- City Streets / County Roads

## Recommended Management

- Manage invasive shrubs
- Manage invasive shrubs, allow natural succession
- Manage invasive shrubs, plant native species
- Maintain for city operations
- Maintain landscape trees, remove hazard trees
- Maintain for recreation
- No active management

0.00 0.13 0.25 Miles

GREEN TIMBER

47N47W

# Ironwood Community Forest Property - Activities

Ironwood City- Norrie Park

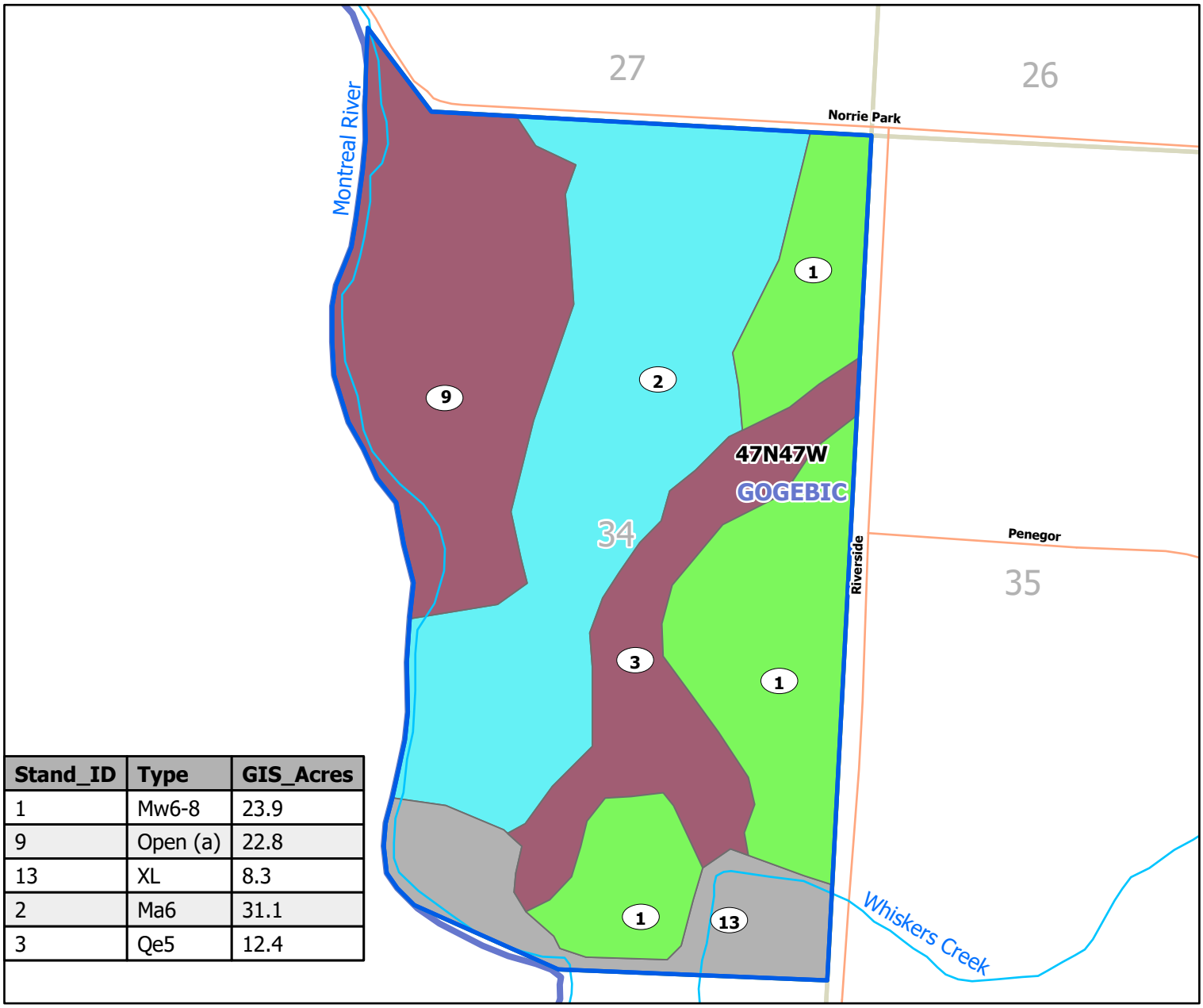
47N47W34

Portion of Section 34

## Gogebic County, Michigan

Date Saved: 7/31/2023
4:39 PM






| Stand_ID | Type | GIS_Acres |
|---|---|---|
| 1 | Mw6-8 | 23.9 |
| 9 | Open (a) | 22.8 |
| 13 | XL | 8.3 |
| 2 | Ma6 | 31.1 |
| 3 | Qe5 | 12.4 |

## Legend

- Ironwood Community Forest Boundary
- Type Boundary
- Town and Range
- Sections
- City Streets / County Roads

## Recommended Management

- Manage invasive shrubs
- Manage invasive shrubs, allow natural succession
- Manage invasive shrubs, plant native species
- Maintain for city operations
- Maintain landscape trees, remove hazard trees
- Maintain for recreation
- No active management

0.00 0.13 0.25 Miles

GREEN TIMBER

47N47W

# Ironwood Community Forest Property - Activities

Ironwood City- Riverside Cemetery and Trails

47N47W21

Portion of Section 21

## Gogebic County, Michigan

-NOT A SURVEY MAP-
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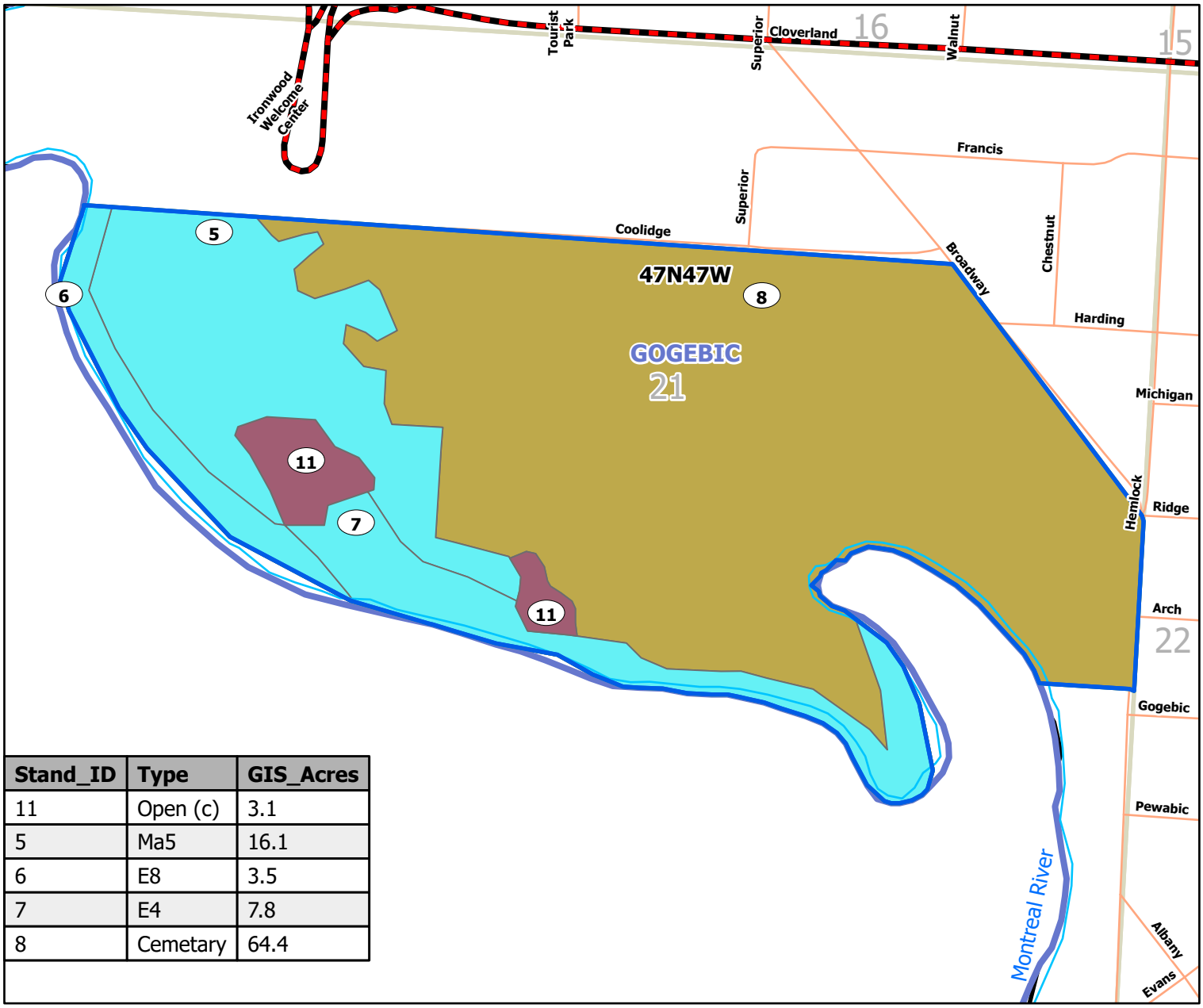


| Stand_ID | Type | GIS_Acres |
|---|---|---|
| 11 | Open (c) | 3.1 |
| 5 | Ma5 | 16.1 |
| 6 | E8 | 3.5 |
| 7 | E4 | 7.8 |
| 8 | Cemetary | 64.4 |

## Legend

- Ironwood Community Forest Boundary
- Type Boundary
- Highways
- Town and Range
- Sections
- City Streets / County Roads

## Recommended Management

- Manage invasive shrubs
- Manage invasive shrubs, allow natural succession
- Manage invasive shrubs, plant native species
- Maintain for city operations
- Maintain landscape trees, remove hazard trees
- Maintain for recreation
- No active management

0.00 0.13 0.25 Miles

GREEN TIMBER

47N47W

# Ironwood Community Forest Property - Soils

Ironwood City- Miners Memorial Heritage Park

47N47W23

Portions of Sections 21, 22, 23

**Gogebic County, Michigan**

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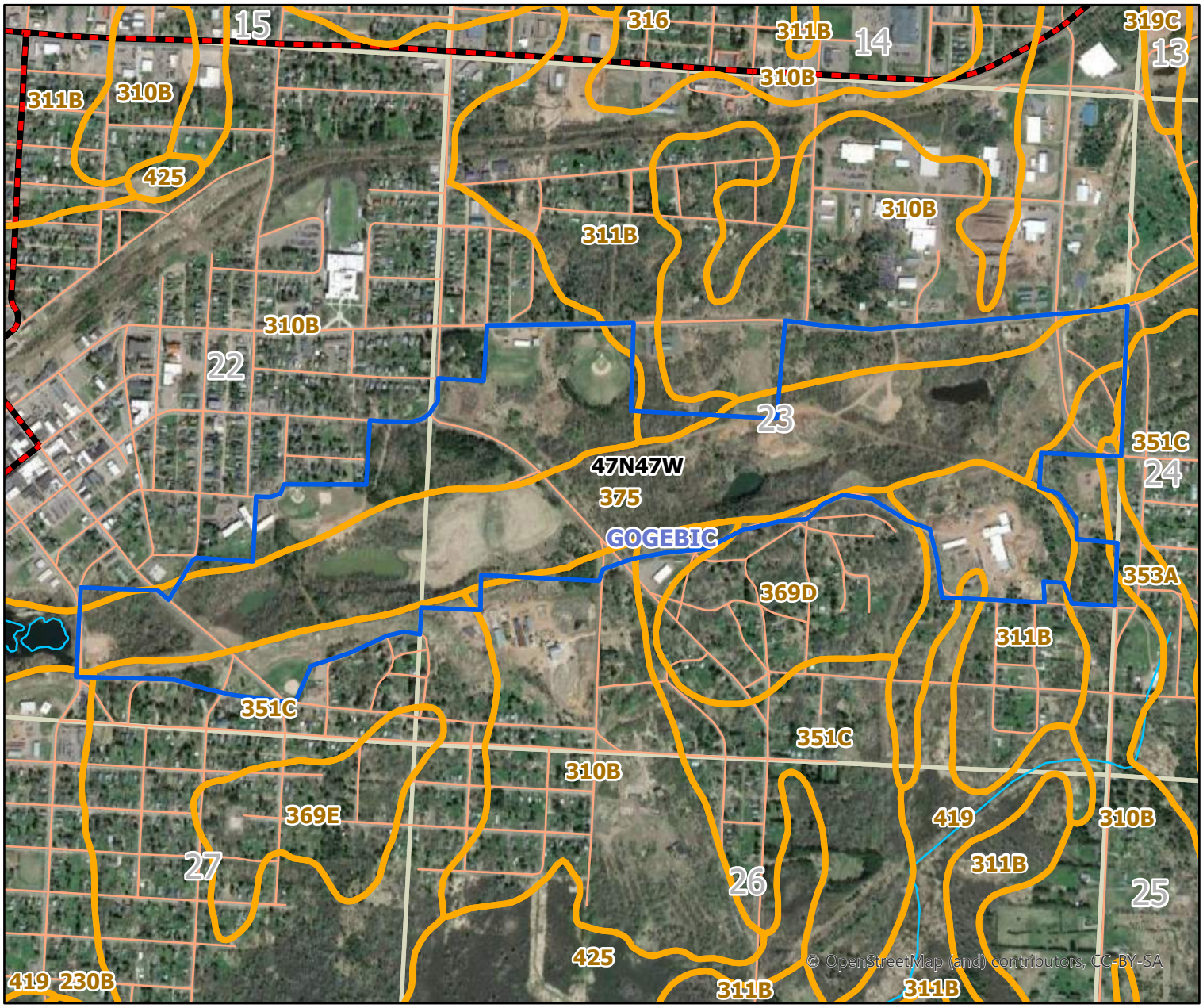


## Legend

- Ironwood Community Forest Boundary
- Soil Boundary
- Highways
- Town and Range
- Sections
- City Streets / County Roads
- Water Features

## Soil Types

230B—Moquah-Arnheim complex, 0 to 3 percent slopes, frequently flooded
310B—Gogebic fine sandy loam, 1 to 6 percent slopes, stony
311B—Tula-Gogebic complex, 0 to 6 percent slopes, stony
351C—Gogebic silt loam, 6 to 18 percent slopes, very stony, rocky
375—Dumps and Pits, mine
429C—Gogebic-Peshekee complex, 6 to 18 percent slopes, very rocky, very stony
432E—Schweitzer-Michigamme-Rock outcrop complex, 18 to 55 percent slopes, very stony
688—Cathro-Leafriver complex, 0 to 1 percent slopes, frequently flooded
689B—Chabeneau-Channing-Gogebic complex, 0 to 6 percent slopes, stony

0.00 0.13 0.25
Miles

GREEN TIMBER

47N47W

# Ironwood Community Forest Property - Soils

Ironwood City- Norrie Park

47N47W34

Portion of Section 34

## Gogebic County, Michigan

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Date Saved: 6/13/2023
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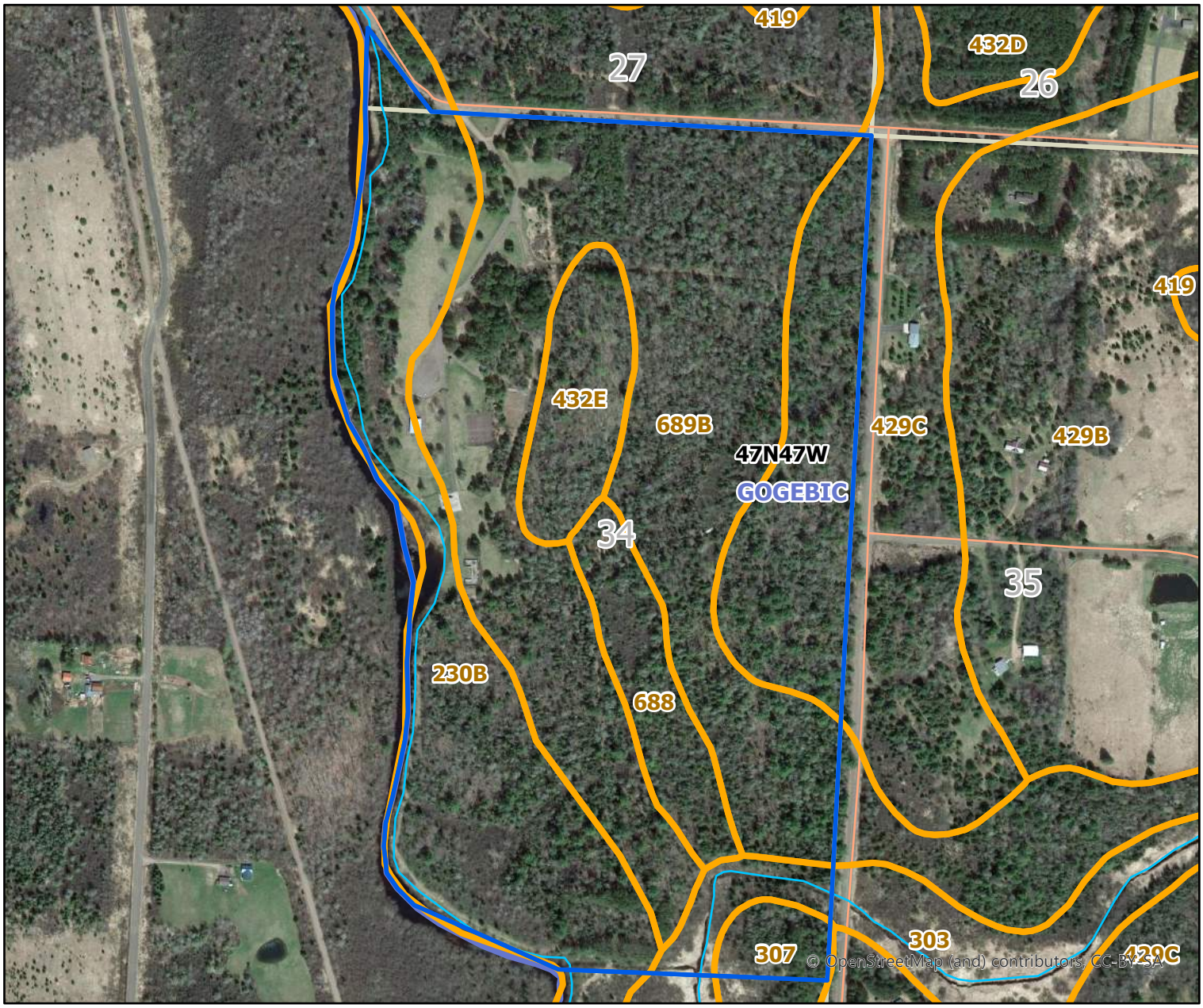


## Legend

- Ironwood Community Forest Boundary
- Soil Boundary
- Town and Range
- Sections
- City Streets / County Roads
- Water Features

## Soil Types

230B—Moquah-Arnheim complex, 0 to 3 percent slopes, frequently flooded
310B—Gogebic fine sandy loam, 1 to 6 percent slopes, stony
311B—Tula-Gogebic complex, 0 to 6 percent slopes, stony
351C—Gogebic silt loam, 6 to 18 percent slopes, very stony, rocky
375—Dumps and Pits, mine
429C—Gogebic-Peshekee complex, 6 to 18 percent slopes, very rocky, very stony
432E—Schweitzer-Michigamme-Rock outcrop complex, 18 to 55 percent slopes, very stony
688—Cathro-Leafriver complex, 0 to 1 percent slopes, frequently flooded
689B—Chabeneau-Channing-Gogebic complex, 0 to 6 percent slopes, stony

0.00 0.13 0.25 Miles

GREEN TIMBER

47N47W

# Ironwood Community Forest Property - Soils

Ironwood City- Riverside Cemetery and Trails

47N47W21

Portion of Section 21

## Gogebic County, Michigan

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Date Saved: 6/13/2023
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## Legend

- Ironwood Community Forest Boundary
- Soil Boundary
- Highways
- Town and Range
- Sections
- City Streets / County Roads
- Water Features

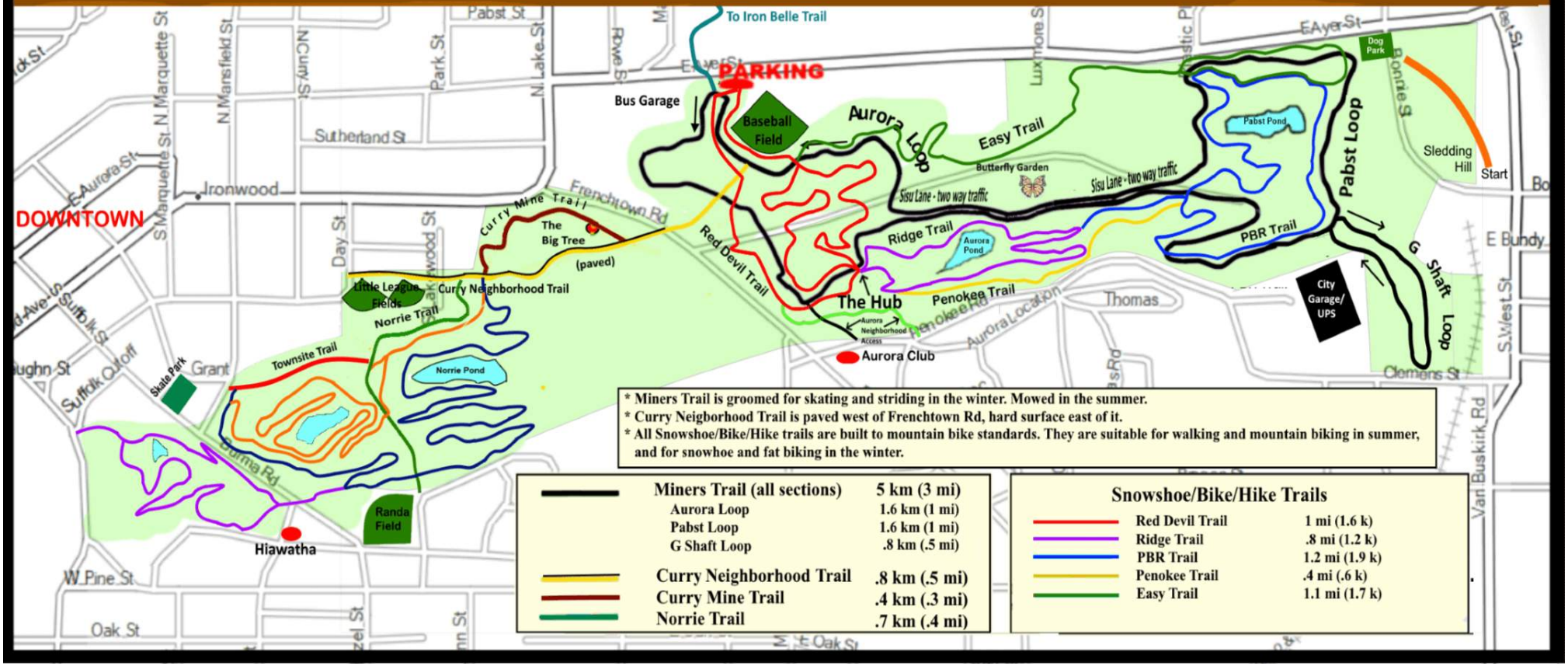
## Soil Types

230B—Moquah-Arnheim complex, 0 to 3 percent slopes, frequently flooded
310B—Gogebic fine sandy loam, 1 to 6 percent slopes, stony
311B—Tula-Gogebic complex, 0 to 6 percent slopes, stony
351C—Gogebic silt loam, 6 to 18 percent slopes, very stony, rocky
375—Dumps and Pits, mine
429C—Gogebic-Peshekee complex, 6 to 18 percent slopes, very rocky, very stony
432E—Schweitzer-Michigamme-Rock outcrop complex, 18 to 55 percent slopes, very stony
688—Cathro-Leafriver complex, 0 to 1 percent slopes, frequently flooded
689B—Chabeneau-Channing-Gogebic complex, 0 to 6 percent slopes, stony

0.00 0.13 0.25 Miles

GREEN TIMBER

# Miners Memorial Heritage Park



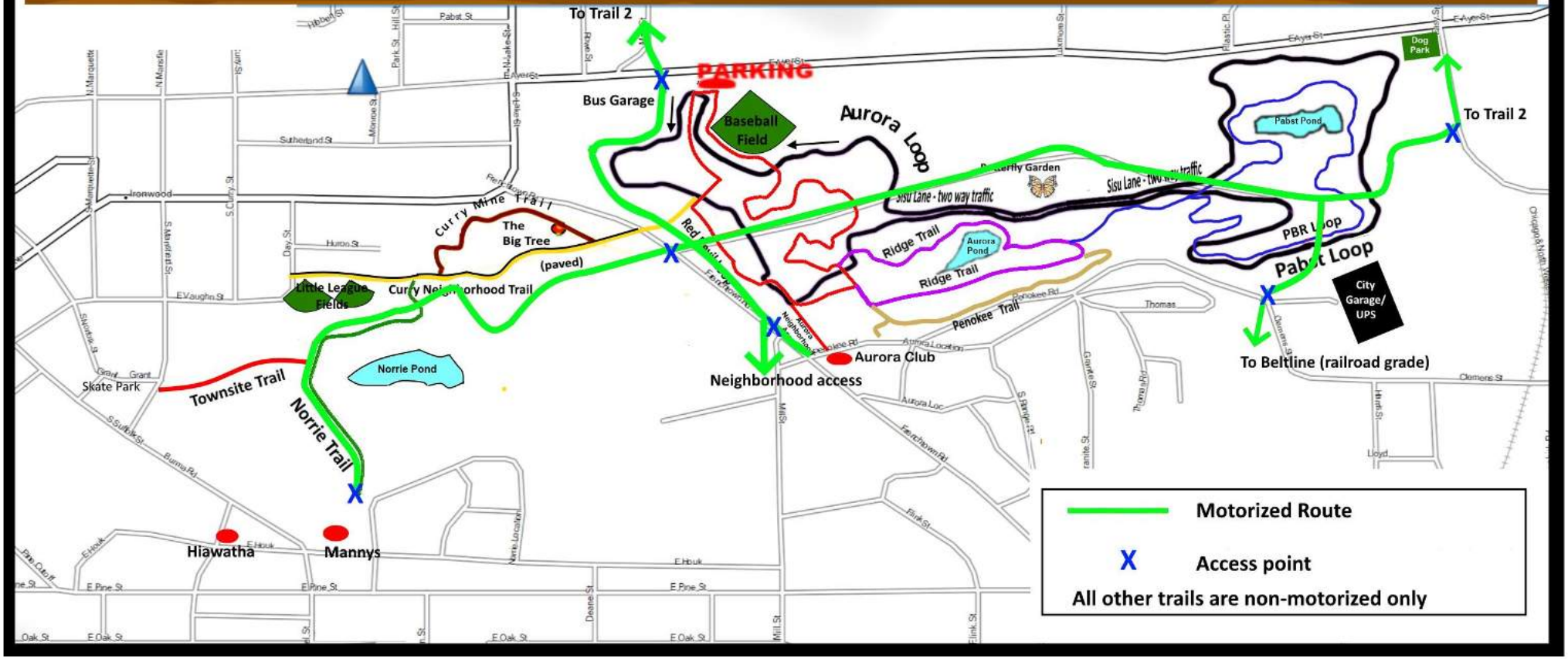

* Miners Trail is groomed for skating and striding in the winter. Mowed in the summer.
* Curry Neigborhood Trail is paved west of Frenchtown Rd, hard surface east of it.
* All Snowshoe/Bike/Hike trails are built to mountain bike standards. They are suitable for walking and mountain biking in summer, and for snowhoe and fat biking in the winter.

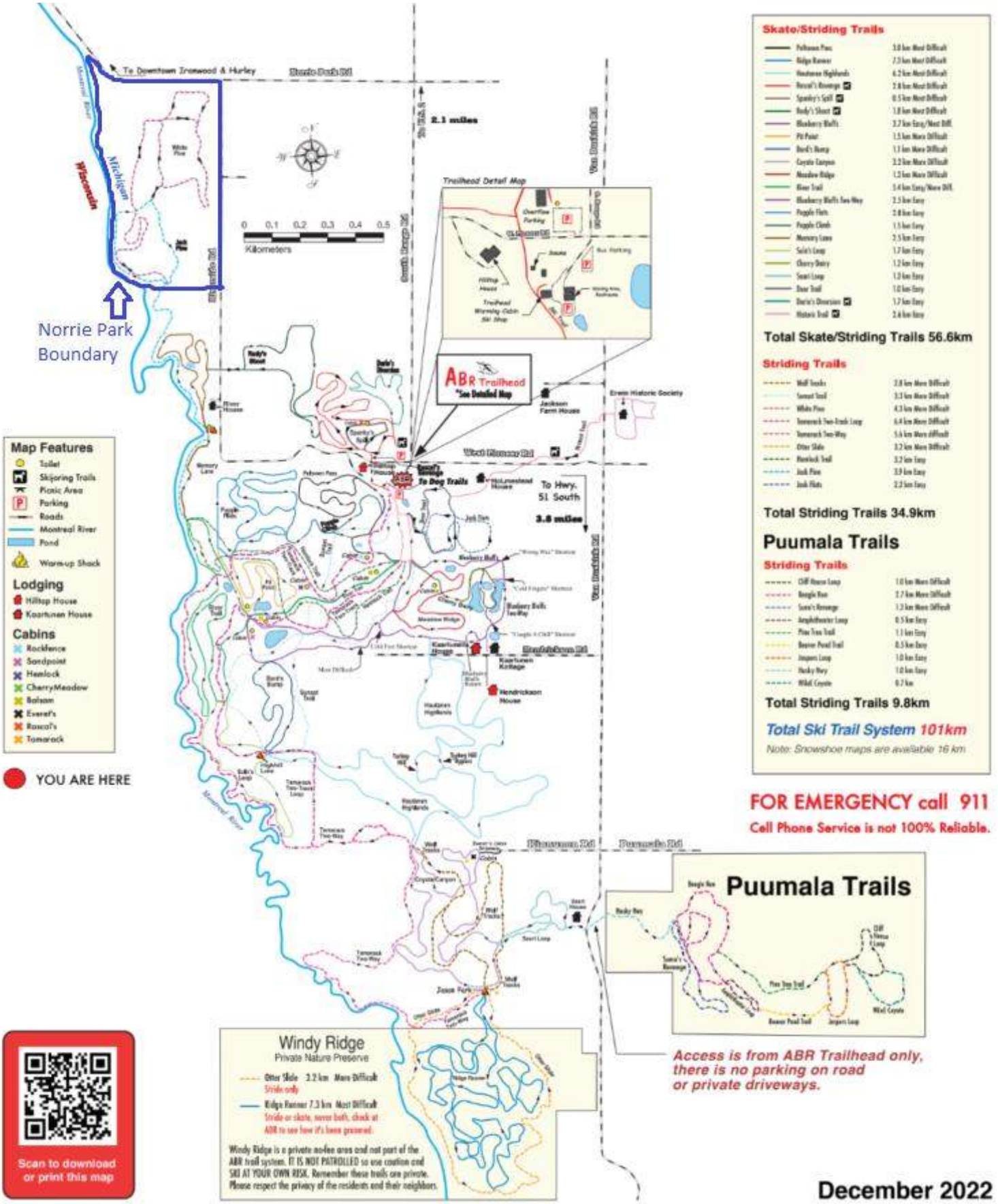
| | |
|---|---|
| **Miners Trail (all sections)** | **5 km (3 mi)** |
| Aurora Loop | 1.6 km (1 mi) |
| Pabst Loop | 1.6 km (1 mi) |
| G Shaft Loop | .8 km (.5 mi) |
| **Curry Neighborhood Trail** | **.8 km (.5 mi)** |
| **Curry Mine Trail** | **.4 km (.3 mi)** |
| **Norrie Trail** | **.7 km (.4 mi)** |

**Snowshoe/Bike/Hike Trails**

| | |
|---|---|
| Red Devil Trail | 1 mi (1.6 k) |
| Ridge Trail | .8 mi (1.2 k) |
| PBR Trail | 1.2 mi (1.9 k) |
| Penokee Trail | .4 mi (.6 k) |
| Easy Trail | 1.1 mi (1.7 k) |

# Miners Memorial Heritage Park
# Motorized Routes




To Downtown Ironwood & Hurley
Wisconsin
Michigan
2.1 miles
Trailhead Detail Map
Norrie Park Boundary
ABR Trailhead
*See Detailed Map
To Hwy. 51 South
3.8 miles
To Dog Trails
Ewen Historic Society
Windy Ridge
Private Nature Preserve
Otter Slide 3.2 km More Difficult
Stride only
Ridge Runner 7.3 km Most Difficult
Stride or skate, never both, check at ABR to see how it's been groomed.
Windy Ridge is a private no-fee area and not part of the ABR trail system. IT IS NOT PATROLLED so use caution and SKI AT YOUR OWN RISK. Remember these trails are private. Please respect the privacy of the residents and their neighbors.
Puumala Trails
Access is from ABR Trailhead only, there is no parking on road or private driveways.
Map Features
Toilet
Skijoring Trails
Picnic Area
Parking
Roads
Montreal River
Pond
Warm-up Shack
Lodging
Hilltop House
Kaartunen House
Cabins
Rockfence
Sandpoint
Hemlock
Cherry Meadow
Balsam
Everett's
Rascal's
Tamarack
YOU ARE HERE
Skate/Striding Trails
Total Skate/Striding Trails 56.6km
Striding Trails
Total Striding Trails 34.9km
Puumala Trails
Striding Trails
Total Striding Trails 9.8km
Total Ski Trail System 101km
Note: Snowshoe maps are available 16 km
FOR EMERGENCY call 911
Cell Phone Service is not 100% Reliable.
Scan to download or print this map
December 2022

# INTRODUCTION

This forest management plan has been prepared for the landowner City of Ironwood in order to describe the current conditions of the forest and related natural resources on their Community Forest properties and parks, and to prescribe management activities for a period of 20 years, commencing at the date listed on the front cover of this plan.

After 20 years this plan will be considered expired and the property should again be visited by a forester in order to assess the conditions of the forest and to make recommendations for future management based on the conditions observed at that time. When the assessment of forest conditions occurs, this forest management plan should also undergo an update or complete revision; this decision should be made by the landowner with the advice of their forester. The property should undergo a brief inspection by a forester in approximately 10 years to determine if any significant changes have occurred on the property that may impact the recommendations set forth in this plan. This plan will describe:

- Goals and objectives of the landowner.
- All features and conditions observed on the land with a focus on those that relate to forest management.
- Recommended management options to fit the landowner's goals while managing the land sustainably and in accordance with current science.

This plan provides a wealth of information about the current condition of the property. At-a-glance information about forest types, management recommendations, harvest dates and soil types can be found on the maps included in Section I of this Forest Management Plan; a summary of the recommended management activities is provided in the "Recommended Treatment Schedule" which is located immediately after the narrative stand descriptions. More detailed descriptions of the forest conditions and explanations of the management recommendations are found in Section III of this plan. Photos are included to illustrate certain conditions and features that were observed on the property.

Terminology that is commonly used in forest management plans but may be unfamiliar to the reader is defined in the Glossary in Section IV.

## LANDOWNER GOALS AND OBJECTIVES

*"Long-term goals would consider the future of the community forest and reflect the City of Ironwood's dedication to community spaces and recreational opportunities."*

The landowner has identified these properties described in this plan for the purposes of a series of similar goals. First and foremost, these parcels are all used for forest recreation of some kind. With this in mind, the landowner's primary goals and objectives are to manage the forests for aesthetics, health, and continued recreational use and development. Additional goals that commonly go hand in hand with recreational goals include general stewardship of the land, which includes benefiting wildlife habitat, water quality protection, and community engagement.

Specifically, the landowner needs a plan that includes guidance, recommended practices, and timetables to help manage and achieve the overall goals. This plan has been written to provide the City with this guidance. This plan is also written to meet the requirements of most forestry programs should there ever be interest in enrolling in any, including but not limited to the American Tree Farm System (ATFS) and Tree City USA. The landowner will meet the requirements of any enrolled programs by following the recommendations provided in this plan, and ultimately by managing the sites using sustainable forest management practices aimed at improving timber quality and productivity, forest health, wildlife habitat, recreation values, and community engagement.

## SUSTAINABILITY AND MULTIPLE USES

In many situations, management recommendations can be tailored to achieve multiple long-term goals while enhancing the current benefits the landowner obtains from the property; for instance, logging roads can be designed to facilitate a harvest now and meet the long-term needs of a landowner for accessing and using his or her property. Conducting sustainable forest management that considers both the current conditions of the land and the desired future outcomes will help to ensure that the future owners and users of the land will have equal opportunities to benefit from the forest. This principle, known as sustainable forest management, considers current conditions of the forest and applies scientific principles of forestry to ensure that the forest is able to provide "the greatest good [for] the greatest number in the long run," as stated by Gifford Pinchot, one of the founders of modern American forestry.

Management actions conducted on one parcel of land can affect natural processes on adjacent parcels. One example of this is when a poorly-built stream crossing washes out and clogs a neighbor's streambed with sediment, thereby degrading trout habitat. Likewise, the ecosystems found in a particular area can influence the outcomes of forest management. Attempting to establish a maple syrup operation on the dry, sandy soils is simply not going to be a successful endeavor. Therefore, it is important for land management options to consider the types of ecosystems present on a given piece of land and on the adjacent properties. Natural occurrences such as windstorms, soil types and topography are not subject to property lines laid out by humans.

Forest management that is based on natural disturbances and considers the range of factors that impact tree growth is a key component of broad-scale "landscape management." It is difficult to coordinate landscape management activities across a number of small parcels of land under different ownerships. Conducting sustainable forest management that considers the influence of ecosystems and mimics natural disturbances is one step towards landscape management. The recommendations made in this management plan have been developed to ensure sustainable forest use.

According to another pioneer in American conservation, Aldo Leopold, "… To keep every cog and wheel is the first rule of intelligent tinkering." This was an early reflection on what is today referred to as "ecological integrity." In short, ecological integrity consists of the ability of a natural system to continue to carry out its typical functions. In order for a system to continue to function, it is important that it retains its original components. Those components may include parts that we cannot see, as well as those that do not have a perceived or measurable "value." One example is deer populations. It was once thought that extirpating wolves and other predators would result in plentiful deer populations, and that there would be no disadvantages to this. Eventually it was realized that even with hunting used as a management tool, predators are still needed to cull out the weakest members of the herd. High deer populations can have negative impacts on forest vegetation and the diversity of tree species. Obviously, there are numerous factors at play in the current size of the deer herd, including winter intensity, feeding by humans, parasites, diseases, and hunting pressure. The interactions between wolves, deer and vegetation are a basic representation of dynamic natural systems. Historically, the focus of wildlife management was on increased populations of game species. Likewise, forest management at times becomes preoccupied with the most valuable timber species, losing touch with the importance of other facets of the forest. Although we may not yet know or understand every interaction within the natural systems we manage, it is important to "keep every cog and wheel" so that these systems may continue to carry out their natural functions. Some species have been lost, so the systems of today may not behave in the ways in which they once did, but there is a degree of resilience to systems whereby other organisms may be able to take over a function. This resilience can be tested when invasive species are introduced that outcompete native species and their populations explode due to a lack of natural controls.

## THIRD-PARTY CERTIFICATION OF SUSTAINABLE FORESTRY

It's common in today's marketplace to see paper products and lumber stamped with a logo that indicates that the product has been produced "from responsible sources." The two most common logos are trademarks of the Forest Stewardship Council (FSC) and the Sustainable Forestry Initiative (SFI). These two organizations oversee the development and enforcement of standards of sustainability. The standards developed by SFI and FSC are intended to be globally relevant and address such factors as diversity, protection of endangered species, protection of water resources, and even the rights of workers and indigenous peoples. Forest management certification was developed by the forestry community as a response to public concern about the loss of natural forests, especially in tropical areas. To attain certification, landowners and producers must adhere to the requirements set forth in the standards of sustainability for the program or programs from which they seek certification. They must also submit to periodic inspection by independent third parties who are familiar with the standards of sustainability, industry standards, and the science of forestry.

Another certification body, which may not always be thought of as such, is the American Tree Farm System (ATFS). The ATFS is a certification system that is unique to the American marketplace and is tailored to meet the unique needs and objectives of family forest owners. Wood produced in accordance with the ATFS standards can also be marketed as certified by SFI. Like the SFI and FSC programs, entities seeking ATFS certification must meet the standards developed by the American Forest Foundation. These standards may be viewed online at https://tinyurl.com/5xuh29pf or provided to the landowner upon request of Green Timber. One of the key requirements of all three certification systems is the development of a forest management plan that meets a specific set of criteria. This plan has been written to meet the requirements of the ATFS. Through membership in the Green Timber Tree Farm Group (GTTFG) forest landowners can attain third-party certification of forest management at no cost to them. Members of the GTTFG sign a Memorandum of Understanding and agree to abide by the standards of ATFS and the requirements of the GTTFG. Because the certification of the group is impacted by the actions of all members, it is imperative that members abide by the requirements of the group. In the current marketplace, there is no financial benefit to third-party certification for small private landowners, however members of the GTTFG receive an annual newsletter, the right to display the familiar diamond-shaped Tree Farm sign, and other benefits from the staff of Green Timber. During times when forest products markets are particularly tight, third-party certification can make the difference between a harvest selling and not selling. More information about the GTTFG can be found online at https://greentimberforestry.com/management/green-timber-tree-farm-group.

# SECTION II: THE LANDOWNER AND THE LAND

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# GENERAL PROPERTY DESCRIPTION

## LOCATION

These properties are located in and around the City of Ironwood, within Gogebic County, Michigan. The exact location of the parcels and the surrounding road infrastructure are depicted on the Locator Map included in Section I of this management plan. Most boundaries of these parcels are fairly obvious, being roads, rivers, or abutting up against maintained, private residences and business yards. These approximate property lines are useful for general property management and recreational activities but may not be precise boundaries. Michigan Statutes mandate that a registered professional surveyor must set all legal property corners and boundaries. More information about surveyors in Michigan is available online at http://www.misps.org/. The legal description of the property is:

T. 47 N. – R. 47 W.
Portions of Sections 21, 22, 23, & 34
City of Ironwood, Gogebic County, Michigan
~458 Acres

## BRIEF DESCRIPTION

This forest stewardship plan covers three community forested areas in and around the Ironwood City area. While there are variations of past and current land use and current forest cover, all three parcels share many similarities. The natural forested area of all three parcels have been heavily influenced in the past through land utilization including mining and logging. Because of this past heavy utilization of the sites, all three parcels contain a strong component of primary successional species and ecosystems. The phrase "primary successional forest" refers to a forest dominated by forest and tree species that are the first to reclaim and grow in heavily disturbed areas. Common primary successional species include aspen, paper birch, box elder, mountain ash, hawthorn, white spruce, pine, and sometimes oak. One common trait with all these primary successional species is that they are all shade intolerant, meaning that they want to grow in full and open sunlight, and will not grow successfully in shaded environments. Another common trait is that many primary successional species are short lived, reaching maturity and succumbing to mortality between 40 and 80 years of age.

Once a forest is established with these species, shade tolerant secondary successional species will start growing up in the understory and prepare to take over when the primary successional species die out from old age. Secondary successional species commonly include sugar maple, red maple, hemlock, balsam fir, yellow birch, ironwood, and sometimes others. Secondary successional species are generally longer lived, living anywhere from 100-400 years of age, and produce a thicker overstory canopy which results in less sunlight penetration and understory growth. The three parcels included in this forestry plan are all in the middle of this successional change from primary successional species (aspen) to secondary successional species (maple).

## Cemetery Property

Figure 1: Photo of the cemetery.

The cemetery property is found on the western edge of town, just south of US Highway 2. About 65 acres of the parcel are covered and utilized as the cemetery. Trees in this area are exclusively planted landscape trees and are maintained on an individual tree management level, with mowed grass growing at the ground level. The remaining acreage, about 31 acres, is dominated by a more natural forest setting and is found on the western side of the parcel bordering the Montreal River. The primary upland area of this forest is dominated by red maple and aspen trees, where the aspen trees are mature and actively dying overtime from old age. This mortality of the aspen trees is making canopy space for the understory secondary successional species, which are slowly becoming more and more dominant over the years. Closer to the river the land slopes downhill and becomes more saturated with water with a water table closer to the soil's surface. This wetter growing environment leads to the growth of more wetland and floodplain species such as black willow, red maple, silver maple, black ash, American elm, balsam poplar, and tag alder. Some areas of this floodplain/river buffer are dominated by mature overstory trees, whereas some areas are dominated more by brush with younger and smaller trees. There are a few hiking trails within the forested area of the cemetery property, but only one that appears to be actively used and maintained, which runs along the river's edge. The forested area is infested with aggressive invasive species including common buckthorn and bush honeysuckle. Other identified non-native woody species within the site include scotch pine, Lombardi poplar, and Norway spruce.

Figure 2: Historical site marker at Norrie Park.

## Norrie Park

The Norrie Park parcel is found just south of town, still bordering the Montreal River. This property contains a small, maintained park area of about 23 acres, and the rest of the property is about 75 acres of natural forestland. The maintained park has some scattered landscape trees, a shelter, playground, heritage sites, an old tennis court, a community garden, hiking trails, picnic benches, and a disc golf course. The forested area of the property is very similar to the upland area of the cemetery property, being dominated by aspen, red maple, and white pine. The aspen is also at maturity and actively dying out over time. As the aspen trees die out, understory red maple, sugar maple, and other secondary species are slowly filling in the canopy gaps created from dying aspen. Balsam fir and spruce trees are also present within the site, and many are showing signs of old age and decline. The white pine trees are primarily found on the eastern side of the property, and are large, dominant individuals. While white pine is somewhat considered a primary successional species, they can grow much larger and older than the aspen trees on the site, and therefore are likely to continue to exist as the forest transitions into a secondary successional forest. There is a lower area within the forest that drains from the northeast to the southwest where water eventually filters into the Montreal River.

