

# Surveys of Coastal and Riparian Systems in Charlevoix, Antrim, Kalkaska, and Emmet Counties, Michigan, USA



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Cover: Julie McLaughlin hiking into a wet meadow along Green River in Jordan Valley State Forest, Antrim County, Michigan on June 29, 2022. Photograph by Rachel Hackett.

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## Executive Summary

Coastal and riparian areas face pressures that can affect the quantity, quality, and function of their larger ecosystem from shoreline development and modification, infrastructure, invasive species, to climate change. Land management and restoration are critical for preservation and resilience of ecosystems with great importance to water quality, watershed health, and biodiversity conservation. The purpose of this project is to assist the Charlevoix, Antrim, Kalkaska, and Emmet Counties Cooperative Invasive Species Management Area (CAKE CISMA) and partners to 1) identify Great Lakes coastal and riparian areas that should be prioritized for protection and restoration, and 2) document populations of invasive species that are commonly treated or new to the area. Michigan Natural Features Inventory surveyed coastal and riparian natural communities owned or managed by Grand Traverse Regional Land Conservancy, Little Traverse Bay Band of Odawa Indians, Little Traverse Conservancy, and Michigan Department of Natural Resources in the CAKE CISMA for rare and listed plant species, rare and high-quality natural communities, and invasive species threats. Michigan Natural Features Inventory documented new records and updated previously documented records of listed species and natural communities in the Michigan Natural Heritage Database and collected coordinates and abundances of target invasive plant species.

In the CAKE CISMA, Michigan Natural Features Inventory identified eight stands owned or managed by project partners as highest priority for management based on the quality, rarity, size, landscape context, and habitat for rare species. Twenty-one sites were described and were marked high or medium priority based on their conservation status, connectivity to higher quality stands, and/or potential to host high quality habitat and rare species. Most of the coastal areas surveyed were small, disconnected from other conservation areas, and contained documented state and/or federally listed species threatened by erosion, private development, and invasive species. The riparian areas were typically larger, connected to other natural and protected areas, ecologically important as headwater sources, and threatened by invasive species, logging, and over browsing. Given the different characteristics and threats coastal and riparian communities faced, coastal sites may benefit from greater monitoring frequency and land acquisition, while riparian sites may benefit from a long-term invasive species management plan and could be monitored less frequently.

# Acknowledgements

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# Introduction

For the North American Great Lakes, one of the world's largest freshwater ecosystems, the state of Michigan, USA, is in a unique place of ecological importance and stewardship. Michigan has approximately 35% of the 15,131 km (9,402 miles) of Great Lakes coastline and the entirety of Michigan drains into the Great Lakes Basin. Stewardship of natural areas in Michigan protects this vital North American resource.

Coastal and riparian areas face pressures that can affect the quantity, quality, and function of their larger ecosystem from shoreline development and modification, infrastructure, invasive species, to climate change. Because of its uniqueness in the world, the Great Lakes coastline is also home to many endemic species. Organizations throughout the region are tasked to protect the functions, services, and species of the Great Lakes with stewardship actions in their areas. These organizations seek the information and tools to formulate efficient ways to combat threats, restore or enhance ecologically important habitats, and protect ecologically important and high-quality natural communities and species. Stewardship of coastal and riparian natural areas can increase ecosystem resiliency to disturbance and climate change.

The purpose of this project is to assist the Charlevoix, Antrim, Kalkaska, and Emmet Counties Cooperative Invasive Species Management Area (CAKE CISMA) and partners to 1) identify Great Lakes coastal and riparian areas that should be prioritized for protection and restoration, and 2) document populations of invasive species that are commonly treated or new to the area. MNFI surveyed coastal and riparian natural communities owned or managed by Grand Traverse Regional Land Conservancy (GTRLC), Little Traverse Bay Band of Odawa Indians (LTBB), Little Traverse Conservancy (LTC), and Michigan Department of Natural Resources (MDNR) in the CAKE CISMA for rare and listed plant species, rare and high-quality natural communities, and invasive species threats. MNFI documented new records and updated previously documented records of listed species and natural communities in the Michigan Natural Heritage Database and collected coordinates, extent within stand, and density of target invasive plant species.

# Methods

## Study Area

The surveys focused on Great Lakes coastal and riparian natural communities in Charlevoix, Antrim, Kalkaska, and Emmet Counties, excluding islands, in Michigan, USA. These counties cover ecoregion section VII Northern Lacustrine-Influenced Lower Michigan and subsections of Highplains, Leelanau and Grand Traverse Peninsula, and Presque Isle (Figure 1; Albert 1995). The elevation in this ecoregion ranges from 177 to 526 m (580 to 1,725 ft). Like the rest of Michigan, the ecoregion’s geology is glacially influenced. Lake Michigan and Lake Huron strongly influence the climate in the coastal regions of this area contributing to greater snowfall [up to 356 cm (140 in)], cooler springs and longer growing seasons (up to 150 days) than the relatively higher elevations of the inland highplains. The climate makes the coastal areas suitable for commercial fruit production. The inland highplains have more extreme temperatures and spring freeze risk. Soils range greatly in the ecoregion from dune sands to clay. Vegetation prior to European settlement (circa 1800) consisted of mostly forest and swamps with open wetland and sand dune habitats. Major rivers in the area include Boardman, Jordan, and Manistee Rivers.

Surveys were conducted on prioritized conservation and recreational lands of the GTRLC, LTBB, LTC, and MDNR (Table 1). Types of coastal and riparian natural communities surveyed for this project included dry-mesic northern forest, emergent marsh, Great Lakes marsh, hardwood-conifer swamp, interdunal wetland, mesic northern forest, northern fen, northern shrub thicket, northern wet meadow, poor conifer swamp, rich conifer swamp, sand and gravel beach, submergent marsh, and wooded dune and swale complexes (Cohen et al. 2015).

Table 1. Number of acres surveyed in 2022 by county and owner/manager. Abbreviations for owners are: Grand Traverse Regional Land Conservancy (GTRLC), Little Traverse Bay Band of Odawa Indians (LTBB), Little Traverse Conservancy (LTC), and Michigan Department of Natural Resources (MDNR).

Owner/manager	Charlevoix	Antrim	Kalkaska	Emmet	Subtotals
GTRLC	0	356	2386	0	2742
LTBB	55	0	0	10	65
LTC	467	0	0	570	1037
MDNR	105	2795	0	649	3549
<i>Subtotals</i>	627	3151	2386	1229	7393

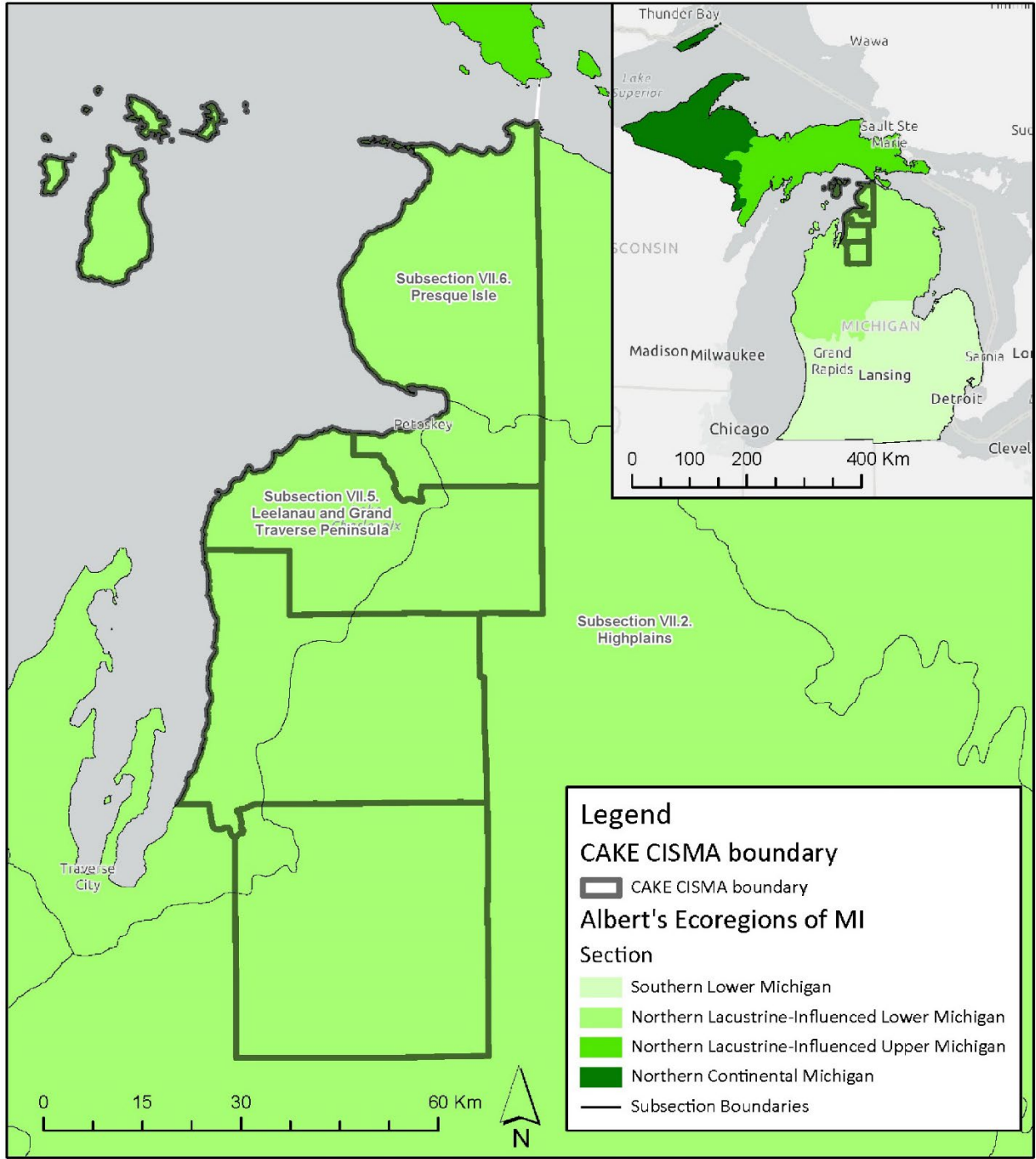


Figure 1. Boundaries of Albert's Ecoregion subsections of the Northern Lacustrine-Influenced Lower Peninsula in the CAKE CISMA region. Inset displays Albert's Ecoregions in Michigan (Albert 1995).

## Field Survey Preparation

To prepare a list of stands<sup>1</sup> to be surveyed, a digital shapefile of the conservation and recreation lands of partners was first geographically subset into those either within the State designated Coastal Zone Management Areas (Michigan Coastal Management Program 2020) or within riparian zones determined by a combination of rivers and streams with a 100 m buffer, mapped wetlands, land-use/land-cover, and digital elevation model data layers (NOAA 2016, Water Resources Division 2020, Great Lakes/Atlantic Region Office, Ducks Unlimited 2021). These stands were further prioritized by scoring and ranking them based on:

- Nearness to existing Ecological Reference Area<sup>2,3</sup> (ERA)
- Nearness to natural community Element Occurrences<sup>2,4</sup> (EO)
- Rareness of the documented reference area or natural community
- Nearness to documented habitat of federally- or state-listed plant and animal species EO<sup>4</sup>
- Date of acquisition for non-state-owned properties

More recent acquisitions were prioritized since they were less likely to have been surveyed as comprehensively as other properties. Wilderness State Park was deprioritized in our survey scheme due to independent efforts to prioritize invasive species management within the park. Additional riparian areas of regional importance in the Jordan River Valley were manually prioritized following discussion with project partners.

## Previously Documented EOs

The Michigan Natural Heritage Database houses records and documentation of Michigan's high quality and/or rare natural communities and federally- and state-listed plant and animal species, and it is managed by MNFI. Each record of a natural community or species is called an element occurrence (EO). Contained in each record is spatial information, directions, EO description, survey dates, surveyors, documentation related to the EO (e.g., report, herbarium specimen, report form), any additional data, and a ranking based on its quality, size, landscape context, and viability of the species population or community.

We queried this database to locate EOs of communities and species that intersected with the stands proposed for survey (Table 2; MNFI 2023).

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<sup>1</sup> Area of a mostly homogenous community type owned by a single entity

<sup>2</sup> Definition of this term can also be found in Appendix A: Definitions, NatureServe Terminology and Ranks

<sup>3</sup> MDNR determination of forest with exceptional conservation value

<sup>4</sup> A record of a listed species or natural community in a Natural Heritage Database

Table 2. List of element occurrences (EO) of natural communities and listed plant species intersecting with surveyed stands. Plant species EOs ranked historic (H) with large spatial inaccuracy were not included in this list. EOID is a unique identifier for each EO in the Michigan Natural Heritage Database. FCS Key is a unique identifier for MDNR forest stands. EO Ranks are explained in Appendix A: Definitions, NatureServe Terminology and Ranks (MNFI 2023).

Name	EO ID	EO Rank	Property Name / FCS Key	Last Observed Date
Great Lakes marsh	1919	AB	Petobego Pond (8280101007, 8280101087, 8280101009)	2006-08-24
Mesic northern forest	20443	CD	Woollam Family Nature Preserve	2015-08-24
Northern fen	2169	B	Orchis Fen Nature Preserve	1981-07-01
Northern fen	17330	BC	Skegemog Lake Wildlife Area	2009-07-25
Northern fen	18795	BC	Deadman's Fen (52048049, 52048054)	2020-06-16
Northern fen	18798	C	Jordan River Fen (52049043)	2011-07-27
Northern fen	18799	BC	Landslide Fen (52056018)	2022-05-27
Northern shrub thicket	18797	B	Jordan River (52049033)	2011-07-27
Open dunes	456	CD	Wilcox-Palmer Shah Preserve	1995-07-21
Open dunes	6368	C	Deane Family Nature Preserve, Woollam Family Nature Preserve	2012-07-15
Rich conifer swamp	8154	B	Minnehaha Creek Swamp (52125003, 52125005, 52125007, 52125010, 52125011, 52125012, 52125013, 52125018)	2007-08-13
Rich conifer swamp	17331	BC	Skegemog Lake Wildlife Area	2007-07-25
Rich conifer swamp	18796	C	Deadman's Swamp (52048049, 52049027)	2020-06-18
Rich conifer swamp	18802	C	Pinney Bridge Swamp (52055007, 52055006)	2021-05-26
Rich conifer swamp	18997	C	Flowing Well Swamp	2022-05-23
Sand and gravel beach	20444	C	Fisher Family Nature Preserve	2015-08-24
Lake Huron tansy ( <i>Tanacetum bipinnatum</i> ssp. <i>huronense</i> )	3686	AB	[REDACTED]	1905-06-18
Lake Huron tansy	4875	C	[REDACTED]	2018-07-15
Lake Huron tansy	5356	BC	[REDACTED]	2018-05-21
Lake Huron tansy	9311	E	[REDACTED]	2017-11-03
Pitcher's thistle ( <i>Cirsium pitcheri</i> )	376	C	[REDACTED]	2004-06
Pitcher's thistle	3804	C	[REDACTED]	2013-06-26
Pitcher's thistle	4113	C	[REDACTED]	1996-05-19
Pitcher's thistle	9139	C	[REDACTED]	2013-06-24
Pumpell's brome ( <i>Bromus pumpellianus</i> )	10371	C	[REDACTED]	2018-08-13
Round-leaved orchis ( <i>Amerorchis rotundifolia</i> )	6758	CD	[REDACTED]	1981-07-14

## Field Survey

To maximize surveyors' time and resources, several types of surveys were considered for each stand: 1) evaluate for EO status, 2) EO or ERA revisit, 3) invasive plant species mapping, or 4) no survey (Figure 2). Survey techniques and measurements for each



survey type are summarized in Table 3. No survey was conducted if 1) the natural community was not a coastal or riparian community or 2) a survey by MNFI staff had been conducted in the last 2 years (2020-2022).

### ***Evaluate for EO Status***

Surveys for evaluating EO status required the most time and resources. In preparation, surveyors reviewed the three components to qualify an area as a natural community EO: 1) size, 2) landscape context, and 3) quality (Faber-Langendoen et al., 2008). The thresholds for each component are not the same for every natural community, but vary depending on that community's local, state, and global rarity, on the quality of documented natural communities of that type in the area, and current threats in the landscape (MNFI 1988). A surveyor often reviews reports of or visits nearby documented natural communities of that type before making a determination. This type of survey consists of a qualitative meander survey ensuring adequate observation of representative features (e.g., riverbank, tributaries, stand interior, stand boundaries) and any stand variations as determined by aerial imagery interpretation (e.g., canopy coverage, species composition, crown size, tree density, disturbances such as windthrow). A surveyor may start a survey recording information for an EO status survey but switch to an invasive plant species survey in the field if one of the three criteria is not met (Figure 2). Information recorded for this type of survey is summarized in Table 3.

### ***EO/ERA revisit***

An EO/ERA revisit survey was conducted in stands previously designated as an EO or ERA, unless the stand had been visited by MNFI staff within the previous five years (i.e., 2017-2022). An EO/ERA revisit is similar to an EO Status survey, but less intensive (Table 3). Some data, like tree age, would be redundant to record unless a major event occurred or a unique individual found.

EO/ERA stands that had been visited by MNFI staff in the last 3-5 years (i.e., 2017-2019) had only an invasive plant species survey conducted. It was assumed that little aside from invasive species had changed significantly during that time, and resources would be better spent elsewhere. EO/ERA stands visited in the last 2 years (i.e., 2020-2022) were not surveyed to better use limited resources for other areas. For more details on this exception, see Other Surveys below.

### ***Invasive Plant Species***

Invasive plant species surveys were the most rapid of the surveys conducted. The objective of invasive plant species surveys was to identify presence, extent, and density of priority invasive species in stands. This information could be used to identify new invasions to the region and assess threats to nearby high priority stands. Stands in which invasive plant species surveys were conducted were stands that were not previously designated as an EO or ERA and did not meet the size, landscape context, or quality thresholds for a stand of that natural community type. Surveyors identified and hiked likely pathways for invasive species (Table 3).

Presence, density, extent, and GPS coordinates were collected when a population of an invasive species was first detected in a stand. If a species was sparse in a stand, multiple points may have been collected in the same stand. Points were aggregated, formatted, and submitted to the Midwest Invasive Species Information Network (MISIN) in the fall of 2022. MISIN is used by most Michigan CISMAs, including the CAKE CISMA, to report, gather, and document invasive species populations and treatment. Widespread invasive species like common dandelion (*Taraxacum officinale*) were not collected, because of their prevalence in the landscape and/or practicality of treatment.

### Other Surveys

Few stands had been surveyed by MNFI staff within the last two years (2020 – 2022) as part of a Natural Community Project on State Forest Lands (Cohen 2021; Cohen 2022). Given the similar procedures and project goal to conserve resources, a stand which was surveyed within the last 2 years may not have been surveyed for the current project, but information is included in this report from those project reports and/or the Michigan Natural Heritage Database (Cohen 2021; Cohen 2022; MNFI 2023).

**Table 3. Summarized differences in techniques and measurements among survey types.**

Technique or measurement	Evaluate for EO	Revisit EO/ERA	Invasive Plant Species
Survey style: Meander	X	X <sup>5</sup>	
Survey style: Visit suspected subhabitats	X	X	
Survey style: Hike invasive pathways (e.g., streams, trails)	X	X	X
Record invasive species, extent, density	X	X	X
Record dominant/abundant species	X	X	X
Record comprehensive species list	X		
Record vegetative structure	X		
Record soil profile/depth/typing <sup>6</sup>	X	X	
Record soil pH	X	X	
Determine tree size(s)	X	X	
Age trees	X		
Examine surrounding landscape and threats	X	X <sup>7</sup>	
Evaluate community condition	X	X <sup>7</sup>	

<sup>5</sup> Less intensive meander than Evaluate for EO status survey

<sup>6</sup> Not permitted on some lands

<sup>7</sup> Examine for changes since last report

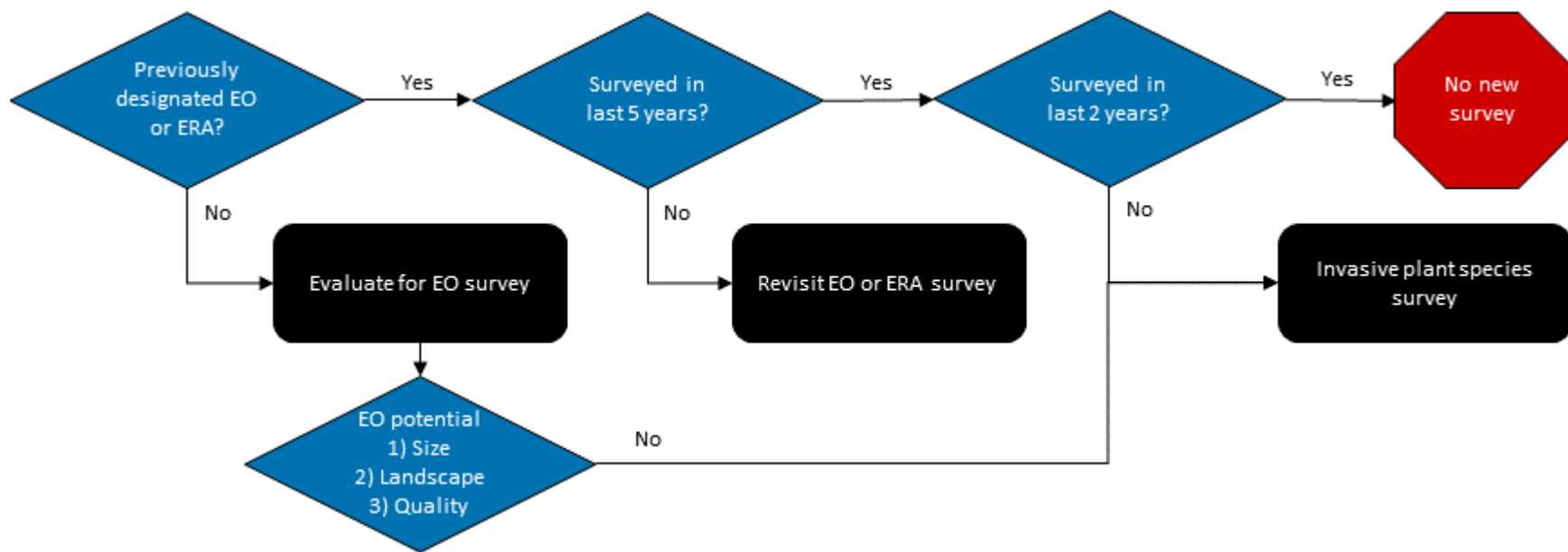


Figure 2. Flow chart of decision-making process to determine type of survey conducted. A blue diamond represents a question/decision to be made before proceeding; a black rectangle represents a survey type.

# Results

## Survey Results

One-hundred and seventy-two stands/properties were surveyed between June 29 and September 14, 2022, in the CAKE CISMA. Two new natural communities EOs were documented and eleven natural community EOs were revisited. Nine previously documented plant EOs were visited in 2022 (Table 4). Five populations were expanded with new patches. We failed to find at least one mapped patch of three EOs, although one survey also had a timing issue. One new population of Pumpell's brome was documented at [REDACTED] (EOID 26398), and a possible new population at [REDACTED] was noted, but the individuals were too senesced for confirmation at the time of survey.

Table 4. Visited plant species EOs intersecting with surveyed stands. EOID is a unique identifier for each EO in the Michigan Natural Heritage Database. FCS Key is a unique identifier for MDNR forest stands. EO Ranks are explained in Appendix A: Definitions, NatureServe Terminology and Ranks (MNFI 2023).

Name	EO ID	Rank	Property Name or FCS Key	Results
Lake Huron tansy ( <i>Tanacetum bipinnatum</i> ssp. <i>huronense</i> )	3686	AB	[REDACTED]	New patches mapped
Lake Huron tansy	4875	C	[REDACTED]	New patch mapped
Lake Huron tansy	5356	BC	[REDACTED]	Failed to find one patch; new patch mapped
Lake Huron tansy	9271	BC	[REDACTED]	New patch mapped
Lake Huron tansy	9311	E	[REDACTED]	Failed to find
Pitcher's thistle ( <i>Cirsium pitcheri</i> )	3804	C	[REDACTED]	New patch mapped
Pitcher's thistle	4113	C	[REDACTED]	Failed to find
Pitcher's thistle	9139	C	[REDACTED]	Present
Pumpell's brome ( <i>Bromus pumpellianus</i> )	10371	C	[REDACTED]	New patches mapped
Pumpell's brome	26398	TBD	[REDACTED]	New population documented
Round-leaved orchis ( <i>Amerorchis rotundifolia</i> )	6758	CD	[REDACTED]	Failed to find <sup>8</sup>

We submitted 1696 invasives species records to MISIN and are available to access through their interface. As a supplement to this report, the batch upload spreadsheet submitted to MISIN was also submitted. Many of these infestations were in low priority stands and were not described in further detail in this report. Observations of the five “least wanted” invasives species in CAKE CISMA (i.e., Asiatic bittersweet [*Celastrus orbiculata*], Japanese knotweed [*Fallopia japonica*], purple loosestrife [*Lythrum*

<sup>8</sup> Survey timing was not ideal for detection

*salicaria*], invasive reed [*Phragmites australis* ssp. *australis*], black swallow-wort [*Vincetoxicum nigrum*]) were subset from the full records and listed in Table 5.

Table 5. Observations of CAKE CISMA “least wanted” invasive species during 2022 surveys. FCS Key is a unique identifier for MDNR forest stands. MISIN area categorization is used: 1 – individual/few/several, 2 – < 1,000 ft<sup>2</sup>, 3 – 1,000 ft<sup>2</sup> to 0.5 acre, 4 – 0.5 acre to 1 acre, 5 - > 1 acre. MISIN density categorization is used: 1 – sparse, 2 – patchy, 3 – dense, 4 – monoculture. Coordinates were rounded to five decimal places for display in table. Observation records were submitted to MISIN October 26, 2022.

Species	Name or FCS Key	Notes	Area	Density	Latitude (DD)	Longitude (DD)
Asiatic bittersweet ( <i>Celastrus orbiculata</i> )	Susan Creek Preserve	At trailhead	2	2	45.35083	-85.18973
Japanese knotweed ( <i>Fallopia japonica</i> )	Jordon River Preserve	Along residential boundary in degraded wet meadow	2	3	45.15037	-85.13379
Purple loosestrife ( <i>Lythrum salicaria</i> )	Jordan River Preserve	Sedge marsh	2	1	45.15009	-85.13292
Purple loosestrife	Susan Creek Preserve		1	1	45.35116	-85.18801
Purple loosestrife	Petobego Pond		1	1	44.86011	-85.43681
Purple loosestrife	Susan Creek Preserve		2	2	45.35283	-85.17364
Purple loosestrife	52051028	Along snowmobile trail edge. Pulled the one I found	1	1	45.08457	-85.08333
Purple loosestrife	Kalman-Harbor Cove	Swale borders and abundant with <i>Typha angustifolia</i>	5	2	45.42459	-84.93253
Purple loosestrife	Kalman-Fischer	In ditch.	5	2	45.42546	-84.93346
Purple loosestrife	52054009	Mostly in middle to northern part of cut.	5	1	45.02833	-85.06431
Purple loosestrife	Skegemog Lake	Scattered throughout ROW	3	1	44.78651	-85.28273
Purple loosestrife	Menonaqua Woods	In roadside and adjacent cattail marsh	5	2	45.41579	-84.90454
Invasive reed ( <i>Phragmites australis</i> ssp. <i>australis</i> )	52051014	One dense stand in NW corner of stand and other smaller clumps spreading nearby.	4	2	45.10010	-85.09210
Invasive reed	52069	Along snowmobile trail and extending into stand. Numerous small to large patches	5	2	45.11376	-85.10850
Invasive reed	Petobego Pond		2	3	44.85819	-85.44450
Invasive reed	Petobego Pond		2	3	44.85410	-85.44490

Species	Name or FCS Key	Notes	Area	Density	Latitude (DD)	Longitude (DD)
Invasive reed	Petobego Pond		2	4	44.85304	-85.44440
Invasive reed	Petobego Pond		2	3	44.85276	-85.44490
Invasive reed	Petobego Pond		2	3	44.85263	-85.44750
Invasive reed	Skegemog Lake	Main trails	2	3	44.81391	-85.30870
Invasive reed	Steven's Creek 52056027	Coordinates where first seen from creek source. More patches downstream.	5	2	44.99410	-85.0280
Invasive reed	Steven's Creek 52056027	Along creek. At least one small patch further upstream.	5	2	44.99461	-85.03000
Invasive reed	52055019	Dense patch	5	2	44.99836	-85.03150
Invasive reed	52056018	Flooding has thinned out patch, but some persisting	5	2	45.01141	-85.01140
Invasive reed	Warner Creek 52048017	Large, dense patch on south side of Warner Creek, east of boardwalk.	5	2	45.06907	-84.94140

Stands were ranked as highest, high, medium, and low management priority. Site summaries for stands containing natural community EOs and medium or higher priority for treatment were included in following pages of the report. Antrim and Emmet Counties contained the highest number of priority stands.

A list of all surveyed stands and county-level maps of medium and higher priority sites can be found in Appendix B: Stands Summar. More information about the natural community types and their global and state rank, status, and condition can be found in Appendix C: Michigan Coastal and Riparian Natural Communities. More detailed descriptions of natural community global rank, state rank, and element occurrence rank can be found in Appendix A: Definitions, NatureServe Terminology and Ranks.

The following site summaries are organized by county, then by site name. Each summary includes information about the landowner or manager, area of extent, descriptions of EOs present, descriptions of priority stands, and a summary of threats and management recommendations.

## Bennett Creek Northern Wet Meadow, Antrim County

Compartment | Stand(s): 52052|007

**Landowner/Manager:** State Forest (Forest Resource Division)

**Size:** 36.7 acres

**Location:** Park at Cosner Nature Preserve lot along M-66. Walk east along hiking trail and through old field to preserve boundary, about 800 meters. Continue east through state forest another 150 meters to wet meadow boundary (Figure 3).

**Survey Type(s):** Invasive species survey

**Natural Community Type(s):** Northern wet meadow (Figure 4)

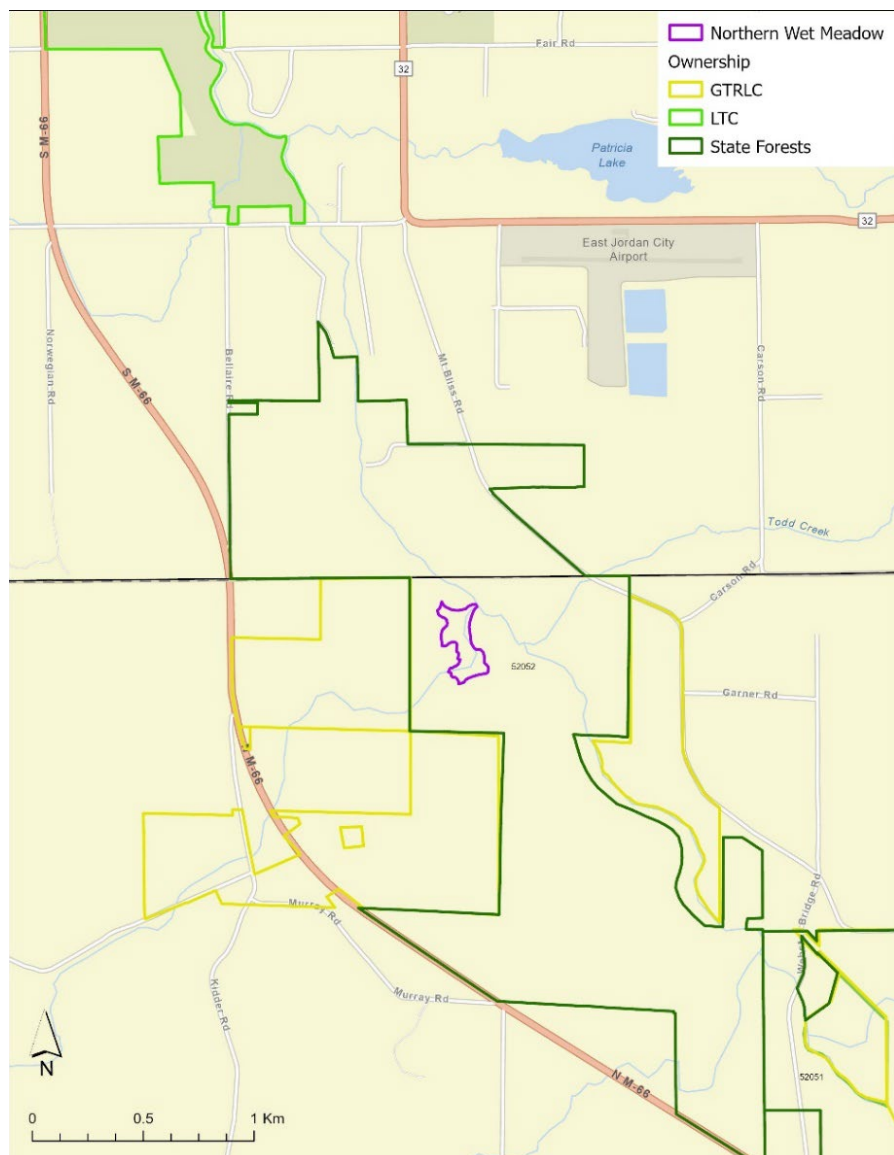


Figure 3. Location of Bennett Creek northern wet meadow in Gaylord Forest Management Unit, Compartment 52052 in Antrim County, Michigan, USA.

**Natural Community Type: Northern Wet Meadow**

**Rank:** G4G5 S4

**Size:** 10.0 acres

**Natural Community Description:** This stand is large and variable in both species composition and ecological integrity (i.e., quality), though the new survey polygon (Figure 4) represents only the higher quality wet meadow zone. There are several upland zones throughout stand 007 that are typically degraded (abundant spotted knapweed [*Centaurea stoebe*], common St. John's-wort [*Hypericum perforatum*], ox-eye daisy [*Leucanthemum vulgare*], various non-native grasses), which intergrade with wet meadow and northern shrub thicket. The portion of the stand south of the old railroad grade comprises a combination of wet meadow and shrub thicket (dry conditions during survey), dominated by tussock sedge (*Carex stricta*) and reed canary grass (*Phalaris arundinacea*) in the wet meadow areas and silky dogwood (*Cornus amomum*), willows (*Salix* spp.), and meadowsweet (*Spiraea alba*) in the shrub thicket zones.

North of the railroad grade and surrounding Bennett Creek is a high-quality zone of northern wet meadow dominated by various sedges (*Carex* spp., *Scirpus* spp., *Schoenoplectus* spp., *Eleocharis* spp.) and grasses (*Leersia oryzoides*, *Phalaris arundinacea*, *Calamagrostis canadensis*). Other characteristic species include swamp milkweed (*Asclepias incarnata*) and common arrowhead (*Sagittaria latifolia*). Few invasive species were detected but bull thistle (*Cirsium vulgare*) occurs rarely along the southern edge of the wet meadow polygon near the stream and marsh thistle (*Cirsium palustre*) and reed canary grass is problematic along the creek at the northern end of the wet meadow polygon (Figure 4). Beaver activity likely formed and/or maintained the conditions within this stand and the wet meadow polygon; numerous beaver-felled aspen occur along the northern stand boundary with stand 075 and white-cedar snags occur scattered along the creek (Figure 5).

**Natural Community Data:** Data refers only to the high-quality area delineated in Figure 4. The wet meadow is dominated by tussock sedge and reed canary grass, with cut grass (*Leersia oryzoides*) locally dominant along the stream banks and wet areas. Swamp milkweed (*Asclepias incarnata*), blue-joint (*Calamagrostis canadensis*), common arrowhead (*Sagittaria latifolia*), and blue vervain (*Verbena hastata*) are locally common to abundant. Other common or characteristic species include *Carex pseudocyperus*, *C. stipata*, *Eleocharis* spp., softstem bulrush (*Schoenoplectus tabernaemontani*), joe-pye-weed (*Eutrochium maculatum*), boneset (*Eupatorium perfoliatum*), wild blue flag (*Iris versicolor*), green bulrush (*Scirpus atrovirens*), bur-reeds (*Sparganium* spp.), monkey-flower (*Mimulus ringens*), common water horehound (*Lycopus americanus*), and common skullcap (*Scutellaria galericulata*).

A plant species list can be found in Appendix D: Plant Species Lists.



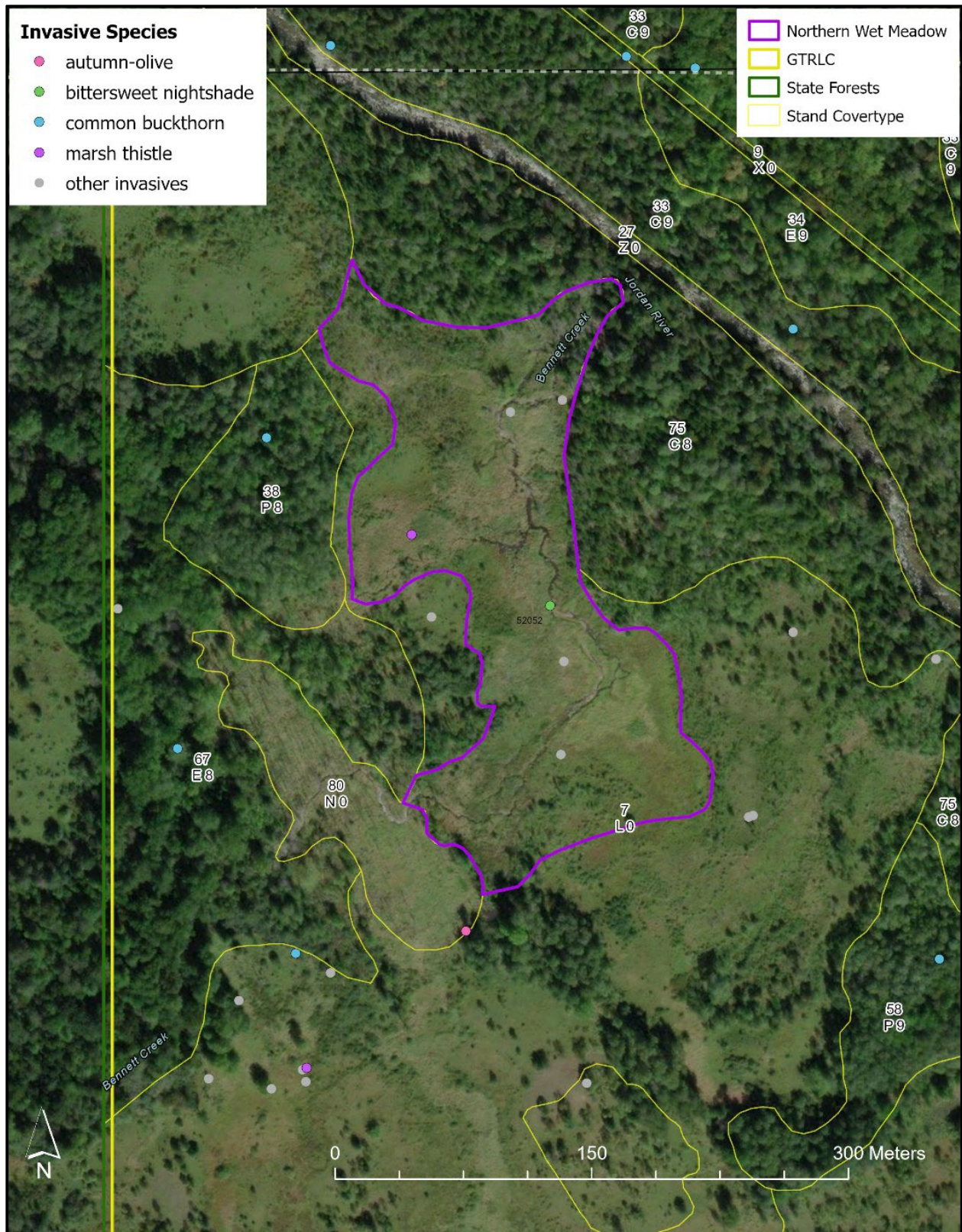


Figure 4. Northern wet meadow natural community along Bennett Creek. Purple outline is the natural community boundary; thin yellow outline is forest management stand boundaries; thick green outline is State land boundary. Each stand is labeled with its stand number and MDNR covertype code.



Figure 5. Northern wet meadow near Bennett Creek in Antrim County, Michigan, USA, on July 16, 2022. Photographs by Clay Wilton.

### ***Management Recommendations***

Given the small size and frequency of northern wet meadows in the region, this stand did not meet EO status, but surveyors considered it a medium priority. Invasive species are the greatest threat to this community, particularly the risk of further encroachment and dominance by reed canary grass. Further spread of the non-native thistles (*Cirsium* spp.) detected in this region also pose a threat to community integrity/quality.

**Management Priority Rank: Medium**

## Cosner Nature Preserve - Bennett Creek, Antrim County

**Landowner/Manager:** Grand Traverse Regional Land Conservancy

**Size:** 108.0 acres

**Location:** Park at Cosner Nature Preserve lot along M-66. Walk SSE along hiking trail about 300 meters to edge of natural community. Much of the high-quality swamp portion can be accessed by the boardwalk trail (Figure 6).

**Survey Type(s):** Evaluate for EO status

**Natural Community Type(s):** Rich conifer swamp (Figure 7)

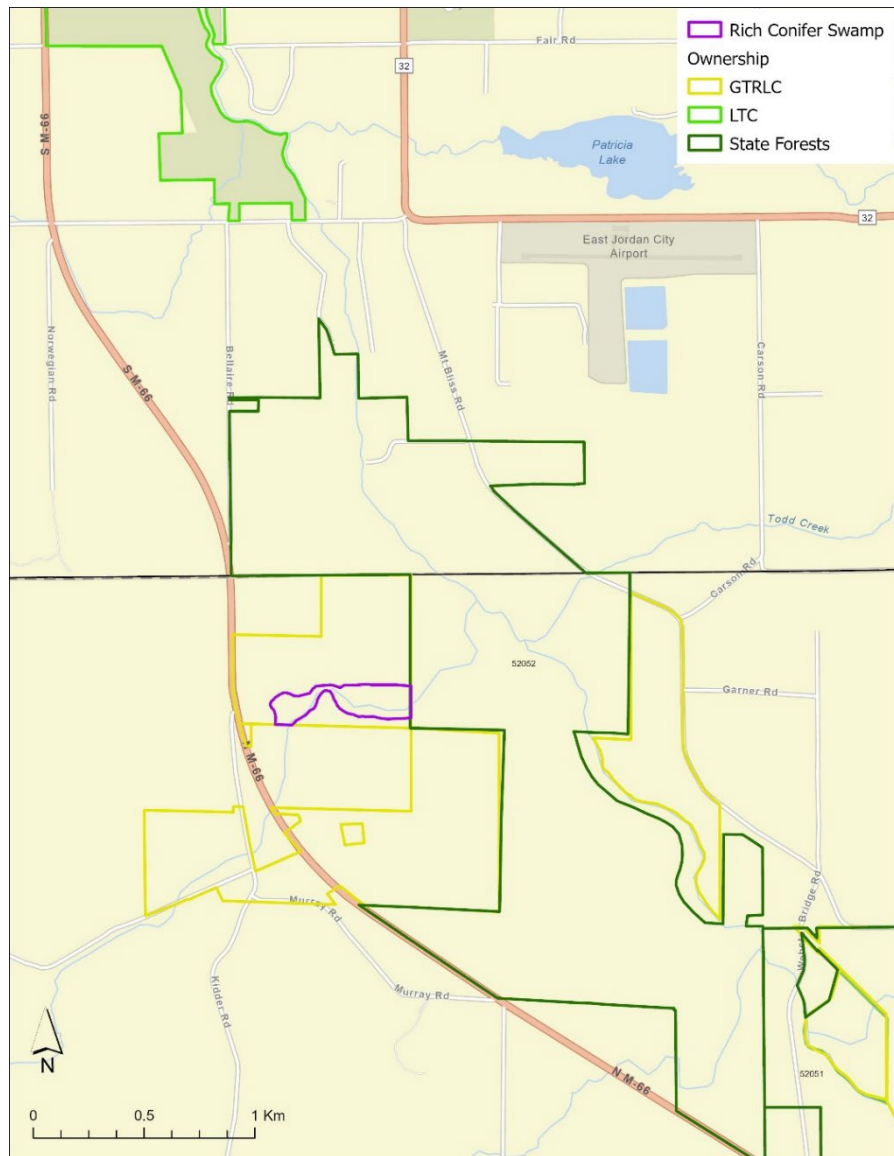


Figure 6. Location of Cosner Nature Preserve in Antrim County, Michigan, USA.

**Natural Community Type: Rich Conifer Swamp**

**Rank:** G4 S3

**Size:** 18.1 acres

**Natural Community Description:** The west half of this polygon represents a nice narrow band of rich conifer swamp that intergrades with zones of northern shrub thicket and hardwood-conifer swamp along a small meandering sandy-bottomed creek. Speckled alder (*Alnus incana*) dominates the tall shrub layer, especially in the wettest areas along the north side of the creek (Figure 7). Common buckthorn (*Rhamnus cathartica*) is present throughout the natural community but has not yet become dominant in this western half (though seedlings are patchily abundant). Several small seeps create rich microhabitats along the stream with a diverse groundcover layer. Areas along the stream bank are often higher and dry with white-cedar (14" DBH, age 102 years) dominating the canopy and sparse shrub and groundcover. Bittersweet nightshade (*Solanum dulcamara*) is a problematic invasive, especially within some of the seep zones (Figure 7).

The eastern half of this polygon is substantially more degraded, with reed canary grass (*Phalaris arundinacea*) becoming dominant along the creek where northern white-cedar drops out of the canopy; this area is more a mix of degraded northern wet meadow and alder shrub thicket. Dead ash logs are prevalent in this area as well. Much of the area on the north side of the creek (i.e., northeast region of stand polygon) is a dense monoculture of common buckthorn. This area was historically ash dominated before EAB mortality and is now composed of sparse canopy bur oak (*Quercus macrocarpa*) and basswood (*Tilia americana*); blue-beech (*Carpinus caroliniana*) and hawthorns (*Crataegus* spp.) persist amongst the dense buckthorn.

The region south of polygon also includes some younger upland mesic northern forest and degraded old fields. North of the polygon includes a large degraded old field dominated by non-native grasses, spotted knapweed, non-native honeysuckles, and various other native and non-native weedy species. Elsewhere in the preserve is predominately early successional zones of young dry-mesic northern forest with planted pines and zones of dense upland shrub (common buckthorn, honeysuckles, hawthorns, etc.).

**Natural Community Data:** The canopy of the main rich conifer swamp zone that dominates the west half of the community polygon is dominated by northern white-cedar (*Thuja occidentalis*) with associates including paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), basswood (*Tilia americana*), eastern hemlock (*Tsuga canadensis*), quaking aspen (*Populus tremuloides*), American elm (*Ulmus americana*), black cherry (*Prunus serotina*), and bur oak (*Quercus macrocarpa*). The sub-canopy is characterized by sapling black ash (*Fraxinus nigra*), green ash (*Fraxinus pennsylvanica*), American elm, northern white-cedar, red maple, basswood, and hawthorns (*Crataegus* spp.).

The tall shrub layer is dominated by speckled alder and the non-native invasive common buckthorn, which is locally dominant in the eastern half of the polygon. Other characteristic shrubs include blue-beech, elderberry (*Sambucus canadensis*), willows (*Salix* spp.), juneberry (*Amelanchier* spp.), hazelnut (*Corylus* spp.), wild red raspberry (*Rubus strigosus*), wild-raisin (*Viburnum cassinoides*), and choke cherry (*Prunus virginiana*). The non-native invasive honeysuckle (*Lonicera* spp.), Japanese barberry (*Berberis thunbergii*), and multiflora rose (*Rosa multiflora*) were also detected at infrequent abundance.