This lower drainage area on the landscape contains more saturated soils and is supporting more wetland forested species such as tag alder, cedar, black ash, black spruce, and tamarack trees. The very southern areas of this parcel are dominated by lowland brush species such as tag alder. Norrie Park is a cross country skiing destination during the winter, and the forested area of the park contains numerous cross country ski trails that connect to other trails outside of the park boundaries. Some of these trails appear to be recently installed, or at least recently maintained as there is fresh woody debris cut and pushed off to the sides, and the ground and soil has been recently disturbed and leveled with the use of equipment such as a bulldozer. Glossy buckthorn can be found across the entire park but is small and young in some areas of the forest. Scotch pine is another non-native woody species that was identified.

Figure 3: Entrance sign at Miners Park.

Miners Memorial Heritage Park (Miners Park)

Miners Park is found basically in the center of town. This park is the location of the original iron mines that were operated and led to the settlement of the City of Ironwood. This area received some of the heaviest human disturbance and influence, with mine pits, cleared forest for space and timber usage, above ground constructed mining buildings and infrastructure, piles of mine tailings, and countless roads, ditches, railways, and more. With this much disturbance, it's safe to assume that the forest we see today basically had to reclaim the entire site from scratch, having little to no root stock or seed bank left to initiate forest growth. After the abandonment of the mines and the lack of continued activity, the site probably started by growing up in grasses. Slowly the site then likely seeded in with brush species and tree species such as mountain ash, quaking aspen, paper birch, box elder, and others. A few locations were artificially planted with red pine trees, but this does not seem to be a common trend throughout the site. Today, the unmaintained areas of the site are mostly reforested to some degree, but the exact age of the trees widely ranges from around 30 to 70 years of age depending on the exact time of abandonment and when reliable seed started to reach each individual location. The forest will be entering into the transition from primary successional species to secondary successional species soon but is still early in the process and is heavily dominated by aspen, box elder, and brush species today. Miners Park is heavily managed and utilized as a recreational destination for residents and visitors. Recreational uses include various ball diamonds, football practice field, numerous hiking and biking trails which likely double as snowshoe trails in the winter, a few motorized trails for ATV and dirt bikes, a dog park, and a butterfly garden. Many of these hiking trails also include numerous informational signs helping to educate visitors about the history of the site and local mining activities. Many of the mountain bike trails appear to have been recently established, especially on the west side of the park, as they appear to still be under construction in that area. The property boundary in this plan also includes a few areas that are actively used by the City for general city management and operations. These areas include an abandoned landfill, a bus garage, a city maintenance and storage facility, open areas used for dumping and storing snow during the winter and debris collected from street sweeping, and a city composting facility for residents. Common buckthorn and bush honeysuckle are two aggressive invasive species that were found throughout the entire site. Garlic mustard is another noxious invasive species that was identified on site but was not found across the whole property at this time. Other identified non-natives woody plants include black locust, scotch pine and Norway spruce.

## LAND HISTORY AND PAST LAND USE

Humans have utilized this land and its resources for many years. There is little debate that early humans interacted with, and in many cases, modified vegetation however there is much speculation regarding the extent of human influence on the land prior to European settlement in this region. Foresters, climate scientists and others have utilized information gathered during initial government land surveys to develop a "snapshot" landscape scale map of prevailing forest cover across Michigan at the time the surveys were completed in the late 1800s. This landscape map of prevailing forest cover can be found online at: https://mnfi.anr.msu.edu/resources/vegetation-circa-1800.

According to the pre-European settlement forest cover maps, all three of these parcels were likely originally dominated by sugar maple and hemlock forests. While this forest type is not found on the parcels today due to the heavy human disturbance and use around town and the iron mines, this forest type is still very persistent on the landscape outside of town due to the ability of these tree species to regenerate in shaded conditions. With less frequent disturbances, the dense forest canopy would limit the ability of other species to grow. It was common for the forest to experience minor, small-scale disturbances such as the death of one tree or a small group of trees due to small localized wind events, or (less often) insect and disease problems. These small areas, known as gaps, would create an area that would allow new seedlings to become established. The size of the gap would determine the amount of sunlight that reached the forest floor. The larger gaps with more sunlight would allow for less shade tolerant species to grow, such as ash and oak. Modern individual tree selection and group selection harvests are somewhat analogous to these disturbances.

Following European settlement, the forests of Upper Michigan were logged in three phases during the late 19th and early 20th centuries. The first phase consisted of a focused effort to only harvest the highly sought-after white pines because lumber from these trees was in high demand at the time. When the seemingly endless supply of pines dwindled, many people left Upper Michigan for the western and southern forests. Those who stayed found opportunities in the hemlock and hardwood forests that remained, transitioning to production of hardwood lumber, railroad ties, mine timbers, charcoal for the manufacturing of iron, and chemical wood for industrial processes. This second phase of logging had the biggest impact on most of the landscape because it cleared the forests that remained after the pines were "cherry picked" out. These new uses created markets for species that were once considered useless, in addition to utilizing a higher percentage of the volume in each tree when compared with the past pine logging. In many parts of the Upper Peninsula wildfires broke out, burning the large amounts of slash and debris that remained following the first two phases of logging. As the fires subsided, the forests began to naturally regenerate with a diverse mixture of tree species. The tree species composition and quality of the forests that regenerated were largely determined by the available seed source and soil conditions. Aspen was one of the most common species in this regenerating forest and once again, markets and utilization adapted to the change in forest composition, leading to today's highly mechanized pulp and paper industry, new products like fiberboard, and the advent of selective cutting. More detailed information about historical forest succession and early human impacts on the forests of Upper Michigan can be found at https://www.nrs.fs.fed.us/gla/reports/history.PDF.

There is no evidence of recent timber management or harvesting of any of these parcels (within the last 50 years). The primary historical use of these sites was for supporting the iron mines that prompted the settlement of the area. Miners Park is the location of the past iron mines, and therefore was basically completely wiped of vegetation at one time. The other two properties were likely stripped at least once, if not more than once, for their timber resources to support the local mines and community, but don't appear to have been cleared of vegetation like Miners Park was.

A search of Michigan's Natural Features Inventory (MNFI) database only shows potential archeological/historical sites as existing in Section 23 (east side of Miners Park), but for purposes of this management plan, we will identify more sites of historical importance. There are known sites with historical significance on all three of these properties. The Cemetery Property obviously contains the current and active city cemetery. The exact timeframe of the establishment of this cemetery is unknown. Miners Park is located on the site of numerous past iron mines that were operated in the end of the 1800s and the early parts of the 1900s. These mines represent the primary reason for the original settlement of Ironwood and the surrounding towns. Norrie Park is dedicated to A. Lanfear Norrie who originally began to explore for iron on the Gogebic Range in 1882. While the Norrie Park location is not known for any special significance to the mining era, it was the location of a Civilian Conservation Corp (CCC) camp for the Norrie Company 3601 between 1933-1942.

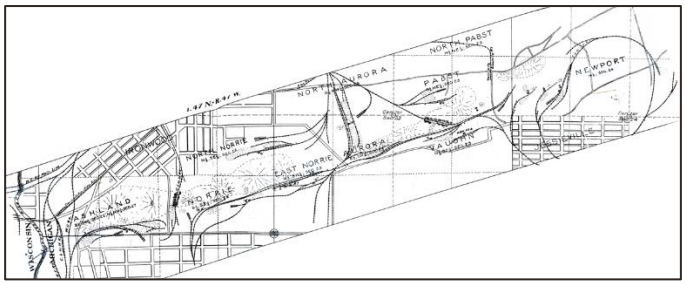


Figure 4: 1905 map showing locations of past iron mines at that time

Due to the sensitive nature of historical sites and potential for public degradation, much of the specific information known about these sites by the State Historical Preservation Office (SHPO) is not publicly available. Many of these sites have been roughly identified, but may not have undergone study to verify, delineate, or evaluate its potential significance. Details held by the SHPO, including the reported potential site boundaries, can only be disclosed to a qualified archaeologist. The Michigan DNR Archaeologist with the State Historical Preservation Office has offered the following summary and recommendations for a very similar scenario:

- ...this area is sensitive for historic and prehistoric archaeological sites.
- Not all previously reported archaeological sites have been field-studied and their extent and potential significance have yet to be evaluated.
- The entirety of the area has not been previously archaeologically surveyed and additional sites may be present.
- The complexity of the area warrants expertise beyond the general guidance you requested [for forest stewardship and management purposes]. I recommend contracting a qualified professional archaeologist for assistance in a survey, site evaluation, and any appropriate site buffering from proposed work. The city would benefit from having an inventory of sites that deserve preservation and stewardship, and this could also be important to community and Tribal relations. As a courtesy to those seeking expertise, the State Historic Preservation Office keeps a list of qualified archaeological consultants who work in Michigan: https://www.miplace.org/4a776e/globalassets/documents/shpo/programs-and-services/archaeology/archaeology-in-michigan/archaeologist-architectural-historian-and-historian-consultants-list.pdf.

- If current or future work in these areas is supported by federal aid, permit or license, it may be necessary to comply with Section 106 of the National Historic Preservation Act. Section 106 compliance could also trigger the need for archaeological survey.

Additionally, the archaeologist has offered the following recommendations for the City of Ironwood specifically: "I recommend that the city does not allow metal detecting or artifact collecting on their lands to protect local history and landscapes. Also, areas along the river and inland may be sensitive for additional archaeological sites not yet discovered or reported; they should consult a qualified professional archaeologist when planning earthmoving activities."

It is beyond the extent of this forestry plan to investigate these sites further and the potential impacts that forest management activities could have on the sites. For this reason, it is recommended that the City of Ironwood consider working with a professional archeologist to develop a plan or methods to protect and/or investigate these sites further if warranted.

If any evidence of other sites is ever located on the property, immediate steps should be taken to protect the site or sites. If a timber harvest or other activity is occurring, it should be temporarily halted until the State Historical Preservation Office (SHPO) can be contacted to determine the nature of the site. The SHPO can then provide recommendations on how to properly protect and, if necessary, document the site. If a landowner does not wish to notify the SHPO of such a site, it is still recommended that activity that may damage above-ground historical resources be avoided and that soil disturbance is minimized so that buried items are protected. Contact information for the SHPO is available online at https://www.miplace.org/historic-preservation/about-shpo/contact-shpo/ .

## CURRENT LAND USE

The three properties and their current land use are briefly discussed in the previous pages under the "Brief Description" section but will be reiterated or expanded upon here.

Cemetery Property

The cemetery property is primarily used as a cemetery, as the title implies. The cemetery is still active with the addition of new plots and is actively maintained within the urban landscape. Beyond the normal operations of an active cemetery, the forested area of the property contains both hiking trails, as well as a small service drive and loop. The service drive and loop serves as a type of dump or storage site as needed for the cemetery operation. Some soil was stored in that area during the time of inspection of the site. This service drive may also have been used in the past when there was an active gravel pit within the forested area, which has since been abandoned. A separate area on the forest's edge is also used as a dump site for organic debris from the cemetery (grass clippings, branches, leaves, etc) and as another soil storage location. The hiking trails appear to have mixed use and maintenance. One trail that follows the Montreal River's edge appears to experience enough consistent use to keep encroaching brush at bay and maintain a decent native soil foot path. Other trails were identified within the central portion of the property, but the signage, paint, and foot path are old and becoming difficult to follow. Encroaching brush makes it difficult to identify the foot path, and less attractive to hike on. All of the trails on the property likely experience snowshoe traffic in the winter.

Norrie Park

Norrie Park serves a wide range of recreational uses. Its 22-acre park area which is the area of the old CCC camp is now an open mowed landscape that offers open spaces for a multitude of activities. Hiking trails offer space to hike and enjoy mother nature. There is a nine-hole disc golf course in the open mowed area. Various shade trees and picnic tables offer space for visitors to rest and relax or enjoy a picnic get together. A shelter and tables are available to provide cover and space for a larger gathering. A playground near the shelter offers space for children to safely run and play. There is an old tennis or basketball court that does not seem to be heavily used or maintained anymore. Behind the tennis court is a community garden that has been active since 2000. Beyond all these activities and opportunities in the open park area, the forested area appears to be heavily managed and used for cross country ski trails during the winter. These trails appear to connect to other trails south of the park that are maintained and managed by ABR Trails, a full service ski center. It is likely that these trails are used for various cross country ski races or events that take place in the area.

Miners Park

Miners Park is the largest of the parcels in this plan, and likely the most heavily utilized park out of the three. Miners Park hosts a large series of trails, ranging from easy hiking through a butterfly garden, to forested hiking, mountain biking, and motorized recreational vehicle routes. Trails can be found basically across the entire park. Some of the hiking trails also include interpretive signage which provides history and education about the mining history of the area. These trails are probably also utilized for snowshoeing, snowmobiling, and fat tire biking during the winter. Outside of the trail portion of the recreational use of Miners Park, the park also hosts four baseball diamonds and a practice football field. Lastly, there is a small dog park located near the northeast corner of the park.

Miners Park is also heavily used by the city for basic city operational needs. Near the southeastern corner of the property is a fenced off garage, equipment storage, and maintenance area that appears to serve as a city maintenance center. There is a large and cleared area off of Ayer Street that serves as a compost dump for the city and its residents. Near the intersection of Frenchtown and Lake Roads, there is a cleared area that appears to likely be used as a snow dump site for the city during the winter. West of Frenchtown Road, there is an old fenced off landfill that is now closed. While this landfill location does not offer current use, it is not accessible to the public. Other small openings on the east side of the property close to roads also seem to be used as storage sites for winter snow and street sweeping debris.

# CURRENT LAND CONDITIONS

## WATER AND WETLANDS

Figure 5: Photo of the Montreal River from the Norrie Park property.

While there are not a lot of wetlands across these properties, there are a fair amount of water features that are worth discussing. The primary water features found on the Cemetery and Norrie Park parcels is the Montreal River, which makes up the Michigan and Wisconsin border in this area. The Montreal River flows northwest and eventually empties into Lake Superior. Both properties also have small, low-lying areas that drain surface and ground water into the Montreal River. Lastly, there are several manmade ponds and water features that can be found on the properties. One small pond exists on the Cemetery property, and this has likely been created by an old gravel pit that has since been abandoned. Miners Park then contains a few ponds, which have likely been created through the abandonment and filling of the old iron mines in the area. Because of this old human use, lack of natural water flow, and the contamination of the water by mine tailings and other city runoff, these manmade ponds likely do not support the same amount and quality of aquatic species that natural water bodies would. Nonetheless, basic efforts should still be made to protect these water bodies and provide the best possible water habitat quality.

It is important that any timber harvesting or other equipment operation on this property considers the potential impacts it may have on water and soil quality. Soil erosion and poor timber harvesting practices can introduce a range of contaminants, including soil particles, leaves and other organic debris, lubricants, fuels, and other chemicals, into surface water and groundwater. Once these contaminants enter water, they can be very difficult to remove. Soil eventually settles out of the water however it can then alter the bed of the lake or river in which it settles, thereby degrading habitat for aquatic insects and fish in larger streams. Man-made contaminants, especially pesticides, fuels and lubricants can have a more drastic impact, especially in large quantities. These materials also do not settle out of the water. For these reasons it is important that loggers are instructed to use care when fueling, lubricating or conducting any other maintenance on their machines.

Forests play many critical roles in the water cycle. During summer rainstorms, forest canopies intercept rainfall, helping to reduce the velocity of the water before it hits the soil, thereby reducing erosion which helps to keep streams, rivers, and lakes clean. Some of the water intercepted by the canopy never reaches the ground as it evaporates back into the atmosphere following the rainstorm. This helps to reduce the amount of runoff. The water that does reach the soil is often reabsorbed by the trees and is either utilized by the trees to conduct photosynthesis or is returned to the atmosphere in a process known as transpiration. The shade of forest canopies, particularly in conifer-dominated forests, helps to slow the rate at which snow melts in the spring. This in turn helps to mitigate water fluctuations in rivers downstream.

The great cutover of the late 19th and early 20th centuries removed forest canopies over large parts of the watersheds of many major river systems. As a result, communities downstream began to experience catastrophic flooding as the snow rapidly melted. Dams were built partly for flood control to address these problems. Trees in wetlands act as pumps helping to keep the area from becoming excessively wet. The loss of trees in a wetland can result in what is known as "swamping." This is a rise in the water table that makes an area unsuitable for tree growth and is often followed by the invasion of species like tag alder and cattails. It is important that timber harvesting in wetland areas consider the possibility of rising water tables and maintain enough trees on a site to keep "pumping" water into the atmosphere. If a water table rises too much, it can drown out the trees that are left behind.

It is recommended that management activities that are implemented on this ownership adhere to the guidelines found in the "Sustainable Soil and Water Quality Practices on Forest Land" manual, also known as Michigan's "Best Management Practices (BMPs)." This manual can be found on the Michigan DNR website at https://tinyurl.com/y8myllnv. Pertinent BMP information will be included in the sections of this plan where they apply.

## WILDLIFE

The city does not have any specific wildlife focused goals but would like to practice good stewardship across the forest and provide as many wildlife benefits as possible. Viewing wildlife of any kind is of great benefit during recreational use of the property.

Figure 6: One of many deer that were observed during the field inspection on the Miners Park property.

There are a few passive things that can be done to benefit wildlife on this property. The first is ensuring that some large dead or hollow trees are retained on the property following a timber harvest. Retention of large cull trees, which are live trees with little to no economic value, as well as standing dead "snags" in a forest provides quality habitat for many species of wildlife. These "wildlife trees," or "den trees," are low in timber value but they still provide a range of benefits to wildlife. Raptors use these trees as nesting locations, or to perch in and hunt from. Animals such as porcupines, bats, and owls use cavities in these trees as dens. Insect larvae feed on decaying wood and many are eaten by woodpeckers. Those insects that reach maturity are a source of food for songbirds, bats, reptiles, and amphibians. Once the trees die and fall over, other animals use the down logs, known as coarse woody debris, for various purposes. Raccoons, foxes and numerous small mammals use down logs as dens. Grouse may use the logs as drumming logs during their mating season. Coarse woody debris retains moisture and provides a crucial refuge for salamanders and other amphibians during hot summer days. When coarse woody debris has decayed to a point where it is no longer usable by most wildlife, it becomes a part of the soil.

Snags and coarse woody debris can also harbor disease and insects that may grow to a large enough population to detrimentally affect the live trees on the property, however during the field inspection, no serious concerns were noted. Proper forest management must consider the balance of providing enough snags and coarse woody debris to retain the value of the property for wildlife without posing a threat to the health of the forest. The wildlife trees retained on the property should be carefully selected to ensure that they are not harboring any serious diseases or pests that may negatively impact the overall health of the forest. Larger wildlife trees are more beneficial because they take longer to decay and have the capacity to support larger wildlife.

An additional step to potentially benefit wildlife in the short term is by taking care when walking in the woods during the spring months. Many species of birds construct nests on the ground or in low-growing shrubs and these nests could be easily damaged by a footstep or other traffic. Also, the survival strategy of a newborn fawn is to remain still when it is in danger, so it could be possible to injure a fawn if one does not walk with care.

Fields and other openings in the forest create edge habitat. Edge habitat occurs at the transition between two distinctly different cover types, most often the transition between forests and clearings. In addition to the herbaceous plants which provide a source of forage for many species, the trees growing along the edge of the forest form very dense crowns that extend low on the tree trunk. These dense, extensive crowns provide extra nesting habitat and produce high quantities of seed. Birds of prey including bald eagles and hawks also take advantage of these open areas for the easy hunting such areas provide.

One of the biggest wildlife benefits the community can work towards is the removal and suppression of invasive species. Invasive species flourish in areas because they have no natural predators. This allows invasive species to take over sites, essentially pushing out native species that our native wildlife populations need to survive. In pushing out native species, invasive species lower the biodiversity of a specific site. Less vegetative biodiversity means that there are less habitat niches that could serve a wider range of wildlife. For these reasons amongst others, control of invasive species is a major priority for this forest management plan. More management discussions and recommendations regarding invasive species will be included in the forest health and vegetation management sections of this plan.

Maintaining a highly diverse forest is one of the best ways to benefit many kinds of wildlife. Different kinds of wildlife require different aspects from their environment, and the more diverse options available, the more that wildlife will be able to make use of them. Many species of wildlife also require different kinds of habitat for different purposes or times of year. For example, white tail deer like to move into areas with good forage opportunities during the spring and summer. Deer will commonly move in the spring to find open field areas to forage on grasses, or areas of high-quality hardwoods to forage on leeks. In the fall and winter, they move on to browse on woody stems for their food source. In addition to food, deer also require easy access to drinking water during the warmer periods of the year. Lastly, their shelter preferences also change over the course of the year. During the winter when there is deep snow and harsh temperatures, deer will tend to move to areas containing thick conifer canopies for the thermal cover and lessened snow depths. During the summer and fall, deer will tend to linger and bed down in young, forested stands, tall grass, or brush thickets for the protection and cover these areas provide from predators. This is just one species of wildlife that utilizes all these different habitats.

When maintaining quality wildlife habitat, the landowner should seek to maintain a highly diverse forest to accommodate as many species as possible. This includes not only providing diversity in species composition, but also diversity in age and size class. Different tree species will also provide different food sources, such as oaks providing hard mast seeds, and apple trees providing soft mast fruit. Hemlock and cedar, which are not commonly found on these parcels, should generally be retained to also provide tall thick canopy conditions, and thermal cover for ground dwelling species. Some aspen dominated areas could be maintained in aspen and managed to continuously provide younger forest age classes which will provide thick cover for wildlife to hide in and browse for food. Young and brushy balsam fir and spruce trees are great for providing cover for small rodents and rabbits. The creation of brush piles during invasive shrub management can also benefit the small rodent and mammal populations. In turn, the presence of these species will then attract and benefit predators such as foxes, coyotes, and more, filling out an entire food web within the ecosystem.

The following tables provide a sampling of some of the wildlife that may be observed on and near the property.

| **The various forest types are used by migrating and non-migrating birds such as:** | | |
|---|---|---|
| Black-capped Chickadee | Kingfishers | Warblers |
| Blue Jay | Nuthatches | Wild Turkeys |
| Flickers | Ruffed Grouse | Woodcock |
| Finches | Sparrows | Woodpeckers |
| Grosbeaks | Thrushes | Wrens |

| **The northern white cedar, mature pine and mature hardwoods found on the property and in the area offer ideal perching, hunting and nesting opportunities for owls and other raptors such as:** | | |
|---|---|---|
| Bald Eagle | Great Horned Owl | Red-Tailed Hawk |
| Barred Owl | Northern Goshawk | Rough-Legged Hawk |
| Broad-Winged Hawk | Red Shouldered Hawk | Saw-Whet Owl |

| **The wetlands and streams found on and near the property offer good habitat for wildlife species that require large amounts of lowland brush and water to survive. Some of the animals that may be found in these areas of the property are:** | | |
|---|---|---|
| Beaver | Frogs | Otter |
| Bitterns | Herons | Turtles |
| Fish | Muskrat | Various Waterfowl |

| **There are many terrestrial animals that exist on the property. The vegetation provides a variety of food sources and rotten, hollow trees offer den opportunities. Some examples of the animals that benefit from the habitat of this property and the surrounding area are:** | | |
|---|---|---|
| Black Bear | Mink | Salamander |
| Bobcat | Pine Marten | Snakes |
| Chipmunks | Porcupine | Toads |
| Coyote | Rabbit | Weasel |
| Fisher | Raccoon | White-tailed Deer |
| Fox | Red Squirrel | Wolf |

## FOREST HEALTH

Forest health is a broad term and may have different meanings to individual landowners as well as forest managers. In this section, specific information is given about threats to forest health and the resilience of the forests growing on this property. Special emphasis is given to "pest" problems in the form of both native and non-native insects and diseases, such as fungi, that are most relevant to this property and location.

The forests across these three parcels have some positive forested ecosystem traits but are considered at risk of declining health. The presence of aggressive invasive species such as buckthorn and honeysuckle threaten the forest's ability to regenerate over time. This threat will almost certainly lead to instances where the overstory dies out over time, but the thick understory brush and cover created by the invasive plants could restrict the regeneration of natural species. This will likely lead to a general decline in the forest overstory canopy, and a thickening of the brush layer over time if left alone. Another forest health concern includes low productivity or potential due to heavy soil disturbance in the Miners Park area. While there is not much for ash species found on the properties, any pockets of black ash found in wetland swales will almost certainly be killed by emerald ash borer (EAB) when the insect pest makes its way through the area. No positive EAB presence was made during the inspection of these sites, but that doesn't mean it's not already present. Climate change is another item of forest health concern that should be considered in future forest management and project planning.

It is important to recognize that insects and fungi are a natural part of all forests. The forests in this region have evolved over thousands of years in concert with a particular suite of organisms. In an unmanaged forest, these organisms serve to rid the forest of less vigorous trees and those that are stressed by other factors such as physical damage caused by wind or fire. The death of these weaker trees frees up growing space, nutrients and water for the most vigorous trees; dead fallen trees are recycled into the soil. Given favorable conditions, it is possible for native organisms to reach such high populations that they are capable of damaging and even killing perfectly healthy trees. In a catastrophic outbreak the damaging agent eventually runs out of habitat, essentially "eating itself out of house and home" at which time its population returns to normal levels allowing the forest to redevelop, usually in a younger state. In other cases, conditions may change, becoming unfavorable for the damaging agent, or predators arrive and bring its population back in check.

Generally, younger trees and those that are growing vigorously are the most resilient to damage caused by insects and diseases. Trees do not "heal" damage, rather they rely on their ability to compartmentalize, or "seal off" damage caused by fire, insects, fungus, and wind. Rapidly sealing off a wound minimizes the chances that insects or diseases can enter the tree through the wound. Young trees and vigorously growing older trees are the most capable of compartmentalizing damage and growing new wood over the damaged areas; slow growing trees are less able to fend off subsequent attacks. Additionally, certain species are better at surviving damage. White birch, balsam fir and aspen are naturally very short-lived trees with wood that is very susceptible to decay, as a result physical damage to these trees is typically more likely to lead to major problems than equivalent damage to a white pine, cedar or sugar maple.

Forest health does not necessarily equate to timber quality. A large, vigorously growing white pine may have many large branches that are undesirable for the production of quality timber. Conversely, when a stand is selectively harvested, trees with dieback or physical damage may still be capable of yielding quality sawlogs if they are harvested in a timely manner, before the disease or decay has had a chance to progress. Maintaining a healthy forest involves periodic observation; this can be as simple as a landowner noting an unusual condition and contacting a forester to assess it. Annual monitoring is not always necessary unless a particular severe insect or disease is threatening the forest on the property.

**Emerald Ash Borer**

Ash trees make up a minor proportion of the stocking on this ownership. All species of ash trees[1] are susceptible to damage and death caused by an insect known as the emerald ash borer (EAB), which is an insect native to Southeast Asia that is believed to have entered the U.S. through shipping materials. Once an ash tree is infected, it can be killed by EAB in a matter of a few years. Populations of ash trees in Lower Michigan are being decimated by EAB; in the Upper Peninsula EAB has been documented, and its impacts are quickly spreading and becoming more evident over time. The adult stage of EAB, shown in Figure 7, is virtually harmless to trees, however the juvenile stage of the insect (larva) feeds on the living tissues of the tree just under the bark; this cuts off movement of water, nutrients and energy throughout the tree. Over a period of just a few years, the presence of these larvae will cause enough damage to completely kill the tree. There are a few things to watch for that may be indicative of an EAB infestation. The most obvious signs are death of ash branches progressing from the top downward towards the trunk. As the top branches of the tree are killed, the tree will produce epicormic branches, or suckers, low on the stem to continue producing energy. As the top branches die, the bark will begin to slough off and S-shaped tunnels will be seen on the exposed wood. These symptoms would generally be observed in multiple trees; the death of a single ash tree is not necessarily indicative of EAB, it may be a result of some other factor. Ash trees are found as a minor component across this entire ownership; the loss of this species will not drastically change the forest; however the loss of a species is still a concern due to the change in diversity.

Figure 7: Adult Emerald Ash Borer

[1] Species of mountain ash, including American mountain ash and European mountain ash are not impacted by EAB as they are not "true" ash species.

**Climate Change**

The Earth's climate has changed over the past century, and these changes are expected to continue. The following section is a quick summary of observed and projected climate changes and anticipated impacts to forests (Janowiak et al. 2014; more information at www.forestadaptation.org). Specifically in northern Wisconsin and western Upper Michigan, some of the changes that have already been observed include:

- The average annual temperature has increased by 1.4° F over the past century.
- Average winter temperatures have increased by more than 2° F over the past century.
- Average annual precipitation has increased by more than two inches, particularly in the spring and fall.
- Heavy rainfall events (greater than three inches) have become much more frequent.
- Lake ice break-up, leaf-out, and bird migration dates are shifting earlier into the spring
- Fall killing frosts are occurring later.

Climate change is projected to continue, although there will always be uncertainty in long-term projections. The best available science supports the idea that temperatures will increase across all seasons in northern Wisconsin and western Upper Michigan over the next century. Projected change is on the order of 2 to 9° F by the year 2100, with winters likely to continue warming faster than other seasons. Precipitation is projected to increase up to one inch (rainfall equivalent) during winter and about one to three inches in spring by the year 2100. The greatest uncertainty exists for summer precipitation, with slight increases or large decreases possible. There may be greater moisture stress to trees and plants in summer and fall, because higher temperatures will lead to greater water loss from evaporation and transpiration.

Climate change will not affect all forest species, communities, and parts of the landscape in the same way. Additional stress will amplify some threats that forests already face, such as insect pests and diseases. Generally, boreal tree species are expected to decline, and temperate or southern species are expected to be favored (see species tables found in the Appendix of this plan). Species and forest types that are more tolerant of disturbances may have less risk from climate change, and forests with greater diversity (species, genetic, and structural diversity) may also have less risk.

Confronting the challenge of climate change presents opportunities for forest managers and landowners to plan ahead, assess risk, and ensure that the benefits forests provide are sustained into the future. Landowners will naturally have unique goals for their woods, and different opportunities and constraints for how they might respond to climate change risk. These factors will help determine the most appropriate actions to prepare for climate change. Different adaptation actions can be used to resist change, boost resilience, or encourage change. Choosing a range of actions may be appropriate for many landowners, depending on their values and site-specific risks or opportunities. This plan made use of an "Adaptation Workbook" that has been produced to help forest managers and landowners incorporate climate change considerations into forest management (www.forestadaptation.org/far).

Included in the Appendix of this management plan are two lists detailing the climate change projections for individual tree species. Each list details a different climate change scenario, one with less change occurring, the other with greater climate change occurring. These lists were used to aid the development of the management recommendations set forth for the different forest types found on this ownership, which will be discussed in detail later in this plan.

Invasive Species

The following paragraphs offer brief descriptions of various invasive or noxious species that were identified on the parcels either by field inspection, or through review of online invasive species reporting systems. Invasive species can range from very noxious to not noxious at all, and therefore not all the listed species need to be aggressively controlled or removed. The most noxious invasive species represent large challenges when looking to manage a forest long term, and they often easily outcompete native species and suppress regeneration of native forest and tree species. Once an invasive species becomes established on a site, it is next to impossible to totally eradicate the species, and therefore prevention of the spread of a species is one of the most important tools in control. The earlier a species is detected, the easier it is to control and possibly eradicate. Invasive species that are well established on the properties, such as buckthorn, should not receive massive control efforts to eradicate. Instead, the management and control of well-established invasive species should focus instead on ensuring the maintenance and management of a native forest overstory. This will likely incorporate smaller, localized projects to temporarily control invasive species where forest regeneration is needed. Once forest regeneration is well established on a specific site, whether through natural seed or artificial planting, then extensive control of that localized site can taper off.

**Common (European) Buckthorn, and Glossy Buckthorn**

Common Buckthorn (*Rhamnus cathartica*) Glossy buckthorn (*Rhamnus frangula*) are invasive shrubs that were introduced to the United States for ornamental and landscaping use. Both varieties of buckthorn were observed on the property, with common buckthorn being identified across the cemetery and Miners Park properties, and Glossy Buckthorn being identified across the Norrie Park property. Birds and other wildlife consume the berries and spread the seeds across the landscape in their excrement. Buckthorn can also be spread by equipment that picks up and harbors clumps of soil that may contain seeds. Even the tread on someone's boots can transport invasive seeds from place to place. Buckthorn is a vigorously growing shrub that produces a large number of seeds. The buckthorn shrubs can grow to upwards of 10-20 feet tall and rapidly spread to fill the understory of many forest sites. One of the greatest concerns associated with buckthorn from a forest management standpoint is that dense thickets of buckthorn can completely inhibit hardwood regeneration. Additionally, buckthorn tends to leaf out early in spring and keeps its leaves late into fall. This characteristic allows it to shade out spring ephemeral plants that grow before the tree canopy has fully developed. Buckthorn also can shade out most other native understory vegetation that is needed as food for wildlife.

Figure 8: photo of a Common buckthorn branch, taken on the property.

Buckthorn resprouts readily when cut and so repeated efforts are necessary to control it once it has become established. Herbicides are also effective but come at a cost and must be applied carefully to avoid damaging desired vegetation. Even if a patch of buckthorn can be completely killed with a combination of cutting and herbicide treatment, the seeds remain viable for a long period of time and will continue to recolonize the site until the seed bank is exhausted. The presence of buckthorn on this property is already well established and will continue to pose a problem for the indefinite future. It is recommended that the landowners work to control this shrub in order to promote forest regeneration, however recognize that it will be extremely difficult or impossible to actually eradicate it. More information regarding these species and the management or control options are provided in the appendix of this plan.

**Garlic Mustard**

Garlic mustard has been identified within Miners Park but does not appear to be consistently growing across the entire park yet. Garlic mustard is a smaller herbaceous plant that can grow in shaded environments, making it particularly successful at taking over forest understories and choking out future forest understory and regeneration growth. Garlic mustard plants have a two-year life cycle, where the first year the plant grows and stores nutrients, and the second year the plant produces seed. The primary goals when trying to control garlic mustard is to prevent second year plants from producing seed, prevent new seeds from arriving from nearby populations, and to deplete the seed bank. Control methods for garlic mustard include hand pulling or herbicide. While effective, herbicide also generally leads to the death of nearby native species, so is not always encouraged. Hand pulling is easy enough as the plants generally have little root stocks that easily pull out of the ground, but labor intensive as there can be many plants in a small area. Short term control efforts can sometimes lead to soil disturbance and greater seed germination and plant abundance in following years, so long term monitoring and control efforts are recommended when pursuing. Additional description of the plant characteristics, identification, and control methods and planning can be found in the Appendix of this management plan.

**Bell's Honeysuckle**

Bell's honeysuckle is actually a hybrid between two invasive honeysuckle species: Morrow's honeysuckle and Tartarian honeysuckle. Morrow's honeysuckle is native to Japan and Tartarian honeysuckle is native to Eurasia. The most conspicuous characteristic of Bell's honeysuckle is perhaps its height, as this invasive can grow twenty feet tall. Like many invasive plants, Bell's honeysuckle also leafs out well before native plants and holds its leaves longer in the fall than its native competitors. This is one characteristic that allows Bell's honeysuckle to rapidly outcompete native plants, allowing it to create monocultures which significantly limit the amount of natural tree regeneration and abundance of ephemeral plants at a given site. Control methods for Bell's honeysuckle include prescribed burns, herbicide treatments, and manual rooting if the established plants are still relatively young. One of the key aspects to understand about Bell's honeysuckle is that it can readily grow new stems from root suckers. Therefore, control methods must be implemented very thoroughly for three to five years in a row to eradicate Bell's honeysuckle from a given site. More information on Bell's honeysuckle can be found in the Appendix of this forest management plan.

**Japanese Knotweed**

Like many invasive species, Japanese knotweed was introduced to the United States in the late 1800s as an ornamental in gardens. After its introduction to gardens, it was quickly noticed that the plant could grow in a variety of conditions and had an extensive fibrous root network. These two characteristics are highly sought after while selecting plant species for erosion control. Hence, Japanese knotweed quickly gained popularity for stabilizing soils as the United States rapidly developed new areas. However, by the 1930s, the negative consequences of Japanese knotweed became more apparent. In the 1930s, people began to realize that Japanese knotweed began to grow in monocultures that would exceed fifteen feet in height, containing individuals that would develop dense woody stems that closely resemble bamboo. These cohorts of Japanese knotweed began to degrade environmental and aesthetic qualities of urban and forested areas and even limit access to areas due to the dense growth of these woody bamboo-like stems. Japanese knotweed is typically found in recently disturbed areas such as road right-of-ways and abandoned homesteads, in addition to lowland areas such as riverbanks. Japanese Knotweed generally spreads through underground root rhizomes but can also be spread through fragments of root and stem material. The ability for the species to root and spread through cut fragments makes control of this invasive very difficult, as any mowing or cutting efforts can assist in the spread. Japanese Knotweed can also hybridize with Giant Knotweed, at which point the species can start to reproduce and spread via seed as well. Control efforts for this invasive can include manual pulling if the stems are small enough to do so, but herbicide is generally necessary due to the plant's ability to resprout from fragments. In larger cohorts, herbicide application is necessary. Destruction of any live removed plant material is necessary to limit further spread at landscape dump sites. More information related to species identification, characteristics, and control methods can be found in the Appendix of this plan.

**Scotch Pine**

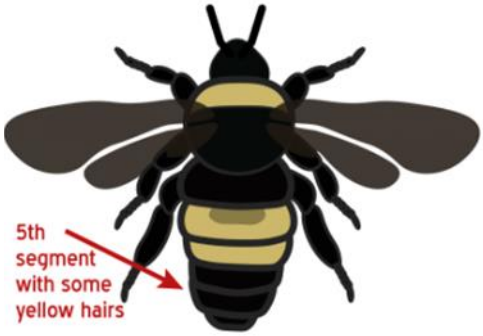
Scotch pine, also known as Scots pine (*Pinus sylvestris*) was observed in a few places within all three parcels included in this plan. Scotch pine is a tree species native to Europe and was introduced to the United States for reforestation in places where a fast-growing tree capable of growing on poor or sandy sites was needed. Scotch pine is also sold as a Christmas tree. In some places, Scotch pine has escaped cultivation and become an invasive species, outcompeting native tree species. Relative to other invasive species, Scotch pine is not extremely noxious however its ability to outcompete native species is a concern. Scotch pine was likely planted on or around these parcels either for use as future Christmas trees or as part of a reforestation effort and is now regenerating successfully in open conditions where reforestation is still taking place. During future management activities, all scotch pine stems could be cut to prevent further natural spread in the short term. That said, having scotch pine trees is still better than no trees or site takeover by buckthorn, so maintaining scotch pine in certain scenarios may be beneficial overall at this time. Scotch pine can be identified by its flaky bark which is dark near the base of the tree and orange to butterscotch colored on younger growth, and stiff bluish green needles that are approximately two to three inches long. Norway spruce (*Picea abies*) are also planted on the properties in some scattered locations. Although this species is well established, they are not as aggressive as Scotch pine and therefore are not viewed as a significant threat, however if the regeneration of these species begins to interfere with the growth of native species, steps should be taken to remove them as well. For the time being, they should be managed in accordance with the recommendations set forth in Section III of this Forest Stewardship Plan.

Based on the geographic location of the property and the ecosystems present there is not a high risk of wildfire. Therefore, it is not necessary to conduct specific forest management aimed at reducing the risk of wildfire. However, precautions should be taken to minimize the risk of accidental fires during dry periods when leaf litter and other organic material are extremely dry. Things to consider include parking vehicles with hot exhaust systems on clear areas and not in tall dry grass, the operation of small engines, and outdoor fires. The Michigan DNR provides daily assessments of fire danger throughout snow-free periods of the year. Fire danger can be viewed online by visiting https://tinyurl.com/y29x9g6f and clicking on the link "Daily Fire Danger - Fire Danger Rating" near the top of the page. Information about burning permits can be found online at https://tinyurl.com/y2vkhsmy.

## RARE, ENDANGERED, AND THREATENED SPECIES

During the property inspection, no threatened or endangered plant or animal species were noted. A search of the Michigan Natural Features Inventory (MNFI) indicates that two species of concern may make use of this property. These species include the yellow banded bumblebee (Bombus terricola) which is identified as a species of special concern in Michigan, and the Calypso orchid (Calypso bulbosa) which is identified as threatened in Michigan.

The **Yellow-Banded Bumblebee** *(Bombus terricola)* is rare, although the exact status is uncertain. Not much is stated of its preferred habitat or food sources, except that it is mostly found in and around wooded areas. It is said that the bee was formerly common and widespread across much of the eastern US and Canadian Provinces but has vanished from all but isolated patches of its native range along with other North American bumblebees. Habitat loss from urbanization and agriculture use, spread of pathogens from commercial bumblebees, and widespread use of neonicotinoids are all blamed for much of the drastic population decline of the yellow banded bumblebee. Management strategies to favor this insect include scaling back the use of herbicides and pesticides, conservation of healthy habitat, and promoting native wildflower re-establishment. These management strategies largely pertain to agriculture settings, but also may pertain to aspects of forest management on this property.




Source: UW Madison

Source:https://www.ontario.ca/page/yellow-banded-bumble-bee

Figure 9: Images of the Yellow Banded Bumblebee.

The **calypso orchid** (*Calypso bulbosa*) is a threatened species that can be identified by its small magenta flower with a distinct pubescent pouch that hangs below the pedals of the flower. This plant is small, ranging from ten to twenty centimeters in height. The flower of the calypso orchid blooms in early May through July, making these months the ideal time to survey and identify calypso orchid's presence or lack thereof on the property. This plant has been identified in all but five Upper Peninsula counties and is associated with lowland conifer forest types. Some associated plants are northern white-cedar, balsam fir, spruce, blue-bead lily, and American fly honeysuckle. Such growing conditions and associated vegetation are not common on the property, but possible habitat may be found in Norrie Park. More information on calypso orchid is included in the Appendix of this forest management plan.

It is possible that other threatened or endangered species may use the property. If any such species are encountered on the property, it may be necessary to alter the management prescribed in this plan. The changes will depend on the type of species found, and the degree to which they make use of the property. More information about the MNFI is available online at https://mnfi.anr.msu.edu/.

## FORESTS OF RECOGNIZED IMPORTANCE

Forests of Recognized Importance (FORI) are defined by the American Tree Farm System as "globally, regionally, and nationally significant large landscape areas of exceptional ecological, social, cultural, or biological values." FORI occur at the landscape level, not the individual stand or ownership level. In Michigan, FORI on private forest land mostly consist of critical wildlife habitat (such as habitat used by endangered species), rare forest types, corridors of unique rivers, and Great Lakes coastlines. The Michigan Tree Farm Committee has defined important wildlife habitat as any forest that provides habitat required by state and federally listed threatened or endangered species. Rare forest types include primarily old growth forests but may include other exceptional forest communities. Corridors of unique rivers include the portions of those rivers designated as "Natural Rivers" or "Wild and Scenic Rivers." The Natural River and Wild and Scenic River designations created prohibitions on dam building and other development supported by the Federal Government on sections of river. These designations do not explicitly prevent development, nor do they give the Federal Government control over private property. Owners of property along Wild and Scenic Rivers and Natural Rivers are encouraged to manage the land in a fashion that preserves the aesthetic values of the river. The Great Lakes coastline includes all those properties located within one mile of a Great Lake shoreline. Additionally, the Green Timber Tree Farm Group has identified all properties located within one-half mile of the shoreline of the Portage Waterway as FORI. This distinction applies to Portage Lake, the Portage Lake Canal extending from McLain State Park to South Entry, and Torch Lake, but does not include tributaries of any of these water bodies. The Portage Waterway has great economic and cultural significance to the inhabitants of the Copper Country as it was a vital transportation link during the days of copper mining and has become a recreational and aesthetic asset to the area and its residents.

None of the properties within this forest management plan meet the above-described criteria to be considered a FORI, but each parcel does have significant social, cultural, and historical values at a local level. When management is implemented on a property known to be within a FORI it is vital that it is done in a fashion that protects the ecological integrity of the property. This property is not located within a known FORI but it is still extremely important that all Best Management Practices are followed when conducting a timber sale or establishing or maintaining roads, trails, and stream crossings. Strictly adhering to the Best Management Practices guidelines will drastically reduce or eliminate the potential for runoff and sedimentation to enter and degrade the waterway. More information on Best Management Practices can be found in the "Sustainable Soil and Water Quality Practices on Forest Land" manual. This manual can be found on the Michigan DNR website at https://tinyurl.com/y8myllnv.

## SOILS

The word "soil" is defined as "the product of the *parent material*, influenced by *climate* and *biota*, in a *landform*, over *time*." Each of the five terms listed in italics exerts a specific influence over how a soil forms. These five factors interact in diverse ways resulting in the broad diversity of soils found across the planet, and even on one particular parcel of land. Each factor influencing soil formation is briefly described below.

**Parent Material:** Parent material is the source of the mineral components of soil. It is typically unweathered rock but can also be recently deposited beach sand, or rocks and gravel deposited by glaciers. Parent material provides the majority of the nutrients used by plants; it also plays a major role in the soil texture.

**Climate:** The climate relates to temperatures, rainfall, wind and other weather phenomena that work to erode the parent material and make it more usable for plant growth. Climate also impacts the types of plants and animals that use soil in an area, which directly impact soil formation.

**Biota:** Biota are the particular groups of plants and animals that occupy an area. Plants impact soil formation by using particular nutrients, and root growth causes fractures in rock to expand and eventually split. Animals can impact soil formation by mixing and aeration. Insects and earthworms often have a more significant impact on soil formation than larger wildlife like deer and moose.

**Landform:** Landform affects how soil accumulates and how parent material erodes. Little if any soil will form on steep rock outcrops, while a great deal of sediment and organic matter can gather in low-lying areas, forming soils that are often very high in nutrients, but which may also contain excess amounts of water.

**Time:** Time is crucial to the development of soils. The longer a soil is allowed to develop, the stronger the impacts of the other four factors can become. A soil that has existed for thousands or tens of thousands of years may have a finer texture and more nutrients available for plant growth than a soil that began to form a few hundred years ago.

Soil maps are labeled with **mapping unit symbols.** A mapping unit symbol is a number and letter combination that refers to a unique soil type, found across the landscape on a particular slope class. The number indicates a unique soil series, determined by factors such as texture, color, moisture and acidity. The letter in the mapping unit symbol corresponds to the slope of the soil. An area listed as "A" slope is generally flat or very gently sloping, while an area listed as "F" slope is extremely steep. The letters from B to E indicate intervals along the gradient from mostly flat to extremely steep. These areas are mapped separately and given unique mapping unit symbols to allow considerations to be made for the slopes. In forest management, the slope of the landscape can impact the safety of timber harvesting operations in an area and increase the potential for erosion following a timber harvest. Soil descriptions also provide information about drainage characteristics and available water capacity. Drainage is a measure of how rapidly excess water moves through the soil and can range from excessively drained to very poorly drained. If a soil is poorly drained, excess water is retained for a longer period of time; this can result in stagnant conditions where oxygen, necessary for root growth, is limited. Available water capacity is essentially a measure of the water available for plant growth after all excess water has drained out following a precipitation event. It can be visualized by considering the soil as a sponge, which has become saturated in a bowl of water. When the sponge is removed from the bowl, excess water drains out. At a certain point, no more water drips out of the sponge, however it is still possible to extract water from the sponge by wringing it out.

The water that can be wrung out of the sponge may be thought of as its available water capacity. Moderate available water capacity is usually tolerable for the growth of most upland trees and other forest plants except during times of extreme droughts. During droughts, trees and other plants are often unable to obtain adequate amounts of water for proper growth; it is during these times that they can be at an increased risk of attack by insects and diseases. Maintaining at least partial forest cover and preventing soil compaction can help to preserve a soil's ability to retain water, thereby protecting against unnecessary drought stresses. Keeping partial forest cover helps to keep the soil cooler, which limits evaporation; preventing compaction maintains the structure of the small spaces between soil particles, which are crucial in the retention of water. Available water capacity ranges from very low to very high. A soil with very low available water capacity can limit plant growth by causing moisture stress, which can also make plants more susceptible to insect damage or disease.

Figure 10 shows the chart used to determine the specific texture of a soil, with modifiers such as "fine" reflecting the specific size of particles within the soil. The texture of a soil is one of its most important characteristics for a number of reasons. Texture impacts how rapidly water moves downward through the soil, the amount of water held in the soil following precipitation and the length of time for which it is held there, the availability of nutrients and the stability of trees in high winds, as well as many other characteristics. The three primary soil textures are sand, silt and clay, with sand being the coarsest and clay being the finest. The size of soil particles impacts how closely together they occupy the space of the soil. Smaller soil particles are able to pack together more tightly. The tightly packed soil particles of a silt or clay give it a higher surface area per unit of mass than a comparable volume of sand. This extra surface area means that silt and clay are able to retain more water than sand. Nutrients needed for plant growth are dissolved in the water that occupies this space in the soil. On the other end of the spectrum, when a soil becomes packed too densely together, for instance after being compacted by improper logging operations, its ability to retain small pockets of oxygen in the "pore spaces" between soil particles is decreased. This limits root growth because roots require oxygen to conduct respiration. Sandy soils are less susceptible to compaction than clays or silts.

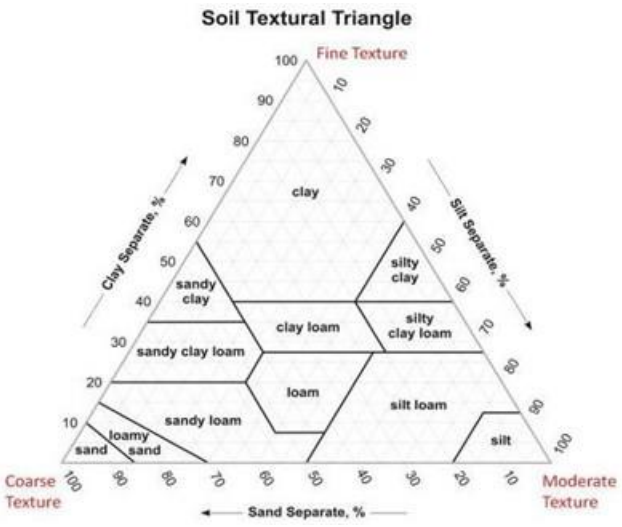



**Figure 10: USDA Soil Textural Triangle.**
**Source: http://soils.usda.gov/education/resources/lessons/texture/textural_tri_hi.jpg**

The soils we see today have formed over the span of approximately 10,000 years since the last glaciers retreated from what is now Upper Michigan. Following the retreat of the glaciers, upland areas consisted of little more than exposed bedrock, deposits of sand, rock and gravel, and scattered large boulders. Many low-lying areas consisted of small lakes and ponds. Over time this material has been weathered down both physically and chemically into varying soil types, and material has been eroded by wind and water to fill some low-lying areas. Other low-lying areas have undergone the process of wetland soil development.

According to Web Soil Survey, a service of the Natural Resource Conservation Service (NRCS) there are 14 unique soil types found across this property. The soils found on this property, arranged from most common to least common, are:

375: Dumps and Pits, mine
311B: Tula-Gogebic complex, 0 to 6 percent slopes, stony
310B: Gogebic fine sandy loam, 1 to 6 percent slopes, stony
689B: Chabeneau-Channing-Gogebic complex, 0 to 6 percent slopes, stony
230B: Moquah-Arnheim complex, 0 to 3 percent slopes, frequently flooded
351C: Gogebic silt loam, 6 to 18 percent slopes, very stony, rocky
429C: Gogebic-Peshekee complex, 6 to 18 percent slopes, very rocky, very stony
432E: Schweitzer-Michigamme-Rock outcrop complex, 18 to 55 percent slopes, very stony
688: Cathro-Leafriver complex, 0 to 1 percent slopes, frequently flooded
303: Bowstring-Arnheim complex, 0 to 1 percent slopes, frequently flooded
307: Lupton and Cathro soils, 0 to 1 percent slopes
369D: Dishno-Gogebic-Peshekee-Rock outcrop complex, 18 to 35 percent slopes, very stony
419: Pleine-Cathro-Gay complex, 0 to 1 percent slopes, stony
353A: Tula fine sandy loam, 0 to 4 percent slopes, stony

The distribution of these soil types across the property is depicted on the Soils Map, which is included in Section I of this plan. The first five soils listed make 85 percent of the acreage included in this plan. These soils will receive the most detailed description. The rest will be described briefly as they pertain to forest management activities on the property.

The **Dumps and Pits, mine (375)** soil type covers the majority of the Miners Park property. As the name implies, the soils in this area are not naturally occurring, and are instead a creation, or leftover, of the historical mining activity this area experienced. The exact conditions of the ground and soil in this area are highly variable, but consist of ponds (old pits), steep slopes, mine tailings or piles of broken-down bedrock, trash, old building foundations, and other minor formations. Trees and vegetation can generally be found growing within much of this soil type, but the quality and species mix is highly variable.

The **Tula-Gogebic complex, zero to six percent slopes, stony (311B)** soil type can be found dominating much of the Cemetery property and scattered around parts of the Miners Park property. Both soil types included in this complex are very similar, consisting of a fine sand or silt mixture near the soils surface, and transitioning to a sandy/gravel mixture below 20 inches in depth. The water table in the Tula soil type is between zero and 12 inches deep, while the Gogebic soil type has a water table between 10 and 18 inches down. Both soil types contain a fragipan around 12 to 35 inches down into the soil profile. More information regarding a fragipan layer is described in the following paragraph for the soil type 310B.

The **Gogebic fine sandy loam, one to six percent slopes, stony (310B)** soil type covers the majority of the Miners Park property that is not affected by past mines and pits. It is a moderately well drained soil with low water availability. The depth to the water table is about 12 inches and at about 20 inches is a restrictive fragipan. A fragipan is a layer of densely compacted soil particles; the presence of a fragipan can limit or completely restrict the growth of tree roots. A fragipan found at a shallow depth can make trees susceptible to windthrow following a heavy timber harvest however 20 inches is adequate depth for most trees to be securely rooted. The stony designation indicates that around 15 to 35 percent of the soil is occupied by rock fragments ranging from 10 to 24 inches in diameter.

The **Chabeneau-Channing-Gogebic complex, 0 to 6 percent slopes, stony (689B)** is the dominating soil type found in the Norrie Park property. All three of the soil types within this complex follow a similar trend as the previously described natural soils, containing about 20 inches of a fine sand or silt mixture at the surface, and a gravelly sand mixture deeper down. One noticeable difference in this complex is that all three soil types do not have a restrictive fragipan layer, and therefore roots and water can more easily penetrate lower into the soil profile. That said, the water table throughout this complex still exists somewhere between about 6 and 18 inches deep into the soil profile.

The **Moquah-Arnheim complex, 0 to 3 percent slopes, frequently flooded (230B)** soil type can be found near the Montreal River on both the Cemetery and Norrie Park properties. This soil complex is found in river floodplains, and therefore is frequently flooded from year to year. The Moquah soil type is found covering a little over half of this floodplain area. This soil type contains stratified layers of silt loam and fine sand, probably deposited over time from various flooding events. The Moquah areas are well drained, and normally have a water table about 42 inches below the soil surface. With that in mind, the Moquah soil type covers areas that could be described as seasonally dry floodplains. These areas are likely to flood or become very saturated during spring snow melt or during exceptionally high rainfall events, but then are quick to drain and dry out during the summer months. The Arnheim soil type has a mucky layer at the soil's surface, and then consists of similar layers of silt and fine sand underneath. These areas are lower on the landscape than the Moquah soils and are frequently flooded or at least saturated with a water table at the soil's surface. Areas with the Arnheim soil type are described as wet floodplains, and likely stay wet year-round.

The rest of the soil types found within the parcels generally cover less than 10 acres a piece, and offer minimal impacts to the general management of the forests. Additionally, many of the undescribed minor soils share similar characteristics as the soil types already described.

Detailed technical information about each soil type on this property is included in the Appendix of this forest management plan. More information on the soil types found on this property may be obtained on the Natural Resources Conservation Service (NRCS) web site at: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx or by contacting the NRCS Marquette, Michigan office at (906) 226-9460.

## ROADS AND TRAILS

Within the parcels included in this plan, there is a vast array of roads and trails, ranging anywhere from blacktop public roads used for general vehicle transportation to the infrequently visited hiking trails. A general summary of these roads and trail systems will be provided here, and more detailed maps are available online, on site, and in the beginning of this plan with the other forest cover maps.

All three of these properties can be accessed via public, blacktop roads. The Cemetery property has public city roads traveling on its borders on the north and east sides of the parcel. The Miners Park property has many different city roads that define edges of the park boundaries, and some roads which intersect the property. Norrie Park is most readily accessed from Norrie Park Road, which defines the northern edge of the park, but can also easily be accessed for walking traffic from Riverside Road which defines the park's eastern boundary.

Internal access to the Cemetery property includes the vast network of single lane gravel roads that provide access throughout the cemetery portion of the property. Many of these roads loop around or end as they approach the wooded area on the western side of the parcel. There is a single maintenance drive that enters the wooded area on the cemetery property. This drive contains a gate at its entrance into the forest and provides a short access loop for vehicles and equipment. Beyond this, the rest of the wooded area only contains foot trails for further hiking access. There is one main foot path that appears to experience frequent enough traffic to remain open and visible. This main trail travels along the edge of the Montreal River, around the western and southern edges of the property. There were a couple other marked trails within the central parts of the forest on this parcel, but they appear to experience little to no summer traffic any more as these trails are growing in with brush and are difficult to find and follow at times. It is possible and likely that all these trails on the Cemetery property experience some winter traffic, primarily in the form of snowshoeing. No map of these trails was ever found during the creation of this plan.

Internal access to the Miners Park property is very limited to vehicles or motorized recreational machines, but there are numerous hiking, snowshoeing, and biking paths. There are just a few main trails that allow motorized recreational vehicles such as ATVs and snowmobiles, and those can be seen on the map that specifically shows Motorized Routes. Basically, all of the rest of the trails within the Miners Park property are limited to foot and bicycle traffic. These trails cover the property very thoroughly, and their approximate length and locations can be seen on the trail maps referenced earlier. The trails in the southwestern portion of the property, west of Frenchtown Road appear to be the most recent trails constructed in the past 2-3 years. Many of these trails are still under minor installation efforts, with signs and maps still to be installed as of the June field inspection that was done in 2023 for this plan. These trails provide exceptional opportunities for community members to hike, snowshoe, or bike.

Figure 11: Mountain bike trails are very commonly found and easy to follow on the Miners Park property.

Internal access to the Norrie Park property mainly includes a short, paved drive to a parking lot in the northwest corner of the property, and then cross-country ski trails throughout the wooded portion of the park. There are a few additional hiking paths, such as along the Montreal River's edge, but most of the trails on the property appear to be primarily managed and maintained for winter cross country ski use. Even so, these trails make excellent summer hiking trails for the public. The cross-country ski trail routes can be seen on a map included in this plan. These trails appear to have received some recent management and possibly new trail construction, as there were areas of cleared stumps and debris and freshly graded and leveled soil.

It is strongly recommended that the landowner or their consulting forester document the condition of all roads and trails prior to the start of any timber harvesting or other management activities on the property. Photographs or videos are a great way to accomplish this. Contracts between the landowner and any contractors should include a stipulation that roads and trails are to be returned to a condition that is as good as or better than they were in at the start of harvesting. Contractors should also be required to post a bond that can be used to pay for repairs if they are necessary. Any personal use trails on the property should be clearly marked and contracts should clearly state what condition these trails must be left in when harvesting is finished.

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# SECTION III: VEGETATION DESCRIPTIONS AND MANAGEMENT RECOMMENDATIONS

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## VEGETATION ASSESSMENT

### METHODS

In June of 2023 a field inspection was conducted on this property. Prior to conducting the field inspection, geographic information system (GIS) software and aerial imagery of the property were used to delineate boundaries of different forest types, or stands, on the property. The stand boundaries were then loaded onto a GPS unit that was carried in the field by the forester conducting the inspection. During the field inspection, each stand was visited; the forester observed the conditions on the ground and adjusted the stand boundaries as needed to accurately delineate changes in forest vegetation. The forester takes a minimum of four variable radius plots in each stand using a 10 basal area factor prism. The forester also used the GPS unit to log the location of various features and points of interest including roads and trails, property corners, and structures, to name a few.

Within each stand, a number of observations and measurements were recorded including all attributes listed in the following table:

| | | |
|---|---|---|
| Tree Species Composition | Tree Quality and Health | Predominant Tree Size Class |
| Tree Stocking (Basal Area[2]) | Regeneration Stocking | Harvest History |
| Potential for Future Harvesting | Seasonal Restrictions to Harvesting | Ground Vegetation |
| Exotic and Invasive Plant Species | Soil Conditions | Wildlife and Endangered Species |

Additionally, the condition of the roads and trails on the property was closely inspected. Roads and trails are an important property feature for most landowners, and the condition of roads and trails on the property are important factors in the feasibility and value of timber harvesting on a given piece of land.

Each stand has been given an alphanumeric timber type code that reflects the predominant species, primary size class, and total stocking level of the stand. In most cases, each stand on a given property will have a unique timber type code, however there are some cases where multiple stands may share a particular timber type code in order to reflect differences in past management or other conditions.

At the completion of the field inspection, GIS software was again used to "true up" the stand lines in order to arrive at an accurate estimate of acreage per stand. It is crucial to know with accuracy how large a stand is in order to accurately estimate timber volume within that stand. Soils data provided by the Natural Resources Conservation Service were used to generate a soils map of the property which is useful in predicting forest productivity and limitations to harvesting equipment. Other data provided by the State of Michigan were used to generate maps which depict the location of streams, lakes, and public roads.

Data and observations collected in the field were considered in arriving at the harvest recommendations and schedules provided later in this section.

[2] Basal area is a measurement used by foresters to identify the relative density of the forest and reflects the cross-sectional area of all trees five inches in diameter and larger, as measured at four- and one-half feet above the ground, and expressed in units of square feet per acre. The higher the basal area, the more densely stocked a stand is. Basal area is one of the most useful measurements in determining when many timber types are ready to be harvested, and is closely related to timber volume.

Some of the primary factors considered in making these recommendations include forest type, size and stocking class, landowner objectives, site conditions observed in the stand, current and anticipated market conditions, and insect and disease problems.

Seven forested stands were identified on the property; additionally, seven nonforested stands were identified. Each stand will be described in detail in the following pages. After the description of each stand, management recommendations that consider the landowner objectives and desired future conditions of each respective stand will be provided.

# STAND DESCRIPTIONS AND MANAGEMENT RECOMMENDATIONS

## STAND 1

| | |
|---|---|
| Acres: | 23.9 |
| Forest Type: | Mw (Northern Hardwoods with white pine) |
| Stocking Level: | 6-8 (heavily stocked, poletimber dominant, but sawtimber well represented) |
| Tree Quality and Potential: | average quality with good potential |
| Site Index: | 63 |
| Site Index Species: | sugar maple |
| Basal Area: | 130 |
| Management Objective: | positive aesthetics, recreational use, encourage native species. |
| Treatment Month and Year: | Ongoing |
| Treatment Description: | Manage invasive shrubs, allow natural succession |
| Stand Health: | Good |
| Desired Future Conditions: | mature, mixed northern hardwood/pine stand |

### STAND DESCRIPTION:

Stand 1 can be found on the eastern side of the Norrie Park property. The soils are generally upland and sandy, providing adequate growing conditions for the tree species present, which can be seen in the following table:

| DOMINANT | | CO-DOMINANT | |
|---|---|---|---|
| **Red Maple** | **White Pine** | **White Spruce** | **Balsam Fir** |
| **Aspen** | | **Sugar Maple** | |
| | | | |

Stand 1 is a very well stocked stand with a healthy mix of red maple, white pine, and mature aspen. The stand appears to be relatively even aged and was likely established via a heavy disturbance around 60 to 70 years ago. The maple and pine trees are capable of longer life expectancies, and are therefore generally healthly, and growing well at this time. The maple trees are mostly found in the poletimber size class, ranging from around six to ten inches in diameter, while the white pine are capable of faster growth, and range into small sawtimber size classes from 11 to 16 inches in diameter at breast height (DBH). Mixed in with the maple and pine is a moderate amount of mature aspen trees.

Figure 12: Photo of Stand 1

These individuals generally range from 10 to 15 inches in diameter and are started to show signs of decline and mortality due to old age. The southern most part of this stand has some planted red pine and scotch pine, which appear to be a similar age class as the rest of the stand.

While there is not too much advanced growth of buckthorn within the stand at this time, glossy buckthorn stems are present throughout. Many of these stems are still scattered, young, and non-seed bearing. The presence and density of buckthorn is expected to grow overtime.

## MANAGEMENT RECOMMENDATIONS:

Because Stand 1 is utilized for recreation including hiking and cross-country ski trails, the primary management objective is to manage the forest for positive aesthetics long term. In order to accomplish this, Stand 1 should be managed in a way that encourages the growth of a mature forest overstory that is capable of a long life expectancy. Because the stand is already dominated by maple and white pine trees, it is well underway and currently providing the natural, mature forest overstory that is desired. For this reason, only minor work and treatment activities are necessary to maintain the health of the stand.

As the aspen decline, die, and fall out of this stand, the existing maple and pine trees are well situated to take advantage of the natural canopy thinning and grow into those spaces. The aspen should be allowed to fall out in this natural way over time. Aspen trees that die close to trails may need to be proactively cut down in order to minimize risk to trail users and minimize debris falling on the trail over time that needs to be cleaned up. Aspen trees that die more than 50 feet away from any trails should be left standing to rot naturally and provide snags to wildlife. The benefit of snag trees within the forest is further described in the wildlife section of this plan. The maple and pine tree canopies will expand and make use out of the canopy gaps created by dying aspen trees and will require little to no maintenance or management during the life of this plan.

The primary management needed within Stand 1 includes the management and treatment of glossy buckthorn over time. While the stems are currently small, young, and not negatively affecting aesthetics, they are present and will continue to grow and fill in the forest understory over time. Buckthorn stems should be identified and removed over time to maintain easy use of the forest, and the positive aesthetics of a natural and relatively open understory found in a mature forest setting. Because of the presence of the invasive species across the stand and within surrounding stands and properties, total eradication is highly unlikely. Instead, priority should be given to occasional treatments in order to suppress the invasive from becoming a visual or physical nuisance, and to prevent any stems from becoming seed bearing and spreading further.

The planted red and scotch pine in the southern portion of this stand is heavily overstocked and could use a thinning, but would be difficult to do commercially without an active harvest in the near vicinity. Additionally, the logistics of removing forest products could be challenging due to the surrounding wet soils that would require winter conditions, but the property is heavily utilized for recreation during the winter months. More in depth review, discussion, and details regarding a thinning in Stand 1 should be discussed and put into a specific project plan if commercial harvesting is pursued within the Norrie property.

## STAND 2

| | |
|---|---|
| Acres: | 31.1 |
| Forest Type: | Ma (northern hardwoods with aspen) |
| Stocking Level: | 6 (heavily stocked poletimber) |
| Tree Quality and Potential: | average quality with average to good potential |
| Site Index: | 63 |
| Site Index Species: | sugar maple |
| Basal Area: | 100 |
| Management Objective: | positive aesthetics, recreational use, encourage native species. |
| Treatment Month and Year: | Ongoing |
| Treatment Description: | Manage Invasive Shrubs, supplemental planting of native species as needed |
| Stand Health: | Good |
| Desired Future Conditions: | Mature northern hardwood stand |

### STAND DESCRIPTION:

Stand 2 is found in the center of the Norrie Park parcel, just east of the mowed and maintained park area with public access roads. The soils are generally upland and sandy, providing adequate growing conditions for the tree species present. Occasional low spots can be found within the stand, giving way to more lowland tree species such as tamarack and black spruce. The dominant upland soils contain the following species mix:

| DOMINANT | | CO-DOMINANT | |
|---|---|---|---|
| **Red Maple** | **Quaking Aspen** | **Sugar Maple** | **White Spruce** |
| | | **Balsam Fir** | **White Pine** |
| | | | |

Stand 2 shares many similarities with Stand 1, with the primary difference being that there is a lower amount of white pine trees present, and a higher portion of aspen trees present. Beyond this, the general age, health, and outlook is very similar. Because there is a somewhat higher portion of aspen, spruce, and fir trees present, there is a higher amount of trees dying from old age now and over time. This is causing this area to show larger canopy gaps, increasing sunlight penetration, and increasing the amount of understory growth.

Stand 2 has a larger presence of glossy buckthorn in the understory, which includes both a higher stems per acre value and stems that are larger and more mature. This buckthorn presence is expected to continue to grow and will likely suppress regeneration and the growth and replacement of native vegetation if left untreated. This suppression of regeneration and growth of native vegetation will affect both overstory and understory forest conditions.

## MANAGEMENT RECOMMENDATIONS:

Similar to Stand 1, Stand 2 is utilized for recreation including hiking and cross-country ski trails. For this reason, the primary management objective for Stand 2 is identical to Stand 1 and is to manage the forest for positive aesthetics long term. In order to accomplish this, Stand 2 should be managed in a way that encourages the growth of a mature forest overstory that is capable of a long life expectancy. Because the stand currently contains a healthy stocking of maple trees, it is well underway and currently providing the natural, mature forest overstory that is desired. That said, there are pockets of aspen, spruce, and fir that are dying out that are relatively large and do not have a lot of replacement trees such as maple, cherry, birch, or other longer lived hardwood tree species. Buckthorn is expected to dominate these pockets and suppress native tree regeneration over time. Management of the buckthorn is recommended in order to encourage the growth of native forest tree species across the stand, but specifically in these areas that are struggling to successfully regenerate replacement overstory trees. Supplemental planting may be necessary in conjunction with the invasive species management and control to fully replace the overstory.

Management recommendations are very similar to Stand 1 and will be summarized in a briefer manner here. Stand 2 can largely be left alone to allow the natural process of succession to take place, allowing aspen to fall out and maple trees to fill in the canopy gaps created. Buckthorn management and suppression should occur across the entirety of the stand with occasional treatments to suppress the invasive from becoming a visual or physical nuisance, and to prevent any stems from becoming seed bearing and spreading further.

More intensive management of the invasive will be necessary in larger canopy gaps that are identified as needing assistance for native overstory tree replacement. This more intensive management will include more frequent monitoring and treatments to ensure the invasive shrub does not overgrow and choke out native tree seedlings and saplings, whether naturally occurring or artificially planted. If a canopy gap is identified as buckthorn dominant and in need of forest rehabilitation, an initial removal and treatment of the buckthorn stems present should be initiated as soon as possible. Following the buckthorn removal, the remaining vegetation should be evaluated. If there are enough native tree stems remaining to fill in the canopy gap, no supplemental planting is needed. If there are not enough tree stems present, supplemental planting should be initiated as soon as possible, ideally within one year of the initial buckthorn removal/treatment. Target sapling density should be at least 12 foot by 12 foot spacing, and can be closer if more naturally occurring tree stems are present. 12x12 spacing would equate to about 300 trees per acre. If supplementally planting the site, a tighter spacing of 8x8 or 10x10 feet can be used to overcome some mortality, which is inevitable in most planting operations. The exact spacing may also depend on the tree species planted. Hardwood stems should generally be planted at the 12x12 or 10x10 foot spacing, whereas conifers can be planted at the 8x8 spacing. Tree species to be planted can include:

- Full sunlight (center of canopy gaps): red pine, white spruce, red oak, white oak, white pine, hickory species, black walnut, eastern red cedar, and sycamore
- Mixed sunlight/shade (edges of canopy gaps): red maple, sugar maple, balsam fir, northern white cedar, basswood, hemlock, and white pine.

The hickory, walnut, red cedar, and sycamore trees are individuals that don't traditionally grow in Michigan's Upper Peninsula but are a few species that are listed to possibly do well in our changing climate according to the reporting done by *Janowiak et al. 2014.* Further information related to assisted migration of tree species is provided in the forest health section of this plan. Planted (or naturally occurring) seedlings or saplings will require annual monitoring and possible follow-up treatments to ensure they are not out competed by buckthorn regrowth. At the point that the individual saplings are 12 feet tall and greater, they should be capable of surviving and growing into the overstory without continued intensive human management. Additionally, planted seedlings and saplings may require protective features to prevent excessive damage from wildlife. Deer browse may affect some species more than others, and fencing may be necessary in some instances. Tree tubes may also assist to protect younger planted seedlings that are under three to four feet in height. Specific planting specifications should be created in individual project plans used site to site and over time.

Figure 13: photo of the cross-country ski trails in Stand 2 following recent maintenance work

## STAND 3

| | |
|---|---|
| Acres: | 12.4 |
| Forest Type: | Qe (lowland conifer with lowland hardwood) |
| Stocking Level: | 5 (well stocked poletimber) |
| Tree Quality and Potential: | poor to average quality with average potential |
| Site Index: | 35 |
| Site Index Species: | Tamarack |
| Basal Area: | 80 |
| Management Objective: | Maintain native forest cover, protect soil and water quality |
| Treatment Month and Year: | Ongoing |
| Treatment Description: | manage invasive shrubs |
| Stand Health: | good |
| Desired Future Conditions: | Maintain current conditions and minimize buckthorn growth and impacts |

### STAND DESCRIPTION:

Stand 3 is a lowland forested stand found within the Norrie Park parcel. This stand is generally found in the center of the forested area, with water draining south to a point where it eventually connects and empties into the Montreal River. While some of this water drainage may be surface flow during the wettest times of year including spring snow melt and heavy precipitation events, most of the water flow is subsurface. An early June inspection of the site already showed next to no surface water, but soils were still wet, and lowland tree species dominate the site. This indicates that the water table is still close to the soil's surface for most of the year. The lowland soils present contain the following species mix:

| DOMINANT | | CO-DOMINANT | |
|---|---|---|---|
| **Tamarack** | **White Spruce** | **Black Ash** | **Red Maple** |
| **Balsam Fir** | | **Northern White Cedar** | **Tag Alder** |
| | | | |

Tamarack is the most common species identified in Stand 3. These trees are found growing in the lowest and wettest soils present. Underneath the tamarack may be a few associated species from the list above, but the understory is largely dominated by tag alder and other lowland brush species. As the soils rise and offer slightly less saturated conditions, white spruce, balsam fir, and red maple start to mix in. These species are commonly found around the edges of the stand in the transition zone from wetland soils to more true upland soils of Stands 1 and 2. Some areas are also dominated by northern white cedar and black ash, which are two common swamp species that tolerate muck soil conditions very well. These areas also contain a mix of the associated species listed in the table above.

## MANAGEMENT RECOMMENDATIONS:

The management objective for Stand 3 is to maintain the native forest cover across the site, while also protecting the soil and water quality (hydrology) present. To do this, minimal active management is needed. Due to the wet soils present, equipment operation should be minimized with the stand, and limited only to roads and crossings created. Some low impact equipment operation may take place during the winter months if needed, but rutting and soil impacts should be minimized. The only true management that Stand 3 needs is the occasional buckthorn evaluation and removal/treatment as needed. This will help reduce invasive takeover and encourage the maintenance of the native species present.

With the presence of black ash within the stand, there is expected to be impacts and mortality from emerald ash borer over time. While unfortunate, there is nothing that can be reasonably done to prevent this situation. As ash trees die and open up the ground to increased sunlight, it will be even more important to monitor the regrowth and ensure that buckthorn is not taking over.

## STAND 4

| | |
|---|---|
| Acres: | 143.5 |
| Forest Type: | Am (Aspen dominated with northern hardwoods) |
| Stocking Level: | 5 (moderately stocked poletimber) |
| Tree Quality and Potential: | poor quality with poor to average potential |
| Site Index: | NA Highly variable due to past soil disturbance (Mining) |
| Site Index Species: | NA |
| Basal Area: | 85 |
| Management Objective: | positive aesthetics, recreational use, encourage native species. |
| Treatment Month and Year: | Ongoing |
| Treatment Description: | Manage Invasive Shrubs, supplemental planting of native species as needed |
| Stand Health: | poor to average |
| Desired Future Conditions: | Mature forested timber stand dominated by long lived species, such as pine and northern hardwoods |

### STAND DESCRIPTION:

Stand 4 is a highly variable stand that has experienced significant past soil disturbance. Stand 4 is identified as the entire forested area within the Miners Park property. While there are minor variations from location to location across the forest, there are several similarities that warrant merging all these areas into a single stand.

Basically this entire site was once completely cleared and utilized for iron mining operations. There were several individual mine sites, including but not limited to the Ashland mine, various Norrie Mines, Aurora Mines, and Pabst Mines. The first mines opened and started shipping iron ore around 1884 and were in various states of operation until the mid-1900s. There is countless informational signs along the various trails within the park that offer more information about the history of the site. These past mining activities have led to highly variable soil conditions, consisting commonly of rocky mine tailings and steep slopes.

Following the mining era of the park area, areas were likely abandoned and allowed to regrow with vegetation and forest in lieu of any activity. Areas that were allowed to reforest (Stand 4), likely started by growing up in grasses and various herbaceous vegetation first. Shrubs and primary successional tree species such as aspen, paper birch, and pine then likely seeded into the area over time. This woody vegetation likely started as scattered individuals, like what can be found in the butterfly garden area at this time. As these individuals grew up and started casting seeds themselves, the site would have then filled in with woody vegetation, slowly growing into the forest that we finally see today. Some locations were also planted with red pine trees, so some scattered small pine plantations can also be found within Stand 4's boundaries. Scotch pine was likely planted somewhere within the park or surrounding area, because scotch pine regeneration can be found along some spots along the southern border of the stand.

| DOMINANT | | CO-DOMINANT | |
|---|---|---|---|
| **Quaking Aspen** | **Bigtooth Aspen** | **Sugar Maple** | **Black Cherry** |
| **Red Maple** | **Paper Birch** | **White Spruce** | **White Pine** |
| **Red Pine** | **Box Elder** | **Native Shrubs** | **Invasive Shrubs** |

The most dominant and common tree species found within Stand 4 is quaking aspen, with some bigtooth aspen mixed in. These species are the most common primary successional species, being able to seed in from great distance, grow very quickly in full sunlight, and regenerate from existing root stock when cut or dying. Paper birch and red maple have also performed relatively well in these conditions, with most of the red maple being slightly behind the aspen growth and now being in the codominant canopy or understory. Box elder can also commonly be found in areas of Stand 4 and is more of a junk species that assists in reforestation than anything. Most of the mature forested trees found across the stand range from approximately 30-60 years of age. The rest of the tree species listed in the above table can be found in scattered locations across the stand.

The understory of Stand 4 is then dominated by brush, shrubs species, and younger trees. The most commonly seen shrub species include mountain ash, common buckthorn, honeysuckle, and serviceberry. Mountain ash and service berry are both native species and can be expected to submit to the shaded conditions of the forest overstory and decline in numbers over time. The buckthorn and honeysuckle on the other hand are both invasive and can be expected to be very aggressive in growing habits and choke out other vegetation growth overtime. There is a mix of other shrubs present in the understory as well. Trees found growing in the understory contain a mix of everything listed in the above table, but the most common ones include red maple and black cherry.

Stand 4 contains an extremely high amount of present and past human activity. Past mine ruins, junk, and other human influenced landscape is commonly found across the site. Some of these areas may be considered to have historical importance and may warrant protections from further disturbance. Present human activity within Stand 4 primarily consists of various recreational trails. Trails include but are not limited to motorized trails (for ATVs, snowmobiles, etc…), mountain bike trails, hiking trails, and interpretive trails.

## MANAGEMENT RECOMMENDATIONS:

The management objectives for Stand 4 are very similar to those of Stand's 1 and 2. Being that the site is primarily used for recreation and historical protection, continued recreational use and pursuing positive aesthetics of the site are some of the highest priorities. In a forestry sense, encouraging and maintaining native species that are capable of longer life expectancies is important for ecosystem health, and will then also naturally benefit the aesthetics of the site.

While Stand 4 is dominated by aspen, it still shows plenty of potential to follow natural succession trends and slowly transition into a more maple and cherry dominated stand over time on its own. It is recommended that the overstory of Stand 4 be largely left alone and allowed to move through this transition over time. This will consist of allowing the current aspen and paper birch trees to mature and die out, giving way to longer lived shade tolerant species such as maple, cherry, yellow birch, and others. Dying and dead trees next to any recreational trails should be cut down to reduce hazards to trail users, similar to the recommendation provided for Stands 1 and 2. Red maple can be expected to be the most common species in this replacement population. Traditional commercial timber harvesting will not be able to assist in much of this transition process due to a number of challenges. Challenges include but are not limited to:

- Potential damage to trails, potential damage to historical sites and artifacts, steep/inoperable slopes, high traffic and therefore high risk of damage or injury to persons or personal property, low value potential of products, high logistics cost associated with setup and operation.

There may be a few select areas that could be commercially harvested to assist in maintaining forest health, but these areas are small and offer little potential for traditional harvesting systems. Niche operations or logistics would need to be found and thorough discussion would be needed between city management officials, the city's consulting forester, and the potential contractor. If any activity like this is pursued, individual project plans should be created to discuss specific details associated with each project. Main areas that could be considered for further investigation include:

- aspen clearcutting and red pine thinning north of the old landfill
- aspen thinning to accelerate hardwood replacement and red pine thinning just east of Burma Road

The primary management recommendation for Stand 4 is similar to that of Stand 2. Invasive shrub removal and treatment is the highest priority in assisting in the forest succession to ensure that the forest can regenerate and grow up with new, longer-lived hardwood trees. If invasives are left to dominate the understory, the forest will almost surely struggle to regenerate successfully, and will lead to a thinning out of the overstory over time. This will reduce forest cover, increase brushiness, and lower the aesthetics and usability of the property. Additionally, the increase of invasive species and reduction of native species will lower the wildlife habitat value over time.

This is a large and scattered stand, where invasive species such as buckthorn and honeysuckle are already very well established. The total removal and eradication of these species should not be the goal, but instead the areas should be managed as needed to maintain trails, aesthetics, usability, and native forest overstory cover. Areas where the maple and other native species can regenerate and fully replace of the declining aspen overstory can largely be left alone for the time being. Invested resources and efforts should instead be focused on areas where aspen overstory trees are declining and little to no replacement forested trees are growing. Identifying these areas will require frequent monitoring over time. City staff or other trail/park maintenance crews and groups can do general monitoring from year to year and start to identify potential areas needing attention and intervention to assist in overstory regeneration. When these areas needing additional attention are identified, it is recommended that the city work with their consulting forester, or another qualified professional, to further investigate the site and prepare a site-specific project plan. following removal of the invasive in any defined site, the replanting should follow the same guidelines that are provided for Stand 2 in Norrie Park.

Figure 14: conditions within Stand 4 are highly variable, but this photo from the property shows an idea forest setting. Open, invasive free, and visually appealing understory, with younger maple and yellow birch trees growing up to replace the declining aspen and paper birch overstory.

## STAND 5

| | |
|---|---|
| Acres: | 16.1 |
| Forest Type: | Ma (Northern Hardwoods with Aspen) |
| Stocking Level: | 5 (Well Stocked poletimber) |
| Tree Quality and Potential: | average quality with good potential |
| Site Index: | 63 |
| Site Index Species: | Sugar Maple |
| Basal Area: | 90 |
| Management Objective: | positive aesthetics, recreational use, encourage native species. |
| Treatment Month and Year: | Ongoing |
| Treatment Description: | Manage Invasive Shrubs, supplemental planting of native species as needed |
| Stand Health: | good |
| Desired Future Conditions: | Mature forested timber stand dominated by northern hardwood species |

### STAND DESCRIPTION:

Stand 5 can be found on the Cemetery property and is found across most of the upland soils that are still forested. This stand appears to be almost identical to that of Stand 2. This stand was likely aggressively harvested for the timber products available around 60 to 70 years ago and has received little management since. The result is now a hardwood and aspen mixed stand, that is mid succession where the aspen trees are dying and falling out and giving way to a more hardwood dominated stand. There is a small pond and lowland brush area in the southwest corner of the stand where there was an old soil or gravel pit at one time. Additionally, there is a black ash and tag alder swale in the northern portion of the stand that drains towards the west into the Montreal River. There are some recreational trails within the stand, but only the trail following the river appears to see any summer use. The other trails may see more winter snowshoe use, as there is no evidence of a snow free foot path.

| DOMINANT | | CO-DOMINANT | |
|---|---|---|---|
| **Red Maple** | **Quaking Aspen** | **Bigtooth Aspen** | **Sugar Maple** |
| **Paper Birch** | **Black Cherry** | **Red Oak** | **Black Ash** |
| | | **Invasive Shrubs** | **Native Shrubs** |

While the overstory in Stand 5 is almost identical to Stand 2, the understory has some variation. Stand 5's understory is dominated by common buckthorn that is very well established, and a healthy amount of honeysuckle as well. Native understory shrubs such as hawthorn, serviceberry, and mountain ash are also relatively common and should be maintained as much as possible when treating and removing invasives.

## MANAGEMENT RECOMMENDATIONS:

The management objectives and recommendations for Stand 5 are identical to those of Stand 2. The main areas expected to need assistance in forest cover regeneration at this time are the black ash swale in the northern part of Stand 5. When invasive shrub management takes place, efforts to retain native species should be made, specifically to maintain the Hawthorne shrubs that are present.

Figure 15: example photo of the current conditions found in Stand 5. Notice the greater sunlight penetration in the background. An example of the kind of area that should be monitored over time to ensure that tree regeneration is growing adequately to fill back in the dominant canopy, and not being outcompeted by invasive shrubs.

## STAND 6

| | |
|---|---|
| Acres: | 3.5 |
| Forest Type: | E (lowland hardwoods) |
| Stocking Level: | 8 (well stocked sawtimber) |
| Tree Quality and Potential: | average quality with average potential |
| Site Index: | 60 |
| Site Index Species: | Red Maple |
| Basal Area: | 80 |
| Management Objective: | positive aesthetics, recreational use, encourage native species. Also protect soil and water quality. |
| Treatment Month and Year: | Ongoing |
| Treatment Description: | Manage Invasive Shrubs, supplemental planting of native species as needed |
| Stand Health: | okay |
| Desired Future Conditions: | Mature forested timber stand dominated by riparian hardwood species |

### STAND DESCRIPTION:

Stand 6 can be found in a small area in the northwest corner of the cemetery property. This stand exists in the floodplain of the Montreal River and is found at the bottom of a short but steep slope on the western edge of Stand 5. Stand 6 is dominated by sawtimber sized riparian hardwood species, including black willow and red maple. Silver maple may also be present but was not identified during inspection. Aspen, box elder, and black ash are also present to some extent. While many of these trees are sawtimber sized, they generally do not offer good quality due to the crooked and forked nature of the stems.

| DOMINANT | | CO-DOMINANT | |
|---|---|---|---|
| **Black Willow** | **Red Maple** | **Quaking Aspen** | **Box Elder** |
| | | **Black Ash** | |
| | | | |

The understory of Stand 6 is primarily dominated by shrub species, which is relatively common for floodplain areas. These shrub species consist of buckthorn, honeysuckle, tag alder, amongst some scattered others. There is also some tree seedlings and saplings mixed in with the understory, consisting primarily of red maple.

## MANAGEMENT RECOMMENDATIONS:

The management objectives for Stand 6 are very similar to Stand 5, being to maintain aesthetics and native forest canopy cover. Additionally, because of the stand's proximity to the Montreal River, protecting the sensitive soil and water quality present is also an important and primary goal. To accomplish these goals, Stand 6 should largely be left alone, and monitored over time to ensure that the stand is maintaining a dominant native forest canopy cover. If areas are identified to have a declining overstory and are not regenerating with native forest trees naturally, a site-specific plan to treat invasives and regenerate or plant native species should be created and implemented.

Because of the proximity of Stand 6 to the Montreal River, these efforts should be done without the use of heavy equipment as much as possible, and soil disturbance should be minimized at all costs to prevent unnatural erosion events which can lower water and habitat quality within the river. Additionally, herbicide use to control invasive species should be limited as much as possible. Small and targeted use of herbicide such as the application on cut stumps is permissible, but broadcast spraying of growing vegetation should be avoided.

An additional difference between Stand 6 and other stands within this plan that have similar recommendations are the species to be planted. Most other stands have the capacity to support upland species but Stand 6 should have lowland or wetland tree species prioritized for artificial regeneration efforts. Replanting efforts in Stand 6 should include the following species:

- Full sunlight (center of canopy gaps): white spruce, bur oak, white pine,
- Mixed sunlight/shade (edges of canopy gaps): silver maple, red maple, balsam fir, northern white cedar, hemlock, and white pine.

## STAND 7

| | |
|---|---|
| Acres: | 7.8 |
| Forest Type: | E (lowland hardwoods) |
| Stocking Level: | 4 (poorly stocked poletimber) |
| Tree Quality and Potential: | poor quality with average potential |
| Site Index: | 60 |
| Site Index Species: | Red Maple |
| Basal Area: | 50 |
| Management Objective: | positive aesthetics, recreational use, encourage native species. Also protect soil and water quality. |
| Treatment Month and Year: | Ongoing |
| Treatment Description: | Manage Invasive Shrubs, supplemental planting of native species as needed |
| Stand Health: | poor |
| Desired Future Conditions: | Mature forested timber stand dominated by riparian hardwood species |

### STAND DESCRIPTION:

Stand 7 is located along the southern edge of the Cemetery property along the Montreal River. Stand 7 is basically identical to Stand 6 in the sense that it is a riparian floodplain for the Montreal River and is dominated by riparian species and forest type. That said, Stand 7 does not have the same steep slope leading down to the floodplain like Stand 6 does. The other main variation between Stands 6 and 7 is that Stand 7 does not have the same sawtimber sized overstory, and instead is a mix of shorter and younger trees mixed with brush. This brush includes both native tag alder and invasive shrubs such as buckthorn and honeysuckle. Some areas are regenerating with enough forested tree species to be able to fully reclaim the overstory over time, but other areas within Stand 7 are already showing signs of brush dominance and forested regeneration is unlikely to succeed without intervention and active management. Stand 7 contains the continuation of the actively used Riverside Trail that is described in Stand 6's description.

| DOMINANT | | CO-DOMINANT | |
|---|---|---|---|
| **Red Maple** | **American Elm** | **Aspen** | **Paper Birch** |
| **Black Cherry** | | **Balsam Poplar** | **White Spruce** |
| | | **Native Shrubs** | **Invasive Shrubs** |

### MANAGEMENT RECOMMENDATIONS:

The management objectives and recommendations for Stand 7 are identical to those of Stand 6. Immediate monitoring, invasive treatment, and reforestation efforts should be prioritized in Stand 7 over Stand 6 in the first five years of this forest management plan as there are already scattered micro sites within Stand 7 that need management intervention to assure successful reforestation of the natural forest canopy.

## STAND 8

| | |
|---|---|
| Acres: | 64.4 |
| Forest Type: | Cemetery (dominated by urban landscape trees and mowed lawn grasses) |
| Stocking Level: | NA |
| Tree Quality and Potential: | Mixed |
| Site Index: | 65 |
| Site Index Species: | Red Maple |
| Basal Area: | NA |
| Management Objective: | Maintain individual tree health and manage hazard trees as needed |
| Treatment Month and Year: | Ongoing |
| Treatment Description: | Prune growing trees, Remove or mitigate hazard trees, Remove dead trees |
| Stand Health: | Good |
| Desired Future Conditions: | Continuously maintained urban site with mowed lawn, and a mixed variety of overstory/understory landscape trees and shrubs |

### STAND DESCRIPTION:

Stand 8 is found on the Cemetery Property and consists of the area that is utilized for cemetery purposes. The cemetery is actively used and maintained, which means that the vegetation present includes mowed lawn grasses and artificially planted shrubs and trees. The planted shrubs and trees are heavily managed by pruning efforts on an individual tree basis. Stand 8 is entirely more of an urban forest landscape than a natural one. Most of the trees within Stand 8 are healthy and well cared for, but there are some of dead or declining individuals present.