The ground cover varies from a rich/diverse herbaceous layer in the wettest portions of the swamp to depauperate in the driest areas and under dense northern white-cedar cover. The wet areas support numerous characteristic rich conifer swamp species, including bulblet fern (*Cystopteris bulbifera*), naked miterwort (*Mitella nuda*), dwarf raspberry (*Rubus pubescens*), foamflower (*Tiarella cordifolia*), goldthread (*Coptis trifolia*), star-flower (*Trientalis borealis*), partridge berry (*Mitchella repens*), Canada mayflower (*Maianthemum canadense*), purple avens (*Geum rivale*), sensitive fern (*Onoclea sensibilis*), jack-in-the-pulpit (*Arisaema triphyllum*), fowl manna grass (*Glyceria striata*), maidenhair fern (*Adiantum pedatum*), horsetail (*Equisetum* spp.), black snakeroot (*Sanicula marilandica*), wild-ginger (*Asarum canadense*), cinnamon fern (*Osmundastrum cinnamomeum*), marsh-marigold (*Caltha palustris*), and marsh skullcap (*Scutellaria galericulata*). Non-native invasive species detected include bittersweet nightshade (*Solanum dulcamara*), helleborine (*Epipactis helleborine*), bull thistle (*Cirsium vulgare*), marsh thistle (*Cirsium palustre*), common burdock (*Arctium minus*), common St. John's-wort (*Hypericum perforatum*), and common speedwell (*Veronica officinalis*; Figure 7).

A plant species list can be found in Appendix D: Plant Species Lists.

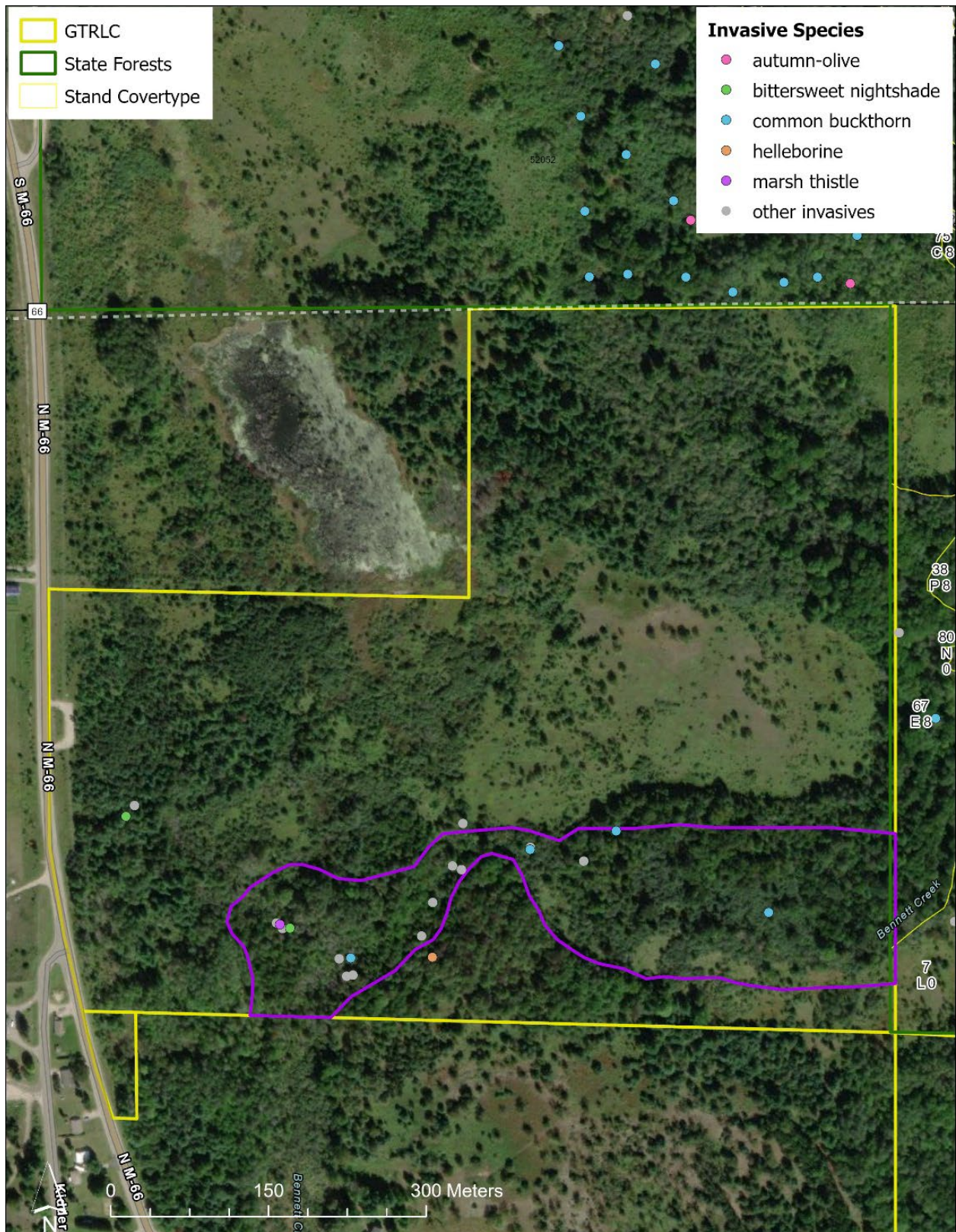


Figure 7. Medium management priority natural community in Cosner Nature Preserve. Purple outline is the boundary of the rich conifer swamp; yellow outline is the boundary of the Preserve. Each dot is an observed invasive species described in legend.



Figure 8. Boardwalk through rich conifer swamp in Cosner Nature Preserve on July 16, 2022. The threat of invasive species along the trail can be seen with the common burdock (*Arctium minus*) in the foreground. Photograph by Clay Wilton.

### ***Management Recommendations***

The primary threat to this natural community is the invasive common buckthorn, which has taken over much of the eastern portion of the stand (Figure 7). Other invasive species of special concern include bittersweet nightshade (taking over seep zones and small areas along creek) and bull and marsh thistle (currently low density but could become problematic). Overall, the east half of the stand is severely degraded by buckthorn and probably not of restoration priority. The west half remains fairly high quality and deserves invasive removal and monitoring, especially along the boardwalk and trails frequented by visitors (Figure 8). Hemlock is present in the swamp canopy. A pest of this species, hemlock woolly adelgid, is spreading northward and should be monitored for regularly.

**Management Priority Rank: Medium**

## Deadman's Creek, Antrim County

Compartment | Stand(s): 52048|049, 054; 52049|027

Landowner/Manager: State Forest (Forest Resource Division)

Size: 197.4 acres

Location: Southwest of Jordan River Road, 2.5 km (1.6 mi) east of Big Marsh Road, west of the pin turn to the north (Figure 9).

Survey Type(s): Invasive species survey, other survey (Cohen 2020)

Natural Community Type(s): Northern fen, rich conifer swamp (Figure 10)

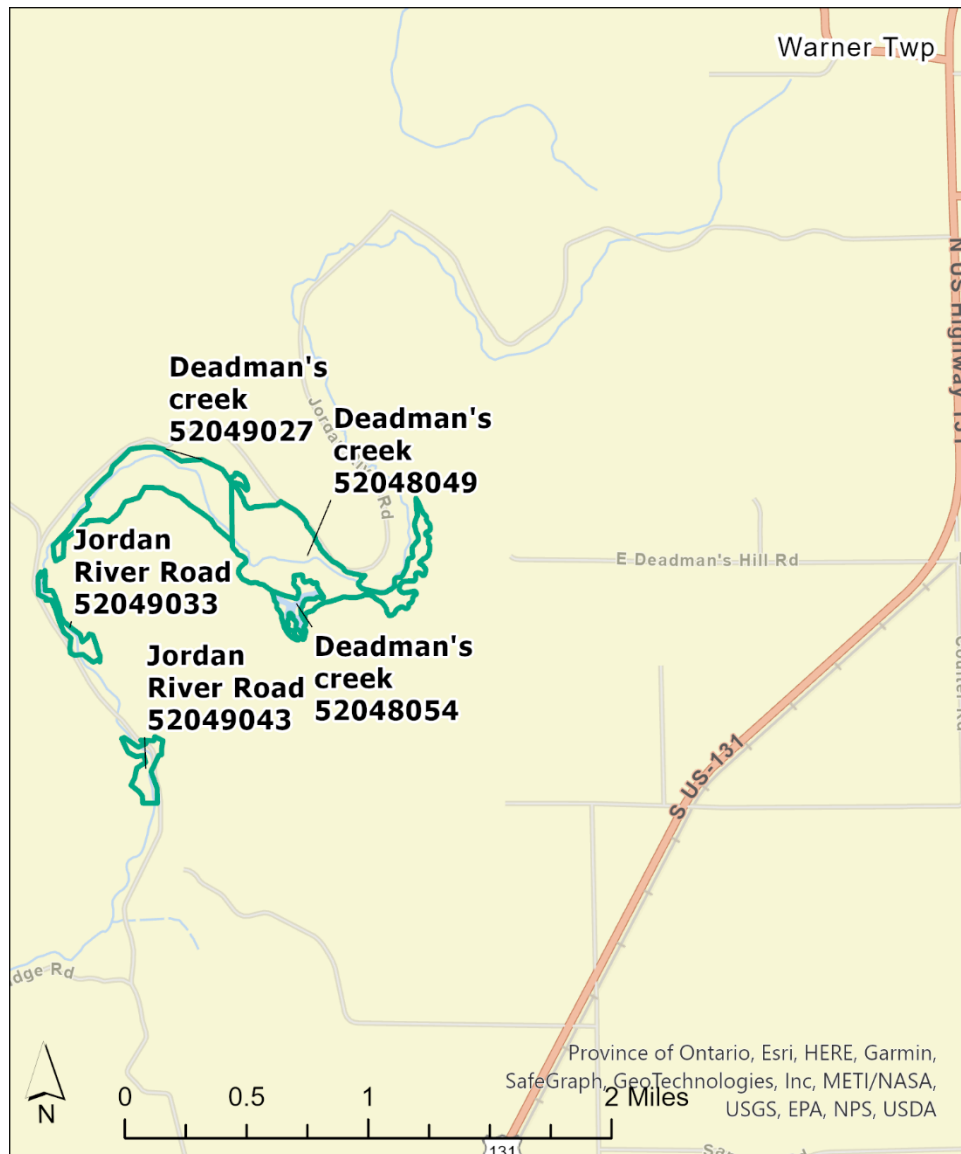


Figure 9. Location of priority Deadman's Creek stands in Gaylord Forest Management Unit, Compartments 52048 and 52049 in Antrim County, Michigan, USA.



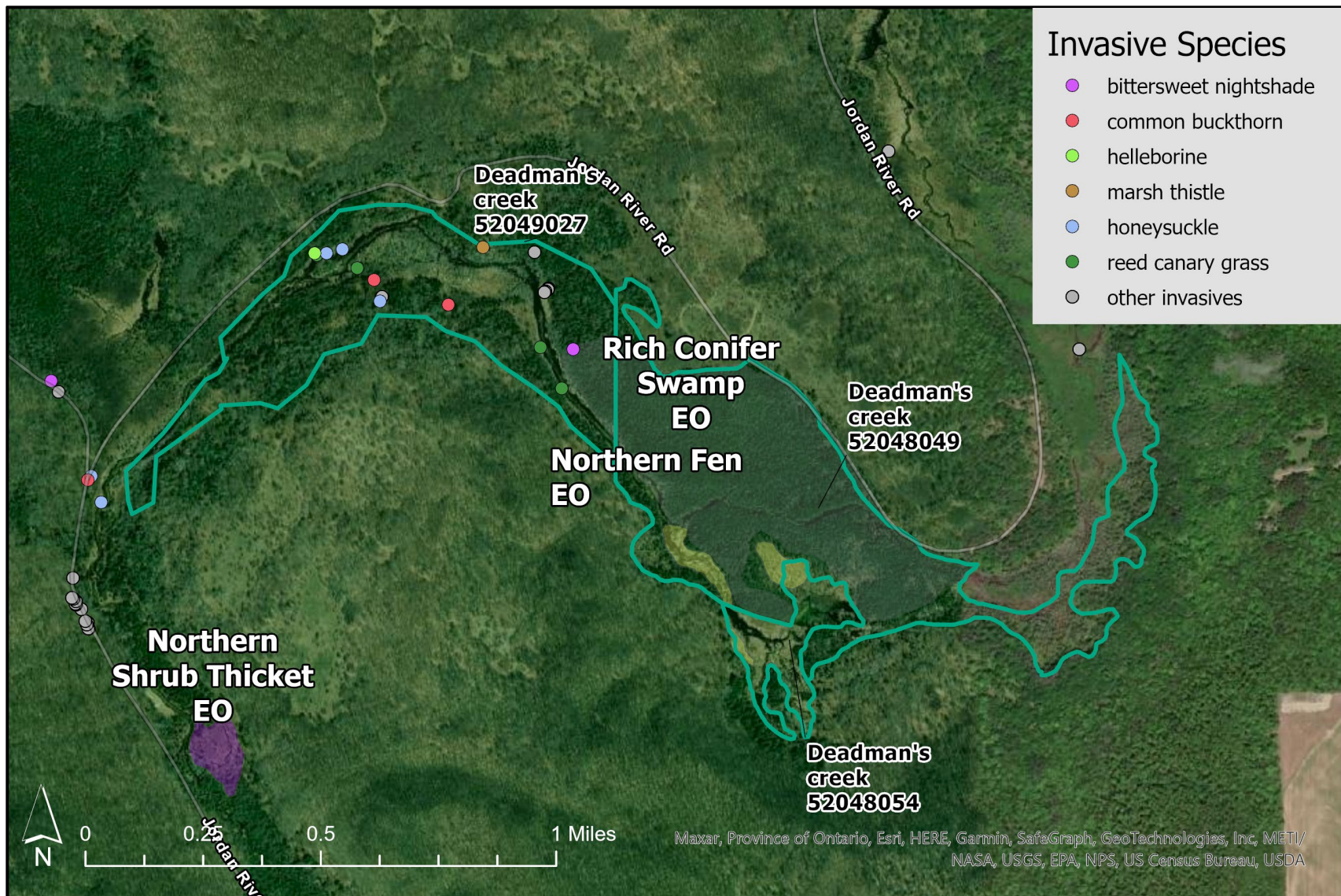


Figure 10. Natural community EOs and invasive species observed near Deadman's Creek. Cyan lines are stand borders. Transparent purple represents rich conifer swamp EO and transparent yellow represents the northern fen EO. Each dot is an observed invasive species described in legend.

**Natural Community Type: Northern Fen**

**Rank:** G3 S3

**EO Identification Number:** 18795 (Deadman's Fen)

**EO Size:** 5.2 acres

**EO Rank and Justification:** BC. High floristic diversity and distinct ecological zonation due to gradients in soil and water chemistry. Reduced acreage in 2020 due to beaver flooding and invasion by non-native narrow-leaved cattail (*Typha angustifolia*). Beaver flooding along Jordan River is also contributing to the increase in reed canary grass (*Phalaris arundinacea*) and narrow-leaved cattail along the river margin and locally within the fen.

Complex is within the Gaylord Forest Management Unit and is part of a large block of unfragmented state forest managed for timber production, wildlife, recreation, and biodiversity. Surrounding upland forest on moraine is primarily actively managed northern hardwoods and early successional aspen forest. A dirt road winds along the bottom of the Jordan River Valley and hiking trails occur within the wetlands and in the surrounding upland forest. Rivers and streams within the Jordan River Valley experience significant foot traffic from anglers.

**EO Data:** Small pocket of highly diverse northern fen occurring along headwater streams feeding into Jordan River surrounded by steep end moraines. Cold groundwater seepage generates nutrient rich growing conditions suitable for fen species. Fen characterized by braided streams feeding into Jordan River and low *Sphagnum* hummocks and localized floating mats. Drainage associated with Jordan River is dominated by rich conifer swamp and surrounding moraines are dominated by mature northern hardwoods. Mortality of tamarack (*Larix laricina*) along margin of Jordan River due to flooding. Beaver activity have influenced the fen and surrounding wetlands.

The soils are characterized by 30 to 50 cm of inundated to saturated peats (pH 7.3-7.8) and occur over wet, medium-textured sands (pH 7.5-8.0).

**Natural Community Type: Rich Conifer Swamp**

**Rank:** G4 S3

**EO Identification Number:** 18796 (Deadman's Swamp)

**EO Size:** 72.6 acres

**EO Rank and Justification:** C. Rich conifer swamp occurring along seepage slopes and headwater streams feeding into Jordan River surrounded by steep end moraines. Burnt snags occur locally and suggest that the cedar swamp established following logging era fires approximately 100 years ago. The diameter of the cut stumps is typically larger than the size of the canopy trees. The non-native autumn olive (*Elaeagnus umbellata*) occurs locally. Deer browse pressure is high and has limited cedar regeneration. Hiking trail passes through portion of the swamp.

Complex is within the Gaylord Forest Management Unit and is part of a large block of unfragmented state forest managed for timber production, wildlife, recreation, and biodiversity. Surrounding upland forest on moraine is primarily actively managed northern hardwoods and early successional aspen forest. A dirt road winds along the bottom of the Jordan River Valley and hiking trails occur within the wetlands and in the surrounding upland forest. Rivers and streams within the Jordan River Valley experience significant foot traffic from anglers.

**EO Data:** Dense and diverse rich conifer swamp located on seepage slopes and along headwater streams feeding into Jordan River. Jordan River and numerous streams and rivulets that feed into it are fed by cold groundwater seepage. Well-developed *Sphagnum* hummocks and hollows and locally tussocks sedge (*Carex stricta*) provide microsite diversity by creating small-scale gradients in soil moisture and soil chemistry. Windthrow and coarse woody debris occur locally within the rich conifer swamp. Windthrow is more prevalent closer to the Jordan River. Large canopy trees 95 to 105 years old with DBH ranging 28 cm to 55 cm. Many northern white cedar trees (*Thuja occidentalis*) were rotten. Deer trails, pellets, and heavy browse noted throughout. Active beaver signs are prevalent.

The soils are characterized by deep, 40 to 100 cm saturated peats (pH 6.5-7.5) and overlie wet medium-textured sands (pH 7.0-7.3).

**Other Natural Communities:** *Hardwood-conifer swamp, northern shrub thicket, northern wet meadow, rich conifer swamp*

Several patches natural communities were in stand 52049027 during the survey. These areas were not considered large enough in size or high enough quality to qualify as an EO; but they are identified as medium priority for invasive species management due to their connectivity to Deadman's Fen (EOID 18795) and Deadman's Swamp (EOID 18796), biodiversity, and relatively low densities of current invasive species infestations.

***Management Recommendations***

Allow natural processes to operate unhindered and retain an intact buffer of natural communities surrounding wetlands to minimize threat of hydrological alteration. Reducing local deer densities is also recommended. Containment and treatment of invasive species like reed canary grass, narrow-leaved cattail, honeysuckle, and autumn olive. The Jordan River Road and the Jordan River may act as pathways in the spread of invasive species and should be monitored regularly to contain the infestations to the road and control patches that spread into the higher quality habitat.

**Management Priority Rank: Medium**

**Jordan River Road, Antrim County  
Compartment | Stand(s): 52049| 033, 043**

**Landowner/Manager:** State Forest (Forest Resource Division)

**Size:** 25.1 acres

**Location:** On Jordan River Road west of US Highway 131, between the intersection of Jordan River Road with Big Marsh Road and Jordan River Road with Pinney Bridge Road (Figure 11).

**Survey Type(s):** Other surveys (Cohen 2011)

**Natural Community Type(s):** Northern fen, northern shrub thicket (Figure 12)

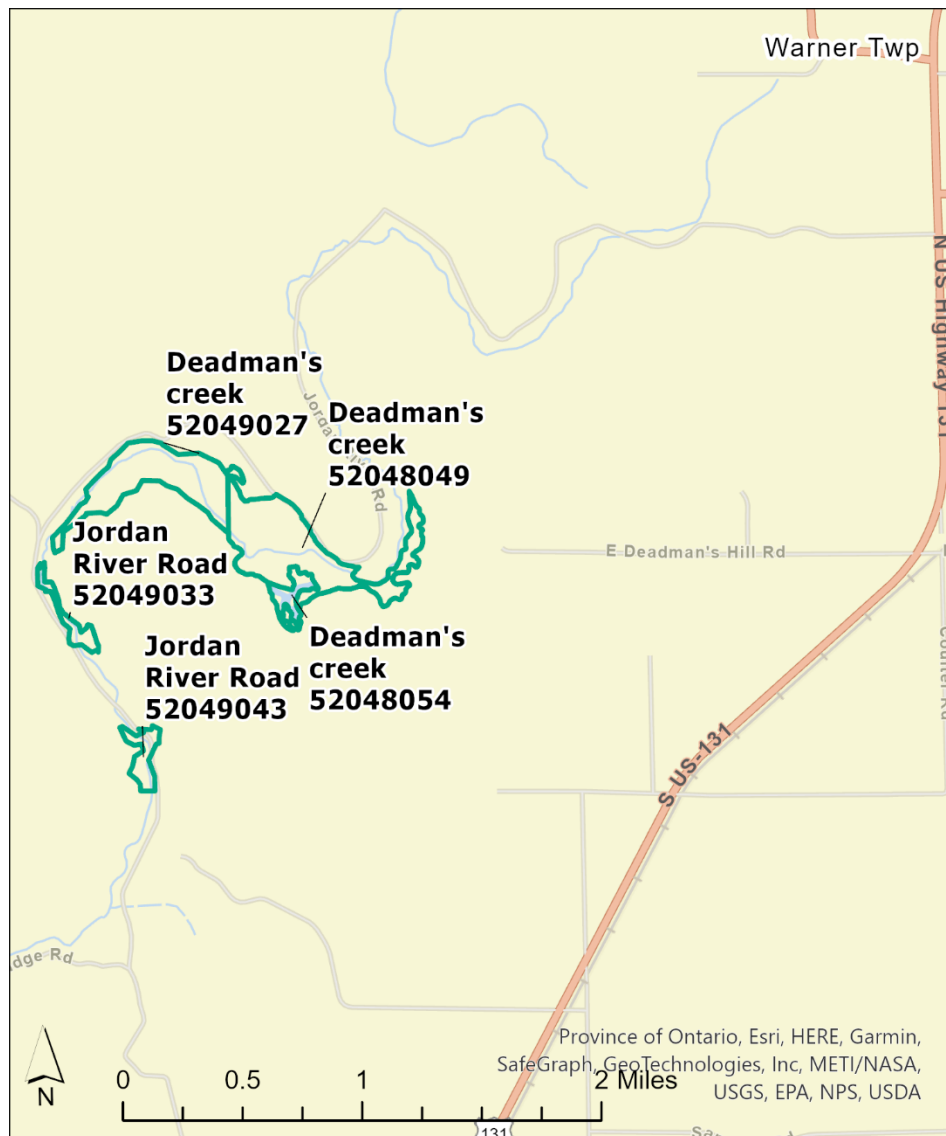


Figure 11. Location of priority Jordan River Road stands in Gaylord Forest Management Unit, Compartment 52049 in Antrim County, Michigan, USA.



Figure 12. Natural community EOs near Jordan River Road. Cyan lines are stand borders. Transparent purple represents northern shrub thicket EO, and the two transparent yellow areas represents the northern fen EO. Each dot is an observed invasive species described in legend.

**Natural Community Type: Northern Fen**

**Rank:** G3 S3

**EO Identification Number:** 18798 (Jordan River Fen)

**EO Size:** 0.26 acres

**EO Rank and Justification:** C. There are two small patches of sloping northern fen, in Gaylord Forest Management Unit, Compartment 49, stands 33 and 43. High plant diversity and distinct ecological zonation due to gradients in soil and water chemistry. Species composition and zonation patterned by natural processes. Drainage associated with Jordan River is dominated by rich conifer swamp and surrounding moraines are dominated by mature northern hardwoods, managed by Gaylord Forest Management Unit.

Complex is within part of a large block of unfragmented state forest managed for timber production, wildlife, recreation, and biodiversity. A dirt road winds along the bottom of the Jordan River Valley and hiking trails occur within the wetlands and in the surrounding upland forest. Rivers and streams within the Jordan River Valley experience significant foot traffic from anglers.

**EO Data:** Scattered and stunted conifers include tamarack (*Larix laricina*) and black spruce (*Picea mariana*). Canopy closure ranges from 5-15%. The tall shrub layer comprises 10-15% of the area and is characterized by speckled alder (*Alnus incana*), tamarack, and slender willow (*Salix petiolaris*). The low shrub layer comprises 20-40% of the area and is characterized by red-osier dogwood (*Cornus sericea*), alder-leaved buckthorn (*Rhamnus alnifolia*), willows (*Salix* spp.), tamarack, and northern white cedar (*Thuja occidentalis*). Characteristic ground cover species include sedges (*Carex* spp., *C. flava*, *C. sterilis*), rough-leaved goldenrod (*Solidago patula*, *S. rugosa*), marsh fern (*Thelypteris palustris*), bog lobelia (*Lobelia kalmii*), wild strawberry (*Fragaria virginiana*), joe-pye-weed (*Eutrochium maculatum*), boneset (*Eupatorium perfoliatum*), broad-leaved cattail (*Typha latifolia*), swamp aster (*Symphotrichum* sp.), northern bugle weed (*Lycopus uniflorus*), grass-leaved goldenrod (*Euthamia graminifolia*), grass-of-Parnassus (*Parnassia glauca*), fringed brome (*Bromus ciliatus*), and wild mint (*Mentha canadensis*).

The soils are characterized by deep, saturated peats (>1m; pH 7.4-7.7).

**Natural Community Type: Northern shrub thicket**

**Rank:** G4 S5

**EO Identification Number:** 18797 (Jordan River)

**EO Size:** 4.2 acres

**EO Rank and Justification:** B. Small pocket of northern shrub thicket occurring along riparian area within the Jordan River Valley surrounded by steep end moraines. Species composition and structure driven by natural processes. Drainage associated with Jordan River is dominated by rich conifer swamp and surrounding moraines are dominated by mature northern hardwoods, managed by Gaylord Forest Management Unit.

Complex is within part of a large block of unfragmented state forest managed for timber production, wildlife, recreation, and biodiversity. A dirt road winds along the bottom of the Jordan River Valley and hiking trails occur within the wetlands and in the surrounding upland forest. Rivers and streams within the Jordan River Valley experience significant foot traffic from anglers.

**EO Data:** Northern shrub thicket is dominated by dense speckled alder (*Alnus incana*) with tall shrub associates including red-osier dogwood (*Cornus sericea*), slender willow (*Salix petiolaris*), and cherry (*Prunus* spp.). Scattered overstory species include tamarack (*Larix laricina*), red maple (*Acer rubrum*), northern white cedar (*Thuja occidentalis*), and black ash (*Fraxinus nigra*). The low shrub layer is characterized by meadowsweet (*Spiraea alba*), wild red raspberry (*Rubus strigosus*), and alder-leaved buckthorn (*Rhamnus alnifolia*). Characteristic ground cover species include tussock sedge (*Carex stricta*), bluejoint grass (*Calamagrostis canadensis*), rough-leaved goldenrod (*Solidago rugosa*), joe-pye-weed (*Eutrochium maculatum*), purple avens (*Geum rivale*), marsh skullcap (*Scutellaria galericulata*), marsh fern (*Thelypteris palustris*), purple meadow-rue (*Thalictrum dasycarpum*), broad-leaved cattail (*Typha latifolia*), wild mint (*Mentha canadensis*), dwarf raspberry (*Rubus pubescens*), and sensitive fern (*Onoclea sensibilis*).

The soils are characterized by deep (> 1m), saturated peats (pH 7.2-7.5).

**Management Recommendations**

The main management recommendations are to allow natural processes to operate unhindered and to retain an intact buffer of natural communities surrounding the wetland to minimize the threat of hydrological alteration. Reducing local deer densities is also recommended. Monitor and treat invasive species, especially near Jordan River Road and frequently used footpaths.

**Management Priority Rank:** **Medium**



**Landslide Creek Headwaters, Antrim County  
Compartment | Stand(s): 52057|024**

**Landowner/Manager:** State Forest (Forest Resource Division)

**Size:** 12.3 acres

**Location:** From Landslide Scenic Parking Overlook at the end of Harvey Road north of Alba Highway, hike north and east from overlook along trail. West from trail down steep, forested slope (Figure 13).

**Survey Type(s):** Evaluation for EO status

**Natural Community Type(s):** Rich conifer swamp (Figure 14)

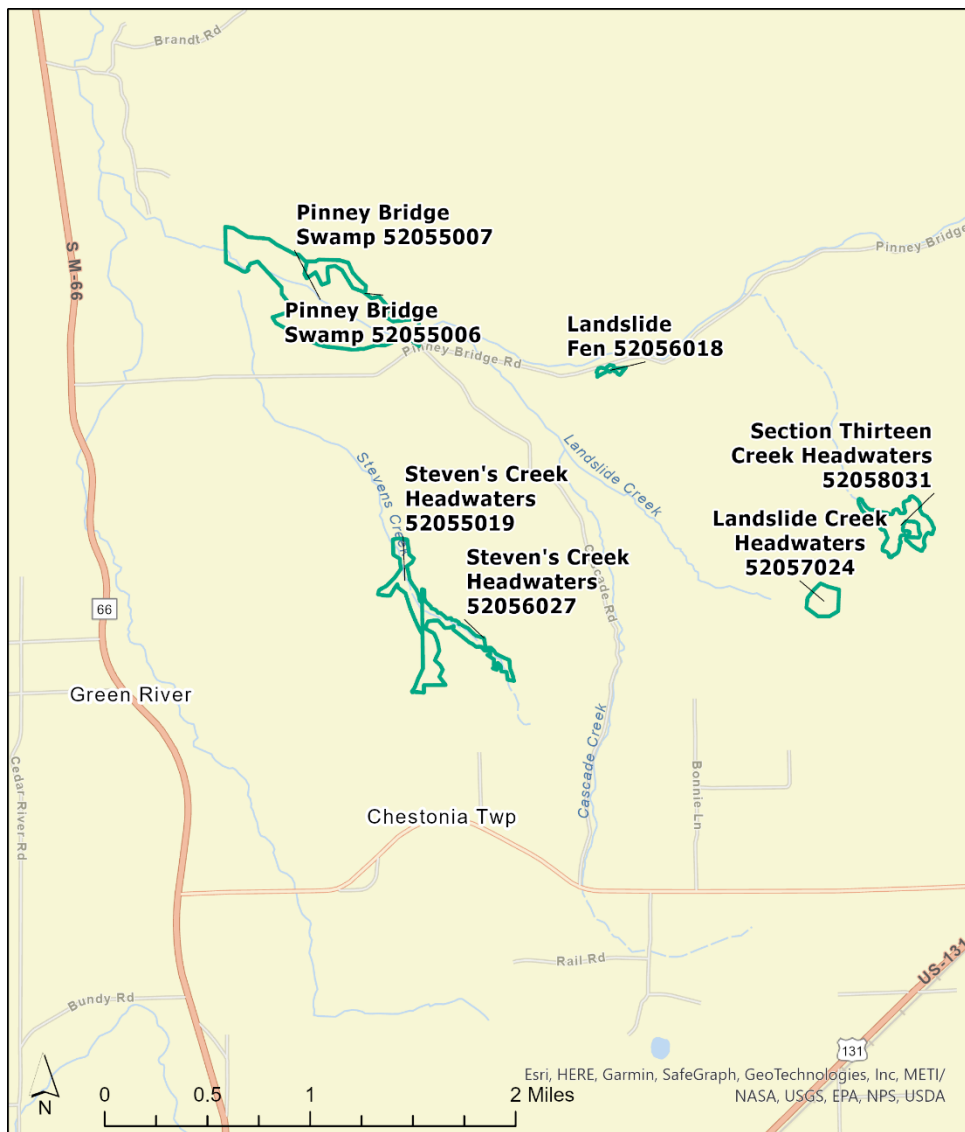


Figure 13. Location of Landslide Creek headwaters in Gaylord Forest Management Unit, Compartment 52057, Stand 024 on State Lands in Antrim County, Michigan, USA.

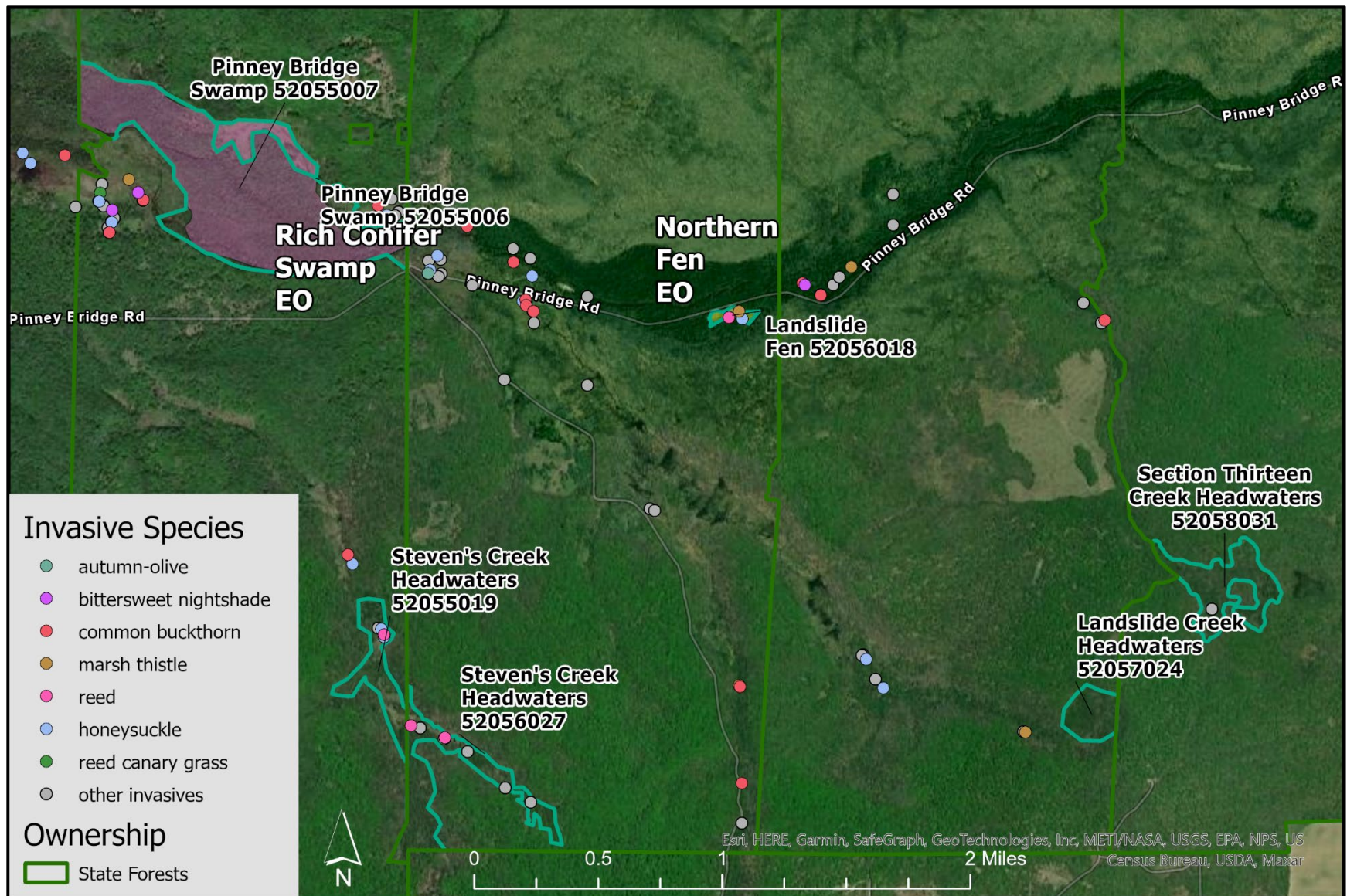


Figure 14. Priority stands in Gaylord Forest Management Unit, Jordan Valley, Compartments 52055, 52056 and 52057. Each stand is labeled with a name and FCS Key. Each dot is an observed invasive species described in legend.

**Natural Community Type: Rich Conifer Swamp**

**Rank:** G4 S3

**Size:** 12.3 acres

**Natural Community Description:** Natural community best resembles rich conifer swamp with dominant hemlock (*Tsuga canadensis*), frequent northern white-cedar (*Thuja occidentalis*) and yellow birch (*Betula alleghensis*). Ground cover is sparse with clumped sedges (*Carex* spp.), wild sarsaparilla (*Aralia nudicaulis*), and Canada mayflower (*Maianthemum canadense*) being most common.

Topography is steep down from North Country Trail. The rest of stand relatively flat with creeks (sandy, less than 1m across), water seeps from creek banks, and occasional mossy mounds (Figure 16). Signs of human activity or dumping present (Figure 15). No signs of hemlock woolly adelgid.

A plant species list can be found in Appendix D: Plant Species Lists.



Figure 15. Children's plastic playset observed in stand on August 17, 2022. Photograph by Rachel Hackett.



Figure 16. Frequent sandy creeks flowing around and beneath conifer trees. Photograph taken by Rachel Hackett on August 17, 2022.

### ***Management Recommendations***

The headwaters are important hydrologically to the area. Significant changes in the area such as nearby logging and trash deposition may affect water quality and quantity. Buffer from logging and identify source of human activity, if possible. Invasive species invading stand from North Country Trail or human activity can easily spread downstream. The only non-native plant species observed within the stand boundaries were helleborine (*Epipactis helleborine*) and common dandelion (*Taraxacum officinale*), but monitor nearby trails with moderate frequency to protect stand and connected waterways. Hemlock is present in the swamp canopy. A pest of this species, hemlock woolly adelgid, is spreading northward and should be monitored for regularly.

**Management Priority Rank: Medium**

**Landslide Fen, Antrim County  
Compartment | Stand(s): 52056|018**

**Landowner/Manager:** State Forest (Forest Resource Division)

**Size:** 3.0 acres

**Location:** On south side of Pinney Bridge Road, approximately 1000 m east of Cascade Road intersection (Figure 17).

**Survey Type(s):** Invasive plant species, other survey (Cohen 2022).

**Natural Community Type(s):** Northern fen (Figure 18)



Figure 17. Location of Landslide Fen in Gaylord Forest Management Unit, Compartment 52056, Stand 018 on State Lands in Antrim County, Michigan, USA.

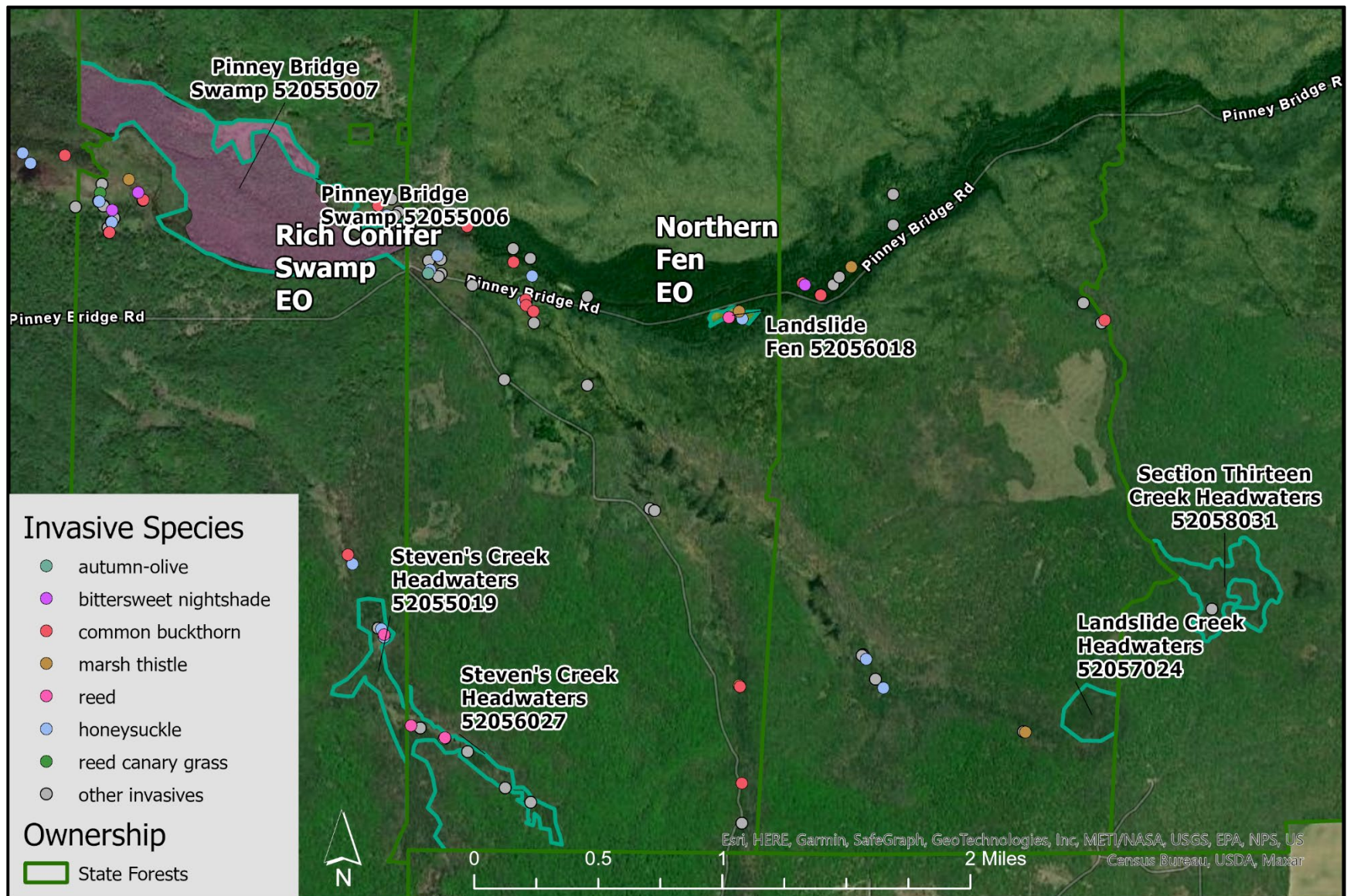


Figure 18. Priority stands in Gaylord Forest Management Unit, Jordan Valley, Compartments 52055, 52056 and 52057. Each stand is labeled with a name and FCS Key. Each dot is an observed invasive species described in legend.

**Natural Community Type: Northern Fen**

**Rank:** G3 S3

**EO Identification Number:** 18799 (Landslide Fen)

**EO Size:** 3.0 acres

**EO Rank and Justification:** BC. Small pocket of diverse sloping northern fen occurring along seepage areas within the Jordan River Valley. High floristic diversity and distinct ecological zonation due to gradients in soil and water chemistry. Species composition and zonation patterned by natural processes including a recent beaver flooding. Deer browse prevalent in adjacent rich conifer swamp and likely impacting fen as well. Drainage associated with Jordan River is dominated by rich conifer swamp and surrounding uplands are dominated by mature northern hardwoods.

Complex is within the Gaylord Forest Management Unit and is part of a large block of unfragmented state forest managed for timber production, wildlife, recreation, and biodiversity. Surrounding upland forest is actively managed northern hardwoods and early successional aspen forest. A dirt road winds along the bottom of the Jordan River Valley and hiking trails occur within the wetlands and in the surrounding upland forest. Rivers and streams within the Jordan River Valley experience significant foot traffic from anglers.

**EO Data:** Small pocket of diverse sloping northern fen occurring along seepage areas within the Jordan River Valley surrounded by steep end moraines. Drainage associated with Jordan River is dominated by rich conifer swamp and surrounding uplands are dominated by mature northern hardwoods. Groundwater seepage generates nutrient rich growing conditions suitable for fen species. Hummock and hollow microtopography and sedge tussocks (*Carex* sp.) generate fine-scale gradients in soil moisture and soil chemistry. Portions of the fen have been impacted by recent beaver activity. A dam at the western end of the occurrence has resulted in sustained flooding of the fen. Scattered canopy cedar have succumbed to flooding. Scattered nurse logs within the fen provide suitable substrate for plant/seedling establishment and growth.

A plant species list can be found in Appendix D: Plant Species Lists.

The soils are characterized by saturated peats of variable depth (20-60 cm; pH 7.0-7.8) over wet, medium-textured sands (pH 7.3-7.8).

**Management Recommendations**

Allow for natural processes to operate unhindered. Buffer management to minimize threat of hydrological alteration. Reduce deer density. Bush honeysuckle (*Lonicera* sp.), marsh thistle (*Cirsium palustris*), and invasive reed (*Phragmites australis* ssp. *australis*) observed in fen in 2022. Monitor and treat invasive species, especially invasive reed.

**Management Priority Rank:** High



## Mt Bliss Rich Conifer Swamp, Antrim County

Compartment | Stand(s): 52051|029, 031, 087

**Landowner/Manager:** State Forest (Forest Resource Division)

**Size:** 145.4 acres

**Location:** Accessible from two locations along Mt Bliss Rd, where State Forest land borders road. Parking is easy at 85.0708240°W 45.0844172°N, where there is a small parking area in the forest. Hike west about 280 meters to enter stand 031. Areas on west side of river are accessible by wading across river or via N-S snowmobile trail, which may be accessible from M-66, though did not verify access in field (Figure 19).

**Survey Type(s):** Evaluation for EO status

**Natural Community Type(s):** Rich conifer swamp (Figure 20)

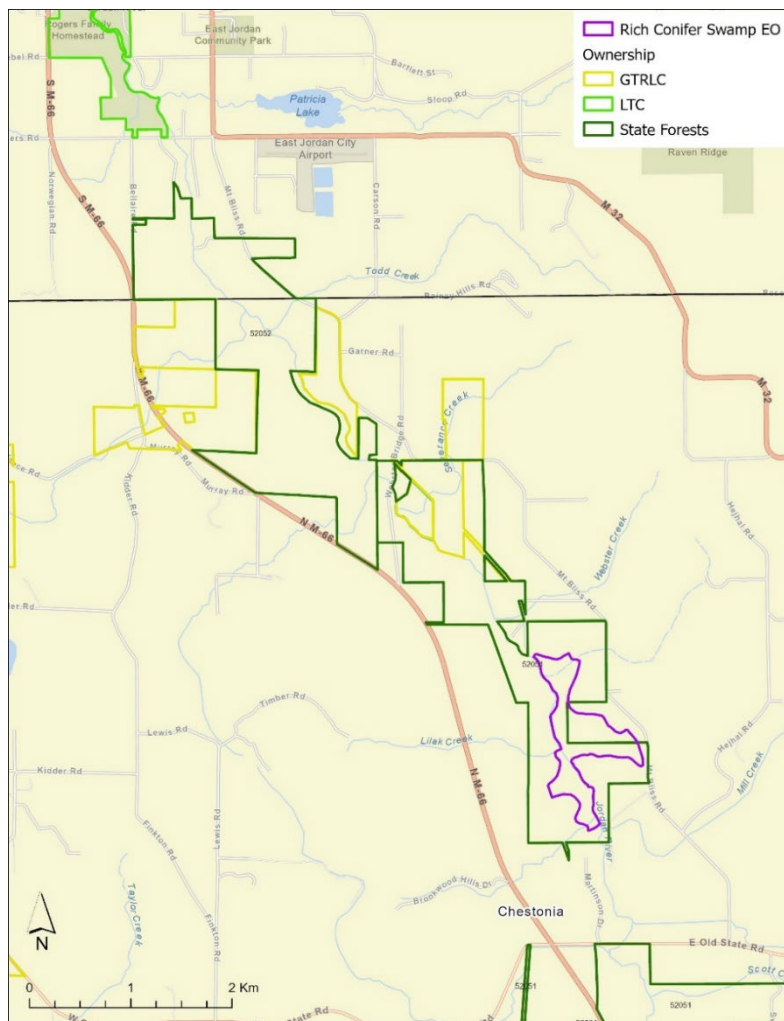


Figure 19. Location of Mt Bliss area Gaylord Forest Management Unit, Compartment 52051 on State Forest lands in Antrim County, Michigan, USA.

**Natural Community Type: Rich Conifer Swamp**

**Rank:** G4 S3

**EO Identification Number:** TBD (new)

**EO Rank and Justification:** C. Fair estimated viability. This stand represents an overall high quality but variable rich conifer swamp occurring along the banks of the Jordan River. This stand is a high-quality example of this natural community within a compartment comprised of mostly small and degraded conifer or hardwood-conifer swamps and early successional upland hardwoods (e.g., *Populus* spp., *Acer* spp.). Large and old cut northern white-cedar stumps, many with smaller diameter northern white-cedar and paper birch growing out of stumps occur scattered throughout the occurrence.