### MANAGEMENT RECOMMENDATIONS:

This forest management plan is largely written for naturally occurring forests and is not designed to provide thorough recommendations for the management of urban forested sites such as the cemetery. It is recommended that the city consider developing a city forest management plan and inventory if one is not already in place and being utilized. It may make sense to have a specific plan created and in place for the cemetery specifically, to differentiate the management between street trees, park trees, and cemetery trees, amongst other landscape like trees the city oversees maintenance of. The Michigan DNR offers annual Community Forest Grants to assist municipal governments in the creation and implementation of these type of urban forestry plans. More information related to these grants may be found online at https://www.michigan.gov/dnr/buy-and-apply/grants/forestry/community or by contacting the DNR Urban Forestry Coordinator, currently staffed by Kevin Sayers. Kevin's contact information can be found at the web link provided.

In a general sense, maintenance of the urban trees found within Stand 8 should continue as is. Growing trees should be pruned by professional arborists to maintain tree structure, health, and functionality within the urban landscape setting. Declining trees should be monitored by a professional arborist to determine if management action should be taken. Dead trees and other hazardous trees and limbs should be removed as soon as reasonably practicable. Over time, new trees and shrubs should be planted in openings to provide continued urban forest growth and benefits of a forest overstory, such as shade, water runoff reduction, aesthetics, and more. Specific planted species should be recommended by a qualified professional, and should consider location, proximity to sensitive surroundings such as roads and trails, soil and rooting capacity, overstory availability for the mature tree, amongst possible other considerations.

## STAND 9

| | |
|---|---|
| Acres: | 51.1 |
| Forest Type: | Open (a) |
| Stocking Level: | NA |
| Tree Quality and Potential: | NA |
| Site Index: | NA |
| Site Index Species: | NA |
| Basal Area: | NA |
| Management Objective: | Continue city management and maintain as open for recreation activities, |
| Treatment Month and Year: | Ongoing |
| Treatment Description: | plant and maintain urban landscape trees as desired/available, minimize invasive encroachment. |
| Stand Health: | NA |
| Desired Future Conditions: | As is, with continued urban forest cover and limited invasive species impacts |

### STAND DESCRIPTION:

Stand 9 is the first of three separate stands that are identified as "open". Each of the stands are further identified with a secondary letter code of (a), (b), or (c) for differentiation. Stand 9 is identified as open (a).

Stand 9 consists of the larger open areas that are utilized and maintained for public recreation. These areas are found on the Norrie Park property, in the maintained park area in the northwest corner of the parcel, and scattered around the Miners Park property. Within the Norrie Park property, Stand 9 contains areas for activities such as disc golf, hiking, dog walking, picnicking, and a community garden. Within the Miners Park property, Stand 9 contains areas such as various sports fields, a dog park, parking lots, and a butterfly garden. These areas within both properties may contain small areas of naturally occurring vegetation, as well as various planted and maintained landscape trees similar to those described within Stand 8. These areas also generally contain large amounts of mowed lawn grasses.

### MANAGEMENT RECOMMENDATIONS:

Similar to Stand 8, areas designated as Stand 9 are largely nonforested or are forested with artificially planted and maintained urban forest settings. For this reason, there are few recommendations to be provided in this forest management plan that is prepared primarily for the management of naturally occurring wooded areas. These areas should be considered for further detailed management planning utilizing urban forest management planning tools if not available or done already, like the recommendations provided for Stand 8.

General recommendations for vegetation found in areas designated as Stand 9 include continued mowing and general management as the city sees fit. Trees should be evaluated and monitored by a professional arborist and pruned or removed as necessary. Additional trees may be planted to replace removed trees or add additional canopy for urban forest benefits as the various sites allow. Small, naturally occurring clumps of forest and trees within areas identified as Stand 9 should be left to grow naturally, and management to minimize invasive species present should be implemented to ensure the continuality of a natural ecosystem.


Figure 16: Photo of one of the ball diamonds found in Stand 9

## STAND 10

| | |
|---|---|
| Acres: | 60 |
| Forest Type: | Open (b) |
| Stocking Level: | None |
| Tree Quality and Potential: | NA |
| Site Index: | NA |
| Site Index Species: | NA |
| Basal Area: | NA |
| Management Objective: | Support City Management Operations |
| Treatment Month and Year: | No Active Forest Management |
| Treatment Description: | No Active Forest Management |
| Stand Health: | NA |
| Desired Future Conditions: | NA, non-forested |

### STAND DESCRIPTION:

Stand 10 is the second of three open stands and is differentiated as open (b). Stand 10 encompasses all the areas of the Miners Park property that are nonforested, not used for general recreation, and are primarily utilized to support city management operations. These areas include a fenced off area that appears to serve as a city storage and maintenance garage on Clemens Street, a city compost facility, a fenced off and closed, old landfill, and a few smaller maintained clearings scattered around that serve to dump and store snow during the winter, street sweeping debris in the spring, and other various materials.

### MANAGEMENT RECOMMENDATIONS:

None of these areas are forested and all appear to be actively used for city operations. For these reasons, there are no recommendations for these areas that pertain to this forest management plan. In general, the city should continue to utilize and manage these areas as they see fit. Edges and unmaintained areas of Stand 10 should occasionally be monitored or cleared of vegetation to ensure that invasive species aren't able to take refuge in these areas.

## STAND 11

| | |
|---|---|
| Acres: | 3.1 |
| Forest Type: | Open (c) |
| Stocking Level: | NA |
| Tree Quality and Potential: | NA |
| Site Index: | NA |
| Site Index Species: | NA |
| Basal Area: | NA |
| Management Objective: | Maintain as open for continued cemetery management operations |
| Treatment Month and Year: | No Active Timber Management |
| Treatment Description: | No Active Timber Management |
| Stand Health: | NA |
| Desired Future Conditions: | NA, nonforested |

### STAND DESCRIPTION:

Stand 11 is located in a few small select locations within the cemetery property and is differentiated as open (c). Stand 11 is very similar to Stand 10 in the sense that it is largely nonforested and primarily utilized to support general city operations, specifically those operations concerned with the Cemetery property. Stand 10 consists of service drives for vehicles and dump and storage sites for cemetery debris including compostable organic debris and soil or fill. There are a few aspen and red maple trees growing in an unmaintained area of Stand 11, with a brush understory similar to that of Stand 5.

### MANAGEMENT RECOMMENDATIONS:

Most of these areas are nonforested and appear to be actively used for cemetery operations. For these reasons, there are no recommendations for these areas that pertain to this forest management plan. In general, the city should continue to utilize and manage these areas as they see fit. Edges and unmaintained areas of Stand 11 should be managed in conjunction with Stand 5 to ensure that native forest cover is allowed to dominate, and that invasive species aren't able to take refuge here.

## STAND 12

| | |
|---|---|
| Acres: | 24.4 |
| Forest Type: | ROW (Right of Ways) |
| Stocking Level: | NA |
| Tree Quality and Potential: | NA |
| Site Index: | NA |
| Site Index Species: | NA |
| Basal Area: | NA |
| Management Objective: | Allow continued maintenance by right of way easement holders. |
| Treatment Month and Year: | No Active Timber Management |
| Treatment Description: | No Active Timber Management |
| Stand Health: | NA |
| Desired Future Conditions: | NA, Non forest |

### STAND DESCRIPTION:

Stand 12 can be found scattered around the Miners Park property and consists of various right of ways including roads and power lines. These areas are nonforested and maintained as such by the right of way easement holders.

### MANAGEMENT RECOMMENDATIONS:

There are no management recommendations as pertaining to this forest management plan for Stand 12. Instead, the city should allow the easement holders of these right of ways to continue to manage the area and lands included as they see fit. The roads are likely already maintained by the city and should continue to be maintained and managed accordingly.

## STAND 13

| | |
|---|---|
| Acres: | 8.3 |
| Forest Type: | XL (lowland brush) |
| Stocking Level: | 0 (nonstocked) |
| Tree Quality and Potential: | Poor quality with poor potential |
| Site Index: | 38 |
| Site Index Species: | White Spruce |
| Basal Area: | 0 |
| Management Objective: | Protect Soil and Water Quality |
| Treatment Month and Year: | No Active Timber Management |
| Treatment Description: | No Active Timber Management |
| Stand Health: | okay |
| Desired Future Conditions: | unimpacted native forest/brush mix |

### STAND DESCRIPTION:

Stand 13 is located at the southern edge of the Norrie Park property. Stand 13 is very wet and dominated by lowland brush species such as tag alder and willow shrubs. Glossy buckthorn is likely present and will grow in densely within the stand over time. These species can tolerate the saturated and often flooded soil conditions present, whereas many tree species are not able to grow and survive here. There are some scattered trees within Stand 13 where the mineral and organic soils are closer to the surface of the water table. These trees include scattered red maple, spruce, tamarack, cedar, and balsam fir. The very eastern edge of the stand near Riverside Road contains a small upland area with more aspen and pine. Wiskers Creek also flows through this stand, further iterating the high-water table present

### MANAGEMENT RECOMMENDATIONS:

The primary objective for Stand 13 is to protect the sensitive soil and water quality present. Because the stand is largely nonforested and is not conducive to support a forest overstory, it is recommended that the stand be left alone and impacts to the soil and water present be avoided altogether. When management is taking place in adjacent areas, these areas should be designated as equipment free zones. Minor buckthorn removal practices could be considered within this stand, but the efforts and investments can almost certainly be better prioritized in other areas more capable of forest growth and recreational activities.

## STAND 14

| | |
|---|---|
| Acres: | 9.0 |
| Forest Type: | XW (Water) |
| Stocking Level: | NA |
| Tree Quality and Potential: | NA |
| Site Index: | NA |
| Site Index Species: | NA |
| Basal Area: | NA |
| Management Objective: | Protect Water Quality |
| Treatment Month and Year: | No Active Timber Management |
| Treatment Description: | No Active Timber Management |
| Stand Health: | NA |
| Desired Future Conditions: | NA, Non forest |

### STAND DESCRIPTION:

Stand 14 consist of small ponds that hold water year-round and are found scattered throughout the center of the Miners Park property. These ponds were likely created during the filling of the past iron mines in the area. Generally, there are no inlets or outlets to these ponds as they are found at the bottom of small depressions on the landscape today.

### MANAGEMENT RECOMMENDATIONS:

There are no recommendations for areas delineated as Stand 14 as they are not forested and do not pertain directly to this plan. That said, the water quality should be protected as much as possible because management directly adjacent to the ponds can indirectly impact the quality within the ponds. Management within 150 feet of any of the ponds should be minimized or low impact as much as possible to prevent soil disturbance and erosion potential. Management that does take place within this buffer should look to minimize equipment operation and soil disturbance as much as possible. Trail construction within these buffers should follow Forestry BMPs for water and soil quality to further minimize the risk of increased erosion.

# RECOMMENDED MANAGEMENT SUMMARY TABLE

The following table lists each stand located on this property corresponding to the recommended treatments that were discussed above. A treatment schedule is described for each stand and treatment.

| Stand | Acres | Treatment Description | Treatment Timeframe | Re-Evaluation Intervals |
|---|---|---|---|---|
| 1 | 23.9 | Allow Natural Succession, Monitor and Manage Invasive Shrubs over time | Ongoing as efforts are available, Low priority | Internal re-evaluations every 5 years, Forester re-evals every 10 years: 2033, 2043 |
| 2 | 31.1 | Monitor and Manage Invasive Shrubs, plant native species where needed | Ongoing as efforts are available, Mid priority | Internal re-evaluations every 3 years, Forester re-evals every 10 years: 2033, 2043 |
| 3 | 12.4 | Allow Natural Succession, Monitor and Manage Invasive Shrubs over time | Ongoing as efforts are available, Mid priority | Internal re-evaluations every 3 years, Forester re-evals every 10 years: 2033, 2043 |
| 4 | 143.5 | Monitor and Manage Invasive Shrubs, plant native species where needed | Ongoing as efforts are available, High priority | Internal re-evaluations every 2 years, Forester re-evals every 10 years: 2033, 2043 |
| 5 | 16.1 | Monitor and Manage Invasive Shrubs, plant native species where needed | Ongoing as efforts are available, Mid priority | Internal re-evaluations every 3 years, Forester re-evals every 10 years: 2033, 2043 |
| 6 | 3.5 | Monitor and Manage Invasive Shrubs, plant native species where needed | Ongoing as efforts are available, Low priority | Internal re-evaluations every 5 years, Forester re-evals every 10 years: 2033, 2043 |
| 7 | 7.8 | Monitor and Manage Invasive Shrubs, plant native species where needed | Ongoing as efforts are available, High priority | Internal re-evaluations every 2 years, Forester re-evals every 10 years: 2033, 2043 |
| 8 | 64.4 | Prune growing trees, Remove or mitigate hazard trees, Remove dead trees. Consider creation of site-specific Urban Forestry plan if not already established | Continue as city managers and maintenance staff see fit | Consult with a professional arborist for re-evaluation intensity. Likely Annually by city staff during normal maintenance activities |

| Stand | Acres | Treatment Description | Treatment Timeframe | Acres |
|---|---|---|---|---|
| 9 | 51.1 | Maintain as needed for continued recreation. Consider plantings to maintain or expand urban forest cover. | Continue as city managers and maintenance staff see fit | Consult with a professional arborist for re-evaluation intensity. Likely Annually by city staff during normal maintenance activities |
| 10 | 60.0 | Maintain open for City operations | NA | Internal re-evaluations every 5 years, |
| 11 | 3.1 | Maintain open for City operations | NA | Internal re-evaluations every 5 years, |
| 12 | 24.4 | No Active Timber Management | NA | NA |
| 13 | 8.3 | No Active Timber Management | NA | Forester re-evals every 10 years: 2033, 2043 |
| 14 | 9.0 | No Active Timber Management | NA | NA |

# RECORD OF COMPLETED MANAGEMENT PRACTICES

Use the following table to track the management activities on your property as you complete them. If you need additional copies of this table, please contact Green Timber Consulting Foresters at (906) 353-8584.

You're encouraged to retain copies of harvest records (scale slips, bid prospectus, bid results, maps, photos, and tax documentation). Such information can be useful in planning future management.

| Stand | Acres Treated | Management Activity | Management Year | Notes |
|---|---|---|---|---|
| | | | | |
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| Stand | Acres Treated | Management Activity | Management Year | Notes |
|---|---|---|---|---|
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# SECTION IV: GLOSSARY AND APPENDICES

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# GLOSSARY

**Agroforestry** - a land-use system that combines both agriculture and forestry in one location.

**Basal Area (Tree)** - cross sectional area of a tree at 4.5 feet off ground in units of square feet (ft2).

**Basal Area (Forest)** - basal area of all trees per acre summed up, in units of ft2/acre; measure of density.

**Biomass** - harvesting and using whole trees or parts of trees for energy production.

**Birdseye** or **Bird-eye** - an abnormality in the grain of wood, most commonly sugar maple, that creates a propensity of small knots visible throughout sawn lumber. Birdseye was once a defect but now is a high-value product when found in quality sawlogs. The mere presence of birdseye in a log does not automatically increase its value exponentially, buyers of birdseye consider many factors when setting prices.

**Board Foot** - a measure of volume 1 foot by 1 foot by 1 inch or 144 cubic inches of wood.

**Bolt** - 8-foot-long piece of wood of a quality that can be sawn into lumber but not meeting agreed-upon standards to be classified as a sawlog. Bolts typically either have a smaller diameter than standard sawlogs, or do not have the grading faces to meet sawlog standards.

**Browse** - parts of woody plants, including twigs, shoots, and leaves, eaten by forest animals.

**Bucking** - the process of cutting a felled tree into merchantable segments, usually at least 8 feet in length. Careful bucking decisions by an experienced operator can maximize the yield of quality sawlogs

**Buncher** or **Feller-Buncher** - a harvesting machine, typically on tracks, that can cut multiple trees and lay them in bunches in the woods to be brought to the landing by a skidder. The cut trees may be delimbed by chainsaw operators in the woods, or may be limbed at the landing by a slasher, processor, or delimber. A buncher may also be called a hot saw.

**Canopy** - the top layer of leaves and branches in the forest, consisting of the overstory trees.

**Carbon Cycle** - the biogeochemical cycle to exchange carbon between the biosphere and atmosphere by means of photosynthesis, respiration, and combustion.

**Carbon Sequestration** - the process of capturing and storing atmospheric carbon dioxide. In a forestry sense, this mainly entails trees capturing atmospheric carbon dioxide and storing it in the form of truck and root wood biomass.

**Clay Soil** - soil textural class consisting of mineral fragments (less than or equal to 0.002 millimeters in diameter). Clay soils are very fine and poorly drained. This means that they hold excessive water during wet times of the year.

**Clearcut** - the harvest of all the trees in an area to reproduce trees that require full sunlight. Reproduction following a clearcut may consist of stump and root sprouts (as in the case of red maple and aspen, respectively), seed (as in the case of spruce and fir) or artificial (as in the case of a red pine plantation).

**Coarse Woody Debris** - down and decaying trees on the forest floor. Coarse woody debris is generally larger than eight inches in diameter and eight feet long.

**Cord** - a unit of wood cut for fuel or fiber that is equal to a stack 4 x 4 by 8 feet long or 128 cubic feet; however a cord does not actually contain 128 cubic feet of wood due to bark and empty space

between logs. A **Face Cord** is a unit of measurement consisting of a stack of wood measuring 4 feet high x 8 feet wide x a shorter length, typically between 12 and 24 inches and cut for fuelwood. A **Lake States Cord** is a cord of wood having a length of 100 inches (8.33 feet). The Lake States Cord was developed at a time when the extra volume was intended to pay for the costs of hauling the wood to the mill.

**Cordwood** - small diameter or low-quality wood suitable for firewood, pulp, or chips.

**Crop Tree** - a young tree of a desirable species with certain desired characteristics, typically a tree that is capable of producing at least one Grade 2 or better sawlog.

**Crown** - the uppermost branches and foliage of a tree.

**Cruise** - a forest survey used to obtain inventory information and develop a management plan.

**Cull** - a tree that has no timber value as a result of poor shape or damage. Large cull trees may have high value for wildlife or aesthetics.

**Curl** - a grain abnormality, often found associated with birdseye, that creates a wavy appearance in cut lumber. Curl is eye catching but not quite as valuable as birdseye. Curl is most commonly found in red maple and sugar maple but may be found in other species as well. Like birdseye, the mere presence of curl does not automatically increase the value of a log.

**Cut-to-Length Logging** - modern, and typically highly mechanized, system of logging which typically consists of one processor and one forwarder. The processor cuts the trees down and then cuts them into segments based on quality and product specifications, and the forwarder hauls them to the landing. In high-value northern hardwood, oak, or pine stands, chainsaw operators may be involved in the felling and bucking of trees in order to maximize value.

**Dendrochronology** - the study of forest growth, climate patterns, and past forest fires using the scars and other evidence observed in the annual growth rings of trees.

**Diameter at Breast Height (DBH)** - diameter of a tree trunk taken at 4 1/2 feet off the ground.

**Diameter-Limit Harvest** - a timber harvest in which all trees over a specified DBH may be cut. Diameter-limit harvests do not consider tree quality and may harvest excellent-quality trees with potential to increase in value while retaining poor-quality smaller trees. Diameter-limit harvests are generally not considered an acceptable silvicultural method.

**Ecology** - the study of how living things interact with each other and the non-living parts of their environment.

**Ecosystem** - the living and non-living components that make up a biological community.

**Endangered Species** - a species in danger of extinction.

**Even-Aged Stand** - a stand in which the age difference between the oldest and youngest trees is minimal (<10 years).

**Forest Stand Improvement (FSI)** - any practice that increases the health, composition, value, or rate of growth in a stand. Also called **Timber Stand Improvement (TSI)** when the focus is on increasing timber volume and value. The term TSI is most commonly used when describing a non-commercial practice, often in sapling sized stand.

**Forwarder** - a logging machine, typically on rubber tires that has a grapple boom to pick up cut logs in the woods and carry them to the landing. Forwarders are typically paired with processors and have relatively low impact on a site compared to a conventional skidder.

**Group Selection** - harvesting groups of trees to open the canopy and encourage development of uneven-aged stands that include species with moderate to high sunlight demands.

**Habitat** - the ecosystem in which a plant or animal lives and obtains food and water.

**Habitat Type** - A particular association of trees and plants that is commonly associated with, or indicative of, a unique set of site conditions and potential for forest growth. Analysis of the habitat type of a particular stand can help inform management decisions. The concept of habitat types has been developed to assess the true potential of a site regardless of past forest management, this is why it is heavily connected to the assemblage of understory plants.

**Hardwoods** - a general term encompassing broadleaf, deciduous trees.

**High Grading** - to remove all good quality trees from a stand and leave only inferior trees. This practice is not considered sound forestry because it focuses only on maximizing current revenue without consideration of future quality and value.

**Intolerance** - characteristic of certain tree species that does not permit them to survive in the shade. Examples of intolerant species include aspen, white birch, red pine, jack pine, and red oak.

**Landing** - cleared area where logs are processed, piled, and loaded for transport to a sawmill.

**Landscape Management** - Management that considers how different parts of the landscape interact to provide wildlife habitat, clean water, and other outcomes. Landscape management must often occur above the individual property ownership level and therefore is difficult to coordinate.

**Loam** - soil textural class consisting of a mix of clay, silt, and no more than 50% sand.

**Log Rule** - a method for estimating the volume of lumber (in board feet) that may be sawn from a particular tree or log by using its diameter and length. Scribner, Doyle and the International 1/4-inch rule are common log rules used in Michigan. A log that scales a certain volume may yield more or less lumber than the rule estimates due to variations in the log, skill of the sawyer, and even inaccuracies of the rule being used. Log rules were devised in the early days of logging to create a basis on which to measure logs and set prices.

**Lump-Sum Sale** - a timber sale in which an agreed-on price for all standing trees designated for harvest is set before the wood is removed (as opposed to a scaled, mill tally or unit sale).

**Mast** - nuts and seeds such as acorns, beechnuts, and chestnuts that serve as food for wildlife.

**Mid-Tolerant** - tree species that can regenerate under partial forest canopy. Examples of mid-tolerant species include yellow birch, basswood, white pine, and red maple.

**Mature** - the point in a tree's life cycle at which it has reached optimal age, size, quality, vigor, or some combination of these attributes. The definition of maturity is dependent upon tree species, site conditions, and landowner objectives. In an industrially-managed aspen forest, 40-year-old trees may be considered mature, while on a parcel being managed for production of coarse woody debris for wildlife habitat, 40 years old is not even halfway to the target age.

**Merchantable** - tree that meets size or quality specifications to be sold for a particular product.

**Muck** - soil texture consisting of poorly-decomposed organic matter that is typically saturated with water for all or most of the year. Muck forms in areas where the biological processes of decomposition are very slow due to low oxygen and highly acidic conditions.

**Northern Hardwoods** – forest type consisting primarily of sugar maple or beech with lesser amounts of red maple, basswood, yellow birch, white ash, red oak, and other species.

**Overmature** - trees that have declined in growth rate because of old age and loss of vigor.

**Overstocked** - trees are so closely spaced that they are not growing at their full potential due to competition for resources.

**Poletimber** - trees having a DBH ranging from 5 to 11 inches.

**Prescribed Fire** - an intentional and controlled fire used as a management tool used to reduce hazardous fuels or unwanted understory plants (invasive, undesirable species, etc.).

**Processor** - A timber harvesting machine that may have steel tracks or rubber tires and that is capable of cutting down trees, delimbing them, and cutting them into pieces of a given length to be sold.

**Productive Forest** - forest capable of producing 20 cubic feet of wood per acre per year.

**Pulpwood** - wood suitable for use in paper manufacturing.

**Regeneration** - the process by which a forest is reseeded and renewed, or the size class of a forest consisting of trees having a DBH of less than 5 inches.

**Riparian Forest Buffers** - strips of land along stream banks where trees, shrubs and other vegetation are planted and managed to capture erosion from agricultural fields. Also known as **Riparian Management Zone (RMZ)** or **Streamside Management Zone (SMZ).**

**Salvage Harvest** - the removal of dead, damaged, or diseased trees to recover value. In the event of a fire or other natural disaster, or severe insect or disease outbreak, salvaging should occur as soon as possible to minimize losses to staining and decay. Oftentimes a significant portion of volume is lost in a fire or other event that warrants a salvage harvest.

**Sapling** - a tree at least 4 1/2 feet tall and between 1 inch and 4 inches in DBH.

**Sawlog** - log large enough to be sawn into lumber, usually larger than 10 inches in diameter on the small end and at least 8 feet long.

**Sawtimber Stand** - a stand of trees having an average DBH greater than 11 inches.

**Scaled Sale** or **Unit Sale** - a timber sale in which the buyer makes regular payments based on mill tally and receipts.

**Scarification** - The act of physically disturbing the surface of the soil to encourage regeneration of species with light seeds that require contact with mineral soil to germinate and grow. Jack pine, white birch, and red pine benefit from scarification.

**Sealed-Bid Sale** - a timber sale in which buyers submit secret bids for a predetermined harvest area and volume of timber. Sealed-Bid Sales should always have a clear deadline and bid opening time. Bids submitted after the deadline should be rejected to be fair to all bidders.

**Seed Tree Harvest** - harvest that retains only a few trees per acre (generally less than 20 per acre depending on species and landowner objectives). Those trees retained should be healthy, vigorous, and capable of producing seed to regenerate the stand. The objective of a seed tree harvest is to regenerate an even-aged stand of trees with high sunlight demands. In some cases, the seed trees that are retained may never be harvested.

**Selection Harvest** - harvesting single trees or groups at regular intervals to maintain uneven-aged forest. Selection harvesting allows land managers a great deal of control over site conditions to

regenerate shade tolerant or mid-tolerant species. In many selection harvests, each tree to be harvested is marked with paint.

**Shelterwood Harvest** - a two-staged harvest method intended to regenerate species with moderate to low shade tolerance. The first harvest in a shelterwood system is known as a prep cut; typically, this harvest brings canopy cover down to approximately 50 percent. When regeneration reaches adequate density and size, the overstory is removed to give the regeneration full sunlight to develop into a new stand. In Michigan, the shelterwood harvest is most commonly used to regenerate red oak, but may have applications for other species as well.

**Silvopasture** - planted trees and improved forages to provide suitable pasture for grazing livestock.

**Silviculture** - the practice of controlling forest composition, structure, and growth to maintain and enhance the forest's utility for a given purpose. Silviculture must consider a range of factors including management goals and objectives, site conditions, species characteristics, and a bit of guesswork to account for unforeseeable events.

**Site Index** - measure of quality of a site based on the height of a dominant tree species at a given age. In Michigan most site indices are based on the average tree height at age 50.

**Site Preparation** - treatment of an area prior to reestablishment of a forest stand to control vegetative competition or expose a suitable seed bed for the desired species. Site preparation may consist of herbicide application, scarification, or manual cutting of competing vegetation with a chainsaw or other hand tools.

**Skidder** - a rubber-tired machine with a cable winch or grapple to drag logs out of the forest. Skidders are usually used only in whole-tree harvest operations and can have very high impacts on some sites. In certain forest types, especially white birch, jack pine, and red pine, using skidders can help to create a seed bed for regeneration. Skidders may also be modified to use for other treatments including pesticide application, firefighting, and scarification.

**Slash** - branches and other woody material left on a site after logging.

**Slasher** - A logging machine that typically operates at the log landing. Skidders bring trees to the landing and the slasher cuts them into merchantable segments based on quality and product specifications. A slasher typically consists of a grapple boom and a large rotating sawblade.

**Snag** - a dead tree that is still standing and that may provide food and cover for a variety of wildlife species.

**Softwood** - any gymnosperm tree including pines, hemlocks, larches, spruces, firs, and junipers.

**Species of Special Concern** - not threatened or endangered yet, but has low or declining populations.

**Species Removal Harvest** - A harvest in which all trees of a given species are designated for harvest. Typical species designated for harvest include aspen, spruce, and fir in a hardwood stand.

**Stand** - a group of forest trees of sufficiently uniform species composition, age, and condition to be considered a homogeneous unit for management purposes. An individual stand is typically geographically contiguous, but may consist of multiple units, or polygons, on a parcel of land.

**Stand Density** - the quantity of trees per unit area, evaluated in basal area, crown cover, or stocking.

Stocking - the number and density of trees in a forest stand. Classified as poorly-stocked, overstocked, or well-stocked.

**Stumpage Price** - the price paid for standing forest trees and paid prior to harvest.

**Succession** - the replacement of one plant community by another over time in the absence of disturbance.

**Sustainable** - a practice that, based on current understanding of a natural system, may be repeated over and over at a particular interval without damaging the ability of a site to continue to meet the desired outcomes. What is considered sustainable on a particular site may change with time due to changes in landowner objectives, environmental conditions, or economic values. In this regard, sustainability may be thought of as a three-legged stool with the legs represented by economic outcomes, social values, and ecological concerns. If one of the three legs is compromised, the stool will not stand.

**Sustained Yield** - concept in forestry that considers the productive capacity of a site or stand, and losses due to natural mortality. In an economically and ecologically sustainable forest management system, harvest volume will not exceed total growth minus losses to mortality. **Maximum Sustained Yield** is a condition in which removals and mortality are approximately equal to growth.

**Thinning** - partial cut in an immature, overstocked stand of trees to increase the stand's value and growth. Thinning is typically implemented in even-aged stands.

**Threatened Species** - a species whose population is so small that it may become endangered.

**Tolerance** - the capacity of a tree species to grow in shade

**Understocked** - trees so widely spaced, that even with full growth, crown closure will not occur. Trees growing in understocked conditions often develop large branches which is undesirable from a timber production standpoint. From an economic standpoint, an understocked stand is not making full use of the site, and therefore is not growing to its full potential.

**Understory** - the level of forest vegetation beneath the canopy.

**Uneven-Aged Stand** - three or more age classes of trees represented in a single stand.

**Veneer Log** - a high-quality log of a desirable species suitable for conversion to veneer. Specifications for veneer logs may differ from those for standard sawlogs, and in some cases, veneer logs may be of a shorter length or smaller diameter than what is standard for a conventional sawlog.

**Well-Stocked** - stand where growing space is effectively occupied but there is still room for growth.

**Whole-Tree Logging** - Logging system that typically consists of a buncher, skidder, and slasher. Chainsaw operators may also be involved in various stages of this system depending on the quality and species of timber being cut.

**Windbreaks** - rows of trees to provide shelter for crops, animals or farm buildings.

# APPENDIX

- Green Timber Consulting Foresters Timber Type-Size-Density Guide
- Forest Health/Invasive Species Information
- MNFI Species Abstracts for Threatened and Endangered
- NRCS Soils Information
- Relevant NRCS job sheets

# GTCF Timber Type Guide

## Timber Types

A – Aspen
B – Birch
M – Northern Hardwoods
D – Central Hardwoods
E – Lowland Hardwoods
K – Oak
H – Hemlock
F – Spruce / Fir
C – Cedar
Q – Lowland Conifer
T – Bog Conifer
P – Natural Mixed Pine
W – Natural White Pine
Wp – Planted White Pine
R – Natural Red Pine
Rp – Planted Red Pine
J – Natural Jack Pine
Jp – Planted Jack Pine
S – Natural White Spruce
Sp – Planted White or Black Spruce
L – Planted Larch
O – Open
XL – Lowland Brush
XU – Upland Brush
XW – Water
XR – Road

1. Capital letter represents dominant timber type.
2. Lower case letter represents co-dominant timber type.
3. First number represents size / density of all merchantable stocking.
4. Second number describes the significance of co-dominant type
5. Co-dominant type only to be used if the presence of co-dominant type alters prescribed management.
6. **Size Class** is determined by the class with the highest basal area representation.
7. Stands with less than 20 $ft^2$/acre of merchantable stems should be considered seedling stands (size classes 1, 2 or 3).
8. **Density** is determined by the total basal area of **all** merchantable stems.

## Example

**Mf 6-2 –** Represents an over stocked northern hardwood pole stand (majority of the basal area represent by trees ranging from 5-10 inches at DBH) with a total merchantable basal area greater than 100 $ft^2$/acre. Spruce / Fir well stocked regeneration (stems 1-4 inches at DBH) is the co-dominant type.

## Size / Density

**Seedling Stands: Determined by average DBH of tree stocking (1-4 inch DBH)**
1 – Poorly Stocked Regeneration: 1-4 inch DBH (< 20 $ft^2$/acre) = <5 cords per acre
2 – Moderately Stocked Seedlings: 1-4 inch DBH (< 20 $ft^2$/acre) = <5 cords per acre
3 – Well-Stocked Seedlings: 1-4 inch DBH (< 20 $ft^2$/acre) = <5 cords per acre
**Pole Stands: Determined by average DBH of basal area (5-10 inch DBH)**
4 – Poorly Stocked Poletimber: 5-10 inch DBH (20-59 $ft^2$/acre) = ~5-15 cords per acre
5 – Well-Stocked Poletimber: 5-10 inch DBH (60-99 $ft^2$/acre) = ~15-25 cords per acre
6 – Overstocked Poletimber: 5-10 inch DBH (100+ $ft^2$/acre) = ~25+ cords per acre
**Saw Stands: Determined by average DBH of basal area (11+ inch DBH)**
**& over 50% of basal area contains at least one, 8 ft. grade 3 sawlog**
7 – Poorly Stocked Sawtimber: 11+ inch DBH (20-59 $ft^2$/acre) = ~5-10 cds & ~1-2 MBF / ac
8 – Well-Stocked Sawtimber: 11+ inch DBH (60-99 $ft^2$/acre) = ~10-20 cds & ~2-3 MBF / ac
9 – Overstocked Sawtimber: 11+ inch DBH (100+ $ft^2$/acre) = ~20+ cds & 3+ MBF / ac

Ohio
Emerald
Ash
Borer
Ash Alert Team

The Ohio State University
College of Food, Agricultural,
and Environmental Sciences
Section of Communications and Technology

fact sheet

# What is Emerald Ash Borer?

**Daniel A. Herms**, Associate Professor, Department of Entomology, Ohio Agricultural Research and Development Center, and State Specialist, Ohio State University Extension

Emerald ash borer (*Agrilus planipennis*) is an exotic, invasive wood-boring insect that infests and kills native North American ash trees (*Fraxinus* spp.), both in forests and landscape plantings. Just like chestnut blight and Dutch elm disease before it, EAB is capable of eliminating an entire tree species from forests and cities throughout the land. This makes it one of the most serious environmental threats now facing North American forests.

### History

Emerald ash borer was unknown in North America until June 2002, when it was discovered killing ash trees in southeast Michigan and neighboring Windsor, Ontario. It is native to eastern Russia, northeastern China, Mongolia, Taiwan, Japan and Korea, where it occurs on several species of ash. It was probably imported into Michigan via infested ash crating or pallets at least 15–20 years ago. Since its accidental importation, EAB has infested and killed millions of trees in southeast Michigan and northwest Ohio.

### Economic and Ecological Impact

All major North American ash species have been killed by emerald ash borer, which infests trees ranging in size from saplings to fully mature trees in forests. While most native borers kill only severely weakened trees, emerald ash borer kills healthy trees as well, making it especially devastating.

The economic and ecological impact of emerald ash borer has already been substantial, and it will be staggering as this exotic pest continues to spread. EAB has the potential to virtually eliminate ash from North American forests, with dramatic effects on ecosystem processes as well as plant and animal communities. Ash species, which inhabit a variety of soils and ecosystems, are dominant throughout the forests of eastern North America. A study by the U.S. Forest Service found there to be more than 3.8 billion white ash trees in Ohio, and the Ohio Department of Natural Resources estimates that one in every 10 trees in the state is an ash. The standing ash timber in Ohio is valued at more than $1 billion. Prior to the arrival of EAB, ash was one of the most important nursery and landscape species in the United States. According to the U.S. Department of Agriculture, wholesale value of ash sold by Ohio nurseries exceeded $2 million in 1998, and the Ohio Nursery and Landscape Association reported that the value of the standing crop exceeded $20 million, a market that has been eliminated by this diminutive insect.

The costs of removing dead and dying ash trees have overwhelmed municipal budgets in many of the affected counties, and private property owners must often pay in excess of $1,000 per tree for removal of large shade trees. Alternatively, they are faced with annual costs of insecticide treatments, which can quickly exceed that amount. A quarantine on ash timber has also had a negative economic impact on sawmills, tool handle factories, and firewood dealers in Michigan and Ohio.

**Taxonomy and Biology**

Taxonomically, emerald ash borer is a beetle (Coleoptera) belonging to the family known as metallic wood-borers (Buprestidae). Adults of many species in this family are brightly colored with a metallic glint, making them favorites of collectors. Larvae of these beetles are known as flatheaded borers, deriving their common name from the larval stage, which appears to have a broadly flattened head (it is actually the thorax which mostly conceals the much smaller head). EAB larvae are white with a long (about one inch when mature) narrow, segmented abdomen that is also flattened, which gives them the appearance of small tapeworms. Adults are elongate, half inch-long beetles with striking, metallic green coloration.


Emerald ash borer belongs to the same genus (*Agrilus*) as bronze birch borer (*A. anxius*) and twolined chestnut borer (*A. bilineatus*), which are both native to North America. The biology of emerald ash borer is quite similar to its native relatives. There is one generation each year. Adults emerge from late May through early August, with emergence peaking in early July. As adults emerge, they leave small (one-eighth of an inch), distinctly D-shaped exit holes in the trunk and main branches, which is a sure sign of infestation. Adults feed on foliage for one to two weeks prior to mating. Females produce about 50 to 100 eggs, which are laid individually on the bark surface or within bark cracks and crevices. Observations indicate that higher branches and upper portions of the trunk are colonized initially, making it difficult to detect early infestations.

As larvae hatch, they tunnel into the tree, where they feed through the summer and early fall on the phloem and outer sapwood, excavating S-shaped, serpentine galleries just under the bark. Larvae continue to feed through summer and into the fall, with most completing their development prior to over-wintering in the outer bark or just under the inner bark within the outer inch of sapwood. Pupation occurs in mid- to late-spring. Adults emerge soon thereafter to complete the typical one-year cycle.

**Host Plants and Host Impact**

Ash species known to be infested by emerald ash borer include green (*Fraxinus pennsylvanica*), white (*F. americana*), black (*F. nigra*), and blue ash (*F. quadrangulata*), as well as horticultural cultivars of these species. Only living trees are colonized. EAB will not colonize a dead tree. Native host plants in Asia also include ash species, with *F. mandshurica* (Manchurian ash) and *F. chinensis* being primary hosts.

Adult beetles feed on foliage, resulting in irregular, jagged-edged patches of missing tissue along the leaf margin, the impact of which is negligible. The larva is the damaging stage, girdling the tree as it tunnels under the bark where it feeds primarily on phloem and xylem tissue. This disrupts the flow of carbohydrates and water between the canopy and roots, which results in canopy thinning, branch dieback, and finally tree death, typically within two to four years of initial infestation.

For more information about EAB, check out these additional fact sheets:

http://ashalert.osu.edu/checkoff_factsheet.pdf (signs and symptoms)

http://ashalert.osu.edu/F_59_Rev06.pdf (management options)

http://ashalert.osu.edu/treat_fs_feb06.pdf (treatment)

http://ashalert.osu.edu/insecticide_17may06.pdf (insecticide options)

Revised July 2006

# CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES

## NORTHERN WISCONSIN AND WESTERN UPPER MICHIGAN

Northern forests will be affected by climate change during this century. A team of forest managers and researchers created a report that describes the vulnerability of forests in northern Wisconsin and western Upper Michigan (Janowiak et al. 2014). This report includes information on the current landscape, observed climate trends, and a range of projected future climates. It also describes many potential climate change impacts to forests and summarizes key vulnerabilities for major forest types. This handout is summarized from the full report.

Remember that models are just tools, and they're not perfect. Models don't account for some factors that could be modified by climate change, like droughts, wildfire activity, and invasive species. If a species is rare or confined to a small area, Tree Atlas results may also be less reliable. These factors, and others, could cause a particular species to perform better or worse than a model projects. Human choices will also continue to influence forest distribution, especially for tree species that are projected to increase. Planting programs may assist the movement of future-adapted species, but this will depend on management decisions.

### TREE SPECIES INFORMATION:

This report uses two climate scenarios to "bracket" a range of possible futures. These future climate projections were used with two forest impact models (Tree Atlas and LANDIS) to provide information about how individual tree species may respond to a changing climate. More information on the climate and forest impact models can be found in the full report. This page shows the most common tree species in this local area, organized into general categories of future expectations. Results for all species can be compared side-by-side on page 2.

Despite these limits, models provide useful information about future expectations. It's perhaps best to think of these projections as indicators of possibility and potential change. The model results presented here were combined with information from published reports and local management expertise to draw conclusions about potential risk and change in the region's forests.

| SPECIES | ADDITIONAL CONSIDERATIONS |
|---|---|
| **LIKELY TO DECREASE** | |
| Balsam fir | Requires cold climate and susceptible to drought, fire, and insects |
| Black ash | Emerald ash borer causes mortality |
| Black spruce | Requires cold climate, susceptible to insect pests and drought |
| Northern white-cedar | Requires cold climate and susceptible to fire and herbivory |
| Paper birch | Early-sucessional colonizer, but susceptible to insects and drought |
| Quaking aspen | Early-sucessional colonizer, but susceptible to heat and drought |
| White spruce | Requires cold climate, susceptible to insect pests |
| Yellow birch | Good disperser, but susceptible to fire, insects, and disease |
| **MAY DECREASE** | |
| Balsam poplar | Early-sucessional colonizer, but susceptible to drought |
| Eastern white pine | Good disperser, but susceptible to drought and insects |
| Jack pine | Tolerates drought and fire, but susceptible to insect pests |
| Red pine | Susceptible to insect pests and diseases, and limited dispersal. |
| Sugar maple | Grows across a variety of sites and tolerates shade |
| Tamarack | Requires cold climate and susceptible to drought, fire, and insects |

| SPECIES | ADDITIONAL CONSIDERATIONS |
|---|---|
| **MIXED MODEL RESULTS** | |
| Bigtooth aspen | Early-sucessional colonizer, but susceptible to drought |
| Eastern hemlock | Hemlock woolly adelgid causes mortality |
| Green ash | Emerald ash borer causes mortality |
| Red maple | Competitive colonizer tolerant of disturbance and diverse sites |
| **NO CHANGE** | |
| Northern red oak | Susceptible to some insect pests and oak wilt |
| **MAY INCREASE** | |
| American basswood | Tolerates shade but susceptible to fire |
| American elm | Affected by Dutch elm disease, grows across a variety of sites |
| American hornbeam | Shade-tolerant, but susceptible to fire and drought |
| Black cherry | Susceptible to insects and fire, tolerates some drought |
| Bur oak | Tolerates drought and fire |
| Ironwood | Grows across a variety of sites and tolerates shade |
| Northern pin oak | Tolerates drought and fire |
| White ash | Emerald ash borer causes mortality |
| White oak | Fire-adapted and grows on a variety of sites |

NIACS
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Get this handout online at: www.forestadaptation.org/Northwoods_treehandouts

## FUTURE PROJECTIONS

Data for the end of the century are summarized for two forest impact models under two climate change scenarios. The Climate Change Tree Atlas (www.fs.fed.us/nrs/atlas) models future suitable habitat, while LANDIS models changes in forest growth over time (future biomass presented in this table).

- ▲ **INCREASE** *Projected increase of >20% by 2100*
- ● **NO CHANGE** *Little change (<20%) projected by 2100*
- ▼ **DECREASE** *Projected decrease of >20% by 2100*
- ★ **NEW HABITAT** *Tree Atlas projects new habitat for species not currently present*

## ADAPTABILITY

Factors not included in the models, such as the ability to respond favorably to disturbance, may make a species more or less able to adapt to future stressors.

- \+ high *Species may perform better than modeled*
- . medium
- – low *Species may perform worse than modeled*

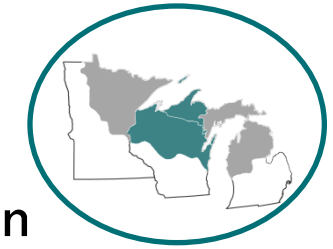
| SPECIES | LOW CLIMATE CHANGE (PCM B1) TREE ATLAS | LOW CLIMATE CHANGE (PCM B1) LANDIS | HIGH CLIMATE CHANGE (GFDL A1FI) TREE ATLAS | HIGH CLIMATE CHANGE (GFDL A1FI) LANDIS | ADAPT |
|---|---|---|---|---|---|
| American basswood | ● | ▲ | ▲ | ▲ | . |
| American beech | ▲ | ▲ | ▲ | ▲ | . |
| American elm | ▲ | | ▲ | | . |
| American hornbeam | ▲ | | ▲ | | . |
| Balsam fir | ▼ | ▼ | ▼ | ▼ | – |
| Balsam poplar | ▼ | ● | ● | ▼ | . |
| Bigtooth aspen | ● | ▲ | ▼ | ● | . |
| Bitternut hickory | ▲ | ▲ | ▲ | ▲ | + |
| Black ash | ▼ | ● | ▼ | ▼ | – |
| Black cherry | ▲ | ● | ▲ | ▲ | – |
| Black hickory | | | ★ | | . |
| Black oak | ▲ | ▲ | ▲ | ▲ | . |
| Black spruce | ▼ | ▼ | ▼ | ▼ | . |
| Black walnut | ▲ | | ▲ | | . |
| Black willow | ▲ | | ▲ | | – |
| Blackgum | | | ★ | | + |
| Blackjack oak | ★ | | ★ | | + |
| Boxelder | ▲ | | ▲ | | + |
| Bur oak | ▲ | ▲ | ▲ | ▲ | + |
| Butternut | ▲ | | ▼ | | – |
| Chestnut oak | | | ★ | | + |
| Chinkapin oak | ★ | | ★ | | . |
| Chokecherry | ● | | ▼ | | . |
| Common persimmon | | | ★ | | + |
| Eastern cottonwood | ▲ | | ▲ | | . |
| Eastern hemlock | ▲ | ▲ | ▼ | ▲ | – |
| Eastern redbud | ▼ | | ▲ | | . |
| Eastern redcedar | ★ | | ★ | | . |
| Eastern white pine | ● | ● | ▼ | ▼ | . |
| Flowering dogwood | ★ | | ★ | | . |
| Gray birch | ★ | | ★ | | . |
| Green ash | ▼ | ▲ | ▲ | ● | . |
| Hackberry | ▲ | | ▲ | | + |
| Honeylocust | ★ | | ★ | | + |
| Ironwood | ● | | ▲ | | + |
| Jack pine | ● | ▼ | ▼ | ▼ | . |
| Mockernut hickory | ★ | | ★ | | + |
| Mountain maple | ▼ | | ▼ | | + |
| Northern catalpa | | | ★ | | . |

| SPECIES | LOW CLIMATE CHANGE (PCM B1) TREE ATLAS | LOW CLIMATE CHANGE (PCM B1) LANDIS | HIGH CLIMATE CHANGE (GFDL A1FI) TREE ATLAS | HIGH CLIMATE CHANGE (GFDL A1FI) LANDIS | ADAPT |
|---|---|---|---|---|---|
| Northern pin oak | ● | ▲ | ● | ▲ | + |
| Northern red oak | ▲ | ● | ● | ● | + |
| Northern white-cedar | ▼ | ● | ▼ | ▼ | . |
| Ohio buckeye | ★ | | ★ | | . |
| Osage-orange | ★ | | ★ | | + |
| Paper birch | ▼ | ▼ | ▼ | ▼ | . |
| Peachleaf willow | | | ▲ | | . |
| Pignut hickory | ★ | | ★ | | . |
| Pin cherry | ● | | ▼ | | . |
| Pin oak | ★ | | ★ | | – |
| Post oak | ★ | | ★ | | + |
| Quaking aspen | ▼ | ▼ | ▼ | ▼ | . |
| Red maple | ● | ▲ | ▼ | ▲ | + |
| Red mulberry | ▲ | | ▲ | | . |
| Red pine | ● | ▼ | ● | ▼ | . |
| River birch | ▲ | | ▲ | | . |
| Rock elm | ▼ | | ● | | – |
| Sassafras | ★ | | ★ | | . |
| Scarlet oak | ★ | | ★ | | . |
| Serviceberry | ★ | | ★ | | . |
| Shagbark hickory | ▲ | | ▲ | | . |
| Shellbark hickory | | | ★ | | . |
| Shingle oak | ★ | | ★ | | . |
| Silver maple | ▲ | | ▲ | | + |
| Slippery elm | ▲ | | ▲ | | . |
| Striped maple | ● | | ● | | . |
| Sugar maple | ● | ● | ▼ | ▼ | + |
| Sugarberry | | | ★ | | . |
| Swamp white oak | ● | | ▲ | | . |
| Sweet birch | ★ | | ★ | | – |
| Sweetgum | | | ★ | | . |
| Sycamore | ★ | | ★ | | . |
| Tamarack | ● | | ▼ | | – |
| White ash | ▲ | ▲ | ▲ | ▲ | – |
| White oak | ▲ | ▲ | ▲ | ▲ | + |
| White spruce | ▼ | ▼ | ▼ | ▼ | . |
| Wild plum | ▼ | | ▲ | | . |
| Yellow birch | ▼ | ● | ▼ | ▼ | . |
| Yellow-poplar | ★ | | ★ | | + |

*SOURCE: Janowiak, M.K., et al. 2014. Forest ecosystem vulnerability assessment and synthesis for northern Wisconsin and western Upper Michigan. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. GTR-NRS-136. 247p.* ***www.nrs.fs.fed.us/pubs/46393***

**www.forestadaptation.org**

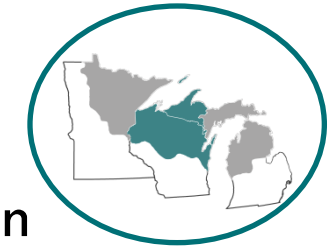
# Climate Change Projections for Individual Tree Species
# PCM B1 Scenario (Less Change)
# Landscape: Northern Wisconsin/Western Upper Michigan



| Generally expected to decrease | Little Change | Generally expected to increase | New Suitable Habitat (Tree Atlas) | Not sure (Disagreement among models) |
|---|---|---|---|---|
| <u>Substantial Declines:</u><br>Black spruce<br>Eastern redbud*<br>Mountain maple*<br><br><u>Smaller declines:</u><br>Balsam fir<br>Paper birch<br>Quaking aspen<br>Rock elm*<br>White spruce<br>Wild plum*<br><br>*Species only modeled by the Tree Atlas (DISTRIB)<br><br>Note: model results only | Bigtooth aspen<br>Chokecherry*<br>Eastern hophornbeam*<br>Eastern white pine<br>Jack pine<br>Northern red oak<br>Northern white-cedar<br>Pin cherry*<br>Red maple<br>Red pine<br>Striped maple*<br>Sugar maple<br>Swamp white oak*<br>Tamarack*<br>Yellow birch | <u>Substantial Increases:</u><br>American beech<br>Bitternut hickory<br>Black ash<br>Black locust*<br>Black oak<br>Black walnut*<br>Black willow*<br>Eastern cottonwood*<br>Hackberry*<br>Red mulberry*<br>River birch+<br>Shagbark hickory*<br>Silver maple*<br>Slippery elm*<br><br><u>Smaller Increases:</u><br>American elm*<br>American hornbeam*<br>Boxelder*<br>Bur oak<br>Butternut*<br>Eastern hemlock<br>White ash<br>White oak | Chinkapin oak*<br>Eastern redcedar*<br>Flowering dogwood*<br>Gray birch*<br>Honeylocust*<br>Mockernut hickory*<br>Ohio buckeye*<br>Osage-orange*<br>Pignut hickory*<br>Pin oak*<br>Post oak*<br>Sassafras*<br>Scarlet oak*<br>Shingle oak*<br>Sweet birch*<br>Sycamore*<br>Yellow-poplar* | <u>(Atlas/LANDIS):</u><br>American basswood (0/++)<br>Balsam poplar (--/0)<br>Black cherry (++/0)<br>Green ash (-/+)<br>Northern pin oak (0/++) |

Source: Janowiak, M.K.; et al. 2014 (In press). **Forest ecosystem vulnerability assessment and synthesis for northern Wisconsin and western Upper Michigan: a report from the Northwoods Climate Change Response Framework**. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. www.forestadaptation.org.

# Climate Change Projections for Individual Tree Species
# GFDL A1FI Scenario (Greater Change)
# Landscape: Northern Wisconsin/Western Upper Michigan



| Generally expected to decrease | Little Change | Generally expected to increase | New Suitable Habitat (Tree Atlas) | Not sure (Disagreement among models) |
|---|---|---|---|---|
| <u>Substantial Declines:</u> | Green ash | <u>Substantial Increases:</u> | Black hickory* | <u>(Atlas/LANDIS):</u> |
| Balsam fir | Northern red oak | American elm* | Blackgum* | Balsam poplar (0/--) |
| Black spruce | Red pine | American hornbeam* | Blackjack oak* | Bigtooth aspen (0/--) |
| Butternut* | | Bitternut hickory | Chestnut oak* | Eastern hemlock (0/--) |
| Chokecherry* | | Black locust* | Chinkapin oak* | Northern pin oak (0/++) |
| Mountain maple* | | Black oak | Common persimmon* | Red maple (-/+) |
| Paper birch | | Black walnut* | Eastern redcedar* | |
| Pin cherry* | | Black willow* | Flowering dogwood* | |
| Quaking aspen | | Boxelder* | Gray birch* | |
| White spruce | | Eastern cottonwood* | Honeylocust* | |
| Yellow birch | | Eastern redbud* | Mockernut hickory* | |
| | | Hackberry* | Northern catalpa* | |
| <u>Smaller declines:</u> | | Red mulberry* | Ohio buckeye* | |
| Black ash | | River birch* | Osage-orange* | |
| Eastern white pine | | Shagbark hickory* | Pignut hickory* | |
| Jack pine | | Silver maple* | Pin oak* | |
| Northern white-cedar | | Slippery elm* | Post oak* | |
| Striped maple* | | White oak | Sassafras* | |
| Sugar maple | | Wild plum* | Scarlet oak* | |
| Tamarack* | | | Shellbark hickory* | |
| | | <u>Smaller Increases:</u> | Shingle oak* | |
| | | American basswood | Sugarberry* | |
| *Species only modeled by the Tree Atlas (DISTRIB) | | American beech | Sweet birch* | |
| | | Black cherry | Sweetgum* | |
| Note: model results only | | Bur oak | Sycamore* | |
| | | Eastern hophornbeam* | Yellow-poplar* | |
| | | Peachleaf willow* | | |
| | | Swamp white oak* | | |
| | | White ash | | |

Source: Janowiak, M.K.; et al. 2014 (In press). **Forest ecosystem vulnerability assessment and synthesis for northern Wisconsin and western Upper Michigan: a report from the Northwoods Climate Change Response Framework**. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. www.forestadaptation.org.

*Michigan Department of Natural Resources*
*Michigan Natural Features Inventory*
*2/2012*

# Glossy buckthorn

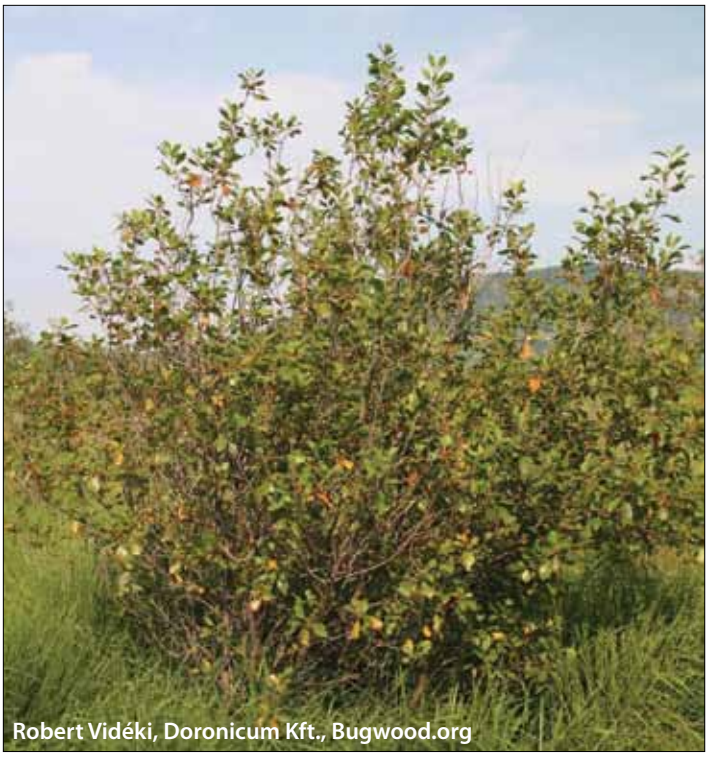
*Frangula alnus*

Glossy buckthorn is native to Eurasia but has been commonly planted in this country as a hedge and for wildlife food and cover. It was widely recommended for conservation plantings in the Midwest until its invasive tendencies became apparent; it creates dense thickets and out-competes native vegetation. Its fruit is widely dispersed by birds and small mammals.

Glossy buckthorn, like many invasive shrubs, leafs out early in the spring and retains its leaves late into fall, increasing its energy production and shading out native plants. It is a particular pest on wet sites and poses a significant threat to Michigan's rich prairie fens, as well as other wetland communities. It is also successful on many upland sites including old fields, roadsides and open woods.

Glossy buckthorn is an alternate host for alfalfa mosaic virus and crown fungus, which causes oat rust disease. It has also been implicated as a possible host for the soybean aphid.

It is widely distributed in some parts of the state, but is just beginning to appear in others. If it is caught early in its initial invasion, it may be eradicated completely.


Robert Vidéki, Doronicum Kft., Bugwood.org

## Identification

**Habit:**
Glossy buckthorn is a small tree or shrub with a spreading crown growing up to 6 m (20 ft) tall. Typically, it has multiple stems when young, and develops into a tree with a trunk that may reach 25 cm (10 in) in diameter at maturity.

**Leaves:**


Suzan Campbell, MNFI

Glossy buckthorn has simple, shiny leaves, with 8 or 9 pairs of veins and untoothed margins. Leaves are alternate although they may appear almost opposite near the branch tips.

**Bark/Stems:**
Glossy buckthorn stems are greenish, often with tiny, soft fine hairs. The bark on older branches is a blotchy grayish-brown with prominent light raised areas. Winter buds lack scales and are rust-colored. The sapwood, just below the outer bark, is yellow and the heartwood is pinkish to orange.


James H. Miller, USDA Forest Service, Bugwood.org

**Flowers:**
Glossy buckthorn flowers are tiny with five greenish-white petals, arranged in clusters at the bases of the leaves. The flowers contain both male and female parts. They bloom from late May through September.


Suzan Campbell, MNFI

**Fruits/Seeds:**


Suzan Campbell, MNFI

Buckthorn has pea-sized fruits with 3-4 seeds. They ripen from green to red to dark purple from July through September, although flowers, unripe and ripe fruit may all be present at the same time. Seeds are viable for several years.

**Habitat**
Glossy buckthorn does best on sunny moist sites, although it can tolerate shade. It is found in a variety of wetlands including fens, as well as pastures, fence rows, roadsides, open woods including aspen stands and woodland edges.

## Similar species

### Common buckthorn


Paul Wray, Iowa State University, Bugwood.org

The related common buckthorn (*Rhamnus cathartica*) has finely toothed leaves and flowers with four petals rather than five. Often, it has a small thorn at the tip of its branches, between the terminal buds, which are covered by scales. It has 3 to 5 leaf veins rather than the 8 or 9 of glossy buckthorn. It is also invasive.

### Alder-leaved buckthorn


Bev Walters, University of Michigan

The native alder-leaved buckthorn (*Rhamnus alnifolia*) is less than 1 m (3 ft) tall and has leaves with tiny rounded teeth and 6 or 7 pairs of veins. Its flowers lack petals but have five sepals, rather than four. It grows in fens and other wetlands.

### Dogwoods

Dogwoods (*Cornus* spp.) have opposite leaves rather than alternate and their fruit and flowers are arranged in clusters on reddish stems. The fruit is blue or white, rather than deep purplish black.


Suzan Campbell, MNFI

## Reproduction/Dispersal

Glossy buckthorn reproduction is primarily by seed. Buckthorn is insect pollinated and cannot self-fertilize. Plants mature quickly and can produce fruit at heights of less than 1 m (~3 ft) tall. They can also sprout from the root crown when cut. Plants that have been top-killed can produce fruit on new shoots within the same season.

Although many glossy buckthorn seedlings appear under their parent plants, germination and seedling survival rates are highest in full sun on exposed soils. Glossy buckthorn often establishes in open fields, in the sunny edge along paths and roads and along the forest edge. Following removal of mature shrubs, abundant seedlings rapidly germinate and must be considered when formulating control strategies.

Birds are a major dispersal agent for glossy buckthorn. Robins, cedar waxwings, rose-breasted grosbeaks and starlings have been observed feeding on their abundant fruits. The unripe fruit contains the chemical emodin, which has a laxative effect, facilitating its spread. Small mammals also disperse glossy buckthorn seed, particularly rodents. Mice eat and store glossy buckthorn fruit and seedlings sprout from their abandoned caches.

Fruit production is greatest on sites in full sun with moist soils. Plants in shadier conditions can persist without fruiting for years until a gap in the canopy appears and they receive enough sunlight to flower and fruit.

## Planning a control program

Resources for invasive species control invariably fall short of the actual need, so it is important to prioritize sites for treatment and plan carefully. Assessing both the scope of the problem and any available resources is a critical first step:

- Map known populations; is the species widely distributed throughout the region? Just beginning to appear?
- Does it occur on high value sites? Important hunting or recreational lands? High quality natural areas? Sites with high cultural value?
- How is it distributed? Is it sparsely scattered in otherwise native vegetation? Does it cover large expanses of low quality habitat?
- Is there the potential to utilize volunteers?

Given this information, develop a strategy for control:

1. Prioritize high value sites where success can be achieved for treatment;
2. Choose appropriate control methods, given site conditions and available resources.
3. Do these control methods require any permits (i.e. herbicide application in wetlands, prescribed burning)?
4. Focus on mature plants, particularly those in full sun with abundant fruit;
5. Eradicate smaller satellite populations;
6. Treat larger core infestations of lower value as resources permit.
7. Monitor to ensure desired results are being achieved; adapt management to improve success.

### Best survey period

Because glossy buckthorn leafs out early and retains its leaves late in fall in much of the state, it is often easiest to locate for mapping or control efforts in early spring or late fall when the leaves of native vegetation are absent or have changed color. It is also easier to distinguish from its neighbors when in fruit.

### Documenting occurrences

In order to track the spread of an invasive species on a landscape scale, it is important to report populations where they occur. The Midwest Invasive Species Information Network (MISIN) has an easy-to-use interactive online mapping system. It accepts reports of invasive species' locations from users who have completed a simple, online training module for the species being reported. It also offers the potential for

batch uploading of occurrence data for any invasive species.

Herbaria also provide a valuable and authoritative record of plant distribution. The University of Michigan Herbarium's database can be searched online for county records of occurrence, for example. When glossy buckthorn is first encountered in a county where it had not been known previously, specimens should be submitted to the Herbarium to document its presence. Check the "Online Resources" section for links to both of these resources.

# Control

A primary goal in controlling this species is to prevent seed production and dispersal. Glossy buckthorn is one of the most difficult invasive shrubs to control. A variety of techniques including both mechanical and chemical controls may be most effective and should be tailored to the specific conditions on the site. It is critical to monitor the site to ensure that cut stumps and treated shrubs do not resprout and that the seedbank is exhausted. Removal of a dense glossy buckthorn thicket "overstory" results in dense seedling response. Where abundant seed sources are present nearby, monitoring may be required indefinitely.

## Mechanical control

In the very earliest stages of invasion, when only scattered seedlings and young plants are present, mechanical controls such as pulling and digging may be adequate to control or eradicate glossy buckthorn. Mechanical control methods are particularly useful where volunteers are available. These methods are impractical in larger, established infestations, with mature shrubs, but may effectively supplement the use of herbicide.

### Pulling

In loose, sandy soils, glossy buckthorn seedlings can be hand-pulled easily, particularly when the soil is moist and the population is small. Pull steadily and slowly to minimize soil disturbance and tamp down the soil afterwards. In heavier soils, however, roots are so tenacious that the bark strips off the seedling when pulled. Tools such as the Weed Wrench® or Root Talon® provide additional leverage, facilitating the removal of somewhat larger plants.

### Cutting/Mowing

Cutting or mowing mature glossy buckthorn shrubs stimulates resprouting unless the cut surfaces are treated with herbicide. Mowing may be helpful in maintaining open areas by preventing the establishment of seedlings.

### Girdling

For mature, single-stemmed buckthorn specimens, girdling may be easier than removing the entire tree. Girdling entails the removal of a strip of bark and cambium around the trunk. The cambium, a thin layer just inside the bark, transports water and nutrients between the plant's roots and its leaves. When it is cut, the tree slowly begins to die.

Use an axe or saw to make two parallel horizontal cuts around the trunk several inches apart, cutting through the bark and cambium. Then, knock off the bark between the cuts. The tree should be checked periodically for two years to cut off any resprouts and to ensure that the bark does not heal over. Girdling is more effective when used in conjunction with herbicide.

### Flooding

On wetland sites where water levels have been lowered artificially, restoring the hydrology may kill or set back glossy buckthorn. An extended period of flooding during the growing season is required. The duration and timing of flooding is as important as water depth. This is perhaps most appropriate where restoring hydrology is part of a larger management program and should be used in conjunction with other control methods as needed. It is important not to raise water levels higher than they were historically, to avoid harming sensitive native vegetation.

## Chemical control

In most cases, effective control of glossy buckthorn requires the use of herbicide. Factors that should be considered when selecting an herbicide for use on a particular site include proximity to water or wetlands, presence or absence of desirable native vegetation, potential for erosion and the effectiveness of the herbicide under consideration on glossy buckthorn. Because glossy buckthorn remains green much later than many native species, fall treatment may minimize damage to desirable broadleaf plants.

### General considerations

Anyone applying herbicides as part of their employment must become a certified pesticide applicator. In addition, certification is required for the use of some herbicides under any circumstances. The certification process is administered by the Michigan Department of Agriculture and Rural Development and a link to their website is included in the "Online Resources" section.

A permit from the Michigan Department of Environmental Quality is usually required to apply herbicide where standing water is present—in wetlands, along streams, rivers or lakes, or over open water. A permit is also required for herbicide use below the ordinary high water mark along the Great Lakes or Lake St. Clair shoreline, whether or not standing water is present. A link to their website is included in the Online Resources section.

A number of adjuvants or additives may be used with herbicides to improve their performance including mixing agent, surfactants, penetrating oils and dyes . Some are included in premixed products while others must be added. Adjuvants

do not work with all products; consult the product label to determine which adjuvants may be used with a specific herbicide formulation.

Dyes are useful in keeping track of which plants have been treated and making spills on clothing or equipment apparent. Some premixed herbicide include them or they can be added to others. Clothing dyes such as Rit® can be added to water soluble herbicides, while other products require oil-based dyes. Consult the product label for specific instructions.

Crop Data Management Systems, Inc. (CDMS) maintains a database of agro-chemicals that includes herbicide labels for specific products. Herbicide labels contain information on application methods and rates, specific weather conditions, equipment types, nozzles etc. to provide the desired coverage and minimize the potential for volatilization or drift. A link to the CDMS website is included in the "Online Resources" section.

Read the entire pesticide label before use. Follow all directions on the label.

**Herbicide specifics**

Triclopyr provides effective control of broad-leaved plants but does not kill grasses or some conifers. It is available in both amine (e.g., Garlon 3A®) and ester (e.g., Garlon 4 Ultra®) formulations. The amine formulation can be safely used in wetlands.

Triclopyr can be used as a foliar spray once glossy buckthorn is fully leafed out in spring until just before it changes color in fall. The ester formulation should be used with a vegetable oil based multi-purpose adjuvant (e.g. SprayTech® Oil) and the amine formulation should be used with a wetland-approved non-ionic surfactant (e.g., Cygnet Plus®).

Triclopyr can also be used in conjunction with cut surface treatments; cut-stump, girdling and frilling. Treatments may be applied throughout the year including when snow is present, however control may be reduced in early spring when the sap is beginning to flow or during periods of drought in summer. Ester formulations are particularly effective for root or stem-sprouting species such as glossy buckthorn because the triclopyr persists in the plant until it dies. The ester formulation should be used with a penetrating oil (e.g., AX-IT®), which improves effectiveness and increases the amount of time after cutting in which treatment can occur. Penetrating oil also facilitates absorption in basal bark treatment.

In wetlands or other sensitive areas, the amine formulation may be used for cut-surface treatments but must be painted onto the cut surface immediately. It can also be used for drill and fill techniques.

Triclopyr is particularly effective when used in conjunction with imazapyr (e.g., Arsenal®). Imazapyr acts over an extended period of time and can persist in the soils —an advantage in providing greater control. However, since it is non-selective it can also kill valuable non-target species. Imazapyr is considerably more expensive than triclopyr.

**Foliar application**

Foliar application of herbicide can be useful on sites with extensive glossy buckthorn populations and few desirable natives. Herbicide should be applied after spring sap flow to actively growing plants, although during periods of drought or other stress, it may not be effective. It can be applied to glossy buckthorn foliage with squirt bottles, backpack sprayers or boom-mounted sprayers.

The product label for the specific herbicide being used provides essential information on coverage; how much of the foliage should be treated and how wet it should be. Herbicide labels also contain information on specific weather conditions, application modes, equipment types, nozzles etc. to provide the desired coverage and minimize the potential for volatilization or drift.

The herbicide applicator is responsible for managing drift and damage to non-target vegetation. Wind speeds between 3 and 10 miles per hour are best for foliar herbicide spraying. At higher wind speeds, herbicide may be blown onto adjacent vegetation or water bodies.

At lower wind speeds, temperature inversions can occur, restricting vertical air movement. Under these conditions, small suspended droplets of herbicide can persist in a concentrated cloud and be blown off-target by variable gusts of wind. Ground fog indicates the presence of a temperature inversion, but if no fog is present, smoke movement on the ground can also reveal inversions. Smoke that layers and remains trapped in a cloud at a low level indicates an inversion, while smoke that rises and dissipates indicates good air mixing.

In hot, dry weather, herbicide can evaporate rapidly. Setting equipment to produce large droplets can help compensate for this. In general, follow all directions on the label of the specific herbicide being used, in order to prevent damage to non-target vegetation or water bodies.

**Cut-stump/Girdling/Frilling**

Cut-stump treatment, girdling and frilling may be used in any season except during spring, when sap is flowing upwards.

Cut-stump treatment is useful for species like glossy buckthorn that normally resprout after cutting. After the stems have been cut, they are painted with concentrated herbicide, using a squirt bottle or wicking applicator. Small stems can be cut several inches above the ground so that both the sides and the cut surface may be treated. On large stems, cuts should be made as close to the ground as possible and only the cambium—the thin layer where active growth

occurs, just inside the bark—should be treated. Product labels list what adjuvants may be used to increase effectiveness of the herbicide; penetrating oils only work with ester formulations, for example. Similarly, dyes, which are useful in keeping track of which stems have been treated, work with specific herbicide formulations.

Frilling, or the "hack and squirt" method, is useful for larger trees. Downward cuts are made around the circumference of the trunk and the resulting cavity is immediately treated with herbicide using a squirt bottle or backpack sprayer. Because the cambium is exposed and treated immediately, an amine formulation can be used.

Herbicide can also enhance the effectiveness of girdling, which was described under mechanical controls. Following girdling, the exposed cambium along the cuts is painted with concentrated herbicide.

Treated plants should be monitored for at least a year as they may still resprout. New stems may be treated with a foliar spray, or cut and retreated.

### Basal bark

Basal bark treatment can be used on stems that are less than six inches in diameter at any time except during heavy sap flow in spring. It should not be used when snow or water prevent herbicide from being applied at the ground level or when stems are saturated. It it is most useful during the dormant season. Typically, ester formulations of herbicide are used with penetrating oils.

For stems that are less than six inches in diameter, concentrated herbicide can be applied to a band of bark around glossy buckthorn stems or trunk. In basal bark treatment, concentrated herbicide is applied to a band of bark around buckthorn stems extending up 18 inches from the ground. Basal bark treatment is most effective on younger stems with thin bark.

### Drill and fill/Injection

Drill and fill, and injection techniques are useful on larger trees. They leave the tree in place to break down over time, providing valuable habitat and structure. They can be used any time of year except during spring sap flow.

The drill and fill technique entails drilling holes into the tree at a downward angle and filling them with a measured amount of concentrated herbicide using a squirt bottle. One hole should be drilled for each inch of diameter.

Specialized injection tools are also available to inject herbicide pellets below the bark. They are precise and require little preparation or clean-up. They are also expensive, however and may be unwieldy in dense brush.

Because concentrated herbicide is used it is very easy to exceed the annual per acre amount that is allowed for a given product. Consult the product label for specifics.

## Prescribed burning

In fire-adapted communities, prescribed burning may enhance control of glossy buckthorn over the long term, but should always be considered as part of an integrated management plan for the site as it will stimulate the species over shorter time spans. When prescribed burning is initiated, it should be supplemented with other buckthorn control methods.

### General considerations

A permit is required before implementing a prescribed burn. The Michigan Department of Natural Resources (DNR) is responsible for issuing burn permits in the Upper Peninsula and Northern Lower Peninsula unless a municipality wishes to do so. Municipalities located in the Southern Lower Peninsula issue burn permits under authority of the state law. A link to the DNR local fire contacts web page is included in the "Online Resources" section. In the Southern Lower Peninsula, contact the local Fire Marshall for permits and more information. Some municipalities require insurance coverage before a permit is issued, to cover the cost of damages if the fire should escape.

Before initiating a program of prescribed burning, a written burn plan establishing the criteria necessary for starting, controlling, and extinguishing a burn is required. The burn plan includes details such as specific weather conditions, locations of control lines, ignition pattern, equipment and personnel needed, contingency plans, and important phone numbers. The burn plan is essentially the "prescription" for how to conduct the burn safely while accomplishing the management objectives.

If other invasive species that are stimulated by burning are present on the site, planning should incorporate additional control methods to eradicate them.

### Prescribed burning specifics

Fire alone does not provide effective control of glossy buckthorn as it will only top-kill mature plants. Even small saplings and seedlings seem to survive fire well. Fire is totally useless as a control method unless there is adequate fuel underneath the buckthorn. Fall fires stimulate vigorous resprouting. Early season fires, when root carbohydrate levels are low, do not stimulate as many resprouts.

Prescribed fire also results in lots of seed germinating; glossy buckthorn seeds germinate more readily on bare soils that have been exposed by fire. A plan for follow-up treatment is required as there is rarely enough fuel to kill these densely sprouting seedlings in a regular prescribed burn.

Fire can be useful in fire-adapted communities once mature glossy buckthorn has been removed and the native vegetation that provides fuel recovers. When adequate fuel is present, fire will kill seedlings and help exhaust the seedbank.

A five second treatment with flame from a propane torch around stems that are less than 4.5 cm ( 1.75 in) in diameter will also kill young plants. In fire-adapted communities. If left untreated, common buckthorn can alter fire ecology as fuels do not accumulate beneath it.

## Biological control

Initial efforts to find biological controls for glossy buckthorn were combined with those for common buckthorn. It now appears that these two species are not as closely related as once believed and share few specialized arthropod pests.

A 2008-2009 European effort involved literature review and field surveys. It found one genus-specific leaf hopper, a free living sap sucker (*Zygena suavis*), on glossy buckthorn. Five more arthropod species that were found only on glossy buckthorn were identified from the literature but were not seen in the field.

Researchers noted that "Current indications are that finding species-specific or genus-specific agents for biological control of *F. alnus* will be difficult". Additional field work is needed to identify potential biocontrol agents.

## Disposal of plant parts

When seedlings or young shrubs are pulled, they should be disposed of in a manner that will ensure that their roots will dry out completely. In addition, if fruit is present, it should be burned or bagged and placed in a landfill. Where this is not possible, any resulting seedlings will require monitoring and control.

Although landscape waste cannot generally be disposed of in land fills, Michigan law permits the disposal of invasive species plant parts. See the "Online resources" section below for a link to the relevant legislation.

## Online resources:

**CDMS - herbicide labels:**
*http://www.cdms.net/LabelsMsds/LMDefault.aspx?t=*

**Fire Effects Information System,** *Frangula alnus*
*http://www.fs.fed.us/database/feis/plants/shrub/fraaln/all.html*

**Invasive.org,** glossy buckthorn
*http://www.invasive.org/browse/subinfo.cfm?sub=5649*

**Invasipedia at BugwoodWiki,** *Frangula alnus*
*http://wiki.bugwood.org/Frangula_alnus*

**Invasive Plant Atlas of New England,** Glossy buckthorn
*http://www.eddmaps.org/ipane/ipanespecies/shrubs/Frangula_alnus.htm*

**Midwest Invasive Species Information Network,** Glossy Buckthorn
*http://www.misin.msu.edu/facts/detail.php?id=13*

**The Michigan Department of Agriculture and Rural Development—Pesticide Certification**
*www.michigan.gov/pestexam*

**The Michigan Department of Environmental Quality—Aquatic Nuisance Control**
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*http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3710---,00.html*

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**The Nature Conservancy's Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas**
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**University of Michigan Herbarium - Michigan Flora Online**
*http://michiganflora.net/*

# Quick reference - Glossy buckthorn

This chart has been provided as a convenience, to summarize the pros and cons of each herbicide and to present details on adjuvants, concentrations, etc. that do not fit into the discussion in the preceding sections. Although every attempt has been made to ensure accuracy, the product labels for the listed herbicides are the ultimate authority for their usage. Where there are conflicts, always follow the label directions. Techniques are listed in order of general preference by MDNR Wildlife Division staff but not all are suitable for wetlands or sensitive sites. Site conditions vary—choose a method that is best suited to conditions on the site being treated.

Anyone using herbicides in the course of their employment is required to be a certified pesticide applicator. Treatment in wetlands or over open water requires a permit from the Michigan Department of Environmental Quality.

These chemicals are available in a variety of formulations and concentrations. Concentration is listed below as a percentage of the active ingredient (AI) to facilitate use of different products. Always follow all directions on the product label including mixing instructions, timing, rate, leaf coverage and the use of personal protective equipment.

| | Herbicide | % A.I. | Adjuvant | Timing | Pros | Cons |
|---|---|---|---|---|---|---|
| **Basal Bark** | **Triclopyr ester** (e.g., Garlon 4 Ultra®) | 22-30% | Use a penetrating oil (e.g., AX-IT®), unless it is already included in product, e.g. Michigan blend. | Use any time of year, including winter months<br>EXCEPT during heavy spring sap flow OR when snow or water prevent application at ground level OR when stems are wet. | Relatively selective herbicide and technique.<br>Less labor-intensive than many other techniques if conditions are appropriate. | Use only on stems that are >1/4 inch and <6 inches in diameter.<br>Not approved for use in wetlands. |
| **Foliar Spray** | **Triclopyr ester** (e.g., Garlon 4 Ultra®) | 2-3% | Use a vegetable oil based multi-purpose adjuvant (e.g. SprayTech® Oil). | After spring sap flow, while plant is actively growing but before leaves change color.<br>Fall ideal as many natives go dormant earlier. | Kills buckthorn very effectively.<br>Broad-leaf specific—will not harm sedges and grasses. | Since it is used during the growing season, it is not a suitable technique for high-quality sites with many broad-leaf natives.<br>Not approved for use in wetlands. |
| **Foliar Spray** | **Triclopyr amine** (e.g., Garlon 3A®) | 2-3% | Use a wetland-approved non-ionic surfactant (e.g., Cygnet Plus®). | After spring sap flow, while plant is actively growing but before leaves change color.<br>Fall ideal as many natives go dormant earlier. | Safe for use in wetlands<br>Kills buckthorn very effectively.<br>Broad-leaf specific—will not harm sedges and grasses. | Since it must be used during the growing season, it is not a suitable technique for high-quality sites with many broad-leaf natives. |
| **Cut-stump** | **Triclopyr ester** (e.g., Garlon 4 Ultra®)<br>+<br>Imazapyr (e.g., Arsenal®) | 15-18%<br>+<br>3% | Use a penetrating oil (e.g., AX-IT®). | Use any time EXCEPT during spring sap flow. | Most effective herbicide combination for this technique (in killing buckthorn—as well as many other plants).<br>Can be used on stems >6 inches in diameter. | Imazapyr is highly active in the soil and may kill adjacent plants.<br>Not approved for use in wetlands. |
| **Cut-stump** | **Triclopyr ester** (e.g., Garlon 4 Ultra®) | 31-44% | Use a penetrating oil (e.g., AX-IT®), unless it is already included in product, e.g. Michigan blend. | Use any time EXCEPT during spring sap flow. | Relatively selective herbicide and technique.<br>Can be used on stems >6 inches in diameter. | Not approved for use in wetlands. |
| **Cut-stump** | **Triclopyr amine** (e.g., Garlon 3A®) | 31-44% | | Use any time EXCEPT during spring sap flow. | Safe for use in wetlands.<br>Relatively selective herbicide and technique.<br>Can be used on stems >6 inches in diameter. | Cuts must be treated IMMEDIATELY - will not mix with penetrating oil. |
| **Injection** | **Triclopyr amine** (e.g., Garlon 3A®, Renovate®) | 27% | | Use any time EXCEPT during spring sap flow. | Suitable for very large specimens. Extremely selective herbicide and technique.<br>Safe for use in wetlands. | Labor intensive. (Inject 1 ml into cambium at 3-4 inch intervals around entire trunk). |

*Michigan Department of Natural Resources*
*Michigan Natural Features Inventory*
*2/2012*

# Common buckthorn

*Rhamnus cathartica*

Common buckthorn is native to Eurasia and was introduced to North America in the 1880s as an ornamental plant. Its abundant fruit is dispersed by birds and it spreads rapidly, replacing native vegetation and lowering species diversity. Like many non-native shrubs, common buckthorn leafs out early in spring and retains its leaves late into fall, shading out spring wildflowers and tree seedlings.

There is some evidence that common buckthorn is allelopathic, producing chemicals that inhibit the growth of other species.

Buckthorn alters ecosystem processes in complex ways. Its leaves and fruit are high in nitrogen. Invasive earthworms, which need rich litter, break it down rapidly, destroying beneficial fungi and exposing bare soils in the process. These soils provide ideal conditions for buckthorn germination and seedling growth but many native trees and shrubs need the beneficial fungi and will not reproduce without it.

Common buckthorn is a primary overwintering host for the soybean aphid. It is also an alternate host for alfalfa mosaic virus and crown fungus, which causes oat rust disease.


Chris Evans, River to River CWMA, Bugwood.org

## Identification

**Habit:**
Common buckthorn is a deciduous woody shrub or small tree that ranges from 3 to 7.5 m (10-25 ft) in height. When young, it has multiple stems but with age it becomes a tree with a single trunk that may reach 25 cm (10 in) in diameter.

**Leaves:**
Common buckthorn has simple, dark green leaves, with toothed margins and 3 to 5 pairs of prominent leaf veins, which curve as they approach the leaf tip. The leaves are alternate, but some may appear opposite.


Paul Wray, Iowa State University, Bugwood.org

**Bark/Stems:**


Chris Evans, River to River CWMA, Bugwood.org

Common buckthorn twigs often have thorns at their tips, between the terminal buds. Branches are dotted with light-colored vertical raised marks. The bark is brown to gray and peels with age. The inner bark is orange.

**Flowers:**


Robert Vidéki, Doronicum Kft., Bugwood.org

Common buckthorn has small, green-yellow, four-petaled flowers that are clustered along the stem. Male and female flowers are borne on separate shrubs. The fragrant flowers appear in May and June.

**Fruits/Seeds:**
Common buckthorn has abundant small, round fruits that ripen from green to purplish black. They are only produced on female plants but have high germination rates. Unripe fruits contain emodin, which has a laxative effect.


Suzan Campbell, MNFI

**Habitat:**
In its native range, common buckthorn occupies a surprising range of habitats: dry open forests, alkaline fens, sunny open sites and alvar. In North America, it occurs in disturbed and undisturbed habitats including roadsides, old fields, prairie fens, savannas and a variety of woodlands.

## Similar species

### Glossy buckthorn

The related invasive glossy buckthorn (*Frangula alnus)* has untoothed leaves and flowers with five petals rather than four. It lacks a thorn at the tip of its branches and its terminal buds are not covered by scales. It has 8 or 9 leaf veins rather than the 3 to 5 of common buckthorn.


Suzan Campbell, MNFI

### Alder-leaved buckthorn


Bev Walters, University of Michigan

The native alder-leaved buckthorn (*Rhamnus alnifolia*) is less than 1 m (3 ft) tall and has leaves with tiny rounded teeth and 6 or 7 pairs of veins. Its flowers lack petals but have five sepals, rather than four. It often grows in fens and other wetlands.

### Dogwoods

Dogwoods (*Cornus* spp.) have opposite leaves rather than alternate and their leaf margins are untoothed. The fruit and flowers are arranged in clusters on reddish stems. The fruit is blue or white, rather than deep purplish black.


Suzan Campbell, MNFI

## Reproduction/Dispersal

Reproduction in common buckthorn is by seed, although it can also regenerate from root and stump sprouts. It is usually dioecious, with male and female flowers on separate plants. Female plants are far more numerous than male plants and bear abundant fruit. In ideal conditions, it can produce fruit at four years of age although this varies tremendously depending on light and moisture availability.

Buckthorn fruits are widely dispersed by animals. Also, many fruits fall directly beneath the parent shrubs, resulting in a dense carpet of seedlings. Although the fruit is apparently bitter and persists on the shrub through winter, many species including birds, deer and elk eat and transport fruit.

Seeds are also dispersed by mice, which eat and store them; some may germinate from abandoned caches. Seed will not germinate until the fleshy fruit is eaten or rots away. Seed that has been eaten may germinate without overwintering, but germination rates are higher for seeds that overwinter.

Common buckthorn seed remains viable in the soil from two to six years. The seedbank beneath mature buckthorn may have 500-1,000 seeds per meter in the top few inches of soil. Following removal of mature shrubs, thousands of seedlings rapidly germinate and must be considered when formulating control strategies.

## Planning a control program

Resources for invasive species control invariably fall short of the actual need, so it is important to prioritize sites for treatment and plan carefully. Assessing both the scope of the problem and any available resources is a critical first step:

- Map known populations. Is the species widely distributed throughout the region? Or is it just beginning to appear?
- Does it occur on high value sites? Important hunting or recreational lands? High quality natural areas? Sites with high cultural value?
- How is it distributed? Is it sparsely scattered in otherwise native vegetation? Does it cover large expanses of low quality habitat?
- Is there the potential to utilize volunteers?

Given this information, develop a strategy for control:

1. Prioritize high value sites where success can be achieved for treatment.
2. Choose appropriate control methods, given site conditions and available resources.
3. If using herbicide, be sure to read the product label before finalizing plans. Is there potential for harm to non-target species? Have you made adequate provisions to minimize damage?
4. Do these control methods require any permits (i.e. herbicide application in wetlands, prescribed burning)?
5. Focus on mature female plants, particularly those in full sun with abundant fruit.
6. Eradicate smaller satellite populations.
7. Treat larger core infestations of lower value as resources permit.
8. Monitor to ensure desired results are being achieved; adapt management to improve success.

### Best survey period

Because common buckthorn leafs out early and retains its leaves late in fall in much of the state, it is often easiest to locate for mapping or control efforts in early spring or late fall when the leaves of native vegetation are absent or have changed color. Female plants are also conspicuous in fruit, though male plants are not.

### Documenting occurrences

In order to track the spread of an invasive species on a landscape scale, it is important to report populations where they occur. The Midwest Invasive Species Information Net-

work (MISIN) has an easy-to-use interactive online mapping system. It accepts reports of invasive species' locations from users who have completed a simple, online training module for the species being reported. It also offers the potential for batch uploading of occurrence data for any invasive species.

Herbaria also provide a valuable and authoritative record of plant distribution. The University of Michigan Herbarium's database can be searched online for county records of occurrence, for example. When common buckthorn is first encountered in a county where it had not been known previously, specimens should be submitted to the Herbarium to document its presence. Check the "Online Resources" section for links to both of these resources.

# Control

A primary goal in controlling this species is to prevent seed production and dispersal. A variety of techniques including both mechanical and chemical controls may be most effective and should be tailored to the specific conditions on the site. It is critical to monitor the site to ensure that cut stumps or treated plants do not resprout and the seedbank is exhausted. Where abundant seed sources are present nearby, monitoring may be required indefinitely.

## Mechanical control

In the very earliest stages of invasion, when only seedlings and young plants are present, mechanical controls such as pulling and repeated cutting may be adequate to control or eradicate common buckthorn. Mechanical control methods are particularly useful where volunteers are available. These methods are impractical in larger, established infestations, with mature shrubs, but may effectively supplement the use of herbicide.

### Hand-pulling

Common buckthorn seedlings can be hand-pulled easily, particularly when the soil is moist and the population is small. Pull steadily and slowly to minimize soil disturbance and tamp down the soil afterwards. Tools such as the Weed Wrench® or Root Talon® provide additional leverage, facilitating the removal of somewhat larger plants.

### Cutting/Mowing

Cutting or mowing mature common buckthorn shrubs stimulates resprouting unless the cut surfaces are treated with herbicide. Mowing may be helpful in maintaining open areas by preventing the establishment of seedlings.

## Chemical control

In most cases, effective control of common buckthorn requires the use of herbicide. Factors that should be considered when selecting an herbicide for use on a particular site include proximity to water or wetlands, presence or absence of desirable native vegetation, potential for erosion and the effectiveness of the herbicide under consideration on common buckthorn. Because buckthorn typically remains green much later than many native species, fall treatment may minimize damage to desirable plants.

### General considerations

Anyone applying herbicides as part of their employment must become a certified pesticide applicator. In addition, certification is required for the use of some herbicides under any circumstances. The certification process is administered by the Michigan Department of Agriculture and Rural Development and a link to their website is included in the "Online Resources" section.

A permit from the Michigan Department of Environmental Quality is usually required to apply herbicide where standing water is present—in wetlands, along streams, rivers or lakes, or over open water. A permit is also required for herbicide use below the ordinary high water mark along the Great Lakes or Lake St. Clair shoreline, whether or not standing water is present. A link to their website is included in the "Online Resources" section.

A number of adjuvants or additives may be used with herbicides to improve their performance including mixing agents, surfactants, penetrating oils and dyes . Some are included in premixed products while others must be added. Adjuvants do not work with all products; consult the product label to determine which adjuvants may be used with a specific herbicide formulation.

Dyes are useful in keeping track of which plants have been treated and making spills on clothing or equipment apparent. Some premixed herbicide include them or they can be added to others. Clothing dyes such as Rit® can be added to water soluble herbicides, while other products require oil-based dyes. Consult the product label for specific instructions.

Crop Data Management Systems, Inc. (CDMS) maintains a database of agro-chemicals that includes herbicide labels for specific products. Herbicide labels contain information on application methods and rates, specific weather conditions, equipment types, nozzles etc. to provide the desired coverage and minimize the potential for volatilization or drift. They also contain critical information about the potential for damage to valuable non-target species. A link to the CDMS website is included in the "Online Resources" section.

**Read the entire pesticide label before use. Follow all directions on the label.**

### Herbicide specifics

Triclopyr provides effective control of broad-leaved plants but does not kill grasses or some conifers. It is available in both amine (e.g., Garlon 3A®) and ester (e.g., Garlon 4 Ultra®) formulations. The amine formulation can be safely used in wetlands.

Triclopyr can be used as a foliar spray once buckthorn is fully leafed out in spring until just before it changes color in fall. The ester formulation should be used with a vegetable oil based multi-purpose adjuvant (e.g. SprayTech® Oil) and the amine formulation should be used with a wetland-approved non-ionic surfactant (e.g., Cygnet Plus®).

Triclopyr can also be used in conjunction with cut surface treatments; cut-stump, girdling and frilling. Treatments may be applied throughout the year including when snow is present, however control may be reduced in early spring when the sap is beginning to flow or during periods of drought in summer.

Ester formulations are particularly effective for root or stem-sprouting species such as commmon buckthorn because the triclopyr persists in the plant until it dies. The ester formulation should be used with a penetrating oil (e.g., AX-IT®), which improves effectiveness and increases the amount of time after cutting in which treatment can occur. Penetrating oil also facilitates absorption in basal bark treatment.