The far south end of the stand is more degraded, characterized by a dense sapling balsam fir sub-canopy under sparse canopy pole balsam fir, white spruce, and tamarack. Shrub and groundcover in this area is mostly *Salix* spp., various sedges, and common cattail (*Typha latifolia*). Ash (*Fraxinus* spp.) was also more prevalent in the canopy here and mortality from EAB has further degraded this portion of the stand. This region is excluded from the EO boundary.

Overall, few invasive species were observed, with common buckthorn (*Rhamnus cathartica*) and non-native honeysuckle (*Lonicera* spp.) only periodically encountered in low or patchy density (Figure 20). Much of the stand interior is lower quality, characterized by even-aged (ca. 65 years old) pole northern white-cedar, black spruce, and balsam fir dominating the canopy and lower diversity groundcover. This natural community extends into a large area of private land (inferred by aerial imagery only). Portions of stands 029 and 087 on the west side of the Jordan River are of equal or slightly lower quality

**EO Data:** Species composition is variable across the occurrence but composed primarily of native species characteristic of rich conifer swamp. Canopy coverage varies from closed canopy conifer swamp to sparse and open canopy areas of northern shrub thicket (speckled alder [*Alnus incana*], willows [*Salix* spp.]) or northern wet meadow along the Jordan River and interior where windthrow or ash mortality from emerald ash borer (EAB) has created large canopy gaps. Patchy and often dense areas of windthrow make traversing stand quite difficult, though many areas along the riverbank with larger diameter northern white-cedar and white pine are open and almost park-like to walk through.

Closed canopy areas are typically dominated by northern white-cedar, with black spruce (*Picea mariana*), white spruce (*Picea glauca*) and balsam fir (*Abies balsamea*) variably being dominant or co-dominant, and canopy associates including tamarack (*Larix laricina*), white pine (*Pinus strobus*), paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), and basswood (*Tilia americana*). Super-canopy white pine mostly occurs along the Jordan River and more interior on the west side of the river (stand 087). The wettest

areas support a diverse groundcover dominated by *Sphagnum* spp. hummocks and wet depressions with numerous characteristic species (e.g., bulblet fern [*Cystopteris bulbifera*], naked miterwort [*Mitella nuda*], dwarf raspberry [*Rubus pubescens*], foamflower [*Tiarella cordifolia*], goldthread [*Coptis trifolia*], star-flower [*Trientalis borealis*], partridge berry [*Mitchella repens*], wintergreen [*Gaultheria procumbens*], bunchberry [*Cornus canadensis*], wild strawberry [*Fragaria virginiana*], Canada mayflower [*Maianthemum canadense*], wood anemone [*Anemone quinquefolia*], sedge [*Carex leptalea*], bluebead-lily [*Clintonia borealis*], swamp valerian [*Valeriana uliginosa*], alder-leaved buckthorn [*Rhamnus alnifolia*], Labrador-tea [*Rhododendron groenlandicum*]; Figure 21). Intermediate wet-dry areas support a lower species diversity in the groundcover, with sedges (*Carex* spp.), royal fern (*Osmunda regalis*), and cinnamon fern (*Osmundastrum cinnamomeum*) typically dominating the forest floor. The driest areas of the stand typically have a sparse to depauperate groundcover layer of wild sarsaparilla (*Aralia nudicaulis*), poison ivy (*Toxicodendron radicans*), and sedges.

The patchy low shrub layer is characterized by alder-leaved buckthorn, Labrador-tea, dwarf raspberry, Canada blueberry (*Vaccinium myrtilloides*), Canadian fly honeysuckle (*Lonicera canadensis*), and gooseberry/current (*Ribes* spp.). The patchy, tall shrub layer is characterized by speckled alder, willows, Michigan holly (*Ilex verticillata*), wild-raisin (*Viburnum cassinoides*), red-osier dogwood (*Cornus sericea*), ninebark (*Physocarpus opulifolius*), and the non-native invasives common buckthorn (*Rhamnus cathartica*), honeysuckle (*Lonicera* spp.), and autumn-olive (*Elaeagnus umbellata*).

Northern wet meadow zones are especially characteristic along the riverbank, supporting a diverse sedge, grass, and forb community, including wood anemone (*Anemone canadensis*), turtlehead (*Chelone glabra*), marsh pea (*Lathyrus palustris*), common milkweed (*Asclepias syriaca*), blue vervain (*Verbena hastata*), common water horehound (*Lycopus americanus*), blue-joint (*Calamagrostis canadensis*), Canada goldenrod (*Solidago canadensis*), tussock sedge (*Carex stricta*), cut-leaf coneflower (*Rudbeckia laciniata*), virgin's bower (*Clematis virginiana*), fringed loosestrife (*Lysimachia ciliata*), marsh skullcap (*Scutellaria galericulata*), marsh bellflower (*Campanula aparinoides*), and swamp milkweed (*Asclepias incarnata*).

Gook Creek is a narrow meandering shallow, sandy bottom stream entering this stand from adjacent stand 027; it eventually spreads out becoming characterized by deep muck soils and slow-moving water where the hydrology supports a diverse groundcover characteristic of conifer swamps, including wild sarsaparilla, foamflower, spotted touch-me-not (*Impatiens capensis*), sensitive fern (*Onoclea sensibilis*), bulblet fern, Canada mayflower, sedges, Canada blueberry, and cut grass (*Leersia oryzoides*).

Stand 087 occurs on the west side of the Jordan River but merits inclusion within this EO. This stand harbors areas of large (e.g.,  $\leq 78.2$  cm DBH) and old (112 years) white pine and large (e.g., 47.0 cm DBH) old (149 years) northern white-cedar, a rare occurrence within this compartment. Although much of this stand supports drier organic

soils than typical of this conifer swamp, there are patchy zones of moist conditions and the characteristic species suite noted in the eastern side of the occurrence. Few invasive species were detected in this stand.

Stand 29 is primarily degraded and is mostly excluded from the EO polygon. However, the southern portion of the stand is generally much higher quality, though lower quality and less diverse than on the east side of the river. The canopy is characterized by large log and pole northern white-cedar (45.7 cm DBH, 163 years) with associates including eastern hemlock (*Tsuga canadensis*), white spruce, balsam fir, and paper birch with low species diversity in the groundcover layer.

A plant species list can be found in Appendix D: Plant Species Lists.

The soils are characterized by saturated sapric peats ranging from circumneutral to alkaline (pH 7.0-7.5).

### **Management Recommendations**

This occurrence should be conserved to allow natural processes to operate unhindered, including protection (e.g., restricted timber extraction, erosion control) of hydrology associated with this natural community (e.g., Gook Creek). Recent timber harvest along Gook Creek (i.e., stands 024, 026, 103) may threaten community integrity through erosion, sedimentation, and introduction of invasive species. Periodic monitoring and removal of invasive species is needed: namely common buckthorn, honeysuckles, autumn-olive, bittersweet nightshade (*Solanum dulcamara*), helleborine (*Epipactis helleborine*), and marsh thistle (*Cirsium palustre*). A two-track trail runs through the narrow central area of the occurrence to provide river access and would be good to periodically monitor for invasive species. Deer browse pressure is likely limiting regeneration of northern white-cedar and threatening persistence of rare plant species (e.g., orchids, *Taxus canadensis*). Hemlock is present in the swamp canopy. A pest of this species, hemlock woolly adelgid, is spreading northward and should be monitored for regularly.

Surrounding private land that appears from aerial imagery to be a continuation of the community may be worth acquiring for conservation of this occurrence.

**Management Priority Rank: Medium**

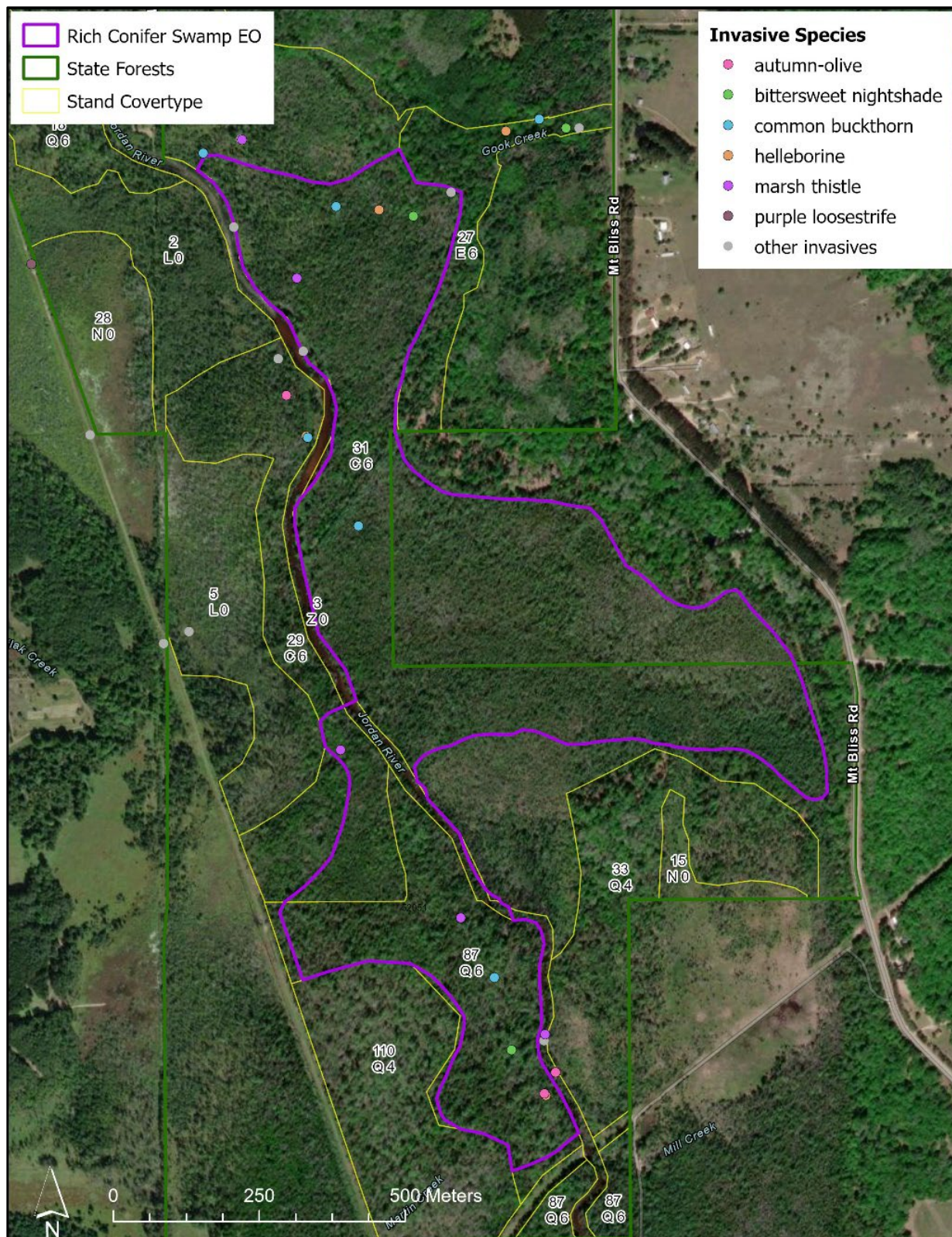


Figure 20. Proposed rich conifer swamp EO in Compartment 52051. Purple outline is the EO boundary; yellow outline is forest management stand boundaries; thick green outline is State land boundary. Each stand is labeled with its stand number and MDNR forest inventory cover type code. Each dot is an observed invasive species described in legend.



Figure 21. Subhabitats found in Mt Bliss Rich Conifer Swamp on July 19, 2022. Photographs by Clay Wilton.

## Petobego Pond, Antrim and Grand Traverse Counties

Compartment | Stand(s): 8280101|007, 008, 009

**Landowner/Manager:** State of Michigan

**Size:** 141.5 acres (78.5 acres on State land)

**Location:** Northeast of Traverse City. From the intersection of Bates Road and US-31 in Acme Township, continue northward on US-31 for 0.2 miles until you reach a dirt road on the left. Follow the dirt road toward Petobego Beach. To access the marsh by foot, park at the side of the dirt road where space allows and walk northwest. To access by boat, paddle from Petobego Beach northward into Petobego Pond. A trail network in need of maintenance parallels the marsh on the east and north sides. Access the trail network from the parking lot at the end of the dirt road to Petobego Beach (Figure 22).

**Survey Type(s):** EO revisit

**Natural Community Type(s):** Great Lakes marsh (Figure 23)

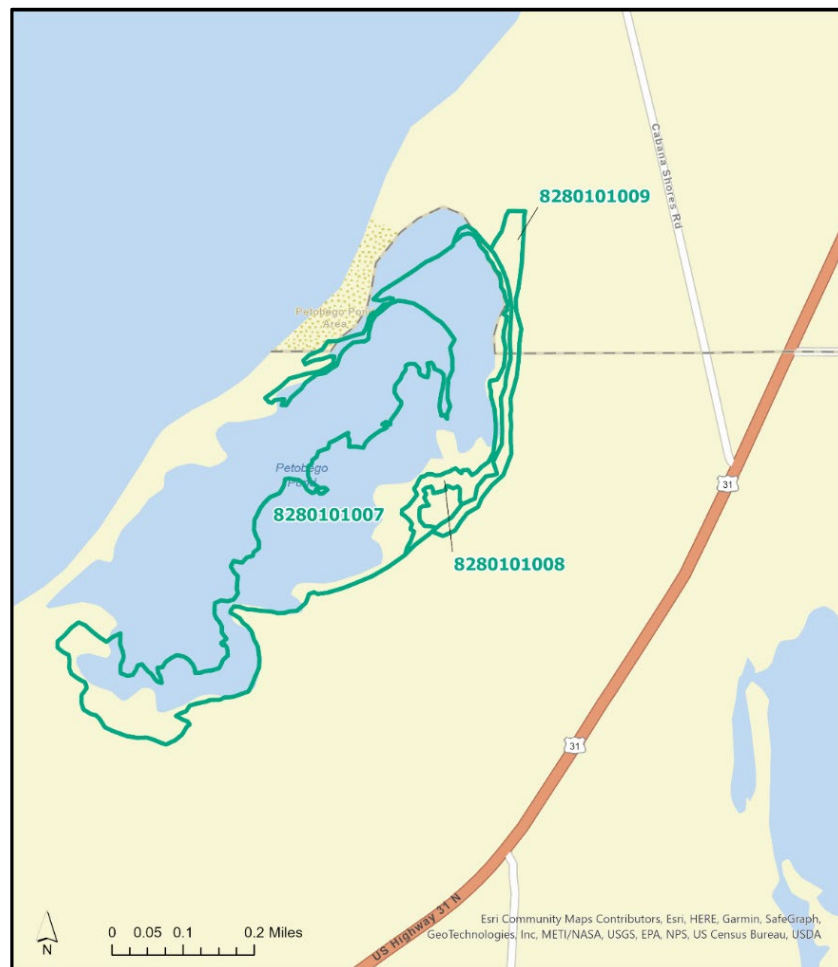


Figure 22. Location of Petobego Pond Great Lakes marsh on State Lands in Antrim and Grand Traverse Counties, Michigan, USA.

**Natural Community Type: Great Lakes Marsh**

**Rank:** G2 S3

**EO Identification Number:** 1919 (Petobego Pond)

**EO Size:** 141.5 acres

**EO Rank and Justification:** BC. Overall, high species diversity (> 100 species) and well-developed vegetative zonation formed from natural processes. Large wetlands surrounded by high-quality dry-mesic northern forest. Few invasive species were noted, and minor human disturbance primarily restricted to shore-lines and limited to foot traffic with some minor ORV damage localized in the southwestern most wetland.

**EO Description:** Petobego Pond and the surrounding stands span several different types of wetland natural communities. The Great Lakes marsh natural community consists of a shrub margin, wet meadow vegetation, emergent marsh, and submergent marsh. These communities are found within stands 8280101007 and 8280101008. Stand 8280101009 consists primarily of a rich conifer swamp natural community.

The Great Lakes marsh submersed vegetation zone in stand 8280101007 contains a diversity of native submersed and floating-leaf aquatic plant species. Native watermilfoils (*Myriophyllum* spp.) and native pondweeds (*Potamogeton* spp., *Stuckenia* spp.) dominate the submersed vegetation, while floating-leaf sweet-scented waterlily (*Nymphaea odorata*) and yellow pond-lily (*Nuphar variegata*) are prevalent on the water's surface. Emergent vegetation is unfortunately dominated by non-native graminoids, with large patches of invasive reed (*Phragmites australis* ssp. *australis*), reed canary grass (*Phalaris arundinacea*), and non-native cattails (*Typha angustifolia* and *T. xglauca*). A wet meadow zone around the shores of Petobego Pond extends into stand 8280101008, with diverse sedges (*Carex* spp.) and wet meadow forbs present. Some non-native Canada thistle (*Cirsium arvense*) and purple loosestrife (*Lythrum salicaria*) were observed in the wet meadow zone. A shrub zone lies at the margin of stands 8280101008 and 8280101009 and includes native shrub species such as sweet gale (*Myrica gale*), meadowsweet (*Spiraea alba*), red-osier dogwood (*Cornus sericea*), and swamp rose (*Rosa palustris*).

A rich conifer swamp natural community exists in the narrow band of lowland forest on the northwest side of Petobego Pond (stand 8280101009). The canopy is dominated by northern white-cedar (*Thuja occidentalis*), with prevalent windthrow and canopy gaps. Invasive shrubs have established in the understory, including glossy buckthorn (*Frangula alnus*), Japanese barberry (*Berberis thunbergii*), and non-native honeysuckles (e.g., *Lonicera tatarica*). A footpath parallels the boundary of this stand to the west.

No listed plant species were observed during the 2022 site visits.

**EO Data:** The following data refer only to the Great Lakes marsh natural community delineated in the map below. The Great Lakes marsh submersed vegetation zone in



stand 8280101007 is dominated by native submersed and floating-leaved aquatic plants. Prevalent species include yellow pond-lily (*Nuphar variegata*), sweet-scented waterlily (*Nymphaea odorata*), native watermilfoils (*Myriophyllum sibiricum* and *M. verticillatum*), musk grasses (*Chara* spp.), native pondweeds (e.g., *Potamogeton natans*, *P. richardsonii*, *P. illinoensis*), and eelgrass (*Vallisneria americana*). The emergent vegetation zone is heavily invaded by non-native graminoid species, such as non-native reed (*Phragmites australis* ssp. *australis*), reed canary grass (*Phalaris arundinacea*), and non-native cattails (*Typha angustifolia* and *T. xglauca*). Native emergent vegetation includes hard-stem bulrush (*Schoenoplectus acutus*), three-square (*Schoenoplectus pungens*), common arrowhead (*Sagittaria latifolia*), and bur-reed (*Sparganium fluctuans*). Some submersed aquatic species that can tolerate low water levels were found on mud flats within the emergent zone; these species are variable-leaved pondweed (*Potamogeton gramineus*) and flat-leaved bladderwort (*Utricularia intermedia*). The wet meadow vegetation zone in stand 8280101008 consists of diverse sedges (e.g., *Carex stricta*, *C. retrorsa*), Canada bluejoint (*Calamagrostis canadensis*), and forbs such as common beggar-ticks (*Bidens frondosa*), marsh cinquefoil (*Comarum palustre*), Kalm's lobelia (*Lobelia kalmii*), and northern bugle weed (*Lycopus uniflorus*). The shrub zone lining the edge of the Great Lakes marsh natural community consists of the following shrub species: speckled alder (*Alnus incana*), red-osier dogwood (*Cornus sericea*), shrubby cinquefoil (*Dasiphora fruticosa*), sweet gale (*Myrica gale*), swamp rose (*Rosa palustris*), sage willow (*Salix candida*), and meadowsweet (*Spiraea alba*).

A plant species list can be found in Appendix D: Plant Species Lists.

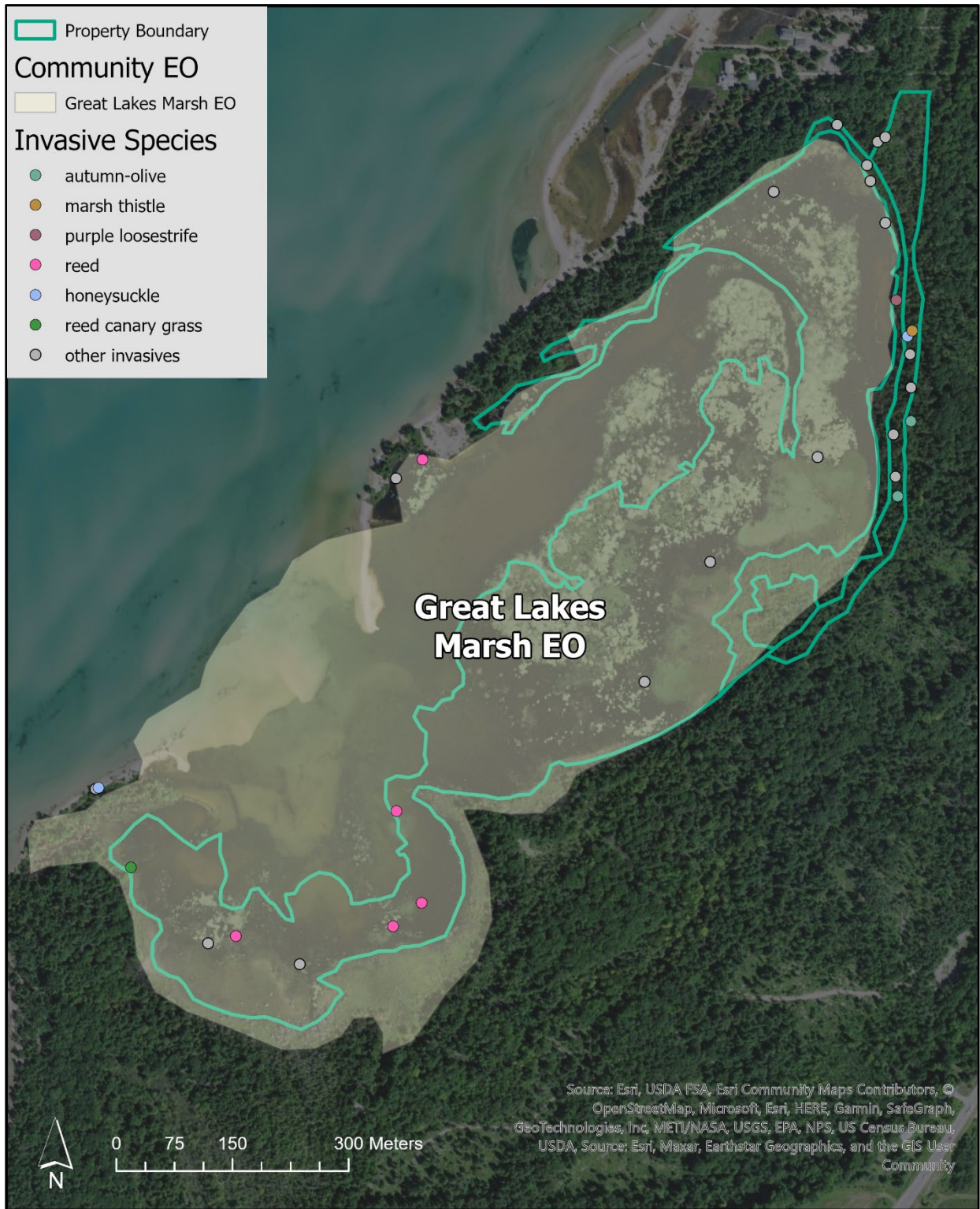


Figure 23. Great Lakes marsh (EOID 1919) and invasive species observed. Yellow outline is the boundaries of stands of State lands. Each dot is an observed invasive species described in legend.



Figure 24. Great Lakes marsh subhabitats observed during the site visit to Petobego Pond on August 28, 2022. Top: Eastern shoreline of Petobego Pond showing the shrub thicket margin grading into the wet meadow zone and finally into the emergent marsh zone. Bottom: Abundant hybrid cattail (*Typha x glauca*) in the emergent marsh zone. Photographs taken by Elizabeth Haber.

### **Management Recommendations**

Of all the mapped Element Occurrences of Great Lakes marsh in Michigan, Petobego Pond is in the top 25% in terms of its quality and estimated viability. It is the only Great Lakes marsh Element Occurrence in the Grand Traverse Bay region. The quality and geographical uniqueness of Petobego Pond combine to make it a feature meriting special protection and management actions.

The beach near Petobego Pond experiences heavy use in the summer months. It is a popular destination for recreation and one of few areas of natural shoreline on Grand Traverse Bay to allow public access.



When water levels and wave action combine to make favorable conditions for sand spits to form at the entrance to Petobego Pond, beachgoers sunbathe and recreate on these sand spits and could disturb the sensitive habitat nearby. Migrating waterfowl were observed during surveys using the sand spits for resting and aggregating. To protect these spits for wildlife habitat, they could be fenced when present.

Invasive plants pose the greatest threat to the integrity of this Great Lakes marsh natural community. The abundance of invasive graminoids has increased dramatically from the last MNFI survey of Petobego Pond in 2006. Invasive common reed patches were found at 5 locations within the Pond. Large patches of invasive cattails are now found throughout the shoreline areas of the pond and into the center. Invasive reed canary grass also occurs frequently in the southern half of the pond. The only invasive species which seems to have decreased in the pond from 2006 is purple loosestrife (*Lythrum salicaria*); only one occurrence of this species was found in the 2022 site visits. It is imperative that a management plan for invasive graminoids be developed and enacted in Petobego Pond. The diverse emergent marsh vegetation zone is being choked out by aggressive invasive graminoids, resulting in the loss of suitable habitat for lower-stature wetland plant diversity.

On August 2, 2015, a derecho storm with hurricane-force straight-line winds hit the western coast of the northern Lower Peninsula, with its epicenter in the Grand Traverse region. The winds caused massive damage to nature and property, and the effects of this storm are still visible in the forested lowlands surrounding Petobego Pond. Numerous windthrown trees still litter the ground and the tree canopy is far more open than it was before the storm. This disturbance has allowed invasive species to establish

and spread in the understory. Invasive shrubs, such as glossy buckthorn (*Frangula alnus*), Japanese barberry (*Berberis thunbergii*), autumn-olive (*Elaeagnus umbellata*), and non-native honeysuckles (e.g., *Lonicera tatarica*) are frequent in the understory. No mention of these species occurs in the 2006 survey data from Petobego Pond. Of greatest concern is the prevalence of glossy buckthorn seedlings and saplings in the lowland forest. Management for invasive shrubs in the margins of Petobego Pond should be included in any invasive species management plan for the pond itself.

**Management Priority Rank: Medium**

**Pinney Bridge Swamp, Antrim County**  
**Compartment | Stand(s): 52055|006, 007**

**Landowner/Manager:** State Forest (Forest Resource Division)

**Size:** 156.1 acres

**Location:** East of M-66 on Pinney Bridge Road. Park where Pinney Bridget Road intersects with Cascade Road and hike north across Jordan River. The swamp is west of the trail adjacent to the river (Figure 25).

**Survey Type(s):** Other survey (Cohen 2021)

**Natural Community Type(s):** Rich conifer swamp (Figure 26)

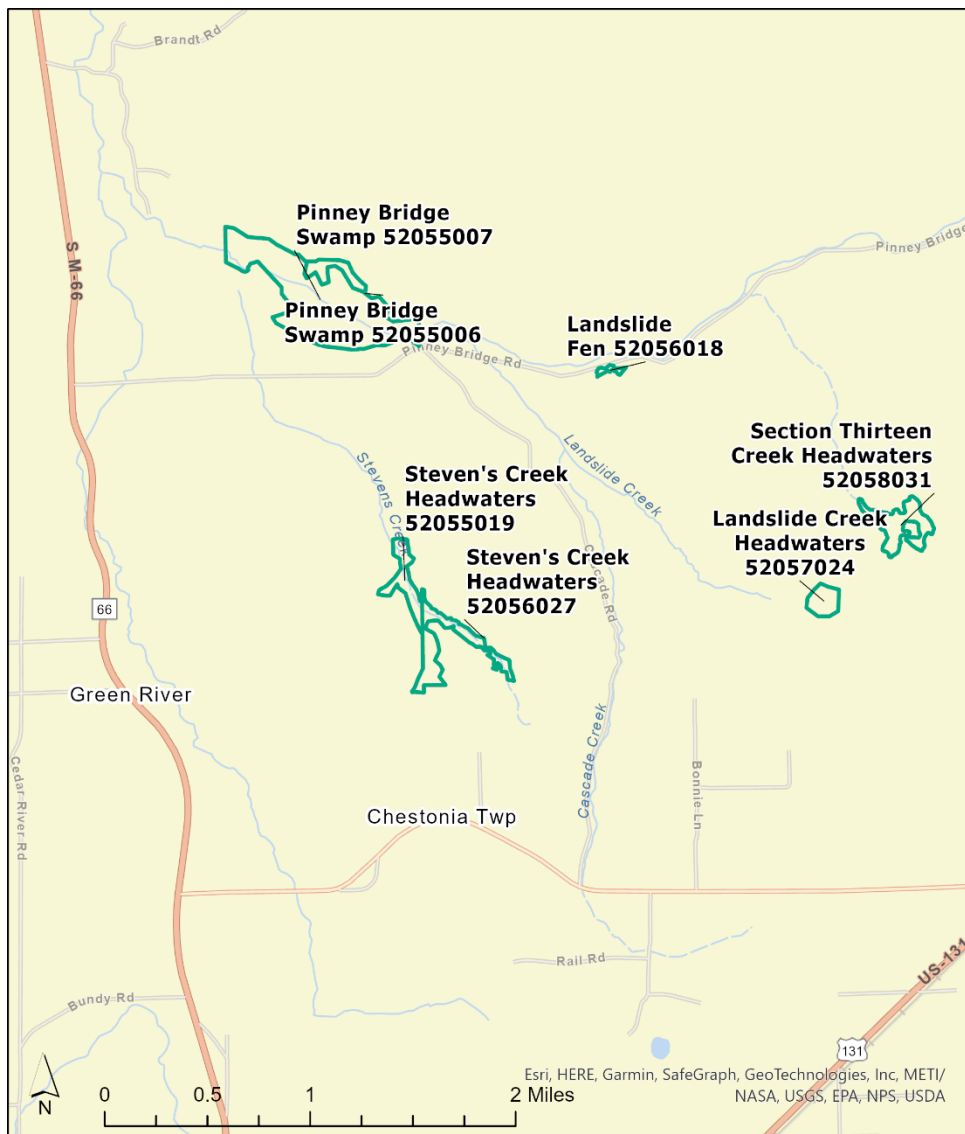


Figure 25. Location of Pinney Bridge Swamp in Gaylord Forest Management Unit, Compartment 52055 on State Lands in Antrim County, Michigan, USA.



Figure 26. Priority stands in Gaylord Forest Management Unit, Jordan Valley, Compartments 52055, 52056 and 52057. Each stand is labeled with a name and FCS Key. Each dot is an observed invasive species described in legend.

**Natural Community Type: Rich Conifer Swamp**

**Rank:** G4 S3

**EO Identification Number:** 18802 (Pinney Bridge Swamp)

**EO Size:** 142.6 acres

**EO Rank and Justification:** C. Rich conifer swamp occurring along seepage slopes and headwater streams feeding into Jordan River surrounded by steep end moraines. Cut stumps occur locally within the swamp, concentrated along the river and stream margins. Canopy ash has been killed by emerald ash borer. Black ash (*Fraxinus nigra*) sprouts are common in the understory. Infrequent common buckthorn saplings and seedlings were noted in 2021 and removed. Deer browse pressure is high and has limited cedar regeneration. Deer browse was noted on orchids.

Complex is within the Gaylord Forest Management Unit and is part of a large block of unfragmented state forest managed for timber production, wildlife, recreation, and biodiversity. An old logging road passes through a section of the swamp.

Surrounding landscape includes other wetlands that drain into Jordan River (e.g., northern fen, northern shrub thicket) with uplands dominated by mature and managed northern hardwoods and early-successional aspen forest on moraine geology. Several dirt roads, old logging roads, and hiking trails occur among all surrounding natural communities. Rivers and streams within the Jordan River Valley experience significant foot traffic from anglers.

**EO Data:** Dense and diverse rich conifer swamp located on seepage slopes and along headwater streams feeding into Jordan River. Well-developed sphagnum hummocks and hollows occur locally and provide microsite diversity by creating small-scale gradients in soil moisture and soil chemistry. Locally there are pockets of braided streams and small swamp islands within the streams. Windthrow and coarse woody debris are prevalent within the rich conifer swamp. A small stretch of swamp was flood-killed resulting from beaver activity. Northern white-cedar (*Thuja occidentalis*) with DBH of 26.7 cm was estimated to be greater than 110 years old. Coarse woody debris load is composed of small diameter species including balsam fir (*Abies balsamifera*) and black ash with canopy ash having succumbed to emerald ash borer.

A plant species list can be found in Appendix D: Plant Species Lists.

The soils are characterized by deep ( $\geq 1$  m) saturated peats (pH 7.0-7.5) that overlie wet medium-textured alkaline sands.



**Management Recommendations**

Allow natural processes to operate unhindered; retain an intact buffer of natural communities surrounding the wetland to minimize hydrological alteration. Reduce deer densities to allow natural forest regeneration and understory species. Treat invasive species, especially common buckthorn (*Rhamnus cathartica*), and monitor river, trail, and old logging road for invasive species.

**Management Priority Rank: High**

**Section Thirteen Creek Headwaters, Antrim County  
Compartment | Stand(s): 52058|031**

**Landowner/Manager:** State Forest (Forest Resource Division)

**Size:** 27.3 acres

**Location:** North from Landslide Scenic Parking Overlook to where North Country Trail crosses forest road. Take trail east approximately 250 m (Figure 27). Trail overlooks steep bank to stand.

**Survey Type(s):** Evaluate for EO status

**Natural Community Type(s):** Mesic northern forest (Figure 28)

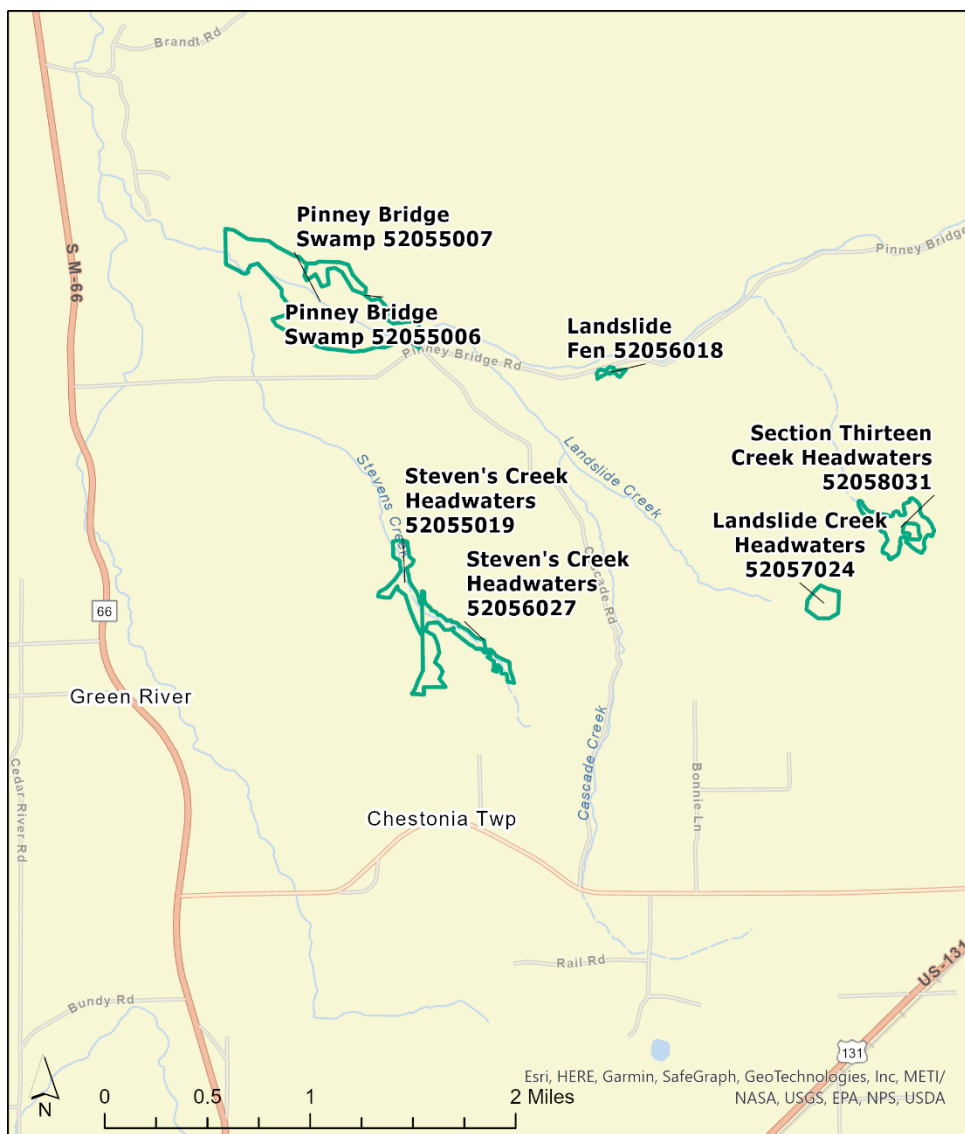


Figure 27. Location of Section Thirteen Creek headwaters in Gaylord Forest Management Unit, Compartment 52058, Stand 031 on State Lands in Antrim County, Michigan, USA.

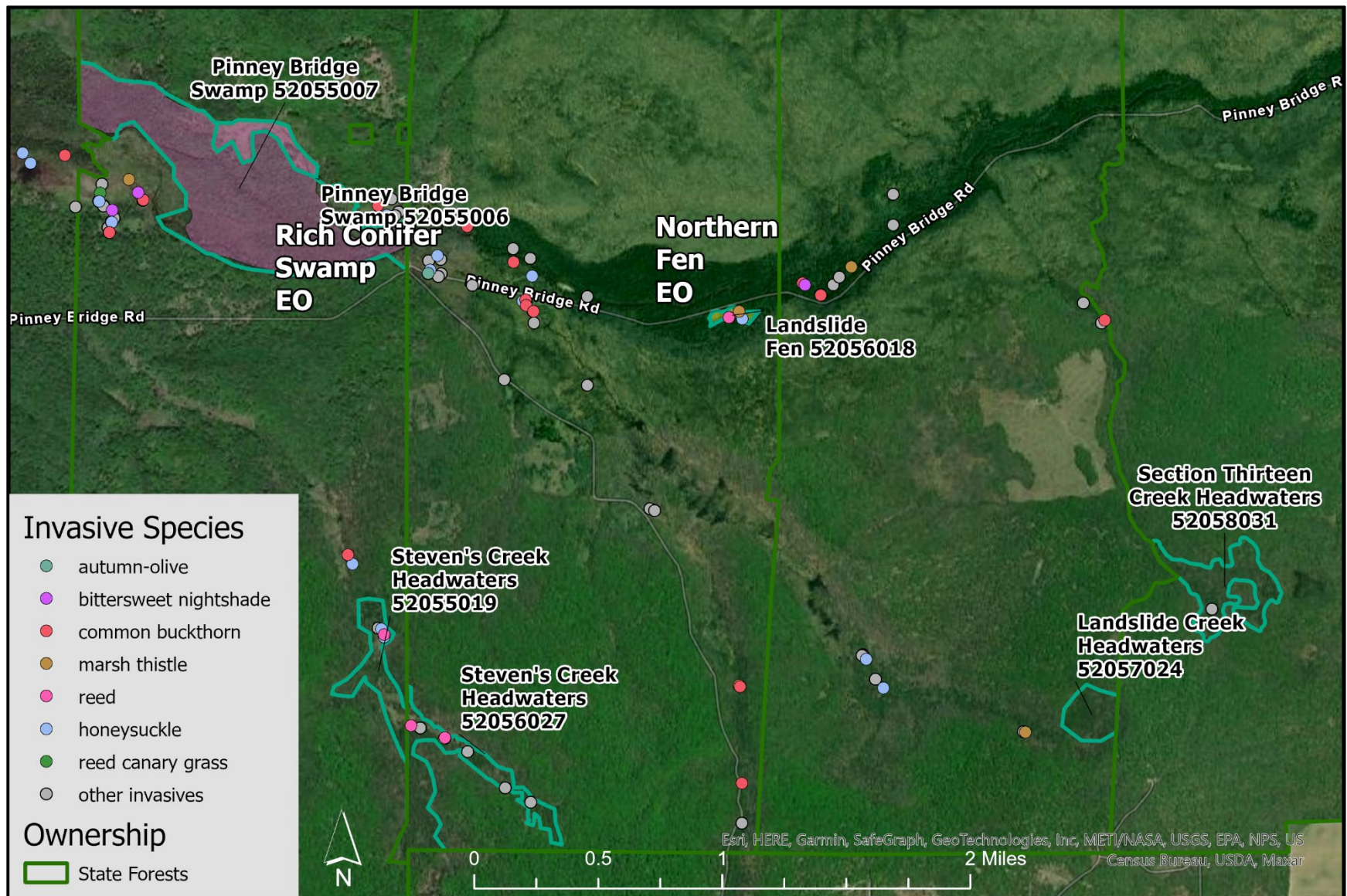


Figure 28. Priority stands in Gaylord Forest Management Unit, Jordan Valley, Compartments 52055, 52056 and 52057. Each stand is labeled with a name and FCS Key. Each dot is an observed invasive species described in legend.

**Natural Community Type: Mesic northern forest**

**Rank: G4 S3**

**Size: 27.3 acres**

**Natural Community Description:** Section Thirteen Creek runs at the base of steep topography of surrounding mesic northern forest (Figure 29). Northern white-cedar (*Thuja occidentalis*) and hemlock (*Tsuga canadensis*) locally dominate with frequent yellow birch (*Betula alleghensis*). Intermittent patches of once hardwood-conifer swamp but are now dead ash (*Fraxinus* spp.), sedges (*Carex* spp.), cinnamon fern (*Osmundastrum cinnamomeum*), and cattail (*Typha latifolia*; Figure 30) dominated wet meadow. There were signs of beech bark disease on DBH 8" trees, and no signs of hemlock woolly adelgid. Ferns, sedges, and mosses abundant along banks of shaded creek. In several areas water seeps from steep banks into mossy areas.

A plant species list can be found in Appendix D: Plant Species Lists.

Soil profile in cedar seep area was approximately 18 cm of sandy loam (pH 4.5) over 27 cm of clay sand (pH 5.8) on 15 cm of silt clay (pH 8.5) before hitting rock.



Figure 29. Section Thirteen Creek at base of mesic forest valley. Photograph taken on August 17, 2022, by Rachel Hackett.

**Management Recommendations**

The headwaters are important hydrologically to the area. Significant changes in the area such as nearby logging may affect water quality and quantity. Buffer from logging. Most invasive species observed covered relatively small areas. Treat invasive species likely to spread down river, starting at the headwaters. Monitor for invasive species along creek, canopy gaps, and nearby trail. Hemlock is present in the forest canopy. A pest of this species, hemlock woolly adelgid, is spreading northward and should be monitored for regularly.

**Management Priority Rank: Medium**



Figure 30. Section Thirteen Creek passing through area of open canopy dominated by sedges and ferns.

**Stevens Creek Headwaters, Antrim County  
Compartment | Stand(s): 52056|027, 52055|019**

**Landowner/Manager:** State Forest (Forest Resource Division)

**Size:** 50.8 acres

**Location:** West of Cascade Road between Pinney Bridge Road and Alba Highway approximately 900m. Old roads from Cascade Road parallel with north and south ends of stands lead about 500 m toward stands (Figure 31).

**Survey Type(s):** Evaluate for EO status, invasive plant species surveys.

**Natural Community Type(s):** Hardwood-conifer swamp (Figure 32)

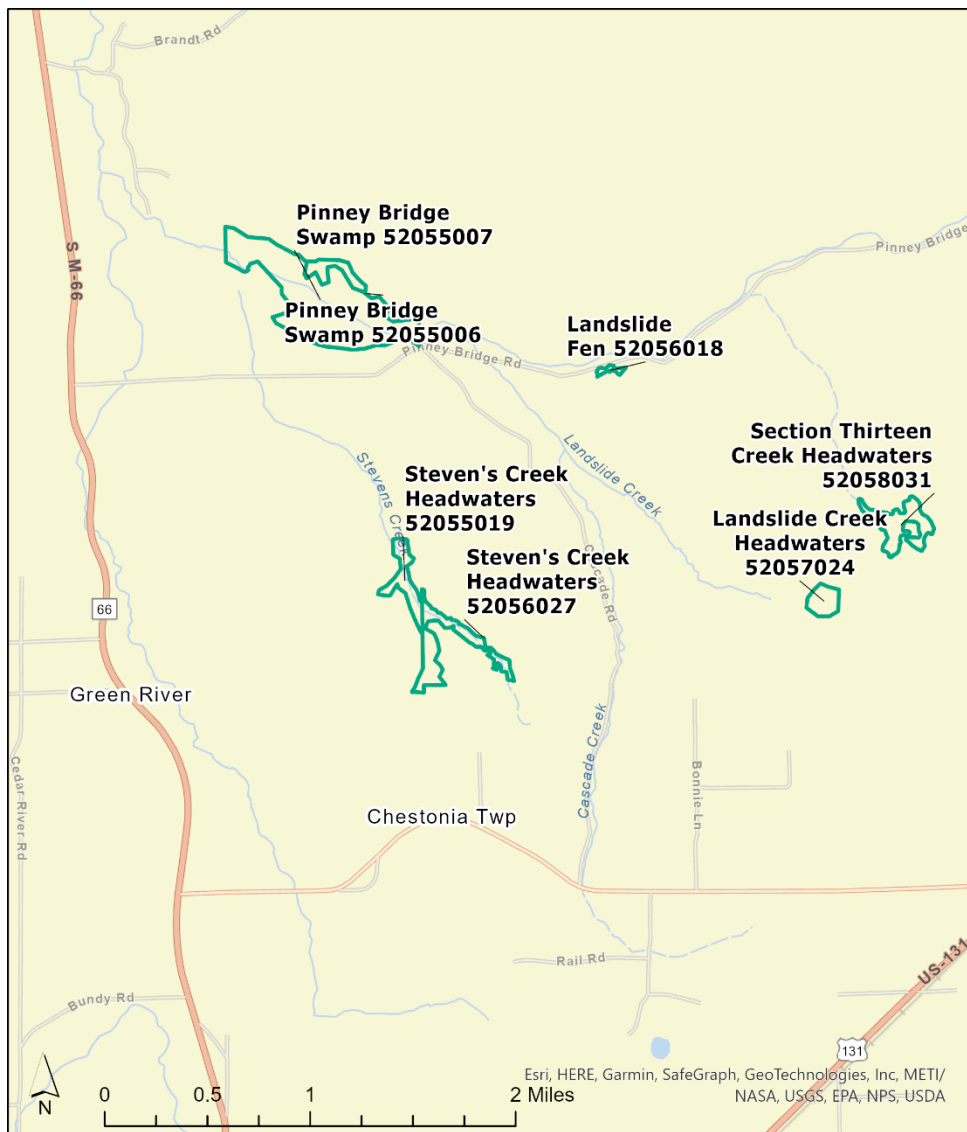


Figure 31. Location of Steven's Creek headwaters in Gaylord Forest Management Unit, Compartment 52055 and 52056 on State Lands in Antrim County, Michigan, USA.



Figure 32. Priority stands in Gaylord Forest Management Unit, Jordan Valley, Compartments 52055, 52056 and 52057. Each stand is labeled with a name and FCS Key. Each dot is an observed invasive species described in legend.