In non-target plants, triclopyr residues in the soils can damage non-target species via root uptake. Use caution in high-quality forests.

In wetlands or other sensitive areas, the amine formulation may be used for cut-surface treatments but must be painted onto the cut surface immediately or it will be ineffective. It can also be used for drill and fill techniques.

Triclopyr is particularly effective when used in conjunction with imazapyr (e.g., Stalker®). Imazapyr acts over an extended period of time and can persist in the soils—an advantage in providing greater control. However, since it is non-selective it can also kill valuable non-target species. Imazapyr is considerably more expensive than triclopyr.

**Foliar application**

Foliar application of herbicide can be useful on sites with extensive commmon buckthorn populations and few desirable natives. Herbicide should be applied after heavy spring sap flow to actively growing plants, although during periods of drought or other stress, it may not be effective. It can be applied to buckthorn foliage with squirt bottles, backpack sprayers or boom-mounted sprayers.

The product label for the specific herbicide being used provides essential information on coverage; how much of the foliage should be treated and how wet it should be. Herbicide labels also contain information on specific weather conditions, application modes, equipment types, nozzles etc. to provide the desired coverage and minimize the potential for volatilization or drift.

The herbicide applicator is responsible for managing drift and damage to non-target vegetation. Wind speeds between 3 and 10 miles per hour are best for foliar herbicide spraying. At higher wind speeds, herbicide may be blown onto adjacent vegetation or water bodies.

At lower wind speeds, temperature inversions can occur, restricting vertical air movement. Under these conditions, small suspended droplets of herbicide can persist in a concentrated cloud and be blown off-target by variable gusts of wind. Ground fog indicates the presence of a temperature inversion, but if no fog is present, smoke movement on the ground can also reveal inversions. Smoke that layers and remains trapped in a cloud at a low level indicates an inversion, while smoke that rises and dissipates indicates good air mixing.

In hot, dry weather, herbicide can evaporate rapidly. Setting equipment to produce large droplets can help compensate for this. In general, follow all directions on the label of the specific herbicide being used, in order to prevent damage to non-target vegetation or water bodies.

**Cut-stump**

Cut-stump treatment may be used in any season except during periods of heavy sap flow in spring. Some chemicals are less effective at lower temperatures or when plants are dormant. Refer to the herbicide label for specific details. Product labels list what adjuvants may be used to increase effectiveness of the herbicide; penetrating oils only work with ester formulations, for example. Similarly, dyes, which are useful in keeping track of which stems have been treated, work with specific herbicide formulations.

Cut-stump treatment is useful for species like commmon buckthorn that normally resprout after cutting. After the stems have been cut, they are painted with concentrated herbicide, using a squirt bottle or wicking applicator. Small stems can be cut several inches above the ground so that both the sides and the cut surface may be treated.

On large stems, cuts should be made as close to the ground as possible and only the cambium—the thin layer where active growth occurs, just inside the bark—should be treated.

Treated plants should be monitored for at least a year as they may still resprout. New stems may be treated with a foliar spray, or cut and retreated.

**Basal bark**

Basal bark treatment can be used on stems that are less than six inches in diameter at any time except during heavy sap flow in spring. It should not be used when snow or water prevent herbicide from being applied at the ground level or when stems are saturated. It it is most useful during the dormant season. Typically, ester formulations of herbicide are used with penetrating oils.

In basal bark treatment, concentrated herbicide is applied to a band of bark around common buckthorn stems extending up 18 inches from the ground. Basal bark treatment is most effective on younger stems with thin bark.

**Drill and fill/Injection**

Drill and fill, and injection techniques are useful on larger trees. They leave the tree in place to break down over time, providing valuable habitat and structure at the same time. They can be used any time of year except during spring sap flow.

The drill and fill technique entails drilling holes into the tree at a downward angle and filling them with a measured amount of concentrated herbicide using a squirt bottle. One hole should be drilled for each inch of diameter.

Specialized injection tools are also available to inject herbicide pellets below the bark. They are precise and require little preparation or clean-up. They are also expensive, however and may be unwieldy in dense brush.

Because concentrated herbicide is used it is possible to exceed the annual per acre amount that is allowed for a given product on sites with large commmon buckthorn infestations. To use this technique safely and legally, calculate the maximum volume of herbicide (at the required concentration) that can be used without exceeding the per acre maximum in advance  Consult the product label for specifics.

## Prescribed burning

In fire-adapted communities, prescribed burning may enhance control of common buckthorn over the long term, but should be considered as part of an integrated management plan for the site as it will stimulate the species over shorter time spans.  When prescribed burning is initiated, it should be supplemented with other control methods.

**General considerations**

A permit is required before implementing a prescribed burn. The Michigan Department of Natural Resources (DNR) is responsible for issuing burn permits in the Upper Peninsula and Northern Lower Peninsula unless a municipality wishes to do so. Municipalities located in the Southern Lower Peninsula issue burn permits under authority of the state law. A link to the DNR local fire contacts web page is included in the "Online Resources" section. In the Southern Lower Peninsula, contact the local Fire Marshall for permits and more information. Some municipalities require insurance coverage before a permit is issued, to cover the cost of damages if the fire should escape.

Before initiating a program of prescribed burning, a written burn plan establishing the criteria necessary for starting, controlling, and extinguishing a burn is required. The burn plan includes details such as specific weather conditions, locations of control lines, ignition pattern, equipment and personnel needed, contingency plans, and important phone numbers. The burn plan is essentially the "prescription" for how to conduct the burn safely while accomplishing the management objectives.

If other invasive species that are stimulated by burning are present on the site, planning should incorporate additional control methods to eradicate them.

**Prescribed burning specifics**

Burning alone does not usually provide effective control of common buckthorn as it will only top-kills mature plants and stimulate resprouting.  Common buckthorn seeds also germinate more readily on bare soils that have been exposed by fire.

Prescribed burning can be useful in fire-adapted communities once mature buckthorn has been removed and the native vegetation that provides fuel recovers. When adequate fuel is present, burning will kill seedlings and help exhaust the seedbank. A five second treatment with flame from a propane torch around stems that are less than 4.5 cm ( 1.75 in) in diameter will also kill young plants.

If left untreated, common buckthorn can alter fire ecology in fire-adapted communities as fuels do not accumulate beneath it.

## Biological control

In recent years, investigators from CABI Bioscience Center in Switzerland and Minnesota DNR and the University of Minnesota have surveyed for suitable agents to control buckthorn in both Europe and the United States. Initial efforts to find biological controls for common buckthorn were combined with those for glossy buckthorn.  It now appears that the two species are not as closely related as once believed and share few specialized arthropod pests.  A number of insect species have been prioritized for further investigation and preliminary host specificity studies.

Buckthorn phytoplasma, a disease that affects buckthorn has been noted in Europe. It causes "witches brooms"—clusters of thin twigs that arise from a single point on a stem. Researchers at the University of Minnesota are looking for phytoplasma here in the United States, to see if it has already been introduced.

## Disposal of plant parts

When seedlings or young shrubs are pulled, they should be disposed of in a manner that will ensure that their roots will dry out completely. In addition, if fruit is present, it should be burned or bagged and placed in a landfill. Where this is not possible, any resulting seedlings will require monitoring and control.

Although landscape waste cannot generally be disposed of in land fills, Michigan law permits the disposal of invasive species plant parts. See the "Online resources" section for a link to the relevant legislation.

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Anyone using herbicides in the course of their employment is required to be a certified pesticide applicator. Treatment in wetlands or over open water requires a permit from the Michigan Department of Environmental Quality.

These chemicals are available in a variety of formulations and concentrations. Concentration is listed below as a percentage of the active ingredient (AI) to facilitate use of different products. Always follow all directions on the product label including mixing instructions, timing, rate, leaf coverage and the use of personal protective equipment.

| | Herbicide | % A.I. | Adjuvant | Timing | Pros | Cons |
|---|---|---|---|---|---|---|
| Basal Bark | Triclopyr ester (e.g., Garlon 4 Ultra®) | 22-30% | Use a penetrating oil (e.g., AX-IT®), unless it is already included in product, e.g. Michigan blend. | Use any time of year, including winter months EXCEPT during heavy spring sap flow OR when snow or water prevent application at ground level OR when stems are wet. | Relatively selective herbicide and technique.<br>Less labor-intensive than many other techniques if conditions are appropriate. | Use only on stems that are >1/4 inch and <6 inches in diameter.<br>Not approved for use in wetlands. |
| Foliar Spray | Triclopyr ester (e.g., Garlon 4 Ultra®) | 2-3% | Use a vegetable oil based multi-purpose adjuvant (e.g. SprayTech® Oil). | After spring sap flow, while plant is actively growing but before leaves change color.<br>Fall ideal as many natives go dormant earlier. | Kills buckthorn very effectively.<br>Broad-leaf specific—will not harm sedges and grasses. | Since it must be used during the growing season, it is not a suitable technique for high-quality sites with many broad-leaf natives.<br>Not approved for use in wetlands. |
| Foliar Spray | Triclopyr amine (e.g., Garlon 3A®, Renovate®) | 2-3% | Use a wetland-approved non-ionic surfactant (e.g., Cygnet Plus®). | After spring sap flow, while plant is actively growing but before leaves change color.<br>Fall ideal as many natives go dormant earlier. | Safe for use in wetlands.<br>Kills buckthorn very effectively.<br>Broad-leaf specific—will not harm sedges/grasses. | Since it must be used during the growing season, it is not a suitable technique for high-quality sites with many broad-leaf natives. |
| Cut-stump | Triclopyr ester (e.g., Garlon 4 Ultra®)<br>+<br>Imazapyr (e.g., Stalker®) | 15-18%<br>+<br>3% | Use a penetrating oil (e.g., AX-IT®). | Use any time EXCEPT during spring sap flow. | Most effective herbicide combination for this technique (in killing buckthorn—as well as many other plants).<br>Can be used on stems > 6 inches in diameter. | Imazapyr is highly active in the soil and may kill adjacent plants.<br>Not approved for use in wetlands. |
| Cut-stump | Triclopyr ester (e.g., Garlon 4 Ultra®) | 31-44% | Use a penetrating oil (e.g., AX-IT®), unless it is already included in product, e.g. Michigan blend. | Use any time EXCEPT during spring sap flow. | Relatively selective herbicide and technique.<br>Can be used on stems > 6 inches in diameter. | Not approved for use in wetlands. |
| Cut-stump | Triclopyr amine (e.g., Garlon 3A®, Renovate®) | 31-44% | | Use any time EXCEPT during spring sap flow. | Safe for use in wetlands.<br>Relatively selective herbicide and technique.<br>Can be used on stems > 6 inches in diameter. | Cuts must be treated IMMEDIATELY—will not mix with penetrating oil. |
| Injection | Triclopyr amine (e.g., Garlon 3A®, Renovate®) | 27% | | Use any time EXCEPT during spring sap flow. | Extremely selective herbicide and technique for large specimens.<br>Safe for use in wetlands. | Labor intensive. (Inject 1 ml into cambium at 3-4 inch intervals around entire trunk). |

**Weed** of the Week

# Exotic Bush Honeysuckles

- *Lonicera maackii* (Amur honeysuckle)
- *Lonicera morrowii* (Morrow's honeysuckle)
- *Lonicera tatarica* (Tartarian honeysuckle)

**Figure 1- *Lonicera maackii***
**Amur honeysuckle**

**Figure 2- *Lonicera morrowii***
**Morrow's honeysuckle**

**Figure 3- *Lonicera tatarica***
**Tartarian honeysuckle**

**Native Origin**: Eurasia (Japan, China, Korea, Manchuria, Turkey and southern Russia); introduced to US for use as ornamentals, for wildlife cover and for soil erosion control.

**Description**: Exotic bush honeysuckles are upright, generally deciduous shrubs that range from 6 to 15 feet in height. The 1-2 ½ inch, egg-shaped leaves are opposite along the stem and short-stalked. Older stems are often hollow. Pairs of fragrant, tubular flowers less than an inch long are borne along the stem in the leaf axils. Flower color varies from creamy white to pink or crimson in some varieties of Tartarian honeysuckle. The fruits are red to orange, many-seeded berries. Native bush honeysuckles may be confused with these exotic species and cultivars, so proper identification is necessary. Unlike the exotics, most of our native bush honeysuckles have solid stems. Plants reproduce by birds feed on the persistent fruits and widely disseminating seeds across the landscape. Vegetative sprouting also aids in the persistence of these exotic shrubs.

**Habitat: :** Exotic bush honeysuckles are relatively shade-intolerant and most often occur in forest edge, abandoned field, pasture, roadsides and other open, upland habitats. Woodlands, especially those that have been grazed or otherwise disturbed may also be invaded by exotic bush honeysuckles. Morrow's honeysuckle is capable of invading bogs, fens, lakeshores, sand plains and other uncommon habitat types.

**Distribution:** Amur, Tartarian, and Morrow's honeysuckle generally range from the central Great Plains to southern New England and south to Tennessee, North Carolina, and Georgia as shaded on the map.

**Ecological Impacts**: Exotic bush honeysuckles can rapidly invade and overtake a site, forming a dense shrub layer that crowds and shades out native plant species. They can alter habitats by decreasing light availability, by depleting soil moisture and nutrients, and possibly by releasing toxic chemicals that prevent other plant species from growing in the vicinity. Exotic bush honeysuckles may compete with native bush honeysuckles for pollinators, resulting in reduced seed set for native species. In addition, the fruits of exotic bush honeysuckles, while abundant and rich in carbohydrates, do not offer migrating birds the high-fat, nutrient-rich food sources needed for long flights, that are supplied by native plant species.

**Control and Management:** Control methods should be initiated prior to seed dispersal (late summer to early autumn) to minimize reinvasion of treated habitats.
**Manual**- Hand remove seedlings or small plants for light infestation; repeat yearly
**Chemical**- apply systemic herbicides
**Burning-** prescribed burning may be effective for exotic bush honeysuckles growing in open habitats.

**References**: www.nps.gov/plants/alien/map/loni1.htm, www.nps.gov/plants/alien/fact/loni1.htm, www.hort.uconn.edu/plants

Produced by the USDA Forest Service, Forest Health Staff, Newtown Square, PA.
Invasive Plants website: http://www.na.fs.fed.us/fhp/invasive_plants

Superior Invasive Plant Solutions, LLC
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# TREATMENT METHODS OVERVIEW

**Cut-stump-** The stem of a plant is cut off, close to the ground, then an herbicide concentrate is applied to the stump to kill the roots. Without herbicide, the plant will re-sprout at the stump. This type of treatment is very effective and efficient for taller, larger diameter stems. Herbicide use is low in volume but high in concentration. The risk for off-target drift is nearly non-existent. This method can be used year-round, with the exception of spring sap flow.

**Girdling/Hack and frill-** This is effectively the same as cut stump, but the entire tree is not cut down. Cuts are made into the bark, encircling the stem. Herbicide is applied to these cuts. This would prove beneficial with very large diameter stems that grow in a very thick stand. Herbicide use is low in volume but high in concentration. The risk for off-target drift is nearly non-existent. This method can be used year-round, with the exception of spring sap flow.

**Basal bark-** A solution of herbicide is applied to the entire bottom 1-2’ of a stem. The herbicide is absorbed through the bark, killing the plant. Herbicide use is moderate in volume and moderate in concentration. Single-stem woody vegetation is the ideal target for this method. It is fairly easy to be selective, but the potential for off-target drift does exist. This method can be used year-round, as long as the entire stem is exposed (no snow).

**Foliar spraying-** An herbicide solution is applied to the leaves of the plant, which is absorbed into the stem, killing it the plant. Ideal for smaller and shorter plants (less than 4 feet tall) and heavy monocultures. This method can only be used when plants have leaves, and should be stopped a couple weeks before autumn arrives. Herbicide volume is high and concentration is low. Off target drift is a concern, but can be easily mitigated by operating in appropriate conditions.

# Garlic mustard

*Alliaria petiolata*

Garlic mustard is native to Europe and parts of western Asia. It was likely introduced to North America for medicinal and herbal uses as well as erosion control. It was first recorded in 1868 at Long Island, NY, and there were likely multiple introductions. It has spread to at least 37 states and six Canadian provinces. Eight states list it as a noxious weed. It is one of few non-native invaders in North America that can tolerate shade, and it thrives in the forest understory. It grows in a variety of soil types but does best in moist, well drained soils. It begins its spring growth before natives emerge and forms dense populations by outcompeting native species for sunlight, moisture, nutrients and space. It is allelopathic, and chemicals released from its roots alter mycorrhizal communities that are critical for many native species including economically valuable trees. Unlike many invaders, garlic mustard reproduces only from seed. It has been implicated in local extirpations of toothworts, which are the primary food source for caterpillars of the West Virginia white butterfly. Chemicals in the plant appear to be toxic, as eggs laid on garlic mustard failed to hatch.

## Identification

### Habit:

Garlic mustard is a cool season herbaceous biennial. During its first year it produces low clusters of leaves (basal rosettes) which remain green through winter. The second year, it sends up a flowering stalk and can grow up to 1 m (3 ft) tall.

### Leaves:

First year garlic mustard leaves are basal; they grow from a central point at ground level. They are kidney-shaped and toothed. After the plant sends up a flowering stem in its second year, the leaves alternate on the stem and are triangular, toothed and stalked. The leaves smell of garlic when crushed.

### Stems:

Usually, garlic mustard sends up one flowering stem per rosette, but occasionally there are more.

### Flowers:

Garlic mustard has numerous small, white flowers held in clusters at the tops of stalks or in leaf axils. Like all members of the mustard family, the flowers have four petals. They bloom from late April into early June.


Suzan Campbell, MNFI

### Fruits/Seeds:

Garlic mustard's seeds are small, shiny, dark brownish-black, and they are held in long narrow capsules. A single plant can produce thousands of seeds. The seeds are viable within a few days of flowering and remain viable for many years.

### Habitat:

Garlic mustard is found in upland and floodplain forests, savannas, along trails, roadsides and disturbed areas. It is shade tolerant but is also found in full sun.


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Chris Evans, River to River CWMA, Bugwood.org

**Root**

The slender, white taproot of garlic mustard is distinctive, forming an S- or J-shape near the top, just below the stem.


## Similar Species

Garlic mustard seedlings can be confused with the basal leaves of kidney leaf buttercup (*Ranunculus abortivus*); however, garlic mustard leaves are more evenly round-toothed on their margins. Upon bolting, the upper leaves of garlic mustard are triangular and sharply toothed, whereas those of buttercup are smooth edged and lanceolate or divided.



**Kidney leaf buttercup basal leaves (left); whole plant (right)**

Henbit (*Lamium purpureum*) and creeping Charlie (*Glechoma hederacea*) have similary shaped leaves, but they are typically smaller with opposite leaves and square stems. Henbit leaves are usually more pointed or triangular while creeping Charlie leaves have more broadly rounded, larger teeth. Large creeping Charlie leaves closely mimic garlic mustard—check for the creeping stem. Unlike garlic mustard, neither of these species send up tall flowering stalks and their flowers are purple and irregular.



**Henbit (*Lamium purpurea*)**



**Creeping Charlie (*Glechoma hederacea*)**

Many violet (*Viola spp*.) leaves are similar; however, most are not so regularly kidney-shaped and have acute tips and shallower teeth. Their roots are not white and lack the characteristic S-shape.


**Dog violet**


Occasionally, white avens (*Geum canadense*) can be mistaken for garlic mustard before the leaves are fully mature. However, the basal leaves of avens are typically trifoliate and on long petioles. The white flowers have 5 petals.

Other small, white-flowered woodland herbs are sometimes confused with garlic mustard, including toothwort (*Dentaria spp*.) and sweet cicely (*Osmorhiza spp*.). Toothwort flowers have four petals like garlic mustard, but the leaves are divided, with three leaflets. Sweet cicely flowers have five petals and the leaves are divided with many leaflets.


**Two-leaved toothwort**


**Sweet cicely**

Garlic mustard can be distinguished from all other woodland herbs before fall by the characteristic garlic odor of the leaves when crushed. If in doubt, checking for the white, S-shaped taproot can usually rule out other species.

## Reproduction/Dispersal

Garlic mustard is a biennial herb that reproduces by seed. It emerges early in the spring from a slender, white tap root and produces basal rosettes of rounded kidney-shaped leaves over the summer. The leaves remain green during the winter and bolt rapidly the following spring to produce flowering stems. These reach about 2-4 feet in height and bear alternate, triangular leaves. Flowers are produced from May through June. Garlic mustard can reproduce by both

cross- and self-pollination, but self-pollination is probably more common. Flowers mature into long, slender capsules filled with a row of many, tiny brown to black seeds by mid-summer. They burst when they are mature, and the seeds rain down onto the ground from July to October, leaving the empty, light brown capsules. The plant dies by late fall.

The seeds get buried where they fall or are dispersed by animals, humans, vehicles, equipment and possibly wind moving through the population. Garlic mustard colonizes floodplain forests as well as upland forests, and seeds can also be dispersed through water flow. They can be distributed upstream as well as downstream by seeds becoming lodged on animals, vehicles or watercraft that travel in many directions. Seed production is very high, and seeds can remain viable in the seedbank for many years.

Garlic mustard does not reproduce by rhizome fragments, but if the root crowns are left in the ground during hand pulling, they may grow new stalks and produce flowers and seed. *If flowering plants are pulled, they can often still produce seed and must be disposed of properly.*

## Best survey period

Detecting garlic mustard is easiest in early spring and late fall because they green-up earlier and senesce later than most native plants. After native species have emerged, it is easiest to detect garlic mustard when in flower during May and June. The distinctive knee-high clusters of leafy, flowering stalks topped with small white flowers stand out. It can be distinguished later in the season by the long, slender capsules; however, these are more difficult to see than flowers.

## Planning a control program

Resources for invasive species control invariably fall short of the actual need, so it is important to prioritize sites for treatment and plan carefully. Assessing the scope of the problem is a critical first step:

- Map known populations.
- Identify leading edges and outliers.
- Is the species widely dispersed throughout the region or is it just beginning to appear?
- How is the species behaving in your area? Is it spreading rapidly?
- Identify potential dispersal pathways and monitor them; is the population along a pathway or stream?
- Does it lie in the path of road-mowing crews that might spread it further? Are there construction sites in the area where it might be introduced in fill dirt?
- Does it occur in high-quality habitat or on important recreational, hunting or fishing lands?

Given this information, develop a strategy for control:

1. Prioritize high-value sites where treatment success can be achieved.
2. Prevent further spread by monitoring leading edges and outliers; focus on second year plants before they go to seed.
3. Choose appropriate control methods given site conditions and available resources.
4. Determine whether any permits are required (e.g., herbicide application in wetlands, prescribed burning).
5. Eradicate smaller, satellite populations.
6. Treat larger, core infestations.
7. Monitor to ensure desired results are being achieved; adapt management to improve success.

## Documenting occurrences

In order to track the spread of an invasive species on a landscape scale, it is important to report populations where they occur. The Midwest Invasive Species information Network (MISIN) has an easy-to-use interactive online mapping system. MISIN I-phone and android phone apps are also available. Links to MISIN and its phone apps are provided in the "Online Resources" section. Herbaria also provide a valuable and authoritative record of plant distribution. The University of Michigan Herbarium's database can be searched online for county records of occurrence, for example. When garlic mustard is first encountered in a county where it has not been documented previously, specimens should be submitted to the Herbarium to document its presence. Check the "Online Resources" section for links to both of these resources.

## Control

Garlic mustard control has been occurring for decades with differing levels of success, primarily tied to the amount of resources available to do the work and the ability to maintain treatment over many years. The primary goals are to prevent second-year plants from producing seed, prevent new seeds from arriving from nearby populations and deplete the seed bank.

Using a variety of techniques including mechanical and chemical control is usually more efficient and effective, and should be tailored to the specific conditions of the site. It is critical to monitor treatment sites for many

years, perhaps indefinitely in some situations, to ensure depletion of the existing seed bank and prevention of seed bank replenished from nearby populations.

Some studies show that initiating garlic mustard control without the ability to maintain the effort over time may do more harm than good. Disturbance from short term control efforts may directly harm native species and facilitate germination of garlic mustard seeds that will compete with native species. Most studies show short-term control efforts do not result in long-term control. Do not get fooled by years in which garlic mustard appears to be in low abundance. As a biennial, it only flowers during the second year of its life cycle and is a good seed banker. More plants are likely to emerge in the following year. Vigilant monitoring is required.

### Hand pulling

Hand pulling over repeated years can be an effective means of control, particularly for small populations. It has also been employed for larger populations with remarkable success, when there are adequate resources for long term control and maintenance.

Hand pulling is typically done in spring and early summer and should target second year plants before they go to seed. Second year plants are easier to pull than first year rosettes and are more important because they are the seed producers. Pulling seedlings usually is not cost-effective except for very small infestations because many seedlings fail to survive.

Plants should be pulled only if the entire root can be removed. Roots remaining in the ground can re-sprout and produce flowers and seed. *Plants may also flower and produce seed after they have been pulled.* They should be bagged and taken to a landfill or dried and then burned or buried deep in the ground.

If second year plants are pulled too close to seed maturation, it will facilitate seed dispersal. Soil disturbance by hand-pulling also stimulates seed germination. Deliberate stimulation in this way, may expedite depletion of the seed bank thereby speeding up long-term control. However, this will only be effective if follow-up management of new sprouts is undertaken before new seeds are produced. Follow-up treatment will be required until the seed bank is exhausted.

A recent study supports the hypothesis that second year garlic mustard plants are important competitors with juvenile garlic mustard plants by shading them and taking up space and nutrients. Extensive management of adult garlic mustard early in the season may increase survival of juveniles that might otherwise be out-competed by second year plants. They will then have to be managed the following year. Some practitioners recommend hand pulling adult plants later in the season to take advantage of this natural control. Further study is needed to ascertain whether shifting pulling efforts to later in the season provides a significant advantage.

### Root slicing

A sharp spade can be used to slice the taproot completely, approximately 1-2” below the surface. However, this will be even more labor intensive than hand pulling as the roots are small and difficult to target. This method can sometimes provide an alternative where plants cannot be easily pulled. It is important to slice the root below the crowns and remove the sliced plants with the root crowns and properly dispose of them.

After slicing roots, monitoring for and treating new sprouts is critical. It is difficult to get all plants during the initial treatment, and even tiny, overlooked plants with only a few flowers will produce new seeds.

### Clipping

For small populations, the flowering tips can be clipped, bagged and removed. However, this is also more labor intensive than hand pulling and must be conducted multiple times during the growing season to capture all the flowers before seed production. Monitoring and clipping additional flowers as they emerge is critical.

### Mowing

Mowing is not usually suitable for garlic mustard infestations, because it will harm associated native species and increase risk of spreading seeds.

### Chemical control

Chemical controls are typically used for large garlic mustard infestations where hand pulling alone is impractical. It is often employed in conjunction with hand pulling or spot treatment with chemicals or hand-held propane torches.

#### General considerations

Anyone applying herbicides as part of their employment must become a certified pesticide applicator. In addition, certification is required for the use of some herbicides under any circumstances. The exam is administered by the Michigan Department of Agriculture and Rural Development and a link to their website is included in the “Online Resources” section.

A permit from the Michigan Department of Environmental Quality is usually required to apply herbicide where standing water is present—in wetlands, along streams, rivers or lakes, or over open water. A permit is also required for herbicide use below the ordinary high water mark along the Great Lakes or Lake St. Clair shoreline, whether or not standing water is present. A link to their website is included in the "Online Resources" section.

A number of adjuvants or additives may be used with herbicides to improve their performance including mixing agents, surfactants, penetrating oils and dyes. Some are included in premixed products while others must be added. Adjuvants do not work with all products; consult the product label to determine which adjuvants may be used with a specific herbicide formulation.

Dyes are useful in keeping track of which plants have been treated, as well as detecting spills on clothing or equipment. Some premixed herbicides include dyes. Clothing dyes such as Rit® can be added to water soluble herbicides, while other products require oil-based dyes. Consult the product label for specific instructions.

Crop Data Management Systems, Inc. (CDMS) maintains a database of agro-chemicals that includes herbicide labels for specific products. Herbicide labels contain information on application methods and rates, specific weather conditions, equipment types, nozzles etc., to provide the desired coverage and minimize the potential for volatilization or drift. They also contain critical information about the potential for damage to valuable non-target species. A link to the CDMS website is included in the "Online Resources" section.

*Read the entire pesticide label before use. Follow all directions on the label.*

**Herbicide specifics**

**Glyphosate** (e.g., Roundup®, Rodeo®, Accord®) can provide effective control of garlic mustard. It should be applied as a foliar spray in the spring to rosettes and bolting plants, well before seeds ripen. It can also be applied to first year rosettes in the fall. Fall treatment will not control seedlings that emerge in the spring and dry conditions may inhibit translocation of herbicide to roots. Fallen leaves can also limit effectiveness. Non-target impacts will be minimized if applications are made while native species are still dormant or after they have senesced.

Glyphosate should be used with a vegetable oil-based, multi-purpose adjuvant (e.g. SprayTech® Oil) on upland sites or a wetland-approved, non-ionic surfactant (e.g., Cygnet Plus®) in wetlands. Glyphosate is not selective and will kill desirable non-target species through over-spray and drift, in some cases leading to increased erosion on site. Glyphosate works best at temperatures above 50 degrees.

**Triclopyr** provides effective control of broad-leaved plants including garlic mustard but does not kill grasses or some conifers, making it particularly useful in grasslands, pastures and old fields. It is available in both amine (e.g., Garlon 3A®) and ester (e.g., Garlon 4 Ultra®) formulations. The amine formulation can be safely used in wetlands.

Triclopyr can be used as a foliar spray once per season. The ester formulation should be used with a vegetable oil-based, multi-purpose adjuvant (e.g. Spray- Tech® Oil), and the amine formulation should be used with a wetland-approved non-ionic surfactant (e.g., Cygnet Plus®).

Do not apply herbicides during a drought, as plants will not translocate chemicals effectively.

**Foliar application**

The product label for the specific herbicide being used provides essential information on coverage - how much of the foliage should be treated and how wet it should be. Herbicide labels also contain information on specific weather conditions, application modes, equipment types, nozzles, etc., to provide the desired coverage and minimize the potential for volatilization or drift.

The herbicide applicator is responsible for managing drift and damage to non-target vegetation. Wind speeds between 3 and 10 miles per hour are best for foliar herbicide spraying. At higher wind speeds, herbicide may be blown onto adjacent vegetation or water bodies.

At lower wind speeds, temperature inversions can occur, restricting vertical air movement. Under these conditions, small, suspended droplets of herbicide can persist in a concentrated cloud and be blown off-target by variable gusts of wind. Ground fog indicates the presence of a temperature inversion, but if no fog is present, smoke movement on the ground can also reveal inversions. Smoke that layers and remains trapped in a cloud at a low level indicates an inversion, while smoke that rises and dissipates indicates good air mixing.

In hot, dry weather, herbicide can evaporate rapidly. Setting equipment to produce large droplets can help compensate for this. If wind and temperature conditions allow, use a finer spray for larger patches. In contrast, spot treatment should occur with a confined spray pattern in order to minimize impacts to adjacent native plants. In general, follow all directions on the label of the specific herbicide being used in order to prevent damage to non-target vegetation or water bodies.

## Prescribed Fire

### General considerations

Permits are usually required before a prescribed fire. The Michigan Department of Natural Resources (DNR) is responsible for issuing burn permits in the Upper Peninsula and Northern Lower Peninsula unless a municipality wishes to do so. Municipalities located in the Southern Lower Peninsula issue burn permits under authority of the state law. A link to the DNR local fire contacts web page is included in the "Online Resources" section. In the Southern Lower Peninsula, contact the local fire marshal for permits and more information. In many situations, insurance is required before a permit is issued to cover the cost of damages if the fire should escape.

Before initiating a program of prescribed fire, a written burn plan establishing the criteria necessary for starting, controlling, and extinguishing a burn is required. The burn plan includes details such as specific weather conditions, locations of fire control lines, ignition pattern, equipment and personnel needed, contingency plans and important phone numbers. The burn plan is essentially the prescription for how to conduct the burn safely while accomplishing the management objectives.

### Fire specifics

Spring burning of garlic mustard can be useful in fire-adapted communities, but prescribed burning alone does not provide effective control of garlic mustard. Fire will typically control seedlings; however, its impact to rosettes and second year plants is variable, depending upon fire intensity and specific burn timing. If fire intensity is not high enough, seedling management will be necessary until the seed bank is exhausted.

Fire also stimulates seed germination, ultimately increasing garlic mustard competition with desirable native species. However, deliberate planning to manage seedlings intensively after a burn can be an effective means of more rapidly depleting the seed bank.

Seedlings can be managed by hand-pulling, spot treatment with herbicide or burning with a hand-held torch.

Prescribed fire is best conducted in spring after garlic mustard seedlings have emerged but before desired vegetation begins growth.

Prescribed burning should be implemented to meet specified management goals in accordance with specific site conditions. Fire may pose a risk to desirable plants; however, it may benefit other fire-adapted species such as prairie grasses, resulting in improved competition with garlic mustard. This should be considered during planning.

## Hand-held propane torch

Freshly emerged seedlings can be quickly killed with a handheld propane torch, but this should be done when conditions are not too dry, to minimize risk of unintended fire. As the first-year plants develop taproots, this method becomes less effective.

## Interseeding

In some situations, native seeding may improve success of garlic mustard control by increasing competition with garlic mustard seedlings. Assessment of the native seed bank prior to control efforts will help determine whether interseeding may be useful.

## Manipulation of the forest canopy

Garlic mustard typically gets a foothold in forests where the canopy is disturbed, and it can take advantage of increased light penetration. It can be advantageous to manage these openings by restoring the canopy quickly. However, garlic mustard is shade tolerant and will persist under full canopy once established.

## Biological control

Currently, four weevil species are being tested for potential use as garlic mustard biocontrol agents: two stem-miners (*Ceutorhynchus alliariae, C. roberti),* a root-miner (*C. constrictus*) and a crown-miner (*C. scrobicollis*). Studies are currently underway to determine the specificity of these agents and likelihood of impact to native species in North America.

## Integrated control

Integrated control first requires understanding the site management goals, the biology of garlic mustard and the environment in which it is growing to select a combination of actions that collectively reduces its impact. Removal of garlic mustard is but one action amidst other changes that likely need to occur to

increase biological integrity or ecological health of the area.

An effective approach is to hand pull outliers and work along the leading edges of an infestation first, pushing the infestation back towards its core, thereby concentrating the infestation and subsequent seed production into a smaller area. Depending upon time and resources available, the site can continue to be hand pulled, or chemical treatment can be applied to the smaller core area, minimizing non-target impacts. Repeated follow-up spot treatments of surviving plants by hand pulling, spot treatment with herbicide, or burning with a hand-held propane torch will be needed.

Vigilance is required to manage any live plants in the kill zone and ensure that other invasive species do not emerge or colonize. Native seeding may improve success, particularly in sites where garlic mustard has been long-established.

## Disposal of plant parts

Root crowns and pulled plants should not be left on site or composted as they may re-sprout and still produce seed. They should be disposed of in a manner that will ensure that their roots will dry out completely. If flowers are present, they should be burned or bagged and placed in a landfill. Where this is not possible, any resulting seedlings will require monitoring and control.

Although landscape waste cannot generally be disposed of in landfills, Michigan law permits the disposal of invasive species plant parts. See the "Online Resources" section for a link to the relevant legislation.

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## Online resources:

**CDMS - herbicide labels**
http://www.cdms.net/LabelsMsds/LMDefault.aspx?t=v

**Fire Effects Information System, *Alliaria petiolata***
http://www.fs.fed.us/database/feis/plants/forb/allpet/all.html

**Invasive.org**
http://www.invasive.org/

**Michigan Department of Agriculture and Rural Development—Pesticide Certification**
http://www.michigan.gov/pestexam

**Michigan Department of Environmental Quality—Aquatic Nuisance Control**
http://www.michigan.gov/deqinlandlakes http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3710---,00.html

**Michigan Department of Natural Resources—Local DNR Fire Manager contact list**
http://www.michigan.gov/dnr/0,4570,7-153-30301_30505_44539-159248--,00.html

**Michigan Invasive Species Coalition:**
http://www.michiganinvasives.org/

**Michigan Invasive Species Program:**
http://www.michigan.gov/invasives

**Michigan's Invasive Species Legislation**
Natural Resources and Environmental Protection Act 451 of 1994, Section 324.4130
http://legislature.mi.gov/doc.aspx?mcl-324-41301

**Michigan Legislation—landscape waste, disposal of invasive species plant parts**
Natural Resources and Environmental Protection Act 451 of 1994, Section 324.11521, 2 (d)
http://legislature.mi.gov/doc.aspx?mcl-324-11521

**Midwest Invasive Species Information System:**
https://www.misin.msu.edu/

**MIPN Invasive Species Control Database**
https://mipncontroldatabase.wisc.edu/

**MISIN Mapping Phone Apps:**

http://www.misin.msu.edu/apps/

**The Nature Conservancy's Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas**
http://www.invasive.org/gist/handbook.html

**University of Michigan Herbarium - Michigan Flora Online**
http://michiganflora.net/

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## Quick reference - Garlic mustard

This chart has been provided as a convenience, to summarize the pros and cons of each herbicide and to present details on adjuvants, concentrations, etc., that do not fit into the discussion in the preceding sections. Although every attempt has been made to ensure accuracy, the product labels for the listed herbicides are the ultimate authority for their usage. Where there are conflicts, always follow the label directions. Techniques are listed in order of general preference by MDNR Wildlife Division staff but not all are suitable for wetlands or sensitive sites. Site conditions vary—choose a method that is best suited to conditions on the site being treated.

Anyone using herbicides in the course of their employment is required to be a certified pesticide applicator. Treatment in wetlands or over open water requires a permit from the Michigan Department of Environmental Quality.

These chemicals are available in a variety of formulations and concentrations. Concentration is listed below as a percentage of the active ingredient (AI) to facilitate use of different products/brands. Always follow all directions on the product label including mixing instructions, timing, rate, leaf coverage and the use of personal protective equipment.

| | Herbicide | % A.I. | Adjuvant | Timing | Pros | Cons |
|---|---|---|---|---|---|---|
| **Foliar Spray** | Triclopyr ester (e.g., Garlon 4 Ultra®) | 1.5-3% | Use a vegetable oil based multi-purpose adjuvant (e.g., SprayTech® Oil) | Target rosettes (first year plants) in October-November if there aren't too many fallen leaves, or in March- April, prior to emergence of natives.<br><br>Best at temperatures above 50 degrees. | Broad-leaf specific--will not harm sedges and grasses.<br><br>Extremely effective. | Not approved for use in wetlands. |
| **Foliar Spray** | Triclopyr amine (e.g., Garlon 3A®, Renovate®) | 2-3% | Use a multi-purpose adjuvant (e.g., SprayTech® or Cygnet Plus in wetlands) | Target rosettes (first year plants) in October - November if there aren't too many fallen leaves, or in March-April, prior to emergence of natives.<br><br>Best at temperatures above 50 degrees. | Safe for use in wetlands.<br><br>Broad-leaf specific--will not harm sedges and grasses. | May be slightly less effective at a given percentage than the ester formulation. |
| **Foliar Spray** | Glyphosate (e.g., Roundup®, Rodeo®, Accord®) | 1-3% | Some products already contain a surfactant - if not, add one (e.g., Cygnet Plus®, NuFilm IR®). | Target rosettes (first year plants) in October-November if there aren't too many fallen leaves, or March-April, prior to emergence of natives.<br><br>Best at temperatures above 50 degrees. | Some products approved for use in wetlands. | Non-selective!<br><br>Use only when few or no natives are present. |
| **Note:** Hand-pull survivor seedlings in May or June, whether you apply herbicide in spring or fall. Be sure to remove the entire root. | | | | | | |

*Michigan Department of Natural Resources*
*Michigan Natural Features Inventory*
*2/2012*

# Japanese knotweed

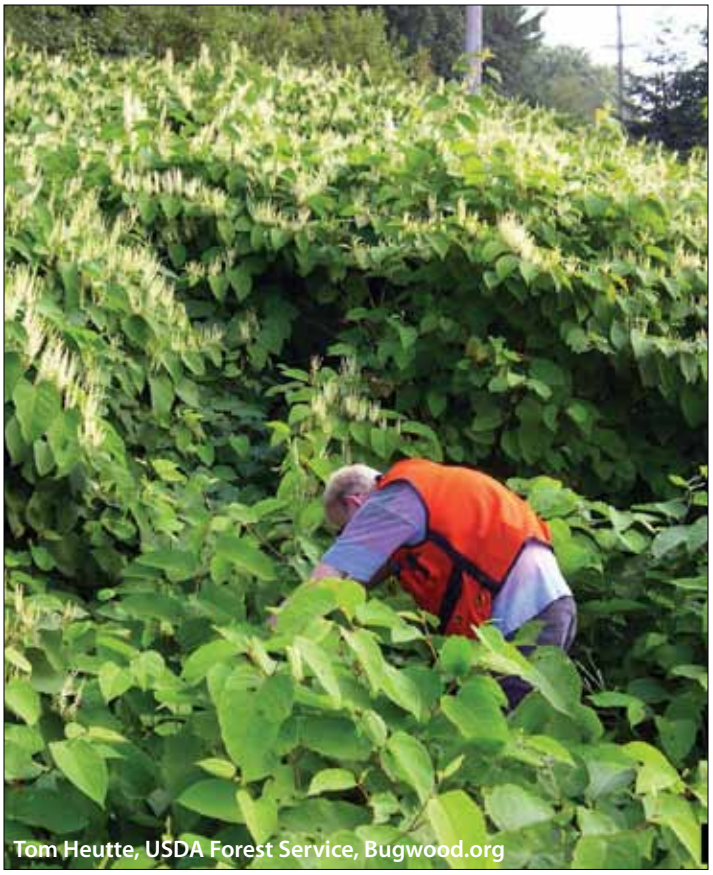
*Fallopia japonica (Polygonum cuspidatum)*

Japanese knotweed is a non-native invasive plant that was introduced from Asia as an ornamental plant. Knotweed spreads vegetatively by rhizomes and also sprouts from fragments of root and stem material, which are dispersed by water, equipment or in fill. It forms fertile hybrids with giant knotweed (*Polygonum sachalininese*). Some populations, particularly hybrids, produce fertile seed.

Knotweed forms dense monocultures, with a thick layer of accumulated leaf and fibrous stem litter. A number of mechanisms contribute to its ability to exclude native species; light limitation, alteration in nutrient cycling and allelopathy—the ability to suppress growth of a potential plant competitor by releasing toxic or inhibiting chemicals.

Knotweed can contribute both to stream bank erosion and to flooding, when its large, fibrous stems wash into the water during periods of peak flow. Its rhizomes and shoots can penetrate asphalt and cracks in concrete. It is most aggressive on sites with natural or human disturbance; stream and riverbanks, roadsides and construction sites.

**Japanese knotweed is legally prohibited in Michigan. It is illegal to possess or introduce this species without a permit from the Michigan Department of Agriculture, and Rural Development except to have it identified or in conjunction with control efforts.**


Tom Heutte, USDA Forest Service, Bugwood.org

## Identification

### Habit:

Japanese knotweed is a perennial, herbaceous shrub growing from 1 to 3 m (3-10 ft) in height. It has a deep taproot and an extensive network of rhizomes that may extend laterally from 7 to 20 m (23-65 ft). Its hollow stalks persist through winter and resemble bamboo.

### Leaves:

Its leaves are simple, alternate and broad, typically growing up to 15 cm (6 in) long and 12 cm (5 in) wide. They have an abruptly pointed tip and a flat or tapering base.


Suzan Campbell, MNFI

### Stems:


Suzan Campbell, MNFI

Japanese knotweed stems are upright, round, hollow, and often mottled, with a fine whitish coating that rubs off easily.

### Flowers:


Suzan Campbell, MNFI

Knotweed has numerous, small, creamy white flowers. They are arranged in spikes near the end of the plant's arching stems. In Michigan, they bloom in August and September. Knotweeds are insect-pollinated.

### Fruits/Seeds:

Knotweed fruits are three-winged and 8 to 9 mm (0.32 in) long. Its seeds are dark and glossy, and may be dispersed by wind, water, birds and insects. Not all seed is fertile.


Chris Evans, River to River CWMA, Bugwood.org

### Habitat:

Japanese knotweed is semi-shade tolerant but grows best in full sun. It is found along roadsides, stream and river banks, wetlands, wet depressions and woodland edges, and can tolerate a wide array of soil and moisture conditions.

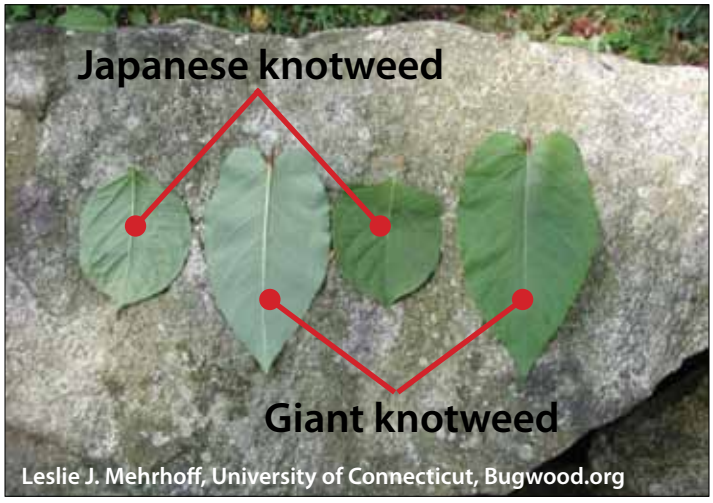
## Similar species

Several other knotweed species are similar to Japanese knotweed. All are invasive non-natives, and control methods discussed here are appropriate for all three species.