**Natural Community Type: Hardwood-Conifer Swamp**

**Rank:** G4 S3

**Size:** 50.8 acres

**Natural Community Description:** Remnants of hardwood-conifer swamp along Stevens Creek (Figure 33). Creek is shallow with cobble near beginning, and sandier downstream. Ash tree (*Fraxinus* spp.) death from emerald ash borer has opened large areas of canopy resembling wet meadow communities. Only large trees of northern white-cedar (*Thuja occidentalis*) remain, other trees are saplings (e.g., ash, elm). Sedges (*Carex* spp.) and grasses (e.g., fowl manna grass, cut grass) dominated herbaceous groundcover mixed with native cattail (*Typha latifolia*), ferns (e.g., lady fern, sensitive fern, maiden fern) and aster family (Asteraceae). Troublesome invasive species present: invasive reed (*Phragmites australis* ssp. *australis*; Figure 34), reed canary grass (*Phalaris arundinacea*), bush honeysuckle (*Lonicera* sp.), and wall lettuce (*Mycelis muralis*). Signs of beech bark disease in area. Evidence of heavy deer browse and beaver activity. Ant mounds present.

Surrounding stands are mesic northern forests with rolling topography with evidence of a logging history. Several old two-tracks lead toward the area from Jordan River Road.

A plant species list can be found in Appendix D: Plant Species Lists.



Figure 33. Remnants of hardwood-conifer swamp along Stevens Creek. Snags of ash and cedar were common. Photograph taken on August 18, 2022, by Rachel Hackett.

**Management Recommendations**

The headwaters are important hydrologically to the area. Significant changes in the area such as nearby logging may affect water quality and quantity. Buffer from logging. Most invasive species observed covered relatively small areas. Treat invasive species likely to spread down river, starting at the headwaters. Invasive reed, reed canary grass, and honeysuckle, were the most troublesome invasives observed. Monitor for invasive species along creek.

**Management Priority Rank:** **Medium**





Figure 34. Invasive reed (*Phragmites australis* ssp. *australis*) was found in several patches less than 1 acre along Stevens Creek. Photographs taken on August 18, 2022, by Rachel Hackett.

## Warner Creek, Antrim County

Compartment | Stand(s): 52048|006, 001, 004, 010, 014, 017; 52047|010, 011, 012

Landowner/Manager: State Forest (Forest Resource Division)

Size: 174.4 acres

Location: West of US 131 on M-32 is Warner Creek Pathway Trailhead, part of North Country Trail network. Hike west then south on trail. (Figure 35).

Survey Type(s): Evaluate for EO status, invasive plant species surveys

Natural Community Type(s): Northern fen, northern shrub thicket, northern wet meadow, rich conifer swamp (Figure 36)

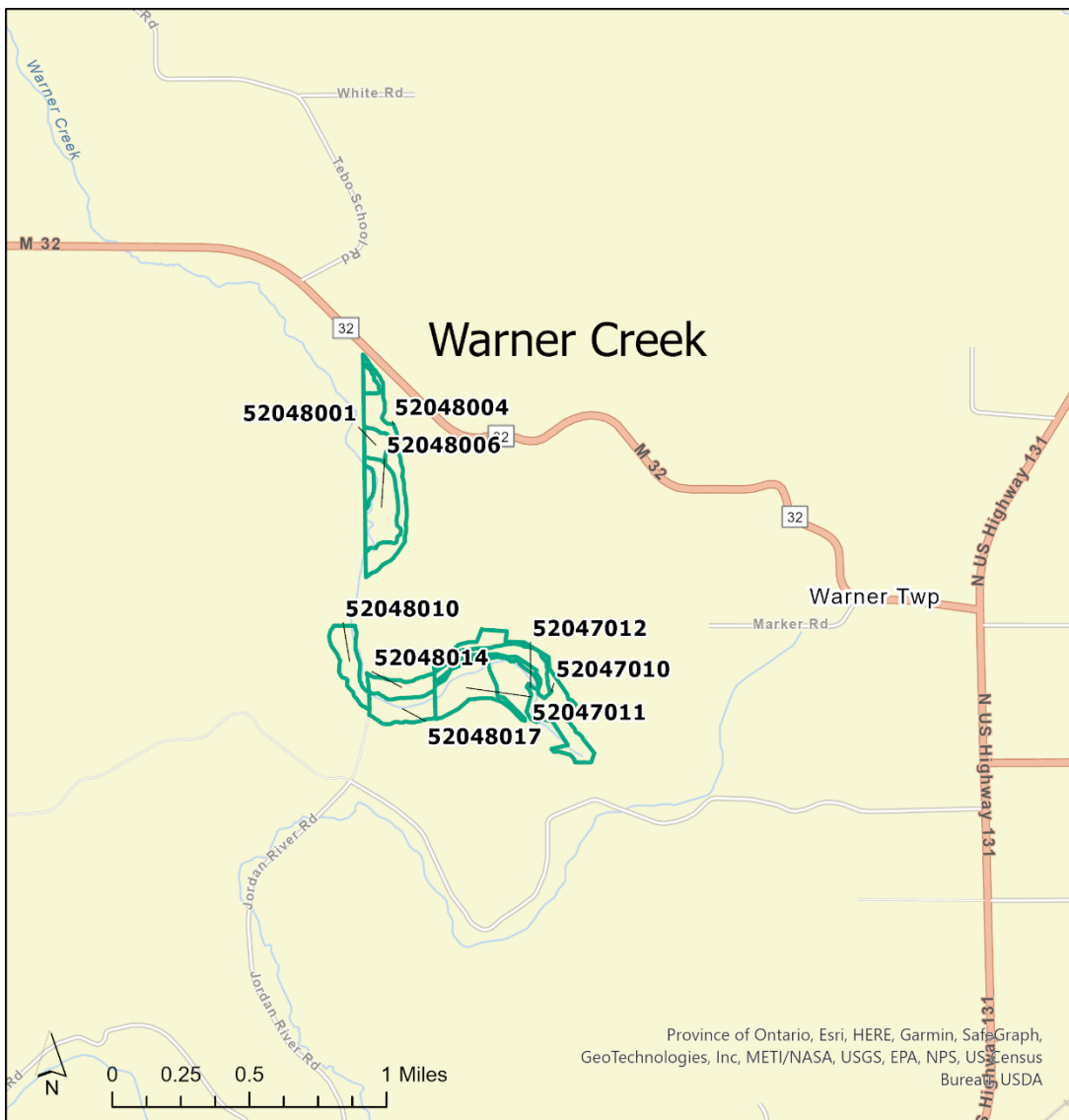


Figure 35. Location of Warner Creek headwaters Gaylord Forest Management Unit, Compartments 52047 and 52048 on State Lands in Antrim County, Michigan, USA.

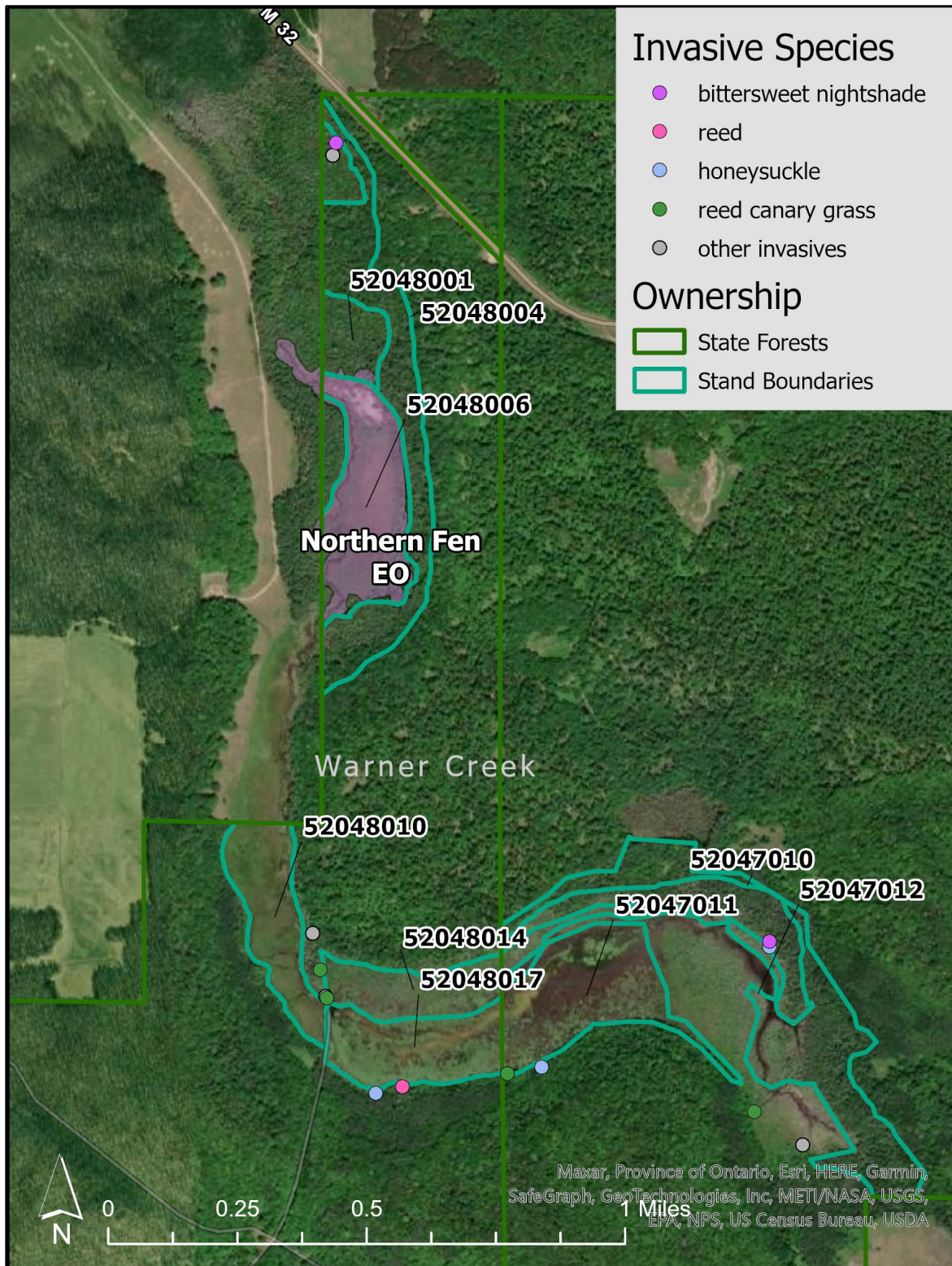


Figure 36. Stands including and connected to Warner Creek Fen (EOID 26388) in Gaylor Forest Management Unit, Compartments 52048 and 52047. Cyan lines are stand borders. Green lines are State Forest boundaries. The transparent purple area is the northern fen EO. Each dot is an observed invasive species described in legend.

**Natural Community Type: Northern Fen  
Compartment | Stand(s): 52048|006**

**Rank:** G3 S3

**EO Identification Number:** 26388 (Warner Creek Fen)

**EO Size:** 21.0 acres

**EO Rank and Justification:** BC. Northern fen with high quality species, high FQA (51.7). Although no invasive species were present, invasive reed (*Phragmites australis* ssp. *australis*) and reed canary grass (*Phalaris arundinacea*) were present upstream. Evidence of deer restricted to periphery. Beaver active in area. Private lands about 50 m to west, downstream. Complex is within part of a block of unfragmented state forest managed for timber production, wildlife, recreation, and biodiversity. Surrounding upland forest and swamps managed by MDNR Gaylord Forest Management Unit and have been logged. Hiking trail 100m to the east.

**EO Data:** Northern fen is mostly on a riverine island formed by Warner Creek west of Warner Creek Pathway, which connects to North Country Trail network (Figure 37). Sedge family (Cyperaceae) dominant with species dominance varying throughout and tree and *Sphagnum* moss mounds. Most of the diversity is in the north with marly, mud flats and *Sphagnum*-Cedar mounds (Figure 38). Tree species were northern white-cedar (*Thuja occidentalis*), tamarack (*Larix laricina*), and white pine (*Pinus strobus*). The trees in the mounds were approximately 35 years old, DBH was mostly 7.0 – 8.0 cm, but some reached 29.0 cm.

Southern area transitions sharply from tussock and Buxbaum sedge (*Carex stricta*, *C. buxbaumii*) dominance to twig-rush (*Cladium marsicoides*) and shrubby cinquefoil (*Dasiphora fruticosa*) with wire sedge (*C. lasiocarpa*) throughout. The change in dominant vegetation caused the color change seen on imagery and Figure 39. Some beaver activity (Figure 40). No invasive plant species observed, but some upstream: invasive reed, reed canary grass.

A plant species list can be found in Appendix D: Plant Species Lists.

Sphagnum mounds have approximately 31 cm of black organic peat (pH 7.5), above gray, gritty, sandy clay marl (pH 8.4).



Figure 37. Warner Creek flowing through the northern fen EOID 26388 on September 2, 2022. Photograph by Rachel Hackett.



Figure 38. Marl zone in northern portion of northern fen EOID 26388 on September 2, 2022. Photograph by Rachel Hackett.



Figure 39. Southern sedge and twig rush dominated zones in Warner Creek Fen (EOID 26388). The color change in the vegetation is where the dominant vegetation changed from tussock, wire, and Buxbaum sedge to wire sedge, twig-rush, and shrubby cinquefoil. Photograph taken on September 2, 2022, by Rachel Hackett.

**Other Natural Communities: Emergent Marsh, Northern Wet Meadow, Rich Conifer Swamp**

**Compartment | Stand(s): 52048|001, 004, 010, 012, 014, 017; 52047|010, 011, 012**

Several areas of natural communities were identified during surveys as medium priority due to their connectiveness to EOID 26388 (Figure 36). Although they do not meet qualifications for EO status, their continued integrity is key to maintain the quality viability of EOID 26388. Portions of the North Country State Trail network and Warner Creek run through these stands, proving a pathway for spread of invasive species like invasive reed and reed canary grass to the northern fen EO.

Table 6. Summary of stands connected to northern fen (EOID 26399). FSC Key is a unique identifier used by Michigan Forest Management Units.

<b>FSC Key(s)</b>	<b>Area (acres)</b>	<b>Natural Community</b>	<b>Notes</b>
52048001	8.5	Rich Conifer Swamp	Cedar dominated swamp with old road in north, transitions gradually into EO. Recent signs of black bear.
52048004	26.2	Mesic northern forest	Warner Creek Pathway thru and adjacent to stand. Dominated by hemlock with abundant cedar and red maple.
52048012 52047012	37.9 7.5	Northern wet meadow	Transitional between northern wet meadow and remnants of hardwood-conifer swamp. Many dead snags imply emerald ash border opened the swamp canopy. Some groundwater seep areas with mossy mounds and small creeks. Old trail or two-track runs north of creek.
52048010	13.1	Northern wet meadow	Along creek. Some groundwater seep and fen like areas, but fen areas not large enough to be designated as a separate community. Beaver active in area and flooding can change landscape.
52048017 52047011	20.1 14.0	Emergent marsh	Resembles emergent marsh that is frequently flooded by beaver activity. Large patches of invasive reed and reed canary grass present. Old trail or two-track runs on southern border of stands 52048017 and 52047011.
52048014 52047010	10.1 16.0	Northern shrub thicket	Shrub dominant with patches of open wet meadow, largest patch in southeast. Beaver activity.



Figure 40. Beaver dam on Warner Creek. Photograph by Rachel Hackett, taken on September 2, 2022

### ***Management Recommendations***

No invasive plant species were observed within the EO boundaries. Figure 36 contains points of invasive species observed upstream from EO: reed canary grass and invasive reed. Currently managed and old trails among stands act as another pathway for invasive species. Treat invasive species in stages upstream from EO. Monitor and treat invasive species along trails, creek, and beaver dams. Hydrology may be altered by beaver activity.

**Management Priority Rank: High**

## Wilcox-Palmer Shah Preserve, Antrim County

**Landowner/Manager:** Grand Traverse Regional Land Conservancy

**Size:** 23 acres

**Location:** North of Elk Rapids. From US-31 north, turn left onto Industrial Park Road, then turn immediately right onto North Bayshore Drive. Travel north on North Bayshore Drive for 1.6 miles until you reach the Preserve entrance. Park along the side of North Bayshore Drive and follow boardwalk path westward toward the beach (Figure 41).

**Survey Type(s):** Evaluate for EO status, EO revisit, invasive species surveys

**Natural Community Type(s):** Open dunes, dry-mesic northern forest (Figure 44)



Figure 41. Location of Wilcox-Palmer Shah Preserve in Antrim County, Michigan, USA.



**Natural Community Type: Dry-mesic Northern Forest**

**Rank:** G4 S3

**Size:** 13.5 acres

**Natural Community Description:**

To the west of North Bayshore Drive is a dry-mesic northern forest natural community. This community extends from the northern to the southern boundary of the Preserve, from the leeward side of the dune ridge eastward for approximately 50 meters. Near the dune ridge, the tree canopy consists of red oak (*Quercus rubra*), red pine (*Pinus resinosa*), and white pine. Further eastward, the canopy becomes dominated by Eastern hemlock (*Tsuga canadensis*). The understory is sparse, especially underneath the hemlocks. Characteristic understory species include Canada mayflower, low sweet blueberry (*Vaccinium angustifolium*), wild sarsaparilla (*Aralia nudicaulis*), and bracken fern. Of note is the occurrence of a large population of Canada yew (*Taxus canadensis*) on the leeward side of the dune ridge. Few invasive species were observed in this natural community.

**Natural Community Data:** The dry-mesic northern forest community occurs on the leeward side of the dune ridge extending eastward for up to 50 meters and spans the entire north/south axis of the Preserve. Along the top of the dune ridge and eastward about 6 meters is a tree canopy dominated by red oak, red pine, and white pine. Some of these trees near the dune ridge are quite old; a red oak with a 66.5cm DBH had 181 rings and a nearby red pine with a 40.5cm DBH had 135 rings. The understory near the dune ridge consists of species adapted to dry and acidic sandy soils, such as low sweet blueberry, wild sarsaparilla, bush-honeysuckle (*Diervilla lonicera*), and bracken fern.

On the leeward side of the dune ridge, throughout the north/south axis of the preserve but especially in the northern end, is a significant population of Canada yew (*Taxus canadensis*). It is notable that this species is so prevalent in the Preserve because it is sensitive to deer browse.

Further inland (to the east), the canopy becomes dominated by Eastern hemlock. The hemlock are typically slightly younger than the trees near the dune ridge; for example, a hemlock with a DBH of 44.5cm had 106 tree rings. The understory beneath the hemlocks is sparse and characteristic species are Canada mayflower, starflower (*Trientalis borealis*), sedges (*Carex arctata*, *C. pensylvanica*), and wintergreen (*Gaultheria procumbens*). Approximately 1 cm of leaf litter/duff occurs over acidic (pH 4.4), medium-textured sand. Notably few invasive species were observed in this habitat, and the non-native species observed were mostly restricted to the trail margins. No rare species were observed in this natural community.

A plant species list can be found in Appendix D: Plant Species Lists.

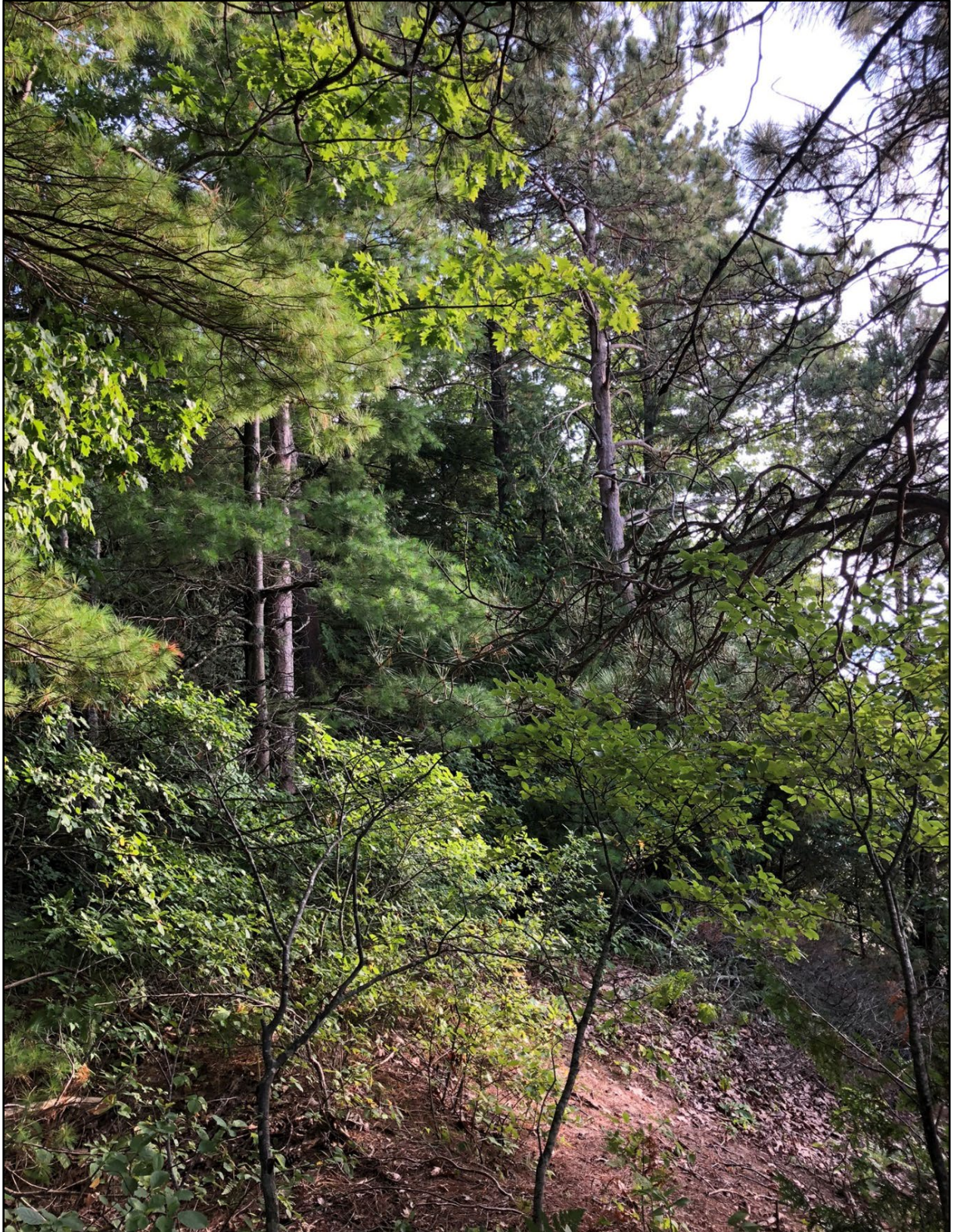


Figure 42. Dry-mesic northern forest natural community in Wilcox-Palmer Shah Preserve on August 27, 2022. Canopy species visible in this photo include red oak (*Quercus rubra*), white pine (*Pinus strobus*), and red pine (*Pinus resinosa*). Photograph taken by Elizabeth Haber.

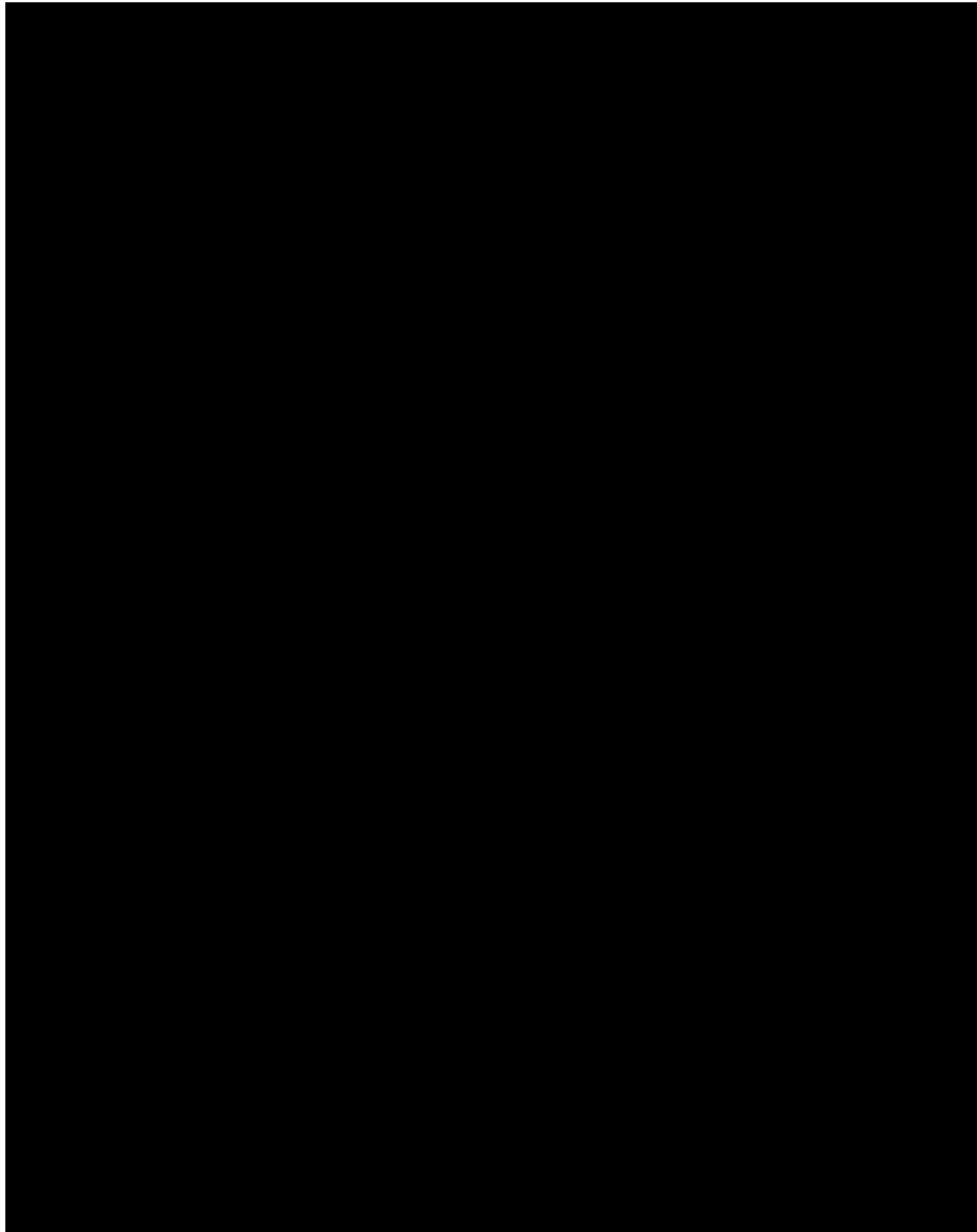


Figure 43.

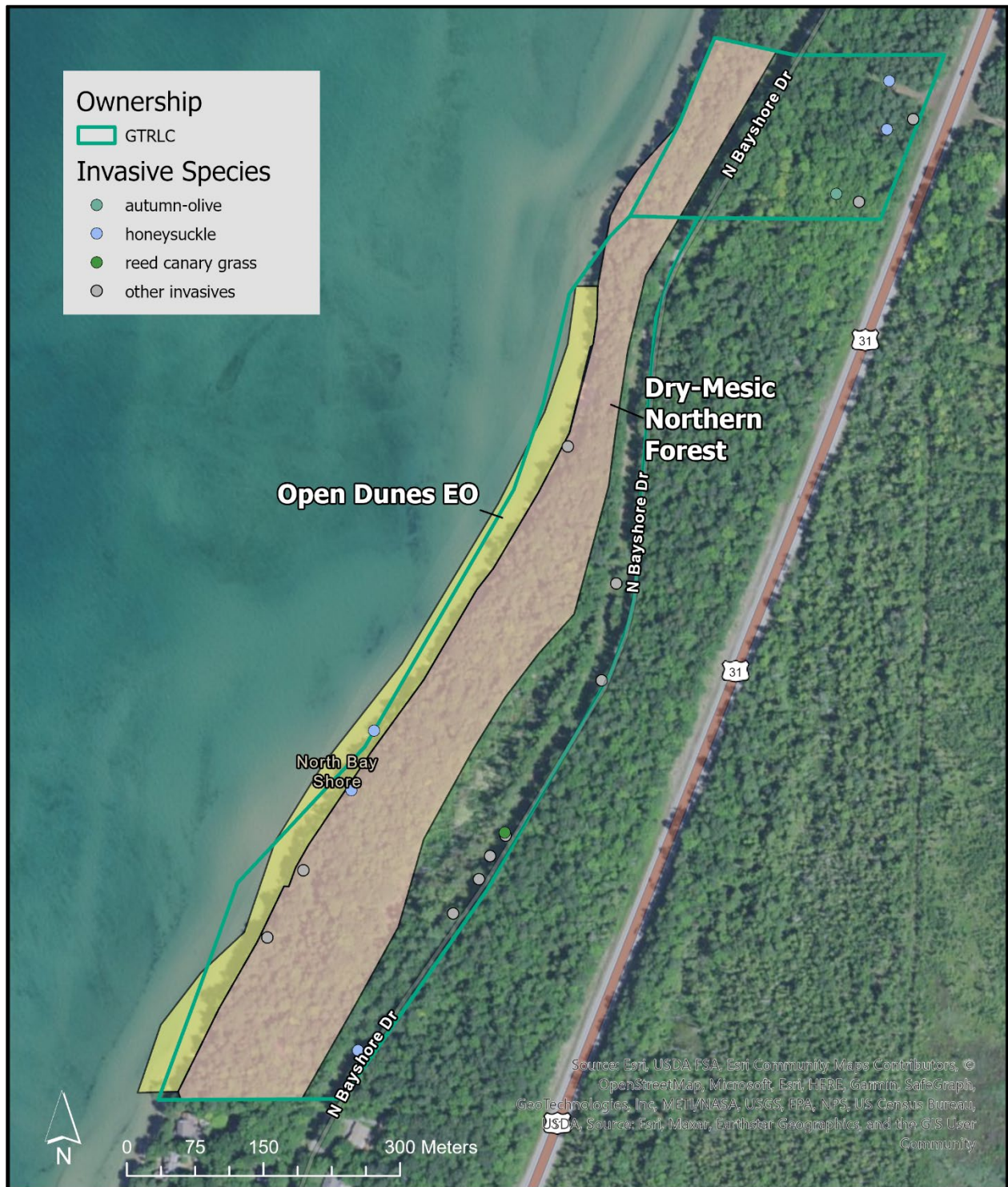


Figure 44. Natural community EOs and invasive species points within Wilcox-Palmer Shah Preserve. Yellow lines are the preserve boundaries. Each dot is an observed invasive species described in legend.

**Natural Community Type: Open Dunes**

**Rank:** G3 S3

**EO Identification Number:** 456 (Wilcox-Palmer-Gates Preserve)

**Size:** 4.0 acres

**EO Rank and Justification:** CD. A very small but intact open dune natural community with state-listed plant species. A low foredune exists in a narrow stretch of open shore along an arm of the Grand Traverse Bay. Approximately 600 m of shoreline is backed by level, secondary upland forest. Beach grass (*Ammophila breviligulata*) dominates the upper beach with some poison ivy (*Toxicodendron rydbergii*), [REDACTED]

[REDACTED] Wilcox-Palmer Shah Preserve is large for a Great Lakes coastal preserve, but it is bordered by private lands and fragmented by a busy highway. The hydrology of Lake Michigan strongly influences the natural processes of this community. As one of the limited areas of public access to Lake Michigan on the eastern shoreline of East Grand Traverse Bay, this preserve experiences a lot of use and the pressures of overuse and impacts including trampling of sensitive dune habitats and carving unofficial footpaths are present.

**EO Description:** An open dunes natural community extends the length of the southern parcel of the Preserve along the Grand Traverse Bay shoreline. This area is heavily impacted by wind and wave action and the plant community consists of species tolerant and dependent on those types of disturbance. Frequently encountered species in this natural community include beach grass (*Ammophila breviligulata*), sea-rocket (*Cakile edentula*), Gillman's goldenrod (*Solidago simplex*), poison-ivy (*Toxicodendron rydbergii*), harebell (*Campanula rotundifolia*), bearberry (*Arctostaphylos uva-ursi*), and wheatgrass (*Elymus lanceolatus*). [REDACTED]

[REDACTED] Invasive species spotted knapweed (*Centaurea stoebe*), soapwort (*Saponaria officinalis*), and bladder campion (*Silene vulgaris*) are present and somewhat frequent in this natural community.

**EO Data:** The dunes are covered with sparse vegetation because of the intensity and frequency of wind- and wave-mediated disturbance. Plant species tolerant to these types of disturbances are present in this community. The most abundant grass species are beach grass (*Ammophila breviligulata*) and wheatgrass (*Elymus lanceolatus*). Frequently encountered forbs include sea-rocket (*Cakile edentula*), Gilman's goldenrod (*Solidago simplex*), wild wormwood (*Artemisia campestris*), harebell (*Campanula rotundifolia*), beach pea (*Lathyrus japonicus*), and hairy puccoon (*Lithospermum caroliniense*). Low shrubs growing at the eastern edge of the open dunes consist of bearberry (*Arctostaphylos uva-ursi*), common juniper (*Juniperus communis*), and poison-ivy (*Toxicodendron radicans*). [REDACTED]

A plant species list can be found in Appendix D: Plant Species Lists.

**Other Natural Communities:**

The Wilcox-Palmer Shah Preserve contains four types of natural communities: open dunes, dry-mesic northern forest, mesic northern forest, and variable wetland communities adjacent to North Bayshore Drive. The open dunes and dry-mesic northern forest natural communities have been described above, and the mesic northern forest and wetland communities are described in the sections below.

**Mesic Northern Forest**

A forested dune plant community resembling a mesic northern forest occurs in the northern parcel of the Preserve between North Bayshore Drive and US-31. The tree canopy in this area is dominated by sugar maple (*Acer saccharum*) with white pine (*Pinus strobus*) and American beech (*Fagus grandifolia*). The understory is open and frequently encountered ground layer species include bracken fern (*Pteridium aquilinum*), wild sarsaparilla (*Aralia nudicaulis*), partridgeberry (*Mitchella repens*), Canada mayflower (*Maianthemum canadense*), sugar maple seedlings/saplings, and big-leaved aster (*Eurybia macrophylla*). Invasive shrubs are present in this habitat, primarily near the US31 ROW. These shrubs are autumn-olive (*Elaeagnus umbellata*), Tartarian honeysuckle (*Lonicera tatarica*), and multiflora rose (*Rosa multiflora*). The small size, prevalence of problematic invasive species, lack of rarity in the surrounding region, and isolated nature within a residential matrix experiencing high development pressure combine to make this natural community a lower priority for management.

**Mesic northern forest –3.8 acres**

**Various herbaceous and shrub-dominated wetland natural communities**

Various wetland habitats occur along both sides of North Bayshore Drive and are influenced by hydrological alteration from the road. In the northern parcel of the Preserve to the east of North Bayshore Drive is a forested and shrub-dominated wetland community with red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), winterberry (*Ilex verticillata*), and diverse sedges (*Carex* spp.). Herbaceous wetland communities occur to the west of North Bayshore Drive, although there are some areas with northern white-cedar (*Thuja occidentalis*) in the tree canopy. The herbaceous wetlands contain a variety of non-native invasive species such as hybrid cattail (*Typha xglauca*), reed canary grass (*Phalaris arundinacea*), Canada thistle (*Cirsium arvense*), bittersweet nightshade (*Solanum dulcamara*). A powerline cut parallels North Bayshore Drive to the west and the ROW maintenance introduces disturbance to the wetland habitats.

### **Management Recommendations**

This property is a vital piece of protected Grand Traverse Bay shoreline within a region experiencing high development pressure. As residential development continues adjacent to the Preserve, the intact habitat within the Preserve will become more and more isolated, which leads to reduced resilience in the face of environmental and human-induced pressures.

**Open dune:** During survey visits, it was observed that many people use the preserve to recreate. The beach was especially popular. This pattern of high use reflects the need for public access to Grand Traverse Bay, which the Wilcox-Palmer Shah Preserve satisfies, but overuse of the beach is a major stressor to the sensitive open dunes natural community.

Overuse of the beach, in combination with several years of extremely high water levels in the recent past, have combined to put enormous stress on the remaining open dunes community.

Limits could be placed on beach access by fencing off areas where rare plants grow and adjacent suitable habitat to provide for spread to safeguard the rare species remaining in the open dunes community.

Several invasive species of concern occur within the open dunes natural community. These include spotted knapweed (*Centaurea stoebe*), soapwort (*Saponaria officinalis*), and bladder campion (*Silene vulgaris*). These plants should be removed where growing near known rare plant populations. Furthermore, monitoring for baby's breath (*Gypsophila* spp.) should be done yearly to prevent these aggressive invaders of dune habitats from becoming established in the Preserve.

**Dry-mesic northern forest:** A small footpath runs north/south through this natural community paralleling the dune ridge. Erosion mitigation measures were observed while surveying, but more protection of the sensitive dune areas could be implemented, especially in the northern end of the Preserve. Non-native species occur along the trail, but do not spread far into the dry-mesic northern forest. Hemlock is locally dominant in the forest canopy. A pest of this species, hemlock woolly adelgid, is spreading northward and should be monitored for regularly.

Although the population of Canada yew (*Taxus canadensis*) in the dry-mesic northern forest is noteworthy, the height of the yew plants is very short indicating deer browsing pressure. As residential development expands in nearby areas, more deer will be forced to use the Preserve resulting in higher levels of vegetation browse. Reducing the deer density in the area should be considered.

**Management Priority Rank: High**

## Jordan River Preserve, Charlevoix County

Landowner/Manager: Little Traverse Conservancy

Size: 41 acres

**Location:** From East Jordan, take M-32 south 0.9 miles to Fair Road. Turn west onto Fair Road and drive west until road becomes a 2-track underneath power lines. Park car and walk westward until you arrive at the Preserve entrance. Walk approximately 750 m north from the preserve entrance until you reach the emergent marsh boundary (Figure 45).

**Survey Type(s):** Invasive species survey

**Natural Community Type(s):** Emergent marsh (Figure 46)

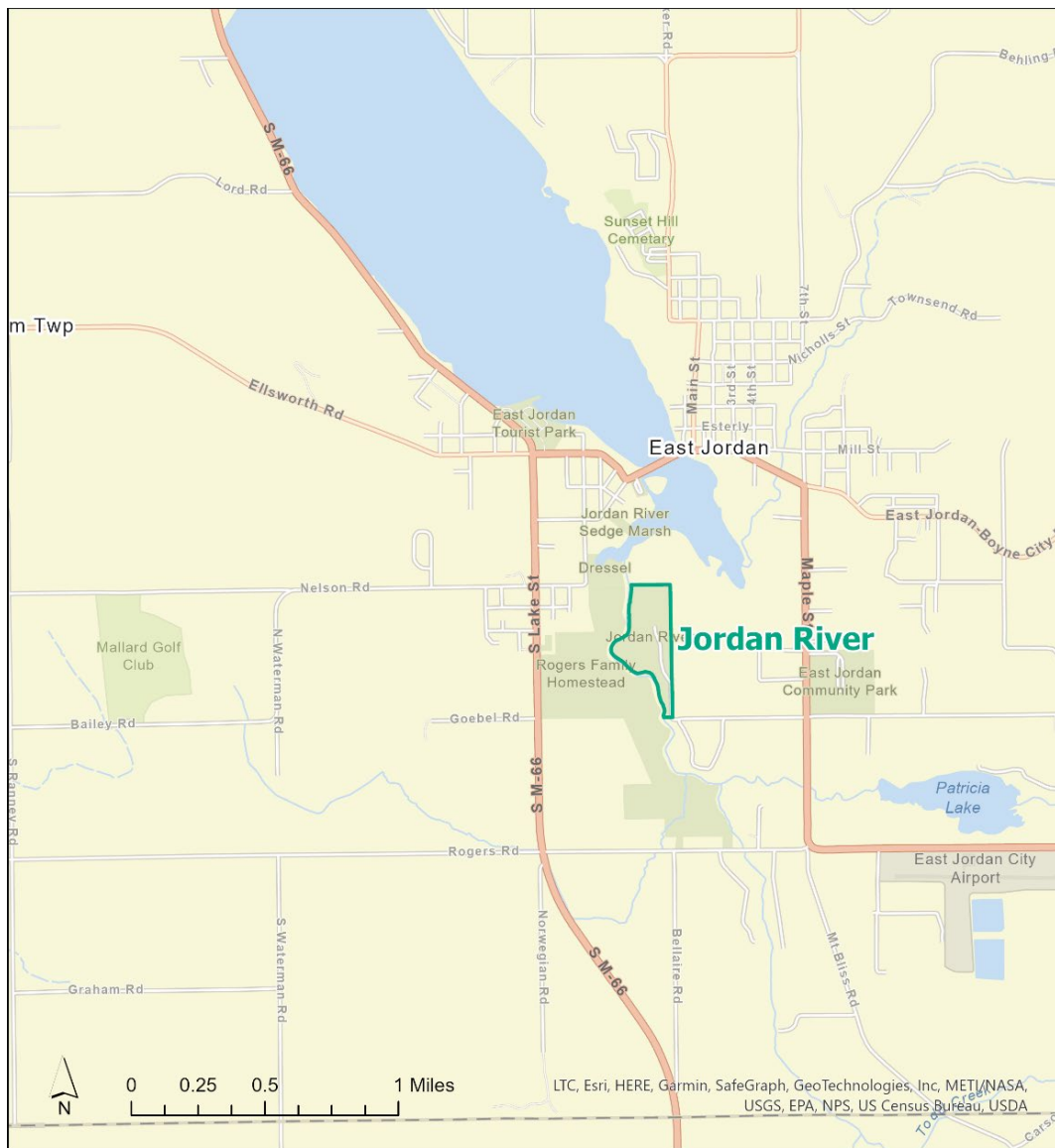


Figure 45. Location of Jordan River Preserve, Charlevoix County, Michigan, USA.



**National Community Type: Emergent Marsh**

**Rank:** GU S4

**Size:** 3 acres

**Natural Community Description:** This property is large and contains two major categories of habitats: upland and riparian.

Much of the property consists of upland habitat and is severely degraded. Abundant common buckthorn (*Rhamnus cathartica*), autumn-olive (*Elaeagnus umbellata*), and non-native honeysuckles (*Lonicera* spp.) form dense thickets. The northeastern upland area of the property is more open and degraded. Frequently-encountered herbaceous species in these open areas include spotted knapweed (*Centaurea stoebe*), poverty grass (*Danthonia spicata*), yarrow (*Achillea millefolium*), timothy (*Phleum pratense*), non-native fescues (*Festuca* spp.), and reindeer lichen (*Cladonia rangiferina*).

The riparian areas of the property occur on the Jordan River floodplain. These areas are for the most part degraded, except for a small 3-acre wet meadow described in the following paragraph. The degraded riparian habitats consist primarily of a hybrid cattail (*Typha xglauca*) and reed canary grass (*Phalaris arundinacea*) dominated floodplain, with occasional sedge (*Carex* spp.) mats and pockets of Canada bluejoint (*Calamagrostis canadensis*). A groundwater seep that empties into the Jordan River occurs in the southern part of the preserve. Although degraded, the seep area retains some higher-quality species including marsh-marigold (*Caltha palustris*), speckled alder (*Alnus incana*), marsh skullcap (*Scutellaria galericulata*), and one large tamarack (*Larix laricina*).

A small section of the northwestern corner of the preserve hosts a higher-quality emergent marsh habitat. This higher-quality habitat extends northward into adjacent non-Preserve property. The habitat is dominated by sedges (*Carex stricta*, *C. aquatilis*), Canada bluejoint, common arrowhead (*Sagittaria latifolia*), and wetland forbs tolerant of fluctuating water levels (e.g. *Bidens cernua*, *Persicaria amphibia*). The emergent marsh habitat has few invasive plant species: reed canary grass, hybrid cattail, and curly-leaf pondweed (*Potamogeton crispus*). Reed canary grass is abundant to the south of the emergent marsh and threatens to expand northward into the higher quality habitat. The vegetation is strongly influenced by prolonged inundation from the Jordan River, which likely helps maintain the native species diversity and abundance in this area.

Two raptor nesting platforms occur to the north of the property boundary and both were occupied at the time of survey. One platform hosted a family of Bald eagles (*Haliaeetus leucocephalus*) and one platform hosted a family of osprey (*Pandion haliaetus*).

**Natural Community Data:** Data refers only to the high-quality emergent marsh habitat delineated in the map below. The emergent marsh is dominated by sedges, including *Carex stricta*, *C. aquatilis*, *C. lacustris*, *C. lurida*, *C. crawfordii*, *C. hystericina*, *C. stipata*, and *C. utriculata*. Canada bluejoint is the most abundant grass. Frequently encountered

emergent plants include common arrowhead, broad-leaved cattail (*Typha latifolia*), and spike-rush (*Eleocharis intermedia*). Annual and perennial forbs form a subdominant component of the flora, with the most common species being nodding beggar-ticks (*Bidens cernua*), water-hemlock (*Cicuta bulbifera*), water-purslane (*Ludwigia palustris*), and water smartweed. Much of the emergent marsh habitat was inundated with up to 25 cm of standing water at the time of survey. In these inundated areas, free-floating plants (e.g., *Lemna minor*, *Spirodela polyrhiza*) and submerged aquatic plants (e.g., *Potamogeton gramineus*, *P. obtusifolius*) were common. No listed plant species were observed in this habitat.

A plant species list can be found in Appendix D: Plant Species Lists.

### **Management Recommendations**

Invasive species are the greatest threat to this community, particularly the spread of reed canary grass and hybrid cattail from adjacent areas. Although the upland areas host abundant invasive species (e.g., *Rhamnus cathartica*, *Lonicera* spp., *Elaeagnus umbellata*, *Berberis thunbergii*, *Centaurea stoebe*), these species typically do not survive well in inundated habitats and therefore do not pose a risk to the high-quality emergent marsh habitat.

**Management Priority Rank: High**



Figure 46. Map of emergent marsh and invasive species points within Jordan River Preserve. Cyan outline shows the boundaries of Jordan River Preserve. Each dot is an observed invasive species described in legend.



Figure 47. Emergent marsh natural community in the Jordan River Preserve, photographed on July 6, 2022. One of two occupied raptor nesting platforms is visible. Photograph taken by Elizabeth Haber.

## Fisher Family Nature Preserve, Emmet County

**Landowner/Manager:** Little Traverse Conservancy

**Size:** 39.0 acres

**Location:** Approximately 3 km northeast of Cross Village along M-119/North Lake Shore Drive/Tunnel of Trees Scenic heritage Route (Figure 48).

**Survey Type(s):** EO/ERA revisit, invasive species surveys

**Natural Community Type(s):** Sand and gravel beach, dry-mesic northern forest (Figure 49)



Figure 48. Location of Fisher Family Nature Preserve in Emmet County, Michigan, USA.

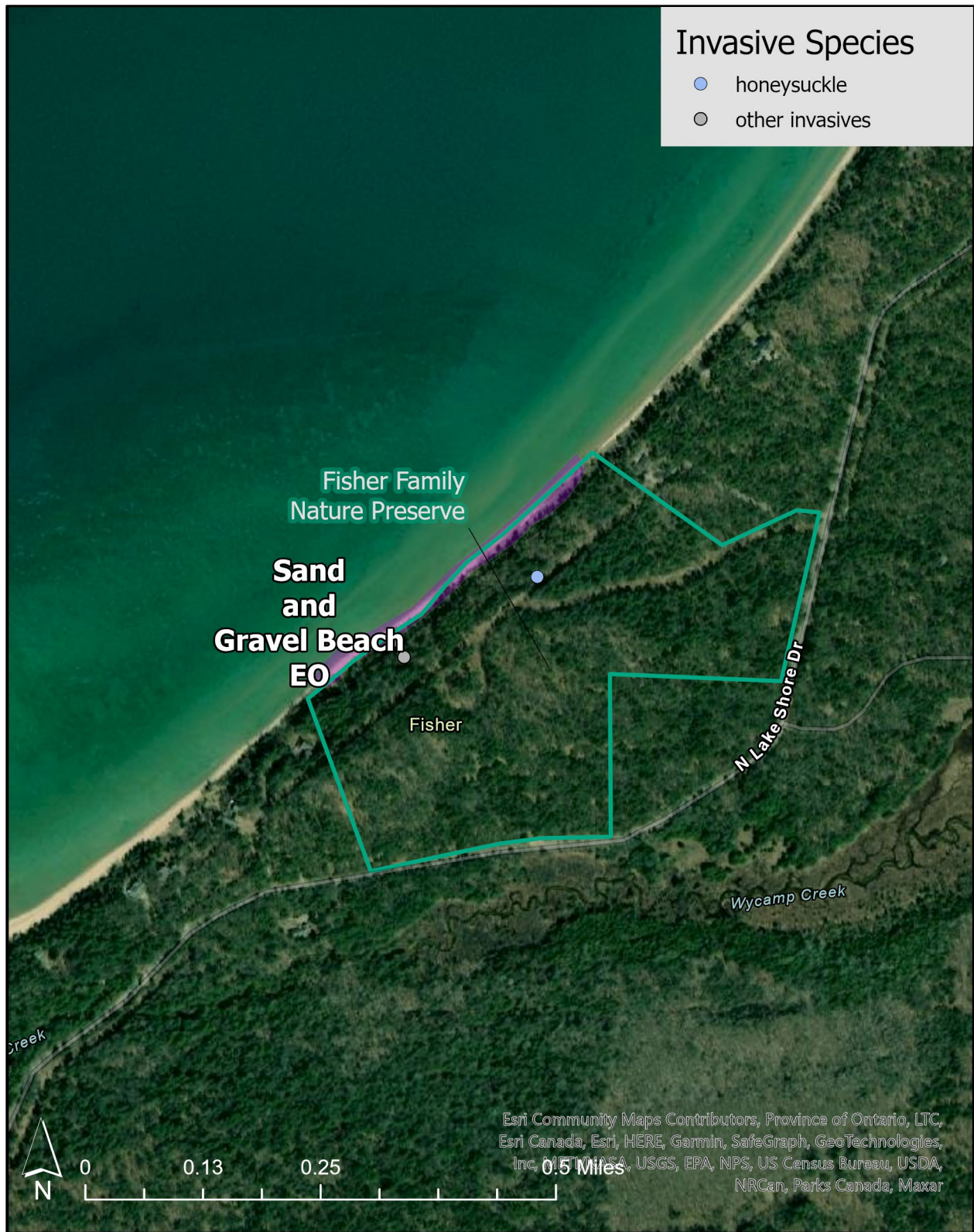


Figure 49. Sand and gravel beach (E0ID 20444) in Fisher Family Nature Preserve is shown in transparent purple. Each dot is an observed invasive species described in legend.

**Natural Community Type: Sand and Gravel Beach**

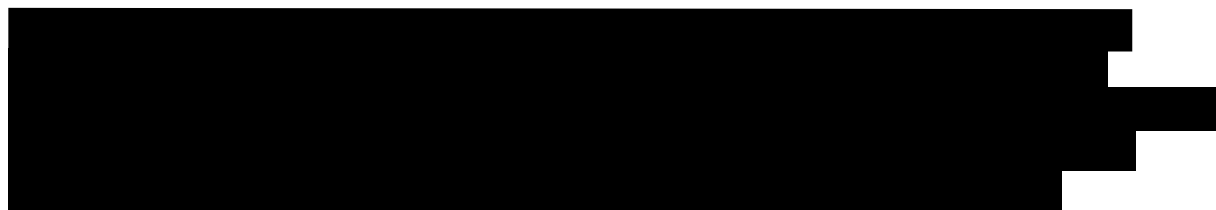
**Rank:** G3? S3

**EO Identification Number:** 20444 (Fisher Beach)

**EO Size:** 2.4 acres

**EO Rank and Justification:** C. Quarter mile stretch of sand and gravel beach that is backed by low foredune and a low bluff, which are in turn backed by young dry-mesic northern forest and dry northern forest. Species composition and community structure patterned by natural processes. Threats limited to foot traffic and non-native species spread. Spotted knapweed (*Centaurea stoebe*) was noted along the beach. The site occurs within the Fisher Nature Preserve, a 39-acre preserve managed by the Little Traverse Conservancy that occurs just west of state forest land and southwest of Wilderness state park. The sand and gravel beach is backed by young dry-mesic and dry northern forests. A powerline passes just east of the shoreline and M-119 occurs further to the east.

**EO Data:** This sand and gravel beach occurs along a quarter mile stretch of Great Lakes shoreline of Lake Michigan. Because of the high levels of natural disturbance, this beach is typically quite open, with sand and gravel sediments and little or no vegetation (Figure 50). Energy from waves and ice abrasion maintain an open beach. The beach is typically 20-30 feet wide and backed by a low foredune locally and a low bluff. In 2022 little foredune was present and there were recent cliff falls from bluff (Figure 51). This sand and gravel beach is characterized by both a low diversity of plant species and low levels of plant cover. A wide variety of plants can develop at the inland margin of sand and gravel beaches, but few establish and persist on the active beach, where there is often intense wind and wave action, resulting in almost constantly moving sand.



Results of a 2007 site survey and FQA can be found in Doucet-B  er *et al.* 2007.



Figure 50. Vegetative bluff above sand and gravel beach (EOID 20444). High lake levels in recent years have washed away much of the foredune.





Figure 51. Recent cliff falls can be seen in the steep bluff along the sand and gravel beach (EOID 20444). Photographs taken on September 9, 2022, by Rachel Hackett.

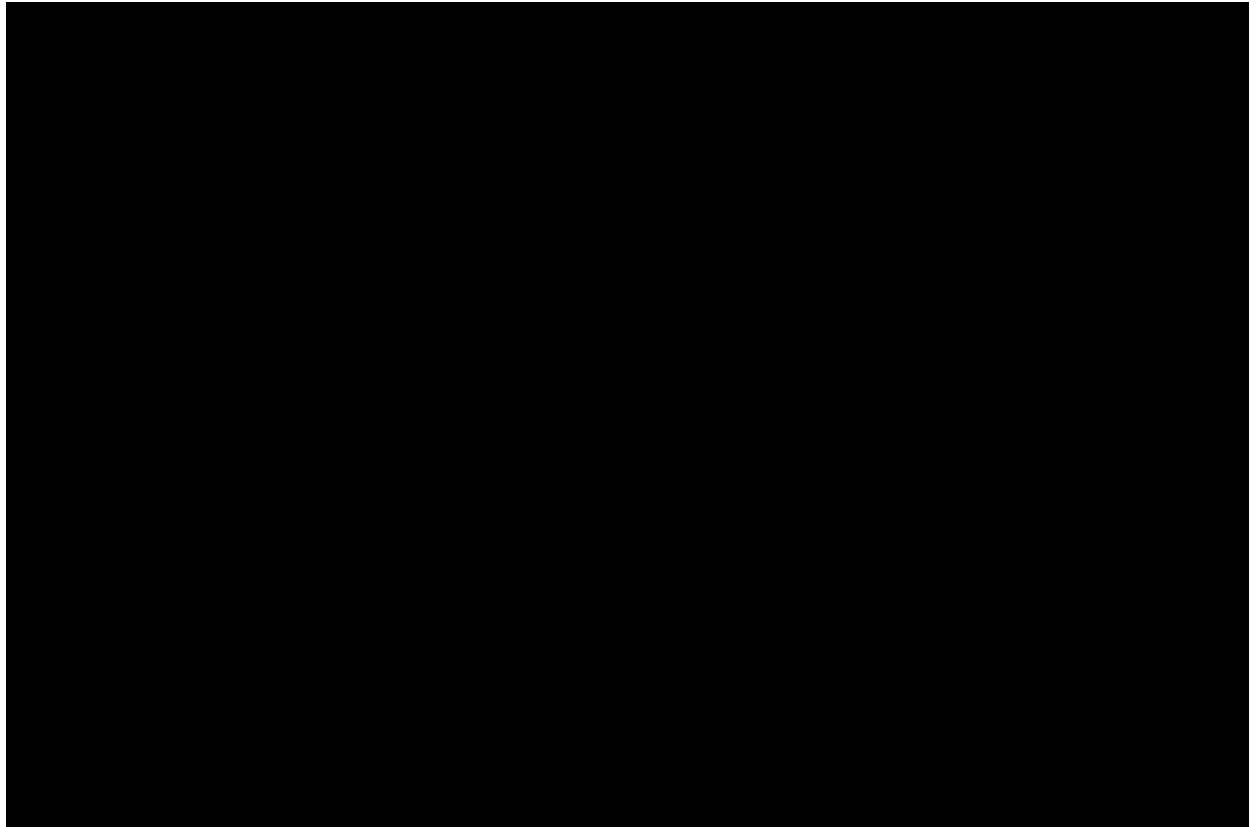


Figure 52.

Photographs taken on September 9, 2022, by Rachel Hackett.

### ***Other Natural Communities: Dry-mesic Northern Forest***

The dry-mesic and mesic northern forests abutting the sand and gravel beach are young. The topography is not as rolling as other forested dune systems in the area and may have been leveled in areas during logging events. A utility line runs through forests parallel to beach. The forests show evidence of logging with some large planted pines (*Pinus resinosa*, *Pinus strobus*) remaining. One red pine had a DBH of 38.8 cm, with 145 rings although the last 80 years of growth appeared stunted. The abundance of aspen (*Populus* spp.) in the canopy increases as one heads from the beach to the road. There was no sign of the hemlock woolly adelgid.

### ***Management Recommendations***

Treat spotted knapweed along beach. Monitor and treat trails, old roads, and utility for invasive species that may spread to beach. Monitor for erosion concerns and consider marking set trail to minimize future anthropogenic erosion.

**Management Priority Rank: Medium**

## Minnehaha Creek Swamp, Emmet County

Compartment | Stand(s): 52125|003, 005<sup>9</sup>, 007<sup>10</sup>, 010<sup>10</sup>, 011<sup>10</sup>, 012, 013, 018<sup>10</sup>

Landowner/Manager: State Forest (Forest Resource Division)

Size: 753.9 acres

Location: North of DNR Parking lot near Silver Creek on Pickerel Lake Road between Blanchard Road and Mason Drive. (Figure 53).

Survey Type(s): EO/ERA Revisit

Natural Community Type(s): Rich conifer swamp (Figure 54)



Figure 53. Location of Minnehaha Creek Swamp and neighboring stands in Gaylord Forest Management Unit, Compartment 52125 on State Lands in Emmet County, Michigan, USA.

<sup>9</sup> Only southern half of stand was surveyed

<sup>10</sup> Unable to access due to time and distance

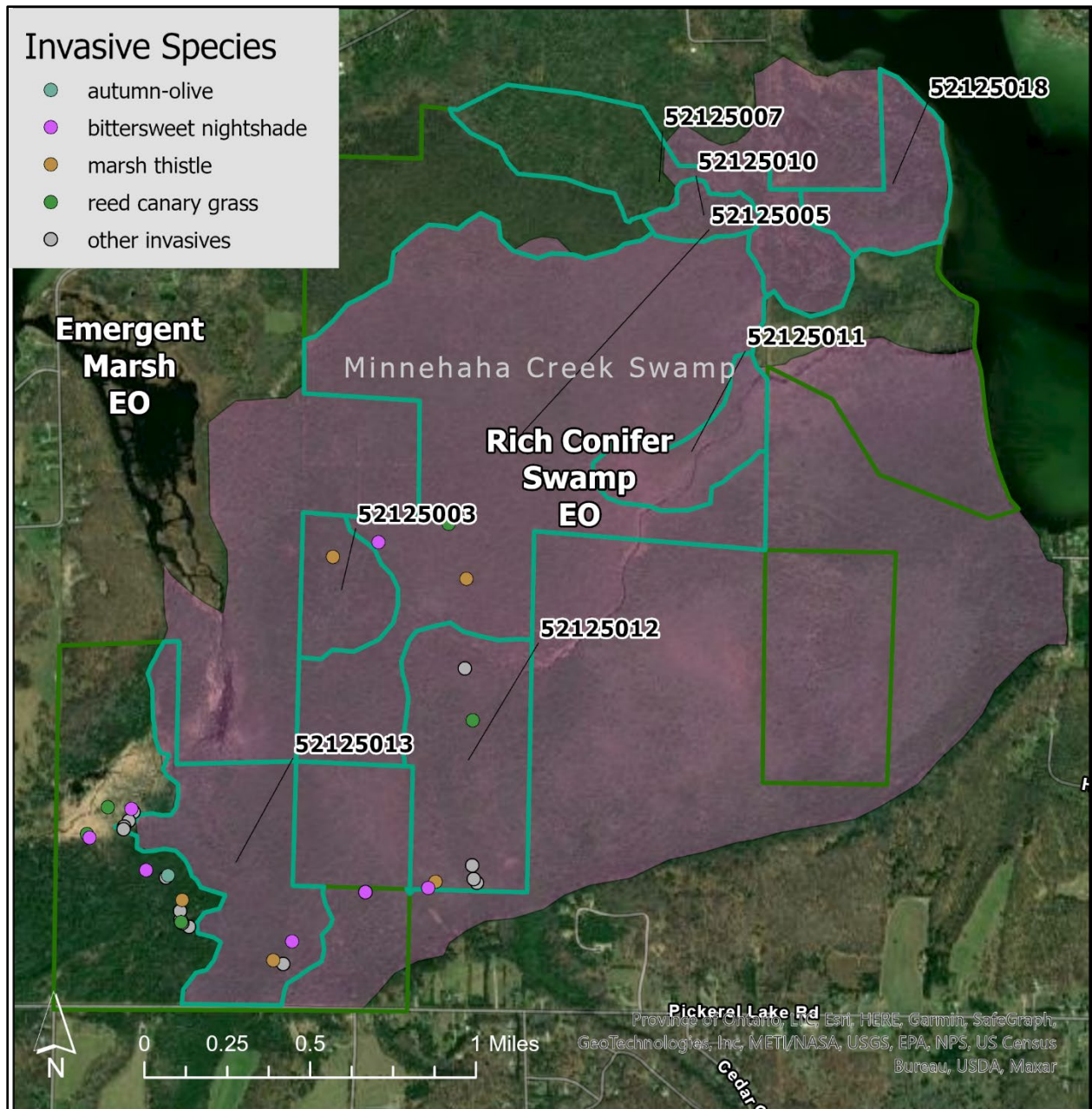


Figure 54. Rich conifer swamp (EOID 8154) in Gaylord Forest Management Unit, Compartment 52125. Cyan lines are stand borders. Transparent purple is the mapped EO. Each dot is an observed invasive species described in legend.

**Natural Community Type: Rich Conifer Swamp**

**Rank:** G4 S3

**EO Identification Number:** 8154 (Minnehaha Creek)

**EO Size:** 1532.0 acres (712.0 acres on State land)

**EO Rank and Justification:** B. Huge swamp complex dominated by rich conifer swamp with several patches of northern fen, hardwood-conifer swamp, northern shrub thicket, and northern wet meadow associated with streams and beaver flooding. Site characterized by high native species diversity driven by complex ecological zonation, natural disturbance, and including mound and sphagnum hummock and hollow microtopography. Cut and burnt stumps from turn-of-the-century logging occur throughout site. Recent anthropogenic disturbance is concentrated in the southern portion of the swamp on private parcels, where logging and trails occur. Reed canary grass (*Phalaris arundinacea*) occurs as a local dominant in flood-killed areas and watercress occurs along the streams. Wall lettuce (*Mycelis muralis*) was observed in drier areas. Deer browse noted throughout. Site occurs in a fragmented landscape with high road densities and prevalence of residential developments and agricultural fields. Remaining upland forest is early successional. Numerous invasives occur along Pickerel Lake Road, which could invade the site. Crooked Lake occurs to the northwest and north and Pickerel Lake occurs to the east. High-quality emergent marsh occurs to the northwest.

**EO Data:** Most of the site is dominated by mature northern white-cedar (*Thuja occidentalis*) swamp (75+ years old) with frequent tamarack (*Larix laricina*) and occasional spruce black spruce (*Picea mariana*), white spruce (*P. glauca*), white pine (*Pinus strobus*), and hemlock (*Tsuga canadensis*). Most canopy trees range from 10 – 38 cm DBH with older trees scattered throughout (145+ years old). Recently disturbed areas occur in areas of windthrow gaps. Patches of hardwood-conifer swamp were once dominated by northern white-cedar with green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*), and black ash (*Fraxinus nigra*), but now areas of ash die-off contain mostly sapling and pole sized trees (ash abundant) and few log sized cedar (DBH 23.3, 9.8, 10.8, 16.2 cm), especially in stand 52125003. Up to eight layers of downed wood and much windthrow occur in the west.

Areas with more open canopy have dense understories with speckled alder (*Alnus incana*), winterberry (*Ilex verticillata*), and balsam fir (*Abies balsamea*). The low shrub layer of the cedar swamp contains swamp fly honeysuckle (*Lonicera oblongifolia*), American fly honeysuckle (*L. canadensis*), alder-leaved buckthorn (*Rhamnus alnifolia*), northern white-cedar seedlings, tamarack seedlings, and balsam fir seedlings. The diverse ground cover is characterized by thick carpets of sphagnum mosses with well-developed sphagnum hummock and hollow microtopography in more mature areas and where hydrology has been stable (Figure 55). Characteristic species include sedges

(*Carex deweyana*, *C. eburnea*, *C. gracillima*, *C. interior*, and *C. trisperma*), fowl manna grass (*Glyceria striata*), dwarf raspberry (*Rubus pubescens*), dwarf scouring rush (*Equisetum scirpoides*), grass-of-Parnassus (*Parnassia glauca*), false mayflower (*Maianthemum trifolium*), and a diverse array of ferns, including oak fern (*Gymnocarpium dryopteris*), cinnamon fern (*Osmundastrum cinnamomeum*), royal fern (*Osmunda regalis*), and sensitive fern (*Onoclea sensibilis*).

Areas impacted by beaver flooding have an open canopy (10-50% canopy cover) with flood-killed northern white-cedar, tamarack, and green ash. These areas are characterized by dense graminoid growth with lake sedge (*Carex lacustris*), tussock sedge (*C. stricta*), bluejoint grass (*Calamagrostis canadensis*), cut grass (*Leersia oryzoides*), reed canary grass (*Phalaris arundinacea*), and broad-leaved cattail (*Typha latifolia*). Prevalent herbs include jewelweed (*Impatiens capensis*), common skullcap (*Scutellaria galericulata*), wild blue flag (*Iris versicolor*), common water horehound (*Lycopus americanus*), and joe-pye-weed (*Eutrochium maculatum*).

The pockets of northern fen have a scattered and stunted canopy of northern white-cedar and tamarack, which are also prevalent in the understory and low shrub layers (Figure 56). The low shrub layer is dense and diverse with additional species including shrubby cinquefoil (*Dasiphora fruticosa*), sweet gale (*Myrica gale*), leatherleaf (*Chamaedaphne calyculata*), and bog rosemary (*Andromeda glaucophylla*). The diverse ground cover is characterized by clumps of tufted bulrush (*Trichophorum cespitosum*) and patches of white beak-rush (*Rhynchospora alba*) and sedges (*Carex flava*, *C. sterilis*). Additional species include marsh fern (*Thelypteris palustris*), small cranberry (*Vaccinium oxycoccos*), bog buckbean (*Menyanthes trifoliata*), pitcher-plant (*Sarracenia purpurea*), false asphodel (*Triantha glutinosa*), round-leaved sundew (*Drosera rotundifolia*), grass-of-Parnassus, Indian tobacco (*Lobelia inflata*), and marsh wild timothy (*Muhlenbergia glomerata*). Northern shrub thicket and northern wet meadow occur along stretches of the creeks, which also support submergent vegetation.

A plant species list can be found in Appendix D: Plant Species Lists.

Soil profile in swamp: 15cm black sapric peat (pH 7.5). Soil profile in fen area: 35cm black sapric peat (pH 7.4); then grey marl (pH 8.2)



Figure 55. Hummock and hollow *Sphagnum* moss topography of Minnehaha Creek Swamp (EOID 8154). Photograph taken September 15, 2022, by Rachel Hackett.



Figure 56. Fen pocket within Minnehaha Creek Swamp (EOID 8154). Photograph taken on September 15, 2022, by Rachel Hackett.

### ***Management Recommendations***

Allow for natural processes to continue. Manage deer density to improve tree regeneration. Recently logged stands in area contain invasive species that may spread into the swamp EO. In the swamp interior, autumn olive (*Elaeagnus umbellata*), reed canary grass, and bittersweet nightshade pose the greatest invasive threats, especially the reed canary grass in the open fen areas. Monitor and treat problem invasive species on ORV trails and borders with logged stands. Spotted knapweed (*Centaurea stoebe*), chicory (*Cichorium intybus*), and Queen Anne's lace (*Daucus carota*) are typically restricted to road corridors. Hemlock is present in the swamp canopy. A pest of this species, hemlock woolly adelgid, is spreading northward and should be monitored for regularly. Heavy deer browse has diminished natural regeneration in the understory. ORV trails originating from adjacent private property are present. Numerous invasives occur along Pickerel Lake Road just south of the swamp including purple loosestrife, which could invade the site

**Management Priority Rank: High**

# Orchis Fen Nature Preserve, Emmet County

**Landowner/Manager:** Little Traverse Conservancy

**Size:** 35.9 acres

**Location:** East of Petoskey near Round and Crooked Lakes. West of Bellmer Road north of the Bellmer and Burke Road intersection (Figure 57).

**Survey Type(s):** EO/ERA Revisit

**Natural Community Type(s):** Northern fen, rich conifer swamp (Figure 58)



Figure 57. Location of Orchis Fen Nature Preserve in Emmet County, Michigan, USA.



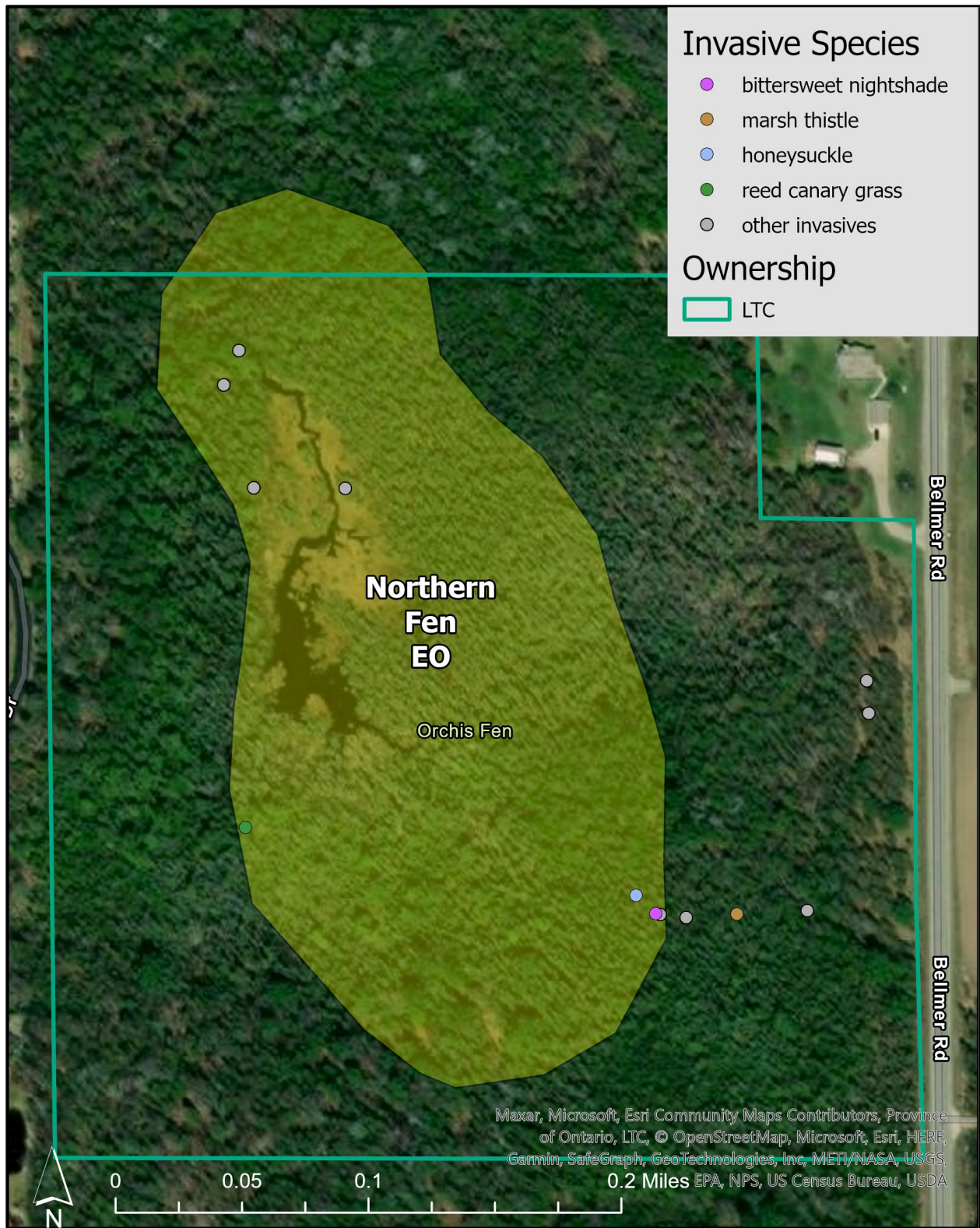


Figure 58. Northern fen (EOID 2169) in Orchis Fen Nature Preserve. Yellow lines are the property borders, transparent yellow represents the northern fen EO. Each dot is an observed invasive species described in legend.

**Natural Community Type: Northern Fen**

**Rank:** G3 S3

**EO Identification Number:** 2169 (Orchis Fen)

**EO Size:** 14.7 acres (14.0 acres on LTC property)

**EO Rank and Justification:** B<sup>11</sup>. The small fen has a high plant species diversity and little direct anthropogenic disturbance. It's buffered from nearby neighborhoods and roads by thriving, but once logged, rich conifer swamp. A private, gated community abuts the west boundary of the property and other private owners manage and farm nearby parcels. Most of the troublesome invasive species are found near the road and utility to the east.

**EO Data:** Much of open fen area has been reduced since it was last surveyed by MNFI in 1981, making open fen smaller in size (Figure 59). Canopy of northern white-cedar (*Thuja occidentalis*) and tamarack (*Larix laricina*) shade much of what was open fen (Figure 60). A larger cedar with DBH of 24.5 cm was aged 110 years old, with most cedars with DBH between 9.0 and 14.0 cm. Some uniquely large white pine (*Pinus strobus*) along the edges had DBH ranging from 30.0 to 40.0 cm with one reaching 71.3 cm. Ground cover is dominated by Cyperaceae including sedges (*Carex* spp.), three-way sedge (*Dulichium arundinaceum*), spike-rushes (*Eleocharis* spp.), and cotton grass (*Eriophorum* spp.) with some *Sphagnum* moss mounds around a silty creek. Bog-bean (*Menyanthes trifoliata*) and bladderworts (*Utricularia* spp.) found in rivulets. Crayfish burrows and ant mounds were common. Evidence of heavy deer browsing is present.

[REDACTED]

A plant species list can be found in Appendix D: Plant Species Lists.

The soil profile in areas where canopy was closing consisted of black peat loam to 28 cm (pH 7.5), over brown, gritty sandy loam beneath (pH 7.8). The soil profile in the open fen was saturated sapric peat to 40 cm (pH 7.0-7.2) then water/empty auger.

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<sup>11</sup> A reduction in rank is being considered after the 2022 visit due to the reduction of the open fen area.



Figure 59. Open fen at Orchis Fen (EOID 2169). Photograph taken on September 14, 2022, by Rachel Hackett.



Figure 60. Canopy of once open fen at Orchis Fen (EOID 2169) is closing with young tamarack, cedar, and spruce. Photograph taken on September 14, 2022, by Rachel Hackett.

### **Other Natural Communities: Rich Conifer Swamp**

Rich conifer swamp dominated by cedar and tamarack with frequent spruce (*Picea* spp.) and occasional hemlock (*Tsuga canadensis*), balsam poplar (*Populus balsamifera*), white pine (*Pinus strobus*), and red maple (*Acer rubrum*). Ground cover is composed of many of the same sedges as in the open fen, but in different size and abundance, with added saplings of overstory trees. Invasive species are more common near the road and utility right-of-way that runs parallel to the road. Some areas are frequently flooded and dominated by cattail (*Typha latifolia*).

**Size:** 21.9 acres

### **Management Recommendations**

Allow natural processes to continue. The acquisition of adjacent rich conifer swamp on private land could buffer potential anthropogenic damage (e.g., filling, logging). Several invasive species were documented: marsh thistle (*Cirsium palustre*), hairy willow-herb (*Epilobium parviflorum*), helleborine (*Epipactis helleborine*), glossy buckthorn (*Frangula alnus*), bush honeysuckle (*Lonicera morrowii*), invasive forget-me-not (*Myosotis scorpioides*), bittersweet nightshade (*Solanum dulcamara*), common dandelion (*Taraxacum officinale*), and common speed-well (*Veronica officinalis*). Treat and monitor regularly for invasive species. The population of glossy buckthorn should be targeted soon while the population is reasonably small and individual shrubs are small in the immediate area.

**Management Priority Rank:** **Highest**

# Thorne Swift and Weimer's Lake Nature Preserves, Emmet County

**Landowner/Manager:** Little Traverse Conservancy

**Size:** 36.5 acres

**Location:** West of Harbor Springs; turn off M-119/North Lake Shore Drive/Tunnel of Trees Scenic Heritage Route on Lower Shore Drive. Preserves are on the southwest side of the road (Figure 61).

**Survey Type(s):** Invasive species survey, plant EO revisit

**Natural Community Type(s):** Open dunes, rich conifer swamp, hardwood-conifer swamp (Figure 62)



Figure 61. Location of Thorne Swift and Weimer's Lake Nature Preserves in Emmet County, Michigan, USA.



Figure 62. Natural communities at Throne Swift and Weimer's Lake Nature Preserves: transparent teal is hardwood-conifer swamp, transparent purple is rich conifer swamp, and transparent yellow is open dunes. Each dot is an observed invasive species described in legend.

**Natural Community Type: Open Dunes**

**Rank:** G3 S3

**Size:** 5.2 acres

**Natural Community Description:** The open dunes community along Little Traverse Bay is composed of several dunes before transitioning into a forested natural community. High Great Lakes water levels over the recent years eroded some of the dunes, exposing some gravel areas near the shore (Figure 63). Dune grasses were the dominant vegetation nearest Little Traverse Bay including beach grass (*Ammophila breviligulata*), sand reed grass (*Calamovilfa longifolia*), and wheat grass (*Elymus lanceolatus*). Small shrubs of creeping juniper (*Juniperus horizontalis*) and sand cherry (*Prunus pumila*) were common and occasional northern white-cedar (*Thuja occidentalis*) dotted the dunes. Herbaceous plants included common milkweed (*Asclepias syriaca*), beach pea (*Lathyrus japonicus*), white camas (*Anticlea elegans*), and wormwood (*Artemisia campestris*).



The portion of the beach [redacted] is roped off, restricting people to a single accessible portion and marked and maintained trails and viewing platform.

A plant species list can be found in Appendix D: Plant Species Lists.



Figure 63. Recent erosion of the open dunes exposed plant roots and gravel patches along the beach. Photograph was taken on September 8, 2022, by Rachel Hackett.

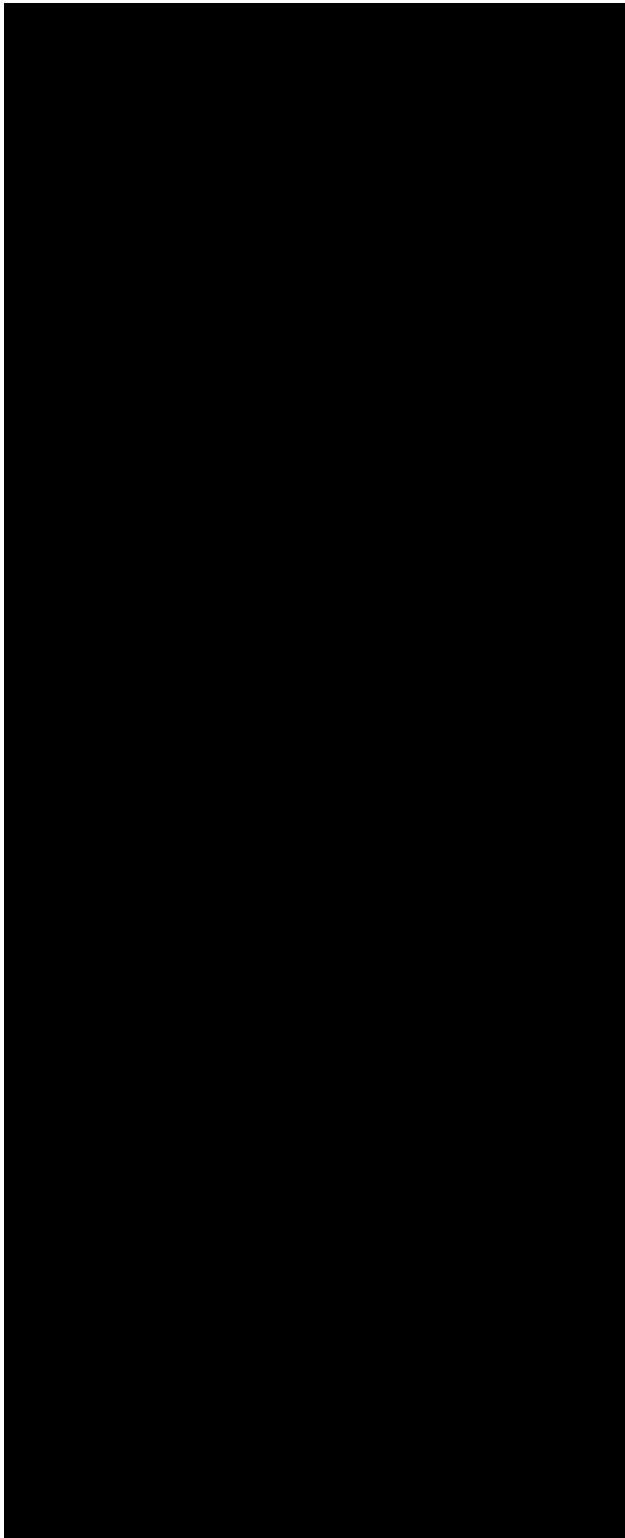


Figure 64. Notable vegetation at Thorne Swift and Weimer's Lake Nature Preserves. Right: Large hemlock, cedar and birch trees were observed in Weimer's Lake Nature Preserve on September 9, 2022. Photographs taken by Rachel Hackett



**Other Natural Community Types: Rich Conifer Swamp, Hardwood Conifer Swamp**

**Natural Community Type:** Rich conifer swamp

**Rank:** G4 S3

**Size:** 17.4 acres

**Natural Community Description:** The community abutting the open dunes most closely resembles rich conifer swamp. The topography was uneven but not as rolling as one finds in most forested dune complexes. Canopy dominated by conifers like northern white cedar, hemlock (*Tsuga canadensis*), and white pine (*Pinus strobus*) with a few dead ash (*Fraxinus* spp.) observed. Balsam fir (*Abies balsamifera*) was abundant in subcanopy. Weimer's Lake is very marly with calcephilic vegetation along the edges. *Sphagnum* moss mounds were more dense and abundant near the lake than in the interior of the swamp. Few large canopy trees (DBH > 50 cm) of hemlock and white pine observed near Weimer's Lake. Several well maintained and used trails run through the swamp on the Thorne Swift Nature Preserve, but Weimer's Lake Nature Preserve has no trails aside from some footpaths along the property boundaries. Many non-native species were observed along trail and borders with private lands. There were no signs of hemlock woolly adelgid.

A plant species list can be found in Appendix D: Plant Species Lists

**Natural Community Type:** Hardwood-conifer swamp

**Rank:** G4 S3

**Size:** 8.7 acres

**Natural Community Description:** The swamp transitions to what resembles a hardwood-conifer swamp further from lakeshore and closer to the road. Canopy dominated by both conifers and hardwoods with large (DBH > 80 cm) hemlock, cedar, and paper birch (*Betula papyifera*; Figure 64). Few 20 cm DBH green ash (*Fraxinus pennsylvanicus*) present. The topography is uneven but roughly flat with several places where runoff from the road flows and pools. There were no signs of hemlock woolly adelgid.

A plant species list can be found in Appendix D: Plant Species Lists

***Management Recommendations***

Continue protecting listed species populations along beach by restricting and directing human traffic. Treat invasive species in open dune system. Monitor and treat observations of new invasive species along trails, road, and private property border.

**Management Priority Rank: High**

## Woollam Family and Deane Family Nature Preserves, Emmet County

**Landowner:** Little Traverse Conservancy

**Size:** Woollam Family Nature Preserve: 70.3 acres

Deane Family Nature Preserve: 4.0 acres

**Location:** Coast of Lake Michigan in Emmet County, approximately 1.5 miles west of Cross Village on M-119/North Lake Shore Drive/Tunnel of Trees Scenic Heritage Route (Figure 65).

**Survey Type(s):** EO/ERA revisit, evaluate for EO status, invasive species surveys

**Natural Community Type(s):** Open dunes, mesic northern forest (Figure 66)



Figure 65. Location of Woollam and Deane Family Nature Preserves in Emmet County, Michigan, USA.

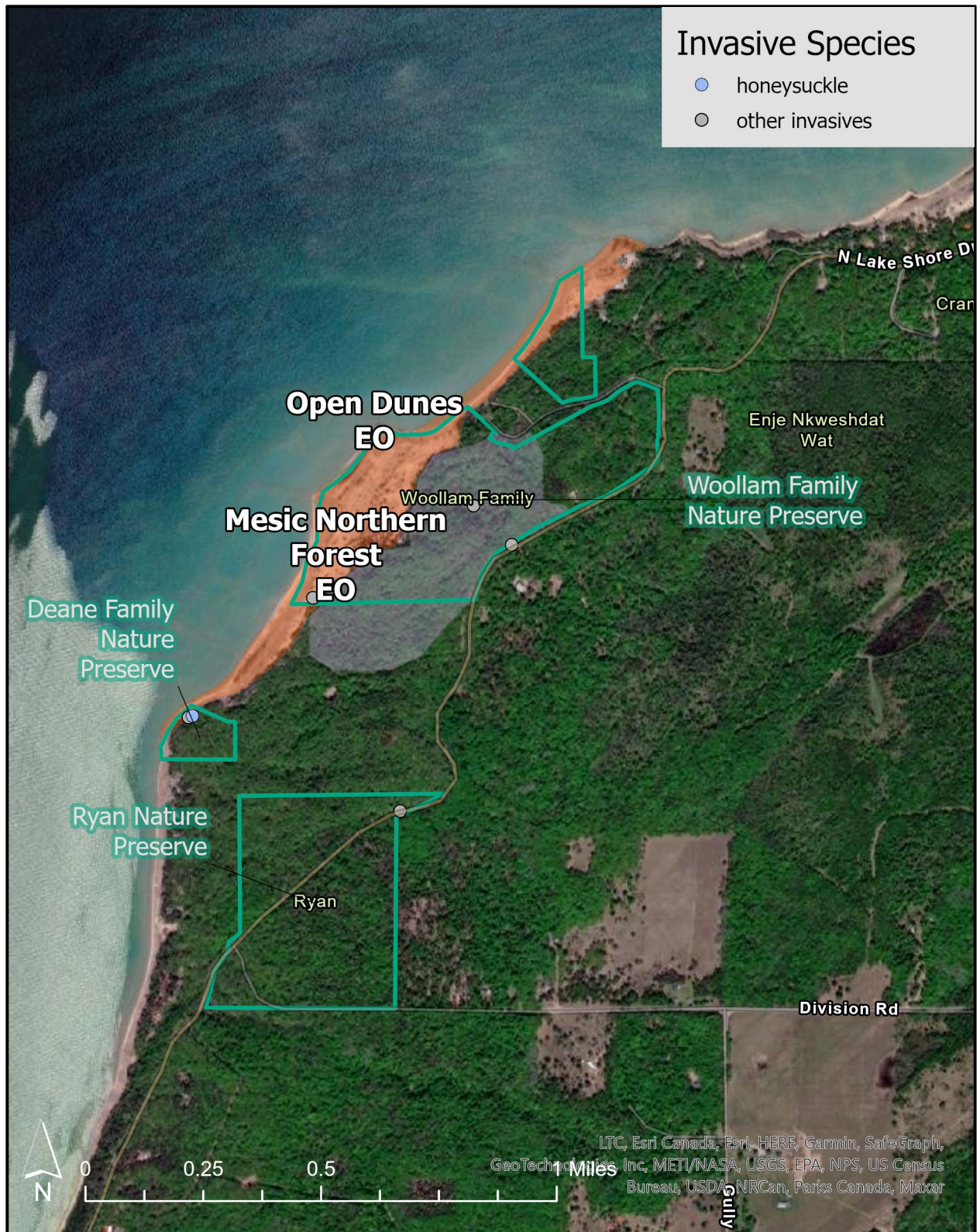


Figure 66. Natural community element occurrences (EOs) located at Woollam Family Nature Preserve: transparent orange represents open dunes and transparent purple represents mesic northern forest. Preserve boundaries are in cyan. Each dot is an observed invasive species described in legend.

**Natural Community Type: Open Dunes**

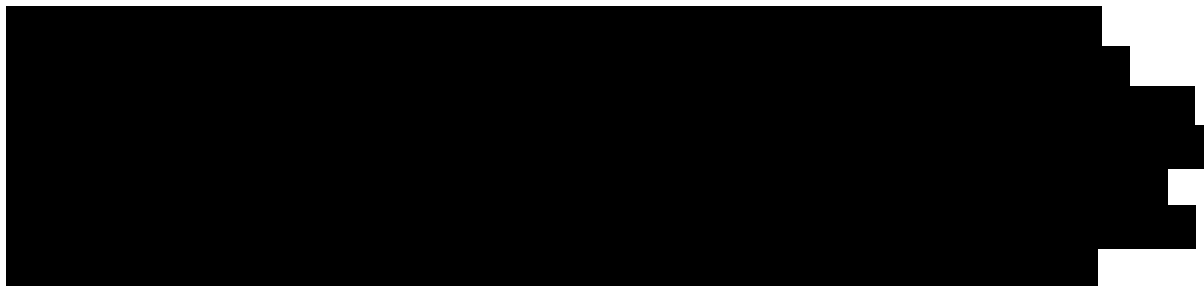
**Rank:** G3 S3

**EO Identification Number:** 6368 (McCort Hill)

**EO Size:** 36.4 acres (24 acres on LTC property including Deane Family Nature Preserve)

**EO Rank and Justification:** C. Small stretch of open dunes occurring along the Lake Michigan shoreline. Open dunes occur above sand and gravel beach with mesic northern forest and residences occurring inland. The greater landscape is moderately fragmented with medium road density. The area surrounding the open dunes remains forested but with large summer homes nestled in the woods. Threats include invasive plants, foot traffic, and erosion. Invasive species observed in 2022 included spotted knapweed (*Centaurea stoebe*), Canada bluegrass (*Poa compressa*), bush honeysuckle (*Lonicera morrowii*), and peppermint (*Mentha × piperita*). Invasive plant species documented in 2012, but not in 2022 included lyme grass (*Leymus arenarius*) and bladder campion (*Silene vulgaris*). Numerous residences occur inland from the dunes, nestled in the forested dunes, and numerous beach access trails pass through the open dunes. Localized dune erosion and denuding of dune vegetation originates and spreads from these trails and residences. Recent path markers placed by LTC have reduced some unauthorized pathways, on their lands, but several still exist, especially on private lands.

**EO Data:** This open dune system is composed of sand with a cobble area between the foredune and the secondary dune. There are many scattered and stunted trees (less than 6 m tall) of paper birch (*Betula papyrifera*), red cedar (*Juniperus virginiana*), red pine (*Pinus resinosa*), white pine (*Pinus strobus*), balsam poplar (*Populus balsamifera*), and northern white-cedar (*Thuja occidentalis*). Grasses dominated vegetative portions of the dunes including beach grass (*Ammophila breviligulata*), sand reed grass (*Calamovilfa longifolia*), Canada wild rye (*Elymus canadensis*), wheat grass (*Elymus lanceolatus*), and little bluestem (*Schizachyrium scoparium*). Small shrubs and other groundcover include sand cherry (*Prunus pumila*), common ground juniper (*Juniperus communis*), willows (*Salix exigua*, *S. lucida*), common milkweed (*Asclepias syriaca*), beach pea (*Lathyrus japonicus*), puccoon (*Lithospermum caroliniense*), white camas (*Anticlea elegans*), harebell (*Campanula rotundifolia*), and wormwood (*Artemisia campestris*).



A plant species list can be found in Appendix D: Plant Species Lists.

The topography is rolling to moderate and the soils are fine-textured wind-blown and wave-worked sands (pH 8.0). Sands are locally mixed with gravel and cobble, especially in the flat dune field. In the interdunal wetland inclusion, the soils are moist to wet, sands (pH 8.0).

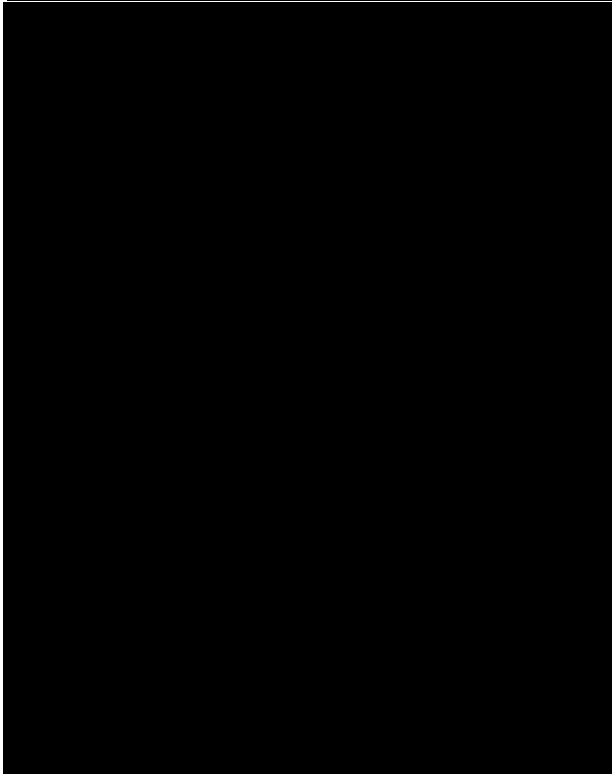
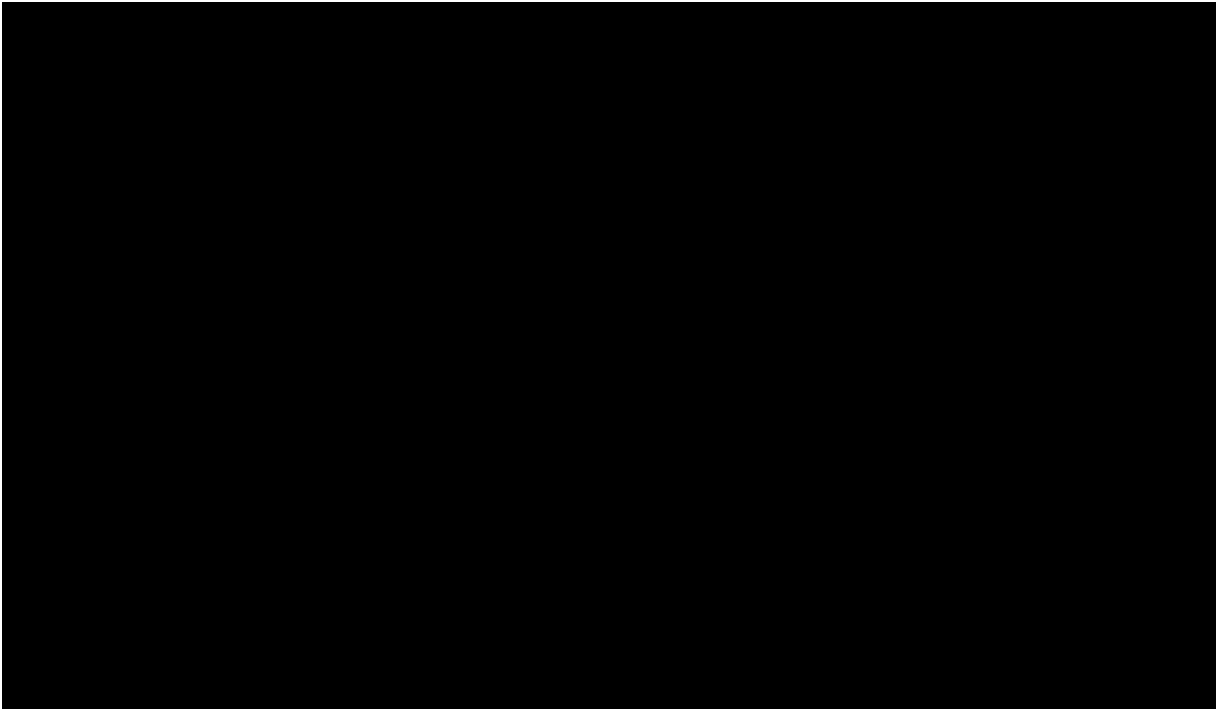


Figure 67. Rare [redacted] found in open dunes (EO 6368) [redacted] (EOID 10371); [redacted]; new county occurrence of northern hawkweed (*Hieracium umbellatum*) (EOID 3804). overlooking Lake Michigan; [redacted] Photographs taken on September 8, 2022, by Rachel Hackett.