### Giant knotweed


Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Giant knotweed (*Fallopia sachalinensis*) is larger than Japanese knotweed, often reaching 4m (13 ft) in height. It can be distinguished by its larger leaves and heart-shaped leaf bases. Its leaves range from 5 to 30 cm (6-12 in) in length, while those of Japanese knotweed are usually 15 cm (6 in) long or less. They taper towards their tips, rather than being abruptly pointed. Giant knotweed leaves have long, wavy hairs on their undersides, while the hairs on Japanese knotweed are reduced to barely visible bumps. Use leaves from the middle of the stem for comparison as those at the tips are most variable. Giant knotweed flowers are held in spikes or branching clusters.



Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Giant knotweed and Japanese knotweed hybridize to form Bohemian knotweed (*Fallopia* X*bohemicum*). The hybrids are fertile and back-cross readily, yielding a continuous range of variation between the characteristics of their parent species, including size, leaf bases and tips. The hairs on the leaf undersides are short with broad bases.

### Himalyan knotweed


Vlado Lamiot, Creative Commons license

The related non-native Himalyan knotweed (*F. polystachyum*) has narrower, sharply-pointed lance-shaped leaves that are up to 20 cm (8 in) long. Its leaf bases may be tapered or slightly heart-shaped. It can grow up to 1.8 m (6 ft) tall. It has not been reported in Michigan to date.

## Reproduction/Dispersal

Most reproduction in Japanese knotweed is believed to be vegetative, although the role of sexual reproduction is receiving increasing attention. As much as two thirds of the mature plant's biomass is stored underground in its extensive systems of thick rhizomes. Rhizomes can reach 7.5 cm (3 in) in diameter and penetrate at least 2 m (7ft) in suitable soils.

In addition, fragments of both stem and root material can sprout, giving rise to new plants or entire colonies. While fragments near the soil's surface are most likely to sprout, sprouting has been demonstrated from fragments up to 1 m (39 in) deep. Because of this, it presents an enormous threat along rivers, streams and floodplains, where plant parts may be washed downstream by flood waters. It can also be spread inadvertently during construction and road maintenance, by mowing crews and in fill dirt.

In Europe, all Japanese knotweed populations appear to be clones of a single female genotype and do not produce pollen. However, they are able to accept pollen from the closely related giant knotweed, producing the fertile hybrid Bohemian knotweed. The hybrid appears to be spreading faster than either of its parent species.

In North America, the situation is more complex and the potential for sexual reproduction both within the species and between related species is a focus of increased interest. Though the European female clone is widely dispersed in the US, other genotypes are also present. Populations have been documented with both male and female plants. Some may maintain reduced forms of the reproductive organs of the other sex. Though the female plants do not produce pollen, they can produce viable seeds. Male plants contribute pollen and may produce the occasional seed. Reproduction by seed has been documented in the Northeast and also in Wisconsin. The potential for spread of the hybrid knotweed may be even greater; both male and female fertile hybrids have been found without either of their parental species in New England. Japanese, giant and hybrid knotweed populations in Michigan should be monitored for seed production, which offers additional opportunities for spread.

Knotweed seedlings generally do not survive under the canopy of their parent plant and appear most likely to establish on bare soil, as they do in their native habitat. In western states, much of their most devastating spread has been along waterways, where soil is continually eroded and re-deposited downstream.

In Michigan, roadside maintenance equipment appears to contribute significantly to knotweed spread, as cut fragments are dispersed along roadways. Dumping of landscape waste by homeowners has also been documented as a source of new populations.

## Planning a control program

Resources for invasive species control invariably fall short of the actual need, so it is important to prioritize sites for treatment and plan carefully. It should be noted that control for all knotweeds is similar. Assessing the scope of the problem in the region of interest is a critical first step:

- Map known populations.
- How was the knotweed population under consideration introduced—was it deliberately planted? Or did it disperse from another population that should be also be eradicated or controlled?
- Identify potential dispersal pathways and monitor them;
  - Is the population along a stream or lake?
  - Is it being spread in landscaping waste?
  - Does it lie in the path of road-mowing crews that might spread it further? Are there construction sites in the area where it might be introduced in fill dirt?
  - Are home owners disposing of landscape waste or distributing cuttings as an ornamental plant?
- How is the species behaving in your area? Is it spreading rapidly? Is it reproducing by seed?
- Does it occur in high quality habitat or on important recreational, hunting or fishing lands?

Given this information, develop a strategy for control:

1. First, prevent further spread; block pathways for dispersal, e.g. road maintenance practices, contaminated fill.
2. Choose appropriate control methods, given site conditions and available resources.
3. If using herbicide, be sure to read the product label before finalizing plans. Is there potential for harm to non-target species? Have you made adequate provisions to minimize damage?
4. Do these control methods require any permits (i.e. herbicide application in wetlands, prescribed burning)?
5. Prioritize high value sites for treatment where the potential for successful control is high.
6. Where knotweed is being spread along waterways, begin control efforts upstream and work downstream; concentrate on sites where erosion/dispersal of fragments is greatest.
7. Eradicate smaller satellite populations.
8. Treat larger core infestations of lower value as resources permit.
9. Monitor to ensure desired results are being achieved; adapt management to improve success.

**Best survey period**

Japanese knotweed is easiest to locate for mapping or control in August and September when it is in bloom. Its clustered spikes of creamy white flowers are distinctive and easy to spot.

**Documenting occurrences**

In order to track the spread of an invasive species on a landscape scale, it is important to report populations where they occur. The Midwest Invasive Species Information Network (MISIN) has an easy-to-use interactive online mapping system. It accepts reports of invasive species' locations from users who have completed a simple, online training module for the species being reported. MISIN can also accept batch uploads of large quantities of data for any species.

Herbaria also provide an authoritative record of plant distribution. The University of Michigan Herbarium's database can be searched online for county records of occurrence, for example.

When Japanese knotweed is first encountered in a county where it had not been known previously, specimens should be submitted to the Herbarium to document its presence. Check the "Online Resources" section for links to both of these resources.

## Control

Mechanical methods alone will not effectively control large Japanese knotweed populations and may make them worse. Control efforts must target knotweed's massive underground system of rhizomes. This network allows it to spread to new areas even as it is being attacked mechanically. Accordingly, chemical treatments are given priority in the following section and then mechanical methods are discussed as some may enhance the effectiveness of chemical control. Specific herbicides, application methods and rates are listed on the reference table at the end of this fact sheet.

To date, a combination of chemical and mechanical techniques, in conjunction with on-going monitoring, provides the most effective control of this species. **Knotweed rhizomes that have not been completely killed off may send up new shoots as many as three years later.** In all cases, monitoring and follow-up treatment will be required for four to ten years, depending on the size and age of the population being treated.

### Chemical control

Japanese knotweed has always been considered difficult to eradicate, even with herbicides. Differing levels of success have been reported for the same chemical on different sites. These results are probably related to differences in the amount of root mass underground.

Older infestations have more extensive root systems and are harder to eradicate or control. Specific site conditions, weather on the day of application, calibration of equipment and applicator experience can also contribute to differing levels of effectiveness.

**General considerations**

Anyone applying herbicides as part of their employment must become a certified pesticide applicator. In addition, certification is required for the use of some herbicides under any circumstances. The certification process is administered by the Michigan Department of Agriculture and Rural Development and a link to their website is included in the Online Resources section.

A permit from the Michigan Department of Environmental Quality is usually required to apply herbicide where standing water is present—in wetlands, along streams, rivers or lakes, or over open water. A permit is also required for herbicide use below the ordinary high water mark along the Great Lakes or Lake St. Clair shoreline, whether or not standing water is present. A link to their website is included in the "Online Resources" section.

A number of adjuvants or additives may be used with herbicides to improve their performance including mixing agents, surfactants, penetrating oils and dyes. Some are included in premixed products while others must be added. Adjuvants do not work with all products; consult the product label to determine which adjuvants may be used with a specific herbicide formulation.

Dyes are useful in keeping track of which plants have been treated and making spills on clothing or equipment apparent. Some premixed herbicide formulations include them or they can be added to others. Clothing dyes such as Rit® can be added to water soluble herbicides, while other products require oil-based dyes. Consult the product label for specific instructions.

Crop Data Management Systems, Inc. (CDMS) maintains a database of agro-chemicals that includes herbicide labels for specific products. Herbicide labels contain information on application methods and rates, specific weather conditions, equipment types, nozzles etc. to provide the desired coverage and minimize the potential for volatilization or drift. They also contain critical information about the potential for damage to valuable non-target species. A link to the CDMS website is included in the "Online Resources" section.

**Read the entire pesticide label before use. Follow all directions on the label.**

**Herbicide specifics**

Imazapyr (e.g., Arsenal®) has shown the greatest documented effectiveness on this species to date. Of all the herbicides included here, it also has the greatest potential for collateral damage to valuable species nearby. Imazapyr can move within roots and be transferred between intertwined root systems of different plants and other species. It has the potential to cause significant damage or death to trees and other species in the area. This movement of herbicide is exacerbated when imazapyr is incorrectly over-applied.

**Because of its potential for collateral damage, imazapyr may not be appropriate for use in high-quality areas, with many desirable native species nearby.**

Imazapyr acts slowly, reaching the massive root system before damaging the leaves. Although it appears to not be working initially, it results in significantly higher die-off rates a year later. Spray should be directed toward the actively growing portions of the plant. Imazapyr persists in the soils for long periods of time—an advantage in providing greater control. However, since it is non-selective it can also kill valuable non-target species wherever it contacts their roots.

Sites where imazapyr has been used should not be planted for at least one year, because of its lingering effects. Imazapyr is available in several wetland-approved formulations but they must be applied by a certified pesticide applicator. Wetland approved formulations must be used wherever standing or open water is present.

Imazamox (e.g., Clearcast®) is also effective against Japanese knotweed, although there has been less research on it than imazapyr to date. Some imazamox formulations are approved for aquatic and wetland sites and can be used in upland settings also. Because it is non-selective, it may kill or harm desirable non-target species, although its impacts vary with concentration and mode of application. See label for additional information.

Aminopyralid (e.g., Milestone®), a broadleaf herbicide, is being tested on Japanese knotweed in other states and also appears to provide effective control. Although it does not kill established native grasses, it may damage nearby trees. As it remains active in the soil for a long period of time, a soil bioassay is needed before planting wildflowers or legumes, which are particularly vulnerable to it. It may be added to the "Quick reference" chart at the back of this document later, as more information on its effectiveness becomes available.

Although glyphosate (e.g., Roundup®, Aquamaster®) kills knotweed foliage quickly, the herbicide is not effectively transported to the roots. In most cases, the plant rebounds the following year. In other cases, regrowth is reduced, but stems and foliage are deformed and do not provide enough surface area for re-treatment. With less surface area, less herbicide will reach the roots and eventually the plant will grow back. On sites where glyphosate is the only permitted herbicide, it should be used in conjunction with other control methods (see the section on Digging under Mechanical Control, including the discussion of cutting through roots to stimulate healthy new growth). Glyphosate, like imazapyr, is non-selective and will kill non-target species.

A number of other herbicides are also effective in controlling knotweed including dicamba, picloram and tebuthiuron but are not recommended because of their potential for groundwater contamination.

**Foliar application**
Herbicide can be applied to knotweed leaves in a number of ways; it can be wiped onto individual plants on sensitive sites or in very small infestations or sprayed on with hand-held, backpack or boom-mounted sprayers. A non-ionic surfactant should be added to allow the herbicide to penetrate the plant's cuticle. Dyes are also useful in indicating which plants have been sprayed and the extent of coverage. Other adjuvants may be suggested on the labels of the specific herbicide being used.

The herbicide applicator is responsible for calibrating equipment, and managing drift and damage to non-target vegetation. Wind speeds between 3 and 10 miles per hour are best for foliar herbicide spraying. At higher wind speeds, herbicide may be blown onto adjacent vegetation or water.

At lower wind speeds, temperature inversions can occur, restricting vertical air movement. Under these conditions, small suspended droplets of herbicide can persist in a concentrated cloud and be blown off-target by variable gusts of wind. Ground fog indicates the presence of a temperature inversion, but if no fog is present, smoke movement on the ground can also reveal inversions. Smoke that layers and remains trapped in a cloud at a low level indicates an inversion, while smoke that rises and dissipates indicates good air mixing.

In hot, dry weather, herbicide evaporates rapidly; set equipment to produce large droplets to compensate for this.

Some herbicides can be applied as invert emulsions; thickened mixtures designed to minimize spray drift and run-off and maximize the amount of herbicide that sticks to and covers leaves and stems. Always follow all directions on the label of the specific herbicide being used, in order to prevent damage to non-target vegetation or water bodies.

**Injection**
Injection is extremely labor intensive and impractical for most situations. It may be useful for applying herbicide on sensitive sites with very small knotweed populations. Typically, a measured amount of herbicide is injected into the plant stem between the second and third node or into the hollow of a cut stem. Stems that are not treated are not killed. For each type of herbicide, there is a maximum amount that can be applied safely per acre, per year, and with large populations, it is possible to reach this amount before all stems have been treated.

## Mechanical control

**Hand-pulling**
Mature Japanese knotweed populations have deep, extensive root systems and hand-pulling the species is not an effective control method.

On sites where there is reproduction by seed, seedlings may be hand-pulled while they are still small. Typically, seeds will not germinate below mature plants but will do so on bare mineral soils nearby.

**Cutting/Mowing**
Cutting or mowing Japanese knotweed is not recommended. Stem fragments can root at the nodes and generate new plants. Frequently, knotweed is spread by roadside mowing crews in just this manner. Although cutting is often recommended to reduce the plant's height and facilitate treatment, unless all plant parts can be removed and destroyed, the risks outweigh the benefits.

**Digging/Tilling/Excavating**
For very small infestations (fewer than 50 stems), digging up and removing ALL of the plant's parts may provide control, but the site should be carefully monitored for at least four years. Again, all plant parts should be destroyed.

Since root fragments may sprout to form new plants, **for most populations, digging alone will not provide effective control.** Tilling or cutting through roots will also increase sprouting. Without herbicide, this is disastrous. When the plant's foliage has been burned by previous herbicide application, however, this will increase the surface area of new, healthy foliage that is available for herbicide absorption during re-treatment.

Excavating living rhizomes from previously treated, deformed plants will also result in new stems with healthy foliage, which will respond more favorably to herbicide treatment in the following year. In conjunction with herbicide applications, the removal of rhizomes may help to deplete a colony's stored energy. Excavating reduces root biomass and increases the stem to root ratio, allowing a more effective follow-up herbicide treatment for any new foliage. Without herbicide follow-up however, knotweed will quickly re-establish with renewed vigor.

Digging, tilling and excavating are never appropriate along river or stream banks, where soil disturbance may result in fragments being washed downstream.

**Prescribed burning**
Little information is available on Japanese knotweed's response to burning but it is not particularly flammable. Giant knotweed has been tested for use as a potential firebreak in Russia and researchers concluded that it "suffers little from the effect of fire."

On sites with fire-adapted communities, Japanese knotweed may alter fire ecology as it will not burn, and fuels do not accumulate beneath it. If prescribed burning is introduced as part of an overall management program, Japanese knotweed will still require additional control measures.

## Biological control

Native North American pests do little damage to Japanese knotweed, but it has over 200 natural enemies in its native range. One species of sap-sucking plant louse, *Aphalara itadori*, has been tested extensively for host-specificity in Great Britain. It was released at several sites for field testing in Britain in March of 2010. It has not been tested for host-specificity in the United States.

## Disposal of plant parts

If you must cut knotweed, all plant parts should be disposed of carefully to prevent regeneration, in accordance with Michigan's invasive species legislation. Options include landfills or some municipal incinerators. Materials to be placed in landfills should be bagged and tied in black plastic bags. Municipal solid waste treatment facilities that are engineered to inactivate potential pathogens in biosolids and maintain temperatures above 55° C for at least three consecutive days will safely destroy plant parts.

Where burning ordinances permit, plant refuse can be dried out thoroughly above ground and burned on site. Plant parts should not be allowed to contact soil during this time to prevent sprouting. Plant parts should not be composted.

Although landscape waste cannot generally be disposed of in land fills, Michigan law permits the disposal of invasive species plant parts. See the "Online resources" section below for a link to the relevant legislation.

## Online resources:

**CDMS - herbicide labels:**
*http://www.cdms.net/LabelsMsds/LMDefault.aspx?t=*

**Fire Effects Information System,** *Polygonum* species**:**
*http://www.fs.fed.us/database/feis/plants/forb/polspp/all.html*

**Invasive.org,** *Fallopia japonica***:**
*http://www.invasive.org/species/subject.cfm?sub=3414*

**Invasipedia at BugwoodWiki,** *Polygonum cuspidatum*
*http://wiki.bugwood.org/Polygonum_cuspidatum*

**Invasive Plant Atlas of New England,** *Polygonum cuspidatum*
*http://www.eddmaps.org/ipane/ipanespecies/herbs/Polygonum_cuspidatum.htm*

**Midwest Invasive Species Information Network, Japanese Knotweed**
*http://www.misin.msu.edu/facts/detail.php?id=25*

**The Michigan Department of Agriculture and Rural Development—Pesticide Certification**
*www.michigan.gov/pestexam*

**The Michigan Department of Environmental Quality—Aquatic Nuisance Control**
*www.michigan.gov/deqinlandlakes*
*http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3710---,00.html*

**Michigan Department of Natural Resources—Local DNR Fire Manager contact list**
*http://www.michigan.gov/dnr/0,4570,7-153-30301_30505_44539-159248--,00.html*

**Michigan's Invasive Species Legislation**
Natural Resources and Environmental Protection Act 451 of 1994, Section 324.4130
*http://legislature.mi.gov/doc.aspx?mcl-324-41301*

**Michigan Legislation—landscape waste, disposal of invasive species plant parts**
Natural Resources and Environmental Protection Act 451 of 1994, Section 324.11521, 2 (d)
*http://legislature.mi.gov/doc.aspx?mcl-324-11521*

**The Nature Conservancy's Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas**
*http://www.invasive.org/gist/handbook.html*

**University of Michigan Herbarium - Michigan Flora Online**
*http://michiganflora.net/*

# Quick reference—Japanese knotweed

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Anyone using herbicides in the course of their employment is required to be a certified pesticide applicator. Treatment in wetlands or over open water requires a permit from the Michigan Department of Environmental Quality.

These chemicals are available in a variety of formulations and concentrations. In some cases, concentration is listed below as a percentage of the active ingredient (AI) to facilitate use of different products. Where this is not possible, the label recommendation for the example product is used. Always follow all directions on the product label including mixing instructions, timing, rate, leaf coverage and the use of personal protective equipment.

| | Herbicide | Conc. | Adjuvant | Timing | Pros | Cons |
|---|---|---|---|---|---|---|
| Foliar Spray | **Imazamox** (e.g., Clearcast®) | 5% Clearcast® by volume | Use a wetland-approved non-ionic surfactant (e.g., Cygnet Plus®).<br>Use dye for identifying treated areas. | Spray late September or October AFTER flowering. | Provides effective control.<br>Available in formulations that are approved for wetland and aquatic sites. | Selectivity varies with concentration and mode of application but it may kill desirable non-target species. |
| Foliar Spray | **Imazapyr** (e.g., Arsenal®) | 1-1.5 % AI or 2 qts/acre | Use a non-ionic surfactant (e.g., Cygnet Plus®).<br>Use dye for identifying treated areas. | Spray late September or October AFTER flowering. | Provides effective control.<br>Available in formulations that are approved for wetlands. | Imazapyr is non-selective, highly active in the soil and may kill nearby plants, including trees. |
| Foliar Spray | **Triclopyr ester** (e.g., Garlon 4 Ultra®) | 3% AI | Use a non-ionic surfactant (e.g., Cygnet Plus®).<br>Use dye for identifying treated areas. | Spray late September or October AFTER flowering. | Provides some control.<br>Broad-leaf specific—may be used where desirable grasses are present. | Less effective than imazamox or imazapyr.<br>May damage foliage without killing roots.<br>Not approved for use in wetlands. |
| Foliar Spray | **Triclopyr amine** (e.g., Garlon 3A®) | 3% AI | Use a wetland-approved non-ionic surfactant (e.g., Cygnet Plus®).<br>Use dye for identifying treated areas. | Spray late September or October AFTER flowering. | Provides some control.<br>Broad-leaf specific—may be used where desirable grasses are present.<br>Can be used in wetlands. | Less effective than imazamox or imazapyr.<br>May damage foliage without killing roots. |

Note: Be careful not to move stems or other plant tissues as Japanese knotweed can regenerate from stem nodes. See section on disposal of plants for additional information. **Treated sites should be monitored for at least four years to ensure that there is no regrowth.**

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

# Plant Fact Sheet

# SCOTS PINE

## *Pinus sylvestris* L.

Plant Symbol = PISY

*Contributed by: USDA NRCS Plant Materials Program*

USDA NRCS National Plant Materials Center
Beltsville. MD

**Uses**

*Windbreaks*: Plant Scots pine in the central or leeward rows of multi-row plantings. It is also recommended for planting as single-row windbreaks.

*Wildlife*: Scots pine is of some importance as food and cover for many birds and small mammals. Although the plant is browsed by whitetail and mule deer, it is not a preferred forage.

*Timber/Christmas tree plantations*: Scots pine is suitable for ornamental and screen plantings. Its year long coloration adds variety to recreation plantings.

**Status**

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

**Description**

Scots pine is an evergreen, spreading tree 80 to 100 feet, pyramidal when young, becoming round topped and irregular in age. The tree is introduced from Eurasia, and has become naturalized in eastern North America. It is cultivated for windbreaks, timber, and Christmas tree plantations. It does best on rich, moist soils, but its winter hardiness and moderate drought tolerance enable it to do well on other soils. It is moderately slow growing, but is long lived.

**Description**

Fruits are tawny-yellow, oblong, symmetrical cones, 1 to 2 inches long. Clusters of flowers are yellow, minute, male and female. Needles occur in bunches of 2, are stout and usually twisted, 1 to 3 inches long, and bluish-green in color. Scots pine branches are spreading, and stems are often crooked in early years. The plant's bark is orange, thin and smooth on upper trunk, dark and fissured below. The tree's root system is widespread, moderately deep, and wind-firm.

**Adaptation and Distribution**

Scots pine is distributed throughout the Northeast and upper Midwest. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

**Establishment**

Plantings should be established during the spring of the year on weed free sites. Stand establishment can be enhanced by using 2 year old field-grown stock. Holes or furrows should be deep enough to contain roots without bending.

**Management**

Weed control is recommended in areas where the tree is grown for shade or Christmas tree plantings. It is also good to shape the tree for the form that you would like to have at time of harvest.

**Pests and Potential Problems**

There are several wood boring, root feeding, foliage feeding, and twig boring insects that attack this tree. The most common pest are cyclaneusma needle cast, western gall rust, Lophodermium needle cast, tip moth, sawflies, pine needle scales and giant conifer aphid.

**Cultivars, Improved, and Selected Materials (and area of origin)**

Scots pine has several intergrading cultivars, differing chiefly in leaf color and growth form. Most have ready use as Christmas trees, although leaves of some cultivars turn yellow-green in winter. Seedlings are available at most commercial conifer nurseries. Seed origin is extremely important in obtaining quality trees for a given sub-region.

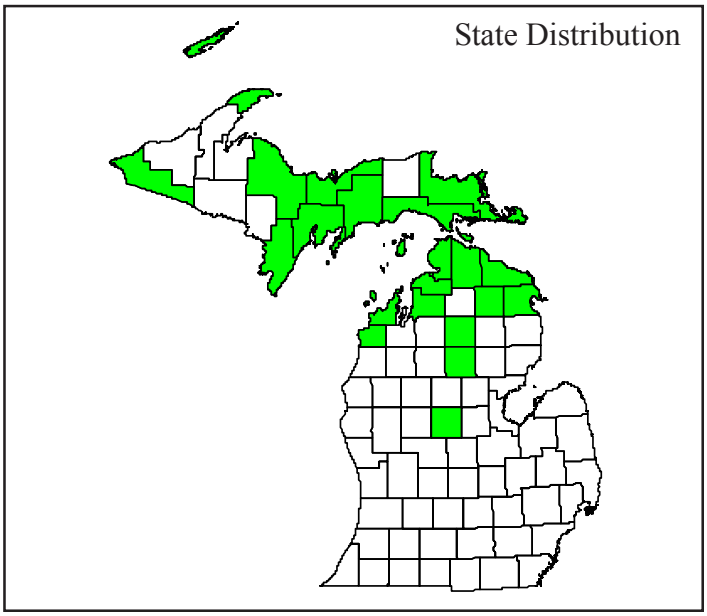
Consult the state extension forester for information from provenance testing to determine the best seed source for your planting.

**Prepared By & Species Coordinator:**
*USDA NRCS Plant Materials Program*

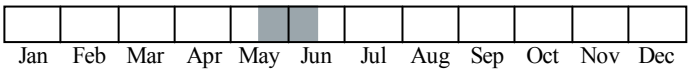
Edited: 05Feb2002 JLK; 060809 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

# *Calypso bulbosa* (L.) Oakes — calypso orchid


Best Survey Period




**Status**: State threatened

**Global and state rank**: G5/S2

**Other common names**: fairy slipper, deer's head orchid

**Family**: Orchidaceae (orchid family)

**Synonyms**: *Cytherea bulbosa* House, *Calypso borealis* Salisb.

**Taxonomy**: This is the only species in the genus *Calypso*. North American plants are sometimes considered var. *americana* (R. Brown) Luer and at least one form, occurring in the Pacific Northwest, differs in proportions, markings, and physiology (Case 1987).

**Total range**: This widespread species nearly circles the globe in the northern hemisphere, ranging throughout North America, Europe, and Asia. In North America, calypso is found from Labrador to Alaska, south to New England, Minnesota, the Great Plains, Arizona, and along the west coast to California. It is considered rare in Maine (S2 rank), Vermont (S2), and Wisconsin (S2-3), South Dakota (S3), and in New Hampshire and New York where it is known only from historical records.

**State distribution**: Calypso is widely distributed in the northern Lower Peninsula and the Upper Peninsula of Michigan, with 85 locational records from 23 counties. At least eight counties have records dating since 1980. Most mainland - especially more southerly - colonies consist of few plants, but large colonies with hundreds of plants occur occasionally to the north, especially on Isle Royale.

**Recognition**: At flowering time the visible portion of this plant consists of a **single pleated oval, basal leaf**, and a leafless stalk 1-2 dm tall, topped by a **tiny solitary flower**. The nodding blossom has **five purple to magenta petals** (1-2 cm long) and a **sac-like lip about 2 cm long**. The **back of the lip** is translucent white and **spotted with purple**, while **the front** is crested with **three rows of yellow hairs**. The lowermost saccate portion is whitish with red-brown to purple markings within and has two conspicuous horns at the base. The seldom seen capsule is erect, elliptical, and about 2.5 cm in length.

**Best survey time/phenology**: Due to its rarity and extremely small size, calypso orchid is notoriously difficult to find. Although its tiny, basal evergreen leaf could potentially be recognized and found with extremely diligent searching, this would be highly ineffective survey strategy. In all practicality one is limited to surveying when the showy flower is present. This survey window varies depending upon the location and specific weather conditions, but in Michigan is usually from late May through early June, varying according to locality and latitude.

**Habitat**: Calypso is an inhabitant of moist coniferous forests with cool soils. In Michigan, it is found in spruce-balsam-cedar swamps, and also in drier cedar-fir thickets along the shores of the upper Great Lakes, especially on calcareous substrates. When found in boggy areas, it inhabits drier hummocks or the bases of old trees or stumps. It is nearly always in the shade (Case 1964). Caljouw (1981) found it under canopy covers of no less than 60% and in soils no warmer than 15° C. Common

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associates include *Trientalis borealis* (twinflower), *Goodyera repens* (lesser rattlesnake plantain), and *Corallorhiza striata* (striped coral-root) (Case 1964).

**Biology**: In Michigan, Calypso plants flower from May to July depending on location, but are always among the first plants to bloom (Case 1964). After flowering, the single leaf fades and the corm produces a new bud on one side. From this bud a new leaf emerges in late summer, surviving the winter until the next flowering season. The corm is globose or ellipsoid and may have a coralloid rhizome attached (Mousley 1924; Correll 1950). Bumblebees of several species pollinate the flowers, but receive no reward since nectar is not produced. Plants are self-compatible, but require the mechanical action of a bumblebee to effect pollination (Mosquin 1970). Fruiting capsules develop in June and July, though they are rarely found, as are seedlings (Case 1964). Mousely (1924) reported rhizomatous roots at the base of the tuber to be a major means of reproduction. Dormancy, commonly of one to two years, has also been reported (Vickery 1984). The whole plant is frequently attacked by rodents, slugs, and fungi, particularly in the eastern U.S. (Correll 1950). Our plants tend to grow in scattered, sparse populations and have not been successfully cultured. The western form seems to be more "aggressive," growing in denser colonies, and has been successfully cultivated for one to two years when carefully tended (Case 1964).

**Conservation/management**: Calypso is protected in at least three Michigan Nature Association sanctuaries, three Nature Conservancy preserves, three state natural areas, two national parks, and in the Sylvania Recreation Area. At any site with considerable public recreation use, this species is vulnerable to trampling by wildflower enthusiasts. Corms are dug in western states for commercial export (Wiley 1968). In the East, logging and drainage of its habitat contribute to calypso's increasing rarity. In Maine, studies suggest that spruce budworm infestations may have damaged calypso populations by reducing shade (Vickery 1984). Publicizing the location of calypso colonies, especially readily accessible ones, should be avoided. Conservation of nearby bee populations could promote fertilization and seed-set.

**Comments**: This species has nutritional, as well as aesthetic value, as the mucilagenous corms were eaten by native Americans in British Columbia (Correll 1950). The name "calypso" comes from Homer's sea-nymph in the Odyssey who kept Odysseus concealed seven years on her island. Both the beauty and rarity of calypso, as well as the seclusion of its habitats, make this a fitting name (Correll 1950).

**Research needs**: Relatively little is known of the natural history of this diminutive orchid, and thus virtually any life history study would aid greatly in management and conservation. Of primary interest would be investigations of this species' breeding system, especially pollination biology and studies leading to a better understanding of the requirements for germination and establishment. Demographic monitoring would also enhance our knowledge of the population dynamics of this species.

**Related abstracts**: rich conifer swamp, ram's head orchid

**Selected references**

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Case, F.W., Jr. 1964. Orchids of the Great Lakes Region. Cranbrook Inst. Sci. Bull. 48. Bloomfield Hills, MI.

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Mosquin, T. 1970. The Reproductive Biology of *Calypso bulbosa* (Orchidaceae). Can. Field-Nat. 84:291-296.

Mousley, H. 1924. Calypso. J. N.Y. Bot. Gard. 25:25-32.

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**Abstract citation**

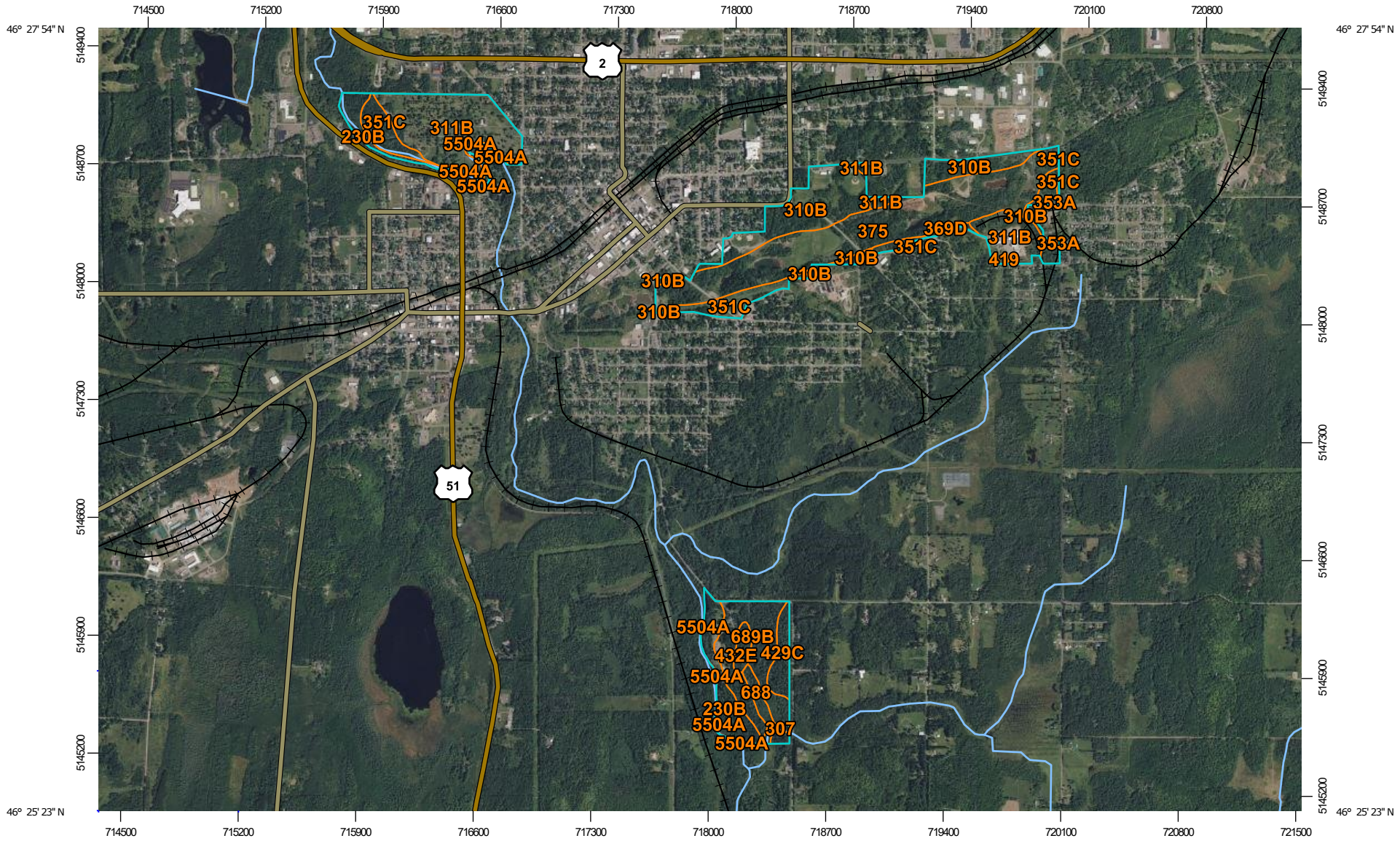
Higman, P.J. and M.R. Penskar. 1996. Special plant abstract for *Calypso bulbosa* (calypso orchid). Michigan Natural Features Inventory, Lansing, MI. 2 pp.



Funding for abstract provided by Michigan Department of Natural Resouces - Wildlife Division, Non-Game Program.

9-99/pjh

Soil Map—Gogebic County, Michigan, and Iron County, Wisconsin
(City of Ironwood)




Map Scale: 1:32,700 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 450 900 1800 2700

Feet: 0 1500 3000 6000 9000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 230B | Moquah-Arnheim complex, 0 to 3 percent slopes, frequently flooded | 38.1 | 8.3% |
| 303 | Bowstring-Arnheim complex, 0 to 1 percent slopes, frequently flooded | 2.4 | 0.5% |
| 307 | Lupton and Cathro soils, 0 to 1 percent slopes | 1.9 | 0.4% |
| 310B | Gogebic fine sandy loam, 1 to 6 percent slopes, stony | 80.7 | 17.6% |
| 311B | Tula-Gogebic complex, 0 to 6 percent slopes, stony | 93.0 | 20.3% |
| 351C | Gogebic silt loam, 6 to 18 percent slopes, very stony, rocky | 32.1 | 7.0% |
| 353A | Tula fine sandy loam, 0 to 4 percent slopes, stony | 0.6 | 0.1% |
| 369D | Dishno-Gogebic-Peshekee-Rock outcrop complex, 18 to 35 percent slopes, very stony | 1.9 | 0.4% |
| 375 | Dumps and Pits, mine | 137.5 | 30.0% |
| 419 | Pleine-Cathro-Gay complex, 0 to 1 percent slopes, stony | 0.8 | 0.2% |
| 429C | Gogebic-Peshekee complex, 6 to 18 percent slopes, very rocky, very stony | 11.8 | 2.6% |
| 432E | Schweitzer-Michigamme-Rock outcrop complex, 18 to 55 percent slopes, very stony | 5.7 | 1.2% |
| 688 | Cathro-Leafriver complex, 0 to 1 percent slopes, frequently flooded | 5.5 | 1.2% |
| 689B | Chabeneau-Channing-Gogebic complex, 0 to 6 percent slopes, stony | 45.9 | 10.0% |
| **Subtotals for Soil Survey Area** | | **457.8** | **99.8%** |
| **Totals for Area of Interest** | | **458.5** | **100.0%** |

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 5504A | Moquah-Arnheim complex, 0 to 3 percent slopes, frequently flooded | 0.7 | 0.2% |
| **Subtotals for Soil Survey Area** | | **0.7** | **0.2%** |
| **Totals for Area of Interest** | | **458.5** | **100.0%** |

# Gogebic County, Michigan

## 375—Dumps and Pits, mine

### Map Unit Setting

*National map unit symbol:* 1qyhx
*Elevation:* 590 to 1,800 feet
*Mean annual precipitation:* 27 to 38 inches
*Mean annual air temperature:* 36 to 45 degrees F
*Frost-free period:* 70 to 170 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Dumps, mine:* 95 percent
*Minor components:* 5 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Minor Components

#### Flintsteel

*Percent of map unit:* 5 percent
*Landform:* Till plains
*Landform position (two-dimensional):* Summit, shoulder, backslope, footslope, toeslope
*Landform position (three-dimensional):* Head slope, interfluve, nose slope, side slope, base slope, crest
*Down-slope shape:* Linear
*Across-slope shape:* Linear, convex
*Ecological site:* F093BY009MI - Alfic Loamy Uplands
*Other vegetative classification:* Tsuga Acer Mitchella (TAM_1), Acer Viola Osmorhiza (AVO_1)
*Hydric soil rating:* No

# Data Source Information

Soil Survey Area: Gogebic County, Michigan
Survey Area Data: Version 14, Aug 29, 2022

Soil Survey Area: Iron County, Wisconsin
Survey Area Data: Version 18, Sep 6, 2022

# Gogebic County, Michigan

## 311B—Tula-Gogebic complex, 0 to 6 percent slopes, stony

### Map Unit Setting

*National map unit symbol:* 2xxjm
*Elevation:* 670 to 1,770 feet
*Mean annual precipitation:* 27 to 38 inches
*Mean annual air temperature:* 36 to 45 degrees F
*Frost-free period:* 70 to 170 days
*Farmland classification:* Farmland of local importance

### Map Unit Composition

*Tula, stony, and similar soils:* 45 percent
*Gogebic, stony, and similar soils:* 40 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Tula, Stony

#### Setting

*Landform:* Moraines, ground moraines
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Base slope, talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Loamy eolian deposits over loamy till

#### Typical profile

*Oa - 0 to 1 inches:* highly decomposed plant material
*A - 1 to 5 inches:* fine sandy loam
*E - 5 to 8 inches:* fine sandy loam
*Bs1 - 8 to 20 inches:* fine sandy loam
*Bs2 - 20 to 28 inches:* fine sandy loam
*2E/Bx - 28 to 37 inches:* gravelly fine sandy loam
*2B/Ex - 37 to 61 inches:* gravelly fine sandy loam
*2C - 61 to 79 inches:* gravelly fine sandy loam

#### Properties and qualities

*Slope:* 0 to 4 percent
*Surface area covered with cobbles, stones or boulders:* 0.1 percent
*Depth to restrictive feature:* 12 to 35 inches to fragipan
*Drainage class:* Somewhat poorly drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low (0.02 to 0.06 in/hr)
*Depth to water table:* About 0 to 12 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water supply, 0 to 60 inches:* Low (about 4.2 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 4w
*Hydrologic Soil Group:* B/D
*Ecological site:* F093BY005MI - Moist Lowlands
*Forage suitability group:* Low AWC, high water table (G090AY001WI)
*Other vegetative classification:* Acer Viola Osmorhiza - Circaea Impatiens (AVO-CI_3), Tsuga Maianthemum Coptis - Dryopteris (TMC-D_1), Low AWC, high water table (G090AY001WI)
*Hydric soil rating:* No

## Description of Gogebic, Stony

**Setting**

*Landform:* Moraines, ground moraines
*Landform position (two-dimensional):* Summit
*Landform position (three-dimensional):* Interfluve, rise
*Down-slope shape:* Convex, linear
*Across-slope shape:* Convex
*Parent material:* Loamy eolian deposits over loamy till

**Typical profile**

*Oe - 0 to 1 inches:* moderately decomposed plant material
*A - 1 to 4 inches:* silt loam
*E - 4 to 5 inches:* silt loam
*Bhs - 5 to 9 inches:* silt loam
*Bs - 9 to 20 inches:* fine sandy loam
*2E/Bx - 20 to 30 inches:* gravelly fine sandy loam
*2B/Ex - 30 to 43 inches:* fine sandy loam
*2Bt - 43 to 51 inches:* fine sandy loam
*2BC - 51 to 59 inches:* fine sandy loam
*2C - 59 to 79 inches:* gravelly fine sandy loam

**Properties and qualities**

*Slope:* 1 to 6 percent
*Surface area covered with cobbles, stones or boulders:* 0.1 percent
*Depth to restrictive feature:* 12 to 35 inches to fragipan
*Drainage class:* Moderately well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low (0.02 to 0.06 in/hr)
*Depth to water table:* About 10 to 18 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water supply, 0 to 60 inches:* Low (about 4.2 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 4e
*Hydrologic Soil Group:* D
*Ecological site:* F093BY008MI - Fragic Loamy Uplands

*Forage suitability group:* Low AWC, adequately drained (G090AY002WI)
*Other vegetative classification:* Acer Tsuga Dryopteris (ATD_1), Acer Viola Osmorhiza (AVO_1), Low AWC, adequately drained (G090AY002WI)
*Hydric soil rating:* No

**Minor Components**

**Gay, stony**
*Percent of map unit:* 10 percent
*Landform:* Depressions on ground moraines
*Landform position (three-dimensional):* Dip
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Ecological site:* F093BY004MI - Wet Lowlands
*Other vegetative classification:* Tsuga Maianthemum Coptis (TMC_1)
*Hydric soil rating:* Yes

**Pleine, stony**
*Percent of map unit:* 5 percent
*Landform:* Depressions on ground moraines
*Landform position (three-dimensional):* Dip
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Ecological site:* F093BY004MI - Wet Lowlands
*Other vegetative classification:* Tsuga-Thuja-Mitella (TTM_2), Fraxinus Impatiens (FI_1)
*Hydric soil rating:* Yes

# Data Source Information

Soil Survey Area: Gogebic County, Michigan
Survey Area Data: Version 14, Aug 29, 2022

Soil Survey Area: Iron County, Wisconsin
Survey Area Data: Version 18, Sep 6, 2022

# Gogebic County, Michigan

## 310B—Gogebic fine sandy loam, 1 to 6 percent slopes, stony

### Map Unit Setting

*National map unit symbol:* 2tp01
*Elevation:* 610 to 1,740 feet
*Mean annual precipitation:* 27 to 38 inches
*Mean annual air temperature:* 36 to 45 degrees F
*Frost-free period:* 70 to 170 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Gogebic, stony, and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Gogebic, Stony

#### Setting

*Landform:* Moraines, ground moraines
*Landform position (two-dimensional):* Summit
*Landform position (three-dimensional):* Interfluve, rise
*Down-slope shape:* Convex, linear
*Across-slope shape:* Convex
*Parent material:* Loamy eolian deposits over loamy till

#### Typical profile

*Oe - 0 to 1 inches:* moderately decomposed plant material
*A - 1 to 4 inches:* fine sandy loam
*E - 4 to 5 inches:* fine sandy loam
*Bhs - 5 to 9 inches:* fine sandy loam
*Bs - 9 to 20 inches:* fine sandy loam
*2E/Bx - 20 to 30 inches:* gravelly fine sandy loam
*2B/Ex - 30 to 43 inches:* fine sandy loam
*2Bt - 43 to 51 inches:* fine sandy loam
*2BC - 51 to 59 inches:* fine sandy loam
*2C - 59 to 79 inches:* gravelly fine sandy loam

#### Properties and qualities

*Slope:* 1 to 6 percent
*Surface area covered with cobbles, stones or boulders:* 0.1 percent
*Depth to restrictive feature:* 12 to 35 inches to fragipan
*Drainage class:* Moderately well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low (0.02 to 0.06 in/hr)
*Depth to water table:* About 10 to 18 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

*Available water supply, 0 to 60 inches:* Low (about 3.2 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 4e
*Hydrologic Soil Group:* D
*Ecological site:* R092XY014WI - Loamy Uplands
*Forage suitability group:* Low AWC, adequately drained (G090AY002WI)
*Other vegetative classification:* Low AWC, adequately drained (G090AY002WI), Acer Tsuga Dryopteris (ATD_1), Acer Viola Osmorhiza (AVO_1)
*Hydric soil rating:* No

## Minor Components

**Tula, stony**

*Percent of map unit:* 10 percent
*Landform:* Moraines, ground moraines
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Base slope, talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* F093BY005MI - Moist Lowlands
*Other vegetative classification:* Low AWC, high water table (G090AY001WI), Acer Viola Osmorhiza - Circaea Impatiens (AVO-CI_3), Tsuga Maianthemum Coptis - Dryopteris (TMC-D_1)
*Hydric soil rating:* No

**Newot, stony**

*Percent of map unit:* 3 percent
*Landform:* Moraines, ground moraines
*Landform position (two-dimensional):* Summit
*Landform position (three-dimensional):* Interfluve, rise
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Ecological site:* F090AY016WI - Loamy Upland
*Other vegetative classification:* Acer Tsuga Dryopteris (ATD_1), Tsuga Maianthemum (TM_1), Mod AWC, adequately drained with limitations (G090AY006WI)
*Hydric soil rating:* No

**Foxpaw, stony**

*Percent of map unit:* 2 percent
*Landform:* Depressions on ground moraines, drainageways on ground moraines
*Landform position (three-dimensional):* Dip
*Down-slope shape:* Concave, linear
*Across-slope shape:* Concave
*Ecological site:* F093BY004MI - Wet Lowlands