**Natural Community Type: Mesic Northern Forest – Woollam Family Nature Preserve**

**Rank:** G4 S3

**EO Identification Number:** 20443 (McCort Hill)

**EO Size:** 41 acres (29 acres on LTC property)

**EO Rank and Justification:** CD. Maturing mesic northern forest occurring on rugged dune topography. Species composition and structure are primarily influenced by natural disturbance factors, past logging, deer herbivory, and are currently being impacted significantly by beech bark disease which has killed the overstory beech generating numerous light gaps and snags and coarse woody debris. Cut stumps occur throughout the forest. The understory and ground cover are notably sparse due to deer browse. The forest is intersected by roads, a powerline, and an old logging trail. Canada bluegrass (*Poa compressa*) is locally dominant. Mesic northern forest occurs adjacent to high-quality open dunes in Little Traverse Conservancy Preserve in forested landscape. The forest occurs just west of M-119. A scotch pine plantation occurs just northeast of mesic northern forest. The surrounding forest is primarily young northern hardwoods with scattered large homes, especially near the shore.

**EO Data:** Maturing mesic northern forest occurring on old sand dunes, with largest canopy trees nearing 130-150 years old with some hemlock greater than 200 years, DBH 30 – 80 cm. Canopy dominated by northern red oak (*Quercus rubra*) with canopy associates including basswood (*Tilia americana*), sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and hemlock (*Tsuga canadensis*). Closer to the lakeshore there is a great diversity of canopy trees with additions of northern white-cedar (*Thuja occidentalis*) and white pine (*Pinus strobus*) and hemlock increasing in importance.

The understory and ground cover is notably sparse, likely due to deer browse. A scattered subcanopy is characterized by ironwood (*Ostrya virginiana*), striped maple (*Acer pensylvanicum*), American beech, sugar maple, hemlock, and black cherry (*Prunus serotina*). Common species of the shrub and groundcover are maple and oak saplings, sedges (*Carex* spp.), wood ferns (*Dryopteris* spp.), rough-leaved rice-grass (*Oryzopsis asperifolia*), and wild red raspberry (*Rubus strigosus*). Non-native species observed in 2022 were helleborine (*Epipactus helleborine*), motherwort (*Leonurus cardiaca*), bush honeysuckle (*Lonicera morrowii*), wall lettuce (*Mycelis muralis*), Scotch pine (*Pinus sylvestris*), and common speedwell (*Veronica officinalis*).

Most of the American beech trees in the canopy are dead or dying from beech bark disease, although some DBH 29 – 48 cm are persisting. Hemlock and striped maple are filling in the gaps left from dead American beech. There were no signs of hemlock woolly adelgid. The soils are characterized by a shallow (1 - 2 cm), acidic soils (pH 4.5-5.0) over medium-textured dune sands (pH 6.0 - 6.5).



A plant species list can be found in Appendix D: Plant Species Lists.

### ***Other Natural Communities: Mesic Northern Forest***

#### **Woollam Family Nature Preserve**

**Size:** 17.9 acres

An additional stand resembling dry-mesic and mesic northern forest is contained in Woollam Family Nature Preserve (Figure 66). Although this forest has some large red oak and white pine canopy trees, overall the forest is younger with more even-aged trees and less diverse ground cover. This portion of the forest also has more numerous and larger canopy gaps caused by beech bark disease. A scotch pine plantation is present and this species is spreading into the rest of the forest including into the mesic northern forest EO. There is also a private drive that bisects the forest. Despite this stand not meeting the qualifications for EO status, threat management in this stand can protect the higher quality areas.

#### **Deane Family Nature Preserve**

**Size:** 3.8 acres

Mesic northern forest is also contained in Deane Family Nature Preserve. The forest is young with even-aged trees and with an understory of almost exclusively saplings and little ground cover. No hemlock woolly adelgid was observed.

### ***Management Recommendations***

Threats to these stands include invasive species, canopy tree diseases, erosion, and private development in between Conservancy-owned parcels. Recent high Great Lakes water levels have contributed to greater than typical erosion in the open dunes. The canopy gaps caused by beech bark disease are leaving the forest susceptible to invasive species invasion and spread by species such as Scotch pine.

The highest priority areas for invasive species management is within the two Element Occurrences. Medium priority for management is the other natural communities identified above. Lowest priority is areas that are already dominated by invasive species, such as roadsides, trailheads, parking areas, and open meadows.

Reduction of the local deer population could improve the recovery of the ground cover in the forest and allow younger trees to reach significant size in the understory to replace canopy trees when gaps occur. The Scotch pine plantation could be managed and restored to mesic or dry-mesic forest incrementally to reduce the spread of this species and minimize erosion. Hemlock is abundant in the mesic forests. A pest of this species, hemlock woolly adelgid, is spreading northward and should be monitored for regularly. The marked and designated hiking trail should reduce erosion but should be monitored for the spread of invasive species.

Acquisition of the private parcels between LTC parcels that contain the open dune EO (EOID 6368) and mesic northern forest EO (EOID 20443) will provide further protection and conservation to those EOs. The open dune EO with its narrow-shape, high

disturbance regime, and habitat for listed plant species makes its conservation especially important.

**Management Priority Rank: Highest**

## Flowing Well Swamp, Kalkaska County

**Landowner/Manager:** State Forest (Forest Resource Division)/GTRLC

**Size:** 1739.4 acres

**Location:** East of Kalkaska, Michigan, on M-72 approximately 14 km (8.5 mi). On the south side of M-72 (Figure 68).

**Survey Description:** Other survey (Cohen 2022).

**Natural Community Type(s):** Rich conifer swamp (Figure 69)

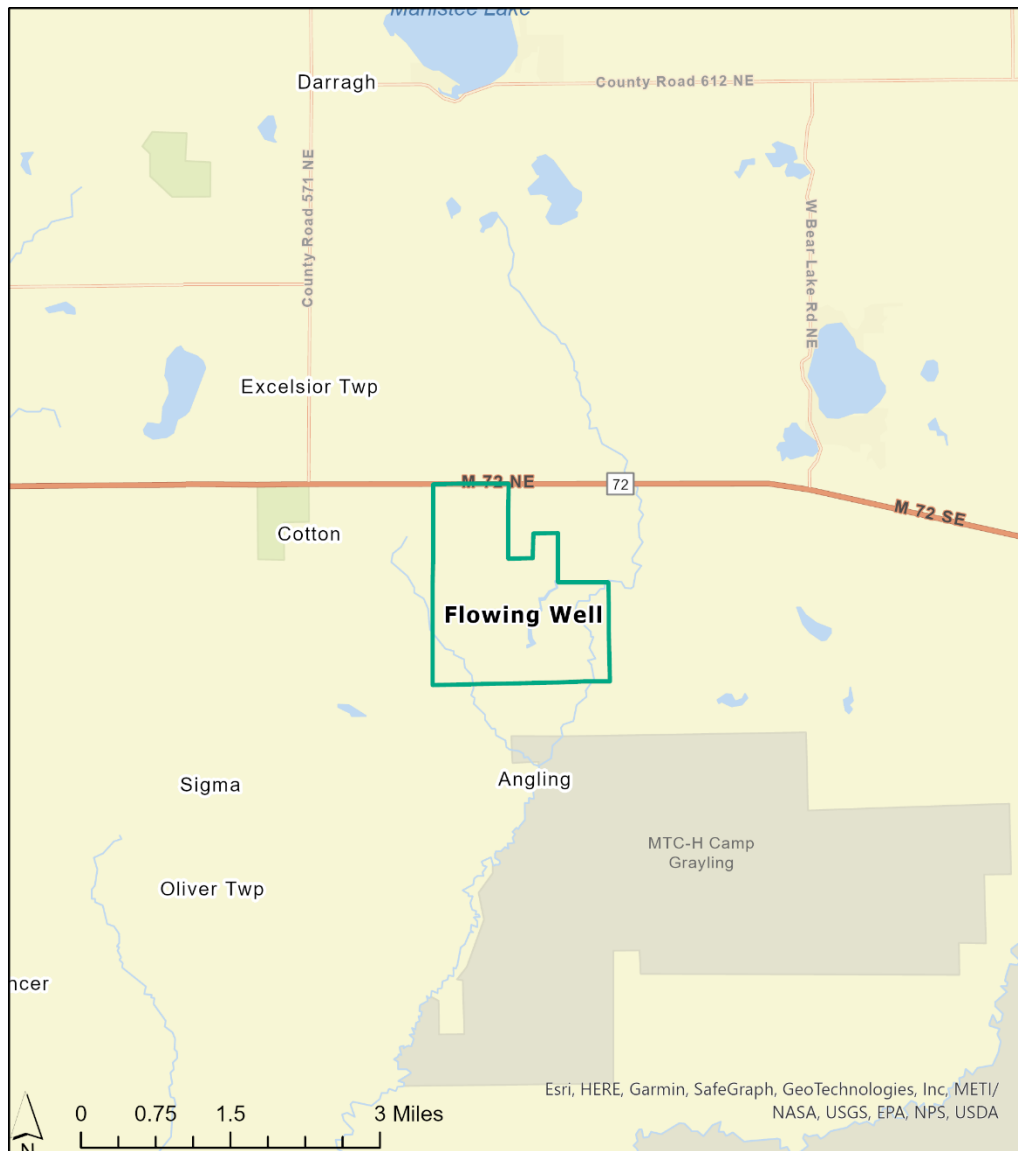


Figure 68. Location of Flowing Well State Property in Kalkaska County, Michigan, USA.

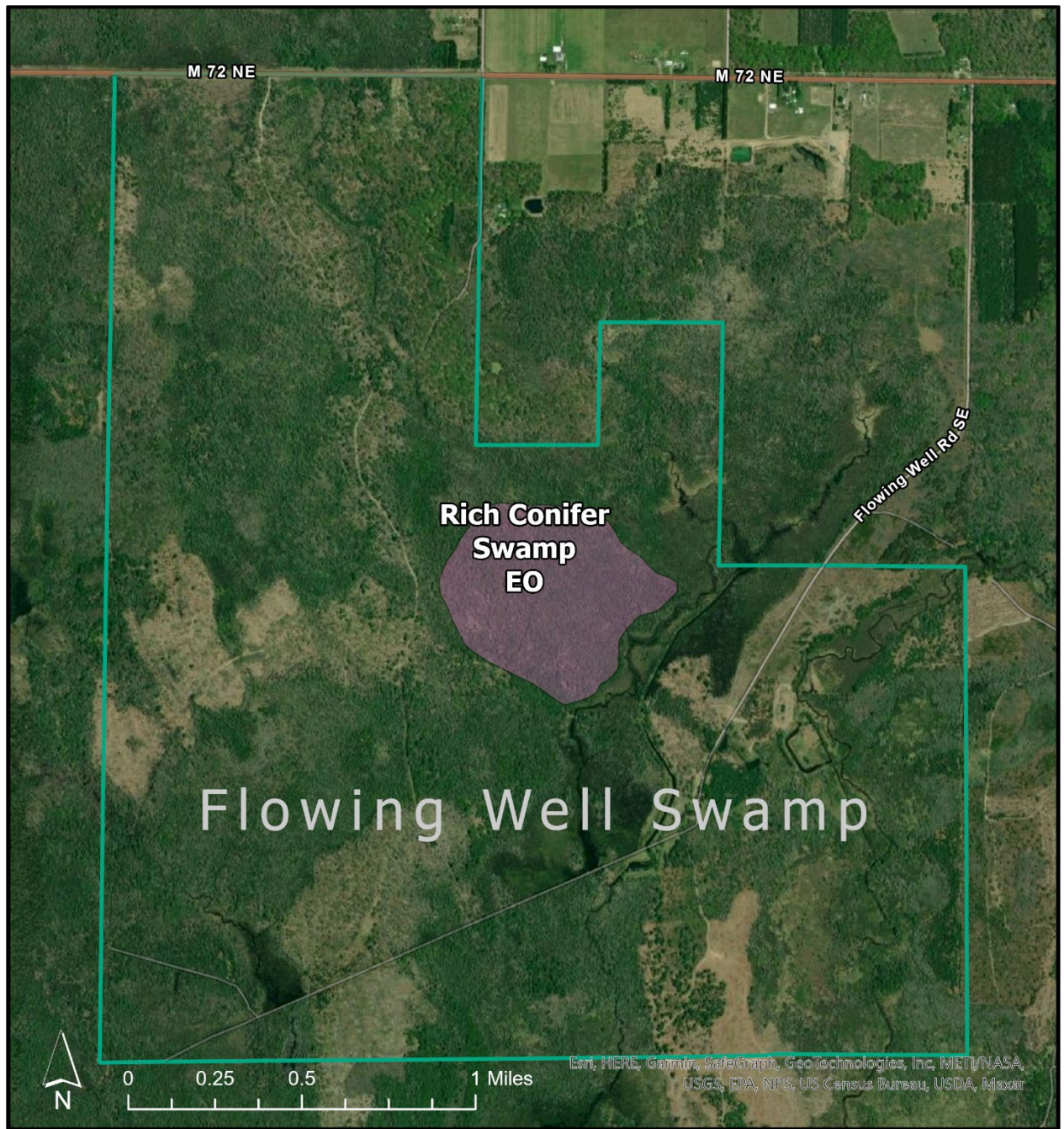


Figure 69. Rich conifer swamp EO on Flowing Well Property. Cyan lines are the property borders. Transparent purple area represents the EO.

**Natural Community Type: Rich Conifer Swamp**

**Rank:** G4 S3

**EO Identification Number:** 18997 (Flowing Well Swamp)

**EO Size:** 82.4 acres

**EO Rank and Justification:** C. A relatively small area of mature rich conifer swamp, buffered by an extensive, younger swamp forest in a predominantly natural landscape, impacted by high levels of deer browse and locally by invasive plant species. High canopy mortality of ash trees is a result of the emerald ash borer. Cut stumps from logging noted throughout the swamp and many of these stumps are larger in diameter than the current canopy trees. The element occurrence is well-buffered and situated at the western margin of a predominantly natural landscape affected by timber management, roads, deer browse, and invasive species. The uplands to the west of the occurrence are on private land and are largely agricultural. Non-natives noted within the swamp include bittersweet nightshade (*Solanum dulcama*) and marsh thistle (*Cirsium palustre*).

**EO Data:** Mature second growth to old-growth rich conifer swamp in an area of broad, poorly drained outwash associated with numerous streams, buffered by disturbed, younger rich conifer swamp and mesic northern forest. Hydrology is largely intact. High canopy mortality of canopy ash from emerald ash borer has resulted in high volumes of coarse woody debris and a more open canopied swamp. Canopy closure in 2022 was observed to range from 50-65% in areas of ash mortality and 75-85% in areas dominated by northern white-cedar (*Thuja occidentalis*). Windthrow of canopy cedar has generated numerous tip-ups that create microtopography. Speckled alder (*Alnus incana*) and Michigan holly (*Ilex verticillata*) are locally prevalent, particularly in canopy gaps and blowdowns. Species composition varies based on microtopography; depressions support dense groundcover, characterized by an abundance of ferns, and mounds support patchier herbaceous cover, primarily comprised of low-growing forbs. Snags and coarse woody debris are abundant. Windthrow also produced possible bear denning sites. Ant mounds noted within the swamp.

A plant species list can be found in Appendix D: Plant Species Lists.

The soil profile is deep peat (> 90 cm; pH 6.5 - 7.5) over sand.

### ***Other Natural Communities:***

Surrounding the rich conifer swamp EO is what resembles hardwood-conifer swamp, mesic northern forest, lower quality rich conifer swamp, and northern shrub thicket, with hardwood-conifer swamp being most prevalent. Ash (*Fraxinus spp.*) death from emerald ash borer has devastated much of the hardwood-conifer swamp, resulting in a much more open canopy and layers of coarse woody debris. The upland forest is frequently thinned, and some areas are dominated by young aspen (*Populus spp.*). There are many old roads and trails that run through the area, providing a pathway for invasive species.

### ***Management Recommendations***

Allow for natural processes to continue. Manage deer density to improve tree regeneration. Recently logged stands in area contain invasive species that may spread to swamp EO; buffer from future logging. Control and monitor invasive species; currently bittersweet nightshade is spreading into canopy gaps and depressions. Although degraded, invasive species control in surrounding habitat, especially those that establish in wet areas and canopy gaps.

**Management Priority Rank: Medium**

## Skegemog Lake Wildlife Area, Kalkaska County

**Landowner:** State of Michigan – managed by GTRLC

**Size:** 2386 acres

**Location:** Skegemog Lake Wildlife Area - Along the eastern shore of Lake Skegemog near Rapid City (Figure 70)

**Survey Type(s):** EO/ERA revisit, invasive species surveys

**Natural Community Type(s):** Northern fen, rich conifer swamp (Figure 71)

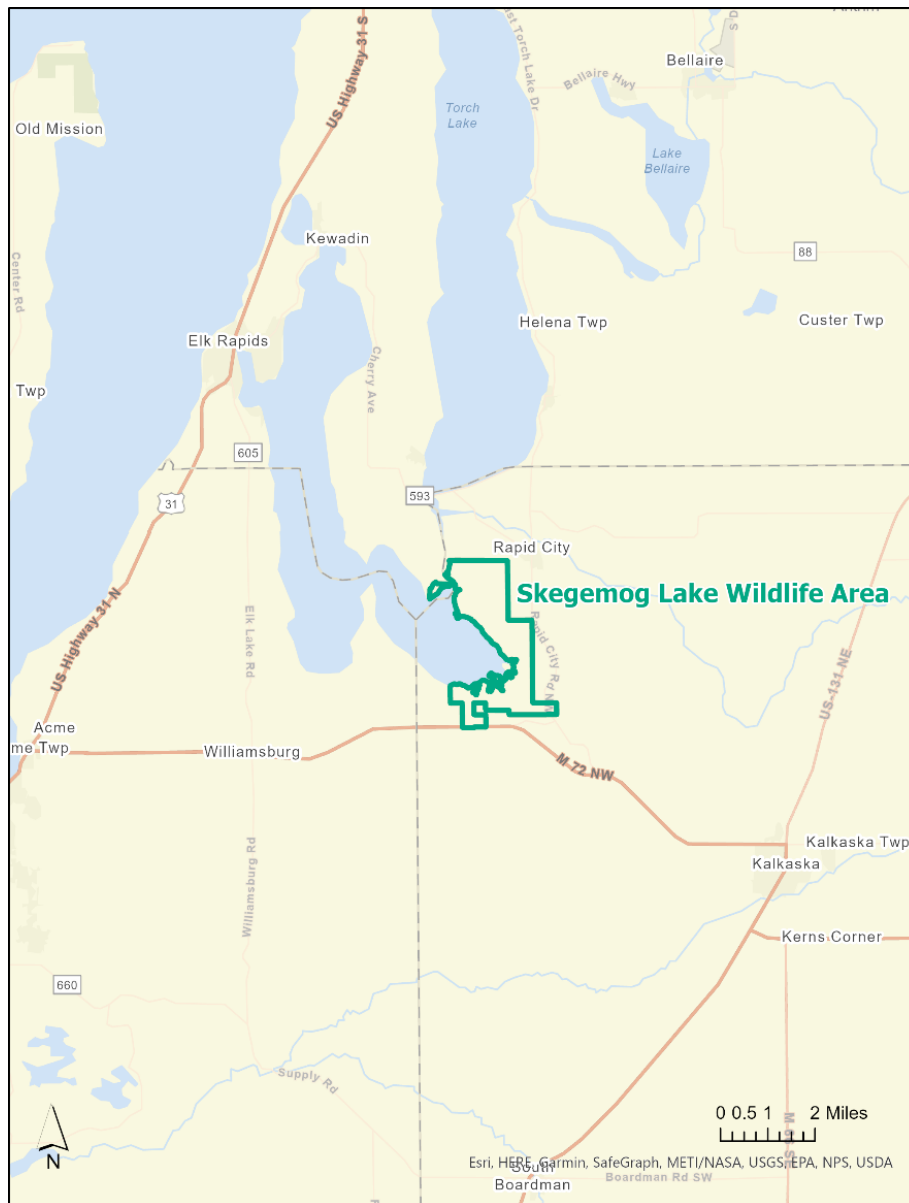


Figure 70. Location of Skegemog Lake Wildlife Area in Kalkaska County, Michigan, USA.





**Natural Community Type: Northern Fen**

**Rank:** G3 S3

**Survey Type:** EO Revisit

**EO Identification Number:** 17330

**EO Size:** 6 acres

**EO Rank and Justification:** BC. Small northern fen occurring along the shores of Skegemog Lake, shaped by natural processes, and buffered by Skegemog Lake and rich conifer swamp. Non-native invasives occur locally within the fen and include reed canary grass (*Phalaris arundinacea*) and narrowleaf cattail (*Typha angustifolia*). A large wetland complex occurring along the eastern shores of Skegemog Lake including northern fen and rich conifer swamp. The greater landscape is fragmented by residential and agricultural lands with numerous roads. Surrounding state lands are managed for recreation and timber production and game in the uplands.

**EO Data:** The northern fen is characterized by a scattered and stunted canopy of northern white-cedar (*Thuja occidentalis*), and tamarack (*Larix laricina*) (Figure 72). The sparse tall shrub layer is dominated by northern white-cedar, tamarack, and chokeberry (*Aronia prunifolia*). The low shrub layer is patchy to dense with sweet gale (*Myrica gale*), bog rosemary (*Andromeda glaucophylla*), leatherleaf (*Chamaedaphne calyculata*), and Labrador tea (*Rhododendron groenlandicum*).

Characteristic ground cover species include sedge (*Carex lasiocarpa*), harebell (*Campanula rotundifolia*), creeping-snowberry (*Gaultheria hispidula*), false mayflower (*Maianthemum trifolium*), dwarf raspberry (*Rubus pubescens*), marsh cinquefoil (*Comarum palustre*), bog buckbean (*Menyanthes trifoliata*), twig-rush (*Cladium mariscoides*), broad-leaved cattail (*Typha latifolia*), common bog arrow-grass (*Triglochin maritima*), pitcher-plant (*Sarracenia purpurea*), marsh fern (*Thelypteris palustris*), round-leaved sundew (*Drosera rotundifolia*), rough-leaved goldenrod (*Solidago rugosa*), marsh St. John's-wort (*Triadenum fraseri*), common bladderwort (*Utricularia vulgaris*), grass-of-Parnassus (*Parnassia glauca*), sensitive fern (*Onoclea sensibilis*), bog goldenrod (*Solidago uliginosa*), white beak-rush (*Rhynchospora alba*), and small cranberry (*Vaccinium oxycoccos*). Clumps of narrow-leaved cattail (*Typha angustifolia*) occur within the fen.

A plant species list can be found in Appendix D: Plant Species Lists.

The fen is characterized by sphagnum hummock and hollow microtopography, which generates fine scale gradients of soils moisture and chemistry. The soils are characterized by deep (> 1 m) saturated to inundated, fibric peats (pH 7.5-8.0), overlying wet sands (pH 7.0).



Figure 72. Northern fen at Skegemog Lake Wildlife Area on June 27, 2022. Photograph by Rachel Hackett.

**Natural Community Type:** *Rich Conifer Swamp*

**Rank:** G4 S3

**EO Identification Number:** 17331 (revisit of existing EO)

**EO Size:** 1455 acres

**EO Rank and Justification:** C/BC. Rich conifer swamp occurring on poorly drained lakeplain within a large wetland complex occurring along the eastern shores of Skegemog Lake including northern fen and rich conifer swamp. Very diverse flora (Figure 73). The greater landscape is fragmented by residential and agricultural lands with numerous roads. Surrounding state lands are managed for recreation and timber production and game in the uplands. Cut stumps scattered about the swamp. A hiking trail and boardwalk pass through the swamp with non-native species occurring along the trail. Beaver flooding has influenced portions of the rich conifer swamp with areas of flood-killed trees occurring along a stream and near Skegemog Lake.

**EO Data:** The rich conifer swamp is dominated by northern white-cedar (*Thuja occidentalis*) with canopy associates including balsam fir (*Abies balsamea*), red maple (*Acer rubrum*), white pine (*Pinus strobus*), tamarack (*Larix laricina*), black spruce (*Picea mariana*), and black ash (*Fraxinus nigra*). Canopy white-cedars range in DBH from 10-40cm. Scattered super canopy white pine occur throughout and range in DBH from 30-60cm. Areas dominated by white-cedar and tamarack tend to be wetter with smaller overstory trees and a denser understory. The tall shrub layer is sparse with white-cedar, beaked hazelnut (*Corylus cornuta*), speckled alder (*Alnus incana*), balsam fir, black spruce, winterberry (*Ilex verticillata*) and spicebush (*Lindera benzoin*). Common species of the low shrub layer are swamp fly honeysuckle (*Lonicera oblongifolia*), Labrador-tea (*Rhododendron groenlandicum*) and alder-leaved buckthorn (*Rhamnus alnifolia*).

The ground cover is diverse. Characteristic ground cover species include wild sarsaparilla (*Aralia nudicaulis*), oak fern (*Gymnocarpium dryopteris*), horsetail (*Equisetum arvense*), jack-in-the-pulpit (*Arisaema triphyllum*), poison-ivy (*Toxicodendron radicans*), goldthread (*Coptis trifolia*), Canada mayflower

(*Maianthemum canadense*), starflower (*Trientalis borealis*), sedges (*Carex pedunculata*, *Carex trisperma*), cinnamon fern (*Osmundastrum cinnamomeum*), bunchberry (*Cornus canadensis*), calico aster (*Symphyotrichum lateriflorum*), small enchanter's nightshade (*Circaea alpina*), dwarf raspberry (*Rubus pubescens*), and water-horehound (*Lycopus uniflorus*). Well-developed sphagnum hummock and hollow microtopography occurs throughout the swamp.

A plant species list can be found in Appendix D: Plant Species Lists.

The soils are characterized by deep (> 1 m) saturated peats (pH 7.0). Well-developed sphagnum hummock and hollow microtopography occurs throughout the swamp.

***Other Natural Communities: Hardwood-Conifer Swamp, Northern Fen, Northern Shrub Thicket, Rich Conifer Swamp***

Several areas of natural communities were located during the survey (Figure 74). These areas were not considered large enough in size or high enough quality to qualify as an Element Occurrence; nonetheless they are identified here as Medium Priority for invasive species management due to their connectivity, biodiversity, and relatively low densities of current invasive species infestations.

**Hardwood-conifer swamp** – 22 acres on the east side of Rapid City Road NW

**Northern fen** – 5 acres within powerline right-of-way

**Northern shrub thicket** – ≥ 8 acres adjacent to Skegemog Lake

**Rich conifer swamp** – 33 acres in northwest sections of site



Figure 73. Several high-conservation value plants found near trails in the rich conifer swamp EO at Skegemog Lake on June 1 and August 8, 2022. From top-left, clockwise: showy lady-slipper (*Cypripedium reginae*), grass-of-Parnassus (*Parnassia glauca*), nodding laddies'-tresses (*Spiranthes cernua*). Photographs by Julie McLaughlin.

### **Management Recommendations**

The main management recommendations are to allow natural processes to operate unhindered. Because this site is a protected area, threats of development or fragmentation within the site are low. The highest quality areas have a large buffer separating them from potential threats. However, new residential developments along the northwest boundaries have potential to become sources of invasive species. The plant nursery to the west may be a propagule source for new invasives such as perfumed cherry (*Prunus mahaleb*), which is already spreading in that area of the site.

The highest priority for invasive species management is within the two EOs. Medium priority for management is the other natural communities identified above. The lowest priority for management is areas that are already dominated by invasive species, such as roadsides, trailheads, parking areas, and open meadows. The most common invasive species found on site included: autumn-olive (*Elaeagnus umbellata*), Canada thistle (*Cirsium arvense*), marsh thistle (*Cirsium palustre*), common St. John's-wort (*Hypericum perforatum*), helleborine (*Epipactis helleborine*), narrow-leaved and hybrid cattail (*Typha angustifolia*, *Typha x glauca*) and reed canary grass (*Phalaris arundinacea*; Figure 74). To control the infestations of non-natives and monitor control efforts, encourage visitors to stay on the trail to prevent spreading invasives into the natural communities and especially the EOs. Monitor hiking trails, deer trails, parking areas and roadsides for invasive species. Deer density could be managed to allow for greater forest regeneration.

**Management Priority Rank: Highest**

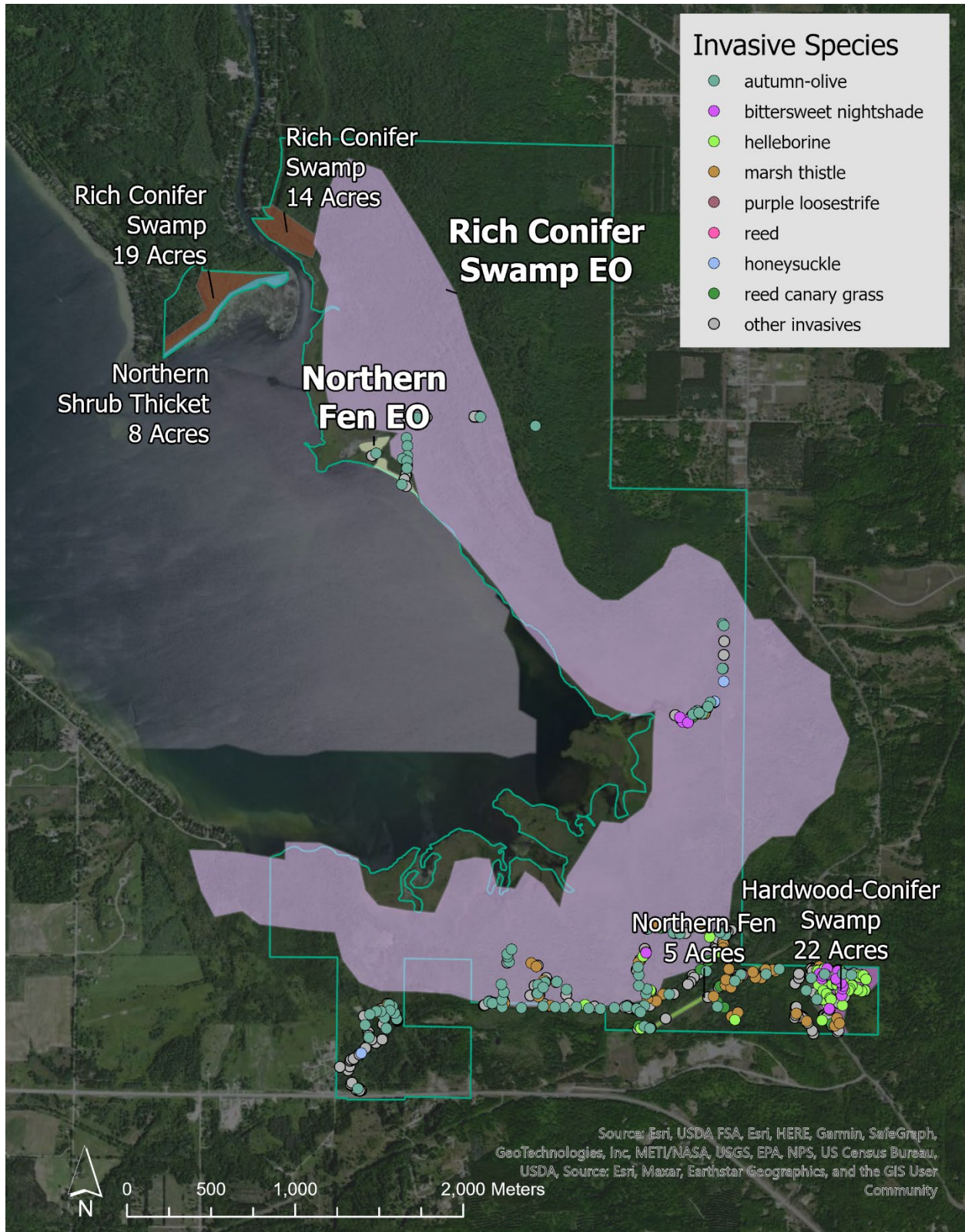


Figure 74. Map of other natural communities and invasive species points at Skegemog Lake Wildlife Area. Cyan lines are the property borders. Transparent purple the northern fen natural community EO. Each dot is an observed invasive species described in legend.

## Discussion

Land management and restoration are critical for preservation and resilience of ecosystems with great importance to water quality, watershed health, and biodiversity conservation. In the CAKE CISMA region, MNFI identified eight stands owned or managed by project partners as highest priority for management based on the quality, rarity, size, landscape context, and habitat for rare species (Appendix B: Stands Summar, Table B – 1). Forty-nine stands across 21 sites were marked high and medium priority based on their EO/ERA status, connectivity to higher quality stands, and/or potential to host high quality habitat and rare species. This information provides an ecological foundation for developing plans for biodiversity stewardship, monitoring, and implementing landscape-level biodiversity planning to prioritize management efforts throughout the four-county region. Threats to the ecological integrity of the stands and immediate management recommendations were presented to guide managers to make efficient and effective plans with the resources they have available.

The coastal and riparian habitats presented distinct differences in reasons they were prioritized. Most of the coastal areas surveyed were small, disconnected from other conservation areas, and contained documented state and/or federally listed species threatened by erosion, private development, and invasive species. Given the typically smaller size, surrounding developed landscape, and critical habitat, these areas would benefit most from an initial treatment of invasive species in the highest quality area and monitoring for threats from surrounding landscape and trails. The status of these natural communities can change quickly from natural and anthropogenic causes, so they may need more frequent monitoring than others.

The riparian areas were typically larger, connected to other natural and protected areas, ecologically important as headwater sources, and threatened by invasive species, logging, and over browsing. Given the larger size and connectivity, these sites would need a more long-term invasive species treatment strategy and for practicality, less frequent monitoring than the coastal areas. It would be best to work in stages from the headwaters downstream or from the highest priority stand upstream. Effects of logging can also affect the quality of these riparian areas. Logging events should be buffered around the high-quality natural communities and water bodies to reduce impacts.

These prioritizations were made strategically based on the expert opinion of MNFI staff to direct management efforts towards those sites with greatest conservation value. Although the methods were described, a GIS modelling framework could be created to prioritize invasive species response that would be more repeatable. Invasive species modeling efforts have been completed on lands owned by the State of Michigan and Saginaw-Chippewa Indian Tribe (Cohen et al. 2019; Cole-Wick et al. 2021). The model uses a multitude of different factors to quantify the abundance of invasive species in the area, integrity of the landscape, integrity of the stand, biodiversity rarity and richness, natural community resiliency, and ecosystem services of the stands. Surveys conducted

for this project could be used to inform evaluations of the biodiversity and integrity of the stands. Models can be customized to a degree to better represent the goals and objectives of the land managers.

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## Appendix A: Definitions, NatureServe Terminology and Ranks

This appendix contains Michigan Department of Natural Resources (MDNR) terms, NatureServe and Natural Heritage Program terminology and descriptions for global, state, and element occurrence ranks. Global and state ranks are assigned at a species- or natural community-level. Element occurrence ranks are assigned at a population- or stand-level.

Table A - 1. Additional definitions of terms and abbreviations used in report. Table modified from Cole-Wick et al. 2021.

Term	Description
Element Occurrence (EO)	A record of a listed species or natural community in a Natural Heritage Database that can contribute to the survival or persistence of that element
Ecological Reference Area (ERA)	A designation given by the MDNR to State Forest, State Parks, or State Wildlife Areas to denote High Conservation Value Area (as defined by the Forest Stewardship Council certification standard) and are Forests with Exceptional Conservation Value (as defined by the Sustainable Forestry Initiative certification standard). They are high quality functioning, ecosystems influenced by natural ecological processes where biological conservation is emphasized and achieved through management and/or restoration
Forest Compartment Stand Key (FCS Key)	Unique identifier for a Michigan State Forest Stand developed from numerical codes of given to the region, district, management unit, compartment, and stand
Natural Community	An assemblage of interacting plants, animals, and other organisms that repeatedly occur under similar environmental conditions across the landscape and is predominantly structured by natural processes rather than modern anthropogenic disturbances, such as timber harvest, alterations to hydrology, and fire suppression. Historically, indigenous peoples were an integral part of Michigan's natural communities with many natural community types being maintained by native management practices such as prescribed fire.
Natural Heritage Database	A repository of records documenting location, status, and characteristics of rare plant populations, animal populations, and natural communities in a designated region
Stand	Polygons representing a relatively homogeneous area of a similar land cover type and age

**Table A - 2. Explanation of state and global status ranks for natural communities. Abridged table developed by NatureServe (2021a).**

<b>Status</b>	<b>Description</b>	<b>Explanation</b>
S1	Critically Imperiled	At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.
S2	Imperiled	At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
S3	Vulnerable	At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
S4	Apparently secure	At a fairly low risk of extirpation in the jurisdiction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
S5	Secure	At very low or no risk of extirpation in the jurisdiction due to a very extensive range, abundant populations or occurrences, with little to no concern from declines or threats.
G1	Critically Imperiled	At very high risk of extinction or elimination due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors.
G2	Imperiled	At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
G3	Vulnerable	At moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
G4	Apparently secure	At fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
G5	Secure	At very low risk of extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.
GU	Unrankable	Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. NOTE: Whenever possible (when the range of uncertainty is three consecutive ranks or less), a range rank (e.g., G2G3) should be used to delineate the limits (range) of uncertainty.

**Table A - 3. Definitions of basic EO Ranks for species and natural communities as defined by NatureServe. Abridged table developed by NatureServe (2021b)**

<b>Rank</b>	<b>Definition</b>
A	Excellent estimated viability - Based on current information on EO rank factors (i.e., condition, size, and landscape context) for the EO, it is believed to have an excellent probability of persisting, if current conditions prevail, for a defined period of time, typically 20-100 years (for communities, persistence within the bounds of natural disturbance regimes).
B	Good estimated viability - Based on current information on EO rank factors (i.e., condition, size, and landscape context) for the EO, it is believed to have a good probability of persisting, if current conditions prevail, for a defined period of time, typically 20-100 years (for communities, persistence within the bounds of natural disturbance regimes).
C	Fair estimated viability - Based on current information on EO rank factors (i.e., condition, size, and landscape context) for the EO, it is believed to have a fair probability of persisting, if current conditions prevail, for a defined period of time, typically 20-100 years (for communities, persistence within the bounds of natural disturbance regimes).
D	Poor estimated viability - Based on current information on EO rank factors (i.e., condition, size, and landscape context) for the EO, it is believed to have a poor probability of persisting, if current conditions prevail, for a defined period of time, typically 20-100 years (for communities, persistence within the bounds of natural disturbance regimes).
E	Verified Extant - EO has been recently verified as still existing, but sufficient information on the factors used to estimate viability of the occurrence has not yet been obtained. Use of the E rank should be reserved for those situations where the occurrence is thought to be extant, but an A, B, C, D, or range rank cannot be assigned.
H	Historical - There is a lack of recent <sup>12</sup> field information verifying the continued existence of the EO, such as when the occurrence is based only on historical collections data, or when the occurrence was ranked A, B, C, D, or E at one time and is later, without field survey work, considered to be possibly extirpated due to general habitat loss or degradation of the environment in the area.
F	Failed to find - EO has not been found despite a search by an experienced observer at a time and under conditions appropriate for the Element at a location where it was previously reported, but that still might be confirmed to exist at that location with additional field survey efforts. For EOs with vague locational information, the search must include areas of appropriate habitat within the range of locational uncertainty. An F rank, when applicable, supersedes an A, B, C, D, E, or H rank.
X	Extirpated - There is documented destruction of the habitat or environment of the EO, or persuasive evidence of its eradication based on adequate survey (i.e., thorough or repeated survey efforts by one or more experienced observers at times and under conditions appropriate for the Element at that location).
U	Unrankable - An EO rank cannot be assigned due to lack of sufficient information on the occurrence.
NR	Not Ranked - An EO rank has not yet been assigned to the occurrence.

<sup>12</sup> The term recent is generally interpreted as follows: [...] For plants or communities, there has been a field survey of the occurrence within the last 20 to 40 years. This higher maximum time limit is based upon the assumption that occurrences of these Elements generally have the potential to persist at a given location for longer periods of time due to plant biology and community dynamics. However, landscape factors must also be considered; thus, areas with more anthropogenic impacts on the environment will be at the lower end of the range, and less-impacted areas will be at the higher end. These time frames represent suggested maximum limits, however the actual time period for historical EOs may vary according to the biology of the Element and the specific landscape context of each occurrence (including anthropogenic alteration of the environment).

## Appendix B: Stands Summary

One-hundred and seventy-two stands/properties were surveyed between June 29 and September 14, 2022, in the CAKE CISMA. Summary of stands surveyed in 2022. Stands ranked medium management priority and higher are found in Table B – 1 while low ranked stands are listed in Table B - 2. County-level maps of medium and higher ranked priorities are in Figure B - 1, Figure B - 2, Figure B - 3, and Figure B - 4.

Table B – 1. Summary of stands surveyed for project that were marked Highest, High, and Medium priorities. The acres listed is that of the entire stand including the EO, if applicable. FCS Key is a unique identifier for Michigan Department of Natural Resources forest stands. Natural Communities were classified using Cohen et al. (2014). EO ID is a unique identifier used in Michigan Natural Heritage Database for the natural community element occurrence contained in the stand. EO Rank is explained in Appendix A: Definitions, NatureServe Terminology and Ranks. Survey types are described in Methods; “Evaluate for EO Status” survey is abbreviated “EO Status” and “Invasive Plant Species” survey is abbreviated “Invasive”. This table has been sorted by Owner/Manager, then by site name with the highest ranked priorities. The rows have been color-coded by their Management Priority: Red – highest, pink – high, orange – medium, green – low.

County	Owner/ Manager	Name or FCS Key	Natural Community	Area (acres)	EO ID	EO Rank	Surveyor	Date Completed	Survey Type	Management Priority
Kalkaska	GTRLC	Skegemog Lake Wildlife Area	Northern fen	6	17330	BC	McLaughlin	08/31/2022	EO/ERA Revisit	Highest
Kalkaska	GTRLC	Skegemog Lake Wildlife Area	Rich conifer swamp	1455	17331	C/BC	McLaughlin	08/31/2022	EO/ERA Revisit	Highest
Kalkaska	GTRLC	Skegemog Lake Wildlife Area	Others	925	–	–	McLaughlin	08/31/2022	EO/ERA Revisit	High
Antrim	GTRLC	Wilcox-Palmer Shah Preserve	Open dunes	4	456	CD	Haber	07/21/2022 08/27/2022	EO/ERA Revisit	High
Antrim	GTRLC	Wilcox-Palmer Shah Preserve	Dry-mesic northern forest	13.5	–	–	Haber	07/21/2022 08/27/2022	EO Status	High
Antrim	GTRLC	Cosner Nature Preserve	NA, degraded upland habitat	89.9	–	–	Wilton	07/16/2022	Invasive	Medium
Antrim	GTRLC	Cosner Nature Preserve	Rich conifer swamp	18.1	TBD	TBD	Wilton	07/16/2022	Invasive	Medium
Charlevoix	LTBB	Taimi Hoag SW	Others	55	–	–	Haber	07/08/2022	EO status	Medium
Charlevoix	LTC	Susan Creek	Others	265	–	–	Haber	07/07/2022 07/30/2022	EO status	Medium

County	Owner/ Manager	Name or FCS Key	Natural Community	Area (acres)	EO ID	EO Rank	Surveyor	Date Completed	Survey Type	Management Priority
Emmet	LTC	Orchis Fen	Northern fen	14.0	2169	B	Hackett	09/14/2022	EO/ERA Revisit	Highest
Emmet	LTC	Orchis Fen	Rich conifer swamp	21.9	—	—	Hackett	09/14/2022	EO/ERA Revisit	Highest
Emmet	LTC	Woollam Family	Open dunes	23.4	6368	C	Hackett	09/08/2022	EO/ERA Revisit	Highest
Emmet	LTC	Woollam Family	Mesic northern forest	29.0	20443	CD	Hackett	09/08/2022	EO/ERA Revisit	Highest
Emmet	LTC	Woollam Family	Mesic northern forest	17.9	—	—	Hackett	09/08/2022	EO status	High
Emmet	LTC	Deane Family	Open dunes	0.6	6368	C	Hackett	09/14/2022	EO/ERA Revisit	Highest
Emmet	LTC	Deane Family	Mesic northern forest	3.8	—	—	Hackett	09/14/2022	Invasive	Medium
Emmet	LTC	Fisher Family Nature Preserve	Sand and gravel beach	2.4	20444	C	Hackett	09/09/2022	Invasive	High
Emmet	LTC	Fisher Family Nature Preserve	Dry-mesic northern forest	36.6	—	—	Hackett	09/09/2022	Invasive	Medium
Emmet	LTC	Thorne Swift	Open dunes,	5.2	—	—	Hackett	09/08/2022	EO/ERA Revisit	High
Emmet	LTC	Thorne Swift	Rich conifer swamp	17.4	—	—	Hackett	09/08/2022	Invasive	Medium
Emmet	LTC	Thorne Swift	Hardwood-conifer swamp	8.7	—	—	Hackett	09/08/2022	Invasive	Medium
Charlevoix	LTC	Jordan River Preserve	Emergent marsh	3	—	—	Haber	07/06/2022	EO Status	High
Charlevoix	LTC	Jordan River Preserve	NA, degraded upland and lowland habitat	38	—	—	Haber	07/06/2022	Invasive	Low <sup>13</sup>

<sup>13</sup> Although the stand is ranked low, it was included in this table because it is a part of a property with higher priority.

County	Owner/ Manager	Name or FCS Key	Natural Community	Area (acres)	EO ID	EO Rank	Surveyor	Date Completed	Survey Type	Management Priority
Antrim	State	Warner Creek 52048006	Northern fen	20	26388	BC	Hackett	09/02/2022	New EO	Highest
Antrim	State	Warner Creek 52048001	Rich conifer swamp	9	—	—	Hackett	09/02/2022	Invasive	High
Antrim	State	Warner Creek 52048004	Mesic northern forest	26	—	—	Hackett	09/02/2022	Invasive	High
Antrim	State	Warner Creek 52047011	Northern wet meadow	20	—	—	Hackett	09/07/2022	Invasive	High
Antrim	State	Warner Creek 52047012	Northern wet meadow	38	—	—	Hackett	09/07/2022	Invasive	High
Antrim	State	Warner Creek 52048010	Northern wet meadow	13	—	—	Hackett	09/07/2022	Invasive	High
Antrim	State	Warner Creek 52048012	Northern wet meadow	8	—	—	Hackett	09/07/2022	Invasive	High
Antrim	State	Warner Creek 52047010	Emergent marsh	16	—	—	Hackett	09/07/2022	Invasive	High
Antrim	State	Warner Creek 52048014	Northern shrub thicket	10	—	—	Hackett	09/07/2022	Invasive	High
Antrim	State	Warner Creek 52048017	Emergent marsh	14	—	—	Hackett	09/07/2022	Invasive	High
Antrim	State	Landslide Fen 52056018	Northern fen	3	18799	BC	Hackett	08/19/2022	Invasive	High
Emmet	State	Minnehaha Creek Swamp 52125003	Rich conifer swamp	31.2	8154	B	Hackett	08/08/2022	EO/ERA Revisit	High
Emmet	State	Minnehaha Creek Swamp 52125005	Rich conifer swamp	372.8	8154	B	Hackett	08/08/2022	EO/ERA Revisit	High
Emmet	State	Minnehaha Creek Swamp 52125012	Rich conifer swamp	89.6	8154	B	Hackett	08/08/2022	EO/ERA Revisit	High
Emmet	State	Minnehaha Creek Swamp 52125013	Rich conifer swamp	90.7	8154	B	Hackett	08/08/2022	EO/ERA Revisit	High

County	Owner/ Manager	Name or FCS Key	Natural Community	Area (acres)	EO ID	EO Rank	Surveyor	Date Completed	Survey Type	Management Priority
Antrim	State	Pinney Bridge Swamp 52055007	Rich conifer swamp	144	18802	C	Cohen	05/26/2021	Other <sup>14</sup>	High
Antrim	State	Pinney Bridge Swamp 52055006	Rich conifer swamp	12.1	18802	C	Cohen	05/26/2021	Other <sup>14</sup>	High
Antrim	State	Bennett Creek 52052007	Northern wet meadow	36.7	—	—	Wilton	07/16/2022	Invasive	Medium
Antrim	State	Deadman's Fen 52048054	Northern fen	13.2	18795	BC	Cohen	06/16/2020	Other <sup>14</sup>	Medium
Antrim	State	Deadman's Swamp 52048049	Rich conifer swamp	107.4	18796	C	Cohen	06/18/2020	Other <sup>14</sup>	Medium
Antrim	State	Deadman's Creek 52049027	Rich conifer swamp	77	—	—	McLaughlin	09/02/2022	Invasive	Medium
Antrim	State	Jordan River 52049033	Northern shrub thicket	11.0	18797	B	Cohen	07/27/2011	Other <sup>14</sup>	Medium
Antrim	State	Jordan River Fen 52049043	Northern fen	14.1	18798	C	Cohen	07/27/2011	Other <sup>14</sup>	Medium
Antrim	State	Landslide Creek 52057024	Rich conifer swamp	12.3	—	—	Hackett	08/17/2022	EO Status	Medium
Antrim	State	Mt Bliss 52051031	Rich conifer swamp	121.2	TBD	C	Wilton	07/19/2022	EO Status	Medium
Antrim	State	Mt Bliss 52051029	Rich conifer swamp	30.6	TBD	C	Wilton	07/19/2022	EO Status	Medium
Antrim	State	Mt Bliss 52051087	Rich conifer swamp	36.0	TBD	C	Wilton	07/19/2022	EO Status	Medium

<sup>14</sup> Property surveyed as a part of another project (Cohen 2011, Cohen 2021; Cohen 2022). Acreage was not included in totals reported in body of report.



County	Owner/ Manager	Name or FCS Key	Natural Community	Area (acres)	EO ID	EO Rank	Surveyor	Date Completed	Survey Type	Management Priority
Antrim	State	Petobego Pond 8280101007	Great Lakes marsh	68	1919	CD	Haber	08/28/2022	EO/ERA Revisit	Medium
Antrim	State	Petobego Pond 8280101008	Great Lakes marsh	5	1919	CD	Haber	09/05/2022	EO/ERA Revisit	Medium
Antrim	State	Petobego Pond 8280101009	Rich conifer swamp	5	—	—	Haber	09/05/2022	Invasive	Medium
Antrim	State	Section Thirteen Creek 52058031	Mesic northern forest	27.3	—	—	Hackett	08/17/2022	EO Status	Medium
Antrim	State	Stevens Creek 52056027	Hardwood-conifer swamp	32	—	—	Hackett	08/18/2022	Invasive	Medium
Antrim	State	Stevens Creek 52055019	Hardwood conifer-swamp	18.9	—	—	Hackett	08/18/2022	Invasive	Medium
Kalkaska	State/ GTRLC	Flowing Well Swamp	Rich conifer swamp	82.4	18997	C	Cohen	05/23/2022	Other <sup>14</sup>	Medium
Kalkaska	State/ GTRLC	Flowing Well	Others, degraded	1657.0	—	—	Cohen	05/23/2022	Other <sup>14</sup>	Low <sup>13</sup>

Table B - 2. Summary of stands surveyed for project that were marked low priority. FCS Key is a unique identifier for Michigan Department of Natural Resources forest stands. Survey types are described in Methods; "Evaluate for EO Status" survey is abbreviated "EO Status?" and "Invasive Plant Species" survey is abbreviated "Invasive". This table is sorted by Owner/Manager, County, and then Name.

County	Owner/Manager	Name or FCS Key	Area (acres)	Surveyor	Date Completed	Survey Type	Management Priority
Antrim	GTRLC	Dearborn Woods and Water	76	Wilton	07/15/2022	Invasive	Low
Antrim	GTRLC	Fishbeck	23	Hackett	08/16/2022	Invasive	Low
Antrim	GTRLC	Sevald Jordan River Valley	93	Wilton	07/18/2022	Invasive	Low
Antrim	GTRLC	Webster Bridge	33	Wilton	07/18/2022	Invasive	Low
Emmet	LTBB	Cross Village	8.3	Hackett	09/13/2022	Invasive	Low
Emmet	LTBB	Wall Parcel	1.7	Hackett	09/13/2022	Invasive	Low
Charlevoix	LTC	Dressel	10	Haber	07/05/2022	Invasive	Low
Charlevoix	LTC	Jordan River Sedge Marsh	2	Haber	07/05/2022	Invasive	Low
Charlevoix	LTC	Jordan River Sedge Marsh	1	Haber	07/05/2022	Invasive	Low
Charlevoix	LTC	Rogers Family Homestead	148	Haber	07/05/2022, 07/06/2022	Invasive	Low
Emmet	LTC	A.C. Fisher	46.3	Hackett	09/13/2022	Invasive	Low
Emmet	LTC	Davis Family	2.9	Hackett	09/13/2022	Invasive	Low
Emmet	LTC	Edwards	1.4	Hackett	09/12/2022	Invasive	Low
Emmet	LTC	Hoogland Family	94	Hackett	09/12/2022	Invasive	Low
Emmet	LTC	James	1.4	Hackett	09/12/2022	Invasive	Low
Emmet	LTC	James	2	Hackett	09/12/2022	Invasive	Low
Emmet	LTC	Kalman	69.4	Hackett	09/13/2022	Invasive	Low
Emmet	LTC	Menonaqua Woods	77.6	Hackett	09/14/2022	Invasive	Low
Emmet	LTC	Menonaqua Woods	25.2	Hackett	09/14/2022	Invasive	Low
Emmet	LTC	Menonaqua Woods	0.4	Hackett	09/14/2022	Invasive	Low
Emmet	LTC	Menonaqua Woods	0.7	Hackett	09/14/2022	Invasive	Low
Emmet	LTC	Menonaqua Woods	0.7	Hackett	09/14/2022	Invasive	Low
Emmet	LTC	Michael Cameron Dempsey	10	Hackett	09/14/2022	Invasive	Low
Emmet	LTC	Ryan	50	Hackett	09/08/2022	Invasive	Low
Emmet	LTC	S.A. Bissell	1.7	Hackett	09/12/2022	Invasive	Low
Emmet	LTC	Weimer's Lake	11.4	Hackett	09/09/2022	Invasive	Low
Antrim	State	52047026	111	Hackett	08/30/2022	Invasive	Low
Antrim	State	52047027	14	Hackett	08/30/2022	Invasive	Low
Antrim	State	52048027	12	Hackett	08/30/2022	Invasive	Low
Antrim	State	52048040	98	Hackett	08/30/2022	Invasive	Low
Antrim	State	52049028	54.1	McLaughlin	09/01/2022	Invasive	Low
Antrim	State	52051001	10.7	Wilton	07/15/2022	Invasive	Low
Antrim	State	52051002	18.9	Wilton	07/18/2022	Invasive	Low

County	Owner/ Manager	Name or FCS Key	Area (acres)	Surveyor	Date Completed	Survey Type	Management Priority
Antrim	State	52051003	22.9	Wilton	07/19/2022	Invasive	Low
Antrim	State	52051005	22.8	Wilton	07/18/2022	Invasive	Low
Antrim	State	52051009	5.17	Wilton	07/17/2022	Invasive	Low
Antrim	State	52051014	62.4	Wilton	07/18/2022	Invasive	Low
Antrim	State	52051017	33.0	Wilton	07/18/2022	Invasive	Low
Antrim	State	52051018	38.7	Wilton	07/18/2022	Invasive	Low
Antrim	State	52051020	14.0	Wilton	07/18/2022	Invasive	Low
Antrim	State	52051021	13.3	Wilton	07/18/2022	Invasive	Low
Antrim	State	52051022	6.9	Wilton	07/18/2022	Invasive	Low
Antrim	State	52051027	12.5	Wilton	07/19/2022	Invasive	Low
Antrim	State	52051028	12.4	Wilton	07/18/2022	Invasive	Low
Antrim	State	52051033	29.0	Wilton	07/19/2022	Invasive	Low
Antrim	State	52051039	6	Hackett	09/01/2022	Invasive	Low
Antrim	State	52051040	147	Hackett	09/01/2022	Invasive	Low
Antrim	State	52051050	35	Hackett	09/01/2022	Invasive	Low
Antrim	State	52051064	12	Hackett	09/01/2022	Invasive	Low
Antrim	State	52051089	28	Hackett	08/31/2022	Invasive	Low
Antrim	State	52051102	22	Hackett	08/31/2022	Invasive	Low
Antrim	State	52051104	20	Hackett	08/16/2022	Invasive	Low
Antrim	State	52051455	27.12	Wilton	07/17/2022	Invasive	Low
Antrim	State	52052009	3.0	Wilton	07/16/2022	Invasive	Low
Antrim	State	52052027	8.3	Wilton	07/16/2022	Invasive	Low
Antrim	State	52052033	37.9	Wilton	07/15/2022	Invasive	Low
Antrim	State	52052034	17.1	Wilton	07/15/2022	Invasive	Low
Antrim	State	52052035	8.1	Wilton	07/15/2022	Invasive	Low
Antrim	State	52052038	2.8	Wilton	07/16/2022	Invasive	Low
Antrim	State	52052039	10.5	Wilton	07/17/2022	Invasive	Low
Antrim	State	52052040	15.8	Wilton	07/17/2022	Invasive	Low
Antrim	State	52052041	2.0	Wilton	07/17/2022	Invasive	Low
Antrim	State	52052042	6.5	Wilton	07/17/2022	Invasive	Low
Antrim	State	52052049	47.3	Wilton	07/17/2022	Invasive	Low
Antrim	State	52052050	29.5	Wilton	07/17/2022	Invasive	Low
Antrim	State	52052051	5.8	Wilton	07/17/2022	Invasive	Low
Antrim	State	52052053	13.0	Wilton	07/17/2022	Invasive	Low
Antrim	State	52052057	2	McLaughlin	09/01/2022	Invasive	Low
Antrim	State	52052058	4.0	Wilton	07/16/2022	Invasive	Low
Antrim	State	52052067	9.8	Wilton	07/16/2022	Invasive	Low

County	Owner/ Manager	Name or FCS Key	Area (acres)	Surveyor	Date Completed	Survey Type	Management Priority
Antrim	State	52052069	18.6	Wilton	07/15/2022	Invasive	Low
Antrim	State	52052070	16	McLaughlin	09/01/2022	Invasive	Low
Antrim	State	52052075	26.5	Wilton	07/16/2022	Invasive	Low
Antrim	State	52052078	9.0	Wilton	07/17/2022	Invasive	Low
Antrim	State	52052080	2.6	Wilton	07/16/2022	Invasive	Low
Antrim	State	52054001	6	Hackett	08/31/2022	Invasive	Low
Antrim	State	52054002	130	Hackett	08/16/2022	Invasive	Low
Antrim	State	52054004	13	Hackett	08/16/2022	Invasive	Low
Antrim	State	52054009	13	Hackett	08/31/2022	Invasive	Low
Antrim	State	52054011	68	Hackett	08/31/2022	Invasive	Low
Antrim	State	52054015	25	Hackett	08/15/2022	Invasive	Low
Antrim	State	52054018	1.5	Hackett	08/16/2022	Invasive	Low
Antrim	State	52054034	3	Hackett	08/15/2022	Invasive	Low
Antrim	State	52055005	32	Hackett	07/01/2022	Invasive	Low
Antrim	State	52055009	5	Hackett	07/01/2022	Invasive	Low
Antrim	State	52055012	8	Hackett	08/18/2022	Invasive	Low
Antrim	State	52055015	7	Hackett	06/30/2022	Invasive	Low
Antrim	State	52055017	9	Hackett	08/18/2022	Invasive	Low
Antrim	State	52055023	7.2	Hackett	06/30/2022	Invasive	Low
Antrim	State	52055024	9.3	Hackett	06/29/2022	Invasive	Low
Antrim	State	52055025	5.4	Hackett	06/30/2022	Invasive	Low
Antrim	State	52055027	51.8	Hackett	06/29/2022	Invasive	Low
Antrim	State	52055029	8.7	Hackett	06/29/2022	Invasive	Low
Antrim	State	52055035	5	Hackett	06/30/2022	Invasive	Low
Antrim	State	52055041	4.9	Hackett	06/30/2022	Invasive	Low
Antrim	State	52055045	6.2	Hackett	06/30/2022	Invasive	Low
Antrim	State	52056008	11	Hackett	08/19/2022	Invasive	Low
Antrim	State	52056009	29	Hackett	08/19/2022	Invasive	Low
Antrim	State	52056012	7	Hackett	08/19/2022	Invasive	Low
Antrim	State	52056015	94	Hackett	08/29/2022	Invasive	Low
Antrim	State	52056016	5.3	Hackett	08/16/2022	Invasive	Low
Antrim	State	52056021	74.9	Hackett	08/18/2022	Invasive	Low
Antrim	State	52056026	24	Hackett	08/18/2022	Invasive	Low
Antrim	State	52057004	3	Hackett	08/29/2022	Invasive	Low
Antrim	State	52057006	85	Hackett	08/29/2022	Invasive	Low
Antrim	State	52057014	6.8	Hackett	08/17/2022	Invasive	Low
Antrim	State	52057020	5.4	Hackett	08/17/2022	Invasive	Low

County	Owner/ Manager	Name or FCS Key	Area (acres)	Surveyor	Date Completed	Survey Type	Management Priority
Antrim	State	52057021	64	Hackett	08/17/2022	Invasive	Low
Charlevoix	State	52052026	6	Haber	07/06/2022	Invasive	Low
Charlevoix	State	52052033	20	Haber	07/22/2022	Invasive	Low
Charlevoix	State	52052034	17.1	Haber	07/22/2022	Invasive	Low
Charlevoix	State	52052063	10	Haber	07/22/2022, 07/29/2022	Invasive	Low
Charlevoix	State	52052064	21	Haber	07/29/2022	Invasive	Low
Charlevoix	State	52052065	7.9	Haber	07/29/2022	Invasive	Low
Charlevoix	State	52052066	16	Haber	07/22/2022, 07/29/2022	Invasive	Low
Charlevoix	State	52052079	5	Haber	07/22/2022	Invasive	Low
Charlevoix	State	52052081	2	Haber	07/29/2022	Invasive	Low
Emmet	State	52125008	10	Hackett	08/09/2022	Invasive	Low
Emmet	State	52125009	13.9	Hackett	08/09/2022	Invasive	Low
Emmet	State	52125014	41.1	Hackett	08/09/2022	Invasive	Low

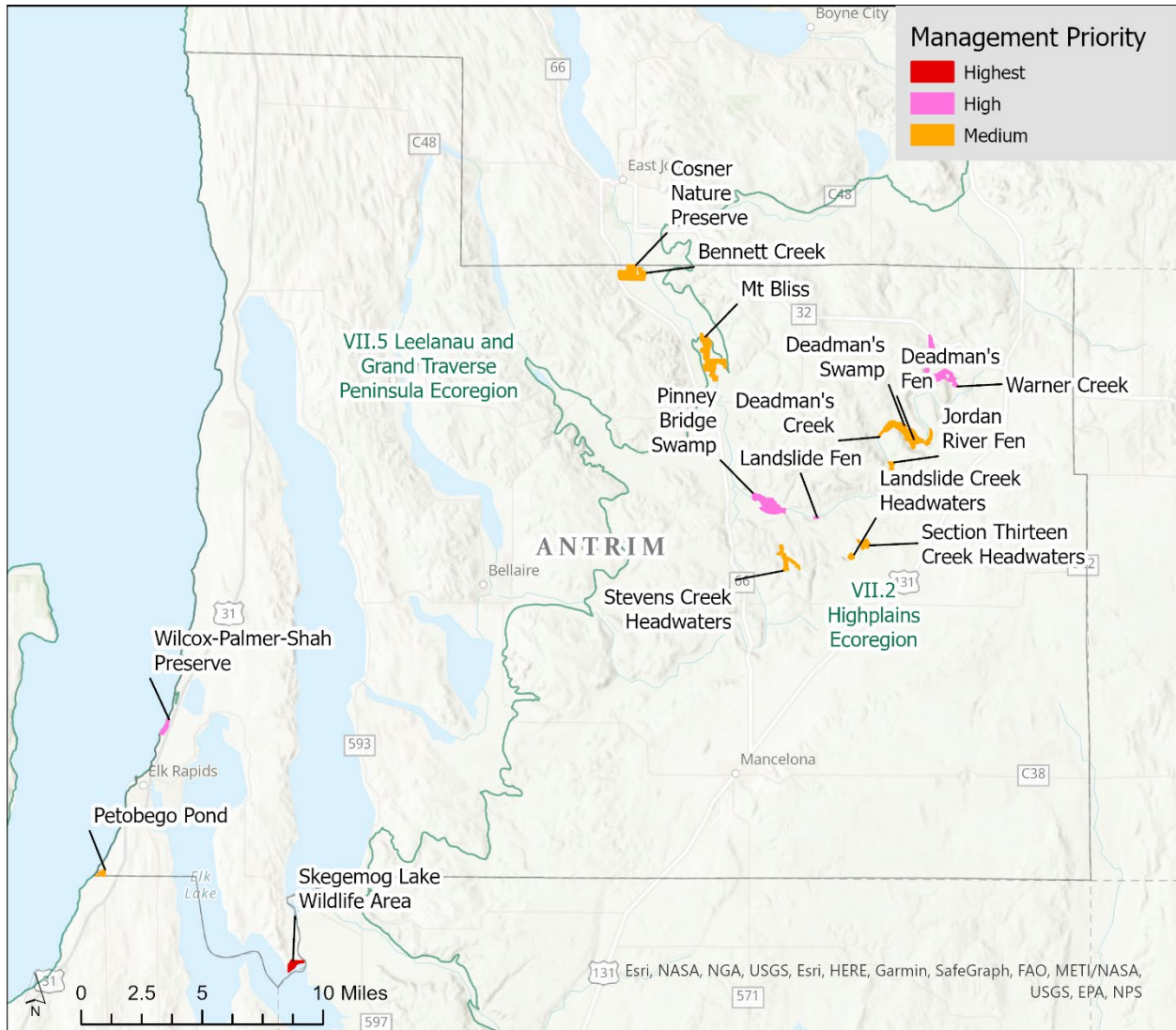


Figure B - 1. Stands of medium or higher management priority in Antrim County. Red represents the highest priority, pink high priority, and orange medium priority. Each stand is listed with its site name used in this report. Antrim county is outlined in solid grey line. The subsections of Albert's Ecoregions are outlined in green line (Figure 1; Albert 1995).

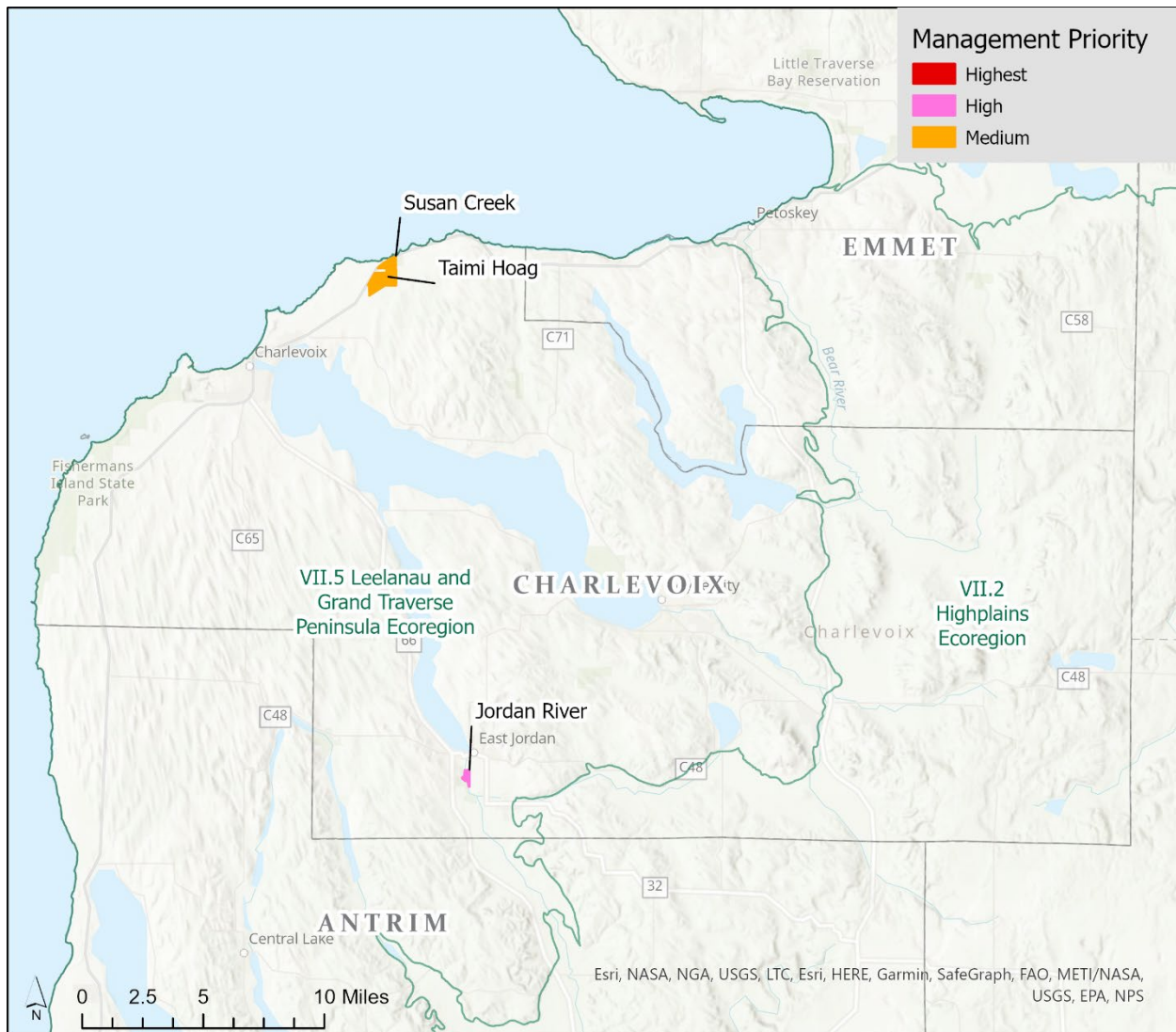


Figure B - 2. Stands of medium or higher management priority in Charlevoix County. Red represents the highest priority, pink high priority, and orange medium priority. Each stand is listed with its site name used in this report. Charlevoix county is outlined in solid cyan line. The Lake Michigan Islands in Charlevoix County were not included in the map. The subsections of Albert's Ecoregions are outlined in green line (Figure 1; Albert 1995).

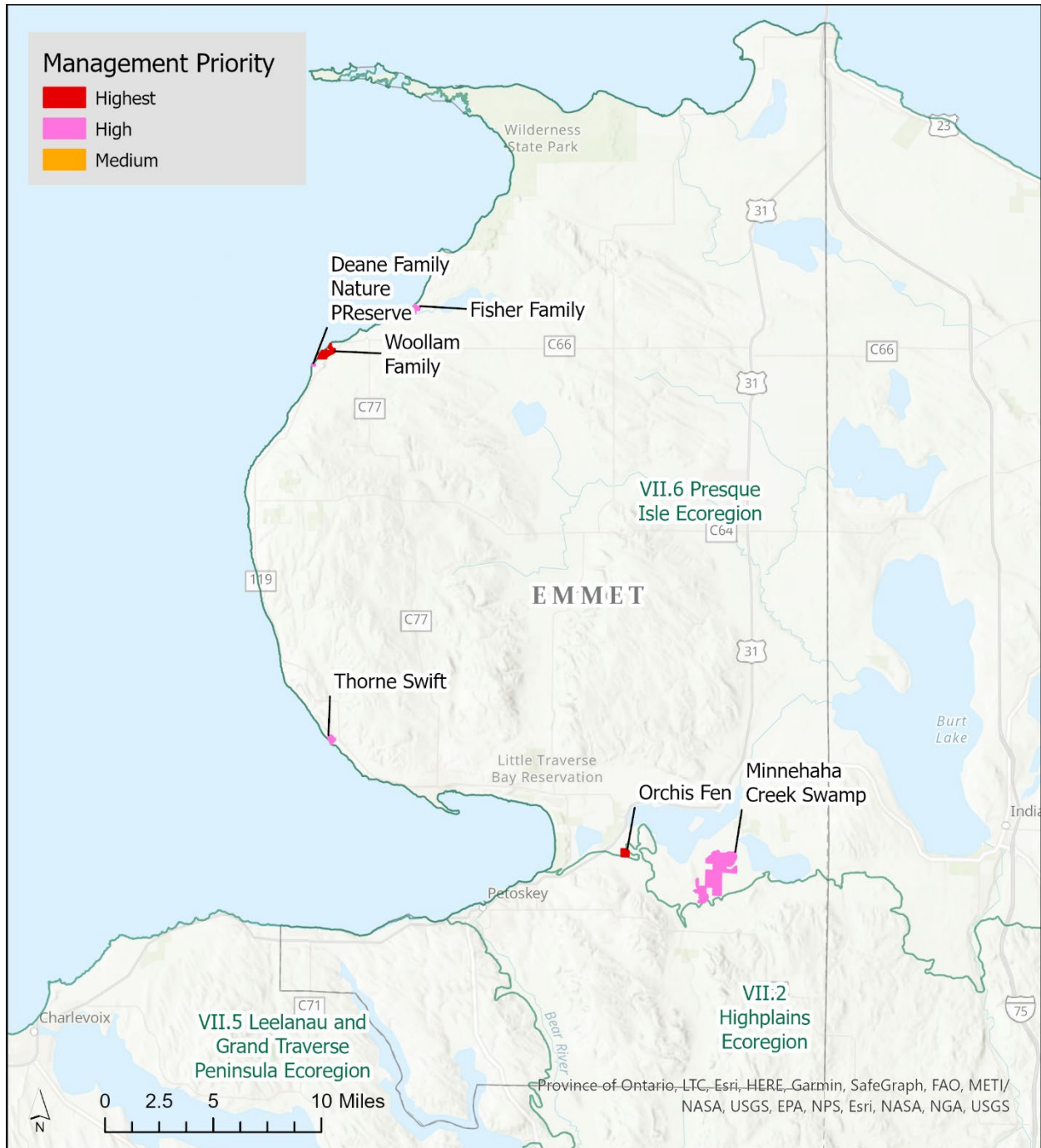


Figure B - 3. Stands of medium or higher management priority in Emmet County. Red represents the highest priority, pink high priority, and orange medium priority. Each stand is listed with its site name used in this report. Emmet county is outlined in solid grey line. The subsections of Albert's Ecoregions are outlined in green line (Figure 1; Albert 1995).



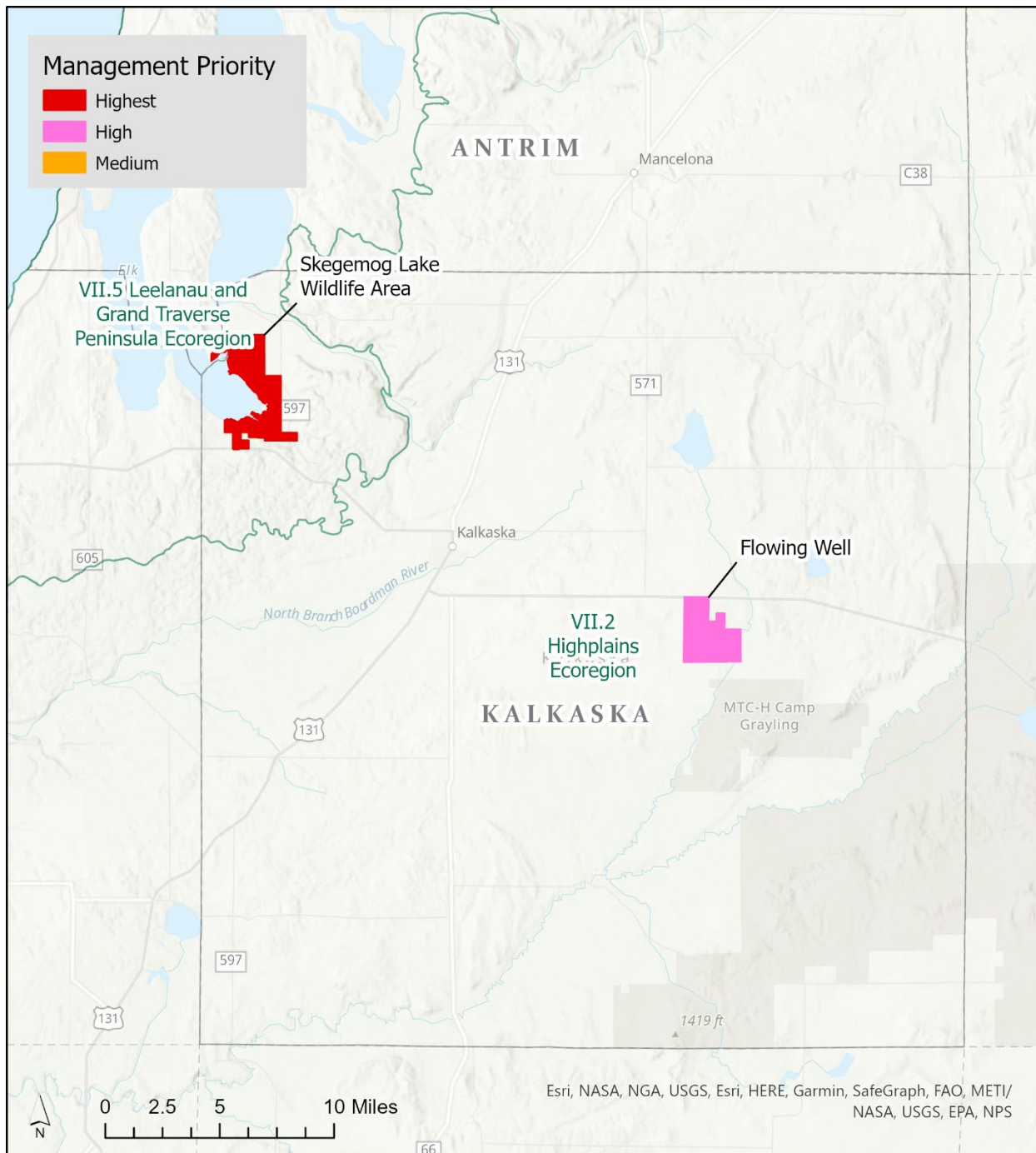


Figure 75. Stands of medium or higher management priority in Kalkaska County. Red represents the highest priority, pink high priority, and orange medium priority. Each stand is listed with its site name used in this report. Kalkaska county is outlined in solid grey line. The subsections of Albert's Ecoregions are outlined in green line (Figure 1; Albert 1995).

## Appendix C: Michigan Coastal and Riparian Natural Communities of Northern Lower Michigan

This appendix contains abbreviated descriptions and information about the coastal and riparian natural communities encountered for this survey. Community overviews are described in Kost et al. 2007 and Cohen et al. 2014. Ecoregion community maps are taken from Albert et al. 2008.

Table C - 1. List of Michigan coastal and riparian natural communities encountered during this project. Global and State Rank refers to the global and subnational rarity of each community (See Appendix A: Definitions, NatureServe Terminology and Ranks).

Natural Community	Global Rank	State Rank	Page
Dry-mesic northern forest	G4	S3	145
Emergent marsh	GU	S4	146
Great Lakes marsh	G2	S3	147
Hardwood-conifer swamp	G4	S3	148
Interdunal wetland	G2?	S2	149
Mesic northern forest	G4	S3	150
Northern fen	G3	S3	151
Northern shrub thicket	G4	S5	152
Northern wet meadow	G4G5	S4	153
Open dune	G3	S3	154
Poor conifer swamp	G4	S4	155
Rich conifer swamp	G4	S3	156
Sand and gravel beach	G3?	S3	157
Submergent marsh	GU	S4	158
Wooded dune and swale complex	G3	S3	159

# Dry-mesic northern forest G4 S3

**Overview:** Dry-mesic northern forest is a pine or pine-hardwood forest type of generally dry-mesic sites located mostly north of the transition zone. The community historically originated in the wake of catastrophic fire and was maintained by frequent, low-intensity ground fires.

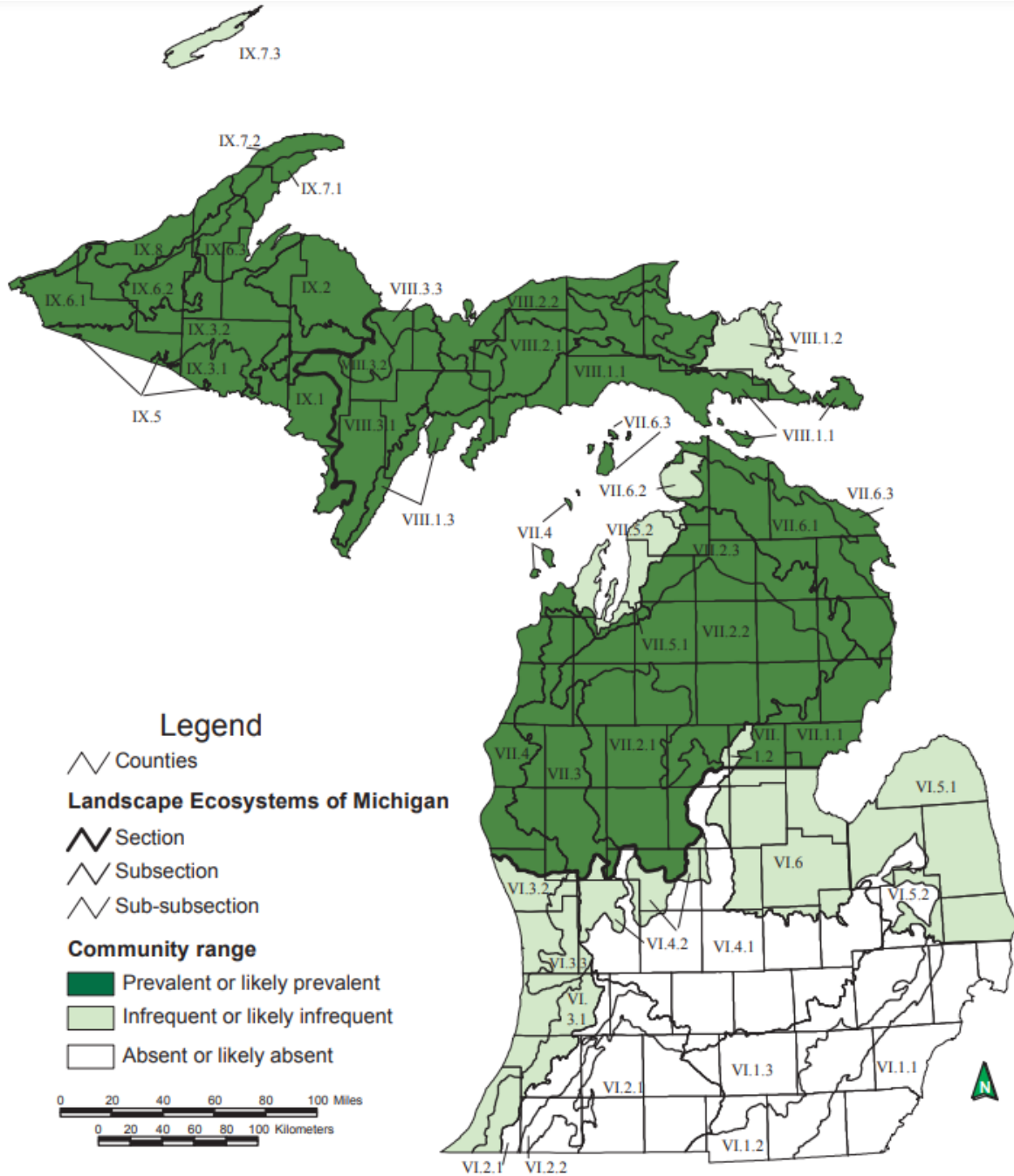


Figure C - 1. Distribution of dry-mesic northern forest in Michigan.

# Emergent marsh

GU S4

**Overview:** Emergent marsh is a shallow-water wetland along the shores of lakes and streams characterized by emergent narrow- and broad-leaved herbs and grass-like plants as well as floating-leaved herbs. Common plants include water plantains (*Alisma* spp.), sedges (*Carex* spp.), spike-rushes (*Eleocharis* spp.), pond-lilies (*Nuphar* spp.), pickerel weed (*Pontederia cordata*), arrowheads (*Sagittaria* spp.), bulrushes (*Schoenoplectus* spp.), and cattails (*Typha* spp.). The community occurs on both mineral and organic soils.

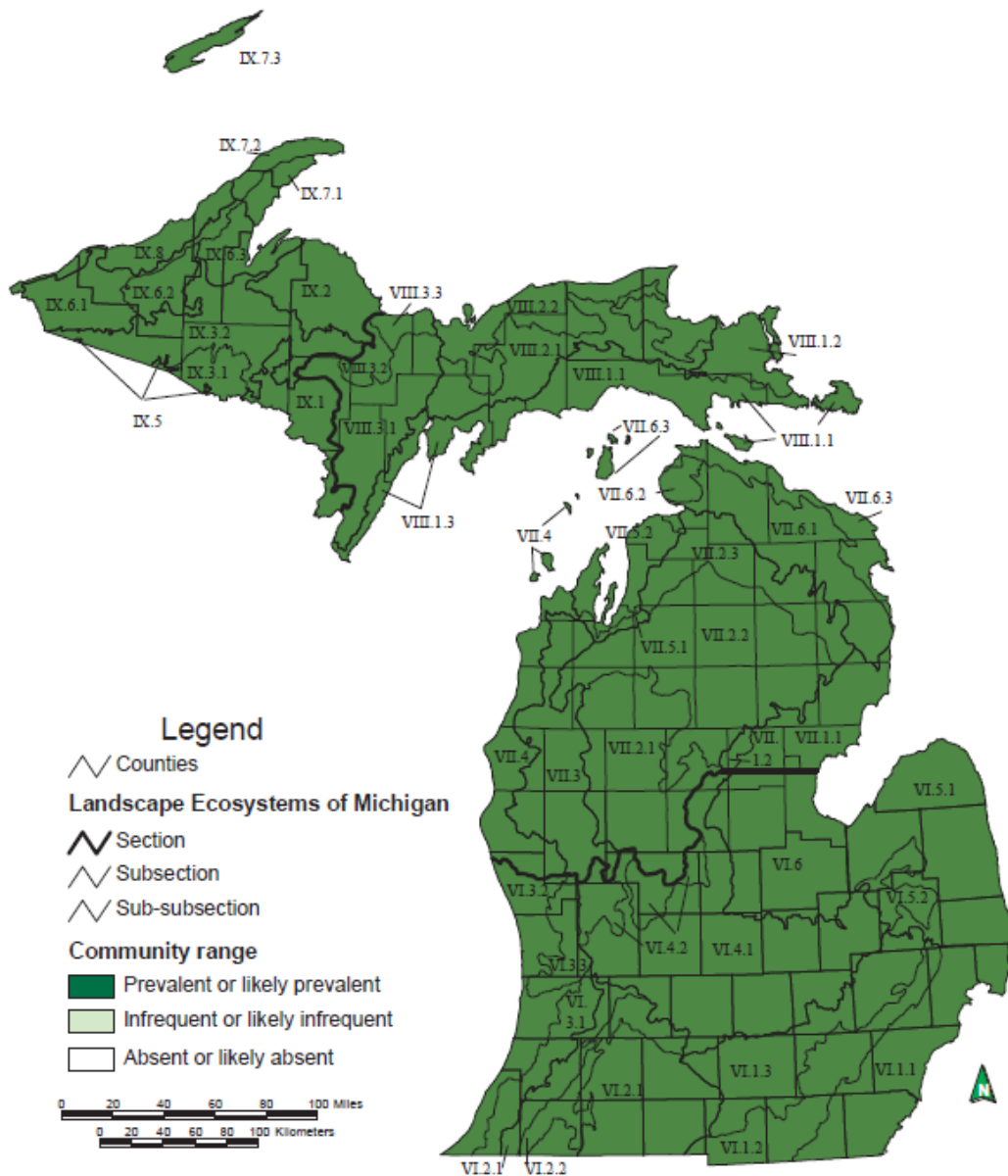


Figure C - 2. Distribution of emergent marsh in Michigan.

# Great Lakes marsh

G2 S3

**Overview:** Great Lakes marsh is an herbaceous wetland community occurring statewide along the shoreline of the Great Lakes and their major connecting rivers. Vegetational patterns are strongly influenced by water level fluctuations and type of coastal feature, but generally include the following: a deep marsh with submerged plants; an emergent marsh of mostly narrow-leaved species; and a sedge-dominated wet meadow that is inundated by storms. Great Lakes marsh provides important habitat for migrating and breeding waterfowl, shore-birds, spawning fish, and medium-sized mammals.

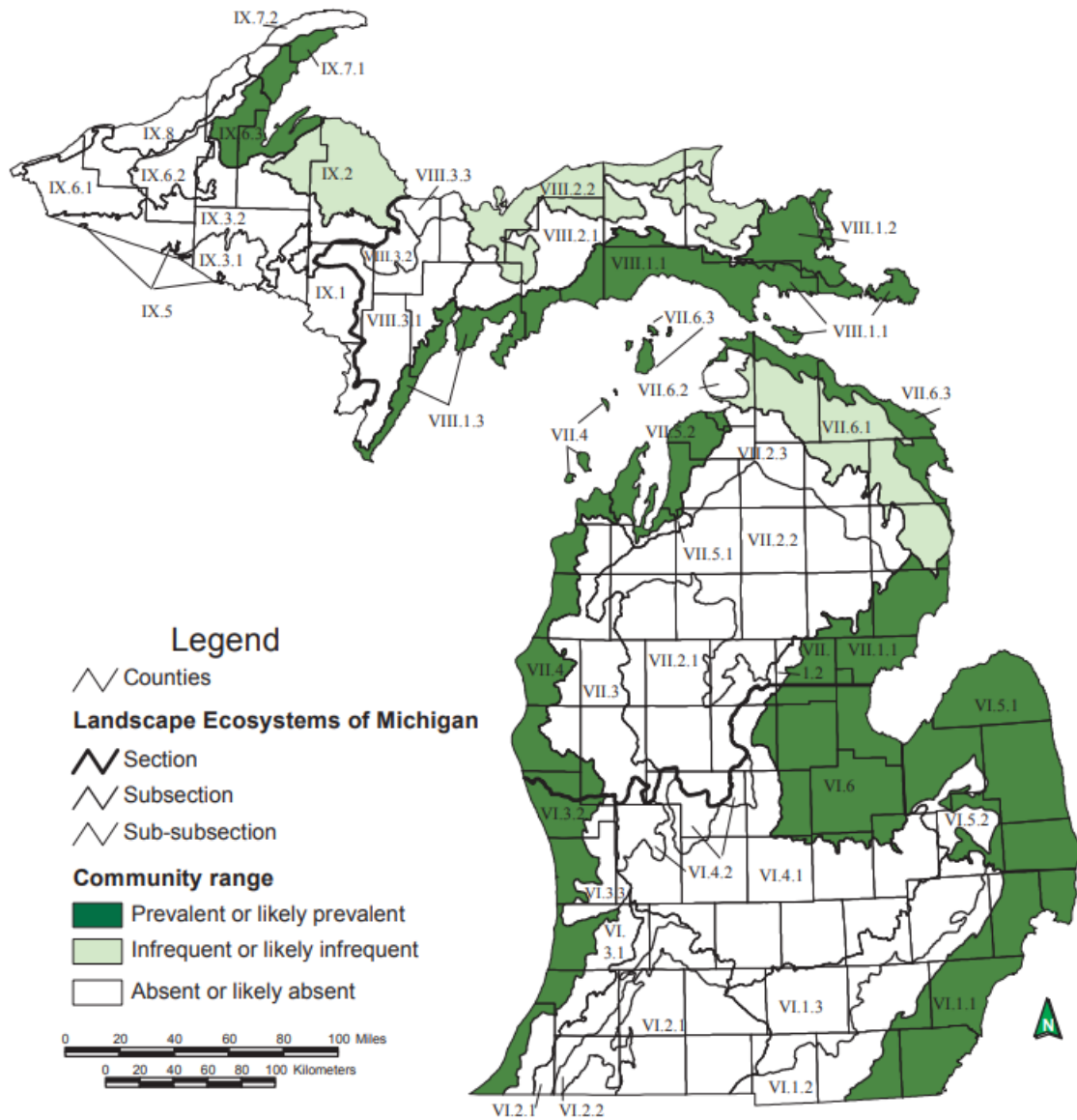


Figure C - 3. Distribution of Great Lakes marsh in Michigan.

# Hardwood-conifer swamp

G4 S3

**Overview:** Hardwood-conifer swamp is a minerotrophic forested wetland dominated by a mixture of lowland hardwoods and conifers, occurring on organic (i.e., peat) and poorly drained mineral soils throughout Michigan. The community occurs on a variety of landforms, often associated with headwater streams and areas of groundwater discharge. Species composition and dominance patterns can vary regionally. Windthrow and fluctuating water levels are the primary natural disturbances that structure hardwood-conifer swamp.

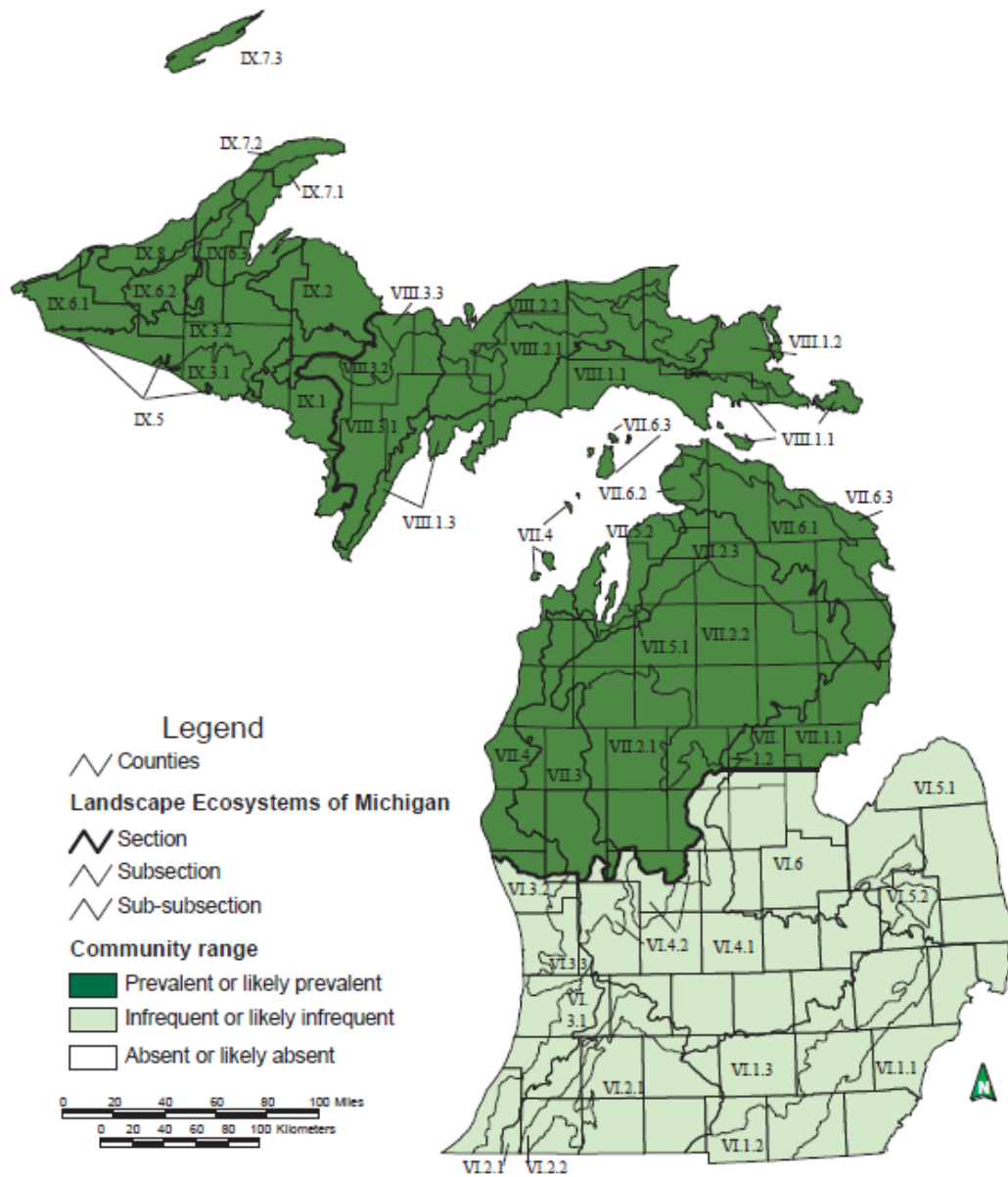


Figure C - 4. Distribution of hardwood-conifer swamp in Michigan.