*Other vegetative classification:* Mod AWC, high water table (G090AY004WI), Fraxinus Impatiens (FI_1), Tsuga Maianthemum Coptis (TMC_1)
*Hydric soil rating:* Yes

## Data Source Information

Soil Survey Area: Gogebic County, Michigan
Survey Area Data: Version 14, Aug 29, 2022

Soil Survey Area: Iron County, Wisconsin
Survey Area Data: Version 18, Sep 6, 2022

# Gogebic County, Michigan

## 689B—Chabeneau-Channing-Gogebic complex, 0 to 6 percent slopes, stony

### Map Unit Setting

*National map unit symbol:* 1kwfv
*Elevation:* 590 to 1,970 feet
*Mean annual precipitation:* 27 to 38 inches
*Mean annual air temperature:* 36 to 45 degrees F
*Frost-free period:* 70 to 170 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Chabeneau and similar soils:* 35 percent
*Channing and similar soils:* 30 percent
*Gogebic, stony, and similar soils:* 25 percent
*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Chabeneau

#### Setting

*Landform:* Stream terraces, eskers, outwash plains
*Landform position (two-dimensional):* Summit
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Coarse-loamy glaciofluvial deposits over sandy and gravelly glaciofluvial deposits

#### Typical profile

*Oe - 0 to 1 inches:* moderately decomposed plant material
*A - 1 to 2 inches:* fine sandy loam
*E - 2 to 5 inches:* silt loam
*Bs1 - 5 to 10 inches:* silt loam
*Bs2 - 10 to 22 inches:* silt loam
*2BC - 22 to 30 inches:* gravelly loamy sand
*2C1 - 30 to 48 inches:* stratified coarse sand to very gravelly coarse sand
*2C2 - 48 to 121 inches:* stratified sand to gravelly sand

#### Properties and qualities

*Slope:* 0 to 3 percent
*Surface area covered with cobbles, stones or boulders:* 0.1 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Moderately well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* About 18 inches
*Frequency of flooding:* None

*Frequency of ponding:* None
*Available water supply, 0 to 60 inches:* Low (about 5.7 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 6s
*Hydrologic Soil Group:* B/D
*Ecological site:* F093BY010MI - Loamy Uplands
*Forage suitability group:* Mod AWC, adequately drained (G090AY005WI)
*Other vegetative classification:* Acer Tsuga Dryopteris (ATD_1), Mod AWC, adequately drained (G090AY005WI)
*Hydric soil rating:* No

## Description of Channing

### Setting

*Landform:* Outwash plains, stream terraces, moraines
*Landform position (two-dimensional):* Footslope
*Down-slope shape:* Linear
*Across-slope shape:* Concave
*Parent material:* Coarse-loamy glaciofluvial deposits over sandy and gravelly glaciofluvial deposits

### Typical profile

*Oi - 0 to 2 inches:* slightly decomposed plant material
*A - 2 to 6 inches:* very fine sandy loam
*E - 6 to 7 inches:* very fine sandy loam
*Bs1 - 7 to 16 inches:* very fine sandy loam
*Bs2 - 16 to 24 inches:* fine sandy loam
*2C1 - 24 to 29 inches:* gravelly sand
*2C2 - 29 to 62 inches:* gravelly sand

### Properties and qualities

*Slope:* 0 to 3 percent
*Surface area covered with cobbles, stones or boulders:* 0.1 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat poorly drained
*Runoff class:* Negligible
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)
*Depth to water table:* About 6 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water supply, 0 to 60 inches:* Low (about 5.3 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 4w
*Hydrologic Soil Group:* B/D
*Ecological site:* F093BY005MI - Moist Lowlands
*Forage suitability group:* Mod AWC, high water table (G090AY004WI)

*Other vegetative classification:* Mod AWC, high water table (G090AY004WI), Acer Tsuga Dryopteris - Circea Impatiens (ATD-CI_2)
*Hydric soil rating:* No

### Description of Gogebic, Stony

#### Setting

*Landform:* Till plains
*Landform position (two-dimensional):* Summit
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Modified loamy eolian deposits over loamy till

#### Typical profile

*Oi - 0 to 1 inches:* slightly decomposed plant material
*A - 1 to 5 inches:* silt loam
*E - 5 to 8 inches:* silt loam
*Bhs - 8 to 12 inches:* silt loam
*Bs - 12 to 20 inches:* fine sandy loam
*2E/Bx - 20 to 33 inches:* gravelly fine sandy loam
*2B/Ex - 33 to 49 inches:* fine sandy loam
*2Bt - 49 to 54 inches:* fine sandy loam
*2BC - 54 to 68 inches:* fine sandy loam
*2C - 68 to 80 inches:* gravelly fine sandy loam

#### Properties and qualities

*Slope:* 1 to 6 percent
*Surface area covered with cobbles, stones or boulders:* 0.1 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Moderately well drained
*Runoff class:* High
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately low (0.00 to 0.06 in/hr)
*Depth to water table:* About 12 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water supply, 0 to 60 inches:* Low (about 3.6 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 4e
*Hydrologic Soil Group:* D
*Ecological site:* F093BY008MI - Fragic Loamy Uplands
*Forage suitability group:* Low AWC, adequately drained (G090AY002WI)
*Other vegetative classification:* Low AWC, adequately drained (G090AY002WI), Acer Viola Osmorhiza (AVO_1), Acer Tsuga Dryopteris (ATD_1)
*Hydric soil rating:* No

**Minor Components**

**Minocqua**

*Percent of map unit:* 5 percent
*Landform:* Depressions on stream terraces, depressions on outwash plains, drainageways on stream terraces, drainageways on outwash plains
*Down-slope shape:* Linear
*Across-slope shape:* Concave
*Ecological site:* F093BY004MI - Wet Lowlands
*Other vegetative classification:* Tsuga Maianthemum Coptis (TMC_1)
*Hydric soil rating:* Yes

**Cathro**

*Percent of map unit:* 5 percent
*Landform:* Drainageways, depressions, swamps
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* F093BY002MI - Mucky Swamps
*Other vegetative classification:* Tsuga-Thuja-Mitella (TTM_2), Fraxinus Impatiens (FI_1)
*Hydric soil rating:* Yes

# Data Source Information

Soil Survey Area: Gogebic County, Michigan
Survey Area Data: Version 14, Aug 29, 2022

Soil Survey Area: Iron County, Wisconsin
Survey Area Data: Version 18, Sep 6, 2022

# Gogebic County, Michigan

## 230B—Moquah-Arnheim complex, 0 to 3 percent slopes, frequently flooded

### Map Unit Setting

*National map unit symbol:* 1kwgz
*Elevation:* 600 to 1,800 feet
*Mean annual precipitation:* 25 to 34 inches
*Mean annual air temperature:* 37 to 43 degrees F
*Frost-free period:* 100 to 140 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Moquah, frequently flooded, and similar soils:* 55 percent
*Arnheim, frequently flooded, and similar soils:* 30 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Moquah, Frequently Flooded

#### Setting

*Landform:* Flood plains
*Landform position (two-dimensional):* Footslope, toeslope
*Landform position (three-dimensional):* Base slope, rise, talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Coarse-loamy alluvium

#### Typical profile

*A - 0 to 5 inches:* loam
*C1 - 5 to 19 inches:* stratified loamy fine sand to loamy very fine sand to silt loam
*C2 - 19 to 48 inches:* stratified fine sand to very fine sandy loam to silt loam
*C3 - 48 to 55 inches:* stratified silt loam
*C4 - 55 to 80 inches:* stratified sand to fine sand to loamy fine sand to silt loam

#### Properties and qualities

*Slope:* 0 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Moderately well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* About 42 inches
*Frequency of flooding:* FrequentRareNone
*Frequency of ponding:* None
*Available water supply, 0 to 60 inches:* High (about 10.3 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 2e
*Hydrologic Soil Group:* A
*Ecological site:* R092XY004WI - Seasonally Dry Floodplains
*Forage suitability group:* High AWC, adequately drained (G090AY008WI)
*Other vegetative classification:* Acer Viola Osmorhiza (AVO_1), Acer Osmorhiza Caulophyllum (AOC), High AWC, adequately drained (G090AY008WI)
*Hydric soil rating:* No

## Description of Arnheim, Frequently Flooded

**Setting**

*Landform:* Flood plains
*Landform position (two-dimensional):* Footslope, toeslope
*Landform position (three-dimensional):* Talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Loamy alluvium

**Typical profile**

*A - 0 to 5 inches:* mucky silt loam
*Cg - 5 to 10 inches:* silt loam
*C1 - 10 to 15 inches:* very fine sandy loam
*C2 - 15 to 24 inches:* silt loam
*C3 - 24 to 80 inches:* stratified very fine sandy loam to silt loam to loamy fine sand to fine sandy loam

**Properties and qualities**

*Slope:* 0 to 1 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Poorly drained
*Runoff class:* Negligible
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* About 0 inches
*Frequency of flooding:* FrequentNoneOccasional
*Frequency of ponding:* Frequent
*Available water supply, 0 to 60 inches:* High (about 10.5 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7w
*Hydrologic Soil Group:* B/D
*Ecological site:* R092XY005WI - Wet Floodplains
*Forage suitability group:* Frequently flooded, organics (G090AY010WI)
*Other vegetative classification:* Frequently flooded, organics (G090AY010WI), Fraxinus Mentha Carex (FMC_1), Fraxinus Impatiens (FI_1)
*Hydric soil rating:* Yes

**Minor Components**

**Cathro, frequently flooded**

*Percent of map unit:* 5 percent
*Landform:* Drainageways, depressions, swamps
*Landform position (two-dimensional):* Toeslope
*Landform position (three-dimensional):* Dip, talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* F093BY002MI - Mucky Swamps
*Other vegetative classification:* Tsuga-Thuja-Mitella (TTM_2), Fraxinus Impatiens (FI_1)
*Hydric soil rating:* Yes

**Gull point, frequently flooded**

*Percent of map unit:* 5 percent
*Landform:* Flood plains on till plains
*Landform position (two-dimensional):* Toeslope
*Landform position (three-dimensional):* Base slope, dip, talf
*Down-slope shape:* Linear
*Across-slope shape:* Concave, linear
*Ecological site:* R092XY005WI - Wet Floodplains
*Other vegetative classification:* Fraxinus Mentha Carex (FMC_1), Fraxinus Impatiens (FI_1)
*Hydric soil rating:* Yes

**Schaat creek, frequently flooded**

*Percent of map unit:* 5 percent
*Landform:* Flood plains on flood plains
*Landform position (two-dimensional):* Footslope, toeslope
*Landform position (three-dimensional):* Talf, dip
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* R092XY005WI - Wet Floodplains
*Other vegetative classification:* Fraxinus Mentha Carex - Caltha (FMC-C)
*Hydric soil rating:* Yes

# Data Source Information

Soil Survey Area: Gogebic County, Michigan
Survey Area Data: Version 14, Aug 29, 2022

Soil Survey Area: Iron County, Wisconsin
Survey Area Data: Version 18, Sep 6, 2022

# Gogebic County, Michigan

## 351C—Gogebic silt loam, 6 to 18 percent slopes, very stony, rocky

### Map Unit Setting

*National map unit symbol:* 2xxjc
*Elevation:* 1,050 to 1,870 feet
*Mean annual precipitation:* 27 to 38 inches
*Mean annual air temperature:* 36 to 45 degrees F
*Frost-free period:* 70 to 170 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Gogebic, very stony, and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Gogebic, Very Stony

#### Setting

*Landform:* Moraines
*Landform position (two-dimensional):* Shoulder, backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Loamy eolian deposits over loamy till

#### Typical profile

*Oe - 0 to 1 inches:* moderately decomposed plant material
*A - 1 to 4 inches:* silt loam
*E - 4 to 5 inches:* silt loam
*Bhs - 5 to 9 inches:* silt loam
*Bs - 9 to 20 inches:* fine sandy loam
*2E/Bx - 20 to 30 inches:* gravelly fine sandy loam
*2B/Ex - 30 to 43 inches:* fine sandy loam
*2Bt - 43 to 51 inches:* fine sandy loam
*2BC - 51 to 59 inches:* fine sandy loam
*2C - 59 to 79 inches:* gravelly fine sandy loam

#### Properties and qualities

*Slope:* 6 to 18 percent
*Surface area covered with cobbles, stones or boulders:* 2.0 percent
*Depth to restrictive feature:* 12 to 35 inches to fragipan
*Drainage class:* Moderately well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low (0.02 to 0.06 in/hr)
*Depth to water table:* About 10 to 18 inches
*Frequency of flooding:* None
*Frequency of ponding:* None

*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water supply, 0 to 60 inches:* Low (about 4.2 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 6s
*Hydrologic Soil Group:* D
*Ecological site:* F093BY008MI - Fragic Loamy Uplands
*Forage suitability group:* Low AWC, adequately drained (G090AY002WI)
*Other vegetative classification:* Acer Tsuga Dryopteris (ATD_1), Acer Viola Osmorhiza (AVO_1), Low AWC, adequately drained (G090AY002WI)
*Hydric soil rating:* No

## Minor Components

**Michigamme, very stony**

*Percent of map unit:* 10 percent
*Landform:* Moraines
*Landform position (two-dimensional):* Shoulder, backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Ecological site:* F093BY008MI - Fragic Loamy Uplands
*Other vegetative classification:* Mod AWC, adequately drained with limitations (G090AY006WI), Acer-Tsuga-Dryopteris (ATD_2), Acer Viola Osmorhiza (AVO_1)
*Hydric soil rating:* No

**Tula, very stony**

*Percent of map unit:* 4 percent
*Landform:* Drainageways on moraines
*Down-slope shape:* Linear
*Across-slope shape:* Concave
*Ecological site:* F093BY005MI - Moist Lowlands
*Other vegetative classification:* Tsuga Maianthemum Coptis - Dryopteris (TMC-D_1), Acer Viola Osmorhiza - Circaea Impatiens (AVO-CI_3)
*Hydric soil rating:* No

**Rock outcrop**

*Percent of map unit:* 1 percent
*Landform:* Moraines
*Landform position (two-dimensional):* Shoulder, backslope
*Landform position (three-dimensional):* Interfluve
*Down-slope shape:* Convex
*Across-slope shape:* Convex

*Hydric soil rating:* No

## Data Source Information

Soil Survey Area: Gogebic County, Michigan
Survey Area Data: Version 14, Aug 29, 2022

Soil Survey Area: Iron County, Wisconsin
Survey Area Data: Version 18, Sep 6, 2022

# Forestland Productivity

This table is designed to assist forestland owners or managers in planning the use of soils for wood crops. It provides the potential productivity of the soils for wood crops.

*Potential productivity* of merchantable or *common trees* on a soil is expressed as a site index and as a volume growth rate number. The *site index* is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. *Common trees* are those that forestland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability. More detailed information regarding site index is available in the "National Forestry Manual," which is available in local offices of the Natural Resources Conservation Service or on the Internet.

The *Base Age* is the age of trees in years on which the site index is based. "TA" indicates total age. "BH" indicates breast height age. "N/A" indicates that base age is not applicable.

The *Site Index Curve Number* is listed in the National Register of Site Index Curves. It identifies the site index curve used to determine the site index.

The *Volume Growth Rate* is the maximum wood volume annual growth rate likely to be produced by the tree species. This number, expressed as cubic feet per acre per year, is calculated at the age of culmination of the mean annual increment (CMAI). It indicates the maximum volume of wood fiber produced per year in a fully stocked, even-aged, unmanaged stand.

Reference:
United States Department of Agriculture, Natural Resources Conservation Service, National Forestry Manual.

# Report—Forestland Productivity

| Forestland Productivity–Gogebic County, Michigan | | | | |
|---|---|---|---|---|
| **Map unit symbol and soil name** | **Potential productivity** | | | **Trees to manage** |
| | **Common trees** | **Site Index** | **Volume of wood fiber** | |
| | | | *Cu ft/ac/yr* | |
| 230B—Moquah-Arnheim complex, 0 to 3 percent slopes, frequently flooded | | | | |
| Moquah, frequently flooded | American basswood | — | — | Eastern white pine, White spruce |
| | Eastern white pine | — | — | |
| | Green ash | — | — | |
| | Quaking aspen | — | — | |
| | Red maple | 60 | 38.00 | |
| | Slippery elm | — | — | |
| | Sugar maple | — | — | |
| | White spruce | — | — | |
| Arnheim, frequently flooded | Balsam fir | — | — | Northern white cedar, White spruce |
| | Black ash | — | — | |
| | Green ash | — | — | |
| | Northern white cedar | — | — | |
| | Paper birch | — | — | |
| | Quaking aspen | — | — | |
| | Red maple | — | — | |
| | Tamarack | — | — | |
| | White spruce | 38 | 72.00 | |
| | Yellow birch | — | — | |

| Forestland Productivity–Gogebic County, Michigan | | | | |
|---|---|---|---|---|
| Map unit symbol and soil name | Potential productivity | | | Trees to manage |
| | Common trees | Site Index | Volume of wood fiber | |
| | | | *Cu ft/ac/yr* | |
| 303—Bowstring-Arnheim complex, 0 to 1 percent slopes, frequently flooded | | | | |
| Bowstring, frequently flooded | Balsam poplar | — | — | Black ash |
| | Black ash | — | — | |
| | Paper birch | — | — | |
| | Red maple | — | — | |
| | Silver maple | — | — | |
| Arnheim, frequently flooded | Balsam fir | — | — | Northern white cedar, White spruce |
| | Black ash | — | — | |
| | Green ash | — | — | |
| | Northern white cedar | — | — | |
| | Paper birch | — | — | |
| | Quaking aspen | — | — | |
| | Red maple | — | — | |
| | Tamarack | — | — | |
| | White spruce | 38 | 72.00 | |
| | Yellow birch | — | — | |
| 307—Lupton and Cathro soils, 0 to 1 percent slopes | | | | |
| Lupton | — | — | — | — |
| Cathro | — | — | — | — |
| 310B—Gogebic fine sandy loam, 1 to 6 percent slopes, stony | | | | |
| Gogebic, stony | American basswood | 66 | — | Eastern white pine, Red pine, White spruce |
| | Eastern hemlock | — | — | |
| | Ironwood | — | — | |
| | Northern red oak | 73 | 64.00 | |
| | Quaking aspen | 75 | 92.00 | |
| | Red maple | — | — | |
| | Red pine | 80 | 168.00 | |
| | Sugar maple | 63 | 42.00 | |
| | White ash | — | — | |
| | Yellow birch | — | — | |

| Forestland Productivity–Gogebic County, Michigan | | | | |
|---|---|---|---|---|
| **Map unit symbol and soil name** | **Potential productivity** | | | **Trees to manage** |
| | **Common trees** | **Site Index** | **Volume of wood fiber** | |
| | | | *Cu ft/ac/yr* | |
| 311B—Tula-Gogebic complex, 0 to 6 percent slopes, stony | | | | |
| Tula, stony | Balsam fir | — | — | Eastern white pine, White spruce |
| | Eastern hemlock | — | — | |
| | Eastern white pine | — | — | |
| | Quaking aspen | — | — | |
| | Red maple | 65 | 40.00 | |
| | Sugar maple | — | — | |
| Gogebic, stony | American basswood | 66 | — | Eastern white pine, Red pine, White spruce |
| | Eastern hemlock | — | — | |
| | Ironwood | — | — | |
| | Northern red oak | 73 | 64.00 | |
| | Quaking aspen | 75 | 92.00 | |
| | Red maple | — | — | |
| | Red pine | 80 | 168.00 | |
| | Sugar maple | 63 | 42.00 | |
| | White ash | — | — | |
| | Yellow birch | — | — | |
| 351C—Gogebic silt loam, 6 to 18 percent slopes, very stony, rocky | | | | |
| Gogebic, very stony | American basswood | 66 | — | Eastern white pine, Red pine, White spruce |
| | Eastern hemlock | — | — | |
| | Ironwood | — | — | |
| | Northern red oak | 73 | 64.00 | |
| | Quaking aspen | 75 | 92.00 | |
| | Red maple | — | — | |
| | Red pine | 80 | 168.00 | |
| | Sugar maple | 63 | 42.00 | |
| | White ash | — | — | |
| | Yellow birch | — | — | |

| Forestland Productivity–Gogebic County, Michigan | | | | |
|---|---|---|---|---|
| Map unit symbol and soil name | Potential productivity | | | Trees to manage |
| | Common trees | Site Index | Volume of wood fiber | |
| | | | *Cu ft/ac/yr* | |
| 353A—Tula fine sandy loam, 0 to 4 percent slopes, stony | | | | |
| Tula, stony | Balsam fir | — | — | Eastern white pine, White spruce |
| | Eastern hemlock | — | — | |
| | Eastern white pine | — | — | |
| | Quaking aspen | — | — | |
| | Red maple | 65 | 40.00 | |
| | Sugar maple | — | — | |
| 369D—Dishno-Gogebic-Peshekee-Rock outcrop complex, 18 to 35 percent slopes, very stony | | | | |
| Dishno, very stony | American basswood | 68 | — | Eastern white pine, Red pine |
| | Quaking aspen | 80 | 95.00 | |
| | Red pine | 80 | 168.00 | |
| | Sugar maple | 70 | 46.00 | |
| Gogebic, very stony | American basswood | 66 | — | Eastern white pine, Red pine, White spruce |
| | Eastern hemlock | — | — | |
| | Ironwood | — | — | |
| | Northern red oak | 73 | 64.00 | |
| | Quaking aspen | 75 | 92.00 | |
| | Red maple | — | — | |
| | Red pine | 80 | 168.00 | |
| | Sugar maple | 63 | 42.00 | |
| | White ash | — | — | |
| | Yellow birch | — | — | |
| Peshekee, very stony | Eastern hemlock | — | — | Eastern white pine, Red pine |
| | Eastern white pine | 53 | 99.00 | |
| | Northern red oak | 55 | 42.00 | |
| | Paper birch | 56 | 59.00 | |
| | Quaking aspen | — | — | |
| | Red maple | — | — | |
| | Red pine | — | — | |
| | Sugar maple | 53 | 34.00 | |
| | Yellow birch | — | — | |
| Rock outcrop | — | — | — | — |

| Forestland Productivity–Gogebic County, Michigan | | | | |
|---|---|---|---|---|
| Map unit symbol and soil name | Potential productivity | | | Trees to manage |
| | Common trees | Site Index | Volume of wood fiber | |
| | | | *Cu ft/ac/yr* | |
| 375—Dumps and Pits, mine | | | | |
| Dumps, mine | — | — | — | — |
| 419—Pleine-Cathro-Gay complex, 0 to 1 percent slopes, stony | | | | |
| Pleine | Balsam fir | 45 | 83.00 | Eastern arborvitae, Tamarack |
| | Balsam poplar | — | — | |
| | Black ash | — | — | |
| | Northern white cedar | — | — | |
| | Paper birch | — | — | |
| | Red maple | — | — | |
| Cathro | Balsam fir | 40 | 72.00 | Northern white cedar, White spruce |
| | Black ash | 15 | 29.00 | |
| | Northern white cedar | 15 | 29.00 | |
| | Paper birch | — | — | |
| | Red maple | 40 | 29.00 | |
| | Tamarack | 35 | 29.00 | |
| | White spruce | — | — | |
| Gay | American basswood | 51 | — | Eastern white pine, Larch, White spruce |
| | Balsam fir | 46 | — | |
| | Black spruce | 51 | — | |
| | Green ash | 52 | — | |
| | Red maple | 51 | — | |
| | Tamarack | 60 | — | |
| | White spruce | 60 | — | |

| Forestland Productivity–Gogebic County, Michigan | | | | |
|---|---|---|---|---|
| **Map unit symbol and soil name** | **Potential productivity** | | | **Trees to manage** |
| | **Common trees** | **Site Index** | **Volume of wood fiber** | |
| | | | *Cu ft/ac/yr* | |
| 429C—Gogebic-Peshekee complex, 6 to 18 percent slopes, very rocky, very stony | | | | |
| Gogebic, very stony | American basswood | 66 | — | Eastern white pine, Red pine, White spruce |
| | Eastern hemlock | — | — | |
| | Ironwood | — | — | |
| | Northern red oak | 73 | 64.00 | |
| | Quaking aspen | 75 | 92.00 | |
| | Red maple | — | — | |
| | Red pine | 80 | 168.00 | |
| | Sugar maple | 63 | 42.00 | |
| | White ash | — | — | |
| | Yellow birch | — | — | |
| Peshekee | Eastern hemlock | — | — | Eastern white pine, Red pine |
| | Eastern white pine | 53 | 99.00 | |
| | Northern red oak | 55 | 42.00 | |
| | Paper birch | 56 | 59.00 | |
| | Quaking aspen | — | — | |
| | Red maple | — | — | |
| | Red pine | — | — | |
| | Sugar maple | 53 | 34.00 | |
| | Yellow birch | — | — | |

| Forestland Productivity–Gogebic County, Michigan | | | | |
|---|---|---|---|---|
| Map unit symbol and soil name | Potential productivity | | | Trees to manage |
| | Common trees | Site Index | Volume of wood fiber | |
| | | | *Cu ft/ac/yr* | |
| 432E—Schweitzer-Michigamme-Rock outcrop complex, 18 to 55 percent slopes, very stony | | | | |
| Schweitzer | American basswood | — | — | Eastern white pine, Red pine |
| | Balsam fir | — | — | |
| | Eastern hemlock | — | — | |
| | Eastern white pine | — | — | |
| | Ironwood | — | — | |
| | Northern red oak | — | — | |
| | Quaking aspen | — | — | |
| | Red maple | — | — | |
| | Sugar maple | 64 | 40.00 | |
| Michigamme | American basswood | 68 | — | Eastern white pine, Red pine |
| | American elm | — | — | |
| | Bigtooth aspen | — | — | |
| | Black cherry | — | — | |
| | Eastern hemlock | — | — | |
| | Ironwood | — | — | |
| | Quaking aspen | 80 | 95.00 | |
| | Sugar maple | 70 | 46.00 | |
| | White ash | — | — | |
| | Yellow birch | 60 | 43.00 | |
| Rock outcrop | — | — | — | — |

| Forestland Productivity–Gogebic County, Michigan | | | | |
|---|---|---|---|---|
| **Map unit symbol and soil name** | **Potential productivity** | | | **Trees to manage** |
| | **Common trees** | **Site Index** | **Volume of wood fiber** | |
| | | | *Cu ft/ac/yr* | |
| 688—Cathro-Leafriver complex, 0 to 1 percent slopes, frequently flooded | | | | |
| Cathro | Balsam fir | 40 | 72.00 | Northern white cedar, White spruce |
| | Black spruce | 15 | 29.00 | |
| | Northern white cedar | 15 | 29.00 | |
| | Paper birch | — | — | |
| | Red maple | 40 | 29.00 | |
| | Tamarack | 35 | 29.00 | |
| | White spruce | — | — | |
| Leafriver | American elm | — | — | Balsam fir, Black spruce, Northern white cedar, Tamarack |
| | Balsam poplar | — | — | |
| | Bigtooth aspen | — | — | |
| | Black ash | — | — | |
| | Quaking aspen | — | — | |
| | Red maple | 54 | — | |
| | Sugar maple | — | — | |
| | White ash | — | — | |

| Forestland Productivity–Gogebic County, Michigan | | | | |
|---|---|---|---|---|
| Map unit symbol and soil name | Potential productivity | | | Trees to manage |
| | Common trees | Site Index | Volume of wood fiber | |
| | | | *Cu ft/ac/yr* | |
| 689B—Chabeneau-Channing-Gogebic complex, 0 to 6 percent slopes, stony | | | | |
| Chabeneau | American basswood | 66 | — | Basswood, Bigtooth aspen, Black cherry, Eastern hemlock, Quaking aspen, Sugar maple, Sugar maple, Sugar maple, Yellow birch |
| | Northern red oak | 73 | 64.00 | |
| | Quaking aspen | 75 | 92.00 | |
| | Red pine | 80 | 168.00 | |
| | Sugar maple | 63 | 42.00 | |
| Channing | American basswood | 66 | — | Balsam fir, Basswood, Bigtooth aspen, Black ash, Black cherry, Eastern hemlock, Quaking aspen, Red maple, Red maple, Sugar maple, Sugar maple, Sugar maple, White ash, White spruce, Yellow birch |
| | Northern red oak | 73 | 64.00 | |
| | Quaking aspen | 75 | 92.00 | |
| | Red pine | 80 | 168.00 | |
| | Sugar maple | 63 | 42.00 | |
| Gogebic, stony | American basswood | 66 | — | Eastern white pine, Red pine, White spruce |
| | Eastern hemlock | — | — | |
| | Ironwood | — | — | |
| | Northern red oak | 73 | 64.00 | |
| | Quaking aspen | 75 | 92.00 | |
| | Red maple | — | — | |
| | Red pine | 80 | 168.00 | |
| | Sugar maple | 63 | 42.00 | |
| | White ash | — | — | |
| | Yellow birch | — | — | |

| Forestland Productivity–Iron County, Wisconsin | | | | |
|---|---|---|---|---|
| **Map unit symbol and soil name** | **Potential productivity** | | | **Trees to manage** |
| | **Common trees** | **Site Index** | **Volume of wood fiber** | |
| | | | *Cu ft/ac/yr* | |
| 5504A—Moquah-Arnheim complex, 0 to 3 percent slopes, frequently flooded | | | | |
| Moquah, frequently flooded | American basswood | — | — | Eastern white pine, White spruce |
| | Eastern white pine | — | — | |
| | Green ash | — | — | |
| | Quaking aspen | — | — | |
| | Red maple | 60 | 38.00 | |
| | Slippery elm | — | — | |
| | Sugar maple | — | — | |
| | White spruce | — | — | |
| Arnheim, frequently flooded | Balsam fir | — | — | Northern white cedar, White spruce |
| | Black ash | — | — | |
| | Green ash | — | — | |
| | Northern white cedar | — | — | |
| | Paper birch | — | — | |
| | Quaking aspen | — | — | |
| | Red maple | — | — | |
| | Tamarack | — | — | |
| | White spruce | 38 | 72.00 | |
| | Yellow birch | — | — | |

## Data Source Information

Soil Survey Area: Gogebic County, Michigan
Survey Area Data: Version 14, Aug 29, 2022

Soil Survey Area: Iron County, Wisconsin
Survey Area Data: Version 18, Sep 6, 2022

USDA United States Department of Agriculture

# Tree/Shrub Establishment (Code 612)
# Michigan
# Implementation Requirements

Implementation Requirements are templates for planners to use to provide site-specific information and instructions necessary to install or implement a conservation practice.

[Notes to planners appear in brackets in this document. Design the practice to meet the criteria and documentation requirements in NRCS-MI Conservation Practice Standard (CPS) Tree/Shrub Establishment (Code 612). Refer to the 612 Guidance Document (GD) for practice design information. An asterisk (*) indicate an item is required to be documented by the 612 CPS.]

**General Information:**

| | | | |
|---|---|---|---|
| Client name*: | | County: | |
| Contract #: | | Farm No: | |
| Specifications date: | | Tract No: | |

**Site Information:**

| | | | |
|---|---|---|---|
| Field(s)*: | | Acres of 612*: | |
| Soil Map Unit(s): | | CTSG(s): | |

**Plan Map*:** Attach a plan map showing the location of the conservation practice.

**Soils Map*:** Attach a soils map for the site, with a description of the soils and ecological site (if available), or describe these under "Additional Information" below. See Web Soil Survey.

**Practice Purpose(s)*:** [check all that apply]

| | |
|---|---|
| ☐ | Maintain or improve desirable plant diversity, productivity, and health by establishing woody plants |
| ☐ | Create or improve habitat for desired wildlife species compatible with ecological characteristics of the site |
| ☐ | Control erosion |
| ☐ | Reduce excess nutrients and other pollutants in runoff and groundwater |
| ☐ | Sequester and store carbon |
| ☐ | Restore or maintain native plant communities |
| ☐ | Develop renewable energy systems |
| ☐ | Conserve energy |
| ☐ | Provide for beneficial organisms and pollinators |

**Site Preparation:**
(For information only – include site preparation in plan as separate conservation practice: Tree/Shrub Site Preparation (Code 490))

| | | | |
|---|---|---|---|
| Initial site preparation method: | | Date: | |
| Additional information: | | | |

T**ree/Shrub Establishment General Information:**

## Tree/Shrub Establishment (612)
## Implementation Requirements

| | | | |
|---|---|---|---|
| Planting method*: | | Planting date*: | |
| Storage requirements: | | | |
| Avg. spacing between rows*: | | Avg. in-row spacing*: | |
| Avg. stems/Ac. *: | | Avg. seedling size/type: | |

**Species Composition:**

| Species* | | Form | Kind of stock[1] | Plants per acre* | Total plants* |
|---|---|---|---|---|---|
| 1 | | ☐ Tree ☐ Shrub | | | |
| 2 | | ☐ Tree ☐ Shrub | | | |
| 3 | | ☐ Tree ☐ Shrub | | | |
| 4 | | ☐ Tree ☐ Shrub | | | |
| 5 | | ☐ Tree ☐ Shrub | | | |
| 6 | | ☐ Tree ☐ Shrub | | | |
| 7 | | ☐ Tree ☐ Shrub | | | |
| 8 | | ☐ Tree ☐ Shrub | | | |
| 9 | | ☐ Tree ☐ Shrub | | | |
| 10 | | ☐ Tree ☐ Shrub | | | |
| 11 | | ☐ Tree ☐ Shrub | | | |
| 12 | | ☐ Tree ☐ Shrub | | | |
| | | Total number of trees/shrubs needed*: | | /ac. | (Total) |

[1] Bareroot, container, cutting, balled and burlapped, etc. Include size, caliper, height, and age as applicable.

**Post-planting Weed Control:**
(For information only – include weed control in plan as separate conservation practice: Mulching (484), Herbaceous Weed Control (315), etc.)

| | | | |
|---|---|---|---|
| Method/practice used: | | Date(s) planned: | |
| Additional information: | | | |

**Additional Practice Specifications***:

## Tree/Shrub Establishment (612)
## Implementation Requirements

[Provide additional practice installation information necessary to complete the practice, including information about herbivore protection, and other techniques needed for the practice to succeed.]

| |
|---|
| Additional specifications: n/a |

## Tree/Shrub Establishment (612)
## Implementation Requirements

**Operation and Maintenance Plan*:**

The following actions are required after completion of initial practice installation to ensure the practice functions correctly during its 15-year practice lifespan:

- Inspections:
  Inspect the site at least monthly during the first year after practice installation. After the first year, inspect the site annually. Look for the following concerns during inspections and take necessary action to address them:
  - Adverse impacts to trees/shrubs by pests, competing vegetation, fire, livestock, non-functioning tree shelters and weed barriers, etc.
  - Presence of invasive species
  - Storm damage
  - Damage by trespass
  - Erosion, compaction, and other soil and water quality concerns
  - Inadequate regeneration (For treatments intended to initiate regeneration, if, after two years, the regeneration is inadequate, initiate artificial regeneration using Tree/Shrub Establishment (612).)

  Consult with a Technical Service Provider, Conservation District Forester, or NRCS conservationist as needed to determine necessary measures to address identified issues identified during inspections.
- Replant the site if survival falls below 80% of the initial planting density.
- Control access by vehicles and/or equipment during and after tree/shrub establishment to protect new plants and minimize erosion, compaction and other site impacts.
- Follow-up weed control requirements: [Plan follow-up weed control using NRCS-MI CPS Herbaceous Weed Treatment (315), but describe requirements here]
- Other Operation and Maintenance requirements:
  [Include information about other needed O&M treatments, including mowing, fertilization, supplemental watering, etc.]

**Design Certification:**

I certify that these specifications meet applicable conservation practice standard criteria, the planning criteria of the resource concerns being addressed, and client goals and objectives.

| | |
|---|---|
| | |

NRCS Representative or TSP Signature Date

**Installation Certification:**

| | |
|---|---|
| Practice check-out notes: | |

I certify that the practice as described above ☐ has been / ☐ has not been installed and managed in accordance to the specifications in the conservation plan and NRCS-MI CPS Tree/Shrub Establishment (Code 612):

| | |
|---|---|
| | |

NRCS Representative Signature Date

# Brush Management

Conservation Sheet 314

**Natural Resources Conservation Service**

**Michigan**

Brush management is the management or removal of woody (non-herbaceous or succulent) plants. Invasive and noxious woody species are included as target species for management or removal. This practice applies on all lands except cropland.

The brush management practice is designed to achieve the desired plant community based on species composition, structure, density and canopy cover or height. This will be accomplished by mechanical, chemical, biological, burning methods alone or in combination.

**Mechanical treatments**, such as hand cutting or mowing, frilling, or girdling and Prescribed Burning will be done at a time that cutting or fire is most critical to control the target brush species. In some cases, forage production may have to be sacrificed in the adjacent area of brush control applications.

**Chemical treatment** methods include:
**Foliage Stem Spraying -** Herbicide sprays are applied to the stem and foliage. This type of application is least effective on resprouting species. Application should be made from the time that leaves are fully expanded in the spring until fall color. Preventing drift to surrounding areas is more difficult with this method. Low-pressure coarse spraying with drift reduction additives is recommended.

**Basal Bark Application -** Basal spraying is a technique to deaden small trees, shrubs and occasionally vines by spraying the green bark of the lower trunk (12 to 18 inches or 30 to 46 cm) with herbicide. Herbicides used for basal spraying are generally applied with oil carriers. The technique is effective on species less than four to six inches in diameter. Care must be taken when herbicide is applied to minimize the amount that runs into the soil.

**Cut Stump Application -** The chemical is applied to freshly cut stump surfaces. Treat before the cut surface dries (within two to three hours after cutting) for optimum control. Stump treatment with the water-soluble herbicides must be done immediately after cutting the tree or vine in order to be effective. The critical area of the stump must be treated to prevent sprouting in the sapwood and bark of the

stump's cut surface. Oil-based carrier herbicides do not move readily within the plant, but penetrate the bark. To be effective in suppressing stump sprouting, the entire stump, and particularly the bark and exposed roots, must be thoroughly sprayed. Treatment with an oil-based carrier herbicide is recommended in the spring when treating species that exhibit a spring "sap flow."

**Frill, Hatchet, or Girdling Application -** Frilling and girdling are methods of controlling standing trees and shrubs that may be done with or without a herbicide. The bark around the base of the trunk is cut and the herbicide is either applied as a separate step or injected simultaneously in the cambium area. These techniques require a considerable amount of time and labor to implement.

**Tree Injection with Spaced Cuts Application -** Tree injection involves introducing an herbicide into the undesirable species through spaced cuts made around the trunk of the woody plant with an axe, hatchet or tree injector. The amount of herbicide to be placed in the cut is specified on the herbicide label. There are various tree injectors available such as "hypo-hatchet," which is a hatchet constructed to inject herbicide when it is struck into the tree.

**Soil Application -** This type of treatment includes pellets, beads, granules or concentrated liquids applied to the soil at the base of the plant within the dripline. Soil-applied herbicides usually remain active in the soil for several months or even years. Treatments can be made at any time of the year when the ground is not frozen, but control will only occur after sufficient rain has fallen. This method should only be used on non-erosive soils. Nearby trees may be injured or killed if their roots extend into the treated area.

**Biological treatment** methods include biological agents such as insects that feed on or disrupt the functions of the target specie(s) and the use of livestock trained or managed to graze and/or browse the target specie(s). NRCS will only develop biological treatment plans utilizing grazing animals. The grazing animals may be livestock owned and managed by the landowner or trained herds/flocks leased by the landowner. To ensure an enduring desired response to brush management, the conservation plan will include Conservation Practice 528 Prescribed Grazing.

Written plans and specifications including sketches and drawings for each field or management unit where brush management will be applied shall be provided to the client that adequately describes the requirements to install the practice and obtain necessary permits.

| Brush Management Design Specifications and Certification | | |
|---|---|---|
| Landowner/Operator Name: | | Farm Name: |
| County: | Township: | Tract and Field: |
| Target Specie(s) to be controlled:<br>Species to be benefited: | | Acres to be treated: |
| Purpose and objectives for using brush management: | | |
| Permits needed: | | |
| Date: | | |

| Brush Management Design Specifications<br>Check all methods that apply<br>Complete appropriate specifications sections | | |
|---|---|---|
| Treated and Untreated areas are designated on: | Map ☐<br>Sketch ☐ | Map or sketch included in client folder?<br>☐ Yes ☐ No |
| Brush canopy and/or species count or transect line locations and percent canopy or species numbers per acre of the target plant(s) | | % canopy in current condition<br>Or<br>(number) of (specie) |
| Photopoint picture taken as documentation? | | % planned control of target specie(s). |
| **Year and season of planned treatment(s):**<br>Date of treatment should be planned to achieve best control by selected method. | | |
| **Treatment Method**: (mark all that apply) | | ☐ Chemical<br>☐ Mechanical<br>☐ Biological<br>☐ Prescribed Burning (338) required |
| Chemical Treatment<br>Any herbicide used to control woody species must be federally and locally registered and must be applied strictly in accordance with registered uses, directions on the label, and other federal or state policies and requirements. The safety measures for the user must be adhered to at all times. | | Planned Application Method:<br>☐ Foliage Stem<br>☐ Basal bark<br>☐ Cut stump<br>☐ Girdling/ Frill with Herbicide<br>☐ Tree/ shrub injection<br>☐ Soil |
| Evaluation and interpretation of herbicide risk: WINPST attached. Discussed with landowner?<br><br>Chemical treatment references (list all or attach): | | |

| | |
|---|---|
| Chemical product label reference(s) (list all or attach):<br><br>Acceptable planned date ranges or growth stages for application:<br><br>Any special mitigation, timing considerations, or other factors that must be considered to ensure the safest, most effective application of the herbicide (drift reduction additives, soil texture and organic matter, for example): | |
| Mechanical Treatment<br>Planned treatment date listed above is selected as the opportune time for best control of target species: | Planned Application Method:<br>☐ Girdling. Equipment needed:<br>☐ Hand cutting, Equipment needed:<br>☐ Brush-hog mowing<br>☐ Flail mowing<br>☐ Dozer/ Backhoe/ Bucket<br>☐ Other, as described:<br>Operating instructions, as applicable: |
| Biological Treatment<br>Grazing plans will include periods of targeted grazing to achieve planned utilization of target species. Temporary fencing may be required to limit access to other forage. Rest periods should be increased when post grazing height of desired specie(s) has exceeded the lower limit. | Planned Application Method:<br>☐ Targeted grazing with livestock, describe kind of livestock:<br><br>Time, frequency and duration and intensity of grazing and/or browsing:<br><br>Planned utilization of target specie(s):<br>%<br><br>Maximum allowable utilization on desirable non-target species:<br><br>Special mitigation, precautions, or requirements associated with the selected treatment: |
| **Monitoring Plan**<br>Target species and protected desirable species will be monitored during the growing season each year. When grazing and/or browsing animals are used as a biological treatment method, monitoring will occur at least once per week during the growing season.<br><br>Records will be kept. Document treatment effects with photo-point snapshots of the treatment area before and after treatment. | Measure and document:<br><br>☐Target species, weekly<br>☐Target species, monthly<br>Other, describe<br><br>Evaluate post-treatment regrowth of the target species:<br>☐Record forms completed for each treatment application.<br>☐Photopoint monitoring pictures submitted. |
| **Operation and Maintenance**<br>Brush management practices shall be | Chemical Safety Plan<br>Emergency services: 911 |

| | |
|---|---|
| applied using approved materials and procedures.<br><br>Operations will comply with all local, state and federal laws and ordinances.<br><br>Evaluation of practice success is an on-going operation.<br><br>Spot treatment of individual plants or areas needing re-treatment should be completed as needed while woody vegetation is small and most vulnerable to treatment effects. | Local hospital emergency number:<br>Local police or sheriff:<br>Ambulance:<br><br>In case of emergency, notify:<br>Name:<br>Phone numbers:<br><br>National Pesticide Information Center<br>1-800-858-7384<br>National Chemical Transportation Emergency Center (CHEMTRAC)<br>1-800-424-9300<br><br>Follow label requirements for mixing/loading setbacks from wells, intermittent streams and rivers, natural or impounded ponds and lakes, and reservoirs.<br><br>Post signs, according to label directions and/or federal, state, tribal or local laws, around fields that have been treated. Follow restricted entry intervals.<br><br>Dispose of herbicides and herbicide containers in accordance with label directions and adhere to federal, state, tribal, and local regulations. Read and follow label directions and maintain appropriate Material Safety Data Sheets.<br><br>Calibrate application equipment according to manufacturer's recommendations before each seasonal use and with each major chemical and site change.<br><br>Replace worn nozzle tips, cracked hoses, and faulty gauges on spray equipment.<br>Maintain records of brush/shrub control for at least 2 years. Records shall be in accordance with USDA AMS Pesticide Recordkeeping Program and Michigan Department of Agriculture requirements. |
| **Review and update plan periodically** | Incorporate new IPM technology<br>Respond to grazing management and complex plant population changes.<br>Avoid the development of plant resistance to herbicide chemicals.<br><br>Date of review: |
| **Design Approval:** | |

| | |
|---|---|
| I certify this practice has been designed with specifications to meet the conservation practice standard and that the client has been advised and given a copy of this plan. | NRCS Signature Date |
| **Client Review and Acceptance:**<br>I have received a copy of the specifications and understand the contents including the scope and location of the practice. I will obtain all necessary permits and/or rights in advance of practice application, and will comply with all ordinances and laws pertaining to the application of this practice.<br>No changes will be made in the implementation of the job without prior concurrence by NRCS.<br>I will follow the prescribed Operation and Maintenance which is necessary for proper performance during the life of the practice. | I have reviewed all specifications and agree to install as specified.<br><br>Client Signature Date |
| **Brush Management Certification** | |
| **Map or sketch provided to client?**<br>☐ Yes ☐ No | Photopoint picture taken before and after treatment as documentation of treatment effectiveness? |
| **Actual date of treatment:** | |
| **Actual acres treated:** | Treated acres match Planned acres?<br>☐ Yes ☐ No |
| Brush Management (314) has been implemented according to the MI NRCS conservation practice standard and as specified above or with modifications as noted above. | NRCS Signature Date<br><br>Client Signature Date |