## Interdunal wetland

G2? S2

**Overview:** Interdunal wetland is a rush-, sedge-, and shrub-dominated wetland situated in depressions within open dunes or between beach ridges along the Great Lakes, experiencing a fluctuating water table seasonally and yearly in synchrony with lake level changes.

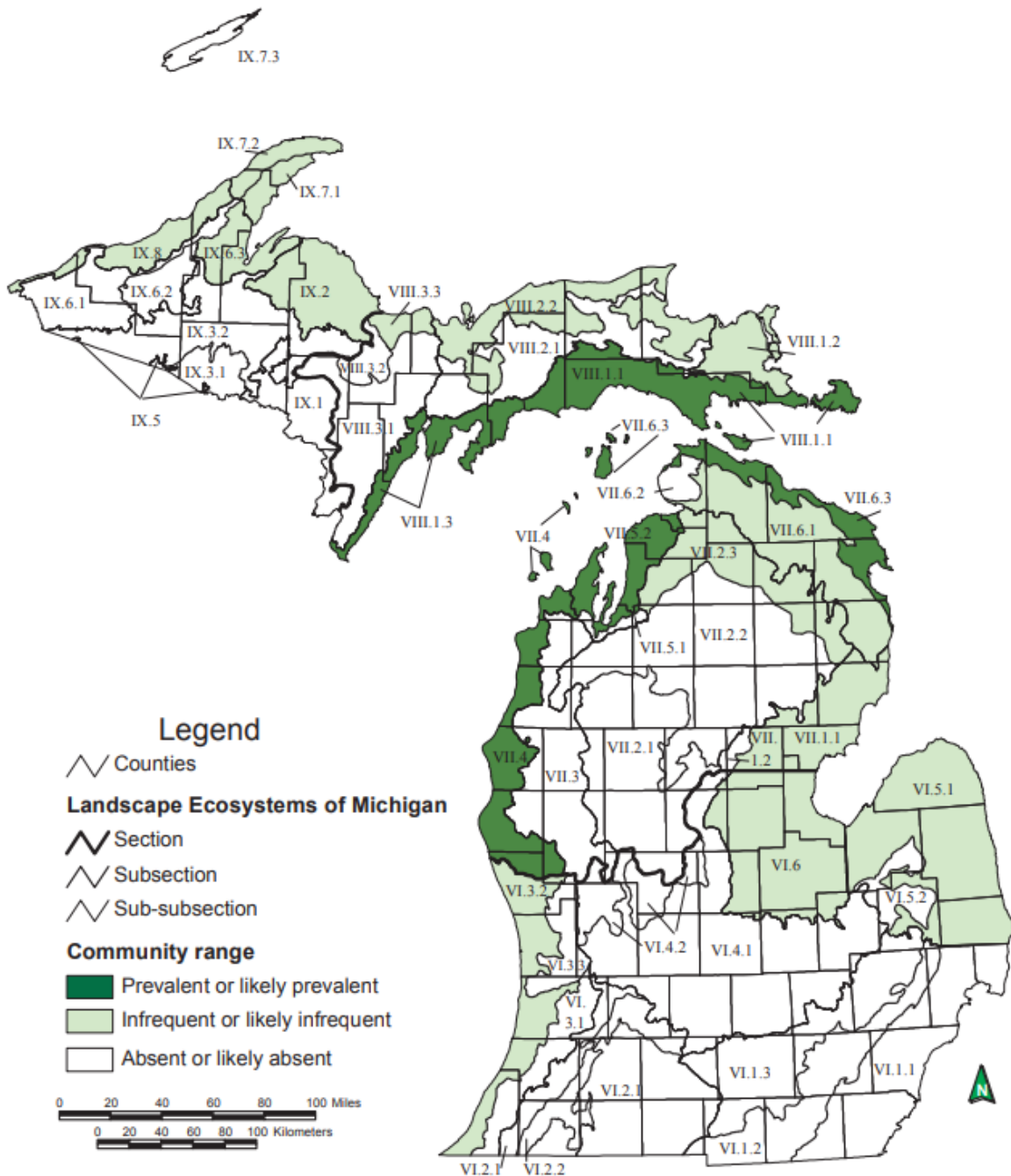


Figure C - 5. Distribution of interdunal wetland in Michigan.

## Mesic northern forest

G4 S3

**Overview:** Mesic northern forest is a forest type of moist to dry-mesic sites lying mostly north of the climatic tension zone, characterized by the dominance of northern hardwoods, particularly sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*). Conifers such as hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*) are frequently important canopy associates. This community type breaks into two broad classes: northern hardwood forest and hemlock-hardwood forest. It is primarily found on coarse-textured ground and end moraines, and soils are typically loamy sand to sandy loam. The natural disturbance regime is characterized by gap-phase dynamics; frequent, small windthrow gaps allow for the regeneration of the shade-tolerant canopy species. Catastrophic windthrow occurred infrequently with several generations of trees passing between large-scale, severe disturbance events. Historically, mesic northern forest occurred as a matrix system, dominating vast areas of mesic uplands in the Great Lakes region. These forests were multi-generational, with old-growth conditions lasting many centuries.

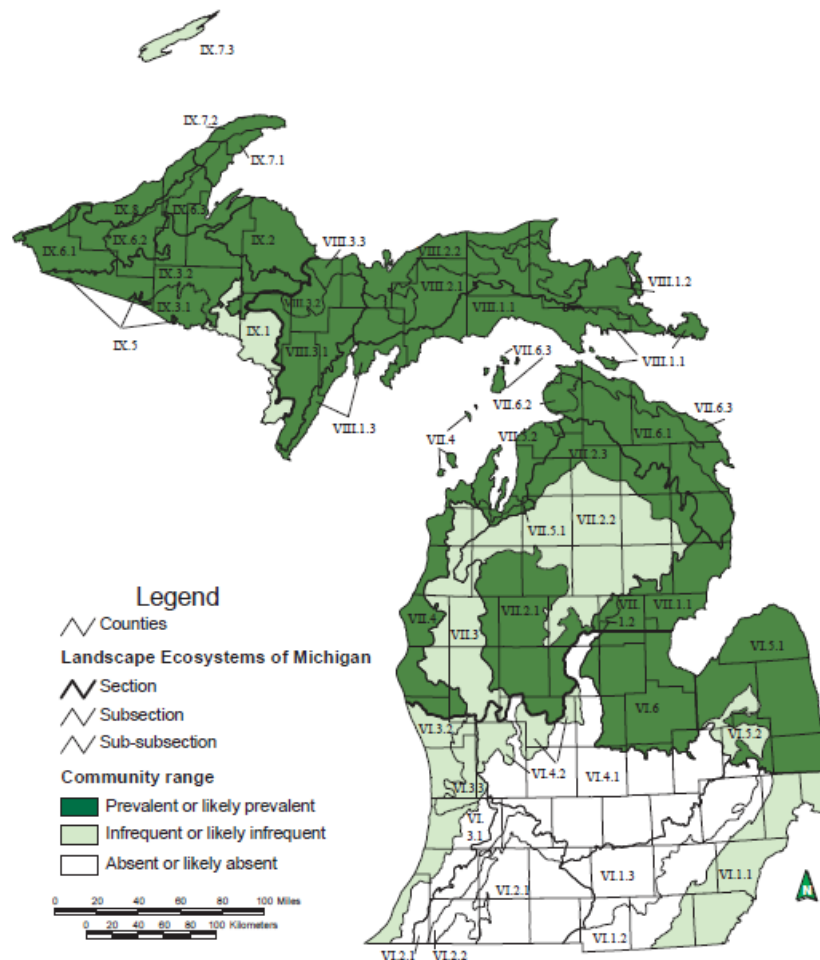


Figure C - 6. Distribution of mesic northern forest in Michigan.



# Northern fen

G3 S3

**Overview:** Northern fen is a sedge- and rush-dominated wetland occurring on neutral to moderately alkaline saturated peat and/or marl influenced by groundwater rich in calcium and magnesium carbonates. The community occurs north of the climatic tension zone and is found primarily where calcareous bedrock underlies a thin mantle of glacial drift on flat areas or shallow depressions of glacial outwash and glacial lakeplains and also in kettle depressions on pitted outwash and moraines Northern fens can be found in the northern Lower and eastern Upper Peninsulas of Michigan.

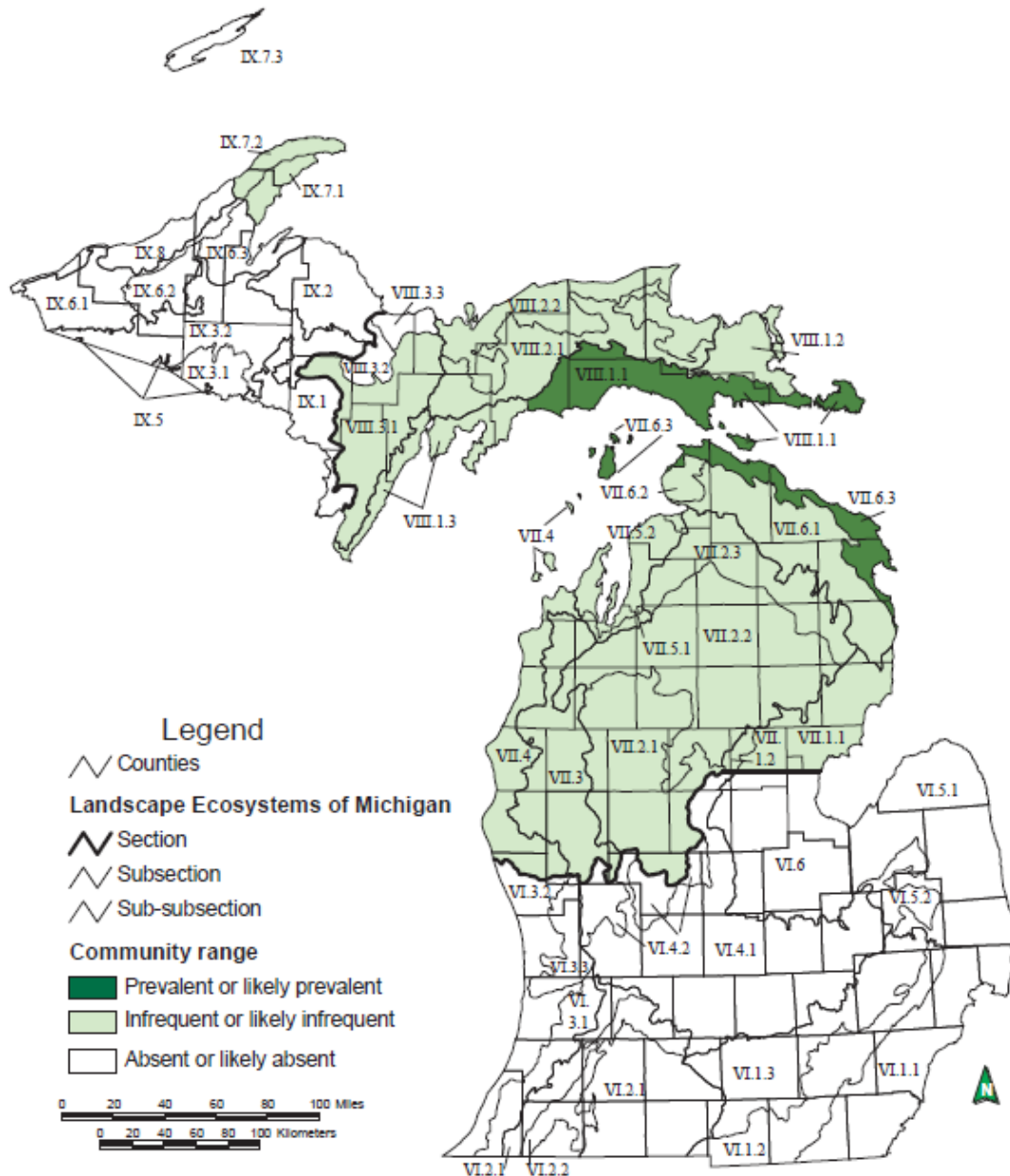


Figure C - 7. Distribution of northern fen in Michigan.

## Northern shrub thicket

G4 S5

**Overview:** Northern shrub thicket is a shrub-dominated wetland located north of the climatic tension zone, typically occurring along streams, but also adjacent to lakes and beaver floodings. The saturated, nutrient-rich, organic soils are composed of sapric peat or less frequently mineral soil, typically with medium acid to neutral pH. Succession to closed-canopy swamp forest is slowed by fluctuating water tables, beaver flooding, and windthrow. Northern shrub thickets are overwhelmingly dominated by speckled alder (*Alnus incana*).

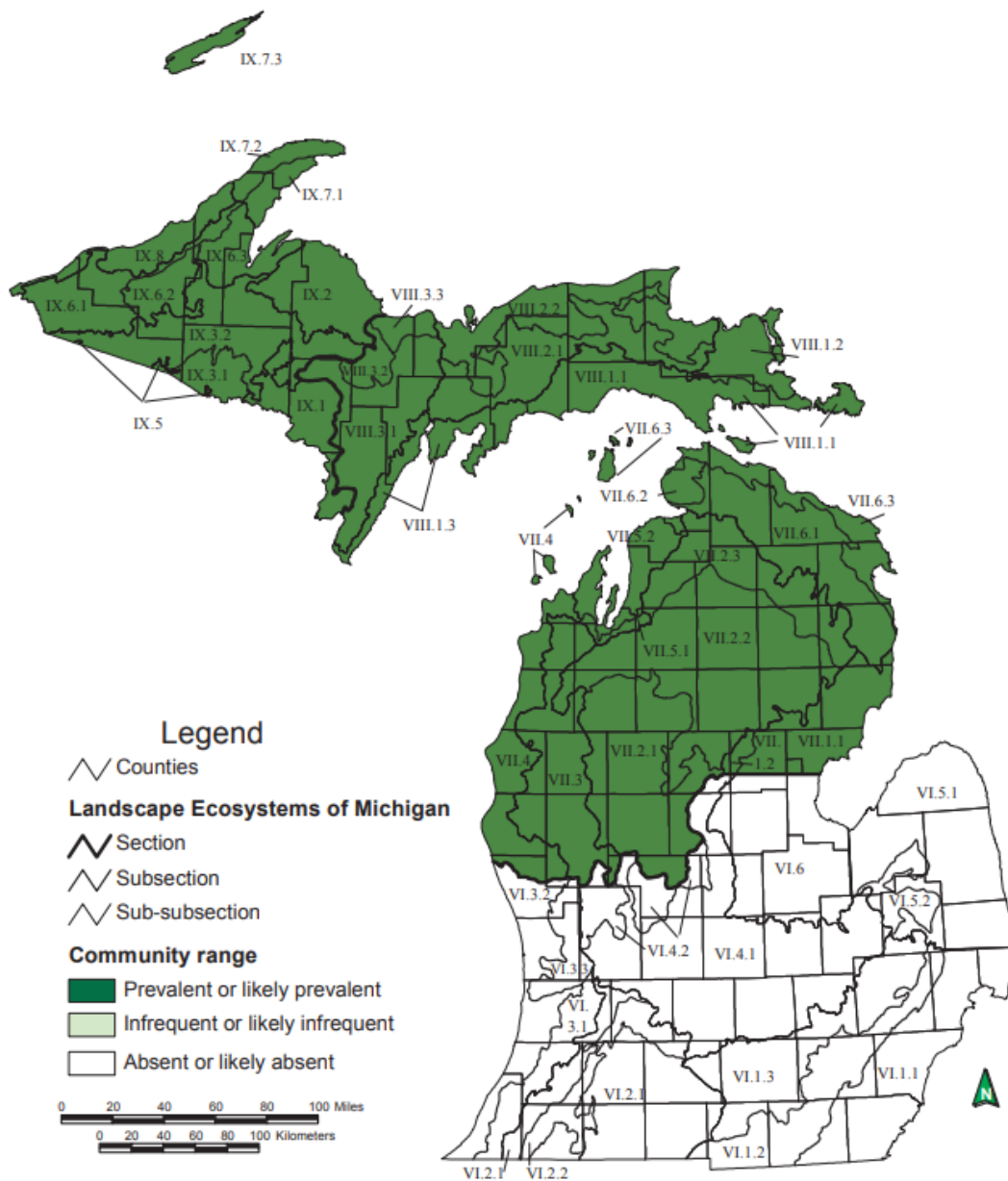


Figure C - 8. Distribution of northern shrub thicket in Michigan.

# Northern wet meadow

G4G5 S4

**Overview:** Northern wet meadow is an open, groundwater-influenced, sedge- and grass-dominated wetland that occurs in the northern Lower and Upper Peninsulas and typically borders streams but is also found on pond and lake margins and above beaver dams. Soils are nearly always sapric peat and range from strongly acid to neutral in pH. Open conditions are maintained by seasonal flooding, beaver-induced flooding, and fire.

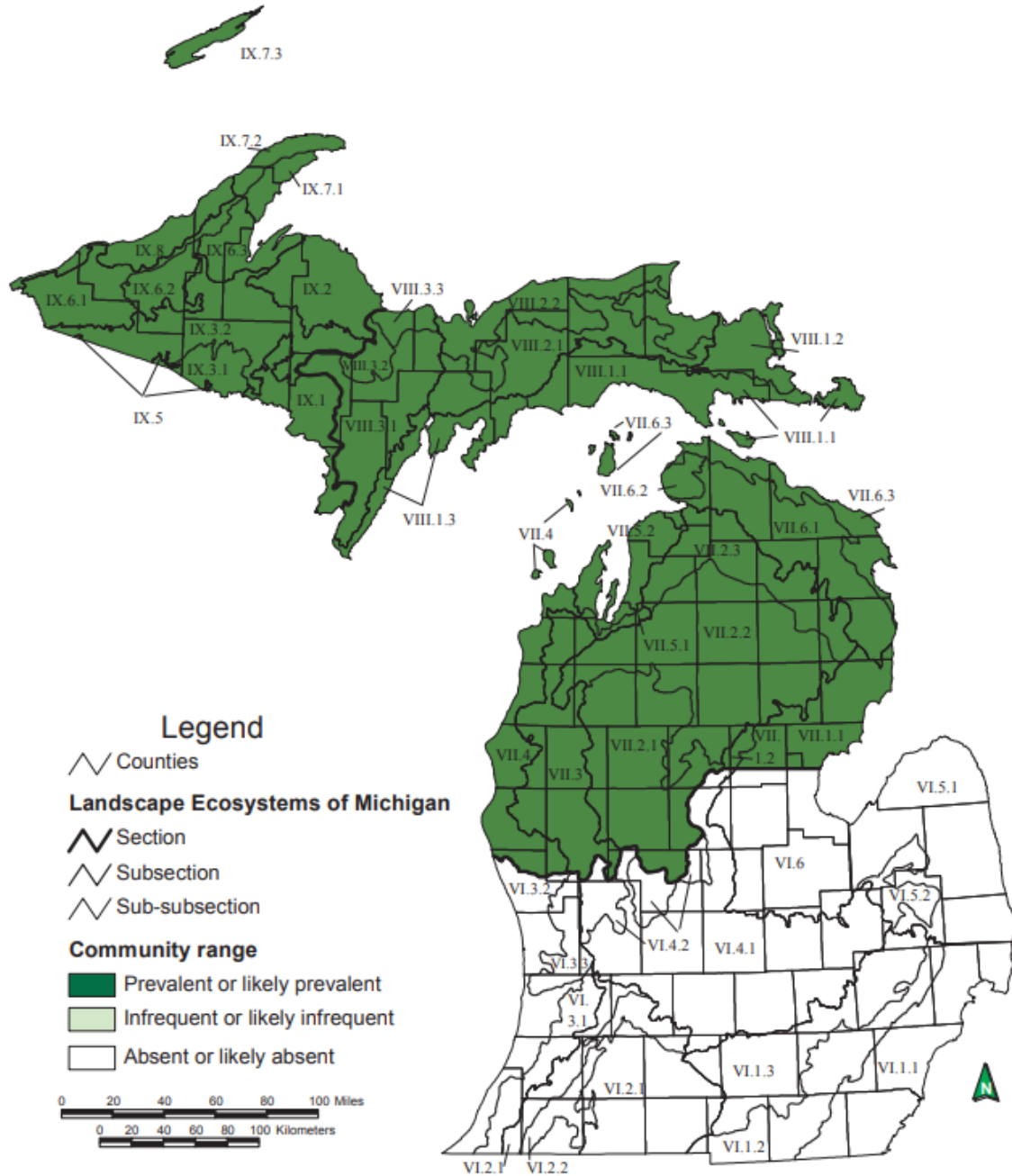


Figure C - 9. Distribution of northern wet meadow in Michigan.

# Open dunes

G3 S3

**Overview:** Open dunes is a grass- and shrub-dominated multi-seral community located on wind-deposited sand formations near the shorelines of the Great Lakes. Dune formation and the patterning of vegetation are strongly affected by lake-driven winds. The greatest concentration of open dunes occurs along the eastern and northern shorelines of Lake Michigan, with the largest dunes along the eastern shoreline due to the prevailing southwest winds.

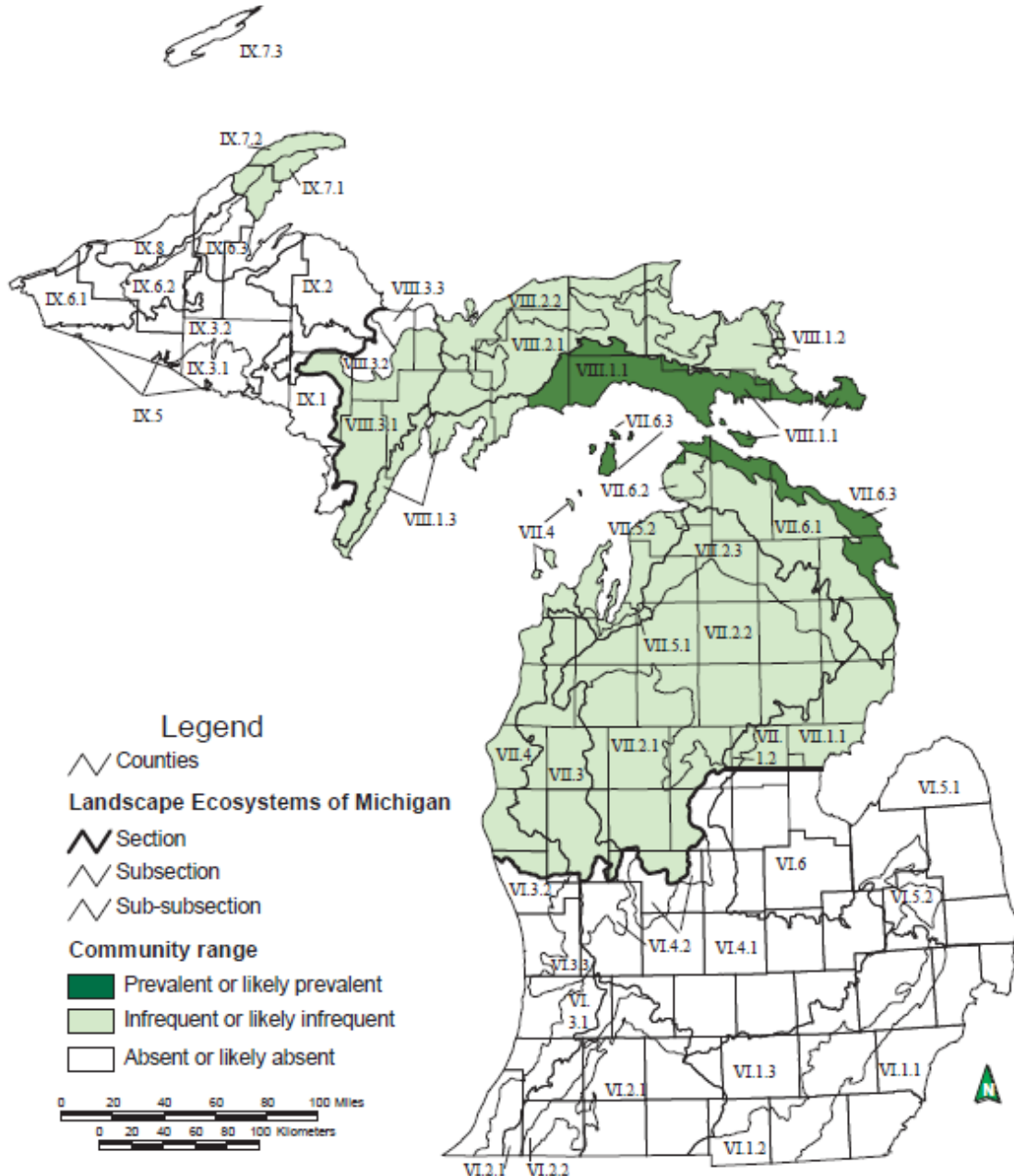


Figure C - 10. Distribution of open dunes in Michigan.

# Poor conifer swamp

G4 S4

**Overview:** Poor conifer swamp is a nutrient-poor, forested peatland characterized by acidic, saturated peat, and the prevalence of coniferous trees, sphagnum mosses, and ericaceous shrubs. This system is found predominantly north of the climatic tension zone, and much less frequently in southern Lower Michigan. The community occurs in depressions in glacial outwash and sandy glacial lakeplains and in kettles on pitted outwash and depressions on moraines. Fire occurs naturally during drought periods and creates even-aged, often monospecific, stands of black spruce (*Picea mariana*). Windthrow, beaver flooding, and insect defoliation are also important disturbance factors influencing species composition and structure.

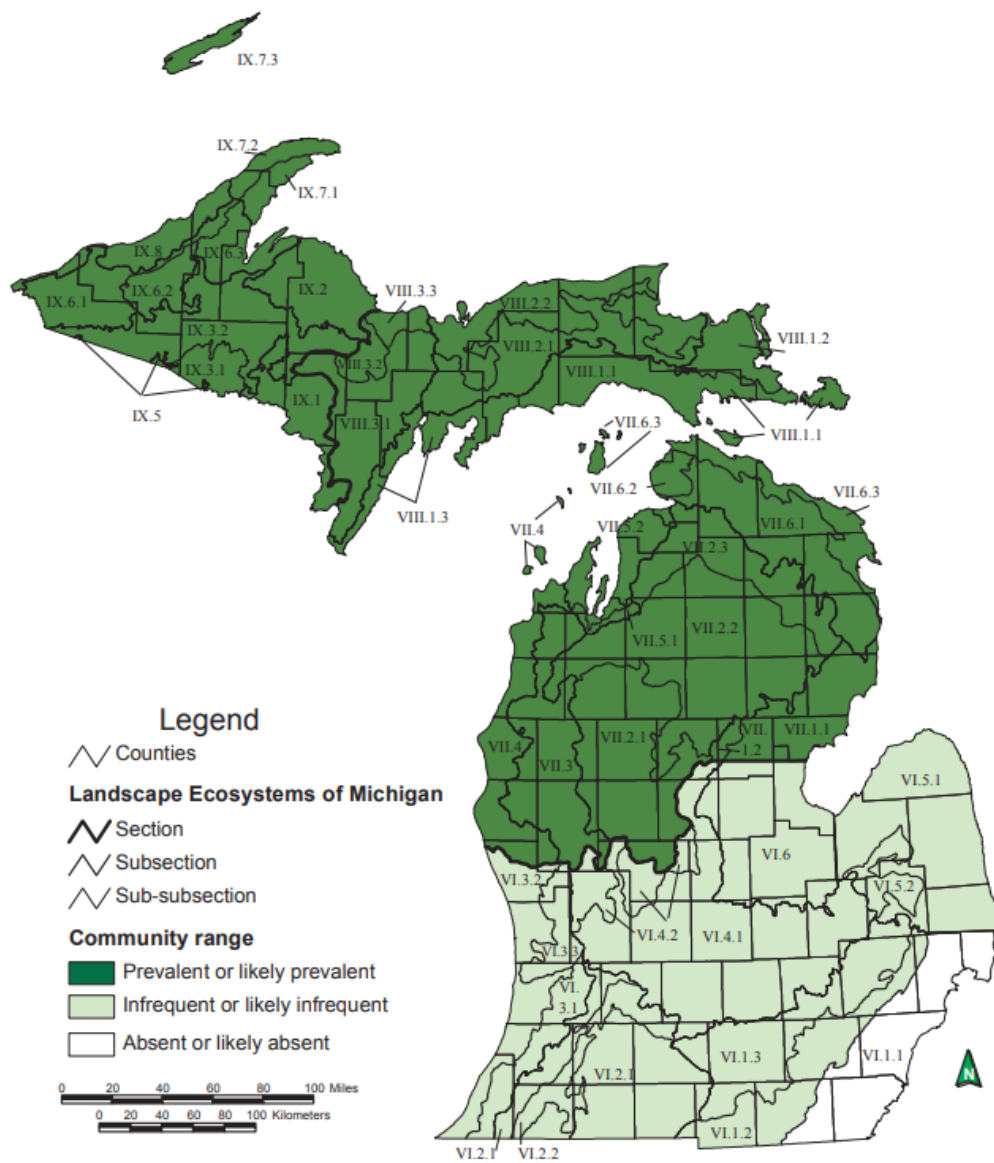


Figure C - 11. Distribution of poor conifer swamp in Michigan.

# Rich conifer swamp

G4 S3

**Overview:** Rich conifer swamp is a groundwater-infl uenced, minerotrophic, forested wetland dominated by northern white-cedar (*Thuja occidentalis*) that occurs on organic soils (i.e., peat) primarily north of the climatic tension zone in the northern Lower and Upper Peninsulas. Rich conifer swamp occurs in outwash channels, outwash plains, glacial lakeplains, and in depressions on coarse- to medium-textured ground moraines. It is common in outwash channels of drumlin fields and where groundwater seeps occur at the bases of moraines. Rich conifer swamp typically occurs in association with lakes and cold, groundwater-fed streams. It also occurs along the Great Lakes shoreline in old abandoned embayments and in swales between former beach ridges where it may be part of a wooded dune and swale complex. Windthrow is common, especially on broad, poorly drained sites. Fire was historically infrequent. Rich conifer swamp is characterized by diverse microtopography and ground cover. The community is also referred to as cedar swamp.

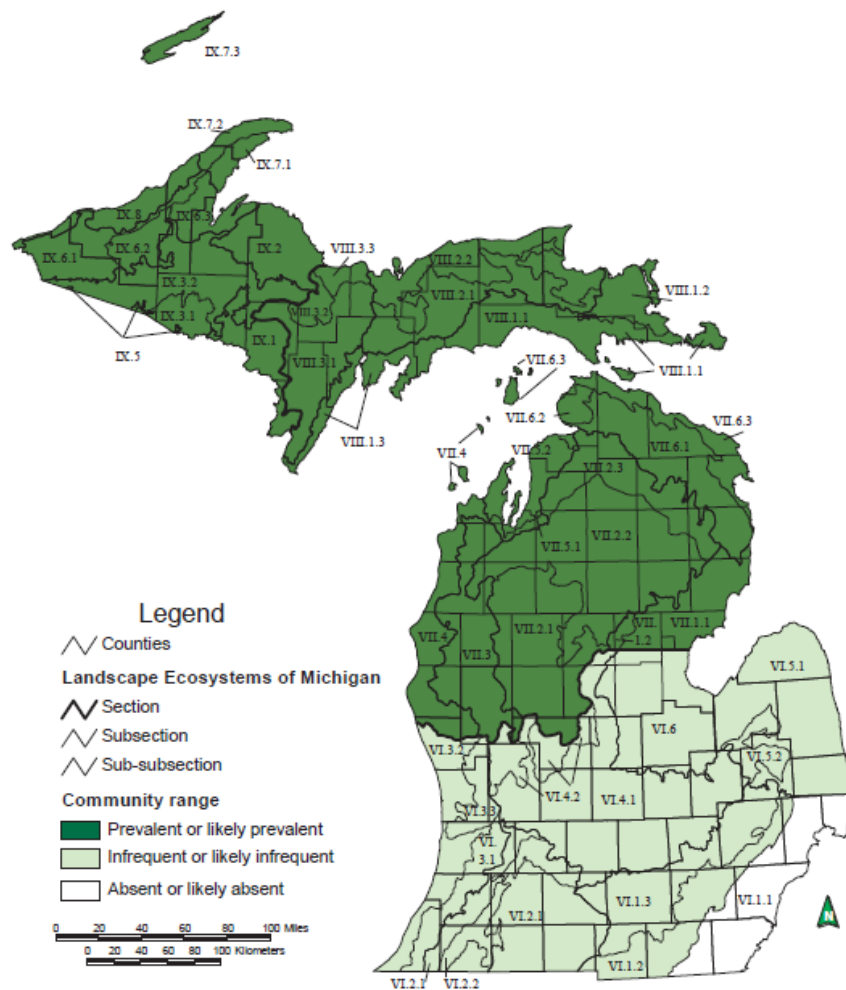


Figure C - 12. Distribution of rich conifer swamp in Michigan.

## Sand and gravel beach

G3? S3

**Overview:** Sand and gravel beaches occur along the shorelines of the Great Lakes and on some of Michigan's larger freshwater lakes, where wind, waves, and winter ice cause the shoreline to be too unstable to support aquatic vegetation. Because of the high levels of disturbance, these beaches are typically quite open, with sand and gravel sediments and little or no vegetation.

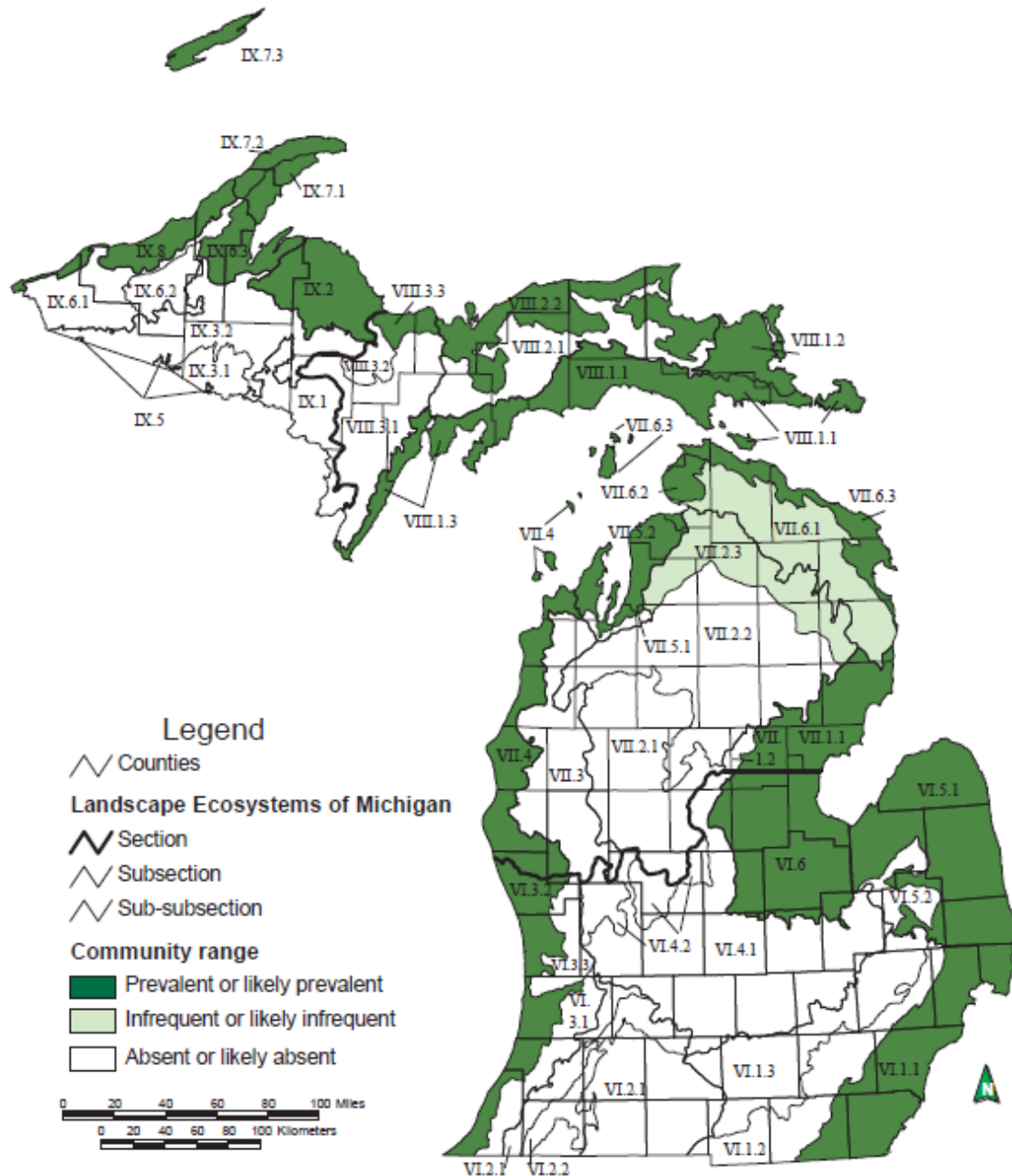


Figure C - 13. Distribution of sand and gravel beach in Michigan.

# Submergent marsh

GU S4

**Overview:** Submergent marsh is an herbaceous plant community that occurs in deep to sometimes shallow water in lakes and streams throughout Michigan. Soils are characterized by loosely consolidated organics of variable depth that range from acid to alkaline and accumulate over all types of mineral soil, even bedrock. Submergent vegetation is composed of both rooted and non-rooted submergent plants, rooted floating-leaved plants, and non-rooted floating plants. Common submergent plants include common waterweed (*Elodea canadensis*), water star-grass (*Heteranthera dubia*), milfoils (*Myriophyllum* spp.), naiads (*Najas* spp.), pondweeds (*Potamogeton* spp.), stoneworts (*Chara* spp. and *Nitella* spp.), coontail (*Ceratophyllum demersum*), bladderworts (*Utricularia* spp.), and water-celery (*Vallisneria americana*).

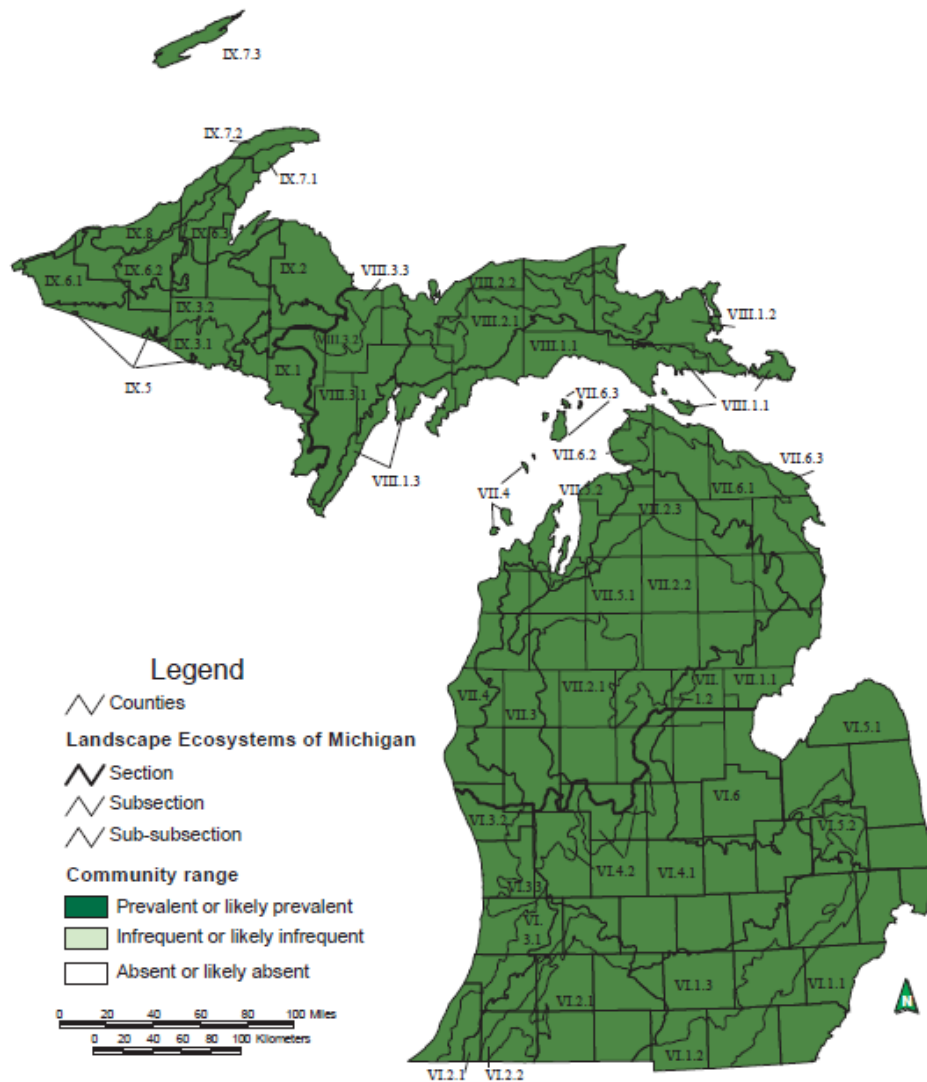


Figure C - 14. Distribution of submergent marsh in Michigan.



# Wooded dune and swale complex

G3 S3

**Overview:** Wooded dune and swale complex is a large complex of parallel wetland swales and upland beach ridges (dunes) found in coastal embayments and on large sand spits along the shorelines of the Great Lakes. The upland dune ridges are typically forested, while the low swales support a variety of herbaceous or forested wetland types, with open wetlands more common near the shoreline and forested wetlands more prevalent further from the lake. Wooded dune and swale complexes occur primarily in the northern Lower and Upper Peninsulas and Thumb region.

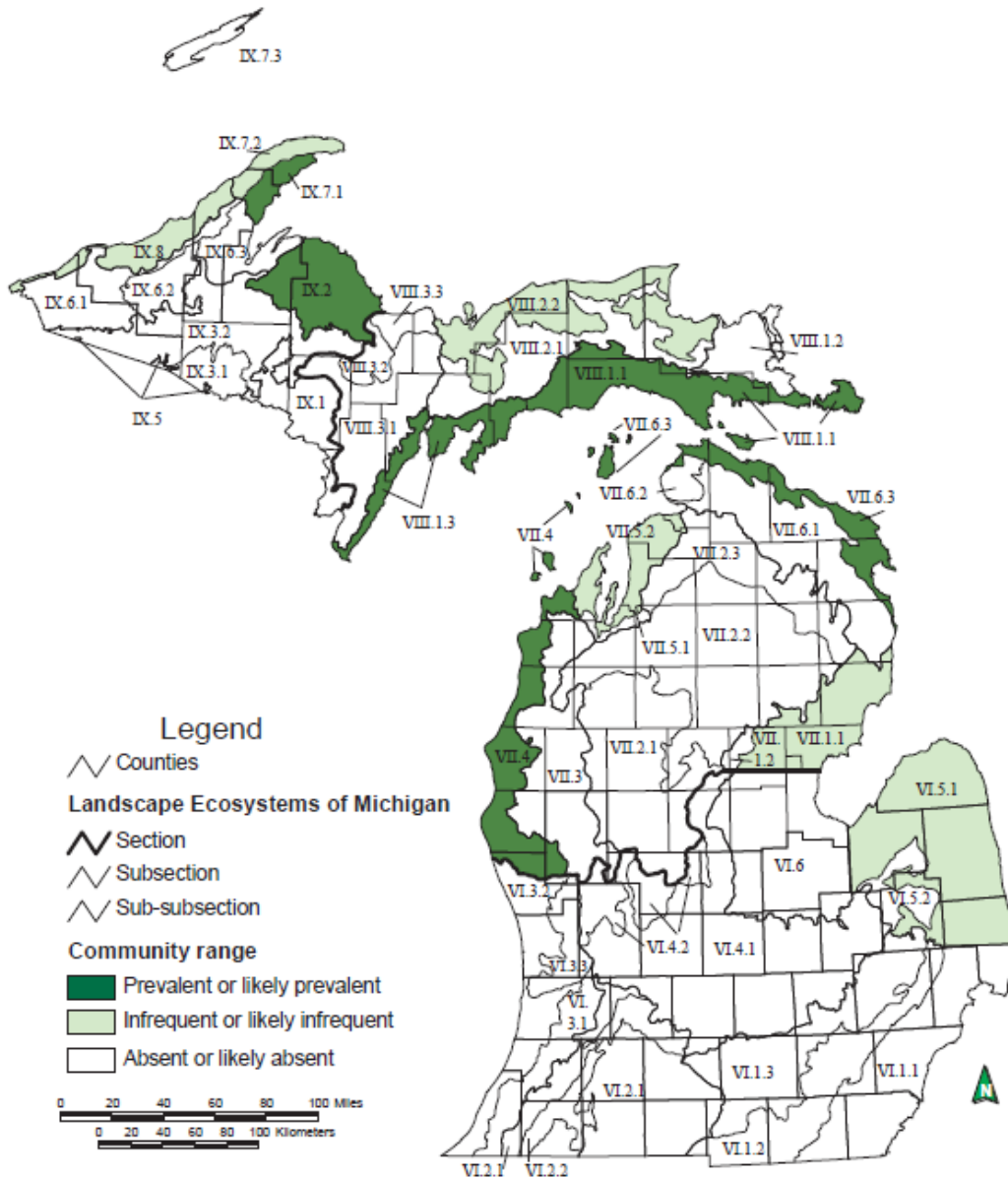


Figure C - 15. Distribution of wooded dune and swale complex in Michigan.

## Appendix D: Plant Species Lists

This appendix contains plant species lists for all highest, high, and medium-priority sites with site descriptions in the main body of the report. Stand lists are not all comprehensive, but they were based on the survey conducted at the time and information available in other survey records (Table 3; Cohen 2011, 2021, 2022, MNFI 2023). A digital file of this list including additional columns was also submitted as supplemental material to this report for easier sorting by partners.

Taxonomy from Michigan Flora (Reznicek et al. 2014) was used.

Reznicek, AA, MR Penskar, B. S. Walters, B. S. Slaughter. 2014. Michigan Floristic Quality Assessment Database. Herbarium, University of Michigan, Ann Arbor, MI and Michigan Natural Features Inventory, Michigan State University, Lansing, MI. <http://michiganflora.net>

**Due to sensitive location information for federally and state listed plant species, this appendix was not included in the publicly available/redacted version of the report. Please contact MNFI for further information.**